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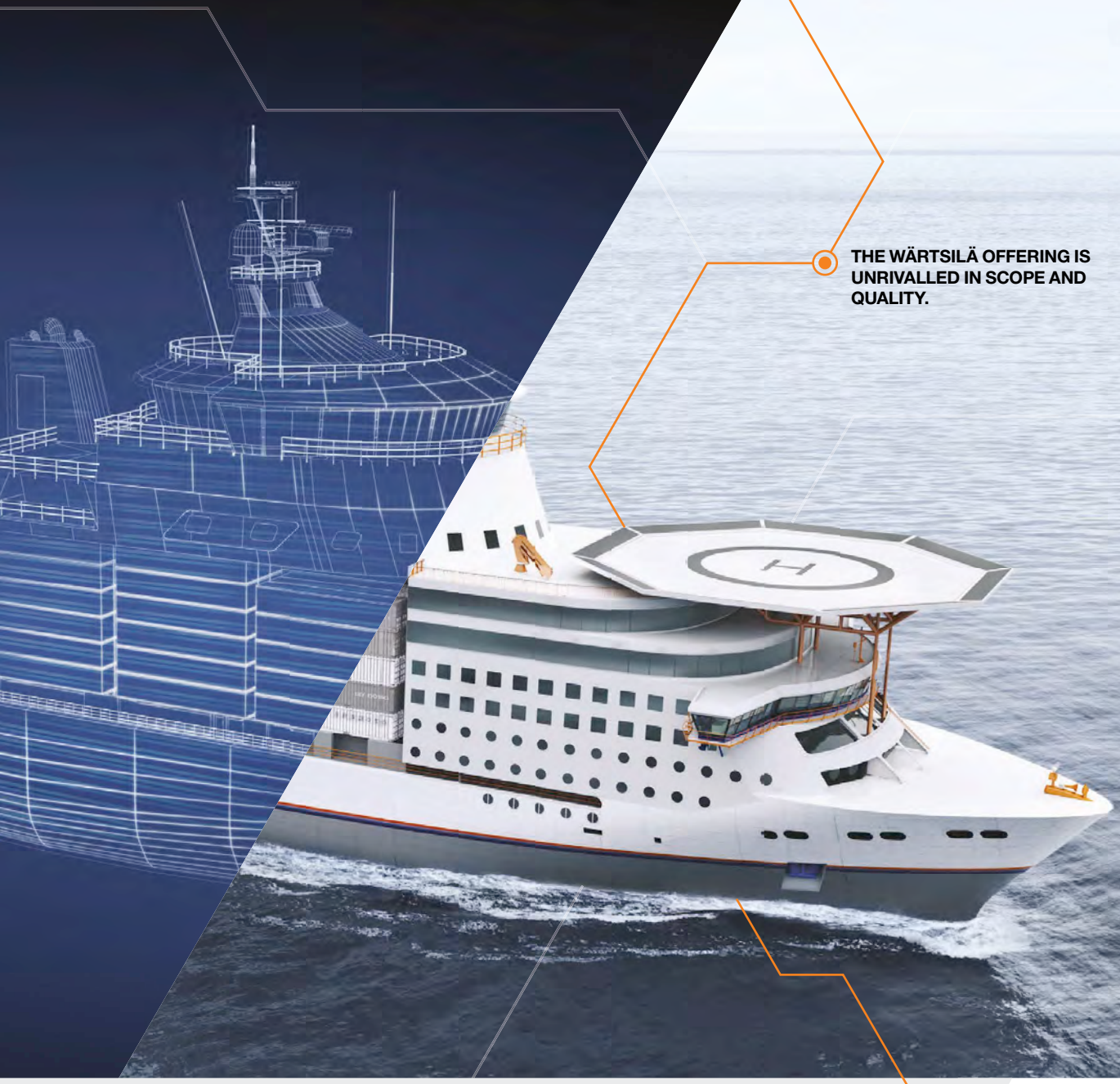

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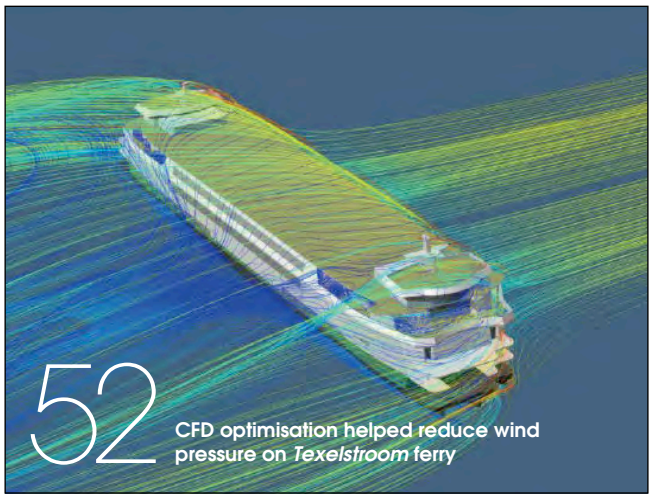

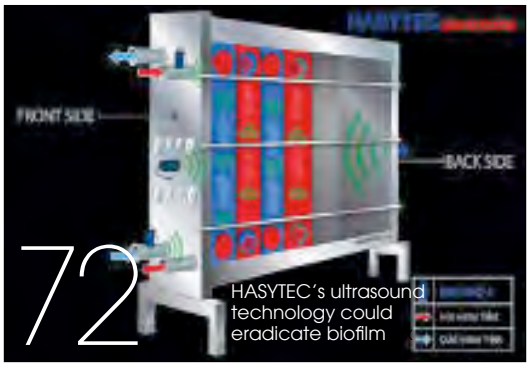

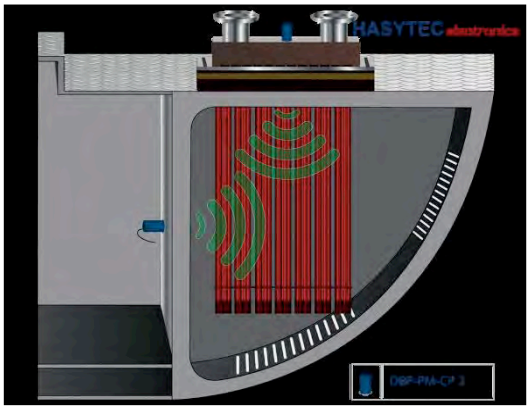

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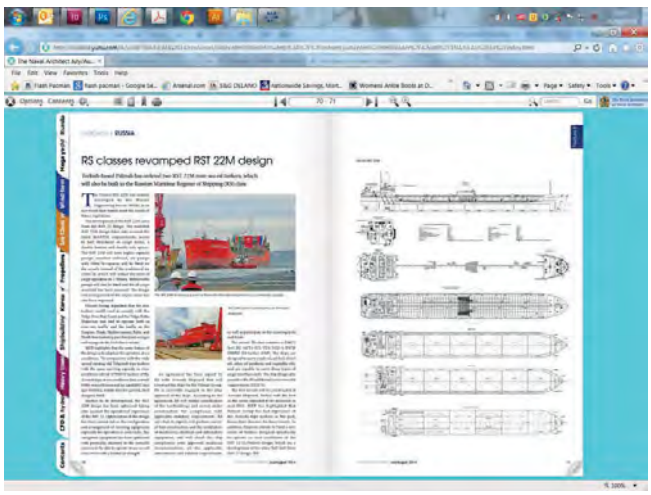

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UBM

China keeps its eyes on the prize

CSSC and Carnival executives signing a US$1.5 billion MOA last year. A series of up to six cruiseships will be built at the Shanghai Waigaoqiao yard

Without shipping, goes the overused adage, half the world would freeze while the other half would starve. Putting aside the slight exaggeration of that statement, it's impossible to ignore the fact we live in thrall of globalisation.

Does that make us citizens of the world? In the early nineties, following the collapse of the old Soviet Union, the American political scientist, Francis Fukuyama, famously put forward the hypothesis that the advent of Western liberal democracy represented, in sociocultural terms, the End of History. All that remained, Fukuyama argued, was for the rest of the world to 'mature' to the same state of political awareness.

That this was a fool's paradise (and in fairness Fukuyama's argument is more complex than I have the space to precis here) was brought into sharp focus by the events and aftermath of 11 September 2001. Industrially advanced nations may bear superficial similarities to each other, but culturally and ideologically it's somewhat more nuanced. The material comforts of capitalism are not a panacea for the world's ills; opposing viewpoints have been volubly and violently expressed, be they religious fundamentalism or 'rogue' states. Concerns about climate change have also forced industrialised nations to accept that unfettered capitalism could have catastrophic long-term consequences for future generations.

Moreover, one country's model of 'capitalism' — or at least a capitalist economy — can be markedly different from another's, often reflecting a deeper-rooted sense of national identity. For the Chinese, it has been the means to achieving prosperity without losing sight of the common goals that remain enshrined in its state constitution.

This conviction, perhaps more than its abundance of human and natural resources, spurred its drive to becoming the superpower of international shipbuilding. But it's also a conviction tempered by pragmatism; the declining orderbook of the past five years has compelled the government to make tough decisions on yard closures and company mergers, while diversifying into markets such as offshore and cruise, which were previously the domain of more established players. The cruise sector in particular illustrates China's determination to develop new partnerships; China State Shipbuilding Corporation's (CSSC) team-up with Fincantieri to build a series of cruiseships for Carnival has seen hundreds of the staff of the Italian shipbuilder relocate to oversee work at the Shanghai Waigaoqiao yard. Carnival was keen to expand into the growing Chinese cruise market and a report published by Reuters in July suggested the Chinese government demanded certain caveats, namely that the vessels must be built in China. Cruise shipbuilding is a major objective of the government's 'Made in China 2025' programme and the more exacting requirements of building higher-end vessels will enhance skills at Chinese yards, and by extension their competitiveness.

Earlier this year I was speaking to Andrew Stump, VP of operations at (CSSC subsidiary) WinGD and president of the recently launched CSSC Marine Service Co. Our conversation turned to the subject of the cultural differences between China and the West and Stump, a New Zealander who spent seven years living in Shanghai, explained how social sensitivity is always necessary when bridging the cultural divide. "All human beings have the same basic human needs and you can always morph and shift mode to satisfy those. The differences come in the way they solve problems and communicate. For the Chinese it's all about the objective. It doesn't matter how long it takes as we get there together."

That paradigm shift can sometimes require trying to explain a concept for which no direct equivalent can be expressed in another language. Much as there is no equivalent in English for the German schadenfreude, Stump said, the same applies to the Chinese and the idea of 'logic'. "They don't have a word for logic so they use our one instead. But of course that means nothing is 'illogical' either because that paradigm doesn't exist."

China, like most nations, keenly protects its own interests but its growth as a global and shipbuilding superpower increasingly belies the old notions of cultural hegemony. Stump noted that one of the most appealing traits of the Chinese is their humility and perhaps it's this quality which is allowing it to embrace the 'best' of Western culture and expertise without losing sight of its own identity. *NA*

Digitalisation

BIMCO joins Shipdex steering committee

Shipping association BIMCO has become an executive member of the Shipdex Protocol steering committee after both parties, along with all nine original committee members, signed an agreement to support the digital exchange of data across the shipping community.

Lars Robert Pedersen, BIMCO deputy secretary general, signed the agreement at BIMCO head office in Copenhagen and expressed his excitement about the partnership: "This new venture will be of great benefit to our members and will complement BIMCO's exciting portfolio of products and services. Shipdex fits neatly with our objective to help ease the administrative burdens for ships and masters. Shipowners will be able to reduce time, administration and costs as this new system is quicker and easier to use, with zero disruption to the ship at sea."

Shipdex chairman, Giancarlo Coletta, was equally optimistic about the future of exchanging electronic data: "We welcome BIMCO as an executive member of the Shipdex Protocol, as we work with the shipping industry to exchange electronic technical data between all parties in a safe, reliable and effective way. We are convinced that Shipdex Protocol is the best candidate to become the universal standard for the exchange of technical data."

Shipdex Protocol is designed to be used by shipowners, shipyards, manufacturers, classification societies and application service providers to store, find, exchange and publish items such as instruction manuals, maintenance plans and spare parts catalogues.

Cruiseship

Rolls-Royce to equip expeditionary cruiseship

Mystic Cruises has chosen Rolls-Royce to equip the environmentally-sustainable cruiseship, MS *World Explorer*, which will offer luxurious cruise itineraries in Antarctica.

The 126m long, 19m wide vessel is already being built at WestSea shipyard in Northern Italy, with an expected completion date of October 2018. Rolls-Royce has supplied two Bergen C25:33L8P main engines and a Bergen C25:33L6P auxiliary dual generator. These will both connect to a Low Voltage AFE SAVeCUBE Power Electric System to allow the engines to operate at variable speeds in order to maximise efficiency. The vessel will also be equipped with a Rolls-Royce automation and control system and a Promas propulsion system with two CPP propellers and two integrated flap rudders.

Mário Ferreira, CEO of Mystic Cruises, says: "The MS World Explorer will be the first of our expeditionary cruiseships and will offer passengers a once in a lifetime experience of exclusivity and personalised service visiting the vast frozen landscapes of Antarctica and small, exclusive ports around the world."

Mystic Cruises' *World Explorer* will offer eco-friendly tours of Antarctica

The ship's first season is already fully chartered to Polar cruise company, Quark Expeditions, which will be offering Antarctic cruises between November and March. Thanks to its size, for the rest of the year, *World Explorer* will visit smaller ports around the world, not accessible to larger cruiseships.

The vessel will be optimised for Antarctic conditions, with a strengthened hull and propellers especially designed to navigate through ice. There will also be room on board for 200 guests and 111 crew members, with Mystic Cruises aiming to offer the "luxury of a five-star plus hotel" on board.

It was also paramount that the new vessel was as green as possible: "Being one of the last unspoiled and untouched regions in the world, Antarctica poses a unique challenge for cruise companies in order to offer the high-quality service that guests are used to in other areas, while being environmentally sustainable. We are very pleased to be working with an industry-leading company such as Rolls-Royce. Since we started our partnership the results have been very positive, and we believe that we made the correct call in selecting them. For us it's essential to have a sustainable, efficient and environmentally friendly solution. That is why we opted for the hybrid technology that Rolls-Royce proposed," Ferreira continues.

Norway

Fosen Yard and Hantong Shipbuilding join forces

Norwegian Fosen Yard and China's Jiangsu Hantong Ship Heavy Industry have formed a joint venture to work together to design and build cruiseships and ro-ro passenger ferries and cargo vessels.

The venture, known as Fosen Hantong, came into effect on 7 July and will involve establishing a company in Trondheim, Norway, in order to provide and develop

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marine design and technology for clients. Hantong will also dedicate a modern shipyard facility to the partnership's projects and will work with Fosen exclusively for projects of this nature for a period of eight years initially.

Both parties hope to bring their expertise and experience to the venture, with Hantong securing "high production capacity, high quality production and also add[ing] financial strength", while Fosen Yard has market-leading resources, knowledge and the operational solutions to make the partnership a success.

Jiangsu Hantong Ship Heavy Industry has already delivered 200 vessels of different types, mainly to European clients, and Fosen Yard has been chosen to design Color Line's Color Hybrid, one of the world's largest hybrid battery-powered vessels.

Autonomous shipping

ABS joins autonamous shipping alliance

ABS is one of nine founding members of the Unmanned Cargo Ship Development Alliance, set up to produce an unmanned cargo ship design that will feature independent decision-making, autonomous navigation, environmental perception and remote control, in a bid to further advance autonomous shipping.

The alliance, officially launched in June this year, is chaired by HNA Technology Group Co, Ltd. Members include CCS, Rolls-Royce, Wärtsilä, China Ship Research & Development Institute, Shanghai Marine Diesel Engine Research Institute Ltd., Hudong-Zhonghua Shipbuilding (Group) Co., Ltd, Marine Design & Research Institute of China (MARIC) and ABS.

The group hopes to deliver the vessel by October 2021 and ABS greater China division president, Eric Kleess, anticipates the project will be a sign of things to come: "Increased digitisation, advanced technologies and new levels of connectivity are changing the way the maritime industry operates. In the coming years, we will see significant changes in the way ships are designed and built, with a strong drive to develop autonomous vessels especially in China. As a key member of this alliance, ABS is aligned closely with industry to support safer and more sustainable maritime operations."

HNA Technology Group vice chairman, Li Weijian, is also optimistic of the alliance's positive influence on the future of autonomous shipping: "Through this collaborative effort, we will apply the latest technologies to develop a new autonomous ship concept. The newly formed alliance is advancing new innovations in ship design and operations, and also working to promote safe adoption of these assets in the market."

Germany

MV Werften delivers luxury river ship for Crystal Cruises

German shipbuilder MV Werften delivered the first of four luxury river cruise vessels for Crystal Cruises in a handover ceremony in Wismar, north Germany, on 3 August.

The 135m long, 11.4m wide *Crystal Bach* will accommodate up to 106 passengers in 55 large suites while cruising along the Rhine, Danube and main rivers throughout the Netherlands, Germany, Switzerland and Belgium.

It's claimed to be the world's most luxurious river cruise vessel, with three gourmet restaurants, spa, piano bar, personal butler service and the world's highest crew-to-guest ratio in the river cruise industry.

Crystal Bach was designed to cruise the rivers of Europe

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Operational safety was also a consideration, as Gustaf Gronberg, SVP of Newbuilding and Marine Operations at Genting Cruise Brands, to which Crystal Cruises belongs, explains: "We have incorporated the best navigational and safety standards on ocean ships to the Crystal fleet of river ships with four Azimuth thrusters for easy manoeuvrability, forward bridge with two navigators seated at all times with a state-of-the-art navigation system and had river ship training at the Simwave simulator centre in Rotterdam."

The second ship in the series of identical cruise vessels, *Crystal Mahler*, was due to be delivered a few weeks after *Crystal Bach*'s handover ceremony, with the two remaining ships, *Crystal Debussy* and *Crystal Ravel* having been under construction at MV Werften's Wismar yard since January. The keel-laying ceremony took place in May and delivery to Crystal River Cruises is scheduled for early 2018.

MV Werften is set to build nine ships within the next five years, including the four river ships for Crystal Cruises. In addition to these, Crystal Yacht Expedition Cruises has ordered three Crystal 'Endeavour Class' yachts and the company will be building two 204,000gt 'Global Class' cruiseships for Genting Cruises in Asia.

Hydrogen

ITM Power to launch hydrogen stations

UK-based ITM Power, which specialises in the manufacture of integrated hydrogen energy systems, will announce plans for a series of large scale hydrogen refuelling station designs at Hydrogen + Fuel Cells North America, part of Solar Power International in Las Vegas, this September.

The designs feature electrolyser configurations of up to 50MW in size, with the ability to produce up to 20tonnes of hydrogen per day. The plans are a response to industry demand for larger hydrogen stations that can be used to refuel heavy logistics vehicles, and with shipping SOx emissions accounting for 13% of annual emissions of the pollutant worldwide, having easier access to hydrogen could have a dramatic, positive impact on SOx figures.

Hydrogen is becoming an attractive alternative for the maritime industry as hydrogen fuel cell technology combines hydrogen with oxygen to produce electricity – eradicating emissions and producing water as the only bi-product of the process.

Dr Graham Cooley, CEO of ITM Power, says: "These new refuelling station designs are being launched in response to a dramatic increase in the number of enquiries for refuelling heavy logistics vehicles at large scale as the viability of hydrogen power continues to gather scale and momentum across a growing number of industrial applications. ITM Power is delighted to be in a prime position to support these important transportation sectors as they plan their transition to a greener vehicle fleet to reduce emissions. Air quality and fossil fuel emissions are now a high priority for governments worldwide."

According to ITM, bunker fuel on large vessels can contain up to 3,500 times more sulphur than the diesel used to fuel passenger cars. The 0.5% sulphur cap coming into force in 2020 will go some way to improving this, but the sulphur content of shipping fuel could still be 500 times higher than road diesel. Shipping also produces 15% of NOx emissions, and 3% of CO2 emissions, globally, with these figures expected to increase over the next 30 years.

Biofouling

New global biofouling project gets go ahead

The GloFouling Partnerships project, a collaboration between the IMO, Global Environment Facility (GEF) and the United Nations Development Programme, will aim to tackle the negative effects of invasive aquatic species on both marine ecosystems and the livelihoods of those living in coastal communities.

Building on the success of the partners' last joint venture, the GloBallast Partnerships project, which worked to reduce the transfer of aquatic organisms through ships' ballast water, the GloFouling Partnerships project's main aim will be to implement the IMO's guidelines on the control and management of biofouling.

Stefan Micallef, director, Marine Environment Division, IMO, says: "IMO has been at the forefront of the international effort to tackle the transfer of invasive aquatic species by ships. Addressing ship's hull fouling is a crucial step to protect marine biodiversity. The treatment of hulls to reduce fouling by aquatic organisms has the additional benefit of reducing greenhouse gas emissions, since the drag of ships is reduced."

The project was approved by the GEF council back in May this year and granted funding of US$6.9 million. Officially called 'Building Partnerships to Assist Developing Countries to Minimize the Impacts from Aquatic Biofouling (GloFouling Partnerships)', preparations for the project will now be undertaken by the IMO Secretariat, which has asked interested Member States to confirm their intention to participate as soon as possible.

Chris Severin, senior environmental specialist from the GEF, adds: "The implementation of the GloFouling Partnerships will be instrumental in battling aquatic invasive species, and will not only lead to healthier, more robust marine ecosystems, but also positively impact economic opportunities and the livelihoods of millions of people across the globe. I am confident it will be another success in the fruitful partnership between the GEF, UNDP and IMO". *NA*

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Scrubbers on a roll

Living with the ECA restrictions has not been the easiest transition that shipping has ever had to make as a result of environmental regulation but it may be the worst is yet to come, writes Malcolm Latarche.

Reducing SOx emissions has been an essential factor for operators to consider ever since MARPOL Annex VI became effective in 2005. Then there was a global cap of 4.5% which reduced to 3.5% in 2012 following the 2008 Annex VI revisions. The more stringent SOx levels applying to ECAs began in 2010 and reduced to the current limit of 0.1% in 2015. But, by and large, it has been achieved despite some cheating and a small number of accidental contraventions.

Making the transition to the 0.5% global cap in 2020 looks to be proving more problematical and costly. Most analysts from within the shipping industry and from oil refining are of the opinion that the decision was political and did not take into account the state of technology and preparedness in either industry and that the 2025 alternative would have been a better choice. Despite those reservations which have been forcefully expressed by many, at MEPC in July the IMO did not feel inclined to offer any olive branches and the 2020 deadline, with no transitional period, is still IMO policy.

