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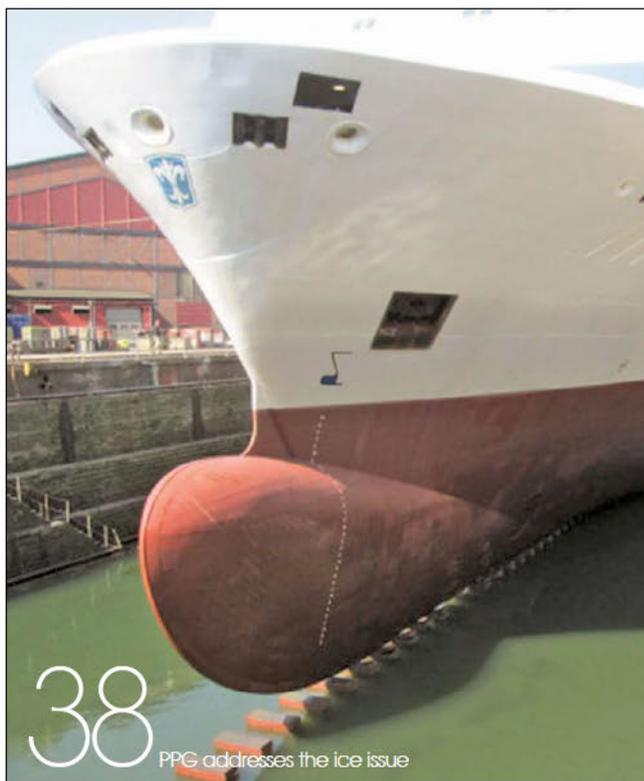
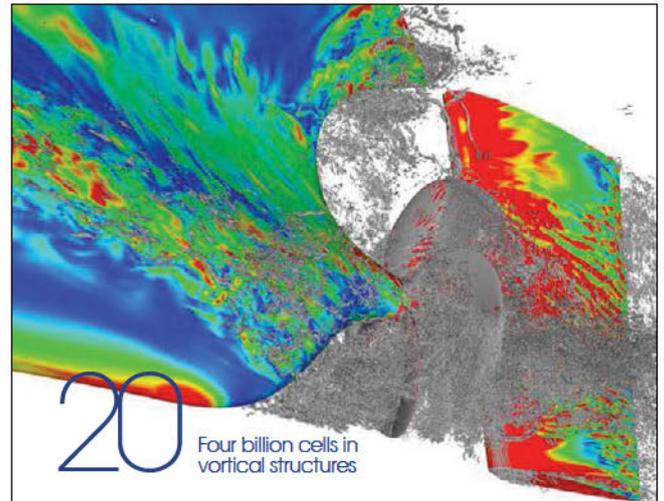
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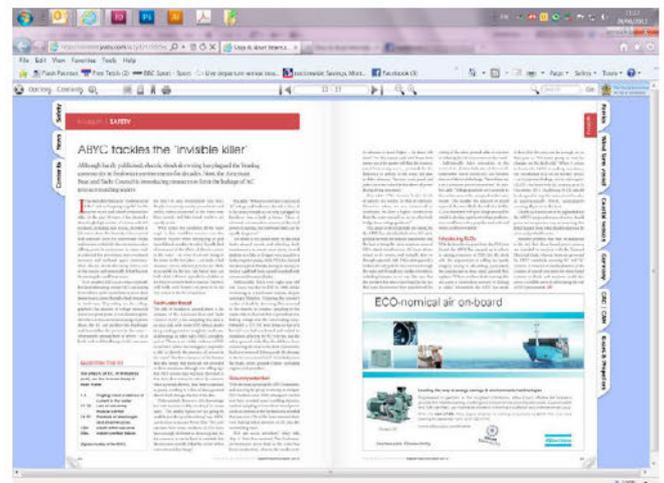
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Tuesday 6 October	1030-1100	United Kingdom Defence Materiel Reform <i>Mr Bernard Gray</i> , Chief of Defence Materiel, United Kingdom
Wednesday 7 October	0830-0900	Enterprise Naval Shipbuilding Plan <i>Rear Admiral Mark Purcell</i> , RAN, Head Maritime Systems, Defence Materiel Organisation
Thursday 8 October	0830-0900	United States Naval Science and Technology Strategy <i>Dr Patricia Gruber</i> , Technical Director of Office of Naval Research Global, United States of America

KEY DATES

- 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**

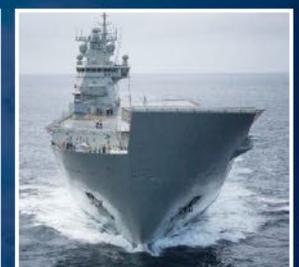
Organised by The Royal Institution of Naval Architects, The Institute of Marine Engineering, Science and Technology, and Engineers Australia, the Pacific 2015 International Maritime Conference will coincide with the prestigious Royal Australian Navy Sea Power Conference, Navy Week celebrations in Sydney and the **PACIFIC 2015** International Maritime Exposition which is organised by Maritime Australia Limited.

The conference program will be conducted in two streams of parallel sessions and will cover the following topics:

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Regulation – too much or too little? In time or too late?

Viking Lady is one of a new breed of low emission vessels, but the industry as a whole will need improve its emissions record as the demand for vessels increases

Regulation and the regulatory process within the maritime industry came under scrutiny in May, with proposals from The Marshall Islands to produce carbon emissions targets for the maritime industry being presented to the IMO's Marine Environment Protection Committee.

The Committee recognised the need to consider the proposals further, but took the view that the priority at this stage should be to continue its current work, in particular, to focus on further reduction of emissions from ships through the finalisation of a data collection system.

In addition, the EU, pre-empting IMO regulation, has passed legislation to enforce a Monitoring, Reporting and Verification (MRV) system for vessel emissions.

Globally the aim for all nations is to maintain global warming at or below 2°C. In order to meet this tough target, all industries must cut their carbon emissions. This presents a particular problem for the shipping industry which accounts for nearly 3% of all industrial carbon emissions - a figure equivalent to that produced by Germany with its 80 million population.

The 3% figure was calculated following the IMO's second greenhouse gas study in 2009. The third study, the results of which have just been released, shows a decline in the levels of emissions from the industry to around 2.2%. However, the report covers the period between 2007 and 2012 – the time when the global economic crisis precipitated by the banking collapse took hold, pushing down economic activity and seeing many vessels laid up as a result.

It would be expected that as economic activity picks up, the emissions from shipping will also rise accordingly.

It is therefore difficult to see any marked difference in the levels of emissions covered by the third GHG study when compared to the second and it seems likely that with the increasing global population, there will be a marked increase in emissions. That being so, the delay in considering the Marshall Islands proposals will surprise and disappoint many.

The EU's proposed legislation to enforce MRV systems for vessel emissions will result in owners having to publicly declare the environmental performance of their vessels. Such transparency will mean that more efficient vessels will be more sought and could see the creation of a Clean Shipping Index.

Some maritime organisations believe that such efficiency data is commercially sensitive information. However, since it seems unlikely that the EU has not considered the sensitivity of the information, it seems not unreasonable to assume that the EU believes that the wider availability of such information is necessary to encourage the industry to make a greater effort to reduce emissions.

However, there is another side to the debate over the merits of national and international regulation and that is that the rules as implemented by the various regulatory bodies can be contradictory, confusing and incompatible (see The confused seas of international and regional regulations pages 24-25).

Kirsi Tikka, President & COO, Europe Division ABS argues that some regulation has evolved and with the various developments has become increasingly complex and less enforceable for the industry which is meant to implement the rules.

Tikka cites the long running debate over the implementation of the Ballast Water Management Convention which has now been waiting for ratification for more than 10 years. That approval may soon be realised but the enforceability of the regulation remains unclear with both the US and IMO offering differing rules for the measuring of organisms in ballast water.

In conclusion Tikka says: "The pressure to adopt regulations without a thorough understanding of their impact may have led to adoption before the industry was ready." It is, she adds, a painful lesson.

According to Tikka the industry is confused by the regulatory system that has evolved. Many consider that such confusion is partly the result of the pressure which vested interests put on regulatory bodies, such as the IMO. Localised or national regulation, whilst this can be a useful tool, is often justified by the length of time taken by the IMO to introduce the required international regulation.

Both the US and EU have in the past successfully used their considerable economic power to attempt to shift move the regulatory debate on. If the industry is indeed confused by the myriad of rules with which it is faced, with it must urge IMO, through its national members, to move more swiftly than it has in the past. *NA*

Offices

SENER inaugurates Manchester office

Engineering and technology group SENER inaugurated its Manchester facilities, the Group's base for its Engineering and Construction area in the UK, last month, which have been fully operational since 2014.

SENER's Marine General Manager Rafael de Góngora highlighted the importance SENER attaches to maintaining a permanent presence in the UK for a wide range of projects and has some 200 British employees in the UK. It uses Manchester as a base for working on projects such as the two Queen Elizabeth-class aircraft carriers for the Royal Navy, using the FORAN System, SENER's CAD/CAM/CAE software for the design and construction of ships and offshore structures.

In 2015, FORAN is celebrating 50 years of continuous reinvention. It is a technological leader in the field and is widely used in marine construction, employed for example in the Royal Navy's Successor nuclear submarines and their Type 26 frigates.

SENER, founded in 1956, had a turnover of £1 billion (US\$1.57 billion) in 2014 and a workforce of more than 5,500 professionals distributed across its offices worldwide. Investment in R&D was £57 million (US\$89.89 million), 6% of the Group's turnover.

Air lubrication

LR verifies sea trials for air lubrication technology

Lloyd's Register (LR) recently verified sea trials for Silverstream's new lubrication technology on a 40,000dwt product tanker. The technology achieved 4.3% fuel savings with scope for further improvement.

The project is funded by Shell and both they and Silverstream Technologies believe that a fully optimised system has potential to deliver more than 5% efficiency savings on an ongoing basis.

The Silverstream System produces a thin layer of micro bubbles that creates a single 'air carpet' for the full flat of bottom of the ship. This reduces the frictional resistance between the water and hull and improves the vessel's operational efficiency, reducing fuel consumption and associated emissions.

Emissions compliance

LR offers regulatory guidance

With key dates looming - 2016 NOx compliance and a 2018 review of fuel availability ahead of a global cap



Early adopters of scrubber technology will gain valuable experience says LR's Environment Manager, Katharine Palmer

for SOx emissions, Lloyd's Register's (LR) new guidance on emissions provides technical information to support operators' investment decisions.

Available to download now at the LR website guidance addresses operational and in-service considerations reflecting further accumulated experience from working closely with clients, industry groups and regulators. As well as a focus on exhaust gas treatment (scrubbers) it also examines the wider scope of options for SOx/NOx compliance beyond exhaust gas treatment.

LR's Environment Manager, Katharine Palmer commented: "Early adopters of scrubber technology, mainly passenger ship and ferry operators, have committed to fleet-wide scrubber implementation programmes. Early adopters gain valuable operational experience as well as a head start in both understanding the technology and realising any benefits."

She added: "But in the majority of the tanker, bulk carrier and container segments the uptake of scrubber technology remains slow. With shorter periods inside Emission Control Areas, lower fuel consumption and typically lower asset residual values, the business case for installing scrubber technology on deep sea tank, bulk or container ships is not, yet, appearing either strong enough or urgent enough to operators."

Whether LNG will make the leap from niche fuel to mainstream is a big question, says LR. Palmer added: "Early adopters of LNG-as-fuel could start seeing a real return on their investment and any 'LNG-ready' ships may start converting to LNG-fuelled, if and when the bunkering infrastructure develops sufficiently. The time for decisions is fast approaching. In 2012 the industry



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needed to start considering their options, now in 2015, time is running out. The compliance options are clear. Ship operators need to evaluate compliance strategies specific to their ships, operation and risk criteria.'

Finance

Teekay finances newbuildings

Teekay LNG intends to issue at least NOK700m (US\$90m) of senior unsecured bonds on the Norwegian bond market.

The bonds, which the company will seek to list on the Oslo stock exchange, will mature in 2020. Proceeds from the issuance will go towards funding instalments on the company's 27 LPG carrier and LNG carrier newbuildings, as well as general partnership purposes.

Teekay LNG has appointed Danske Bank, DNB Markets, Nordea Markets and Swedbank Norway as joint lead managers of the expected issuance.

Education

New premises boosts WMU

Expanded, state-of-the-art, premises for the World Maritime University (WMU) were inaugurated on 19 May in Malmö, Sweden, by IMO Secretary-General and WMU Chancellor Koji Sekimizu. WMU is an international educational institute for the maritime community, operating under the auspices of IMO.

At close to 6,000m², the new facility is nearly double the size of the previous Malmö campus. It provides a new auditorium, multiple research laboratories, seminar rooms, and video-conferencing capabilities for hosting international conferences. An integrated information system embracing unified communications, broadcast media and information management systems for teaching, video-conferencing, research, and management is a central feature of the new site.

The new premises are centred on the refurbished historic Malmö Harbour Master's Building, with dramatic additions designed by the renowned Danish architect Kim Utzon in collaboration with Australian architect Tyrone James Cobcroft of Cobcroft Architects.

Malmö municipality has funded the infrastructure while the up-to-date fittings have been provided through significant donor support. Donors include The Nippon Foundation, the China Classification Society, DNV GL Maritime, the Nakashima Propeller Co. Ltd, Hyundai Glovis, Dr. Peter and Jane Muirhead, the Korean Shipowners' Association, the Korean Registry, the Government of Germany, Shindong Digitech Co. Ltd, Dr. Binali Yildirim, Paul's Fine Art and Antiques,

Nova Marine Carriers, Simsekler Group of Companies Ship Recycling and Ship Chandlers and AVS Global.

Speaking at the launch of the new facility, Koji Sekimizu said, "Today, after more than three decades of increased growth and activity, WMU has outgrown its first home in which it had welcomed its very first students, back in 1983. The new premises mark a historical milestone in the relations between Malmö and the University and will provide the forum for the University to continue growing and meeting the educational needs of the maritime sector."

Personnel

Richard Sadler leaves LR

Lloyd's Register's (LR) CEO Richard Sadler will step down at the end of this year, after eight years in the role. The Lloyd's Register Group Ltd Board of Directors has announced the appointment of current CFO, Alastair Marsh, as his successor.

LR said: "Since Richard Sadler's appointment as CEO in 2007, he and the executive team have implemented a group strategy that has seen LR diversify its service portfolio and grow to a £1bn turnover business. This period saw the creation of the Lloyd's Register Foundation in 2012, maximising the group's contribution to society, and technology leadership through LR's Global Technology Centres in Southampton and Singapore."

After eight years in the role, Sadler told the Board that he would like to step down and pursue new challenges.

Alastair Marsh joined LR as Group Financial Controller in April 2007 and was appointed as Group Finance Director in April 2008. Previously he held a number of senior financial management positions, including CFO and Company Secretary of Superscope Group plc, and prior to that he held similar roles at Easynet Group plc, Laporte plc, and NCR Corporation.

Alastair is a graduate in Business Studies & Accounting from Edinburgh University and a member of the Institute of Chartered Accountants of Scotland. He worked with Price Waterhouse for five years, in both their Edinburgh and Brisbane offices, on a broad range of audit and corporate finance clients, covering a wide range of industries. Alastair also sits on the Board as Executive Director and a number of Boards of subsidiary companies.

Richard Sadler said: "When I was appointed in 2007, I made a public commitment that I would serve as CEO for five years. After eight years in the role I believe it is now time to step down to pursue new challenges while I'm still young enough. It has been a great honour to serve as CEO of LR – it is a unique organisation with a history, purpose and values of which I am immensely proud". [NA](#)

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IMO feels carbon pressures rise

In a submission to the IMO's Marine Environment Protection Committee (MEPC) the Marshall Islands called for the setting of a new global target for reducing greenhouse gas emissions from international shipping, a growing sector currently left out of international climate negotiations, writes *Sandra Speares*.

The Marshall Islands' Minister of Foreign Affairs Tony de Brum commented in advance of the MEPC meeting: "The goal of keeping global temperature rises under 1.5 to 2°C requires action from all countries, and all sectors of the global economy. International shipping must be part of the action. While the sector currently contributes only 2-3% of global emissions, its projected growth is a cause for concern. Without urgent action, it is estimated that the sector could account for up to 14% of global emissions – as much as the entire EU emits today.

"With a strong wind blowing in the climate action sails en route to Paris, the IMO must move to set a sector-wide international shipping emissions target now."

An IMO statement following the meeting said that "the Committee took the view that the priority at this stage should be to continue its current work, in particular, to focus on further reductions of emissions from ships through the finalisation of a data collection system. The Marshall Islands proposal could then be further addressed at an appropriate future session of the Committee. The need to consider the proposal further was recognised and the Committee also looked forward to a successful UN climate change conference (UNFCCC COP 21 meeting) in Paris later this year."

According to Sotiris Raptis, policy officer at Transport & Environment it was "quite frustrating" that the IMO did not support the Marshall Islands' proposal. "It was a pity to see some developed countries not supporting the Marshall Islands stance, including some EU members who were supposed to be the front runners in climate negotiations," he added.

He said that a European Parliament delegation, had observed proceedings at MEPC and, hitherto in Brussels, many believed that on-going processes at IMO would soon deliver meaningful measures, but representatives at MEPC had had a chance to follow the discussions and meet industry representatives and had "drawn their own conclusions" and some MEPs were already proposing new legislative moves on emissions. Raptis believes that IMO tends to move forward to take measures quickly when subjected to external pressure.

Commenting after the decision at MEPC Transport & Environment said: "Today's proposals and procedural excuses at the IMO in London are evidently more important than heeding impassioned pleas by the Foreign Minister of the Marshall Islands and the Climate Change Minister of recently cyclone-ravaged Vanuatu that

shipping must first agree whether a reduction target is the overall objective.

"Of even greater regret is that important European countries – not to mention the US, Australia and Japan – couldn't even bring themselves to mention the word target. Once again it's up to the UNFCCC meeting in Paris at the end of the year to make clear that global action on the climate requires all sectors to act. And the message for the EU is clear.

"The IMO continues to fail in its obligations to act. Europe needs to move quickly now and build on its recently agreed ship emission monitoring regulation by introducing measures to require all ships calling at European ports to make their fair reduction contribution."

Following the meeting the International Chamber of Shipping (ICS) raised concerns about the ballast water convention. "While the progress made by IMO to address various implementation problems identified by ICS should help bring the Convention into force sooner rather than later, ICS fears that the unilateral stance taken by the US may have the opposite effect.

"As requested by the shipping industry in a further submission, IMO Member States built on the progress already made at the previous MEPC in October. ICS believes that shipowners can now have increased confidence that, when the Convention enters into force, ships which have installed 'first generation' equipment in accordance with existing IMO approval guidelines will not be unfairly penalised."

ICS Secretary General, Peter Hinchliffe commented: "The roadmap agreed by IMO Member States shows that at last there is widespread recognition that it is unreasonable to expect shipowners to invest millions of dollars per ship without any certainty that the treatment equipment will not have to be completely replaced in a matter of years, and that ships will not face sanctions due to circumstances beyond their control."

However, ICS fears that the potential impact of the progress made by IMO was partially undermined by the US placing a formal reservation on the outcome. ICS suspects the problems that exist with respect to the separate US approval regime still make it unlikely that flag states which have not yet ratified the IMO Convention will wish to do so in the immediate future given that shipowners under their flags, which trade to the US, could still be unfairly penalised.