The choices currently available to ship operators to meet the 2020 cap are well known and consist of switching to distillates, using alternative fuels or installing emission abatement technology. There is an intriguing possibility that a fuel desulphurisation system may become available in the future but that is not yet a commercial option.

All of the present three options have implications for operators of existing ships and designers of new vessels as well as equipment makers. And with less than 30 months to go until the new global cap becomes mandatory, time is running out fast for decisions to be taken. Using alternative fuels mostly comes down to LNG, but for this to be an option either requires the ship to have dual-fuel engines already fitted, to retrofit new engines or to convert an existing oil-burning engine, always assuming that compatible components for the conversion are available. Not every ship that is fitted with dual fuel engines can use LNG immediately, a fair proportion of ships with dual-fuel engines are not yet equipped with the fuel storage and delivery systems needed to operate in gas mode. For many ship operators, the scarcity of LNG bunkering facilities is a major obstacle that will need addressing.

Switching to distillates requires no capital outlay and may be the only option for some owners but it is scrubber technology that is being seen as the way forward for many, especially those unconvinced about the merits of LNG and unwilling to pay the 20%-30% premium that gas-fuelled ships demand. In the run up to, and the time since the July MEPC, there have been several announcements related to both scrubber development and contracts.

Most recent was Wärtsilä's announcement that it has been contracted to supply scrubbers for two new 56,000dwt Handymax bulk carriers being built at Oshima Shipbuilding for Tokyo based NYK Bulk & Projects Carriers. The ships which will be delivered next year and in 2019 will be the first NYK operated vessels fitted with scrubbers and the first supply by Wärtsilä to Japanese ships.

Announcing the first loading of its newest PCTC Siem Cicero on 3 August, Siem Car Carriers highlighted its eco-friendliness, mentioning its hybrid scrubber system. Earlier in July, during MEPC, it was announced that Virgin Voyages three new cruiseships to be built at Fincantieri would be fitted with Wärtsilä hybrid scrubbers.

There are few types of ships not fitted with scrubbers but cruise vessels have been major customers. All of the major suppliers of exhaust gas cleaning systems have cruise references but that seems not to be deterring new entrants. Simultaneous with the Virgin Voyages announcement, Fincantieri also revealed that it is engaged with GE Power in developing what it called a Shipboard Pollutant Removal System for removing SOx from exhausts. The Italian builder claimed that the tie-up between a shipbuilder and equipment supplier was unique in exhaust gas cleaning circles.

A decade or so ago when the first prototype scrubbing systems were being installed on ships, the number of suppliers involved could have been counted on the fingers of one hand, but the number is growing rapidly. The Exhaust Gas Cleaning Systems Association (EGCSA), the industry body for scrubber makers, now lists more than twenty makers as members.

But there are others active in the field — aside from the new GE Power/Fincantieri venture, ballast treatment maker SunRui recently said it too was developing a scrubbing system. At NorShipping in June, Mitsubishi Heavy Industries, and Mitsubishi Hitachi Power Systems, announced the development of a new large-scale rectangular scrubber intended for ultra-large container ships, which despite its capacity, is more compact than the cylindrical versions that are most common. With the 2020 date approaching, many more makers are expected to join the fray.

However, the scrubber bandwagon may slow if the refiners step up to the mark and produce ultra-low sulphur fuels in sufficient quantities and at an attractive price that could offset the $1 million price tag that has been put on typical scrubber systems. If that were to happen it is also likely that HFO with high sulphur content could disappear, making scrubbers unnecessary. *NA*

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Scrubbers

Wärtsilä scrubbers to be used on Japanese vessels

Wärtsilä has won a contract to supply the exhaust gas cleaning systems for two new 56,000dwt Handymax bulk carriers being built for NYK Bulk & Projects Carriers Ltd., a wholly-owned subsidiary of Nippon Yusen Kabushiki Kaisha —one of Japan's biggest shipping companies.

The vessels, being built at Oshima Shipbuilding Co., Ltd. in Japan, are the first owned or chartered by NYK Group to have exhaust gas cleaning systems installed and the contract also marks Wärtsilä's first time supplying the equipment to a Japanese company.

Sigurd Jenssen, director, exhaust gas cleaning, Wärtsilä Marine Solutions says: "We are pleased and proud to be the supplier of choice for these two new ships, especially as it gives us an inroad into the Japanese market for exhaust gas cleaning solutions. The value proposition that Wärtsilä presented was clearly the deciding factor in the award of this contract."

With scrubber equipment delivery scheduled from July 2018 and predicted dates for the delivery of the completed vessels to NYK currently set at the 4th quarter of 2018 and 1st quarter of 2019, the bulk carriers are on target to be compliant with the IMO's SOx regulations in time for their enforcement in 2020.
www.wartsila.com

Renewable energy

EMP to begin preparations for MRE system trials

Japan-based Eco Marine Power (EMP) has announced plans to commence sea trials of its Aquarius Marine Renewable Energy (MRE) system, following the completion of feasibility studies currently underway.

The advanced integrated system of rigid sails, marine-grade solar panels, energy storage modules and marine computers will allow ships to tap into renewable energy through the harnessing of wind and solar power, thus reducing fuel consumption, air pollution and CO_2 emissions.

EMP, in cooperation with strategic partners and Japanese shipowner, Hisafuku Kisen K.K., has begun feasibility studies on several large bulk carriers, including 2015-built *Belgrano*, 2017-built *Nord Gemini* and 2009-built *Bulk Chile*. For each vessel, the propulsive power that could be provided by EnergySail, the rigid sail device technology, will be estimated based on the trade route that the ship would normally operate on. The total amount of solar power that could be installed on each vessel will also be calculated. Onboard testing and data collection will then be carried out in order to determine which ship will be selected for the sea trial. The chosen vessel will then be equipped with a trial configuration that incorporates all the elements of the Aquarius system, which will operate and be monitored for between 12 and 18 months.

Greg Atkinson, Chief Technology Officer and founder of Eco Marine Power, says: "It's great that we are able

The two Handymax bulk carriers will be NYK Group's first vessels with scrubbers installed

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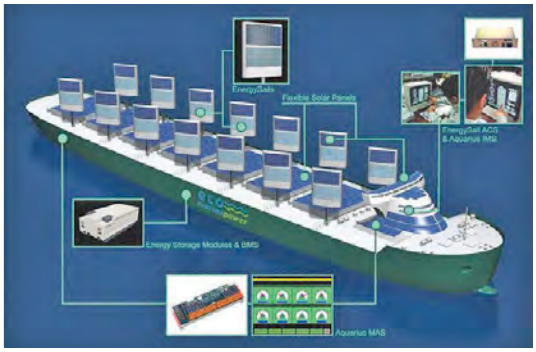
to co-operate with Hisafuku Kisen and we very much appreciate their cooperation in helping us move this important project towards sea trials. We also appreciate the support of our strategic partners and together we believe Aquarius MRE will pave the way towards the widespread adoption of renewable energy on ships."

The proposed preparations will lead to the world's first installation of an integrated rigid sail and solar power system for ships using EMP's patented renewable energy technologies, projected for 2018. It is expected the landmark achievement will encourage ships ranging from coastal cargo vessels to cruiseships to follow suit, especially when EMP's renewable energy devices can even be used when a vessel is at anchor or in harbour.

The EnergySails that are to be used in the upcoming sea trials will be produced at Teramoto Iron Works in Onomichi, Japan. This project will give the company another chance to put their extensive experience manufacturing high spec fittings for ships into action, having been involved with the production of rigid sails back in the 1980s.

Mr. Yoshitaka Teramoto, President of Teramoto Iron Works adds: "Our company is excited to be part of this innovative project that will allow us to showcase our ability to manufacture customised solutions for ships and offshore applications."



Aquarius MRE will feature various technologies to generate renewable energy from the wind and sun

www.ecomarinepower.com

Engines

Talusia Optima gets approval

Marine lubricant company Total Lubmarine has received a No Objection Letter from MAN Diesel & Turbo for the use

of its cylinder lube oil, Talusia Optima BN 100, in the engine manufacturer's two-stroke engines.

The decision means that Talusia Optima is now approved by all three major 2-stroke engine manufacturers: Winterthur Gas & Diesel (WinGD), Japan Engine Corporation (JEC) and MAN Diesel & Turbo.

Approval was granted by the Germany-based MAN Diesel & Turbo following a 8,700 hour sea trial onboard a 14,000 TEU containership fitted with a fuel-efficient 2-stroke 11S90ME-C mark 10.2 B&W engine. The trial took place while the vessel was sailing in and out of Emission Control Areas (ECAs) in Europe and Asia, with over 600 hours spent in ECAs, powered by distillate fuels with a sulphur content of 0.1% or less.

Total Lubmarines technical director, Jean-Philippe Roman, says: "This was our longest ever trial of a new lube and provides both customers and OEMs with the reassurance that Talusia Optima can be safely used on-board vessels trading for lengthy periods in and out of ECAs. The sea-trial and comprehensive validation tests were carried out using a combination of our already approved cylinder oils, Talusia LS 25 and Talusia Universal 100. This allowed for the inspection teams to compare and contrast the performance of the new Talusia Optima product. The results demonstrated the cleanliness of the engine when used with low and high sulphur fuels in and outside the ECAs, and the better efficiency to minimize the liner wear."

Talusia Optima has been designed to be used in conjunction with all distillate fuels with a sulphur content of between 0% and 3.5%, making switching between fuels easier when moving in and out of ECAs, without needing to change lubricants. The lubricant was also formulated using Ash Free Neutralising Molecules (ANM), providing faster and more efficient acid neutralisation and better engine cleanliness and thermal resistance, when compared with conventional BN 100 lubricants.

www.totallubmarine.com

Computer-aided design

NAPA and NDES plan system collaboration

Global maritime software leader, NAPA, and Japanese software development and engineering experts, NTT

Data Engineering Systems (NDES), have announced their collaboration on software that will integrate early stage design and production planning to aid ship design and production, while significantly bringing down costs.

The collaboration will involve linking NAPA's 'NAPA Steel' structural design software with NDES's 'Beagle' 3D ship structure viewing software so that users will be able to take the 3D design data from NAPA's software and use it to create visualisations in Beagle, bridging the gap between the two programmes and allowing production plan examinations to be undertaken much earlier than previous methods have facilitated.

Currently it is possible to study production in NDES's software using data created with 3D-CAD tools, but only at the production design stage. The new collaboration will allow users to do this at the initial design stages, meaning there is the potential for significant cost cuts as structural design and production schemes can be optimised much earlier in the design process.

Ilmo Kuutti, president of NAPA Group, is excited by the union: "NAPA is delighted to start this co-operation with NDES. NDES has a long history of strong expertise in the discipline of ship production design, whereas NAPA is in the leading position in ship initial and basic design. We believe that expanding the usage of NAPA product models to cover production planning, not just early stage design, will benefit ship designers by improving collaboration between different design departments."

NDES will also work on the commercialisation of engineering services, such as design support and structural analysis service, using NAPA Steel. In return, NAPA will provide in-depth technical support to NDES as it prepares for the commercialisation.

www.napa.fi

Ballast systems

Ecochlor secures USCG approval and new CEO

Boston-based Ecochlor has received USCG Type Approval for its entire line of ballast water treatment systems, just two days after Steve Candito made his first official statement as CEO.

Candito, who has spent over 30 years working in the maritime industry, is excited by the recent development: "Tom Perlich [Ecochlor's founder and president] and the rest of the team, along with DNV GL, have done a great job coordinating the long process to filing an application. It was exciting to see it finally reach the finish line during my first week at Ecochlor.

Ecochlor's new CEO, Steve Candito

"Shipowners now have the opportunity to select an approved BWTS that offers an alternative to UV or electrochlorination. The Ecochlor System is the first approved system that uses chemical-injection treatment technology. Plus, it allows for treatment of almost twice the flow rate of any other approved system [up to 16,200 m^3/hr] and it is the only BWTS approved for high flow rates on US flagged tanker installations."

Before joining Ecochlor, Candito founded Foresea Consulting, a company providing advisory services in strategic planning, regulatory compliance and crisis management to the maritime and environmental communities. Prior to that, he was President and CEO of the National Response Corporation (NRC) and earlier in his career worked aboard tankers for Exxon and as an attorney for Haight Gardner Poor & Havens, specialising in maritime litigation and environmental law.

Candito adds: "I am tremendously excited about being at Ecochlor. There are many similarities between this company and the work I did with NRC. When the opportunity with Ecochlor presented itself, I couldn't believe that I was going to get a second chance to do what I love assisting shipowners to make the best decision related to an environmental regulatory requirement, in this case the best BWTS for their vessels, and at the same time helping to protect our ocean's environment."

wwwecochlor.com

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Putting the safety into battery-driven propulsion

Canadian-based energy storage solution provider PBES is determined that quality comes first in the rush towards electrification

Whether for hybrid or fully-powered, advances made in lithium-ion batteries have allowed the technology to quickly establish itself as a viable solution for marine propulsion. Since the launch of the first diesel-electric hybrid ferry, the 43m ro-ro MV *Hallaig*, in December 2012, the scale and ambition of such projects has moved on leaps and bounds with new projects, both retrofits and newbuildings, announced almost monthly.

Ferries, offshore and smaller vessels remain the focus for battery-powered innovation, spurred on in no small measure by the impetus of tightening emission-control regulations. However, Norwegian travel company Hurtigruten's announcement in September 2016 that its forthcoming polar expeditionary ships, *Roald Amundsen* and *Fridtjof Nansen* (due for delivery in 2018 and 2019 respectively), would deploy sustainable hybrid technology is seen by many as a watershed moment. And while its seems unlikely that we will see battery-powered vessels engaged in long-haul transportation any time soon, it no longer seems beyond the realms of possibility.

One company with a vested interest in the technology's continued progress is Canadian manufacturers, Plan B Energy Storage (PBES). Founded in early 2015 by Brent Perry, the former CEO and founder of rival battery supplier Corvus Energy, PBES has quickly established itself with an outspoken commitment to marine energy storage 'done right', placing a strong emphasis on quality.

Grant Brown, PBES's VP for Brand and Marketing (and, like Perry, also one of the co-founders of Corvus) explains: "Due to our experience with other products and projects in the past, when we designed this battery we really looked at how we could make it as safe as possible. The last thing anybody wants is a fire on board a ship. Lithium fires are very unpredictable and difficult to extinguish when they start propagating."

PBES's Grant Brown

In order to achieve this, PBES incorporated a number of unique safety features into its batteries. The most important of these, according to Brown, is a patented liquid cooling system they call CellCool. "CellCool liquid cooling does two things: it provides a safety feature in that it prevents our battery going into thermal runaway [when the heat generated within the cell causes a reaction between the cathode material and electrolyte], because the cooling system can extract more heat than the cells can produce. We're the only battery in the world that can actually prevent thermal runaway from occurring, not just spreading from cell to cell."

While other battery systems rely on air cooling, the PBES method is similar to that found in the engine block of a car. Water is circulated through and around the components before exiting. Because the water is low pressure (around 4psi) it doesn't put strain on the internal seals and components of the cell.

The cooling system is further enhanced by the use of cooling elements within the holders of the battery cells. Unlike many of their competitors, PBES has elected to use aluminium housing for their cells, rather than the more typical (and cheaper) glued-in plastic casing which can't be serviced and requires the replacement of the entire battery. It also facilitates a unique CellSwap system which makes it possible to replace the cell core — each cell is roughly the size of a magazine and slots into the 10mm thick aluminium housing — without any interruption to the vessel's service, not to mention cutting down on electronic recycling.

Safety features are integral to every aspect of the PBES battery design, says Brown. The battery's contactor is built-in and opens up in such a way that there is no voltage or danger of electrocution while it is inactive. Another is the patented E-Vent system, which channels fumes away through a chimney that leads outside in the event of thermal runaway. Brown says: "The reason for this is that when lithium cells start to combust they create a combination of hydrogen gases that is very flammable. The smoke in a lithium fire is actually hydrogen gas. You can't have that in the engine room of a vessel where the firefighters wouldn't even be able to re-enter the room because of the potential for an explosion."

PBES – which has already opened regional plants in Norway, Denmark and China – produces two battery solutions: the PBES Power 65, a 6.5kWh (75Ah cells) module optimised for high performance across a five-year lifespan, and the PBES Energy 97, a 9.7 KW/h (112Ah cells) battery comprised of the same parts but a higher energy density cell. Brown explains: "It's a 30% decrease in size,

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www.mtu-online.com/marine

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weight and ultimately cost. With cell swap it means the owner can start with one type of cell and potentially change them if the ferry changes its route and has different energy needs."

PBES received a notable endorsement in October 2016 when it was awarded the contract to supply the energy storage solution for what will be the world's largest battery-powered ferries: the *Tycho Brahe* and *Aurora*, operated on the Helsingborg–Helsingør route by Scandlines, as part of a modernisation package under the auspices of ABB. Each ferry will be supplied with 640 lithium-ion batteries (a total capacity of 4,160kW/h placed in four 32-foot containers at the top of the vessel, between its two chimneys.

It followed approval of the PBES energy storage system by the Norwegian Maritime Association, which CEO Perry described at the time as "the most important validation PBES could receive." Brown says that flag approval from the Danish Maritime Authority is also imminent, adding: "Right now the ferry market in Scandinavia is very big. Most ferries have been in existence for decades and have a very well logged dataset of how many hours a year they operate, what the wind, weather and tide patterns are and the energy consumption on each route. And by having a battery on shore on each side you can peak shave using the local electrical grid, and the batteries on board the vessel can be smaller."

The big question with battery power is if and when it can be applied to larger deep-sea ships. According to Brown it really depends on the type of vessel under consideration: "Cruiseships I can see it happening right away because it makes a lot of sense. Not only for peak shaving, because of the way the turbines are set up and the different loads, but also when they're berthed and require a UPS [uninterruptible power supply] or for spinning reserve. I personally couldn't imagine being on a vessel with thousands of people and no bathrooms or water.

"But in terms of larger bulk carriers etc. it's going to be a much more gradual process. It just doesn't make sense in terms of efficiencies to buy a big battery when a vessel already runs very efficiently when it's going across the ocean. Even though there are engine pollution issues there's not a lot a battery can do; the efficiencies come from slow steaming, hull design and those kinds of things. But it might be that larger vessels use energy storage for cold ironing when tied up."

Nevertheless, for vessels with the right operational profile, Brown is confident PBES's solution represents a sound investment. After the inevitable start-up costs of the business, it is now in the process of lowering capital costs, savings it hopes to pass onto the customer without compromising on safety or quality. He adds that the "hard lessons" PBES's founders learned during their time at Corvus has made them wary of the cheaper homogenised cells many of their competitors are choosing.

"The marine industry has a tendency to drive prices right down and it may take some sort of horror accident to see the value of the safety features that we've integrated into our system from the beginning. The larger companies almost don't want to acknowledge how important the longevity and reliability of the battery actually is. It's being treated like a little widget."

It goes without saying that not all lithium-ion batteries are built the same. Whereas a Tesla car is powered by 18650 cells (18mm diameter by 65mm length – slightly larger than a 'c' type battery) these would never be suitable for the 24/7 industrial use required by commercial maritime. Brown says PBES batteries are now capable of 15,000 cycles, a 50% increase on what was achievable just two years earlier. However, working in close partnership with its cell supplier, the company is confident of further advances

Series String (1000V)	PBES Power	PBES Energy
Dimensions (including racking, venting and lifting apparatus)	W 896mm, H 2550mm,	
D 632mm	W 896mm, H 2550mm,	
D 632mm		
Weight 10BBUs +1 MBU	950 kg	950 kg
Energy	65kWh	97kWh
Capacity	75Ah	110Ah
Voltage Range	770-1000VDC	770-1000VDC
Nominal Voltage	888VDC	888VDC
RMS Continuous Current	225A	150A
Max Discharge Current	450A	330A
Max Charge Current	225A	110A
Internal Resistance	180mΩ	200mΩ
Electrical Isolation at DC Bus	Breaker	Breaker
Integrated Racking System	Included	Included
Communication to Higher Level System	Modbus/TCP	Modbus/TCP

System specifications for PBES Power and Energy systems

The batteries are typically supplied in stacks with a voltage up to 1,000VDC

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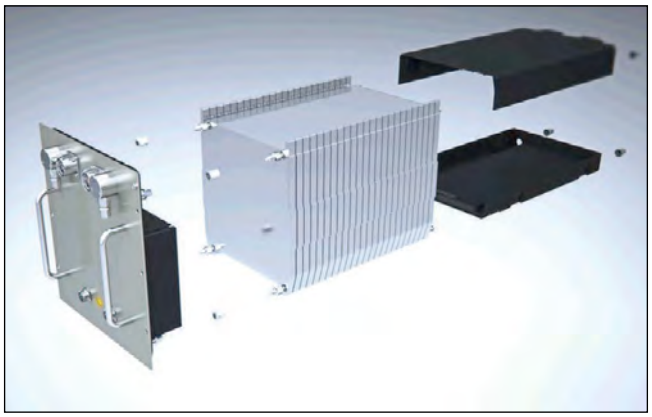
in increasing the energy density and C-rate (the amount that can be discharged in a single hour). This includes investigating the potential of lithium-titanate cells and research with silicon nanoparticles on the anodes and cathodes of the battery that would allow for higher discharge rates.

Brown adds that claims being made by some of PBES's rivals need to be treated with scepticism: "Some companies are talking about discharge rates of 10C, 20C or 30C but they're living in a dream because we know what we have to do in order to get a reliable 3C without damaging or overheating the battery. There are very few pieces of equipment in the world robust enough to handle those discharge rates. You would need to have a circuit breaker the size of a house to disconnect it from the DC bus."

With the growing presence of battery power on board vessels there have been suggestions that separate battery rooms might in time be dispensed with to economise on space, but Brown points out that the advantages in terms of weight reduction compared to an equivalent generator already compensate and there are always alternatives. "The reality is you want these things to be in a central location so that the power transmission from the battery to the DC bus is located in a single area. If you have cables snaking all over the vessel there are going to be line losses and for reasons of serviceability you don't want them hidden."

"Obviously you want the weight as low as possible. There's a vessel I know of in Denmark right now that has four shipping containers with 4MW/h of batteries situated on the roof of the top deck, but it was more practical that way and it passed all the stability tests." *NA*



The innovative CellSwap feature makes it possible to replace individual cell cores

China's rollercoaster ride ends in success

Like the rest of the industry, Chinese yards have endured peaks and troughs since the 2012 downturn, with many closing or merging. But even during these straitened times, the world's largest shipbuilding nation is seeking out new opportunities as Malcolm Latarche reports

It is almost exactly 10 years since China overtook South Korea as the world's largest shipbuilder, at least in terms of new orders. It would take another three years before China's output exceeded that of its neighbour and it has been a position it has held ever since. But being number one today is a great deal different than it was in 2010 and China's fortunes have been as badly hit as any other shipbuilding nation with orderbooks rapidly thinning out, and with them, the number of yards active in shipbuilding.

Excluding fishing ships and naval and inland waterway vessels, in 2000, China produced 135 ships with a combined deadweight of a little over two million tonnes for domestic and foreign customers, according to statistics published by the IMO. In 2005 the number of ships had increased to 493 and the deadweight tonnage to over 10 million tonnes.

In the race to be first in the world, many of China's repair yards switched to shipbuilding so that by 2008 there were almost 600 yards producing vessels, although the vast majority were engaged in domestic building. At that time 90% of delivered deadweight tonnage came from just 35 yards. By 2010, China had an incredible 3,000 yards engaged or planning to be engaged in shipbuilding. The following year was to be the zenith of production, with 1,481 vessels for a deadweight of 69,532,386 tonnes.

China was not unaffected by the crash of 2008 and there were some casualties and bail outs, but the big players survived and there was a new boom still to come. A year after reaching the top spot no less than 244 of the country's yards delivered at least one vessel of 1,000gt, but the good times were coming to an end and last year only 117 yards had vessels of that size completed. China's total output of commercial vessels in 2016 was 745 ships for 36,114,148 tonnes. Today the number of yards is even smaller and because of planned consolidations that number is dropping rapidly.

As the world shipbuilding situation deteriorated from 2012 onwards, the Chinese government took action to reduce the number of failing yards by a two-pronged attack, comprising a scrappage scheme for domestic vessels to be replaced by new vessels and action to reduce the overall number of yards. The latter involved the compiling of a white list of yards deemed viable enough to be given support where necessary and allowing failing yards to wither.

Yet even the state-owned groups were not immune. CSIC, based in northern China, and CSSC in the southern part of the country were rumoured to be considered for merging in 2015 but they have retained their independence. Being state-owned is no guarantee against bankruptcy and from 2015 a number of yards, including Zhoushan Wuzhou Ship Repairing & Building and Sainty, have succumbed.

In the private sector, Mingde Heavy Industry Group was the first victim in 2015 and has been joined by famous names such as Rongsheng and more recently Sinopacific is fighting to survive. At the end of July, Sinopacific announced 300 redundancies at its Zhejiang Shipyard leaving just 260 workers to complete the last vessel in a series of PSVs, along with some miscellaneous vessels. Zhejiang Shipyard was placed under bankruptcy restructuring in April 2016 by a local court in Fenghua city in Zhejiang

The CX103, designed by Ulstein, is to be built by China Merchants

province. The lay-offs at Zhejiang follow the closure of another Sinopacific yard – Yangzhou Dayang Shipbuilding – in late July.

The increasingly strict criteria for yards to stay on the white list has seen it reduce to 71 yards at the end of 2016. According to a Clarkson's Research report in late 2016, the number could reduce even further to 59 yards or less through the course of 2017 as yards merge or become bankrupt. Despite the carnage that Chinese shipbuilding has suffered, there are many shipbuilding nations that would happily swap their fortunes and orderbooks with China.

In terms of ship numbers produced annually, China's slowdown has been almost as rapid as its journey to the number one spot, but when measured in deadweight terms it is still well ahead. This is highlighted by the fact that the 159 ships produced in 2001 had a combined deadweight of 2.7 million tonnes which is almost identical to the mere 15 ships in the forward orderbook for delivery between 2021 and 2023.

Last year Chinese yards delivered 745 vessels for a deadweight of 36,114,148. By the end of July this year the numbers were such that those figures could be exceeded as sources indicate that while 448 vessels were delivered in the seven months – with a deadweight of 28.8 million tonnes – there are more than 860 ships for 26.4 million tonnes that are supposed to be delivered in the last five months of 2017. That is almost certainly not going to happen as owners are still looking to delay or cancel booked vessels.

For the future, 2018's scheduled figures are similar to 2016, but beyond that there are just 222 ships for approximately 21 million tonnes ordered through to 2023. Not the rosiest of pictures but China did hold something like 42% of the global order book at the end of June this year.

Year	Ships delivered	Total dwt
2007	733	17,755,019
2008	949	22,465,507
2009	1,224	37,027,853
2010	1,462	62,252,821
2011	1,481	69,523,386
2012	1,451	67,396,386
2013	1,032	43,950,695
2014	851	36,291,719
2015	832	39,120,871
2016	745	36,114,148
2017 (Jan-Jul)	448	28,755,385
2017 (Aug-Dec)*	868	26,431,324
2018*	670	36,687,341
2019*	174	16,269,720
2020*	33	2,343,640
2021-2023*	15	2,744,000

*Estimates based on current known orders

Chinese ship orders and deliveries 2007-2023

China's growth was initially characterised by construction of the simpler ship types such as bulkers and tankers, but with experience has come more sophisticated types including very large container ships and LNG carriers. To date, the largest boxships built in China are the 2015-buit trio of 17,859 teu vessels CMA CGM *Vasco de Gama, Zheng He* and *Benjamin Franklin* all from Shanghai Jiangnan Changxing HI. There are 17 larger vessels ranging from 19,150teu through to 21,000teu all for COSCO. The yards involved are Nantong COSCO KHI (four vessels), Dalian COSCO KHI (four vessels) and Shanghai Waigaoqiao (nine vessels). All six of the ships above 20,000teu will be built at Shanghai Waigaoqiao.

China's first LNG carrier was built in 2008 for China LNG Shipping Holdings as the first in a six-ship series. A further eight vessels have been built since, half for Chinese interests and two each for MOL and Exxon Mobil. MOL has remained a customer and has another four 174,000m^3

The *CMA CGM Benjamin Franklin*, built in 2015, is one of three sister ships which are still the biggest yet built in China

ships on order, as does Teekay. There have been other foreign buyers as well so that nine of the 17 LNG carriers on order are for export.

As with many other shipbuilding nations, China turned to offshore when the main downturn arrived and with the state-owned offshore oil and gas organisations supporting construction, as well as major foreign operators such as Bourbon, Noble Drilling, Tidewater and Vroon Offshore, China has become the largest builder of offshore vessels. At the end of July, there were 434 offshore vessels on Chinese orderbooks.

There remains one ambition for China to achieve in shipbuilding and that is the construction of a cruise vessel. China has built ferries and ro-paxes for a small number of European owners but the prize of a modern cruiseship had until recently eluded them. Earlier this year, there were rumours of two possible deals that would end the long wait.

In February, Carnival apparently entered into a US$1.5 billion agreement with CSSC to build a series of ships for the growing Chinese cruise market in partnership with Fincantieri. Assuming the venture proceeds, two Vista Class ships and four possible options will be built at Shanghai Waigaoqiao. The first ship is planned to start sailing in 2023. In August, Reuters reported CSSC was setting up a supply chain for cruise shipbuilding in Shanghai. The development authority for the district told Reuters that it will commit about US$740 million to develop the new supply hub.

Although the Vista Class ships are almost certain to be built in due course, the first cruiseship built in China is planned to hit the water in two years from now. The ship is one of a projected ten-ship renewal of Florida-based SunStone Ships. The company specialises in leasing small exclusive ships in the growing expedition cruise sector.

SunStone announced in March that it had agreed a four plus six-ship deal with China Merchants. At the time, SunStone revealed the names of the designers but it was some months later that it was revealed that the actual design will be the first cruise vessel to feature the signature X-Bow of Norwegian shipbuilder Ulstein.

In May, Ulstein issued an announcement saying it had contracted for the design and equipment package for one and options for an additional nine vessels. Designated the CX103 type, the expedition cruiseship is 104.3m long and 18.4m in the beam. It will accommodate 255 persons including passengers and staff. The hull will be built in accordance to polar class PC6 and complies with the notation 'Safe Return to Port and Virtual Anchorage'. It may be a small start for China in cruiseship building but the market in such ships is relatively buoyant and if the past is anything to go by, China will use it as a launch pad for bigger things. *NA*

Green Corridor bulker design heralds sustainable future

The Joint Industry Project is set to provide a sustainable solution to the transportation of iron ore and coal between Australia and China and pave the way for greener shipping

Since the unveiling of the LNG-fuelled 'Newcastlemax' bulk carrier design at Nor-Shipping back in June, 'Green Corridor' has generated a lot of interest. The Joint Industry Project (JIP) includes stakeholders from all stages of the supply chain, each with a vested interest in the venture. This particular route between Australia and China was chosen because of the involvement of three of Australia's largest cargo owners in the project: BHP, Fortescue Metals Group Ltd (FMG) and RioTinto. Woodside, the Australian-owned LNG supplier, is also a key partner, as with LNG bunkering availability still an issue, Woodside has a large amount of gas available in Australia it can put at the disposal of this trade route. Shipowners MOL and U-Ming Marine, ship designer Shanghai Merchant Ship Design & Research Institute (SDARI) and classification society DNV GL, which is acting as project manager, make up the rest of the partnership. The main intention of the JIP is to design an LNG-fuelled bulk carrier that will be used to transport mainly iron ore, but also with the capacity to transport coal, between Australia and China, with bunkering taking place in Australia.

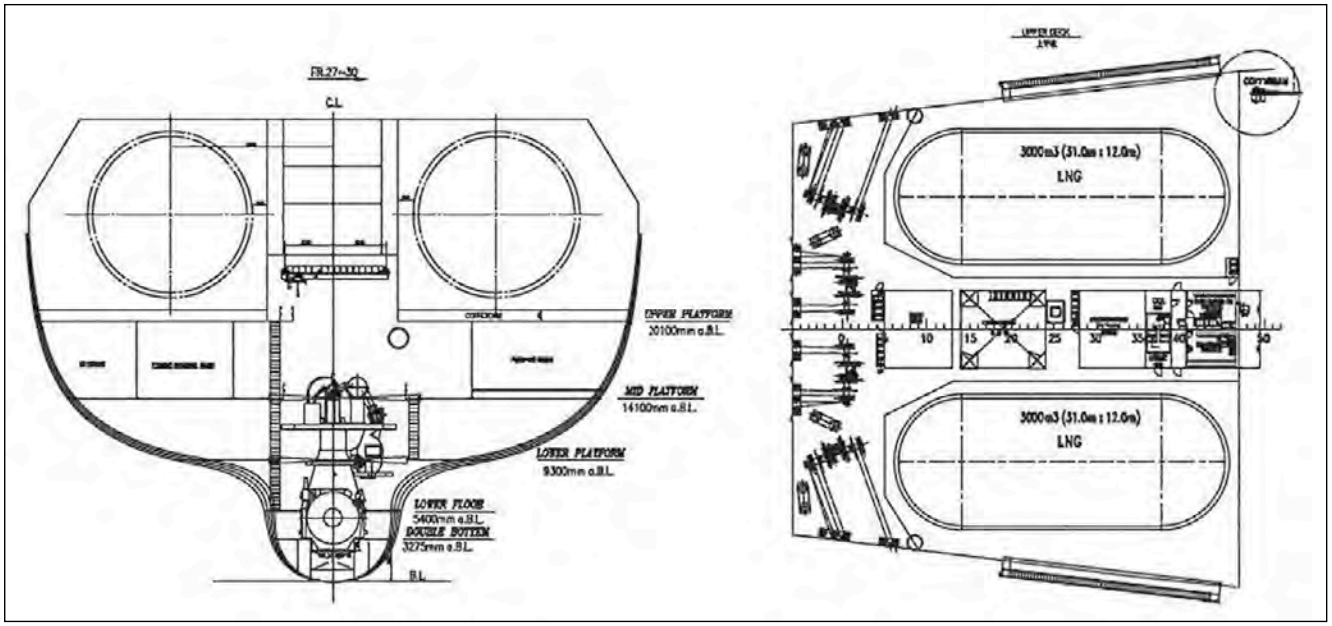
Morten Løvstad, business director bulk carriers at DNV GL – Marine

The design

The 300m long, 210,000dwt dual-fuel Newcastlemax has been developed by Chinese ship designer SDARI and takes inspiration from their Green Dolphin design, which was first launched in collaboration with DNV GL in 2013. Morten Løvstad, business director bulk carriers at DNV GL – Marine, revealed that SDARI was chosen not only for its expertise, but also so that the final design would be readily available to numerous shipyards: "They were invited at quite an early stage and we are very pleased to have SDARI onboard. We wanted the design to be less proprietary, so by selecting SDARI we get a design which many shipyards can build according to."

Chen Gang, technical manager, SDARI, also speaks of the two companies' well-established working relationship: "SDARI has collaborated with DNV GL on various projects for a long time, such as Green Dolphin 38 & 575, and SDARI's Dolphin and Green Dolphin series bulk carrier designs have dominated a large

Figure 1. The vessel, designed by SDARI, will feature two LNG tanks submerged into the top of the engine room



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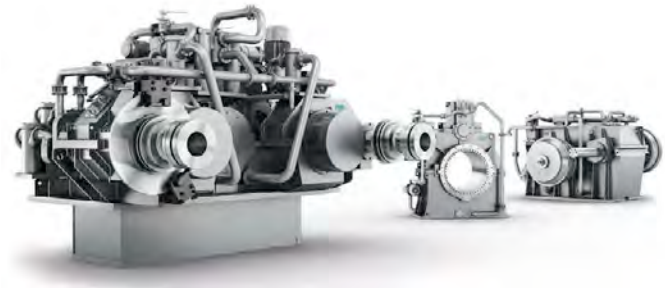

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share of the bulk carrier sector since 2000. To be involved in this project means SDARI can bring the best experience and know-how to the Green Corridor project."

Perhaps the most talked-about aspect of the design is the placement of the two 3,000m^3 Type C LNG fuel tanks. Several different locations were considered before settling on the proposed placement, which will see the tanks on the main deck, below the accommodation quarters but slightly submerged into the engine room to make use of the extra unused height, therefore not jeopardising any extra capacity for cargo elsewhere on the vessel (see Figure 1). Other locations that were considered included mid-ship inside the cargo holders and in front of the engine room.

Placing the tanks so close to the engine room reduces the cost of the cryogenic pipes and diminishes the risk of there being any drop in pressure, compared with if the tanks were placed mid-ship. However, with every design component, there are some issues to work around. For instance, the fuel tanks' placement means that due to the large weight in the aft of the ship, it will experience a very high bending moment, which will need to be compensated for by adding more steel to the hull structure, explains Løvstad. It was also imperative that the placement of the tanks complied with various safety regulations: "The fuel tanks would be surrounded by the steel structure and A-60 insulation, and of course completely separated from the accommodation area and cabins. This design ensures compliance with the IGF Code, including the requirements for fire safety, enclosed spaces around the fuel gas system and full protection from operational impact," continues Løvstad.

At the initial briefing at Nor-Shipping, Løvstad explained the project's aim was to create a design that was more evolutionary than revolutionary, so that the vessel could become a reality as soon as possible. The project partners are hopeful of orders being placed before the end of the year and have set a predicted vessel completion date of 2020, just in time for the sulphur cap enforcement.

Other technologies were considered, such as lightweight composite materials, but didn't make it into the final design. Scrubbers were also considered during the design process: "We did look into scrubbers but we fairly quickly decided that this technology would not meet all the strict environmental regulations that we wanted to comply with. It only addresses the sulphur cap, it doesn't address particulate matter, it doesn't address CO_2 and it doesn't address NOx, so that ruled out scrubbers as an option."

Retrofit options were also contemplated, and a design suitable to be installed in existing vessels was submitted by MOL. It was established that retrofitting would be possible, but the project partners decided to progress with a new build design as it was significantly less expensive. Løvstad argues that a cheap source of LNG would be required to justify such an investment: "There are some challenges from a structural point of view and from a stability point of view. So a retrofit would be possible, but may not be the most attractive or realistic solution, at least in the short term."

Green credentials vs. business sense

One of the challenges with the Green Corridor project was to present a design that is not only environmentally conscious and compliant with the IMO's upcoming regulations, but that will also be attractive from a business perspective, so that cargo owners and shipowners will be encouraged to opt for the design not simply to fulfil their ethical and legal obligations, but because it also makes sound financial sense.

As the production of LNG continues to rise, so does its popularity. According to DNV GL, using LNG as fuel reduces SOx emissions by 100% — good news for the 2020 0.5% sulphur cap — and NOx emissions by 85% in low pressure engines, as well as significant reductions in CO_2. It also almost eliminates particulate matter. Responding to those detractors who argue the fuel isn't environmentally-friendly enough, Løvstad says that LNG is "the greenest option that we have for the ship segment, at least with respect to emissions to air".

Mike Utsler, Woodside's chief operations officer, also finds it to be a financially viable option: "We looked at a wide range of capital and operational costs, including LNG and low sulphur fuel oil price sensitivities, as well as conducting a high-level bunker supply chain assessment. Based on this, we found that under the most realistic scenario, the payback period for the design was under 10 years, and under the optimistic projection just 6.7 years."

With optimisation comes increased efficiency for the vessel's particular use, but also a restriction in the possible use for other routes

TECHNICAL PARTICULARS

Green Corridor 210K

Length overall: 300.0m
Breadth: 50.0m
Depth: 25.2m
Scantling draught: 18.5m
Deadweight at scantling draught: ... 210,000 t
Cargo holds volume: ..... 225,000m^3
LNG tank volume: ..... 6,000m^3
Number of cargo holds: ..... 9 cargo holds
Kind of cargo: ..... grain, coal, ore

Machinery

- Main engine: WINGD 6X72 DF MAN B&W 6G70ME-C9.5-GI

Speed

- Service speed at design draught and CSR with 15% sea margin 14.4 k

EEDI

- 35% below IMO reference line for bulk carriers, complies with EEDI PHASE 3

Class notation

- DNVGL, +A1 BULKCARRIER ESP BC-A GRAB(35)
- CSR, Holds 2, 4 ,6 and 8 may be empty, COAT-PSPC(B) GAS FUELLED

Design features

- Dual-fuel system of LNG and HFO to be applied for main engine, auxiliary engines and boiler
- Endurance of 18,000nm in GAS Mode

Fuel and energy-efficient

- Hull lines optimised for an operating profile including ballast, design and scantling draughts and speeds in the range of 10–15kn
- No-bulb concept for a flexible design with improved overall performance, including operation in realistic sea states
- Added resistance in waves calculated numerically and compared to tank test results

Environmentally friendly

- Designed to comply with current and future expected local and global emission regulations
- Efficient main engine with low fuel consumption and emission levels, IMO NOx Tier III-compliant
- No SOx or PM emission in GAS Mode
- GHG emission 20% less in GAS Mode

The Green Corridor design is set to revolutionise the Australia – China trade route

or applications. Løvstad explains that while the Green Corridor design will be optimised for the Australia – China route, the JIP partners have also been conscious to provide some flexibility for potential employment on other routes: "We did build in a higher LNG capacity to be able to trade on different routes, since a capesize vessel could potentially operate on other trading routes as well, and unlike an ore carrier, the capesize could also carry coal and potentially even grain. Therefore, our design has spare capacity beyond what will be needed for the trade route between Australia and China." However, he points out that the ongoing difficulty of limited LNG bunkering infrastructure means the use of the proposed vessel on other trade routes would have to address the same refuelling challenges.

Chen Gang also adds that vessel designs optimised for particular trade routes could be the future for large carriers: "For small bulk carriers like Handymax, the design should take into consideration that the ship may need to transport various bulk cargo all over the world. It is, therefore , not practical to define a particular trade route. For big carriers like Green Corridor 210K however, the cargo transported is major bulk, like iron ore and coal, so a particular trade route makes sense."

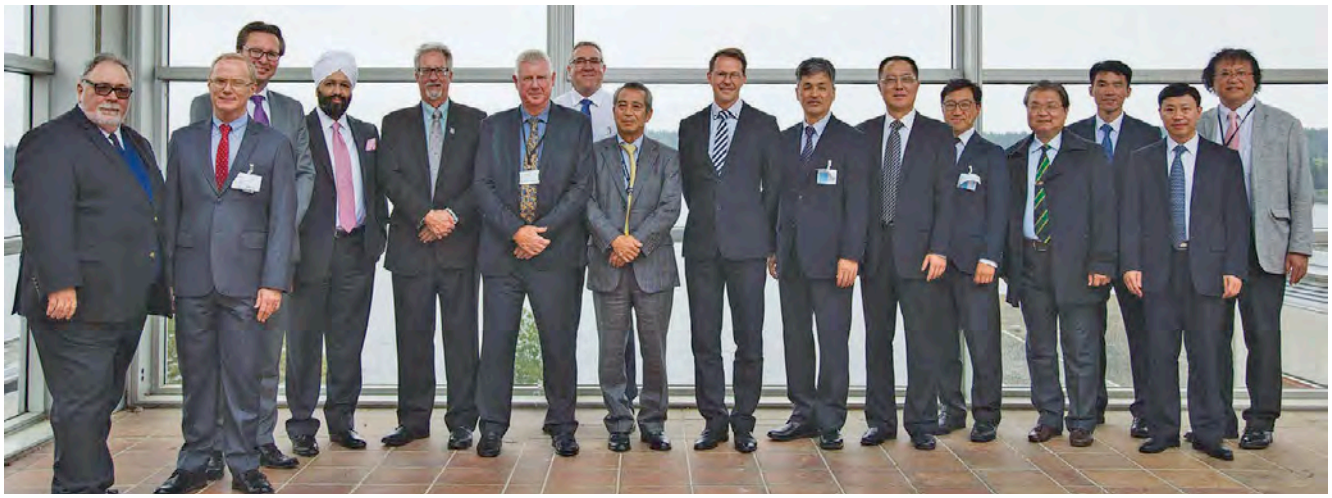
What's next?

As *The Naval Architect* went to press, plans were in place for all partners to meet in Singapore at the end of August to discuss and finalise the results of this initial stage. Green Corridor is also turning its thoughts towards the development of a Very Large Ore Carrier (VLOC), as Løvstad continues:"There's fierce competition between Australia and Brazil on the iron ore export, so some of the miners would like even more optimisation to lower the costs of the transportation of iron ore in particular.