"The problems created by the unilateral approach of the US now requires a separate pragmatic solution outside of IMO," said Peter Hinchliffe. "The legal obstacles created by the timelines enshrined in the US law, and uncertainty as to when the IMO Convention will enter into force, make a solution extremely complex. But in co-operation with other shipowner organisations this will be a priority for ICS in the year ahead." [NA](#)

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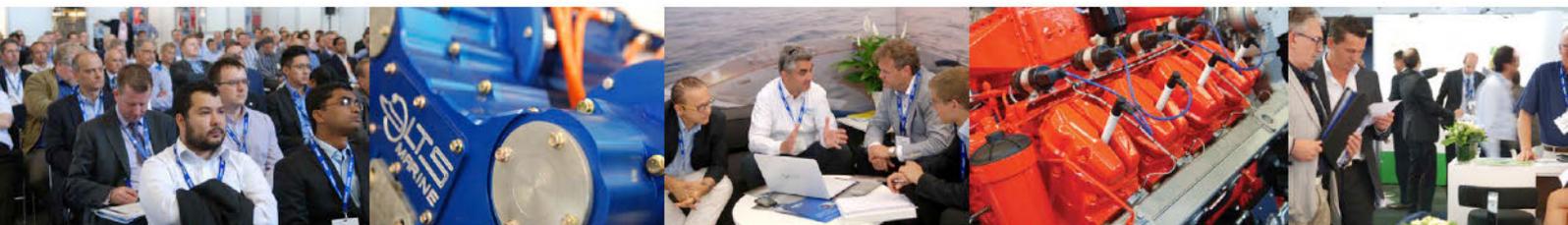
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Scrubbers

Commodore Ferries selects Belco scrubbers

Belco Technologies Corporation (BELCO), a DuPont Sustainable Solutions subsidiary, has won a contract to supply scrubber systems to two Guernsey-based Condor Ferries ships

The company operates a year-round ro-pax ferry link between the Channel Islands, the UK and France with the route on the southern edge of the SOx Emission Control Area (SECA).

Belco will provide four single-stream open loop gas cleaning units for *Commodore Clipper* and *Commodore Goodwill*.

“Exhaust gas cleaning systems will allow the ferries to meet all IMO Annex VI sulphur requirements while continuing to operate on heavy fuel oil. The vessels are similarly sized, each featuring two main engines rated at approximately 4.5MW. Each main engine will have a dedicated exhaust gas cleaning unit. The systems are scheduled to be installed in the autumn of 2015 with performance testing scheduled for early next year,” said the company.

Dupont says the contract will see cooperation between several companies including Oceanox who will manage the project and Houlder as the naval architect involved.

<http://www.dupont.co.uk>

Propulsion

Imtech wins contract for third CMAL ferry

Imtech Marine has been awarded a third contract to supply its electric and hybrid propulsion system for a ferry operated by Caledonian Maritime Assets Ltd (CMAL) of Scotland.

Ferguson Marine, the Glasgow-based yard which built the first two CMAL diesel electric, hybrid ferries, launched a tender last year and Imtech Marine was given the contract in late February.

Installation of the electrical system as well as the diesel-electric system and the Li-Ion battery propulsion system will be completed by Imtech on the third ferry, which will also have an Imtech remote control monitoring system, allowing the owner to track fuel usage in real time.

According to CMAL the first two ferries have achieved fuel savings of around 38%, achieved by charging batteries overnight with locally produced wind energy. Further savings have been achieved through smart load control, through the Imtech Marine Energy Management System (EMS).

Imtech says: “The EMS controls the fuel optimisation by preventing a second generator starting up during the complete working day (adaptive control) and it also controls the load sharing between the diesel generator and batteries based on a “market” control strategy, which matches the energy supply to demand (peak shaving).”

The EMS also provides essential performance feedback to the captain through the energy dashboard. The web based remote monitoring system offers feedback on current and historical performance and maintenance to the fleet owner.

The third CMAL ferry is due to be delivered in April 2016, but Imtech will deliver the propulsion system by December this year. CMAL's first two vessels, the *MV Hallaig* and *MV Lochinvar*, operate between the Isle of Skye and Raasay and between Tarbert (Loch Fyne) and Portavadie respectively.

www.imtech.com/EN

BWMS

Wärtsilä gets three-vessel BWMS order

China's Jinhai Shipyard has placed an order for three Wärtsilä Aquarius UV Ballast Water Management Systems (BWMS) to be fitted to three container ships currently under construction at the yard.



Wärtsilä has received three orders for its Aquarius UV BWMS to be fitted to container ships currently under construction in China

Deliveries of the BWMS will begin at the end of this year and end during next year and the ships will be fitted with 500m³ capacity Wärtsilä Aquarius UV BWMS. “This system utilises a two-stage approach involving filtration and medium pressure UV disinfection technology. Wärtsilä has already obtained IMO Type Approval and Alternate Management System (AMS) acceptance from the US Coastguard (USCG) for this system, and work to achieve full USCG Type Approval for all products

in the Aquarius BWMS range commenced early in 2014,” says the company.

Issues around the Ballast Water Management Convention were the subject of intense debate at last month’s MEPC 68 meeting in London as the industry awaits ratification of the IMO’s convention.

Several states, including Argentina, India, Belgium and Indonesia, have declared that they are in the process of ratifying the legislation. The IMO Secretary General has reiterated that as the barriers to ratification are being discussed and answers developed and there is an expectation that the Ballast Water Convention will be ratified before the end of this year.

www.wartsila.com

Engines

MHI says LP EGR is ready

Mitsubishi Heavy Industries Marine Machinery & Engine Co. Ltd (MHI-MME) claims that it has confirmed that its low pressure Exhaust Gas Recirculation (EGR) system meets the IMO’s Tier III NOx requirements.

According to MHI-MME the low pressure EGR system operates by changing the combustion conditions inside the engine to suppress the generation of NOx through the recirculation of part of the low pressure exhaust gas emitted from the engine turbocharger outlet to a turbocharger intake after it is scrubbed by the EGR scrubber.

The advantage of the system is that it keeps capital and running costs lower than an equivalent high pressure EGR system which utilises high temperature and high pressure exhaust gas.

A MHI-MME statement said: “We duly confirmed that performance such as fuel oil consumption and NOx satisfied the intended objectives through performance confirmation tests executed at Kobe Diesel Co., Ltd. in April 2015.”

It is now planned to install the engine and low pressure system on a 34,000dwt bulk carrier, owned by Shikishima Kisen KK, which is currently under construction at the Hakodate Dock yard, which will allow long-term durability tests.

In addition the company will also evaluate the availability of caustic soda, sludge disposal handling processes and certification processes in collaboration with the vessel operator NYK Bulk & Projects Carriers Ltd/ Nippon Yusen Kabushiki Kaisha as well as Shikishima Kisen KK.

www.mhi-mme.com

Scrubber

AET fits Clean Marine EGCS

The 120,000dwt tankers *Eagle Barents* and *Eagle Bergen* delivered from Samsung Heavy Industries

(SHI), have been fitted with approved exhaust gas cleaning systems (EGCS) provided by Clean Marine.

Measurements of exhaust gas emission and wash-water criteria are well below the limits required by the IMO, ensuring the vessels’ compliance with the 0.1% sulphur limit in ECAs which has been in force since 1 January this year. The vessels are also compliant with the stricter US EPA requirements of a pH above six in wash-water, measured at the outlet.

Classed with DNV GL and flying the Bahamian Flag both the class society and flag state have confirmed that the EGCS complies with “Scheme B – EGC System Approval, Survey and Certification Using Continuous Monitoring of SOx Emissions” of the IMO Resolution MEPC184(59), 2009 Guidelines for Exhaust Gas Cleaning Systems.

The two vessels are owned by AET Sea Shuttle AS, and will operate on a long-term contract with Statoil in the Barents and North Seas. Clean Marine’s Allstream exhaust gas handling system onboard the ships will clean both sulphur oxides (SOx) and particulate matter emissions from two main engines, five auxiliary engines, and three boilers. In total, each EGCS unit will manage 10 exhaust sources and clean 220,000Kg of exhaust per hour.

The system is a hybrid type which can operate in both open loop and closed loop (zero discharge) mode and provides near-neutral pH in wash-water discharged in open loop operations.

The hybrid EGCS enables vessels to trade in all waters and ports well within IMO and local

AET Sea Shuttle have opted for Clean Marine scrubbers for their 120,000dwt tanker newbuilds



regulations. All engines, including the boilers, are integrated into one single scrubbing unit, without any back pressure, due to a patented gas recirculation technology. This Allstream feature makes the system a preferred choice for tanker vessels with many exhaust sources and large oil-fired boilers.

Piping

In the pipeline

GF Piping Systems has received a €15 million (US\$16.3 million) order from the cruise ship builder STX France.

The latest order from STX France covers the delivery of corrosion-free plastic piping systems to equip three new cruise vessels. The piping systems are manufactured at GF facilities in Switzerland, Germany and Austria and they will be delivered during the next two years, starting in the second half of 2015.

GF Piping Systems is experienced in the shipbuilding industry with its piping technologies which have already been installed on the largest cruise vessels currently in operation. The company says it also offers maintenance services for on board piping systems at major ports in the US, Europe and Asia to ensure owners have the maximum availability for their cruise ships.

GF Piping Systems supplies piping systems made of plastics and metal and the company focuses

on system solutions for the safe transport of water and gas in industry, utilities, and building technology. Its product lines include fittings, valves, pipes, automation and jointing technology and covers all water cycle applications.

www.georgfischer.com

BWMS

Evoqua secures US patent

Evoqua Water Technologies has been awarded a second US patent on its technical solution for treating ballast water. This latest patent was awarded by the United States Patent and Trademark Office in March this year.

The company said: “The patent describes a technical solution for treating ballast water under a variety of ambient water qualities. The quality of ambient water can vary widely from port to port where the ship is taking on its ballast. The unique features of Evoqua’s system include the use of oxidation reduction potential (ORP) devices to control certain SeaCURE system operations.”

The patented SeaCURE system takes into account variations in demand and delivers biocide at the dose necessary for successful biofouling control, while minimising unwanted side effects such as the formation of disinfection by-products and corrosion. The ORP system employs low-maintenance probes that measure the oxidising potential of the water in both the sea chest and the ballast tank as input for controlling the addition or concentration of biocide that is ultimately introduced into the shipboard cooling water system. Controlling the SeaCURE system in this way saves energy and reduces operating costs.

“The SeaCURE Ballast Water Management System prevents the displacement of organisms in a two-step approach. After a first step of fine filtration to remove large organisms and mineral sediments, the remaining organisms are eliminated by the addition of an active substance - sodium hypochlorite. This is produced in-situ via electrolysis from seawater eliminating the need to purchase biocides and store or replenish them onboard. Electrolysis is carried out using Evoqua’s Chloropac self-cleaning concentric tubular electrodes.

www.evoqua.com



GF Piping Systems, a division of GF, has received a substantial order totalling more than EUR 15 million from the leading shipbuilding company STX France.

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Cherish the old, explore the new

Most conferences are held bi-annually or tri-annually. COMPIT, the International Conference on Computer and IT applications in the maritime industries, is organised every year and offers an excellent view on the latest trends and developments. Herbert Koelman founder and managing director at SARC reports

This year COMPIT seduced 99 participants from 18 countries to travel to its venue in Eastern Germany, a hamlet called Ulrichshusen, to hear about the latest developments in maritime IT and design.

An evergreen on conferences on Computer-Aided Ship Design is shape modelling. Last year even the COMPIT award was given for a paper on this subject. However, this year it is scarcely addressed; Bastiaan Veelo, from SARC, took a side step on an experiment by using advanced hull form modelling methods for propeller design, and concluded that this approach offers a potential advantage over the prevailing (i.e. NURBS-based) method.

A second contribution in this field was by Stefan Harries, from Friendship systems, who reported on optimising the shape of an Autonomous Underwater Vehicle by utilising the optimisation tool Caeses (formerly known as Friendship Framework) in combination with NavCad (by Hydrocomp). An interesting aspect of this exercise is not just the optimisation as such, but also the collaboration between the two programmes and companies.

This addresses the aspect of data sharing, or Product Data Technology, another all-time favourite. Ten papers were devoted to this theme at COMPIT, which can be grouped into three categories: bilateral interfacing, the centralised product model approach, and peer-to-peer connectivity.

The first category is conceptually simple, 'just' connecting different application programmes by utilising existing file I/O capabilities. Nevertheless this approach can result in remarkably efficient solutions, as elaborated by Christian Cabos, DNV GL, in his presentation on the joint operation of Napa Steel (3D construction modelling), Shipload (wave forces and moments), Poseidon (Rules calculations) and the

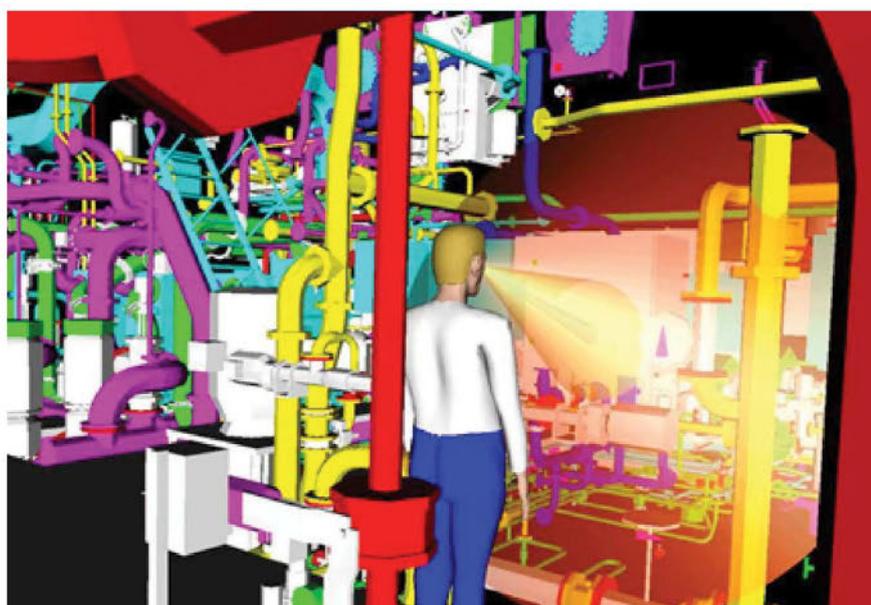


Figure 1 Avatar in ship showing sight analysis

Finite Element software of Patran and Ansys. Although this work is not utilising neutral 3D models, its practical value may be reason to expect others to follow suit on this path.

The centralised model was addressed in some eight papers. The most ambitious in the data integration area was by Lars Wagner, from Prostep, with his presentation on Enterprise Architecture Management (EAM) in shipbuilding PLM. By means of EAM the technology-oriented software is merged with the business-oriented software.

This paper offers guidelines on EAM implementation and presents an application example on requirements management. Other speakers limit the integration to technical software only, such as Hannes Linder, Rostock University, who reports on an integrated system with, as components, Bentley Microsystem, an SQL server, Aveva and Napa. Unfortunately,

the reason for selecting these particular systems was not crystal clear, nor was the interface language or method.

In a contribution from Fraunhofer IGD, Uwe von Lukas also reports on the potential of 3D data in the ship life cycle with open formats and interfaces. The central thesis in this contribution is that although the ship design phase is intensively supported by 3D tools, other life cycle processes, particularly procurement and sales & marketing, are not. An example of using 3D data in design is ergonomic simulation and is presented in figure 1. Furthermore, in order to determine the most favourable carrier for 3D information several 3D file formats have been investigated, such as IGES, STEP, VRML, x3D, JT and 3DPDF, and the clear winner is reported to be JT.

Darren Larkins, SSI Ship Constructor software, concludes in the same line, in his paper on utilising a single 3D product model throughout the ship design process.

As such, this is remarkable, because JT is a visualisation file format. So, although it may contain some structure of the artefact, and some designer intent, it is not developed to represent an integral product model. Apparently, in this field the visions have changed; where once the quest was for centralised and neutral representation methods, as e.g. conceptualised in STEP, now we tend to be happy with 'just' visualisation.

This trend was further explored by your reporter in his presentation of a virtual ship design system composed of multiple independent components. With this approach the distinct applications do not even try to share their product models, but communicate by higher-lever data entities instead, while also sharing their specific processing capabilities in a request/reply fashion. Observant readers of this magazine might remember this from the April issue; because there the essentials of this approach were already elucidated (*The Naval Architect* April 2015 pages 40-42).

Another revolving topic is CFD, Computational Fluid Dynamics, or Colour Full Displays as a cynical friend once said. Milovan Peric, from CD-adapco, presented a historical overview of the development of CFD over the past 30 years. In this very readable paper the development of the CFD software from a single-processor to massive parallel computers is described.

In a case study of the airflow around a F1 racing car, in a grid with some 100 million cells, it is shown that with a small number – up to 4,000 – parallel processors the computation speed increased more or less linearly with the number of processors. With larger amounts of processors, say up to 10,000, the speed in older software versions increased significantly less than linear. However, also in this area software becomes more efficient, with the latest version the computation speed increase amounts to 85% of the processor increase.

Thomas Hildebrandt focussed on the practical application of CFD, in the first instance on grid generation and the improved accuracy that adaptive grid refinement can bring. See for an

example figure 2, where with an adaptively generated grid the diverging wave pattern is much more detailed than in the original, non-adaptive mesh.

A second line in this paper is the way that massive parallel computers can be utilised by the common ship designer. For many advanced CFD applications – such as 6-DOF simulation of multiple bodies, wave breaking and splashing and optimisation – High-Performance Computing (HPC) is a prerequisite, however, there will also be times that all X-thousand processors stand idle. So, acquiring HPC computers and multi-processor software licences may not always be the most economical choice. As an alternative the speaker proposes *Numeca on-demand*, a cloud-based model, where software licenses as well as processor capacity is available on a flexible basis.

A most impressive HPC application was reported by Tatsuo Nishikawa, from the Shipbuilding Research Centre of Japan. He created computational grids of varying sizes around the hull surface and the rotating propeller, the largest grid with some 34 billion cells. Solving this equation is an enormous task, which is done on some 240,000 cores simultaneously. But the result is huge, see figure 3, which shows the eddies arising from the turbulent boundary layer and the propeller.

An intriguing aspect of this exercise is that it simulates vortices, with a diameter of less than 1mm, from which the level of reality can only be verified in an indirect way. This computation has been applied on a 5.5m model of a VLCC, and we can

only wait and speculate when we will see the application extended towards full-scale vessels. As recognition of this outstanding contribution the DNV GL COMPIT award 2015 was given to Nishikawa.

A presentation of a different nature was given by Andrea Serani, from Roma Tre University, who investigated the performance of several derivative-free global optimisation methods. Although the application was on resistance minimisation, the usefulness of these methods extends beyond CFD, so I will certainly keep a yellow post-it sticker on these pages of the proceedings, for if anything to be optimised will pass by.

New on COMPIT was a session on the application of big data. Andreas Krapp, of Jotun, reflected upon the combination of big data and simulation for application on hull performance monitoring. He concluded that for a wide variety of loading conditions a dense CFD-based speed-draft-trim matrix is to be preferred above interpolation of model test curves. Secondly, it was suggested that for adequate hull performance assessment, continuous monitoring is to be preferred above long averaging periods (as in noon reports).

An analysis of massive amounts of AIS data was presented by Kay Dausendschön, DNV GL, not only for the own fleet of a ship owner, but in particular also of the competition. Applications can be found in, for example the dry-dock selection, port

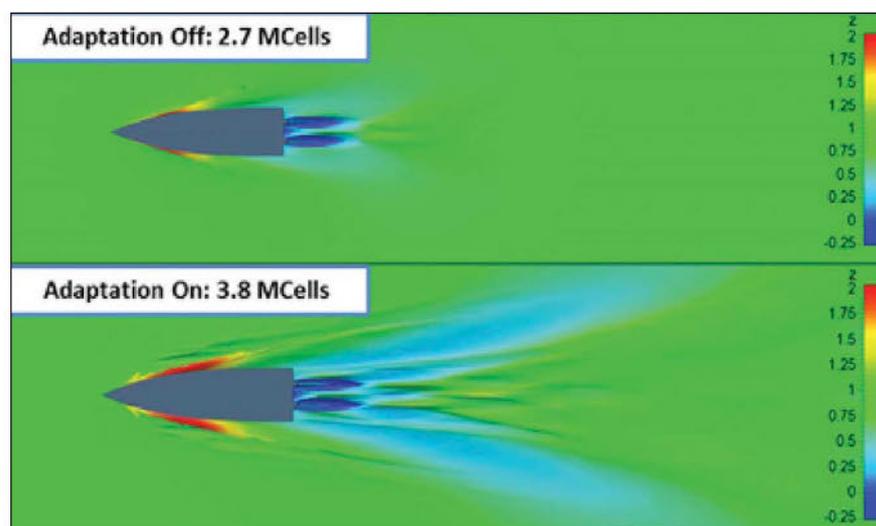


Figure 2 The effect of adaptive grid refinement

or berth selection, delay management and voyage management. Another application of AIS is to collect river water depths in a very dense grid of 25 x 25m cells, so Arno Bons, MARIN, reports. The ‘sensors’ in this system are 50 inland ships equipped with accurate draught and depth gauges, which are transmitting their position and the measured depth continuously.