"With a dedicated ore carrier you have more flexibility to choose the best location for the LNG fuel tanks because you're not so concerned about losing volume capacity from the cargo, and because it's heavy cargo, you usually don't fill up the cargo tanks to the maximum anyway. This means you can utilise some space for the fuel tanks inside the cargo area. On a capesize you also want to have the flexibility to transport coal and grain, where volume is critical, and because that is a lighter cargo you will fill up the cargo holds to the maximum. So that was mainly the reason why we placed those LNG fuel tanks on the deck beneath the accommodation area on the capesize vessel design."

DNV GL is still optimistic that the project is on track to be taking orders for the vessel before the end of the year and discussions are currently taking place between owners and charters and yards. With environmental considerations becoming ever more integral to vessel design, perhaps Green Corridor could be the project to prove that environmentally-friendly shipping can go hand-in-hand with good business acumen. *NA*

The project partners at the DNV GL headquarters in Høvik, Norway



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Battling the resistance

Tritec Marine, a naval architecture and marine engineering consultancy based in Glasgow is endeavouring to lead the way in effective and efficient ship resistance calculation

The firm's principal naval architect, Dr Qiuxin Gao, is a member of a team of Tritec Marine specialists working in the field of CFD.

Tritec's expertise was evidenced in 2016 when Dr Gao received an invitation to present his latest paper on ship resistance at the Second Conference of Global Chinese Scholars on Hydrodynamics in Wuxi, Jiangsu Province. Gao's paper, *A practical approach to calculate ship resistance* ,focuses on computational accuracy and efficiency in relation to calculating ship resistance and flow fields.

The paper presented how to calculate the resistance, sinkage and trim of a modern ship in a batch mode using the open-source OpenFOAM mesh generator and the ANSYS Fluent pressure-based solver algorithms.

Ship resistance is a measure of basic ship hydrodynamic performance. It determines the power consumption and the CO_2 emission of the engine, and is an important index in evaluating how cost-effective and environmentally friendly the shipping operations are.

The abstract reads:

A practical approach of calculating ship resistance and flow field is presented. The meshes were generated using SnappyHexMesh in automated batch mode. An iterative approach was adopted in calculating the ship resistance and flow field around hull with sinkage and trim. The initial sinkage and trim were obtained from the computational results of the double model and were updated from free surface calculations. The computed results were compared with the measured data. The comparisons showed that the computed resistance and flow field coincided well with the model test data.

Dr Gao says: "The main motive to participate in the conference was to share my research with fellow researchers, exchange views on pertinent topics with other experts, and hopefully raise awareness of the work of Tritec Marine both in China and worldwide.

"Accurate calculations of ship resistance and the flow field around the hull are of significant financial, technical, environmental and safety importance… In this paper an iterative approach was adopted in calculating the ship resistance and flow field around hull with sinkage and trim."

In order to facilitate the validation of numerical results, international collaborative model tests were performed to measure resistance, sinkage and trim in free conditions, and velocity and pressure field in fixed conditions.

Dr Gao added: "The meshes were generated using Snappymesh in an automated batch mode. The initial sinkage and trim were calculated using double model and were updated from free surface calculations.

"One or two iterations are enough to obtain converged sinkage, trim and ship resistance. The comparisons show that the computed sinkage, trim and resistance coincide well with the measurements. The method is applicable especially for calculations in high Froude numbers."

As well as presenting the paper to his fellow Chinese scholars, Dr Gao chaired a technical session at the conference.

David Scott, Tritec Marine's general manager and director explains the business has made a conscious effort to expand its knowledge in the field in recent years with a specialist recruitment drive.

Scott believes that Gao's research illustrates the level of expertise Tritec Marine now has as its disposal. He adds: "While we have a decade of experience in new build ship supervision and other project management fields, a significant part of our business is work on energy efficiency, particularly through hydrodynamics.

"We endeavour to support our workforce's ambitions to test current thinking, and whenever feasible we will support their research papers, such as Dr Gao's.

"At a time when energy efficiency and environmentally friendly transportation is at the forefront of the international private and public sectors, we as naval architects collectively bear a responsibility to use our expertise effectively." ***NA***

Dr Qiuxin Gao, principal naval architect at Tritec Marine

MEPC 71 serves up pragmatic solutions

The 71st session of the IMO's Marine Environment Protection Committee was one of the most keenly-anticipated in years and – for some parties at least – it didn't disappoint

The looming implementation date of D-2 standard of the Ballast Water Management (BWM) Convention, which becomes effective from 8 September 2017, has been an ongoing cause of angst for shipowners. In March's *The Naval Architect* we reported on the confusion surrounding the time frame for implementation of the Convention, particularly with regard to vessels built (keel laid) before the effective date.

So while the outcome was not entirely a surprise, many will be relieved that MEPC 71 saw the approval of a revised implementation schedule for BWM compliance, with its adoption at MEPC 72 next year thought to be a formality.

As expected, vessels built after the effective date will need to comply with the D-2 standard immediately, but a more pragmatic timeline has been determined for existing ships. These will have to meet the requirements by the following deadlines:

- The first MARPOL IOPP survey on or after 8 September 2019, if it has been surveyed in the three years leading up to 8 September 2017
- The second IOPP survey after 8 September 2017, if its first survey is due in the two years prior to 8 September 2019

In other words, shipowners have a minimum of two years to ensure their vessel is D-2 compliant but could have as long as seven years; the final cut-off date by which all vessels must have a system installed being 8 September 2024 (the latter deadline also applies to vessels not subject to IOPP renewal).

Unsurprisingly, while shipowners welcomed what might be perceived as a stay of execution, it has drawn a more mixed response from ballast treatment system manufacturers, many of whom may have a further wait before any retrofit windfall, and the very real possibility that for many vessels already in service — such as bulkers — scrapping will be deemed a more cost-effective option.

IMO secretary general Kitack Lim and the committee at the opening of MEPC 71 at IMO's London headquarters on 3 July

However, Tom Perlich, founder and president of BWTS specialists Ecochlor said the delays agreed at MEPC 71 were widely expected in the industry. He adds that in the case of Ecochlor the different ballast system standards applied by the US Coastguard (USCG) mean it's unlikely to impact upon business: "A majority of shipowners in midsize to large bulkers and tankers have routes in United States waters and they are Ecochlor's primary market. Therefore, because the USCG regulations are currently in place, and having now received USCG Type Approval, we are expecting to be very busy through to the end of 2017 and beyond."

Type approval

During MEPC 70 in 2016, the Committee adopted the BWMS Code, which formalised the G8 guidelines for approval of ballast systems. Ballast system manufacturers will now need to carry out their testing in accordance with the revised G8 standards no later than October 2018 (in reality of course most will already be doing so), with the compliance of vessels coming into effect two years after that date. However, shipowners who installed systems compliant with the earlier standard will not be penalised.

IMO has also said that there will be a three-year "experience building" phase beginning from September 2017. This is partly an act of clemency towards those shipowners who adopted the earlier ballast systems who will be allowed to continue using them providing they are maintained in operable condition (even if they can't demonstrate biological efficacy). A recent report published by classification society ABS revealed that in a survey of shipowners and operators, only 57% of ballast systems were being operated, the rest being deemed 'inoperable' or 'problematic'.

The experience building phase also allows for a period of data gathering, analysis and operational implications related to ballast systems. "The data gathering is intended to let us know how we're doing with respect to how many vessels have installed systems and how many have been put into commission and whether the experiences are favourable or not," explains Thomas Kirk, ABS's director of Environmental Performance,

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who attended MEPC 71. "That information will be submitted by the flag to IMO who will provide data analysis. At the end we will revisit the Convention and see if there's anything that needs to be changed, with respect to the code, the testing standards or inherent problems with given technologies and manufacturers."

There remains confusion about the different standards set by the IMO and the USCG, but Kirk stresses that they are, loosely speaking, equivalent to each other. "The big difference with US protocol [which is enshrined in law] is the rules are felt to be more transparent and rigorous. When the G8 guidelines were revisited in 2016 they were informed by the US regulation but don't necessarily comply with each other. The important thing is manufacturers should be testing with both protocols in mind with a view to certification to both standards."

Air pollution and energy efficiency

In January this year, the fourth meeting of IMO's Pollution Prevention and Response (PPR) sub-committee made specific recommendations for consideration at MEPC. Of these, the MEPC adopted amendments to the guidelines on selective catalytic reduction (SCR) systems but decided that proposals to amend MARPOL Annex VI and the NOx Technical Code to address multiple engine operation profiles – e.g. the electronic programming of engines to optimise fuel consumption in different operating modes — required further consideration.

MEPC further adopted the introduction of NOx Tier III (equivalent to an 80% reduction of NOx) emission control areas (ECAs) in the Baltic and North Sea regions, which will enter effect from January 2021. This means that new vessels operating in this region will be subject to the same standards already enforced in the North America and Caribbean ECAs since 2016. Temporary exemption will be granted to a vessel constructed in one ECA to allow it transit out of that region, or if it's intended to come into an ECA for repairs.

Another matter of strong interest to shipowners will be the implementation of the global 0.5% sulphur limit (MARPOL VI reg. 14.1.3). A work programme has been tasked with ensuring what Kirk describes as "a level playing field" to ensure compliance in international waters. Its remit includes developing a standard format for reporting when low-sulphur-compliant fuel is not available and guidance that will help owners and operators be confident the sulphur content of delivered fuel is the same as that stated on the bunker delivery note. Given that fuels may be blended or hybrid, the International Organisation for Standardisation (ISO) has been requested to consider the framework of the ISO 8217 standard (which covers bunker fuel testing and compliance) with a view to establishing some consistency.

EEDI deliberations

An ongoing concern the MEPC addressed was the ability of ro-ro vessels – both cargo and passenger – to meet the requirements of the Energy Efficiency Design Index Phase 2, given the limitations in achieving the necessary physical properties for these ship types. Therefore, MEPC has approved amendments to Regulation 21 of MARPOL Annex VI that will allow for a 20% offset to the EEDI baseline which will compensate for the discrepancies in the current calculations.

EEDI is essentially a ratio of the CO_2 emitted by a vessel divided by the transportation work carried out (i.e. it's directly related to the quantity of fuel consumed) and this consumption can be reduced by improving an engine's efficiency or reducing its power. Determining the minimum propulsion power needed for adverse weather conditions was set out in Interim Guidelines in 2013 (MEPC. 232(65)) and it's now likely that they will be extended to cover EEDI Phase 2 as the committee still feels they are not suitable for finalisation. Kirk explains: "Those discussions are continuing and we hope that by moving to more efficient vessels we're never putting the crew at risk."

Although there remain doubts to the efficacy of EEDI, IMO remains committed to the process and is considering both bringing forward the Phase 3 implementation date from 2025 to 2022 and whether there could be an additional Phase 4.

CO_2 reduction

One area where less progress has been made is the development of a comprehensive IMO strategy on the reduction of GHG emissions in line with the Paris COP21 Agreement on climate change. However, MEPC noted a report from the Intersessional Working Group on Reduction of GHG Emissions which includes a draft outline for IMO's initial strategy, its key points being:

- Context, including emission scenarios
- Vision
- Levels of ambition /Guiding principles
- List of candidate short-, mid- and long-term further measures with possible timelines and their impacts on States
- Barriers and supportive measures; capacity building and technical cooperation; R&D
- Follow-up actions towards the development of the revised strategy
- Periodic review of the strategy

A three-stage approach is proposed, the first of which would be a comprehensive data collection system for fuel oil consumption. This would be followed by a period of analysis of that data before deciding what further measures may be necessary. The working group is scheduled to convene again in October and adoption is now being mooted for MEPC 72 in April 2018, but won't now be entirely finalised before 2023.

For some, such as NGO Transport & Environment (T&E), it remains an ongoing source of frustration. Bill Hemmings, T&E's shipping director, reflects: "Disagreement over how to distribute efforts and the potential costs of measures remain the biggest obstacle to progress." He adds that given the IMO's continued prevarications, alternative measures for cutting GHGs in shipping, such as the EU's emissions trading system (ETS), must remain a viable option.

Nevertheless, other lobby groups are more optimistic. Patrick Verhoeven, secretary general of the European Community Shipping Association (ECSA) believes IMO can now deliver an "ambitious strategy", adding that ECSA members are strongly committed to decarbonisation. "We are prepared to play our part in limiting greenhouse gas emissions and we were pleased to see there was a general willingness among governments to commit to developing a strategy as well," he says. *NA*

Propeller overload factors for the direct power method

Dr Bogdan Ganea and Dr Kieran Dodworth of Brookes Bell division, Safety at Sea Ltd, propose a new method for calculating propeller overload factors that meet ISO and ITTC guidelines when suitable model test results are not available

Propeller overload factors are required by the direct power method applied by the new guidelines of speed-power sea trials analysis, issued by the International Towing Tank Conference (ITTC) and the International Organisation for Standardisation (ISO). The procedure outlined in this article shows how the propeller overload factors can be derived on the basis of the propeller open water characteristics. Whilst the derivation of these factors from the propeller load varying method is preferable, this proposal is intended to allow accurate corrections of ship trial data when suitable model basin data has not been produced.

Speed-power sea trials analysis background

Ship speed-power performance is an important aspect of a typical shipbuilding contract and is necessary to calculate IMO's Energy Efficiency Design Index (EEDI), which is a statutory matter under Resolution MEPC.245(66), 2014. Therefore, the speed-power sea trials must follow rigorous procedures and its data processing must be as accurate as possible. New guidelines for speed-power sea trials data analysis were issued by ITTC, [1] and [2], and ISO [3] in 2014 and 2015 respectively. The data processing involves three stages:

1. *Calculate the corrections for environment effects.* Sea trials are almost never conducted in ideal environment conditions. Therefore, the effect of any deviation from ideal conditions must be removed from measured data by applying appropriate corrections.
2. *Calculate the effect of the corrections to hull resistance and air resistance on the measured speed-power performance data.* The ITTC and ISO standards introduced a direct power method to perform these corrections. The effect of the propeller overloading due to environment effects is calculated by means of the propeller overloading factors.
3. *Calculate the speed performance for the ship on contractual displacement conditions.* In general, the contractual displacement is that of the ship at the design draft whilst the EEDI is calculated for the ship at the scantling draft. The speed-power results determined in stage 2 above must be transposed to the contractual and EEDI conditions.

Propeller overload factors

The quasi-propulsive efficiency variation is calculated by means of the propeller overload factor, assuming the linear correlation:

$$\eta_D = \eta_{D0}\left(1+\xi_P\frac{\Delta R}{R_0}\right) \quad (1)$$

ξ_P **: propeller overload factor for variation of quasi-propulsive efficiency with resistance**
η_D **: quasi-propulsive efficiency in trial conditions**
η_{D0} **:quasi-propulsive efficiency in ideal conditions**
R_0 **: ship resistance in ideal conditions**
ΔR **:resistance correction, i.e. resistance increase in trial conditions,** $R=R_0+\Delta R$.

The propeller delivered power in ideal condition is calculated by:

$$P_{D0} = P_D\left(1+\xi_p\frac{\Delta R}{R_0}\right)-\frac{\Delta R\cdot V_S}{\eta_{D0}} \quad (2)$$

P_D **: delivered power in trial conditions (measured)**
P_{D0} **: delivered power in ideal conditions**
V_S **: ship speed through water in trial conditions.**

The propeller revolution speed in ideal conditions is calculated by means of two other propeller overload factors, ξ_n **and** ξ_V**:**

$$\frac{\Delta n}{n_0} = \xi_n\frac{\Delta P}{P_0}+\xi_V\frac{\Delta V}{V_S} \quad (3)$$

$$\Delta n = n - n_0$$
$$\Delta P = P - P_0 \quad (4)$$
$$\Delta V = V_S - V_{S0}$$

ξ_n **: propeller overload factor on variation of propeller speed with power increase**
ξ_V **: propeller overload factor on variation of propeller speed with ship speed increase**
n **: propeller revolution speed in trial conditions**
n_0 **: propeller revolution speed in ideal conditions**
ΔV **:decrease of ship speed due to shallow water effect, always negative in (4).**

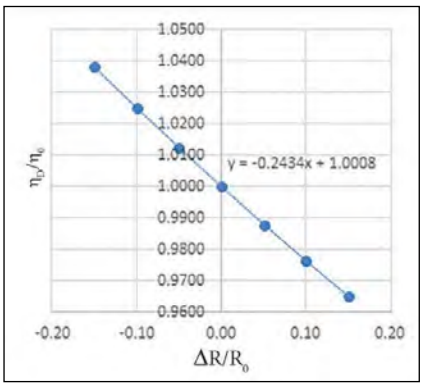

Figure 1. Propeller overload factor ξ_P calculation diagram. ξ_P=-0.2434

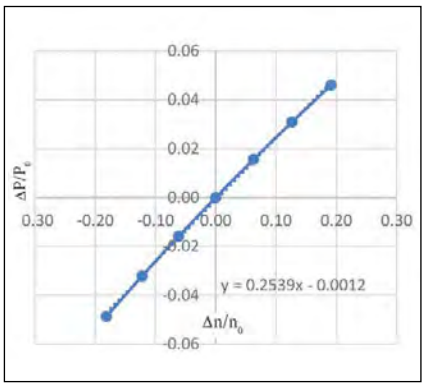

Figure 2. Propeller overload factor ξ_n calculation diagram. ξ_n=0.2539

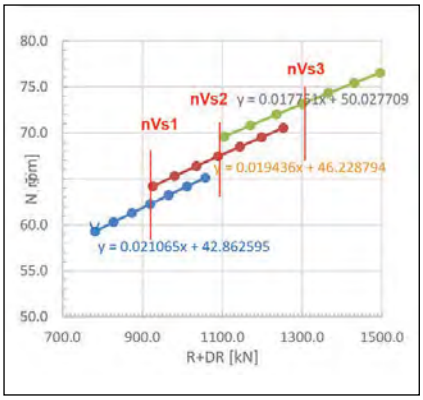

Figure 3. Propeller overload factor ξ_V calculation diagram. Propeller revolution speed against propeller overload for each ship speed

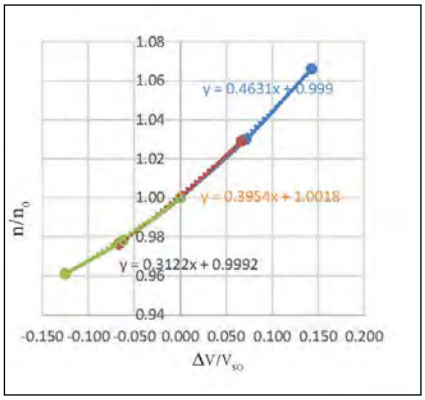

Figure 4. Propeller overload factor ξ_V calculation diagram. Propeller revolution speed variation against ship speed variation

The direct power method involved in Stage 2 is the subject of this paper.

The direct power method

Because the ship resistance during sea trials differs from that which would be found in ideal conditions, the propeller is normally either underloaded, or more commonly overloaded. Overloading means that the propeller must deliver more thrust than in ideal conditions. The quasi-propulsive efficiency, which comprises the propulsive coefficients (wake fraction, thrust deduction fraction, relative rotative efficiency) and the propeller open water efficiency, depends on the propeller load. In the new ITTC and ISO guidelines, the variation of the quasi-propulsive efficiency with the propeller load is calculated as shown in equation (1).

Ideally, the propeller overload factors are determined by self-propulsion basin tests carried out by means of the propeller load varying method, aka the so-called 'British method', [4]. Several propeller loads are imposed by varying the propeller speed, typically ±15% of the revolution speed necessary to move the ship model with the given speed corresponding to that of the ship sailing in ideal conditions. The model speed is kept constant for all propeller revolution speeds. The model propeller thrust (loading) variation replicates the ship in various environmental conditions. This method is significantly more laborious than the propeller constant loading method ,aka the 'Continental method' which involves only a single propeller load which corresponds to the ship sailing in ideal conditions and needs only a single basin run to be conducted for each model/ship speed. Therefore, there are still many ships whose self-propulsion basin tests were carried out by the Continental method.

The latest version of STAIMO, the freeware developed by STA Group to create an accurate and transparent way of performing and analysing speed-power sea trials, implements the ITTC and ISO guidelines. STAIMO proposes default propeller overload factor values for the variation of propeller speed with variation of quasi-propulsive efficiency with resistance (ξ_P), variation with power increase (ξ_n) and variation with ship speed increase (ξ_V): 0.0, 0.20 and 0.33 respectively. But these default values ignore the individual ship characteristics that may influence the accuracy of the analysis. With ξ_P=0, the proposed direct power method is identical to the superseded British Ship Research Association (BRSA) method, which uses a single, constant, quasi-propulsive efficiency to correct for environmental effects.

Proposed procedure

The proposed method for propeller overload factors calculation assumes that the variation of the propulsive coefficients is negligible with the propeller overloading, [3 - Annex J]. Therefore, only the propeller open water efficiency variation is to be accounted for.

The ship resistance in ideal conditions is determined by resistance tests carried out over a range of ship/model speeds. The propeller load varying method is emulated by adding a set of additional resistance corrections to this ideal resistance. The corresponding propeller thrusts are calculated by using the thrust deduction factor. The propeller revolution speed is calculated by solving the quadratic equation created by equating the propeller thrust coefficient to that from the propeller open water characteristics expressed as a quadratic polynomial. The torque coefficient is determined from propeller open water characteristics. With the propeller thrust, torque and advance coefficients, the propeller open water efficiency and the quasi-propulsive efficiency are further calculated for each resistance correction. ξ_P in (1) is calculated by deriving a best-fit line for the variation of quasi-propulsive efficiency with propeller load. Figure 1 shows a plot of a Capesize bulk carrier.

To determine ξ_n in (3), the variation of the delivered power with propeller load must be calculated. The torque

Propeller overload factor	Ballast draught		Design draught	
	STAIMO	Present method	STAIMO	Present method
ξ_P	0.00	-0.24	0.00	-0.22
ξ_n	0.20	0.39	0.20	0.25
ξ_V	0.33	0.31	N/A	N/A

Table 1. Propeller overload factors calculated by present method and those recommended by STAIMO as default of a Capesize bulk carrier

coefficient behind the ship is calculated by using the relative rotative efficiency. Then the delivered power is calculated for each additional resistance. The propeller overload factor ξ_n is calculated by deriving a best-fit line for the variation of propeller speed with delivered power as shown in Figure 2.

ξ_V accounts for the variation of the propeller revolution speed with ship speed for no propeller overload, ΔP=0 in relationship (3). For each model/ship speed, the variation of propeller revolution speed with propeller load is represented, see Figure 3. The variation of propeller revolution speed with ship speed at constant propeller loading is along the vertical red lines through the ship resistance in ideal conditions. ξ_V is determined from the linearly faired variation of propeller revolution speed along the red lines. This is represented in Figure 4. The values of ξ_V are: 0.3122, 0.3954 and 0.4631 for each ship speed respectively.