Robots and unmanned shipping have been occasionally addressed at earlier COMPIT conferences, but with five papers this subject has received quite some attention this year. A prerequisite for the remote control of unmanned ships is secure communications, a subject which was addressed by Ørnulf Jan Rødseth from Marintek. In the contribution of the University College of London, Wenwen Liu presents the design of a path planning algorithm which advises on a collision-free trajectory. This fuzzy algorithm takes input from multiple sensors, currently a gyroscope, compass and AIS. The system has been tested in practice and by computer simulations, and both have been satisfactory. Work is underway to include radar images as well.



Figure 4 The 2015 winner of the DNV GL COMPIT award, Tatsuo Nishikawa

One of the most inspiring presentations at COMPIT was saved until the end, a contribution by Giampiero Soncini on sense and nonsense of unmanned ships. After elaborating on the superfluous nature of the galley and the cook (“with the

money saved in buying, installing, maintaining and operating a galley, one could serve caviar every day to the crew for several years”) the conclusion is that for the western world, with its high wages, unmanned shipping will be the only way to survive as maritime nations.

A final word on the social environment; do not expect long welcome speeches, keynote addresses or city hall receptions if you visit COMPIT. The atmosphere is concise and the attention is fully focussed on the heart of the matter: reporting and discussing the progress of computer applications in the maritime field.

Nevertheless, in combination with the usual sheltering venue – this time COMPIT was hosted in a 16th century castle – this also creates a care-free attitude which is cosy and inspiring. The openness of mind is also reflected by the fact that all presented papers are publically available – through the download section on www.compit.info – let this be an example for other conferences! The next in line for COMPIT will be southern again; from 9-11 May, 2016 in Lecce, in the heel of the boot of Italy. **NA**

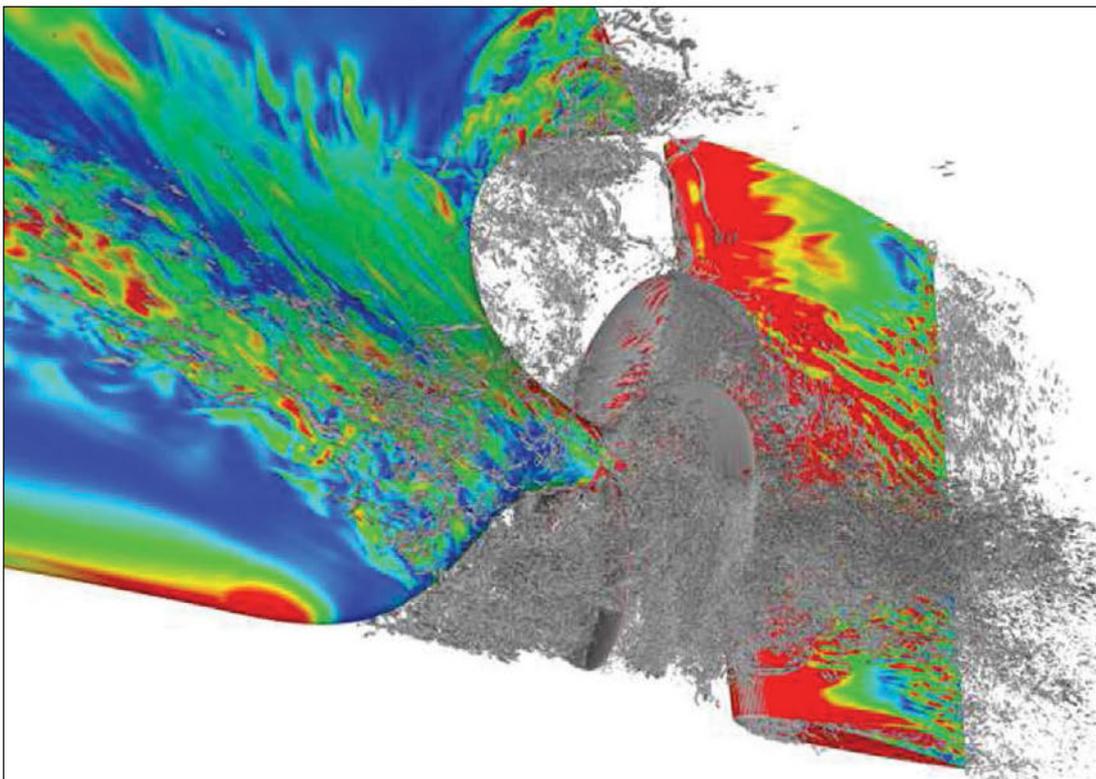


Figure 3 Vortical structures in a computation with 4.4 billion cells

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Candidates gear up for imminent IMO election

Elections for the successor of IMO Secretary-General Koji Sekimizu take place later this month and the six candidates for the position have been outlining their priorities. Last month we looked the policies of four candidates with the remaining two contenders profiled this month

The future direction of the IMO will depend largely on the people that lead it. With the election of the next Secretary-General imminent and the possibility that this will herald a new view at the top, *The Naval Architect* looks at the candidates experience and their views.

Lim Ki-tack, South Korea

Prioritising the application of regulations rather than the creation of new rules is important to South Korea's candidate for the position of Secretary-General at the IMO. For Lim Ki-tack this is perhaps borne out of his nearly 30 years attending IMO meetings.

He attended IMO as Maritime Attaché at the South Korean embassy in London between 2006 and 2009 and earlier still in 1998, he was appointed head of the South Korean delegation to the IMO, but he first began attending IMO meetings in 1986, participating in maritime safety and environmental discussions.

Lim Ki-tack says: "The challenge for IMO is not a lack of regulations, but how best to apply and implement the existing requirements," he went to say that he will establish a robust foundation for the proper implementation of IMO standards by all member states through an evaluation of the "effectiveness of IMO regulations to improve their implementation prospects," by strengthening "flag state implementation through the Member States Audit Scheme," and by making certain that both ship operators and seamen implement regulations by "evaluating the effectiveness of the ISM Code and STCW Convention."

For Lim Ki-tack this means improving the IT systems so that



South Korean candidate Lim Ki-tack is looking to prioritise implementation of regulations, rather than imposing new rules

rule making can be "streamlined", evaluating the functions of the secretariat and maintaining and improving the current "review and reform programme".

Essentially, Lim Ki-tack feels it is important that the IMO is recognised as the sole authority governing international shipping. And to achieve this he says that it is necessary to promote open communications with industry, the media and the general public and to also develop the IMO's visibility and participation with other UN bodies and NGOs.

Safety, he says, remains the main focus of IMO work and to improve safety there is a need for the "close cooperation and participation of all Member States. IMO should focus on strengthening the role of flag states, harmonising PSC activities, place a focus on the human element,

create a strong maritime safety culture and strengthen the safety of ships in coastal areas and at the Ship Port Interface (SPI)."

Maximo Quibranza Mejia, Philippines

For the past two years Mejia has served as the Director General and CEO of the Maritime Industry Authority (MARINA) in the Philippines. MARINA is the responsible body for the creation and implementation of regulation in the Philippines. Before that he was a professor based at the World Maritime University in Malmö, Sweden, for 14 years. Having graduated from the United States Naval Academy in 1988 Mejia went on to study Law and Diplomacy in Massachusetts' Tuft University achieving a Master of Arts in Law and Diplomacy second degree. In 1993 Mejia moved to Sweden

Education has figured large in Mejia's development and it is through providing similar opportunities to future generations that Mejia believes the industry will renew itself.

He says: "The IMO, through the World Maritime University, its apex institution for higher maritime studies, together with the International Maritime Law Institute, its training arm for developing maritime law specialists, must continue to produce and develop future maritime leaders and policy-makers. In this connection, the long-term financial sustainability of these two institutions must be secured."

One of the principal requirements of these emerging maritime leaders will be to maintain the IMO's position as the major regulatory authority for the industry.

Mejia says he "will work tirelessly with member-states, intergovernmental and non-governmental organizations to maintain and secure IMO's role as the venue for the formulation of global standards for shipping. Safety and efficiency in maritime transport can only be afforded by international – not unilateral or regional – regulations."

Those regulations will principally cover such issues as maritime safety which Mejia says "remains the most important function of the IMO. Even as it expands its activities beyond its traditional functions, the focus and emphasis on maritime safety must remain its most primordial concern."

Maritime safety is largely dependent on the skill and dedication of the seafarers who work the vessels and as such seafarer welfare, safety, and competence are also on Mejia's agenda, should he be elected. He believes there will be a surge in demand for shipping services, and therefore seafarers once the global economy has recovered.

Such an increase in demand for shipping capacity will again focus the spotlight on the environment, including the marine environment and emissions into the atmosphere from vessel exhausts. "In formulating standards for the protection of the marine environment, the organisation must ensure that international shipping stays ahead of other transport modes in contributing to the pursuit of a sustainable future," he says.

The focus on the environmental issues and safety will ensure that shipping will be able to improve its public image and promote the industry as a responsible provider of services.

Improving the public image requires a significant level of compliance and Mejia believes that the best way to raise the level of compliance and implementation in many member-states is through technical cooperation programmes. There is, therefore, a need for more creative ideas to secure funding for technical assistance programmes. *NA*

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Regulations float in confused seas

Regulation in the maritime industry is becoming a key focus for owners as the cost of compliance spirals. But owners are entitled to a transparent and robust regulatory and enforcement regime argues Kirsi Tikka, President & COO, Europe Division ABS

Not long ago, maritime safety and environmental regulations were relatively straightforward. The three main pillars – MARPOL, SOLAS and STCW – gave us the necessary structure for operational conduct and, by and large, the industry agreed that their intentions were positive. The addition of the fourth pillar, MLC 2006 (the Maritime Labour Convention), has also turned out (so far at least) to be an equal force for good.

This situation has changed. IMO member states, national governments and lobbyists alike have moved the agenda of safety, oil pollution prevention and human factors into new territory.

As a classification society, we at ABS are often asked for advice on compliance with the new wave of environmental regulations. We can, and do, talk about what these regulations dictate and provide various potential compliance options, but even we may not always have all the answers.

This is because, as the content of the regulations change, the resulting requirements have morphed from challenging but achievable to increasingly complex and sometimes unattainable. The regional variations in the regulations call for complex and sometimes multiple compliance options.

The new breed of regional and international environmental regulations are not necessarily aligned with either the industry or each other. They are often incomplete and enforcement procedures are unclear. Worse still, the technology required to comply may not have matured sufficiently and, in some cases, is still under development.

Ballast water management (BWM) regulations are a prime example of regulations that have not met the best intentions of those who created them. By the time this article is published, the Ballast Water Convention may have been ratified- eleven years after it was adopted. But even now the criteria for sampling and analysis of ballast water and for Type



Maritime regulation must be clear and enforceable says ABS President & COO, Europe Division Kirsi Tikka

Approval have been re-opened for review, despite IMO-approved systems being available and installed on many ships.

The US has its own regulations, but has not approved any treatment systems, so it is impossible to comply except on an interim basis by Alternate Management Systems or ballast water exchange.

The shipping industry is not just confused by this situation, it is bewildered. Shipowners understand their responsibilities; they are a compliance-minded group and, given a clear path to regulatory compliance, the majority will follow it. Unfortunately, the current situation forces the proactive among them to potentially waste money and man hours developing a strategy based upon 'what-if' scenarios.

Industry organisations are warning that compliance efforts must not be delayed given the time required for implementation of a BWM system. However, this is a story that owners have heard for a decade so who can blame them if they are still sitting on the fence?

It would be an untenable situation if equipment that has been approved and installed on board in accordance with adopted international standards is subsequently found to be unacceptable by some authorities. The most significant in coping with the convention is the unavailability of treatment solutions that are practical, robust and acceptable on a global basis.

Approval testing by the US Coast Guard (USCG) began in earnest this spring. That is a glimmer of good news but consider the scenario in which the USCG comes to a conclusion about certain technology that does not align with the other flag states' approvals. The risk for manufacturers of alternative systems that do comply with the convention is a wasted effort both in terms of expense and development time.

The situation regarding air emissions is clearer in some ways, but murkier in others. On the one hand the maximum sulphur levels in the Baltic and North Sea Sulphur Emission Control Areas (SECAs) are well known and long-signposted. The industry has had experience with Emission Control Areas (ECAs) for some years now and the step-down has been phased to ease the burden to a degree.

The more recent creation of an ECA in the waters around North America is based on studies showing the substantial benefits of low sulphur fuels and reduced NOx emissions to large segments of the population, as well as to marine ecosystems. But the shift towards 'low sulphur shipping' is still a controversial measure since it requires a large scale investment to switch to distillate fuel, invest in a scrubber solution or even plan new buildings with alternative fuels. The first two have their own technological challenges, notably availability of compliant fuel and the maturity of sulphur scrubber technology applied to large marine engines.

When NOx is added into the mix, the problem becomes far more challenging and there remains some misunderstanding of the almost 'magical powers' of LNG to solve the

industry's emissions problems. Even if one sets aside the fact that building a dual-fuel ship could cost 40% more than a conventional one, LNG is not a simple solution to the NOx regulations – it requires a visionary attitude from owners as well as a capital commitment.

Given the goal-based options for compliance, it is fair to say that the revisions of MARPOL Annex VI are clear in terms of expectations. Their surely unintended consequence is that, because they leave the challenge of enforcement to coastal and flag states, it is difficult, if not impossible, to estimate the level of compliance. What has currently manifested itself as a European problem will become a global one once the new global sulphur maximum comes into effect in 2020 or 2025.

Actual enforcement in the US ECA, where compliance is shared between the USCG and Environmental Protection Agency (EPA), will prove interesting as the two agencies may take different approaches with respect to the means of determining compliance. Based on recent notifications, the USCG will take the lead and, where potential violations remain unresolved, the EPA will be notified and investigate further.

Earlier environmental regulations which mandated segregated ballast tanks or double hulls were controversial in some respects, but solutions to the problems could be found because the regulations were rooted within traditional ship design and shipbuilding practices. The purposes and rationales for the regulations were clearly understood inside the industry and out, even when politically motivated.

So what has changed? First, the environmental groups pushing the air emission and ballast water agendas have enjoyed public support, the impact of which has not been fully recognised by the industry. The pressure to adopt regulations without a thorough understanding of their impact may have led to adoption before the industry was ready.

Second, both the BWM Convention and the revision of MARPOL Annex VI introduced new sciences, both biology and chemistry, with which the industry had little experience. They were also 'aspirational' in nature; a new concept for international regulation.

Governments and politicians – and thus the national delegations to IMO – found strong support for these regulations among their electorates and pushed the regulations forward on the basis that shipping should play its part in 'going green' or 'being more sustainable'.

What was not fully appreciated when the regulations were being developed is that in order to protect the environment, the industry needs practical, available and feasible technology, as well as enforcement that provides a level playing field to all. We have to ask ourselves: Do these regulations achieve that?

One lesson learned is that development of regulations without the prior availability of proven technological solutions is a questionable policy at best. The consequences we are now faced with from the BWM Convention simply cannot be allowed to happen again.

We are only at the beginning stages of determining the long-term implications of the low sulphur climate in which we now operate – and how well this regulation can be complied with and enforced.

To avoid a repeat of past mistakes, the industry – class societies included – must act in three ways.

We must engage as soon as is feasible in the development of new rules, regardless of the type of regulations being discussed. Class societies now have capabilities that range far beyond technical evaluation of steel structures, i.e. research into human factors, environmental management, operational efficiency and complex technology systems. We should bring these skills to bear, but everyone in the industry needs to play their part.

We need to understand what the public at large wants, since that drives governments to develop regulation and we must also educate the public about what is feasible. As we often hear, the industry would benefit from a better public profile.

Finally, there is a need to communicate to the regional and international regulators why creating unilateral regulations for international shipping will usually make the situation worse rather than better.

At present, the marine industry is sailing in confused seas - an oceanographic term for 'a highly disturbed water surface without a single, well-defined direction of wave travel'. My hope is that by addressing these aforementioned challenges head-on, together we can make a safe passage to calmer waters. *NA*

Emissions: more than just hot air

Emissions have been high on the maritime agenda in the last few weeks with activity both by the EU and deliberations at the IMO's Marine Environment Protection Committee. Sandra Speares examines the latest developments

New legal moves by the European Parliament are aimed at giving shipping users access to transparent data that identifies the most efficient ships and practices according to transport pressure group Transport & Environment (T&E).

In a vote on 28 April this year the European Parliament approved legislation that will see the Monitoring Reporting and Verification

(MRV) of individual ship emissions become compulsory from 1 January 2018. However, the legislation comes with the controversial requirement for the public disclosure of efficiency data, not to mention the fact that the EU is again pushing IMO to develop its regulations quicker.

"The public disclosure of fuel efficiency data will enhance competition for the best ships and

routes, which in turn will trigger market forces that will result in fuel savings," says the lobby group T&E. Adding, "The measure is a stepping stone to CO₂ targets that will start delivering much-needed cuts to shipping's ever-growing emissions."

The MRV regulation will require ship operators to publicly report information on the environmental performance of ships. "Cargo

owners and ship operators have been crying out for efficiency data – some already adhere to a similar yet voluntary ‘Clean Shipping Index’ – as the more cargo a ship can carry using the same amount of fuel, the more efficient, cleaner and cheaper the service.” However T&E says, “Fuel efficiency improvements will be offset by the increase in transport demand”.

Sotiris Raptis, clean shipping officer at T&E, says: “This law is expected to produce a virtuous circle of increased transparency, increased competition and greater fuel efficiency. But this is where our cheering stops. Given that the sector’s rapid growth is set to outstrip efficiency gains, only CO₂ targets under the EU’s 2030 plan and Energy Union can deliver actual emissions cuts.

“The Marshall Islands, the existence of which is threatened by rising sea levels, has called for a global reduction target on maritime carbon emissions. When the holders of the world’s third largest shipping registry can see the existential threat posed by rising shipping emissions, it’s time for European nations to step up to the plate and support definitive action at the IMO.”

Raptis continues: “Currently ships are responsible for over 3% of global greenhouse gas (GHG) emissions. If these emissions were reported as a country, maritime transport would be Europe’s eighth largest emitter. According to the latest IMO study on GHG emissions from ships, under a business-as-usual scenario, shipping could represent 10% of global GHG emissions by 2050.”

Following the vote in the European Parliament, in late April, adopting MRV of individual ship emissions of CO₂, the International Chamber of Shipping, BIMCO and Intercargo issued a statement saying the vote “was expected, being based on the political agreement reached between the EU institutions at the end of last year.

“However, the shipping industry is still disappointed by the Parliament’s confirmation of the EU decision to pre-empt the current IMO negotiations on a global data collection system on shipping’s CO₂ emissions, by adopting a unilateral, regional regulation on the monitoring, reporting and verification of individual ship emissions – which will also apply to non-EU flag ships trading to Europe – in advance of IMO completing its work.

“Until now, with the industry’s support, the IMO negotiations have been progressing well. But there is a danger that the EU initiative will be seen by non-EU nations as an attempt

to present them with a *fait accompli*. The EU Regulation includes controversial elements, such as the publication of commercially sensitive data on individual ships, an idea which had previously been rejected by the majority of IMO governments during a meeting of the Marine Environment Protection Committee in October 2014.”

In advance of the MEPC meeting which ended on 15 May the trade associations believed “It will be vital for EU Member States to explain how the new EU Regulation can be implemented in a way which is fully compatible with whatever might be agreed by IMO for global application, in the interests of avoiding the unhelpful complication of a separate regional regime.

“The shipping industry associations reiterate that the latest IMO Green House Gas Study, published in 2014, found that international shipping had reduced its total CO₂ emissions by more than 10% between 2007 and 2012, despite an increase in maritime trade.”

Following the MEPC meeting ICS said it was “pleased that IMO Member States rejected the idea contained in the EU Regulation that commercially sensitive data about individual ships should be published”.