Table 1 shows the propeller overload factors calculated as above compared against default values of STAIMO freeware for a Capesize bulk carrier. The values were averaged over the ship speeds, 14, 15 and 16 knots. The averaging was done only for comparison as the values used should be those corresponding to the ship speed through water.

Corrected propeller speeds for design/scantling draughts

Stage 3 involves the transposition of the ship speed-power-results for the ship at its trial draughts to the contractual/EEDI draughts. The new ITTC and ISO guidelines provide a procedure only about how to transpose the delivered power. The proportional transposal of the delivered power is a well-established practice. STAIMO applies the proportional correction to transpose the propeller revolution speed from the trial condition which means that the propeller revolution speed correction is independent of that of the delivered power.

In the proposed method, the delivered power correction to the contractual/EEDI conditions is regarded as a propeller overloading. Consequently, the propeller revolution speed may be corrected by means of the ξ_n propeller overloading factor. This maintains the relationship between propeller speed and power defined in the latest version of the ITTC and ISO guidelines. This method is proposed as a tightening-up of the general procedures provided in the ISO standard and can be applied however the propeller overload factors are calculated.

Conclusions

The new guidelines for speed-power sea trials data analysis apply the direct power method to correct the measured data. This method requires propeller overload factors which ideally are determined by self-propulsion tests performed by the propeller load varying method, aka British method. The less laborious method of propeller constant loading method (aka Continental method) is largely used for self-propulsion basin tests even though it cannot directly produce the propeller overload factors required by the new standards. STAIMO freeware, released by STA Group applies these new regulations and has been, widely adopted by the marine industry in recent years. Default values of propeller overload factors are suggested in that software which ignores the particularity of the subject ship.

A method for propeller overload factors calculation is proposed in this article allowing sea trial results to be corrected within the framework of ISO 15016:2015 even when suitable model test results are not available. The method assumes that the propulsive coefficients do not vary significantly with propeller overload which in our opinion is acceptable given that the propeller is only lightly or moderately loaded for most ships. Annex J and Annex K of [3] supports this assumption.

The method proposed in this article, accounting only for the variation of the propeller open water efficiency with propeller load variation, is essentially the same as the Taniguchi-Tamura method adopted in ISO 15016:2002 but reformulated to be consistent with the current version of the standard. Whilst we acknowledge that the more recent process in ISO 15016:2015 is technically better when the British method has been used in model tests, there is an important gap for vessels in which the Continental model basin method has been applied. We hope this article shows a way in which this gap. *NA*

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[1] ITTC Recommended Procedure 7.5-04-01-01.1, Preparation and Conduct of Speed/Power Trials, 2014

[2] ITTC Recommended Procedure 7.5-04-01-01.2, Analysis of Speed/Power Trial Data, 2014

[3] International Standard ISO 15016, Ship and Marine Technology - Guidelines for the assessment of speed and power performance by analysis of speed trial data, second edition, 1st April 2015

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Vestdavit eases into the cruise sector

Better known for supplying launch systems to the naval and offshore sectors, Vestdavit is now setting its sights on equipping polar expedition ships

The Bergen-based company's offering, unveiled at Nor-Shipping in June, is MissionEase Cruise, a scaled-down version of the MissionEase multi-boat launch and recovery system that was first developed for seismic ships, warships and coastguard cutters. The remotely-operated system utilises hydraulic cradles, rails and overhead davits to move boats safely from stowage positions to maintenance, preparation or launch areas within the hangar or mission bay.

Vestdavit's managing director, Rolf Andreas Wigand, explains: "We've designed it for expedition cruiseships where they go into deep fjords, up to icebergs and similar places. The operators want their passengers to have a special experience so they will be carrying several ribs. They will also have waterjets, kayaks and a variety of different gear which they would launch when stationary.

"So there's not the same sea-state requirement for launching [as would be the case with naval or offshore vessels] but it needs to be an efficient system at a good price value and with the ability to store and stow these elements safely while it is cruising along. With MissionEase we decided that instead of having equipment suspended from the ceiling on gantry cranes we would put it on the cargo deck, on rails. Now there is only one or two davits (depending on the chosen configuration) on the ceiling which can be directed to go in and pick up the different things which are then fed into the launch area."

Wigand adds that it is even possible to use the davits for containers should certain equipment need to be containerised. The system is controlled via computer from the cargo area.

MissionEase Cruise spent two years in development and Vestdavit specifically reached out to ship designers. Wigand stresses the importance of naval architects consulting his company at an early stage if a vessel is going to require a launch system so that they can collaborate in developing tailor-made solutions.

Rolf Andreas Wigand

He says: "We target ourselves increasingly at the designers because if you're not in there early it's very difficult to get everything considered. After that come the shipowners and the shipyards. The trouble with the builders is they will invariably pick the solution which meets requirements at the lowest cost. Sometimes they end up buying something [inferior] we would never sell."

Developing systems fit for purpose to operate in the polar regions brings its own unique challenges and also the requirements of IMO's Polar Code, says Wigand. So far, Vestdavit has delivered only deck-mounted equipment, which means it needs to withstand temperatures of -40°C. However, Vestdavit's extensive experience with naval vessels has put them in good stead, says Wigand. Another challenge is building a system which is greener and can get rid of potential pollutants, to which end Vestdavit is exploring electrical systems. "We've developed systems that use environmentally-friendly oil. There was a development project with a Swiss manufacturer for a synthetic oil. It's a very good product but doesn't work below -40°C because the viscosity of the oil changes."

While it's too early to anticipate the demand for MissionEase Cruise, Wigand says that overall the demand is for "bigger and bigger" davits. "We've just delivered the biggest single-point davit we've ever made [the PAP-16000, capable of handling workboats in conditions up to sea state 5], which lifts a boat of 16 tonnes with just one wire, which is the highest load we would recommend for a single wire. One of the challenges was the speed because the customer wanted to lift it at 40m/m, to get the boat out of the water as quickly as possible for safety reasons. Lifting a vessel at that speed requires huge hydraulic systems with dual piping and a lot of power."

Launch and recovery of unmanned systems – surface and underwater - is also becoming a growing area of focus, with one of the challenges being retrieving the vessel from the water. "We've developed different systems, such as a telescopic antennae made from carbon fibre and lifting wires made from synthetic rope. Another approach is to make a cage and lower it into the water. The operator would then drive it into the cage like a computer game."

Underwater vehicles are a particular challenge because of the importance of keeping the vehicle completely stable when lowering it into the water. "With these you need active heave compensated winch systems. So we're looking at dual winch that's both passive heave compensated, with wave compensation on the surface of the water and active heave for underwater."

As shipowners, be they naval, offshore or commercial, become more ambitious in their demands for multiple boat handling systems, stressing the need to abide by sea state requirements becomes increasingly difficult. Wigand says: "It's tough on the selling side because the operators and technicians know what they want but then the procurement is taken over by purchasing. So there can be some mismatch in ensuring the right fit."

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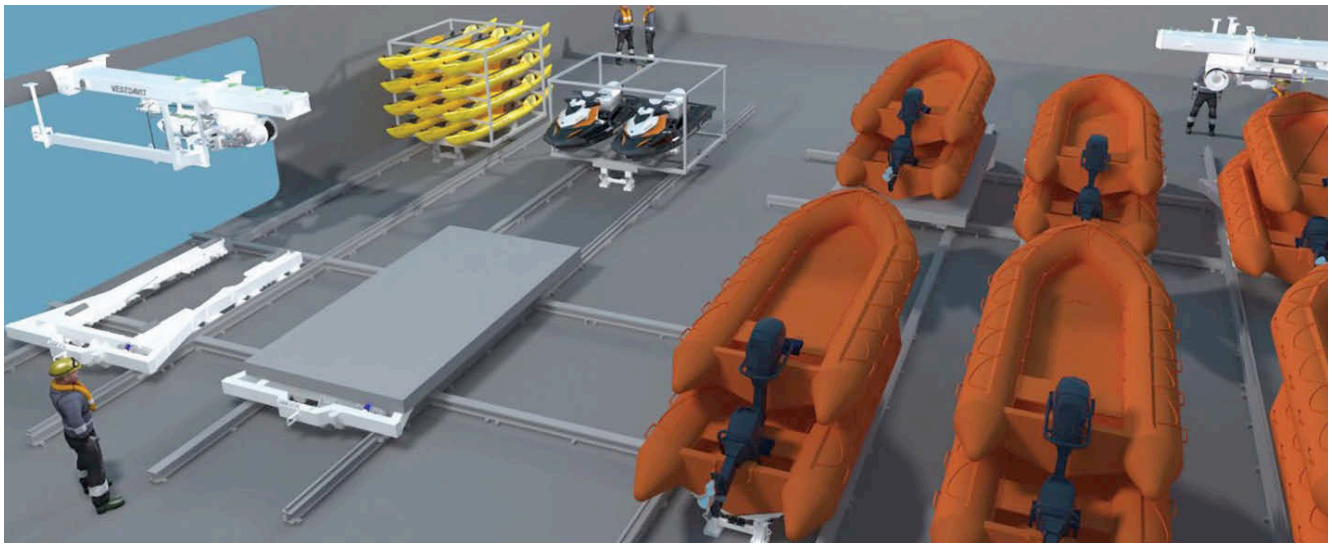


As expedition yachts and ice-strengthened cruiseships seek to explore harsher locations, MissionEase Cruise will allow on-board boats and equipment to be moved safely and quickly

He adds that one of the difficulties is operators are often dependent upon specifications from classification societies which were never initially intended to cover the launch of more specialised watercraft. "So we try and work with the class societies and influence the rules. It's not that they're lagging behind so much as the technology is moving forward so fast and the manufacturers are leading it. So staying on top is almost impossible. But they are good listeners and they want to move ahead." *NA*

Texelstroom ferry is a lesson in stylish, eco-friendly design

The newest vessel to carry passengers between the island of Texel and mainland Netherlands is more sustainable and environmentally-friendly than its predecessors

A collaboration between The Royal Texels Eigen Stoomboot Onderneming (TESO), naval architect and project bureau, C-Job, and design studio, Vripack, *Texelstroom* is a ferry with a plethora of eco-credentials. The vessel, which has been in service since September 2016 and won the prestigious 2017 Shippax Award, operates a ferry service between the Wadden Island of Texel, just off the coast of the Netherlands, and the port of Den Helder on the mainland, travelling through the Wadden Sea, which is listed as an UNESCO World Heritage Site and an area that island inhabitants are keen to preserve and protect.

Eco design

It is powered by a dual-fuel hybrid propulsion system that can run on CNG or diesel, with two of the four main engines dual fuel, and the remaining two suitable for regular diesel. The vessel is mainly run by the dual-fuel engines but can run entirely on diesel if necessary. Using CNG minimises the emission of NOx, SOx and fine particles and the dual-fuel engines also power the electrical propulsion as well as the battery banks, which are also powered by sustainable energy. The batteries have a total of 252 units of 48V lithium-ion modules (of the AT6500 series from Corvus Energy) and have a storage capacity of 1.6 MWh, providing a powerful backup if needed. 'Peak shaving' is employed too, meaning the additional power from the battery is only used during acceleration from the harbour and for the rest of the time, the ship runs on one generator.

LNG was also considered, but as Wietse Bandstra, marketing & sales at C-Job explains, it turned out that CNG made more sense for this particular project: "We designed the vessel for both CNG and LNG. Eventually, CNG was the most viable solution due to logistical reasons. LNG would have had to be delivered by truck every two weeks to the port of Den Helder. Since the homeport is Texel, the vessel needed to sail with only the trucks onboard, being treated as dangerous cargo, to the homeport. During the night, bunkering would take place, however with the vessel being used for multiple ambulance trips a week, especially during high season, the island inhabitants need to rely on the ferry if they need to be brought to the hospital on the mainland. So instead, CNG, generated from both bio-waste and the mainland network, is transported by pipeline over the island. Every night the gas is compressed and fuelled onboard."

C-Job was also able to find an eco-friendly solution to the heating of the interior of the ferry. During operation hours, the cooling water of the generators heats an 80m^3 thermal water buffer tank filled with fresh water which is heated by a heat exchanger from the engines. Overnight, this hot water is used to heat the ship's salon and public areas in place of a boiler, saving both money and eradicating surplus emissions through fuel burning.

The Wadden Islands, to which Texel belongs, have on average the most hours of sunlight each year when compared to the rest of the Netherlands. Texelstroom takes full advantage of this fact, with 700m^2 of solar panels generating sustainable energy on its top deck. All 462 of the panels face Den Helder in the south, with a fixed 15° angle, to make the most of the sun.

CFD analyses of wind behaviour were also conducted by Van Oossanen Naval

TECHNICAL PARTICULARS

Texelstroom

Length oa:	135.4m
Length bp:	135.4m
Breadth moulded:	27.9m
Breadth of main deck:	22.0m
Depth to main deck:	7.18m
Design draught:	4.05m
Scantling draught:	4.40m
Power output:	8,000ekW

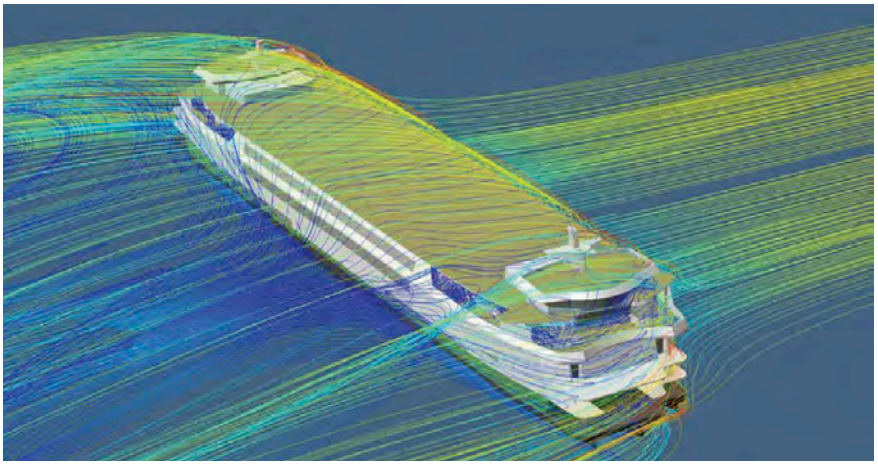


Figure 1: C-job managed to reduce wind pressure on the vessel by using CFD optimisation

Architects and thanks to the results, C-Job were able to reduce the drag coefficient by at least 2% (see Figure 1).

Extra capacity

One of the challenges of the design brief was to increase the onboard car capacity without increasing the size of the vessel substantially, as *Texelstroom* needed to fit into the same port as its predecessor, *Dokter Wagemaker.* Tourism to the island is increasing, and with 70% of all passengers being tourists, space for extra cars was needed. A lower hold was considered to house the extra cars, but the turnaround time of 10 minutes between trips could not be guaranteed. The dilemma resulted in a revolutionary design featuring a T-shaped beam on the top deck that means the vessel can accommodate two extra lanes of cars, bringing the total capacity from 300 up to 340. The completed vessel, which was built at LaNaval shipyard in Spain, is 135m and 28m wide – just 5m taller and wider than *Dokter Wagemaker.*

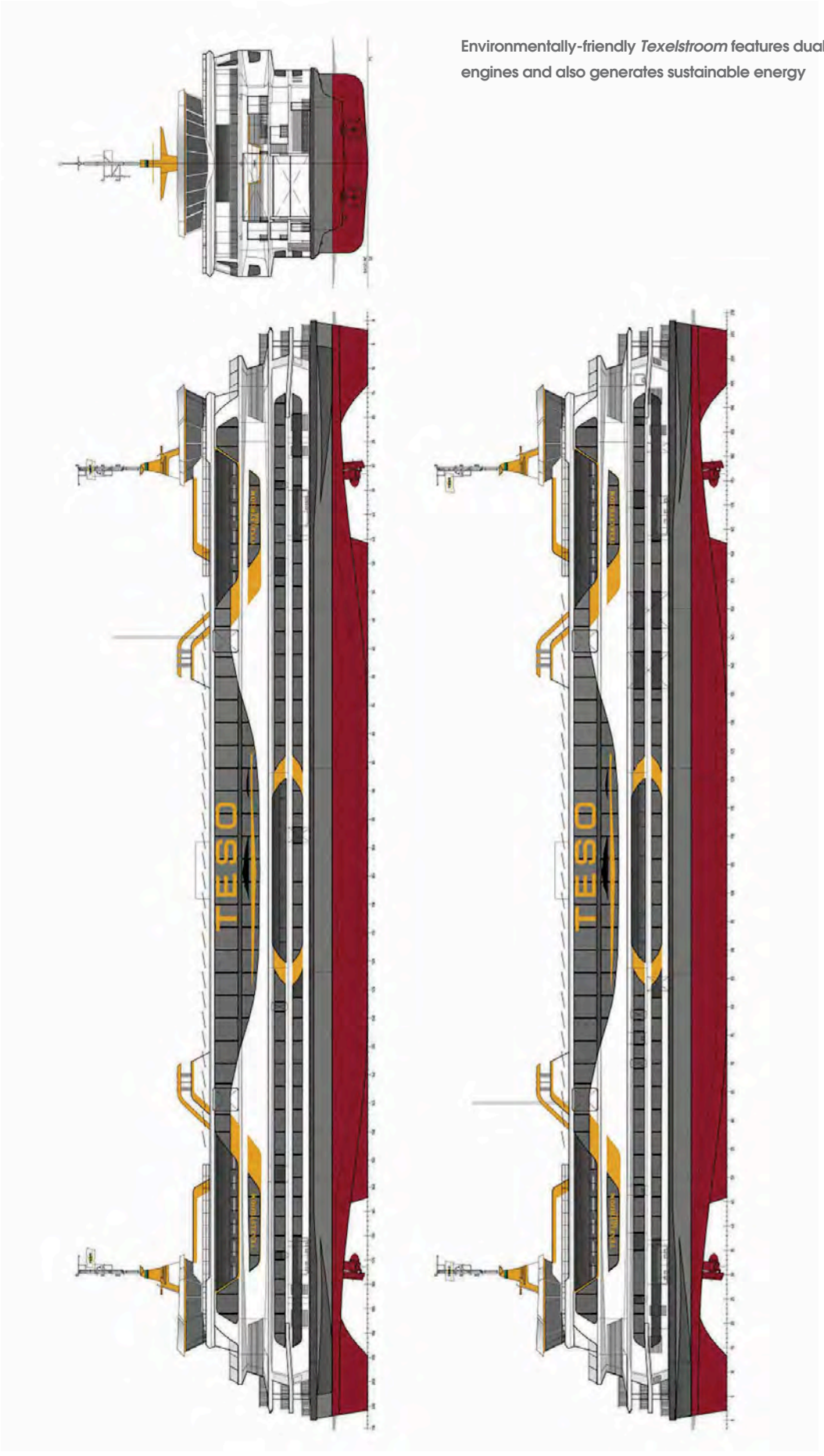
"The biggest challenge was to increase the car capacity of the vessel by 10%, without lengthening, widening or making it higher. This was due to the fact that a longer vessel would be less manoeuvrable, a wider vessel would not fit in the port terminal and a higher vessel would catch too much wind. Together with TESO we came up with a solution where we created a T-shaped main cross section. This way the car capacity was increased by 14%. Also, with a marginal difference in lateral surface, we managed, by CFD optimisation, to reduce the wind pressure on the vessel compared to *Dokter Wagemaker,*" continues Bandstra.

A reflection of the landscape

Ferry operator TESO is a non-profit cooperative, with the majority of its 3,100 shareholders living on the island. This meant it was important that the new vessel represented Texel and the surrounding area and it seems Vripack took great care and attention to detail in this aspect of the design. The exterior of the vessel was inspired by the little tern seabird that calls Texel home, with its yellow beak and black and white feathers. Pine cone scales inspired the large windows in the salon and the colour scheme of the interior fittings reflects the nearby dunes. There's also an interactive play area to keep younger passengers entertained, a restaurant and seating areas with charging facilities. As a final nod to the island, an artificial pine tree native to Texel serves as a meeting point for passengers in the salon.

TESO, along with C-Job and Vripack, also valued the input of the local community, who were asked to contribute ideas during the design process: "The island inhabitants were able to provide suggestions for the new vessel. All ideas were gathered and were applied when they were feasible and if they could benefit the design. Passengers, crew, staff and TESO shareholders were all asked to provide input. About 600 requests were collected. The requests were shortlisted by the newbuild team and checked for feasibility. One of the requests was to reuse engine heat, which is now stored during the day in a buffer tank, to be used overnight to heat the accommodation and technical spaces," says Bandstra.

Texelstroom has deservedly been heralded a triumph in green ro-pax design and is hopefully a vessel that will serve Texel's visitors and inhabitants for many years to come. *NA*



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Damage stability: upcoming SOLAS 2020 regulations

Following on from the earlier update in May's *The Naval Architect*, Keith Hutchinson of Babcock Energy and Marine Technology, on Tyneside in the United Kingdom, and Andrew Scott of the UK MCA report on discussions at the MSC meeting held at IMO between the 7th to 16th June 2017

The final piece of the jigsaw comprising the whole raft of amendments to the current International Convention of Safety of Life at Sea, SOLAS, 2009 regulations for passenger and dry cargo ships, which have been under discussion for several years now, was for the Ninety Eighth meeting of the Maritime Safety Committee, MSC 98, to approve a new formula which will significantly increase the Required Subdivision Index, *R*, for passenger ships (SOLAS Chapter II-1 Regulation 6.2.3). The level at which *R* is set varies according to the number of persons onboard, *N*, and defines the damage stability survivability characteristics of all SOLAS passenger ships in accordance with the established principle that the larger *N* becomes the more survivable the ship should be following penetrative damage. A proposed new formula for an increased passenger ship *R* was accepted at MSC 98, along with the updated Explanatory Notes (EN), thus paving the way for all the proposed amendments to be approved in one go. Subject to formal adoption at MSC 99, tentatively scheduled for 16th to 25th May 2018, they will be known as the SOLAS 2020 amendments and will be applicable to new ships for which the building contract is placed on or after 1st January 2020 or the keel is laid on or after 1st January 2022, or delivery is on or after 1st January 2024.