ICS said that, while some form of metric to account for ‘transport work’ in addition to fuel consumption remains on IMO’s agenda, this now seems likely to be simpler than the metric contained within the EU Regulation. “This is therefore more likely to be acceptable to ICS member national associations, who will review the outcome in detail at a major ICS meeting at the end of May. However, discussion within IMO on this controversial aspect is far from over and will continue at the next MEPC meeting in April 2016.”

ICS secretary general Peter Hinchliffe commented: “There is still a great deal of uncertainty as to where the issue of CO₂ data collection is leading. The European Commission still appears to see the next step as being to use this data to establish a mandatory operational indexing system that can eventually be used to charge ships money. The fact that commercially sensitive data about individual ships will not be published under the IMO system does not prevent this goal from being pursued. The same applies to the EU system, even if the European Commission agrees to align its system more closely with that eventually agreed by IMO by dropping the publication element, which is by no means certain.”

ICS recently dismissed the claim by T&E that modern ships are somehow less CO₂ efficient than those built over 20 years ago as ‘fanciful’ “T&E bases its claims on a report it has commissioned from the respected consultancy CE Delft, but it has used the findings very selectively. Moreover, the actual data from which the report’s analysis is derived finishes before the worldwide implementation of the Energy Efficiency Design Index (EEDI). This came into force in 2013 as part of the IMO mandatory package of CO₂ reduction measures (amendments to MARPOL Annex VI).

The T&E statement appears to confuse overall design efficiency with an ‘estimate of fuel efficiency’ based on generic data. “Modern ships are designed for optimal efficiency which requires far less fuel to be consumed than previously. Largely as a result of fuel efficient operations, the latest IMO Green House Gas Study, published in 2014, shows that international shipping reduced its total CO₂ emissions by more than 10% between 2007 and 2012, at a time when demand for maritime transport continued to increase.

“It is not helpful for T&E to twist the results of the CE Delft study to imply that the IMO EEDI, developed by the combined technical expertise of all the world’s maritime nations, is somehow inadequate. Modern ships, built in line with the EEDI targets which came into effect in January 2015, are required to be designed to be at least 10% more efficient (compared to the agreed IMO reference line), while ships built after 2030 will be 30% more efficient. Combined with continuously improving operational fuel efficiency measures, supported by the mandatory use of Ship Energy Efficiency Management Plans and new technology, the actual CO₂ reductions achieved will be even greater. This is something on which the shipping industry and its regulator, IMO, should be congratulated rather than criticised.”

Commenting on the ICS comments research company CE Delft said it had studied the development of the Estimated Index Value (EIV) of bulkers and tankers since 1960 and of container ships since 1970. The EIV formula is a simplified form of the Energy Efficiency Design Index (EEDI) that was used by the IMO to calculate the EEDI reference lines (which were set as the best fit average lines of all EIVs in the period 1999-2009). “It can therefore be considered as a simple yet accepted measure of design efficiency. We have calculated EIVs on the basis of IHS and Clarkson databases, as

did the IMO. The study shows that the EIV of new ships was on average worse than the EEDI reference line for ships built in the 1960s and 1970s, improved considerably in the 1980s and then deteriorated again.

“This means that, on average, a ship built around 2010 had a design efficiency (as represented by the EIV) that was worse than a similar ship (same ship type, same size) built around 1990. According to the research “One of the main reasons why modern ships have a design efficiency that is worse than ships built around 1990 is that modern ships are, on average, fuller (more block-like). The reason for this is that when freight rates are high, it makes sense to build full ships because within draft

and length constraints, they can transport more cargo than a more slender ship.

“The EIV formula as established by the IMO does not take into account improvements in the fuel efficiency of engines. Our data sources do not allow an evaluation of this impact. However, other sources show that the fuel efficiency of engines has improved since 1990. If one were to take this into account, the deterioration in design efficiency since 1990 would likely have been less than we reported. Our methodology compares similar ships. We have not studied how the fleet average design efficiency has evolved, e.g. due to changes in ship size. This is especially important for container ships, the size of which has

increased considerably in the past decades. Our conclusions relate to design efficiency. We do not make claims about operational fuel efficiency”, said a Delft statement in response to ICS criticisms.

John Maggs, policy advisor at Seas At Risk and president of the Clean Shipping Coalition, says: “CE Delft’s study for Seas At Risk and T&E found that ships can improve their design efficiency by about 5-15% on average just by going back to 1990 designs alone. As CE Delft has reiterated, its findings are based on the data and EIV/EEDI formulae which the IMO itself used. The ICS now needs to take the results seriously and show us why the EEDI targets shouldn’t be reviewed.” *NA*

Russian Register revels in Arctic rules

The Russian Register of Shipping has more than 3,000 ships and other ice navigation facilities, covered by its class rules, confirming RS as an authority in this area of classification services

Advanced technologies used for northern regional development has stimulated the Russian Register of Shipping (RS) to provide adequate regulatory and technical solutions for the sector.

Nowadays, RS is actively investing in the development of rules dealing with ice-resistant items and risk reduction measures during operations in the harsh northern climate.

“The question on the agenda is to adapt the Register stringent requirements for ice ships to the current ship owners’ needs and opportunities without detriment to operational safety”, Maxim Boyko, head to Department of Scientific Research, noted.

Among the issues addressed by the Register is the opportunity for reducing requirements in respect of the annual dry-dock survey of ships. According to Boyko; “The time interval extension between these surveys would be possible due to a number of alternative measures: underwater hull survey, monitoring of hull-structural strength, hull damage, propulsion plant and steering gear, application of corrosion- and wear-resistant coverings on board. The research results will be incorporated in the RS Rules”.

The Ice Certificate issued by RS for ships of a different type is also to be elaborated on in accordance with technological developments.



Maxim Boyko says there is a need to adopt RS requirements for Ice Class Ships

At present, the certificate contains information on measures for safe speed mode observance and on distances a ship can cover in ice. Permissible conditions are developed on the basis of data on actual ice parameters, ship technical conditions, including that of propulsion plant and steering gear in each case. Further development of the certificate is cover for, not only normal operations, but

emergency modes of ship movement as well, when the speed and movement pattern is not controlled.

Infrastructure development for offshore fields implies the laying of subsea pipelines to ensure crude supply to single-point moorings to be then shipped by tankers. To promote a safe development of the resources of the North, the RS Rules contain additional requirements for pipeline construction in low-temperature areas.

The requirements include measures for pipeline protection from glacial exaration; that is protection from the bottom soil being ploughed by ice bodies, prescribing a protective layer of seabed soil as necessary proceeding from ice parameters and the results of ice gouge engineering studies. Besides, compliance with RS requirements for materials and scope of steel pipes product testing is of great importance to reduce risks of pipeline operation at low temperatures.

The process of designing equipment to operate in ice conditions is strategic by nature, since it requires serious investments and a solid scientific and technical basis. Development and elaboration of requirements in the safety sphere of ships and other ice navigation facilities is the priority trend of the RS scientific and research policy. *NA*

“A model not a critic”

After spending the bulk of his career at Pan Ocean Shipping Co., Ltd. Dr. BS Park joined the Korean Register as Chairman and CEO. After some months settling in to his new job he talks to *The Naval Architect* about his aspirations for the company and the challenges that the classification society faces

Intense competition, falling revenues, a static global economy and shipping and shipbuilding markets that are distressed is the difficult macro-view under which Dr BS Park has taken over as Chairman and CEO at the Korean Register (KR).

In addition to the economic difficulties the consequences of the *Sewol* disaster is still being felt, not just at KR, but throughout South Korea and the shipping industry. The life sentence handed to the captain of *Sewol* and the resignation of the former KR chief has added to the challenges that KR must overcome.

A former COO of the Korea P&I Club and CEO at Welson Korea Insurance Brokers Park took over following the departure of Chon Young-Ki, which was precipitated by criticisms levelled at KR over the inspections carried out on *Sewol* some two months prior to its loss.

The appointment of Park, however, is a new beginning; a chance to develop KR and to move on from the catastrophe of the last year. And the moves to develop the business have already begun.

“To cope with these complex and ever changing business surroundings, we have endeavored to diversify our business portfolio into non-marine sectors such as offshore, naval business, renewable energy and other related sectors. That said, KR is known the world over for its technology and we will maintain and enhance the quality of our technical services in all sectors and all market conditions,” explained Park.

In addition KR recognises that new technologies such as the increase in volume of relevant data, the so-called ‘BigData’ explosion, are “beginning to penetrate” the maritime market and the influence of significant regulatory changes and environmental awareness are all “game changers”, says Park.

For these reasons KR believes that its target for the future must be an advisory role to the industry. “Our goal for mid-long term management improvement and growth is to be a ‘Comprehensive



Dr B S Park says that the challenging economic climate will see the Korean Register diversify and expand its services

Technical Advisor’ to the maritime market. In addition, we aim to operate ‘Beyond Compliance’ to deliver high quality services that exceed our customer’s expectations.”

However, KR faces intense competition in the market from a number of class societies that are developing fast. To compete in this market KR is looking to add to the traditional classification services which focus on safety and quality of ships by developing survey guidelines including technical regulations for ships operating in challenging climates such as the Polar Regions and offshore facilities.

Such a move will require research and development of technology for energy efficiency of vessels in general and of gas-fuelled vessels in particular.

“Finally, we are working hard to create mutually beneficial partnerships across the industry to help implement regulatory compliance and deliver the bespoke solutions expected in the future. Our aim is to serve our customers beyond regulatory compliance,” explains Park.

Unfortunately the economic outlook may hamper the development of the maritime business in general and Park describes a bleak picture for the immediate future.

“It seems that the shipping industry will face many more challenging years due to continuing oversupply issues in the bulk carrier and tanker sectors. Growth in mega sized ships and high-efficiency vessels as

well as cost management activities will also intensify competition among shipping companies. Coupled with this, the prolonged economic downturn is likely to encourage a reorganisation of container shipping routes and changes in marketing networks. The emergence of shale gas and the redistribution of refineries will impact the tanker markets and low oil prices are expected to encourage shippers to press for lower freight rates,” he predicts.

Park admits that the “sluggish and complicated market” will inevitably affect the development at KR, but he insists the group is well positioned to support customers in both booming and contracting markets.

“A quiet sea will not make a great captain”, he says, adding, “You can tell the good captains by how they behave when facing unexpected events and extreme situations. The able captain will make brave decisions to overcome adversity and keep his ship on track.”

KR has suffered and overcome a series of hardships over recent years, particularly against the backdrop of the harsh economic climate.

Park’s mantra harks back to Stephen Corvey, the American author, educator and businessman, who said: “Be a light, not a judge. Be a model, not a critic’. During my tenure, I will work hard to assist my staff to achieve our goal of delivering quality technical services to our clients.” **NA**

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LNG tank 'fender' takes vessel design beyond B/5

Locating LNG fuel tanks in ships and the 1/5 B is a burning issue as new designs are developed. Alex W. Vredeveldt, senior scientist and Martijn G. Hoogeland, Project manager, both at the Netherlands Organisation for Applied Scientific Research, TNO report on the crash worthiness of gas powered ships

LNG is recognised as a viable fuel for ships, which will contribute significantly to a reduction of pollutant emissions, most notably SOx and particulate matter. The most convenient storage of the fuel is as a liquid, which implies storage at cryogenic temperatures.

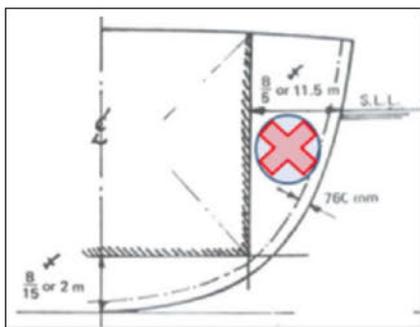
This is currently done in cylindrical double walled pressurised tanks, with the annular space vacuumed. This shape is not easy to fit in a ship design. Moreover up-coming IMO regulations require a minimum safe distance between LNG tanks and the ship's shell, which further restricts the naval architect's design space.

The idea described in this article is a first principles approach, towards tank placement, providing more design freedom without compromising safety, or even improving safety.

Safety considerations

IMO's draft international code of safety for ships using gases or other low-flashpoint fuels (IGF Code) stipulates a minimum safe distance between a storage fuel tank and the ship's shell of 1/5th of the ship's beam, B. At other levels the distance should never be less than 760mm (IGF 2014). Figure 1 illustrates these requirements.

Figure 1 Prohibited locations for fuel tanks



Alex Vredeveldt, senior scientist at TNO

Martijn Hoogeland project manager at TNO



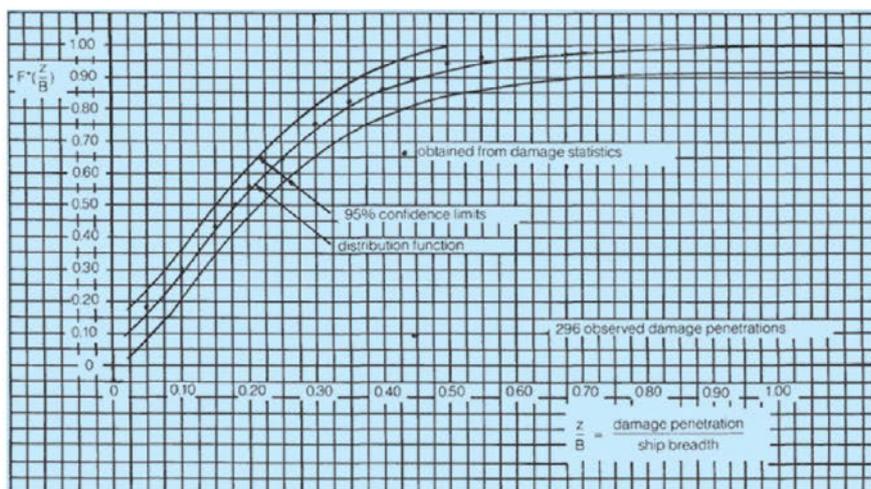
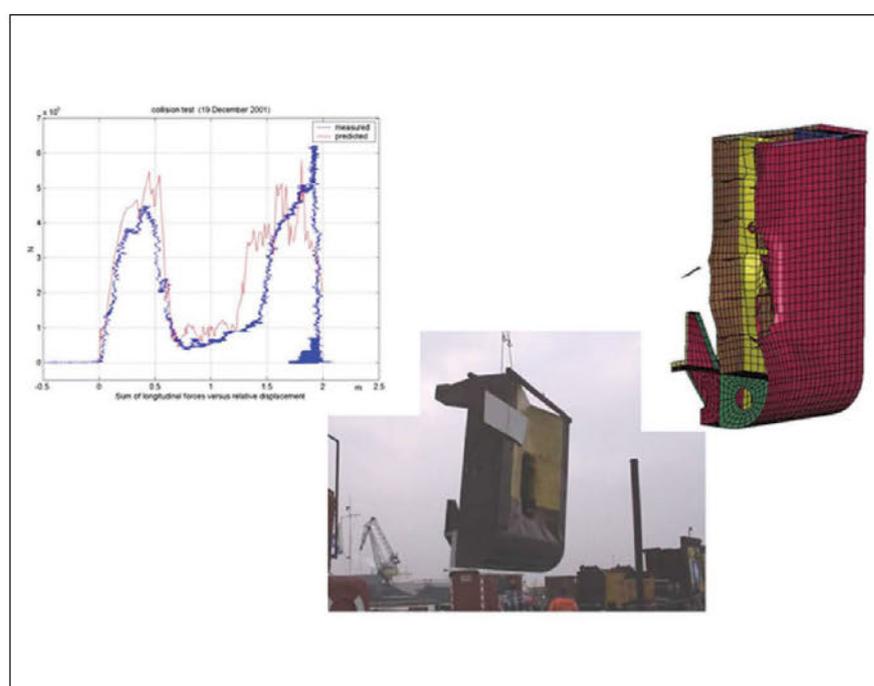


Figure 2 Damage statistics (Source: MCA 1999)

					Probability			
Rating	People	Assets	Environment	Reputation	A	B	C	D
					Has occurred in industry	Has occurred in a maritime company	Occurs at least once a year in a maritime company	Occurs at least once on a ship/platform
0	No injury	No damage	Zero effect	No impact	Green	Green	Green	Green
1	Slight injury	Slight damage	Slight effect	Slight impact	Green	Green	Green	Green
2	Minor injury	Minor damage	Minor effect	Limited impact	Green	Green	Yellow	Yellow
3	Major injury	Local damage	Local effect	Considerable impact	Green	Yellow	Yellow	Red
4	Single fatality	Major damage	Major effect	Major national impact	Yellow	Yellow	Red	Red
5	Multiple fatality	Extensive damage	Massive effect	Major international impact	Yellow	Red	Red	Red

Table 1 A typical risk matrix



This requirement has been taken from existing IMO regulations for sea going gas tankers (IGC 2014), which has proven satisfactory over the past 50 years. In fact the B/5 requirement has been copied from the early SOLAS regulations on damage stability which is inspired by damage statistics recorded between 1948 and 1966. Figure 2 shows the actual cumulative probability density function used at that time.

It shows that, given a collision, the probability of the damage penetration not exceeding 1/5th of the ship's beam equals 55%. It also shows that in 45% of the collision cases, this distance is exceeded. Obviously these statistics are outdated; ship structures have changed significantly since the late sixties of the previous century, so have ship sizes.

Double wall structures, bulbous bows, framing direction, improved material, tenfold increased gross tonnage (to name a few) all have influence on the resistance and impact during a collision. Another aspect is crashworthiness, that is the ability of a ship structure to resist a collision, which depends largely on the actual structural design and applied materials. This aspect is now ignored in IMO regulations.

A common way of dealing with safety, or rather risk in general, is through conducting a formal safety assessment. It defines risk R, as a multiplication of the probability of an undesirable event occurring by the effects of such an event. Table 1 shows a very useful, intuitive, display of risk. Likely events with severe effects are unacceptable. However, when effects are 'slight', a high occurrence probability is acceptable. Events with severe consequences, like an air craft crash, are acceptable only when their probability of occurrence is sufficiently low.

Crashworthiness and the probability of flooding

About 10 years ago, a European project was carried out on the effect of crashworthiness on the probability of flooding (Crashcoaster). The results were reported to IMO in an INF paper submitted by Germany (IMO 2003). It demonstrated

Figure 3 Comparison tests and predictions



Figure 4 Full scale collision test

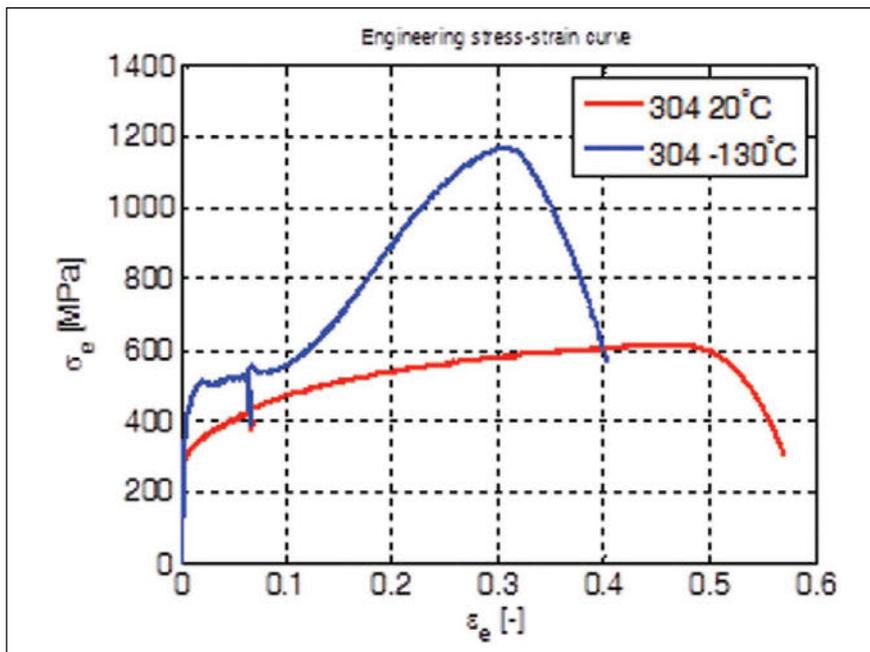


Figure 5 Typical stress strain curves 304 austenitic stainless steel, ambient and cryogenic

that predicting the collision energy absorbing capacity of a ship structure is feasible without excessive efforts.