Having described the background to the changes to *R* in our article in the May issue of *The Naval Architect* [1], this article firstly discusses the newly agreed

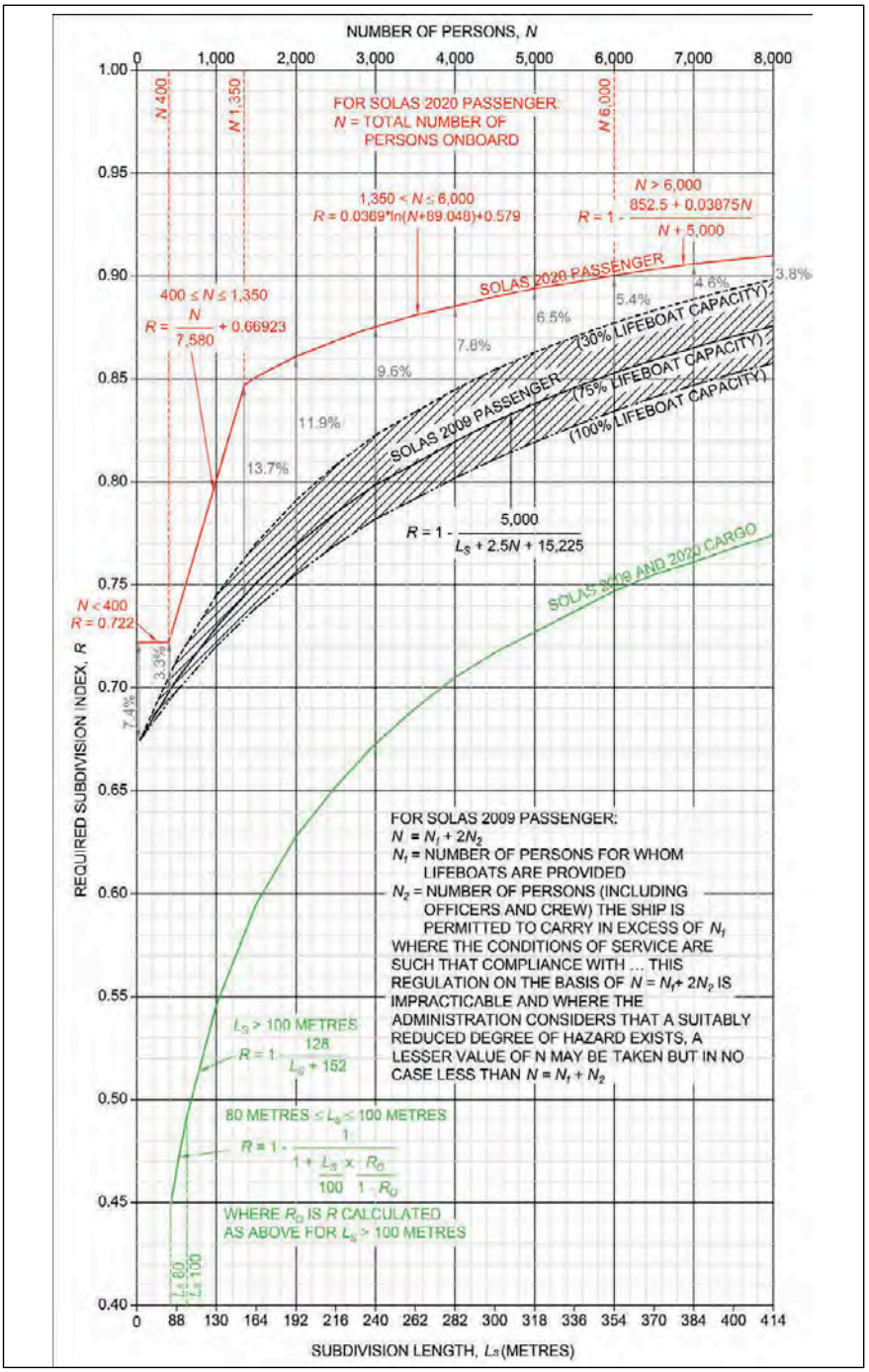

Figure 1: Comparison between the Required Indices *R* for SOLAS 2009 and 2020

passenger ship R index and $s_{final,i}$ factor (SOLAS Chapter II-1 Regulation 7-2.3) in more detail then briefly summarizes the other amendments to SOLAS 2009 Chapter II-1 and the accompanying Explanatory Notes. The issue of the future of the Stockholm Agreement for European Roll-On/Roll-Off (ro-ro) passenger ships once the SOLAS 2020 amendments come into force are also touched upon.

Changes to the Required Subdivision Index, *R*

The damage stability requirements, and hence the degree of subdivision to be provided, is given in SOLAS 2009 Chapter II-1 Regulation 6 in the form of the Required Subdivision Index, R. The formulae for R for dry cargo ships, which is a function of subdivision length, L_S, only is given in Regulation 6.2.1 and 6.2.2. As can be seen from Figure 1, that there are no changes proposed for SOLAS 2020.

The SOLAS 2009 formulae for R for passenger ships appear in Regulation 6.2.3 and, as can be seen from Figure 1, is a function of both L_S and N – noting that in Figure 1 that the values for L_S on the lower x-axis are typical ones from a regressed mean relationship against N, on the upper x-axis, for passenger ferries and cruise ships. The changes being introduced in SOLAS 2020 can clearly be seen in Figure 1 and that R is now purely a function of number of persons on board, N, independent of lifeboat provision.

Summary of changes to passenger ship R

It will be noted, as mentioned above, that R no longer depends on lifeboat provision, N_l, or, as also mentioned above, subdivision length, L_S, but only on the number of persons on board, N. It was felt that some passenger ships with a relatively short length could carry a disproportionately large number of persons, and vice versa, so that it was preferable to simplify the formula by making R solely dependent on N.

In addition, there are nowadays several equally effective means of rescue available other than lifeboats so it was decided to leave the issue of minimum lifeboat provision solely to the Chapter III SOLAS regulations on life-saving appliances and arrangements rather than linking it to subdivision and damage stability.

Whilst it is undoubtedly the case that lifeboats provide a degree of re-assurance to passengers, the actual proportion of passengers rescued after a damage incident will depend on circumstances other than just the number of lifeboats available, amongst which are, for example: the prevalent weather conditions; whether it is day or night-time; and the availability of local search and rescue facilities.

The final area to be resolved was the level of R for smaller passenger ships, namely those with N up to approximately 1,500, where there were concerns that too large an increase would prove difficult for ships with less flexibility in their subdivision arrangements, more port facility constraints and a greater variety of primary design types. Equally there was a consensus of opinion that R should be increased right across the N range relative to SOLAS 2009.

It was finally agreed to maintain R constant at 0.722 for N up to 400 persons (this being the Chapter II-1

Figure 2: Time-line showing development of 2020 SOLAS amendments particularly as they affect ro-ro passenger ships

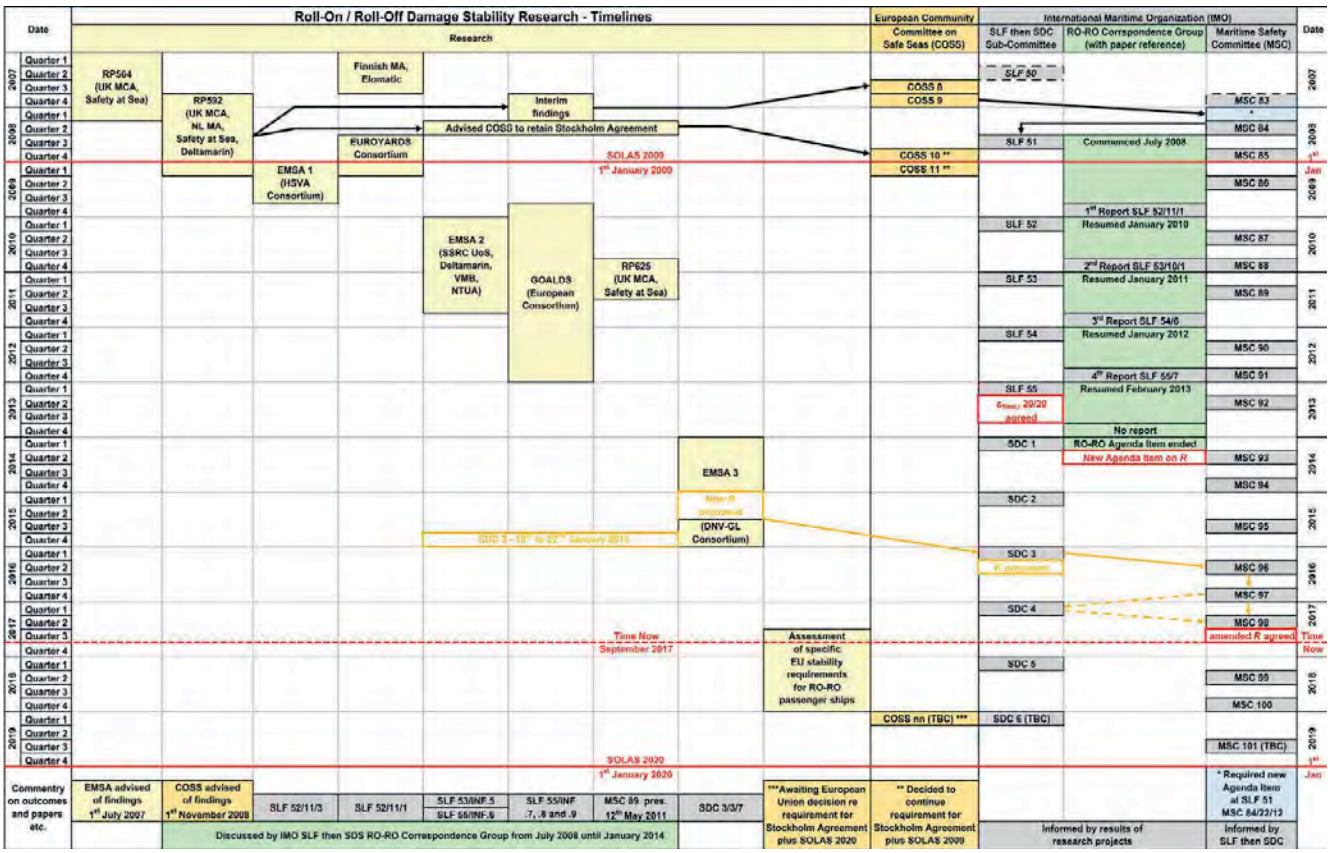

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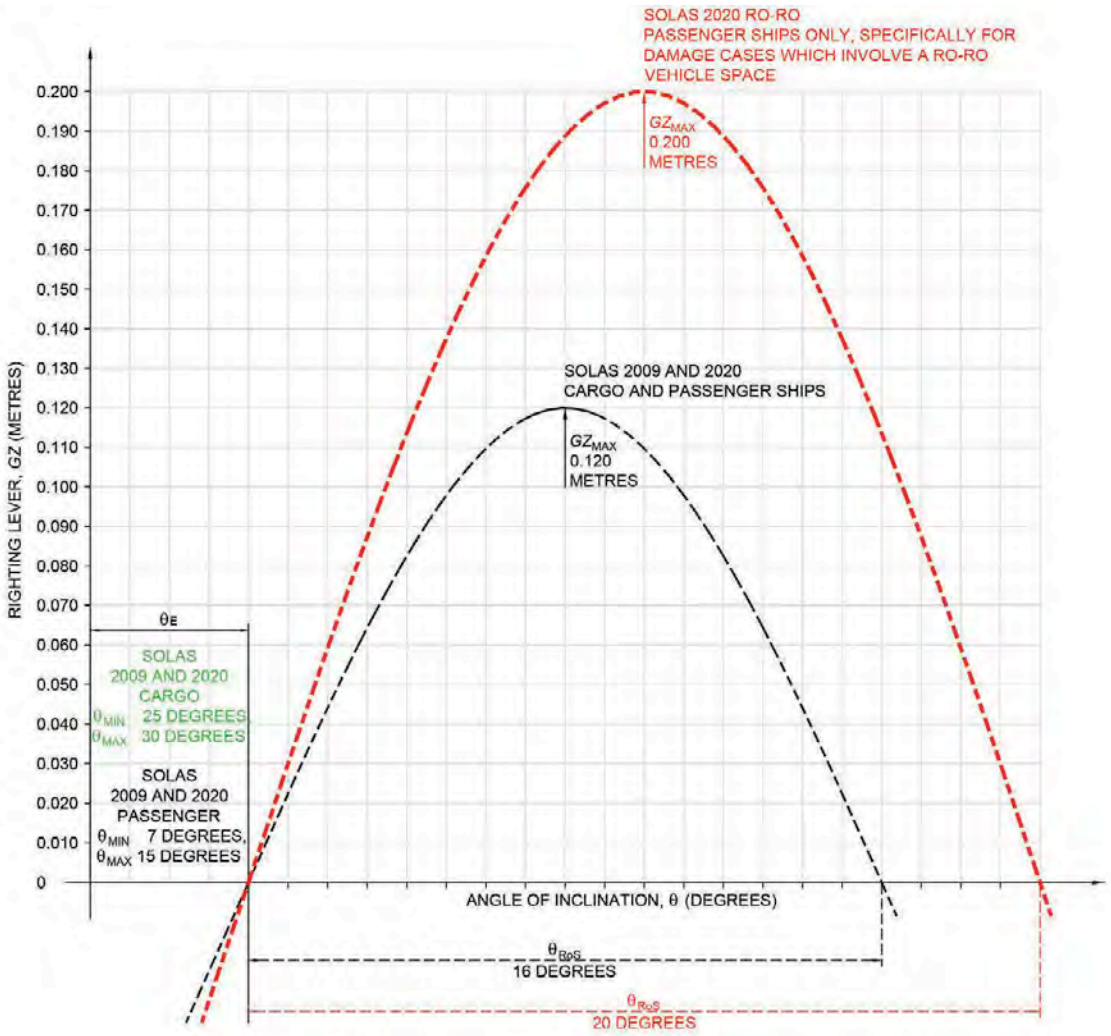
Figure 3: Comparison between SOLAS 2009 and 2020 *GZ* curve requirements to give an $S_{final,i}$ of 1



SOLAS 2009 AND 2020 RESIDUAL PROBABILISTIC DAMAGE STABILITY CRITERIA
(FINAL STAGE OF FLOODING)

CRITERION	UNITS	SOLAS 2009 AND 2020 CARGO	SOLAS 2009 AND 2020 PASSENGER	SOLAS 2020 PASSENGER RO-RO SPACES
POSITIVE RESIDUAL RIGHTING LEVER (*GZ*) CURVE RANGE, θ_{RoS}	DEGREES	16		20
MAXIMUM RESIDUAL RIGHTING LEVER GZ_{MAX}	METRES	0.120		0.200
ANGLE OF HEEL DUE TO UNSYMMETRICAL FLOODING AFTER EQUALISATION (DAMAGE EQUILIBRIUM ANGLE), θ_E	DEGREES	MINIMUM 25 MAXIMUM 30	MINIMUM 7 MAXIMUM 15	

Regulation	Subject	Amendment	Reason
A 1.3.4	Cargo ship alterations	Deleted	*A*/*R* ratio not relevant for new SOLAS 2009 ships
A 2	Definitions	Draught, trim, bulkhead deck modified	Increased clarity
B 4	General applicability	Footnote excluding specified cargo ships now in Regulation text	Footnotes do not have same legal authority as Regulation text
B-1 5-1	Information to the Master	Limiting *KG* / *GM* data now to include trim	Expansion and clarification, particularly of Reg. B-1 5-1/4
B-1 7.2	Attained Index *A*	Treatment of trim in calculation of *A*	Increased clarity
B-1 7.3	Residual *GZ* calculation	Constant displacement removed; free trimming added	Added weight method can be used during IS flooding
B-1 7-2.5	Bulkhead deck	"of passenger ships and the freeboard deck of cargo ships"	Clarification - applies in many Regulations
B-1 7-2.5.3.3	Immersion giving s = 0	Immersed pipe / duct in damage extent if risk of progressive flooding	Expansion and clarification
B-1 7-2.5.5	Watertight hatch covers	Reference to "small watertight hatch covers" removed	"Small" undefined; "watertight" now applied to all hatch covers
B-1 8.1 and 2	Fore end damage (passenger ships)	Text changes and how to account for trim	Clarification of extent of fore end damage
B-1 8.3	Extent of damage (passenger ships)	Removes references to *N* and L_S; now "persons carried"	Consequential upon changes to *R* formula in Reg. B-1 6.2.3
B-2 9.3 and 6-8	Double bottoms	Small wells, vertical damage extent; cargo ships < 80 metres	Expansion and clarification
B-2 12.5.1	Fore Peak bulkhead	Penetration pipe may be fitted with a butterfly valve; cargo ships	Consolidates a common practice into SOLAS
B-2 16	Testing of watertight closures	Title changed; hatches to be tested; includes small cargo ships	Testing of hatches omitted previously
B-2 16-1.2	Vents through the bulkhead deck	Added "watertight area"; removed "allowable" and "IS"	To harmonise with the rest of probabilistic SOLAS
B-2 17.3	Air pipes within a superstructure	Now considered unprotected if no watertight means of closure fitted	Consequential upon switch to probabilistic SOLAS
B-4 19.2	Open watertight doors in passenger ships	Deleted	Provision now conditional; see MSC.1/Circ.1380
B-4 19-1	Damage control drills	Whole new provisions for passenger ships	Consequences of *Costa Concordia* loss
B-4 20	Loading of passenger ships	"Passenger" deleted	Now applies to all ships
B-4 20.1	Loading of ships	Ship to be upright; loading in accordance with SIB permitted	Initial list not permitted; confirmation of current practice
B-4 21.1 and 4	Operation of watertight doors	"drills" replaced with "operational tests"	More appropriate wording
B-4 21.1	Leaving port	"leaving port" replaced with "voyage commences"	"Port" is too specific; replaced in several Regulations
B-4 22.3	Open watertight doors	Footnote added referring to new guidance in MSC.1/Circ.	See B-4 19.2. Updated Circ.1380 not yet available
C 35-1 3.4	Bilge pumps	"All flooding conditions" now limited by reference to Reg. B-1 8	Clarification

Figure 4: Main amendments to SOLAS 2009 Chapter II-1 Parts A, B, B-1, B-2, B-4 and C (MSC.421(98))

Regulation 8 breakpoint between 1- and 2-compartment deterministic minor damages) then increase it linearly to intersect the line previously agreed at MSC 96 (largely as the result of the EMSA 3 research project) at an *R* of 0.8473 and an *N* of 1,350. This latter figure was itself a compromise between setting a breakpoint at *N* = 1,100 or *N* = 1,600 to determine the slope of the line connecting it to *N* = 400. Thereafter the line followed the one previously agreed at MSC 96 based on the EMSA 3 project.

The agreed *R* versus *N* line is very much a consensus derived over a considerable period of time, and mostly based on the results of research projects described in more detail in some of our previous work [2, 3, 4, 5] and summarized in Figure 2.

Overall effect of changes to passenger ship R

The net result in terms of a percentage increase in *R* in comparison with the SOLAS 2009 line assuming 75% lifeboat capacity, N_1, is illustrated in Figure 1. The

Figure 5: Main amendments to the Explanatory Notes (EN) (SDC4/16 Annex 1, MSC.429(98))

Explanatory Note	Subject	Amendment	Reason
A 1.3	Application	Much expanded; explains what happens following alteration	Clarifies SOLAS text now that Reg. A 1.3.4 is deleted
A 2.11	Light service draught	Reference to lower draught limit deleted; excludes temporary water ballast	Moved to EN B-1 5-1.4; excludes BWM, dry-docking etc.
B 4.1	General applicablity	Entire table and footnote on OBO ships deleted	All footnotes now included in SOLAS text
B-1 5.2	Intact Stability	Reference to MSC/Circ.1158 deleted; some contents moved here	Updated guidance on what constitutes a sister ship
B-1 5.4 and 5	Alterations	New guidance included	Clarification of when to incline and when new SIB needed
B-1 5-1.4-6	Information to the Master	Completely revised and expanded, with new diagrams	Clarification; dealing with trim in *GM* / *KG* limit curves etc.
B-1 6.2.4	Degree of hazard	Deleted	*R* now dependent only upon *N*, persons on board
B-1 7.1	Attained Index *A*	New EN's 7 to 10 added	Clarification on when new *A* calculations are needed
B-1 7.2	Effect of trim on *A*	Much reduced here but moved to EN B-1 5-1.4-6 in a modified form	More rational to included these notes under EN B-1 5-1
B-1 7.5	*A* calculation at ends	New EN3 inserted, with diagram; old EN3 now EN4	Guidance on treating penetration with curved waterlines
B-1 7.6	Free surfaces	New EN included with cross-reference to EN for *R* under Reg. 7-2.2	How to deal with free surfaces in all stages of flooding
B-1 7.7.1	Pipes / valves near bulkhead deck	Now relaxes "directly adjacent" to "as close as practicable"	Clarification; occurs in several places
B-1 7.7.2	Minor progressive flooding	Changes pipe cross-sectional area; new breakpoint 150 metres	Different requirement needed for larger ships
B-1 7-1.1.2	Transverse subdivision	Two new ENs with diagrams added (4.1 and 4.2)	Clarification of *b*; treatment of complex waterlines aft
B-1 7-2.2.3	Sequential flooding	Extensively expanded with new sub-paragaphs and examples	Clarification of complex calculation procedures needed
B-1 7-2.2.4	Cross-flooding	Extensively expanded; includes alternative procedures	New MSC.362(92) replaces MSC.245(83); clarification
B-1 7-2.3	RO-RO $s_{final,\ i}$	New EN inserted	Explains use of T_{GZmax} and T_{range}
B-1 7-2.4	Displacement to use	Deleted	Now in revised SOLAS text
B-1 7-2.4.1.1	Definition of breadth	Deleted	Now in revised SOLAS text
B-1 7-2.5	Cross-flooding in cargo ships	Deleted	Now in revised SOLAS text for Reg. B-1 7-2.2
B-1 8.3.2/5	Persons on board	Deleted	*R* now dependent only upon *N*, persons on board
B-2 9	Double bottoms	Extensively expanded and modified with new diagrams etc.	Reflects changes in the SOLAS text and expands it
B-2 12	Bow doors	Deleted	Now incorporated into SOLAS text for Reg. B-2 12.7 and 12.8
B-2 12.6.1	Butterfly valves	New EN inserted with diagrams	Reflects changes in the SOLAS text
B-2 12.10/11	Aft Peak bulkheads	New ENs inserted with diagrams	Aft end bulkhead and stern tube arrangements
B-2 13.2.3	Closed / open pipes	New EN inserted	Clarification of what constitutes open / closed systems
B-2 13.7.6	IEC standard	Deleted	Footnote corrected in SOLAS text
B-2 15-1	Cargo ship openings	New EN inserted	Clarifies applicability of Regs. B-2 15-1.1 to 15-1.3
B-2 17.1	Sliding watertight doors	Extensively expanded and modified with new diagrams etc.	Necessary clarification of terminology
B-2 17.3	Air pipe open ends	Revised	Reflects changes on SOLAS text
B-2 17-1	RO-RO access	New EN inserted	Clarifies applicability of Regs. B-2 17-1.1.1 to 17-1.1.3
B-4 22	Use of "Port"	New EN inserted	Explains wider use of the term "port"

most significant increase lies in the range between N of 1,350 and 2,000 which roughly covers the medium to larger-size ro-ro passenger ship category. It should be remembered that R is also a measure of how many of the whole array of damage cases and sea states encompassed by the probabilistic method are permitted to capsize. Thus, very approximately, if R is 0.75 then 1 in 4 of all cases may result in capsize whereas for an R of 0.80 the expected loss rate is reduced to 1 in 5 cases. An increase in R from 0.75 to 0.85 therefore represents a reduction in the total number of damage cases predicted to result in loss from approximately 1 in 4 to 1 in 6.

From this it can be concluded from this that a very significant increase in safety level will have been put in place for all new passenger ships from 1st January 2020.

Additional requirement for ro-ro passenger ships

For ro-ro passenger ships, in addition to the above modifications to R, there is also a change in the so-called $s_{final,i}$ factor in SOLAS Chapter II-1 Regulation 7-2.3 as discussed in our paper last year [2]. This will mean that the Attained Index, A, will be lowered to some degree resulting in the R index becoming more difficult to achieve.

This change is aimed at accounting for the increased vulnerability of ro-ro passenger ships to the Water-on-Deck (WOD) effect whereby flooding of the open vehicle deck can bring about rapid capsize, something which was not taken into account in the SOLAS 2009 amendments. SOLAS 2009 Chapter II-1 Regulation 7-2.3 has now been replaced by the following:

The factor $s_{final,i}$ shall be obtained from the formula:

$$s_{final,i} = K \cdot \left[\frac{GZ_{max}}{TGZ_{max}} \frac{Range}{TRange} \right]^{\frac{1}{4}}$$

where:

GZ_{max} is not to be taken as more than TGZ_{max};

Range is not to be taken as more than *TRange*;

TGZ_{max} = 0.20m, for ro-ro passenger ships each damage case that involves a ro-ro space.

TGZ_{max} = 0.12m, otherwise

$K = 1$ if $\theta_e \le \theta_{min}$

$K = 0$ if $\theta_e \le \theta_{min}$

$$K = \sqrt{\frac{\theta_{max} - \theta_e}{\theta_{max} - \theta_{min}}} \quad \text{otherwise,}$$

where:

θ_{min} is 7° for passenger ships and 25° for cargo ships; and

θ_{max} is 15° for passenger ships and 30° for cargo ships

θ_e is the equilibrium heel angle in any stage of flooding, in degrees

The changes in the GZ_{max} and *Range* requirements for damage cases involving the ro-ro space represent a substantial increase in comparison with SOLAS 2009, as illustrated in Figure 3) implying that the $s_{final,i}$ factor for an identical damage / loading scenario could be significantly reduced when computed using the new SOLAS 2020 formula. This in turn could mean that the partial Attained Indices A_s, A_p and A_l in Regulation 7 will be reduced as will the overall A, resulting in R being more difficult to attain. One mitigating factor is that the reduction in the partial indices is likely to become less as draught decreases and, for the light draught, d_l, A_l may not be affected at all thanks largely to the overall average increase in residual freeboard.

It is proving quite difficult to predict the effect of the changes to $s_{final,i}$ on A, with estimates ranging from a reduction of 3% for larger ro-ro passenger ships up to 10% or more for smaller ships. This is largely because it is dependent on so many ship-specific design factors. For example, using the SOLAS 2009 formula, a large number of damage / loading scenarios will result in an $s_{final,i}$ factor of 1, implying survival in all sea states up to a significant wave height, H_s, of 4 metres. Since historical accident statistics show that approximately 99% of all incidents involving penetrating damage occur in sea states below an H_s of 4 metres, an $s_{final,i}$ factor of 1 effectively means that the damage / loading scenario in question will always be survivable, and thereby contribute fully to the Attained Index summation, A. Equally, a significant number of damage / loading scenarios may result in an $s_{final,i}$ factor of 0, implying capsize in any sea state, resulting in zero contribution to A. In between these two extremes lie a relatively small number of cases where $0 \le s_{final,i}$ which may or may not survive depending on the severity of the sea state at the time of damage.

Using the SOLAS 2020 formula the likelihood is that those cases which comfortably achieved an $s_{final,i}$ factor of 1 under SOLAS 2009 will continue to do so and those vulnerable to capsize with an $s_{final,i}$ factor of 0 will continue to be so. In the intermediate range of $0 \le s_{final,i} \le 1$, the values will decrease for all cases involving damage to the vehicle space. Some will be reduced sufficiently to indicate that capsizing may now occur ($s_{final,i} = 0$) and those with a marginal $s_{final,i}$ factor of 1 could be reduced to something less than 1, indicating an increased risk of capsize in heavier seas. From this it can be seen that making general predictions at present about the overall net reduction in A is quite difficult and only by comparing the results from the detailed calculations for a large sample of ships types and sizes will a fuller picture

Future of the Stockholm Agreement

At present SOLAS 2009 compliant European flagged ro-ro passenger ships and foreign flag ships operating in European waters must apply the Stockholm Agreement (EC Directive 2003/25/EC, as amended) to allow for the WOD effect. The question of whether or not this situation will continue once SOLAS 2020 enters into force is yet to be decided. A European Community (EC) funded project to investigate the risks of discontinuing the Stockholm Agreement after 1st January 2020, entitled 'Assessment of specific EU stability requirements for ro-ro passenger ships', is currently underway with completion due at the end of 2018. At that time the outcome will be assessed by experts and recommendations on the future European Union (EU) regulatory framework made accordingly. The United Kingdom will

participate in any discussions which take place prior to Brexit and, to ensure that its ro-ro passenger ships can continue to trade in European waters after Brexit, will obviously abide by whatever decision the EU finally makes.

Summary of other main amendments to SOLAS 2009 and Explanatory Notes

Apart from the changes to SOLAS Chapter II-1 Part B-1 Regulations 6 and 7-2.3 discussed above, Figures 4 and 5 summarise the most significant remaining regulatory amendments and changes to the Explanatory Notes which will come into force in 2020. *NA*

Summary

The forthcoming SOLAS 2020 damage stability regulations have been outlined and their implications briefly illustrated and discussed. The authors will endeavour to inform the profession in greater detail as to these at suitable RINA organised and other forums in the near future.

Disclaimer

The views expressed in this article are those of the authors and do not necessarily represent those of the organisations to which they belong or the professional institutions of which they are members.

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Living in the cloud – how web-based apps will make high-tech more accessible

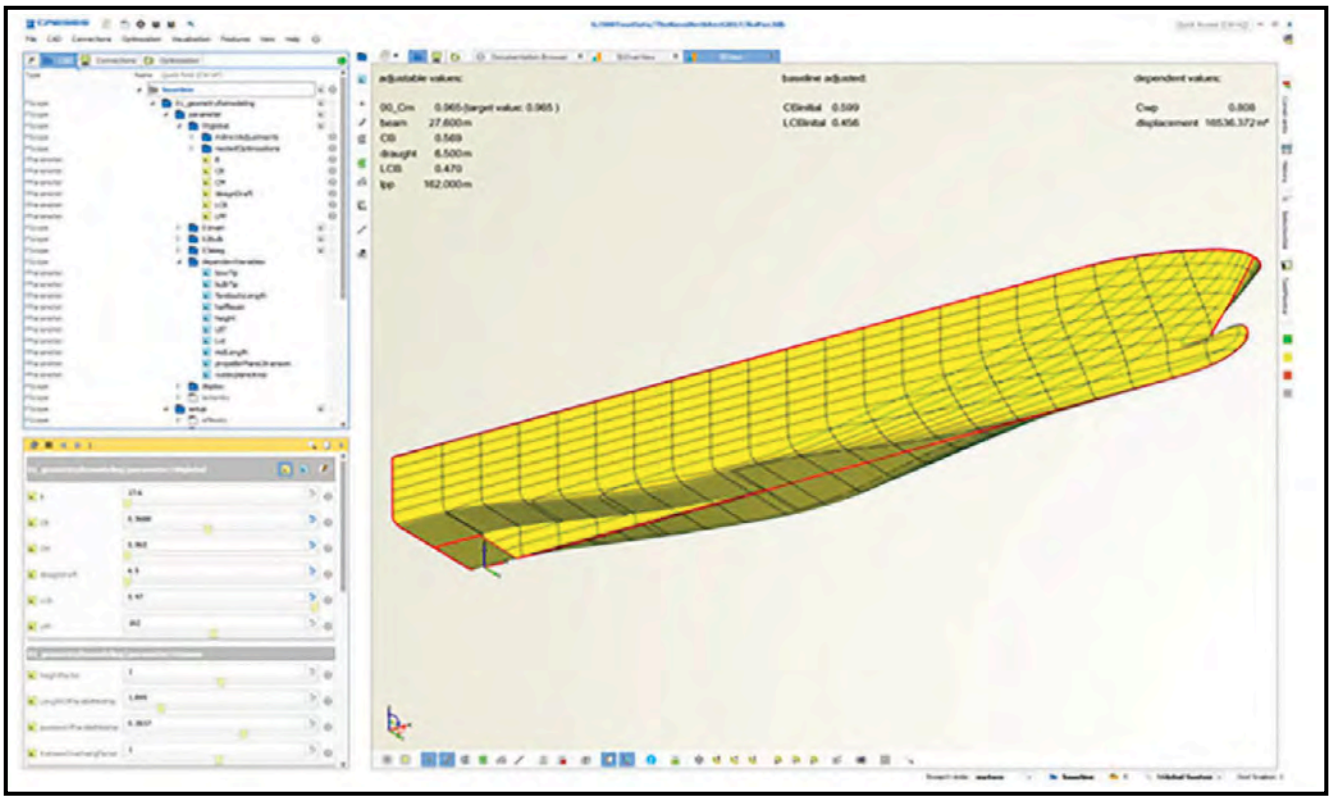
Dr. Stefan Harries, of Friendship Systems AG, discusses the advantages of using web-based apps in the design and simulation of vessels and what they mean for the future of naval architecture

Simulation and optimisation are two buzz words that are frequently used when people talk about the development of high-tech products such as ship hulls, propellers and energy-saving devices. Even engineers working in the field can get somewhat lost when it comes to the many details that need to be taken into account when setting up and running numerical simulations and automated optimisations. Naturally, one cannot completely water down the complexity of something inherently complicated, but the advent of apps and the offer of cloud solutions will make life easier – at least in certain situations.

With the introduction of Apple's first iPhone on January 9 2007 and later the first iPad on January 27 2010, apps quickly became a part of everyday life. Both launches can be regarded as game changers in the way people communicate and use services without the necessity of large investments or the need to be an expert in a particular field of interest. A common characteristic of apps is that the user can do a few predefined things easily and quickly. If the app readily offers what you want, great, and if it doesn't you then have to look for a different solution. Maybe another app will do the job or you will have to take a more sophisticated approach, for instance applying a comprehensible software tool yourself or asking a team of experts to work on your behalf.

Most readers will have experience with weather apps and their simple functionality – to show current and predicted weather conditions for a selected location using a combination of icons and figures, with a few versions providing things like wind speed and sunrise and sunset times too What would be a meaningful equivalent to a weather app for a naval architect? Would it not be useful to instantaneously get a faired hull form on the basis of just a handful of inputs such as length, beam, draft and block coefficient? As a designer it would certainly speed up the time spent at the concept stage if you could readily download a first hull form, say as an STL file, along with some derived parameters such as wetted surface area and centre of buoyancy, in particular if you work on a ship type for which

Figure 1: Ro-pax vessel realised within CAESES



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you have little experience. Similarly, as an operator you may encounter a situation where you intend to charter a ship that is offered in the market. With the scarce data typically available at this point in time, you may have quite a bit of guesswork to do. It would therefore be really valuable to produce a reference ship that readily provides reasonable estimates for resistance and propulsion, yielding the necessary intelligence for taking a decision.

CAESES as background technology

CAESES by Friendship Systems AG, Germany, is a Process Integration and Design Optimisation (PIDO) environment with built-in CAD functionality. The focus is on variable robust geometry, as needed for ship hulls, propellers, ducts and rudders, but also for intake ports, impellers, volutes and manifolds for turbomachinery. CAESES allows the coupling of any external tool that can be run in batch mode. Codes that are typically triggered and controlled via CAESES for design and optimisation are Computational Fluid Dynamics (CFD) codes like CFX, Converge CFD, FINE/Turbo, Flow-3D, Simerics MP and STAR-CCM+ along with dedicated tools for naval architects such as FINE/Marine, SHIPFLOW, ShipX and v-Shallo. The idea is to investigate large numbers of design variants from which to select the best solution, for instance, the ship with the highest energy efficiency at a range of speeds fulfilling a specified transport task.

As can be easily imagined, the standard CAESES solution comes as a Computer Aided Engineering (CAE) system that is handled by highly-educated specialists. Typically, these people are members of larger teams, working in shipyards and design offices (e.g. DSME, SDARI), for system providers (e.g. Voith, Rolls-Royce), at consultancies and model basins (e.g. HSVA, Force).

Let us take a look at the modeling of a ro-pax ferry's hull for illustration. Figure 1 shows selected parts of the geometric definition of the vessel which was developed within the European R&D project HOLISHIP (www.holiship.eu).

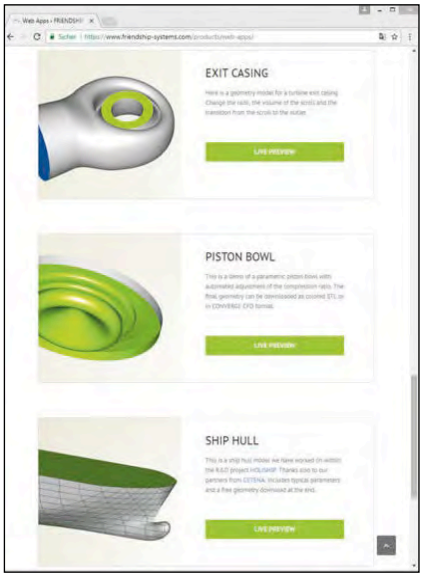

Figure 2: Showroom of various web apps on the basis of CAESES

The creation of such a model – which is intended to serve different purposes such as input to hydrodynamic analyses in both calm water and sea states, intact and damage stability analyses and life-cycle cost assessment– involves partners with different expertise, here specifically CETENA (Italy), HSVA (Germany), NTUA (Greece) and Friendship Systems (Germany). It takes several days to establish and a few iterations to adjust to the requirements of all partners involved. In order to use the system effectively you should have enjoyed a few days of CAESES training and, ideally, an introduction to the model itself.

Within the CAESES' GUI the engineer has access to all definitions, parameters and dependencies that make up the model. You are completely free to introduce changes and utilise any functionality that CAESES offers, for example, special exports like panel meshes, watertight flow domains as coloured STLfiles, standard IGES or STEP files.

Web apps based on CAESES

If you are not a simulation engineer, however, you may not need or even wish to go into all these details. Instead, you might be quite happy to just get a specific kind of output for very limited input. For these kind of users Friendship Systems has started to extend CAESES such that selected functionality can be packaged as a web app for access via a web browser, be it from a workstation, notebook or a mobile device. When opening a web app a CAESES project is launched on a server, which can be either run in a local area network with restricted access or hosted by Friendship Systems as a global cloud service.

A number of web apps have already been launched, previews of which can be tested out at www.friendship-systems.com in the 'products' area of the site (see Figure 2).

Figures 3A to 3D show the usage of the web app for the ro-pax vessel introduced above. Different pages of the web app constitute a meaningful workflow as predefined by the expert that initially set up the application within CAESES. In the example, the first page offers controls for the main particulars within lower and upper bounds, always guaranteeing high-quality shapes. Modifying several parameters via sliders may change the length of the vessel, its draft and the length of the parallel mid-body as depicted in Figure 3B. As soon as the main particulars are established the user moves on to the next page (see Figure 3C), so as to adjust local parameters (for the bulb, in this example). On page 4 of the web app, depicted in Figure 3D, the final geometry can be downloaded for saving or further processing within a second web app and/or an independent computer program.

Things to expect

The variety of web apps that can be established is boundless and different user groups will benefit from different types of offerings. Current implementations focus on variable geometry, but further web apps are being developed with a primary function as simple as the conversion of certain file types, for instance the transformation of a NAPA IGES file for a hull form into a flow domain ready for meshing, up to more advanced solutions, such as the design and analysis of a standard propeller via the Wageningen B-Series.

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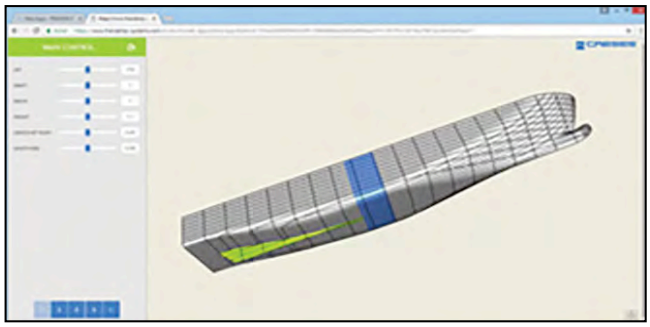
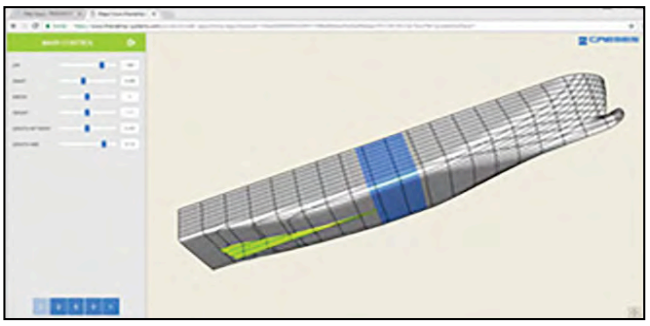
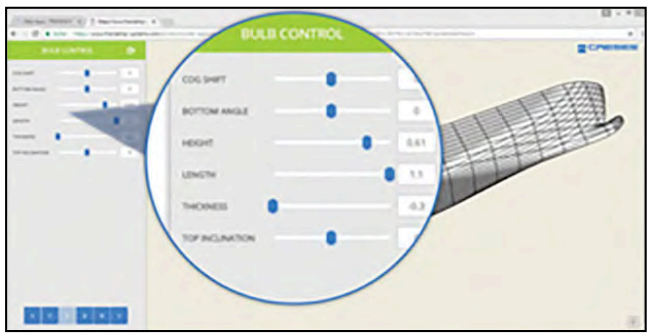


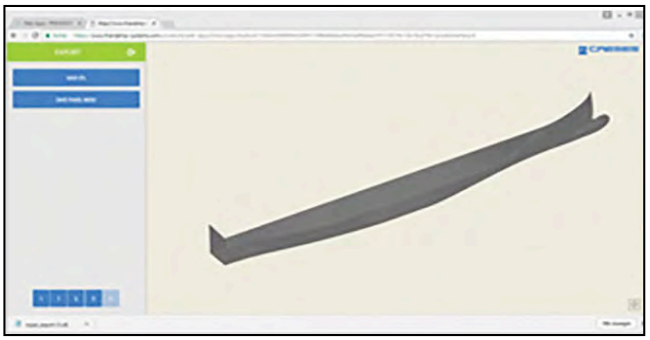
A: Start page with controls of main particulars (page 1) A: Start page with controls of main particulars (page 1)



B: Modification of the vessel by adjusting several parameters such aslength, draft and length of the parallel mid-body (page 1)



C: Adjustment of bulb parameters (page 2); magnifying glass shows parameters that modify the default values



D: Export of modified geometry as a watertight STL-file (page 4)

Figure 3: Web app for a ro-pax vessel on the basis of CAESES

An in-depth article on the former can be found on the CAESES blog. The latter is presently under development within a German R&D project, HYKOPS, and aims at configuring a realistic stock propeller. It is hoped the app will achieve this by swiftly generating the input for a CFD-based self-propulsion test, creating an initial propeller design for further optimisation or just by building a standard propeller from a well-defined geometric model.

In principle, the technology within CAESES is available to offer generic solutions in the cloud or tailored solutions for a single company. CAESES, with its flexible coupling mechanisms, even enables the wrapping of third-party tools which are not inherently made for web-based application. Within the European R&D project, HOLISHIP, a web app has been launched that combines the ro-pax web app shown in figure 3 with a potential flow analysis for the wave resistance, namely v-Shallo by HSVA.

Friendship Systems specialises in simulation-driven design (SDD) and is confident that a wide spectrum of Computer Aided Engineering (CAE) solutions will be made accessible in the cloud. CAESES users and tool developers are encouraged to wrap their solutions into apps and make them available to wider user groups. This will create new business models for engineers and scientists as many more people will benefit from the knowledge available – and at lower costs. Naturally, this is going to be particularly successful if a lively community of both users and providers develops. HOLISHIP brings together the critical mass to push forward. In this sense, we will see a certain democratisation of high-tech solutions in the not-too-distant future.

In the early 20th century a safari was an exclusive journey of an adventurer, experiencing the beauty of Africa. You needed money and time to spend, better have carried a gun and had to walk on foot or ride on horseback. It probably was a great experience but only a few people could afford it. In the early 21st century safaris are done by people that are considerably less knowledgeable with regard to the environment they are travelling in. Instead of guns they carry cameras and they drive in off-road cars that give comfort and safety. After all, it is better to have a bit of steel and glass between you and the lion that stalks 20 feet from you.

A software system like CAESES is a bit like the wilderness – great things to do and to achieve within a multitude of possibilities. A web app on the basis of CAESES is like a guided tour to the wildlife – you get specific results for limited resources and zero risk. There is no better or worse. The preferred solution depends on the background and expectation of the user. Certainly, first engineering solutions that are provided in the cloud are beginning to change the perception of how to design, analyse and optimise high-tech products. *NA*

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Cloud-based numerical towing tanks – anytime, anywhere and for anybody

Dr Karsten Hochkirch and Carsten Hahn, both of DNV GL, argue the benefits of using a web-based application to conduct 'virtual trials', but can an app really replace model basin tests?