Figure 3 shows a typical result from this project where results from an actual full scale collision test (Figure 4) were compared with simulation results. The depicted results refer to a short sea general cargo ship with a length of 80m. In fact the INF paper proposes a procedure where exceptional crashworthiness of a ship structure is 'rewarded' with a reduced

probability of flooding of compartments protected by such structures (and therefore a higher attained subdivision index A).

This approach is in fact adopted by the European inland waterway authorities albeit for tankers carrying hazardous cargo aiming at reducing the probability of loss of containment, rather than damage stability. It is now part of the regulations on the carriage of hazardous cargos on inland waterways (ADN 2014, chapter 9.3.4). As a consequence, many inland waterway

tankers are now fitted with a crashworthy side structure.

Crashworthiness of LNG tanks

Following the work done in the European project, an initiative was taken to investigate the crashworthiness of LNG storage tanks with respect to ship collisions. The main goal was to establish the actual tank vulnerability with the ultimate aim to calculate the probability of tank rupture and consequential loss of containment.

Since currently no technical evidence exists on the effects of a rupture of a pressurised vacuum tank carrying LNG fuel, one must fear for the worst, that is suffocation, BLEVE, fire and/ or loss of structure due to the brittle fracture of ship steels at cryogenic temperatures. Hence the application of such tanks is only acceptable when the probability of rupture and consequential total loss of containment, is sufficiently low.

There were two technical issues to solve;

1. Will the tank rupture when the volume reduction due to the tank deformation during a collision exceeds the volume of the initial vapour space over the liquid (liquid full condition)?
2. Will the structural material of the tank still behave in a ductile manner when subjected to a collision impact in cryogenic conditions?

The crashworthiness FE simulation software can cope with fluid/ gas structure interaction as well as temperature dependent material behaviour. The software was amended with a routine which calculates the steep internal pressure build-up in the tank in case of a 'liquid full' occurrence. Also tank material tests were done with full thickness specimens at cryogenic temperatures and realistic deformation rates.

Figure 5 shows typical stress strain curves for austenitic structural stainless steel 304, which is often used for LNG tanks. It is clear that yield stresses increase with low temperatures while fracture strains decrease, albeit that the actual values are still comfortably high.

Crash tests were done on small size tanks (20 litres), under pressurised and cryogenic conditions, which were used to verify the predictive calculation method.

Figure 6 shows a still of a high speed camera recording of this test. The deformation of

the tank closely resembles the predicted deformation as shown in Figure 7.

Towards the tank ends the diameter of the tank increased during the crash, due to the 'liquid full' condition. It is remarkable that the tank shell does not rupture, not even at large deformations. Apparently it acts as a fender. Moreover it is very encouraging to see that the simulation results match the test results satisfactorily, both with respect to structural strength and as gas-liquid-structure interaction.

Having established the validity of the simulation method, it was decided to analyse a typical pressurised cryogenic vacuum tank of 35m³, representative for inland waterway shipping. Figure 8 shows the predicted deformation in case of a collision by an inland waterway push barge. Figure 9 shows the calculated energy absorption values up to tank rupture, for three different filling ratios.

A 'full' tank tends to show a larger collision energy absorbing capacity compared to tanks with smaller filling ratios, mainly due to the 'fender' effect. It is interesting to note that collision energies available at the European inland waterways are assumed not to exceed 22 MJ (ADN 2014). Hence the absorbing capacity of the tanks is substantial. When scaled to sea going vessels, similar effects are to be expected.

A weak point of fuel tanks, as they are adhering to IGF instead of IGC, is the pipe penetrations. For storage tanks, one dome with various safety measures is required, while for fuel tanks multiple penetrations are allowed. Although the tank may not rupture, penetrations of piping into the tank probably will due to this inherent weakness. The associated outflow areas are expected not to exceed those of the piping. If this is indeed the case, loss of containment does not occur instantaneously and is expected to be manageable. There is no heat source, so evaporation goes slowly. This, however, still needs to be investigated.

Replacing the B/5 requirement

In this paper, it is shown that the crashworthiness of LNG fuel tanks



Figure 6 Still from tank crash test high speed video recording

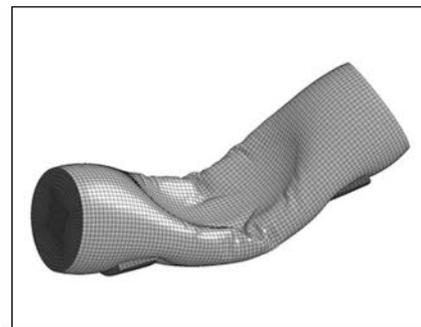


Figure 7 Predicted tank deformation

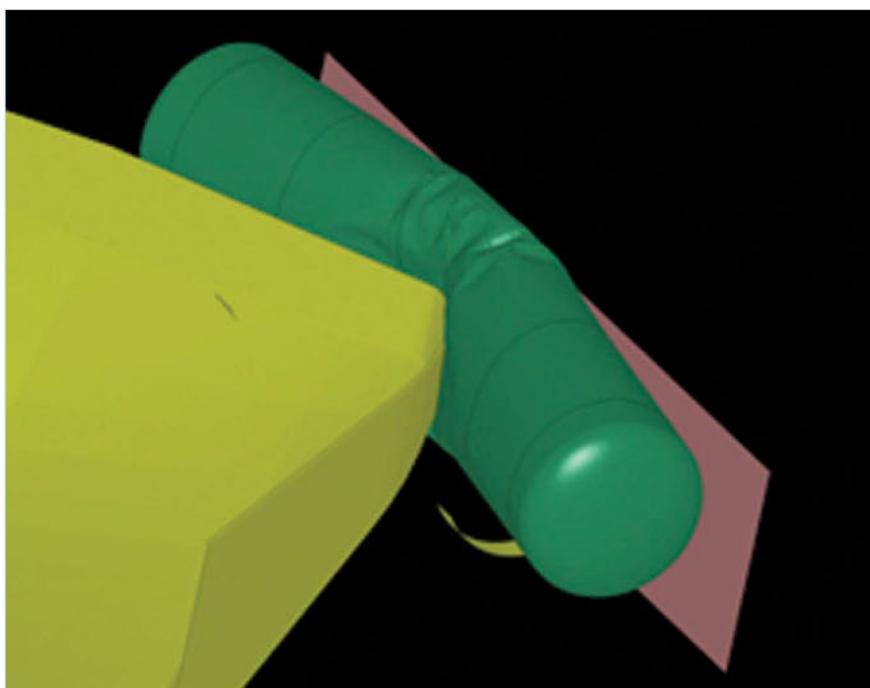


Figure 8 Simulation results 35 m3 cryogenic tank

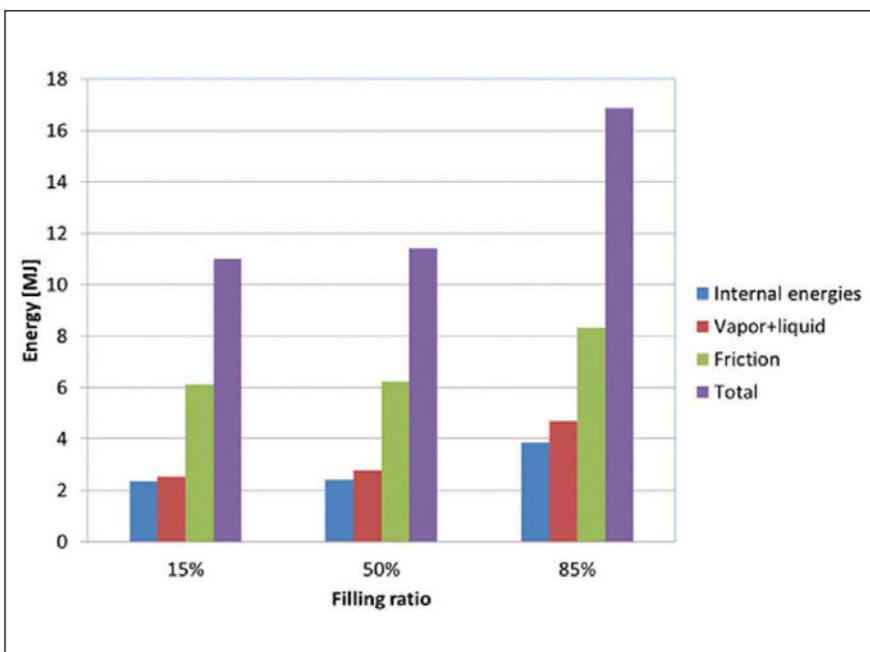


Figure 9: Energy absorption up to tank rupture

which contain fuel can be calculated. Moreover, the energy absorbing capacity is significant as fuel tanks act as fenders. However, the piping is a weak point and needs greater attention.

With these results available it is proposed to consider the vulnerability of pressurised cryogenic LNG tanks with respect to collisions explicitly. As yet, no probabilities of tank rupture were determined. However, such probabilities can be calculated through correlating existing damage statistics databases, in conjunction with automated identification of ships (AIS) shipping data, with collision impact absorbing capacities (crashworthiness) of cryogenic pressurised vacuum tanks together with the resistance of the ship structure. With such evidence, acceptable safe distances between tanks and the ship's outer shell can be determined for actual ship designs instead of hiding behind the B/5 rule, especially considering this rule is based on statistical data that is more than 50-years old.

The explicit approach of crashworthiness and effect analysis of 'slow' loss of containment is considered to be most beneficial particularly for dredgers, short sea shipping, ferries and cruise ships. *NA*

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Overcoming inertia towards new inert gas systems

Twin bed dry inert gas generators have been the industry standard for years, but advances in drying technology mean that shipowners and shipyards have a genuine alternative, writes Frode Lauritzen, engineering director of maritime protection at Wilhelmsen Technical Services

Innovation is a subject the maritime industry spends a lot of time talking about. With the multiple, challenges of regulatory compliance, operational efficiency and crew competence, the adoption of new technology and systems is often promoted as the answer to the industry's problems.

That may be true in part – and certainly when considering topics such as navigation, communications and operational efficiency – but when the subject is safety, the industry seems less able to take into account the reality of innovation.

This is despite fundamental changes that encourage it, such as the IMO's goal-based standards and the adoption by class societies of risk-based, probabilistic design approaches. However, as the entire industry is judged by its safety record and environmental performance, it is necessary to embrace new technologies.

Why inert gas systems?

Vessels carrying liquefied natural or petroleum gas – as well as crude and refined products – require by IMO regulation a system that generates inert gas to eliminate the potential risks of vapour explosion. Build-up of vapour can occur both on the



Frode Lauritzen says WTS's Maritime Protection IG system is cheap and compact to install and operate

voyage and during cargo operations. Either way, the outcome can be devastating.

Dirty cargoes, including crude oil and crude oil products normally require inert gas to be produced by burning diesel oil in a dedicated inert gas generator or using the boiler exhaust as the source.

For LNG and LPG tankers, a dry inert gas generator is used to produce the gas needed to inert and dry the cargo tanks, cargo piping and machinery and purge the tanks. The inert gas has an oxygen content of less than 1%. These systems need an additional cooler and dryer, compared with systems on traditional oil tankers which can use humid gas.

In addition, classification societies require that all tank inspections are carried out with a safe atmosphere where the oxygen level is increased to 21% before the inspection. This is achieved by operating the inert gas generator in fresh air mode to aerate cargo tanks. This can also be used for drying and aeration of the hold spaces.

Dual bed drawbacks

Traditional dry inert gas systems are generally dual bed systems. Dual bed dryers consist of two beds, or towers, filled with activated alumina adsorbent beads of between 4 and 8mm diameter, as well as process and regeneration heaters, cooler, blowers and valves to re-direct the airflow.

While one bed of desiccant supplies dry inert gas to flow through the drying vessel to the consumers, the other bed – with saturated desiccant – is regenerated, by forcing hot air through it.

When the regeneration is complete, the two beds run in parallel for a short time before the process is reversed and the regenerated bed becomes the one supplying the dry inert gas and the first bed goes into the regeneration mode.

Many modern LNG/LPG vessels are still fitted with this type of twin-bed inert gas system despite their many disadvantages.

These include long start up times and very high energy usage, because the system needs to regenerate the bed which is not in use. This requires a large volume of gas and also has a long cycle time, which allows the heat of adsorption to dissipate from the desiccant material, wasting energy.



The assembly of an IG cooler and dryer

Spikes and deviations in temperature and dew point can occur during the bed changeover process, with additional risks of dust carry over. Twin bed systems have a large footprint, meaning they take up a large amount of space in the engine room.

Their complexity means they have relatively high lifecycle maintenance costs and a relatively short life time of between six and eight years.

Assessing alternatives

In the last two decades, several major advances have been made to the drying technology used in inert gas generators and several types of dryers have been developed that overcome the disadvantages of dual bed dryers.

This is not to say that traditional technologies do not work – they do and have for many years – but that shipyards and shipowners continue to specify the old dual-bed technology suggests they are not aware of the new technologies available, or are content to put up with their inherent flaws.

Both shipowners and shipyards have preferred supplier and vendor lists. Shipowners will often look for a significant number of installation references before specifying new equipment. For some shipyards, as long as the suggested systems meet the required specifications and target price, then these are the systems they will specify.

In considering how to improve inert gas generator performance, increase operational efficiency and lower costs, Wilhelmsen Technical Solutions looked at other, well proven, alternatives to assess technology that had not been previously considered in maritime applications.

The result is a system – marketed under the well-known Maritime Protection brand - that replaces the traditional two bed adsorption dryer with a compact, rotating adsorption system. Dryers of this kind have been used for many years in other parts of industry for drying low pressure gases with great success, but Maritime Protection Inert Gas Systems are the first to have successfully adapted these for inerting purposes.

New approaches

The key element in the system is the rotation adsorber which results in a very compact adsorption dryer with a constant dew point and inert gas temperature, with no variations during the inerting process. Adsorption

rotor dryers – which feature desiccant rotor dehumidifiers - are far more efficient, more compact and require less maintenance than any previous dual bed desiccant dryer.

The rotor matrix is manufactured from alternate layers of corrugated sheets of silica gel and metal silicates, chemically bonded into a tissue of inorganic fibres in a honeycomb structure. As a result, the rotor has a small external surface compared with a conventional system, but also has a large internal surface.

This, combined with the special microstructure of the silica gel material, ensures maximum contact area to give the rotor a very high capacity for absorbing water vapour. The rotor is driven by a gear-motor with a timing belt transmission. A belt tension device prevents the belt slipping and overloading the rotor's motor.

The process of creating dry, clean and soot-free inert gas begins with the combustion of gasoil supplied by the fuel oil pump with air provided by blowers. The gas produced by the inert gas generator is led into the cooler and dryer skid through an inlet box designed to produce a uniform bulk flow through the cooler.

The cooler reduces the humidity to a dew point of +5°C before the inert gas is led into the rotating dryer. The cooling effect is provided through a glycol/water based system from

a separate refrigeration plant. In the dryer, the dew point of the inert gas is lowered to the required specifications below -45°C with oxygen content less than 1%.

The system comprises a series of compact modules, providing important savings in space and cost for the shipyard. It is a configuration increasingly preferred by shipowners too.

Installation is easier and less costly as the Maritime Protection DIGG system is 50% lighter and smaller in terms of engine room footprint compared with dual bed systems

The benefits in context

Maritime Protection inert gas systems are built in compliance with the IMO SOLAS Convention including its latest amendments and meet all Class and IMO guidelines in the demanding conditions of shipboard operation.

Ultimately, the big difference in how Wilhelmsen Technical Solutions approaches inert gas production is to focus on overall production quality by improving the performance of critical components – in this case the dryer units.

As a result, its inert gas units are not just easier to install and operate; they offer easier maintenance and more efficient operations. Maintenance is effected through a hinged burner front door allowing easy access. Filters, dryer rotor and other major components can be easily checked through inspection hatches.

With a short cycle time of around eight minutes it takes only 15-20 minutes from start up to delivery of inert gas to the tanks; far more responsive than dual bed systems, which may need four to six hours to start-up, saving operating costs and consuming less fuel oil and energy.

The system is fully automatic meaning it can operate unattended with no manual adjustments required. An intuitive operator panel displays all process parameters and different modes of operation can be selected. The unique design of the combustion chamber means there is no need for a drain to the bilge as any oil spill from the burner nozzle remains in the combustion chamber.

WTS' Maritime Protection IG systems have now been on the market for close to 10 years, and it has taken the industry a long time to recognise that the new solution could be adopted with minimal risk. The system has been delivered to more than 80 vessels. *NA*

Preparing the system on the assembly line



Classy coatings on ice

PPG Protective and Marine Coatings is fulfilling growing demand for 'ice class' marine coatings for hull protection. Developed in PPG's own facilities, *SIGMASHIELD* 1200 delivers abrasion and impact resistance in ice, combined with low friction properties. Christophe Cheikh, PPG Protective and Marine Coatings Product Manager reports

The coating, developed for very high abrasion and impact applications on decks and hulls, combines a top of the range phenolic epoxy with carefully selected pigments to provide exceptional performance in icy waters.

PPG says that increasing interest from owners specifying ice-capable coatings for newbuildings and existing tonnage as the potential of Arctic transits and Arctic offshore activity grows, has seen a surge of interest in its coatings.

SIGMASHIELD 1200 has already seen more than a decade of service on ships operating in areas of heavy ice formation, including the Baltic Sea and St Lawrence Seaway/Great Lakes system.

The size of the ice-going fleet is increasing as is the size of the ships themselves. Currently, around 10% of the ice class order book is above 60,000dwt, with the majority of the investments made by owners in Germany, China, South Korea and Norway. German owners have the second largest share of the order book and the largest proportion of the ice fleet, while China has the second largest ice-capable fleet on order.

Already proven in harsh ice conditions in different parts of the world *SIGMASHIELD* 1200 boasts a low friction coefficient in ice that has been confirmed by Aker Arctic Technology, a major independent testing institution, which specialises in low-temperature testing at the limits of ice-going conditions.

A case study

Based in The Netherlands, Wagenborg Shipping has more than 100-years' experience in North West Europe, the Mediterranean, trans-Atlantic routes and beyond. Its modern and environmentally friendly fleet of around 180 vessels



Ice is a major danger for marine coatings, and PPG has addressed this problem with its *SIGMASHIELD* coatings

has an average age of just 6.7 years with a capacity of 2,000–23,000tonnes. Tallinn Shipyard is a subsidiary of the industrial holding BLRT Grupp. Located at the mouth of the Gulf of Finland, the shipyard services vessels using ports in the Baltic States, Russia, Finland and on the east coast of Sweden.

The B-Class vessels *Balticborg* and *Bothniaborg* operate between The Netherlands, Germany, Sweden and the UK to a tight schedule with very limited maintenance time. They also face severe ice conditions in winter, so the hulls need excellent, long-lasting protection to ensure reliable, economical performance levels.

When approaching PPG, the owners' key priority was to ensure maximum return on investment by selecting a coating which would minimise damage, reduce subsequent repair costs and improve operational efficiency.

PPG offers two abrasion and ice-resistant coatings, *SIGMASHIELD*

460 and *SIGMASHIELD* 1200, which both work with anticipated ice conditions during service life. For the *Balticborg* and *Bothniaborg*, regularly sailing in heavy ice conditions during the harsh Baltic winters, *SIGMASHIELD* 1200 coating was recommended to provide optimal underwater hull protection.

The coating, developed for very high abrasion and impact applications on decks and hulls, combines a top of the range phenolic epoxy with carefully selected pigments offering what PPG claims is an "exceptional performance in icy waters".

The benefits

Ice is indisputably the major source of danger for a hull's outer shell coating. PPG addresses this potentially destructive situation by combining these key attributes:

- Outstanding impact- and abrasion resistance; smooth surfaces promote fuel savings

- Excellent cathodic protection and creep resistance
- Standard- and low-temperature version for enhanced curing performances
- Excellent application properties; also possible in winter conditions
- Single-coat application using standard equipment
- Easy maintenance and repair
- Excellent creep resistance, reducing size (and hence cost) of repair areas
- Recognised by Lloyd's Register as an abrasion resistant ice coating
- Recognised by Aker as a low-friction surface coating for ice-breaking ships

SIGMASHIELD 1200 was tested on Wagenborg's offshore vessels

Antarticaborg and *Articaborg*, which operate in the Baltic Sea during the most heavy ice conditions. The results convinced Wagenborg to apply the coating on two of their ro-ro vessels *Balticborg* and *Bothniaborg*.

After reviewing PPG's product specification and guarantee, Wagenborg was confident that SIGMASHIELD 1200 would give optimal protection for their vessels. Following detailed examination of the *Balticborg* project, the customer was delighted by the coating's performance and ease of application. Tallin Shipyards also reported that, following the advice from PPG's technical surveyor, few adjustments

in working procedures were needed to make the coating application process particularly easy.

Izak van Rhijn, Technical Superintendent of Wagenborg Shipping commented: "In the wintertime they face severe ice conditions and thus need excellent protection for the hull. After reviewing the specification of the product and the guarantee given by PPG we were convinced that this product would give the optimal protection to our vessels. Another big benefit of this product is the single-layer application. No undercoat or second layer is required, which saves valuable time and thus money, during the dry dock period." *NA*

Keeping your guard up

HEMPAGUARD X5 and X7 are the first products on the market to utilise the patented ActiGuard technology. Kim Flugt Sørensen, Dorte Hillerup, Anders Blom, Stefan Møller Olsen, Diego Meseguer Yebra explain how the technology works

By fusing hydrogel-based Fouling Release technology with a controlled release of biocide, ActiGuard provides a biocide-activated hydrogel surface, simultaneously controlling the release of biocide.

This paper shows, amongst other things, how the biocide release-rate in ActiGuard is independent of sailing speed unlike traditional antifouling coatings. This means that ActiGuard-based coatings deliver extraordinary antifouling performance under idle conditions, but does not waste unnecessary amounts of biocide while the ship is sailing, thereby extending its active lifetime.

Due to the silicone binder, HEMPAGUARD has the same initial fuel efficiency offered by silicone-based Fouling Release coatings. However, the fuel efficiency is extended dramatically due to the protection against fouling provided by ActiGuard.

The antifouling performance of HEMPAGUARD greatly exceeds that of any antifouling systems regardless of sailing



Figure 1: Comparison of static performance of 3 different Fouling Release technologies. The pictures have been taken after 8 months of static immersion in Singapore

speed and water temperature, hence solving the problem of long idle periods in fouling-aggressive waters. Considering together the limited amount of biocide utilised and the significant impact ActiGuard has on antifouling performance, this technology marks the beginning of a new era of

unprecedented fuel-efficiency from Fouling Defence coatings.

Fouling Release

Fouling Release coatings do traditionally not contain any biocides. Instead, biofouling is prevented by physical means

Source	Δ Friction coefficient%	Remarks
Weinell et al. [2003]	6.1%	Rotary study. Topcoat on smooth PVC
Candries et al. [2003]	3.5%	Rotary study. Full system on smooth PVC
Schultz [2004]	3.0–4.0%	Full system on 304SS. No sandpaper strip
Candries and Atlas [2005]	5.3%	Topcoat on smooth steel. Turbulent boundary layer measurements
Westergaard [2008]	1.4%	Towing test. Full system on smooth Al/smooth under-coats
	5.0%	Towing test. Full system on Rz50 467 μ m panels

Table 1: A summary of the reported differences in friction coefficients between freshly immersed antifouling coatings and freshly immersed Fouling Release coatings. A positive relative difference in friction coefficient is in favour of Fouling Release.

(i.e. smoothness, flexibility and surface tension) [Yebra et al. 2004]. The first generations of Fouling Release coatings were highly hydrophobic. This meant that the adhesive of biofouling organisms could hardly wet the surface. Therefore the strength of adhesion was low and the flexibility of the coating allowed the seawater current to peel off the biofouling organism during the operation of the vessel.

However, these coatings were dependent on a relatively high activity and speed in order to be efficient in preventing accumulation of biofouling. Typical requirements were an activity level of 75% at or above 15 knots to sustain their self-cleanability [Yebra and Catalá 2011].

In these conditions, good performance against shell fouling and macroalgae were seen, but at high activities and temperatures, slime still accumulated [Yebra and Catalá 2011]. A well-developed slime layer serves as a substrate for other fouling organisms, ultimately compromising the non-stick properties of the silicone surfaces. Therefore, the fuel-efficiency of the first generation of Fouling Release coatings decreased significantly over time.

Hydrogel-based Fouling Release

In 2008, Hempel A/S launched a hydrogel-based Fouling Release coating inspired by state-of-the-art biomedical

research. They thereby moved the concept of Fouling Release from hydrophobic surfaces to the opposite extreme: super-hydrophilic hydrogels. To increase biofouling resistance, these coatings contain a hydrophilic modified silicone polymer that migrates to the surface upon immersion and creates a hydrogel layer at the outermost surface of the coating [Yebra and Catalá 2011].

The hydrogel-surface offers a potent means to protect against biofouling organisms. Figure 1 shows a comparison of the antifouling performance between a hydrogel-based, a hydrophobic (pure silicone), and a fluoropolymer -based Fouling Release coating. The figure shows the performance after 8 months static immersion in Singapore. It is evident from the figure that the hydrogel-based coating deters biofouling better than any of the other Fouling Release coatings. These results are in agreement with several investigations previously reported in the scientific literature (e.g. Zhang et al. [2013], Zargiel and Swain [2012], Scardino et al. [2012], Zargiel et al. [2011]).

Even though hydrogels offer a significant improvement to the performance of Fouling Release technology, all conventional Fouling Release systems tend to decline in performance over a five-year operational period. Further improvement of the performance was therefore needed to prolong the fuel-efficiency of Fouling Release coatings.

Biocide in Fouling Release coatings

Biocide release from Fouling Release coatings has, until recently, not been possible due to:

- Only low amounts of biocides can be used to maintain surface smoothness and low surface energy
- A very rapid release of biocides from the silicone matrix, which is not optimal for controlled release purposes

The figure 2 below shows the effect of adding biocides to commercial Fouling Release coatings, it is evident that the biocides do not improve the performance compared to a biocide-free hydrogel-based Fouling Release coating.

Figure 2: comparison of biocide-free and biocide containing commercial Fouling Release coatings. Left: Hempasil X3 (no biocide) after 7 months immersion in Singapore. Right: Hempasil 77500 with biocide after 7 months in Singapore.



With the introduction of the ActiGuard technology, it has become possible to exploit biocides in silicone-based coatings and thereby further prolong the fouling-free period of these types of coatings.

Fuel efficiency

Clean Fouling Release coatings are known to possess improved fuel-efficiency over conventional antifouling coatings [Schultz 2007]. This is due to the smoothness and lower friction coefficient generally associated with silicone coatings [Yebra and Catalá 2010].

Table 1 shows a summary of the differences in friction coefficient between clean Fouling Release coatings and self-polishing antifouling coatings, as reported in the scientific literature. It is seen that Fouling Release coatings consistently show less drag-resistance than antifouling coatings. However, these results are all based on freshly immersed coatings, and, in order to retain the fuel efficiency for a given coating, it needs to stay as clean as, or cleaner, than the antifouling counterparts.

General coating characteristics

The extremely efficient utilisation of biocide offered by ActiGuard (see later in this text) allows for keeping the pigment volume concentration very low. Hence, the coatings can resemble conventional Fouling Release coating in their physical properties. In fact, HEMPAGUARD coatings share many of the same physical properties as hydrogel-based Fouling Release coatings: They are based on a silicone elastomer; they have a low content of pigments and fillers and they have a low content of Volatile Organic Compounds.

Surface smoothness

The low amount of biocide in HEMPAGUARD ensures that the coating is very smooth after application. This is a highly distinctive feature of silicone-based Fouling Release coatings [Yebra et al. 2004]. Figure 3 shows the surface morphology obtained using laser profilometry on a fresh and an aged HEMPAGUARD coating compared to that of a conventional self-polishing antifouling coating (SPC). It is seen that there is a significant difference in surface roughness between the two coating

types. Furthermore, HEMPAGUARD remains largely unaltered after seawater exposure while the SPC becomes visibly rougher at the microscale.

ActiGuard technology

ActiGuard works by forming a biocide-activated hydrogel on the surface of the coating. The hydrogel traps the biocide during diffusion out of the film thereby increasing the surface concentration of the biocide and prolonging the retention time of biocide in the coating matrix and on the surface. The working mechanism of ActiGuard is schematically illustrated in Figure 5.

The figure illustrates how the concentration of biocide in the hydrogel surface of the coating increases for a coating based on ActiGuard. This is because the biocide is trapped in the hydrogel on the way out of the coating. In addition to very effectively utilising a minimal amount of biocide, it also means that the biocide concentration can be kept at a level where the silicone coating retains its smoothness and flexibility.

Biocide content

ActiGuard needs only a very limited amount of biocide to work efficiently during prolonged immersion. Figure 5 shows the average biocide content surface area of coating for HEMPAGUARD X5 and X7 compared to a conventional silyl acrylate antifouling specification. It is evident from the figure that the biocide content in a typical ActiGuard-formulation is almost negligible compared to that of conventional antifouling.

Biocide release

The biocide release-rate from ActiGuard can be described by the Ficks' laws of diffusion. The theoretical biocide release shown in Figure 6 has been modelled from laboratory testing and the model predictions have been verified by ship-scale trials.

Biocide release rate over time

Biocide release from non-polishing film matrices has historically been used for marine fouling prevention [Yebra 2004]. However, compared to these technologies, ActiGuard keeps a high and stable biocide release-rate.

Figure 7 shows the development in biocide release-rate from ActiGuard. Also shown in the figure is the relative biocide release-rate of a conventional, non-polishing, antifouling coating containing the same amount of biocide; it is seen that for ActiGuard, the release-rate is kept higher and more stable than for other non-polishing coating types. The stable release-rate ensures efficient utilisation of the biocide, while still protecting effectively against fouling.

Biocide release-rate as a function of temperature

The release-rate of biocide from ActiGuard-based Fouling Release coatings is sufficient to prevent fouling and very stable as shown above. However the biocide release-rate varies with temperature. For a vessel protected from fouling by ActiGuard, an increase in temperature of the surrounding seawater will cause an increase in biocide release-rate.

However, since fouling pressure also changes with temperature, the temperature dependency of ActiGuard is an important factor in preventing fouling at all temperatures. In fact, comparing the development in biocide release-rate from ActiGuard to the temperature dependency of fouling accumulation rates, as reported by Egan (1987) gives the plots shown in Figure 8.

It is seen that the biocide release rate from ActiGuard follows the increasing fouling pressure. This means that ActiGuard utilises the biocide effectively. At low temperature, where the fouling pressure is low, the release-rate from ActiGuard is correspondingly low. However, the release-rate will increase with the increasing fouling pressure, arising from the higher water temperature. Hence no excess of biocide is released unnecessarily from ActiGuard.

Biocide release rate as a function of travelling speed

One major advantage of the ActiGuard technology compared to any antifouling technology to date (including the now banned tin-based) is the stable biocide release-rate irrespective of travelling speed.

Measurements of biocide leaching have been performed on samples immersed dynamically at speeds ranging from 0.08 knots to 20 knots. The results are shown

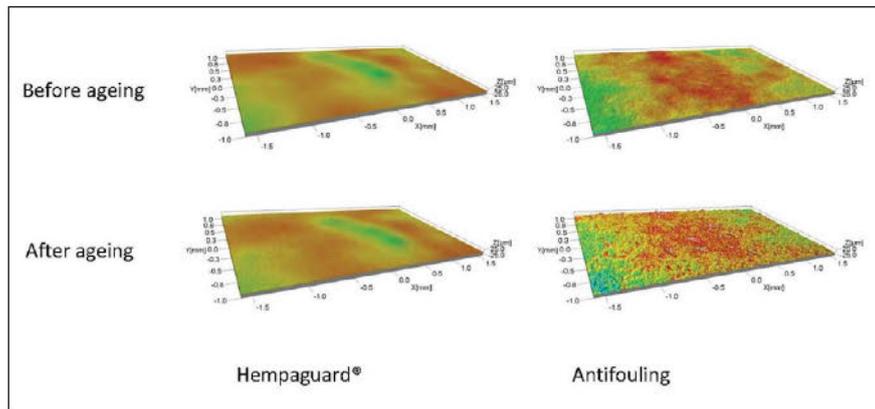


Figure 3: Smoothness of HEMPAGUARD® (left) and a SPC antifouling (right) before (top) and after (bottom) aging.

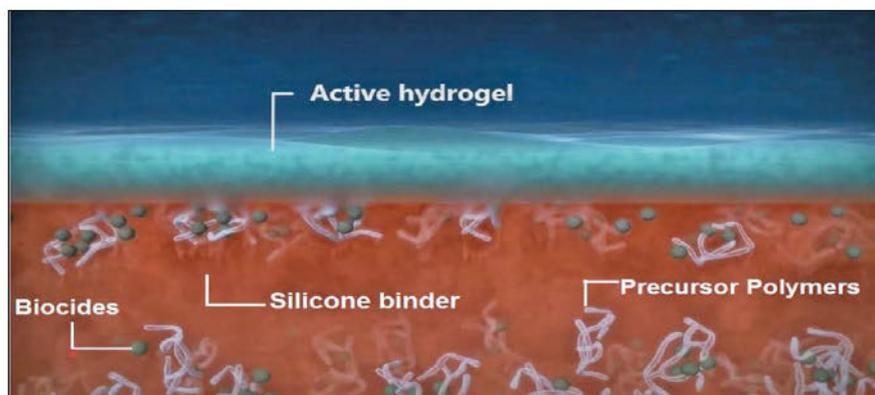


Figure 4: schematic illustration of the working mechanism of ActiGuard

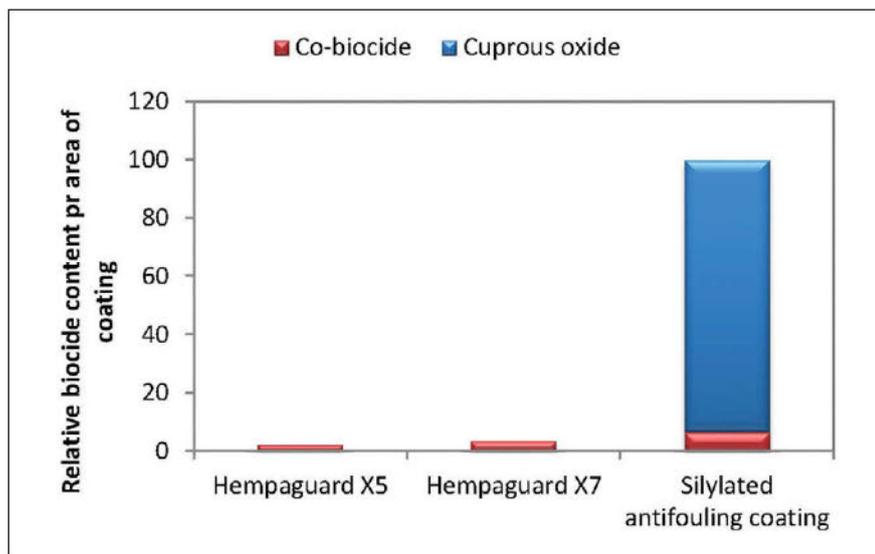


Figure 5: Average biocide content per surface area for HEMPAGUARD X5 and X7 systems compared to a conventional antifouling system. The calculation is based on conventional specifications (150µm DFT for HEMPAGUARD and 280µm for the antifouling system)

in Caption: Figure 9. The figure shows that the release-rate of biocide from ActiGuard is stable between 0.2 and 20 knots. This means that even at static conditions, where

the sea current is more than 0.2 knots, the biocide release-rate is equal to that of a vessel travelling at 20 knots. At currents down to 0.1 knots, the release-rate of biocide is 85%

that of a ship sailing at full speed. This is a key factor allowing vessels with very low speed and activity to be protected against fouling.

From an environmental perspective, the stable release of biocide irrespective of travelling speed means that less “waste” biocide is released into the environment. Conventional antifouling coatings release more biocide when the flow-rate is higher [Kiil et al. 2002]. Due to the lower fouling pressure at higher flow-rates, conventional antifouling therefore utilise biocides inefficiently. A final advantage of this speed-independent behaviour is that, whereas conventional antifouling coating systems are specified according to the speed of operation and water-type, ActiGuard-based specifications only depend on the trading waters of the vessel. This also means that the sailing pattern can be changed during operation without affecting the service-life of the coating or its efficiency.

Static performance tests

Numerous performance tests have been carried out in order to assess the antifouling performance of the HEMPAGUARD systems. The test show the comparison of HEMPAGUARD coatings to the biocide-free Fouling Release coating, Hempasil X3. The comparison is done based on static immersion at different locations around the world. It is evident from the figure, that irrespective of the marine environment, the HEMPAGUARD systems perform significantly better than the current state-of-the-art hydrogel-based Fouling Release technology.

Fouling protection of scratches

Damages are prone to occur on all antifouling systems including Fouling Release and Fouling Defence coatings in certain areas of the vessel. Until now, Fouling Release systems have been defenceless once damaged. However, ActiGuard’s activated hydrogel provides a window of defence for the coating even after damage.

It is seen that HEMPAGUARD coatings are still able to deter fouling even under these conditions. However, as the coating acts as a reservoir for biocide, removing part of the coating will also remove an equivalent part of the protecting agent. The performance of damaged areas of HEMPAGUARD is therefore limited compared to that of an

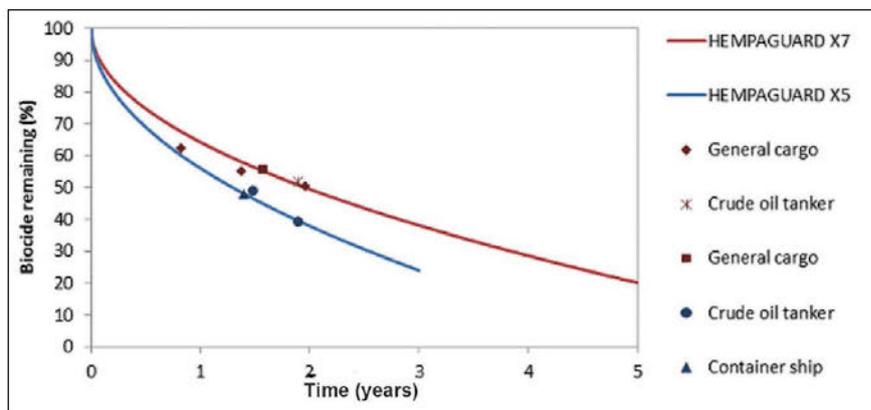


Figure 6: Real-life testing compared to modelled biocide release. All examples are trading ships

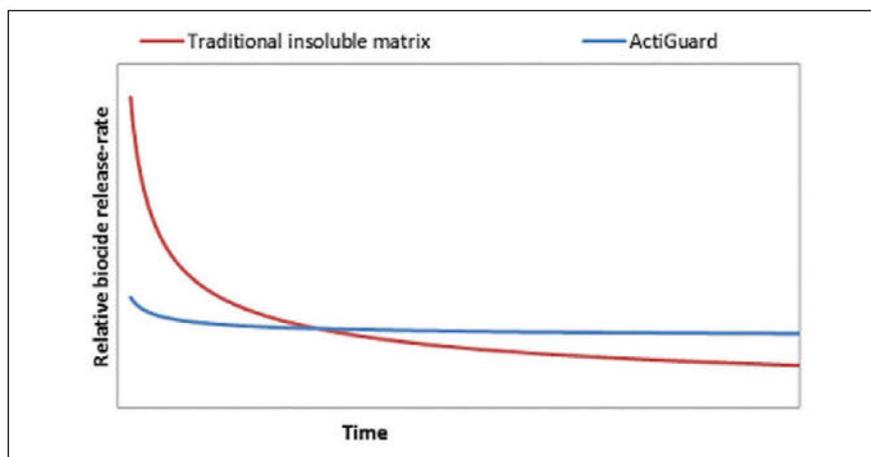
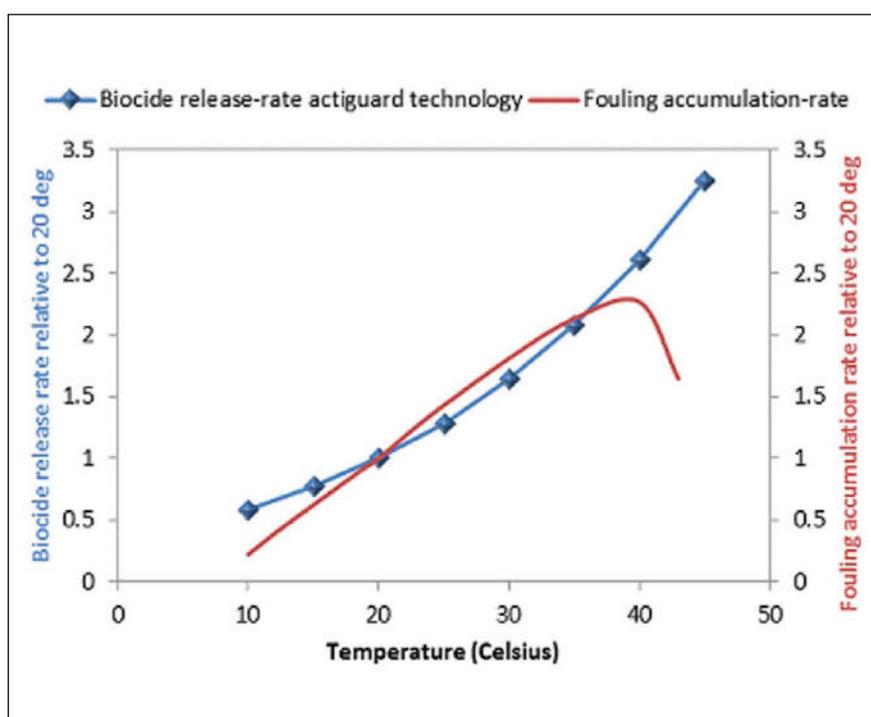


Figure 7: Comparison between the development in biocidal release-rate between ActiGuard and a conventional insoluble matrix antifouling coating. Both coatings contain the same amount of biocide initially



intact coating. Severely damaged panels immersed in Singapore (strong fouling pressure) have been seen to remain fouling free between 2 to 4 months during static immersion.

In addition to rough damage inflicted by a spatula, scratches inflicted by roughening of the full coating surface using sandpaper have also been tested. It is seen that whereas the conventional Fouling Release coating has lower performance after roughening, HEMPAGUARD retains its good performance even in static conditions.

This effect is also seen in Figure 12, showing pictures taken during an underwater inspection of a HEMPAGUARD test patch after 22 months in service. The area is damaged by scattered scratches, but it can be seen from the figure that HEMPAGUARD still shows excellent performance.

Conclusions

ActiGuard is a novel technology that fuses antifouling and Fouling Release technologies via biocidal activation of a hydrogel-layer. This enables ActiGuard to offer fouling protection while minimising the biocide release to the environment. HEMPAGUARD X5 and X7 are the first Fouling Defence coatings based on ActiGuard. Because the binder system in HEMPAGUARD is silicone, it offers long-term fuel-efficiency via a very smooth hull which remains free from fouling for longer than alternative technologies available in the market.

Considering the limited amount of biocide utilised in ActiGuard to efficiently prevent biofouling together with the significantly improved fuel-efficiency. NA

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Figure 8: Comparison of the development of biocide release-rate from ActiGuard and fouling pressure as a function of temperature.

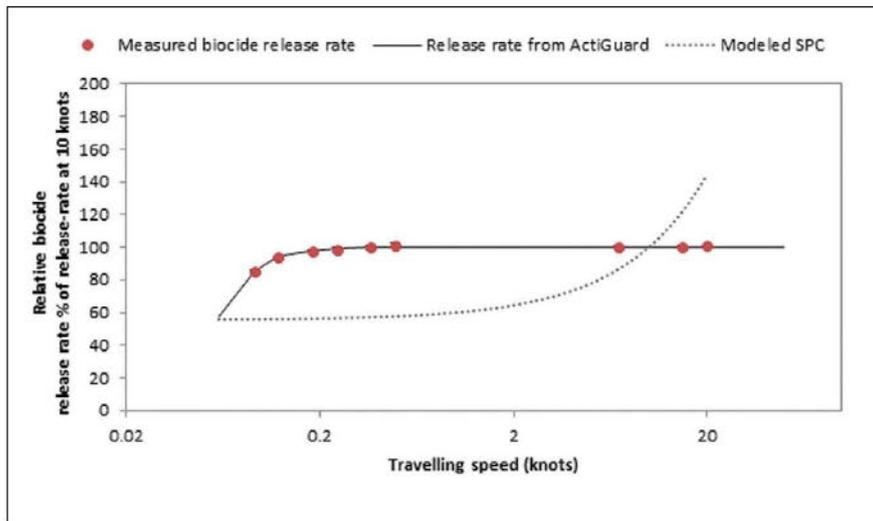


Figure 9: Relative biocide release rate from ActiGuard as a function of travelling speed (10 knots as reference speed). Also indicated is the relative biocide release rate from conventional SPCs, adapted from Kiil et al. (2002). Note the logarithmic scale on the X-axis.

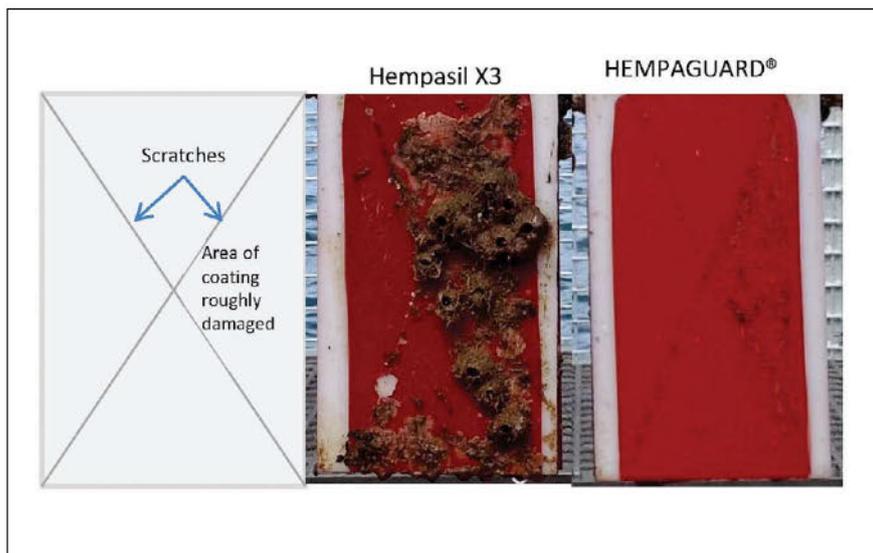


Figure 10: Pictures of damaged panels after 20 months immersion in Spain. Left: illustration of the panel's damage-patterns. Middle: Hempasil X3 with heavy fouling on damaged areas. Right: HEMPAGUARD coating.



Figure 12: Pictures of a test patch that has been mechanically damaged by scratches. The pictures were taken after 22 months in service.

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Figure 11: Pictures of panels damaged by sandpapering. Left: Hempasil X3 compared to Hempaguard after 19 months immersion in Spain. Right: Hempasil X3 compared to Hempaguard after 11 months immersion in Singapore

The appliance of science

Water ballast tank coatings are fundamental to the structural integrity of ships. It is, therefore, essential that they are applied correctly. Nippon Paint Marine has developed an innovative coating that enables a yard to maximise efficiency and gives the shipowner confidence that their tanks receive the optimum coating

Thickness is the key to a successful ballast tank coating. NOA60HS; a pure epoxy coating incorporating an SI (Self Indicating) function was developed exclusively for water ballast tanks (WBT) and was launched in Japan in October, 1997.

The SI function is based on the careful control of pigments and pigment transparency at certain thicknesses. Only when the correct thickness has been met does the coating become fully opaque.

Self-indication, therefore, helps both the applicator and the coating inspector recognise when the designed film thickness has been achieved during the coating's application.

NOA60HS showed its long-term-corrosion protection even before the implementation of the IMO's PSPC (Performance Standard for Protective Coatings, adopted in December 2006) aimed at a long-term corrosion protection for WBT.

Thanks to the PSPC rules' proven performance in practice, this functional coating has been widely used from LNG carriers to VLCCs and now its application records marks more than 930

vessels in newbuilding as of April 2015. It has also been successfully used in WBT repair / recoating jobs.

There are clear reasons why the technology is admired in the marine market, explained Akihiro Ueda, a technical general manager of Nippon Paint Marine.

Coating thickness

Coating thickness is the prime factor alongside surface preparation to determine the life of an epoxy coating. That's why measuring dry film thickness and the recording of those readings are mandatory exercises at the newbuilding stage.

Covering the substrate and giving it colour are the roles of paint. However, securing designed thickness throughout the area is essential for a marine paint to protect the vessel from corrosion.

Regular / standard epoxy coatings can cover and hide the substrate with only a dry film thickness of about 30-50microns. Paint sprayers and applicators build up thickness based only on their experience.

Even the most experienced sprayers cannot be certain to achieve the

correct thickness all over the huge and sometimes confined space of a ballast tank. Thickness of paint applied in the critical areas such as edges, corners, weld seams and cut-outs cannot be known or in many cases measured.

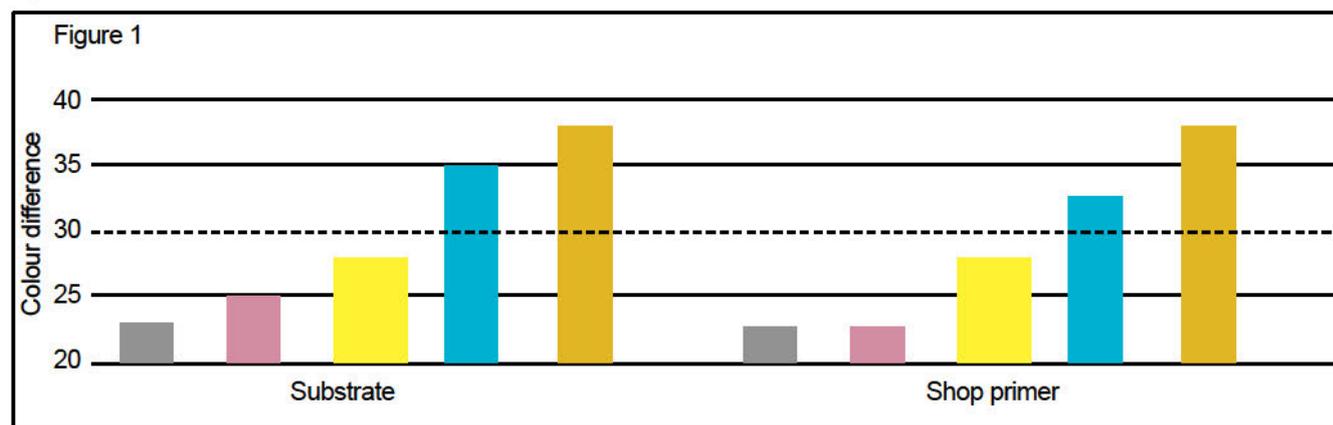
These are the areas where coating breakdown is likely to occur first. NOA60HS is different. During application its appearance changes from see-through (lucent) until it reaches its correct specified thickness whereupon it changes to a solid fully opaque buff texture.

This solid buff colour also shows thickness even on edges, corners and cut-outs; all the areas where regular coatings cannot be measured. The yard, class and the shipowner can all be sure that thickness is even and correct even in the most inaccessible areas to paint.

The paint applicator can therefore control the thickness with NOA while painting is in progress since the appearance of the paint film changes from its lucent tone to one of full texture as its thickness develops.

The final colour shade of the NOA60HS surface when dried remains the same as

Figure 1: Buff colours are more effective than other shades



when wet. Therefore, after painting any areas that have a low film thickness can be easily identified during inspection and repaired before going into service. This will avoid corrosion occurring after delivery and avoid the need for costly and time-consuming repairs.

Nippon Paint Marine has long been studying the hiding power of various coatings at their initial development stage. The company found that buff colour shades are more effective than other potential shades (Figure-1) as the colour that maximises the effect of the SI function.

Excessive thickness

Another concern when it comes to tank coating is that of excessive thickness on corners and welding seams. This extra thickness applied at the yard could lead to potential paint film cracking.

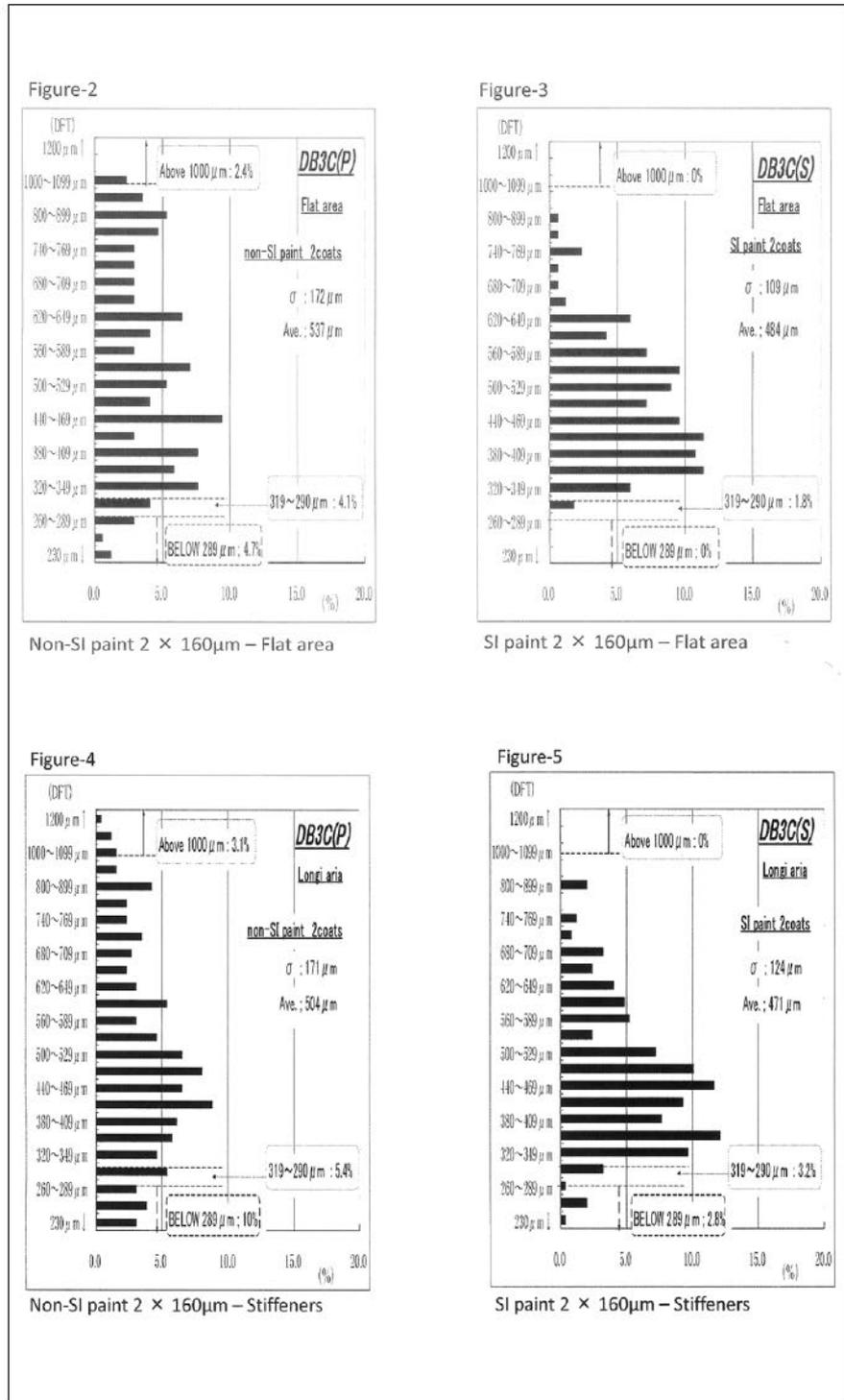
Figure-2, Figure-3, Figure-4 and Figure-5 show the result of film thickness distribution for a test / coating survey that was carried out at Imabari shipyard in Japan. The data of NOA taken from the flat surface and stiffener was compared to the relevant data obtained from tanks where ordinary / standard epoxy tank paint had been applied. The same structures in the tanks were chosen and the application was carried out by the same sprayer in order to make a fair comparison.

Both paints were then applied with the aim of achieving the required PSPC standard of 320microns in total (2 coats at 160microns per coat).

The results showed that using the same sprayer, 4.7% of all measurements for the standard epoxy paint were found to be less than the absolute minimum dry film thickness of 288 microns that is required by PSPC while only 1.8% of the readings taken on the NOA coated area was below this mandatory standard.

This same test showed that NOA60HS had no readings at all of over 1,000 microns in thickness. However, in comparison, 3.1% of the standard epoxy paint exceeded 1,000microns.

In summary, tests showed that the SI function of NOA proved that coatings with an SI can be applied both more evenly and is more reliable in securing the designed film thickness.



Results of a film thickness distribution test at Imabari, Japan

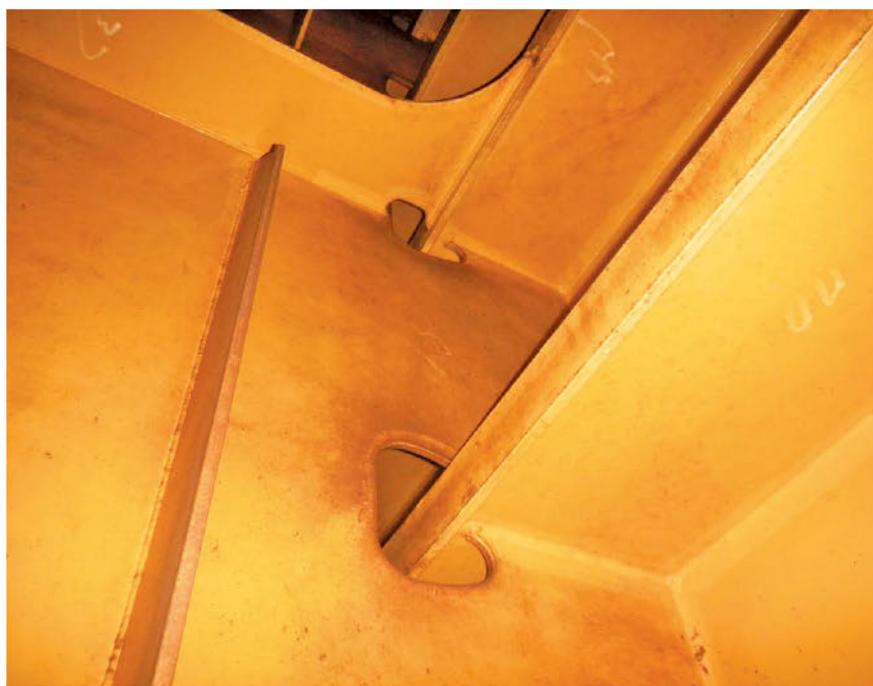
Despite many advances in shipbuilding technology, it should be remembered that paint application is conducted by human sprayers in shipyards and their skill and ability and consequently the result can vary a lot.

Even excellent coatings that perform superbly in laboratory tests can suffer

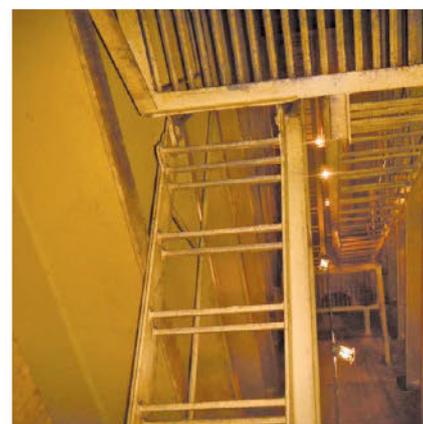
from sub-standard performance through poor application. In shipbuilding, and especially in tank coatings it is rare to find laboratory type conditions.

In Service

Once the coating has been applied, other essential factors for a successful coating



The ballast tanks of an LNG carrier showed a corrosion rate of 0.001% over 10 years



Nippon Paint Marine has been monitoring 24 ships coated with NOA60HS

in WBT are elasticity, adhesion and durability against electric current. These factors are carefully assessed by the test of PSPC.

In addition to being fully approved for PSPC applications, NOA60HS has further qualified for the so-called “alternative system” whose criteria is even tougher than those required for the standard PSPC rules.(see Figure-6 & Figure-7.)

Longevity

Nippon Paint Marine has been monitoring the condition of NOA60HS on randomly selected ships.

One LNG carrier, which is among the 24 ships monitored, had an inspection on its water ballast tanks after more than 10 years in service. The tanks kept in excellent condition throughout with a corrosion rate of 0.001%.

As the SI function gains popularity in the marine market, the technology has been incorporated into other functional coatings for marine use. NOA10F is designed for outside hull use for newbuilding ships while NOA10M is used for maintenance & repair purposes.

Finally, Nippon Paint Marine can reveal that based on NOA60HS, a new coating is under development with a target working life. Work is focussed on refinement and improvement of the SI function and adjustments to the coating’s film formation. [NA](#)

Items	Acceptance criteria for epoxy based systems applied according to Table 1 of this standard	Acceptance criteria for Alternative systems	NOA60HS
Blisters on panel	No Blisters	No Blisters	Passed
Rust on panel	Ri 0 (0%)	Ri 0 (0%)	Passed
Number of pinholes	0	0	Passed
Adhesive failure	> 3.5 MPa Adhesive failure between substrate and coating or between coats for 60% or more of the area	> 5.0 MPa Adhesive failure between substrate and coating or between coats for 60% or more of the area	Passed
Cohesive failure	≥3 MPa Cohesive failure in coating for 40% or more of the area	> 5.0 MPa Cohesive failure in coating for 40% or more of the area	Passed
Cathodic protection current demand circulated from weight loss	< 5 mA / m ²	< 5 mA / m ²	Passed
Cathodic protection disbondment from artificial holiday	< 8 mm	< 5 mm	Passed
Undercutting from scribe	< 8 mm	< 5 mm	Passed
U-bar	Any defects, cracking or detachment at the angle or weld will lead to system being failed	Any defects, cracking or detachment at the angle or weld will lead to system being failed	Passed

Figure 6: Acceptance criteria for PSPC system

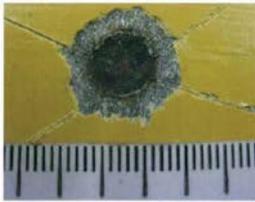
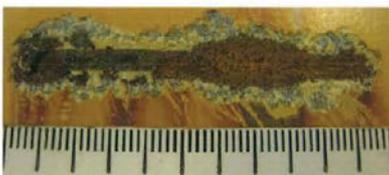
Test items	Criteria for alternative systems	Results
Cathodic Protection Disbondment from Artificial holiday	< 5 mm	 <p>Disbondment from holiday 2.7 mm</p>
Undercutting from scribe	< 5 mm	 <p>The undercutting along both sides of scribe < 3.3 mm</p>

Figure 7:

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The Royal Institution of Naval Architects

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Shallow draught steamers for the colonies

Empires, colonies and protectorates are out of fashion, but in the second half of the 19th century the idea of empire was seen as a natural one, with Britain the logical successor to Rome, Portugal, Spain and the Dutch. Richard White examines shipping in the days of Empire

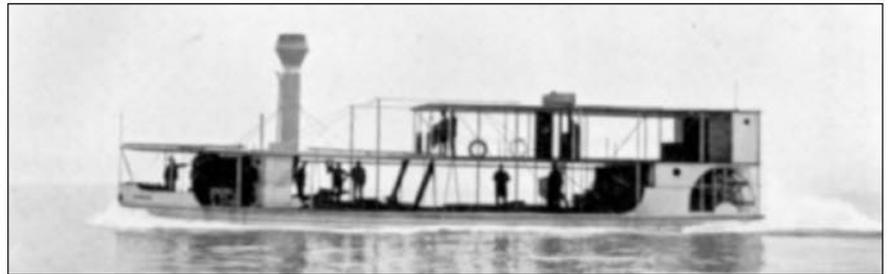
As long established controller of India and also of the world's seaways, the British were then engaged in competition with European states for control of Africa. While the underlying motives were influence and profit, the British were also world leaders in technology.

They saw as part of their duty to the countries they had taken control of to be the improvement of infrastructure, conspicuously railway networks, flood management and irrigation and much else besides. And part of the mother country's industrial capacity was occupied in building inland waterways vessels for various regions of the empire, often to be carried in small pieces far into the interior of the continents.

One very small component in a very large scheme in India was the subject of a paper read at an INA meeting in 1867, and it gives a flavour of the times. An example of vessels built to support infrastructure projects in the empire was a group of tug steamers for the Godavery River (now Godivara) in the 1860s. This river drains a vast area of central India. It arises in the hills only about 80km from the west coast of the country, but then flows nearly 1,500km east to a delta on the Bay of Bengal.

Historically it had been a region of flood and drought and periodic famine. In 1850s the British began a long series of works to control and use the river, beginning with a large barrage and continuing with other dams, canals and irrigation channels, in the end creating the "rice bowl of Andra Pradesh." As part of the long programme tugs were needed to tow barges, and their construction was recounted by the designer, James Napier, at an INA meeting in 1867.

Typical of the imperial way of working, the requirements were transmitted to the



Sternwheeler Karanga built by JS White in the UK for colonial service. A design philosophy very different from the classic US Mississippi steam-boat

mother country and the vessels designed and built there, then sent out to India. Also typical of the way new ideas and materials are tried out on smaller vessels before they find their way into large and valuable oceangoing ships, these cargo/tugs were to be built in galvanised steel.

People were aware that steel with its much greater strength would one day take over from wrought iron in shipbuilding, but the steelmaking processes of the time either gave small quantities of high quality steel, or material in greater volume with variable properties, one sample three times the strength of another of supposedly the same quality, and general unreliability, in particular a tendency to brittleness.

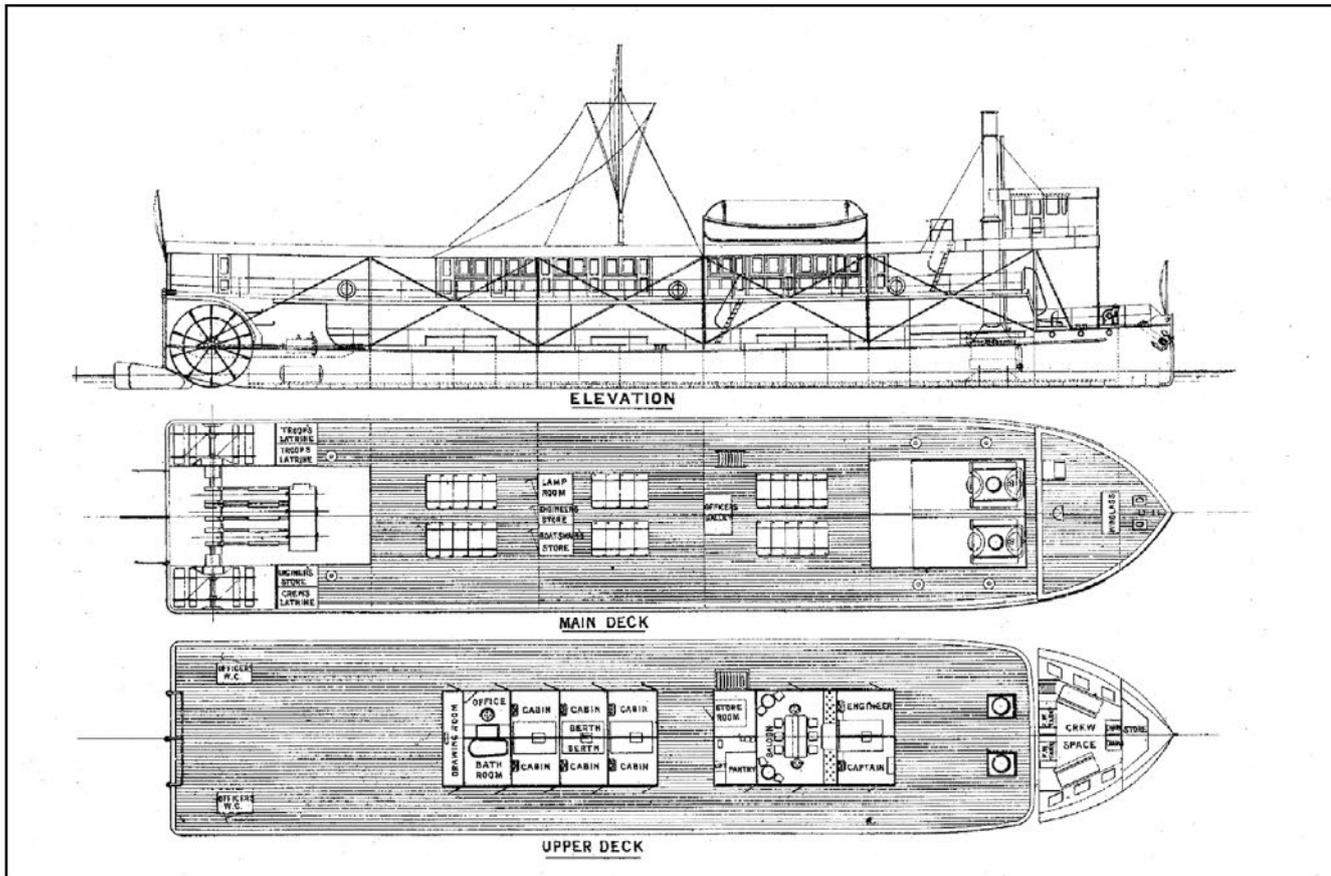
Napier reported that the tugs were being built by Randolph & Elder in Glasgow. Cast steel was specified for the bottom, 1/8 inch thick, supported by longitudinals at 2ft centres and galvanised. Barges were being constructed at the same time, and one of these would have a brass bottom, and one painted steel, the idea being to see how long the hulls retained their smoothness once they were operating on the Godavery river. Neither the cast steel or the subsequent galvanising were as even as hoped, but still were considered less rough than iron plates.

Construction of the tugs was ingenious. The hull itself was very shallow, with 1ft

maximum draught, 2.5ft freeboard and a displacement of 79tonnes on a length of about 130ft. As an open boat it would not be strong enough, so the shade deck 9ft above the bottom was made of thin steel as the upper strength member of a beam, the shear forces between hull and deck carried by an angle iron girder structure.

The INA audience was impressed by this way of achieving longitudinal strength in a shallow draught vessel. Because of restricted lock widths the tugs were given feathering sternwheel propulsion, with 8ft long twin rudders ahead of the paddlewheels. Power was provided by a compact twin high pressure steam engine. The boiler, of locomotive type working at 150 lb/in², was near the bow to give acceptable weight distribution. The towing hook was located at almost mid-length and above the shade deck. Because there was a good chance that the hull could be holed on the rocky riverbed, a powerful Giffard steam ejector was fitted, capable of pumping 2-300tons of water per hour.

Discussion of the paper centred on galvanising of steel; was it reliable, would it peel off? Once it wore off, what should be done? Napier's answer reflects the robust attitude to innovation of the time: "Do nothing, or paint the bare places. They will not be worse than old iron vessels with



Valiant built in the UK to carry cargo and passengers in Nigeria, with a 2ft draught. Note the split sternwheels and multiple expansion steam engine

the paint off; and it is possible they may be much better as I expect that the zinc will protect from corrosion more steel than it immediately covers. The vessels may be working seven or eight years, and save all the money in the meantime if successful; and if not, the Government will have spent about £8 per ton on a fruitless experiment.”

In 3000 pieces

Moving forward 40 years and changing the focus to Africa, a paper presented by Sir Edward Reed in 1906 reviewed vessels constructed during the previous decade or two for the marine departments of the many colonies and protectorates, whose requirements were handled by the Crown Agents. Most of these ships and boats of many sizes were designed and built in the UK and shipped out to where they were needed. Often this involved completely erecting the vessel and fitting it out, but with bolts between hull sections and loosely fitted equipment. It could then be dismantled and sent out in pieces.

An example given by Reed was two sisterships, *Winifred* and *Sybil*, twin screw

shallow draught passenger/cargo vessels destined to operate on Lake Victoria. After complete loose assembly in Britain each was divided into over 3000 sections and packages, shipped to Africa, loaded onto the new Ugandan railway at Kilindini and transported to the shore of the lake, where they were laboriously built up again and launched.

Sternwheel paddle steamers were favoured for many waterways, with shallow draught and limited beam. Comparatively simple machinery, according to Reed, “rendered possible the employment of native engineers with little skill; a consideration of much importance in the colonies mentioned, where Europeans can only be engaged at comparatively high salaries, and require frequent intervals of leave for the recuperation of their health.”

British stern wheeler design tended to take a different path from the classic Mississippi steamers of the US. Steel hulls were favoured, with canvas covered wood planks for the upper decks. Rather than a single full width paddle wheel at the stern and single expansion engines

turning cranks at the ends of the paddle shaft, designs from the UK often featured quarter wheels, where there were two wheels at the stern within the hull beam, turned by an engine between them. In some of Reed’s examples a triple expansion surface condenser engine was used for fuel economy. Reed argued that the split wheel vessels steered well with a single centreline rudder, whereas a full width sternwheeler would need two or three rudders.

But the sternwheeler was under threat from the tunnel stern propeller. Reed showed several vessels of various sizes, and summarised the advantages as higher propulsive efficiency, and the ability to use lighter, cheaper, engines than the heavy high torque machinery needed for large slow turning paddlewheels. With a propeller in a tunnel and nearly half its diameter above the static waterline shallow draught was not compromised, and Reed quoted the steamer *Rose*, built for Nigeria, with two 2ft 8in diameter propellers in tunnels and a draught of 1ft 7in.

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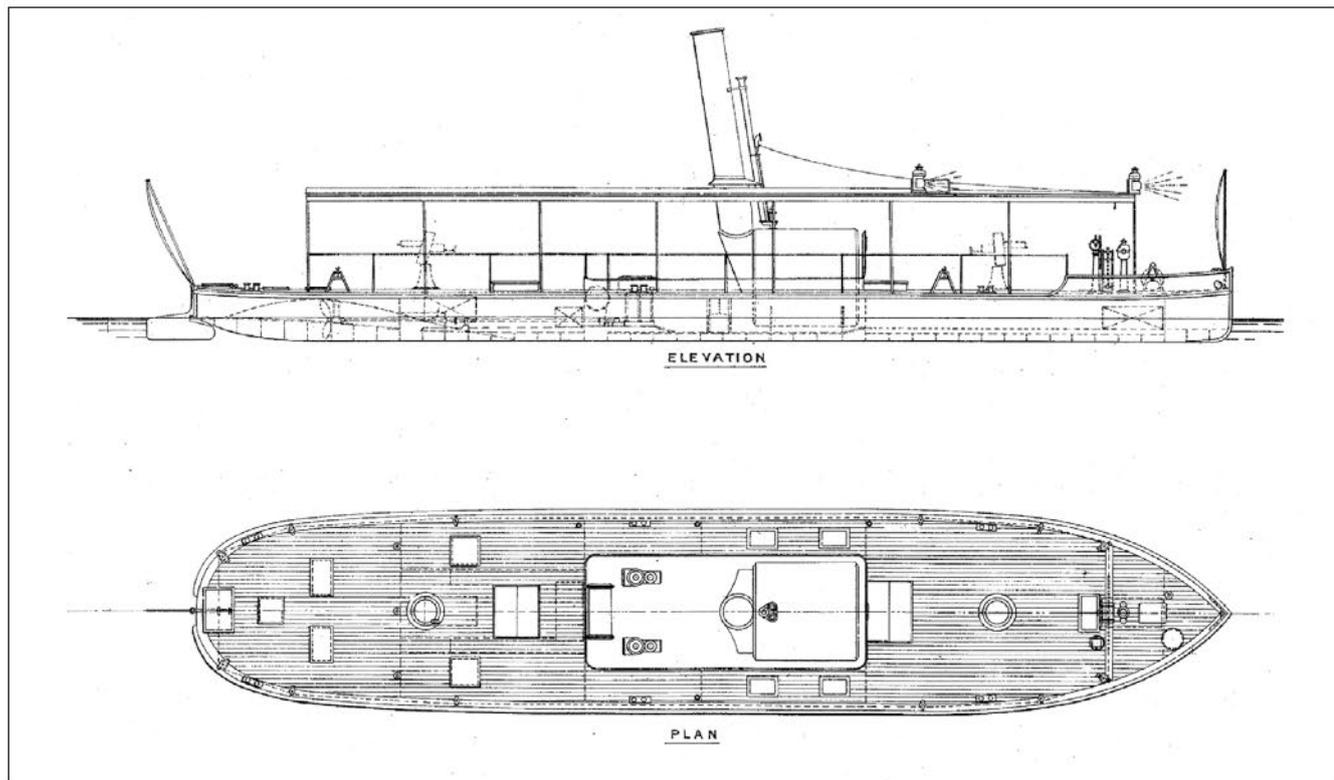
Sir Edward Reed was a man of wide experience, at that time Hon. Vice-President of the INA and a Fellow of the Royal Society. He had risen to be Chief Constructor, the head designer of British warships at a period of rapid technical change, but resigned and set up in private

practice, much of his design output being the types of vessel mentioned here.

In connection with meeting requirements from the colonies, he was fairly outspoken about the vagueness of some of the instructions received from the colonies via the Crown Agents, and

unrealistic demands for carrying capacity, speed, low power and shallow draught combined with low cost. Draught was often specified in an arbitrary fashion, and he pointed out that on these shallow river vessels, one more inch of draught gave a valuable jump in cargo capacity. *NA*

The small twin screw steamer *Rose* showing the tunnel which allowed propeller drive an shoal draught and lighter high speed engines



LETTERS TO THE EDITOR

Witness to the *Lucy Ashton* trials

Dear Sir,

Although I have been retired for many years and out of the marine business for longer, I still have much pleasure in reading *The Naval Architect*.

I was particularly interested in *Measuring Lucy's Resistance*, by Richard White [TNA April 2015 pg 52]. I was an apprentice engineer in Denny's Engine Works from 1950 to 1955, during the time the *Lucy Ashton* trials took place. In some way or another, we were all

involved and certainly kept informed of progress each day.

To work for Denny's was a most rewarding experience in many ways. Denny's was one of the few shipbuilders to have their own experimental tank and were involved in a wide range of research, often jointly with the BSRA, and produced numerous 'learned papers' to RINA, IMarE and IESS. In many cases the management and research team were entering 'uncharted waters' as was the case

with the *Lucy Ashton* trials, but the people involved were truly pioneers and I was privileged to have met them.

The press at the time knew nothing of the purpose of the trials, but the headlines were mostly speculating that they were jet propelled ships for the future!

Thank you for an interesting journal.

Douglas N Dick CEng. FI Mar.E, MRINA, MRIN

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Dr Kenneth W FISHER, FRINA

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Editorial Position

The Institution is looking for a person to join its editorial team, to work on *The Naval Architect* and *Shiprepair & Conversion Technology* magazines. Working with the Editors' the successful candidate will be expected to research, write, sub-edit copy and liaise with contributors. Applicants will be expected to attend industry events, both in the UK and abroad.

The successful candidate will need to be literate, numerate and be a team player who can develop relationships with senior industry players.

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LAMENTABLE INTELLIGENCE FROM THE ADMIRALITY

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.

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SHIPS AND SHIPBUILDERS: PIONEERS OF SHIP DESIGN AND CONSTRUCTION

By Fred Walker FRINA

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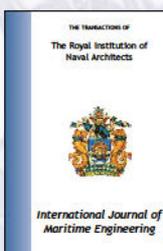
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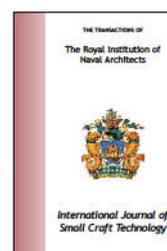
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www.workboatshow.com/

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