Computational fluid dynamics (CFD) collectively denotes techniques used to solve equations describing the physics of flows. As with any other simulation technology, CFD has progressed rapidly over past few decades, evolving from a research tool to a widely accepted tool in industry (see *Peric and Bertram (2011), Hochkirch and Bertram (2012)*). The term 'Numerical Towing Tank' has been used for many years now to describe the simulation of resistance and propulsion tests as an alternative to classical model basin tests, *Bertram (2000)*. The progress in the numerical techniques can be seen in the annual Numerical Towing Tank Symposium series (www.uni-due.de/IST/ismt_nutts), and the CFD in Ship Hydrodynamics workshops which are held approximately every five years. However, as *Peric and Bertram (2011)* pointed out, the progress in user-friendliness and ease of access is arguably even more important. Commercial CFD solvers have become more user-friendly and pay-as-you-use schemes have reduced barriers for small and medium enterprises such as shipyards and design offices. *Hildebrandt and Reyer (2015)* presented such a scheme for the maritime industries, where high-performance, cloud-based computing hardware and parallel licenses for the CFD solver can be rented by the core-hour. However, the user still needs to master the CFD software and generate the grid and input specifications.

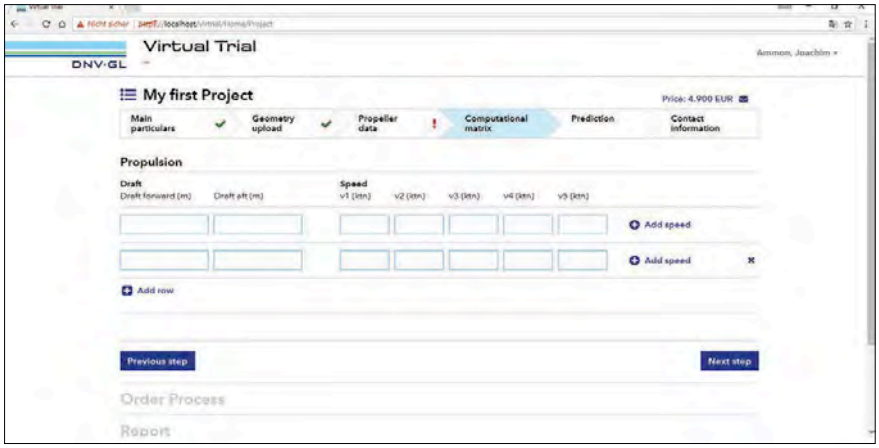

Figure 1: Sketch of the user interface in My DNV GL application allowing detailed case specification

The idea of the virtual trial takes the development to the next level as part of DNV GL's push towards maritime digitalisation. Digitalisation describes approaches that employ new business processes to exploit digitisation, the process that turned analogue paper technology into digital-computer technology. Digitisation converted classical model tests into CFD simulations. Over the years, the processes have been streamlined and completely automated for selected applications, such as numerical simulations

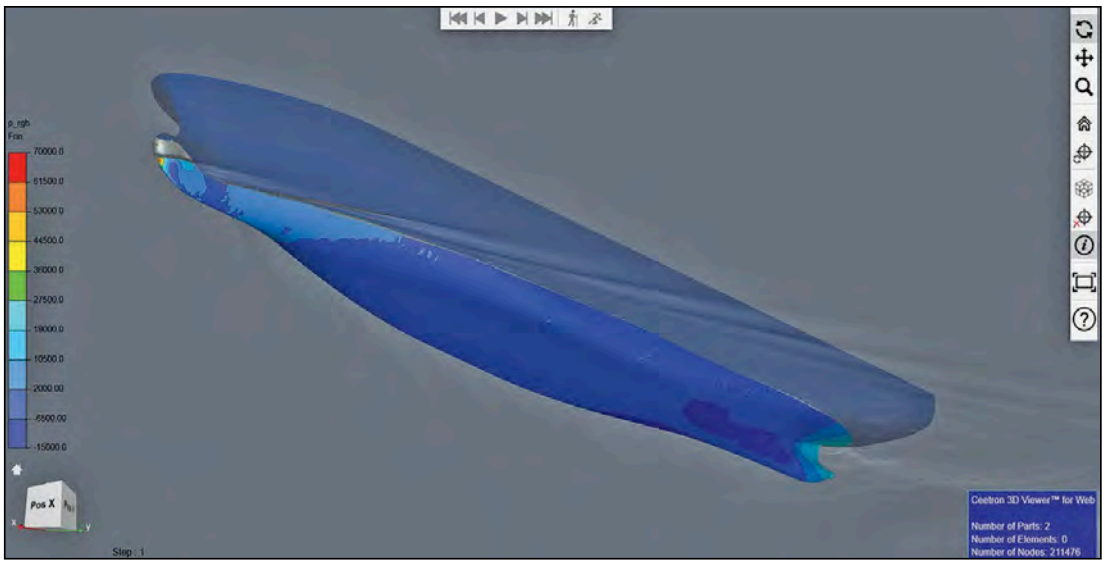

Figure 2: Standard CFD result display from virtual trial report

of resistance and propulsion tests, e.g. *Hansen and Hochkirch (2013)*.

With My DNV GL (https://my.dnvgl.com/), the company has created a central digitalisation platform with a multitude of apps, *Dausendschön (2016)*. Offering fully automated CFD simulations to assess the resistance and propulsion aspects of ships now brings the various elements together, allowing virtual trials at any time, from anywhere and by anybody, as no CFD specific input is needed. In essence, ship designers or other interested parties can then launch virtual trials in complete anonymity and receive results within one week —much faster than in classical towing tank business.

The virtual trial development

The virtual trial is a fully digital service from data submission to reporting, offered via the My DNV GL portal.

The virtual trial offers full-scale RANSE (Reynolds-averaged Navier-Stokes equations), VoF (Volume of Fluid), CFD, resistance and propulsion simulations for ships. RANSE means that viscosity is directly reflected in the basic physics, i.e. boundary layer formation and flow separation can be captured by the fundamental equations. VoF means that complex wave formation, including breaking waves, is accurately reflected in the numerical model. Full scale means that the simulation mimics a sea trial, avoiding the notorious scale-effects that come with model test extrapolation to full scale. This is especially important if larger breaking waves appear, for example at intermediate drafts or blunt foreships, *Hochkirch and Mallol (2013)*.

The customer uploads the ship geometry as an STL or IGES file and defines the scope of simulation runs (variations of draft, trim, speed) in the My DNV GL web interface and launches the simulations, as shown in Figure 1. Project information and status is visible to the customer in the My DNV GL portal throughout the entire project.

A standardised web-based report format is then made available to the customer via the My DNV GL portal. The standard format with standard plots, as shown in Figure 2, shall become an industry-accepted reference for comparison and benchmarking. Ship designs can be compared against each other consistently, even if the projects are submitted from different parties. The outcome is impartial and consistent. Own designs can be compared against anonymised state-of-the-art designs from our database, as seen in Figure 3. This best-practice comparison gives rapid and intuitive insight into improvement potential for investigated designs.

The service offering is open to anybody who owns ship lines. This will be predominantly shipyards and design offices, but could also extend to ship operators who might be in need of independent power predictions for given hull forms.

The virtual trials offer tangible benefits from a customer point of view, mainly in terms of time and cost. This is best illustrated by a typical project, for instance, where a shipping company wants to evaluate three shipyard proposals for a newbuilding project, each at design and ballast draft and over a range of five speeds. For each combination of draft and speed, the company wants to look at resistance (without propeller) and propulsion (with propeller). Let us assume that the shipping company has required each yard to upload its respective lines as part of the bidding process. Figure 3 compares then the virtual trial with a typical ship model basin in central or northern Europe. We conducted specific interviews with key ship operators, yards and design offices to sound out the market response to the virtual trial service. The service received generally positive feedback, with specific praise for the short response time and low costs, the benchmark functionality which allows competitor comparisons and the fresh reporting style.

To conclude, the virtual trial assesses resistance and propulsion characteristics of hull forms with significant advantages in terms of costs and response time compared to model tests. Such web-based, completely digitalised services are expected to disrupt hydrodynamic consultancy. The initial customer response indicates that such online services will be embraced rapidly, mirroring similar trends in consumer goods. *NA*

Figure 3: Time and cost involved in virtual trials vs. classical model testing

	Virtual trial	Model Test
Lead time	1 week	~10 weeks
Costs	€17,100	~€80,000
Propeller	Wageningen CD-series	Stock propeller

Acknowledgement

This paper will be presented at the High-Performance Marine Vehicles (HIPER) conference in South Africa on 11-13 October. The authors would like to thank Volker Bertram for his input.

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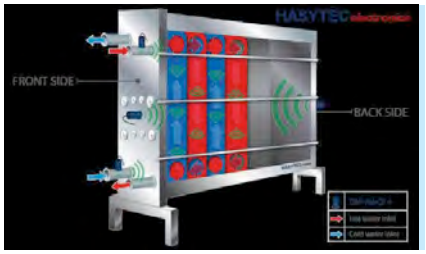
Sound barrier: an ultrasonic solution to biofilm

Jan Kelling, director sales & projects at Hasytec Electronics, discusses the impact of biofilm and how ultrasound could be the eco-friendly answer to the problem

Marine growth and fouling always stem from the initial formation of biofilm, the green slimy layer which occurs on liquid-carrying surfaces after only a few seconds.. The process begins with a group of micro-organisms, in which cells stick to each other. These micro-organisms are then able to multiply under favourable conditions, and as a result, will form biofilm. All known solutions for eradicating biofilm are either harmful to the environment or don`t achieve the desired results, and bio film will eventually become resistant to chemicals after a while in order to defend itself. Therefore, more eco-friendly ways of protecting both the environment and the vessel's surfaces have to be found.

The Biocidal Products Regulation (EU) 528/212 concerns the market placement and use of biocidal products "which are used to protect humans, animals, materials or articles against harmful organisms" and is related to the IMO convention, 'International Convention on the control of harmful Anti-Fouling Systems on Ships (2001)'.

Without looking for alternatives, following these conventions will lead to companies taking the risk of using less effective antifouling systems, which will in turn lead to higher costs for maintenance and repair, higher fuel expenses and increased environmental impact because of transferred foreign organisms carried on the vessels' hulls and all other liquid-carrying surfaces on board.



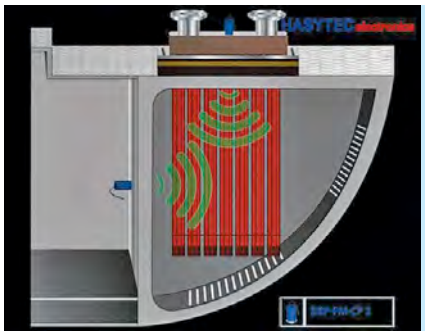


Figure 1: HASYTEC's Dynamic Biofilm Protection transmits low-powered ultrasound waves to prevent biofilm forming

But where are these alternatives to replace the currently used antifouling systems? Any solution has to be environmentally-friendly and sustainable, but also proven to be effective, to ensure a properly running vessel from the offset.

Ultrasound against marine growth and fouling

In the past, ultrasonic methods followed the idea of getting rid of hard growth which was already attached by using high-powered ultrasound. Causing hard cavitation, this working principle might work in certain situations but it also has the potential to damage the vessel's steel itself. As a consequence, this approach was not accepted by the market. Using low-powered ultrasound, which does not cause cavitation in a certain combination of frequencies, altitudes and power consumption, follows only one idea: preventing biofilm on every liquid-carrying surface. By preventing biofilm in this way, marine growth, such as barnacles, shells and algae, is also avoided. This working principle is relatively new and unknown on the market but this kind of antifouling system has huge potential regarding protecting the environment, being sustainable and not harming humans or animals.

A 2007 study (1) of North Sea fish species' reaction to low-powered ultrasound (conducted in a large tank) found that while the fish altered their behavior for the duration of the 900ms acoustic stimulus – increasing their swimming speeds and often making tight turns – they would resume normal swimming behavior within a few seconds.

Dynamic Biofilm Protection

Based in Schönkirchen, northern Germany, and with 22 years of electrical engineering experience, Hasytec Electronics has developed the Dynamic Bio film Protection ultrasound system, which is based on the

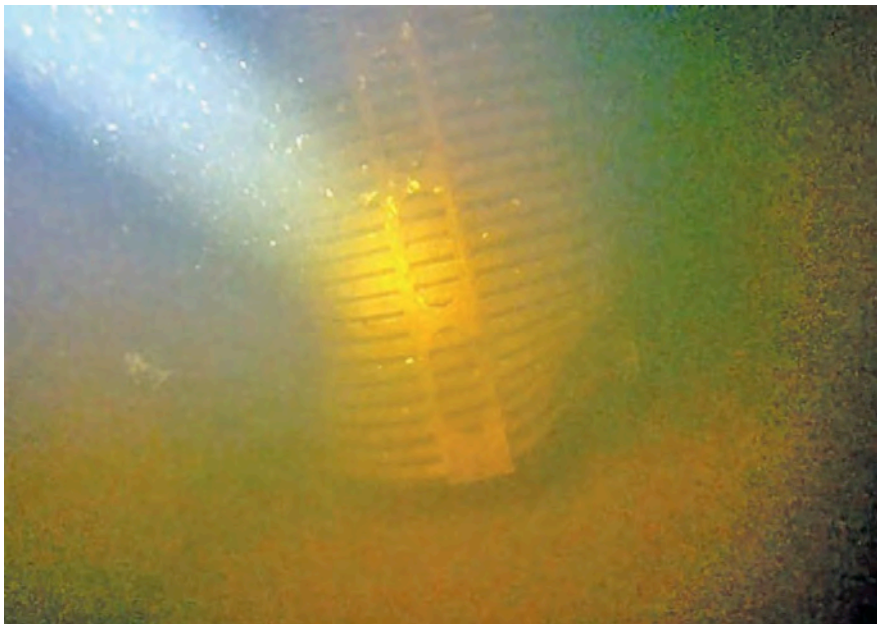
The DBP will only emit ultrasound waves with frequencies not harmful to the environment and humans

above working principle and has already proved its effectiveness.

Hasytec Dynamic Biofilm Protection (DBP) combines low power consuming transducers with an intelligent software to enable the transducers to be directed, highly focussed and controlled. Hasytec DBP runs a very precisely tuned program of several frequencies and power consumptions in order to prevent micro-organisms attaching to the treated surface, which will subsequently prevent biofilm from forming.

The installation of the ultrasound transducers involves gluing them to the inner part of the vessel, meaning no holes have to be drilled. The metal transports the ultrasound signal into the liquid (mostly water) and as a consequence it completely diffuses through the medium (see Figure 1). These diffused ultrasound waves will destroy all unicellular organisms by breaking their membrane-bound organelles, thus preventing the biofilm and in turn preventing all biofilm-related problems e.g. fouling, marine growth, bacteria, clogging and blockage.

Due to the fact that the emitted ultrasound is running on several different frequencies, which only prevent biofilm and destroy unicellular organisms, it doesn't cause harm to the environment, including marine life such as fish, or humans.



A box cooler that has beenprotected by DBP for approximately nine months, belonging to a vessel trading across the North Sea and Baltic Sea

Propeller of a Suezmax Tanker protected by DBP for approximately six months, on a ship vessel trading across the US, Middle East and Europe

Installation

Installation of Hasytec DBP is very easy and going to drydock is not necessary. An installation can be realised at any given time and only hull protection installations require drydock conditions to reach the ballast water tanks, if applicable.

In relation to the number of transducers to be installed, a complete team of service engineers can handle even the installation for hull protection in a few days, so drydock time doesn't has to be extended. Installation for cooling protection will not require more than three days.

Applications

The system works on hulls, seawater cooling systems such as sea chests, strainers and plate coolers as well as on box coolers, propellers, thruster tunnels, tanks and fresh water generators. Hasytec DBP is also suitable for offshore installations.

There are only two conditions required to run the system sufficiently — the treated surface has to be cleaned and 230V power supply has to be provided 24/7.

The Hasytec DBP is maintenance-free, sustainable, environmentally-friendly and has a five-year warranty on the result. Further systems to protect the treated application are not necessary.

Return on investment

The initial investment is comparable with the investment in other systems, such as cathodic protection for cooling systems or anti-fouling paints for hull protection. Depending on the market price for copper it can even be on the same level as just replacing the anodes of other marine growth prevention systems.

Biofilm is something that continues to plague vessels, and increase their maintenance outlays, worldwide. Using ultrasound to prevent its formation in the first place not only satisfies many eco regulations, but should save shipowners precious time and money usually spent on its removal. *NA*

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RINA-QinetiQ
Maritime Innovation Award

Innovation is key to success in all sectors of the maritime industry and such innovation will stem from the development of research carried out by engineers and scientists in universities and industry, pushing forward the boundaries of design, construction and operation of marine vessels and structures

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The Award is made annually to either an individual or an organisation, in any country. Nominations for the Award may be made by any member of the global maritime community, and are judged by a panel of members of the Institution and QinetiQ. The award will be announced at the Institution's Annual Dinner.

Nominations are now invited for the 2017 Maritime Innovation Award. Individuals may not nominate themselves, although employees may nominate their company or organisation.

QinetiQ

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Nominations may be forwarded online at **www.rina.org.uk/maritimeinnovationaward**

or by email to:
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Nominations should arrive at RINA Headquarters by 31st December 2017.

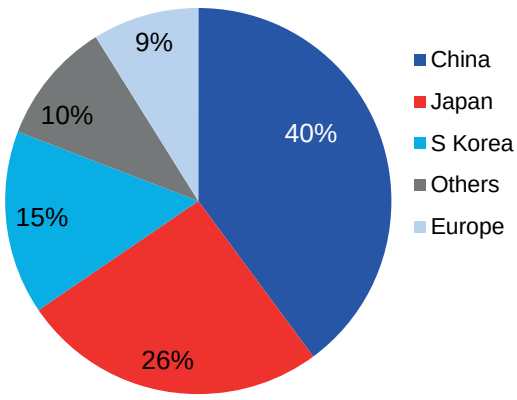
Queries about the award should be forwarded to the Chief Executive at **hq@rina.org.uk**

Clarksons Research: Historic and Scheduled Delivery

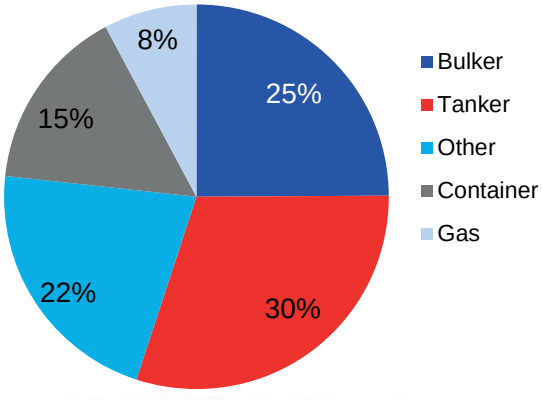
Data extract from World Fleet Register available at https://live.clarksons.net/wfr2/

Vessel Type	2005		2006		2007		2008		2009		2010		2011	
	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half
VLCC >= 200,000	5	13	15	14	18	22	32	20	30	24	35	27	22	21
Suezmax 120-200,000	14	12	15	11	9	5	23	22	26	12	25	18	15	23
Aframax 80-120,000	29	21	29	27	26	42	62	33	39	31	28	31	15	14
Panamax Tankers 60-80,000	24	20	27	15	17	26	26	12	15	16	19	10	6	7
Products 30-60,000	60	56	71	69	73	91	93	67	66	46	46	28	30	49
Products 10-30,000	1	10	9	9	8	5	5	5	7	6	8	6	4	6
Chem & Spec. 10-60,000	55	43	60	62	84	103	106	69	76	61	51	41	10	11
Tankers < 10,000	29	29	32	45	64	91	72	70	65	51	53	51	34	37
Capesize > 100,000	32	27	30	27	20	24	33	77	101	112	128	123	65	63
Panamax 80-100,000	22	23	22	16	15	17	27	21	60	60	82	97	95	100
Panamax 65-80,000	36	26	22	22	23	20	18	15	18	33	36	44	39	34
Handymax 40-65,000	53	39	50	50	66	60	85	100	168	167	199	199	146	147
Handysize 10-40,000	38	38	47	63	75	73	115	153	161	169	172	173	115	115
Combos > 10,000	0	0	0	0	0	0	0	0	3	2	3	0	0	0
LNG Carriers	12	16	16	16	25	26	22	17	15	12	5	10	2	4
LPG Carriers	9	14	16	20	27	33	25	18	18	18	16	14	8	22
Containers > 8,000 teu	34	28	20	17	25	25	22	13	30	33	46	25	28	51
Containers 3-8,000 teu	45	53	58	71	71	60	62	57	78	41	33	26	19	46
Containers < 3,000 teu	89	115	105	122	139	110	67	52	55	26	33	30	38	29
Offshore	4	5	3	17	15	16	12	19	22	25	28	21	9	12
Cruise Vessels	6	0	7	3	6	3	3	6	9	4	4	2	1	6
Ro-Ro Ferries	11	5	12	10	21	6	11	8	10	13	10	9	8	6
Other	104	127	142	134	155	155	153	162	172	178	182	181	99	98
TOTAL	**712**	**720**	**808**	**840**	**982**	**1,013**	**1,074**	**1,016**	**1,244**	**1,140**	**1,242**	**1,242**	1,408	808

Orderbook by Builder region (No. Vessels > 100m LOA)



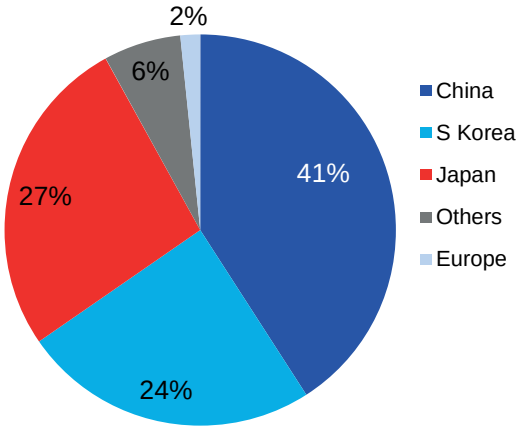
Orderbook by Sector (No. Vessels > 100m LOA)



2012		2013		2014		2015		2016	Scheduled Orderbook		
1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	OB2017	OB2018	OB2019
9	14	10	9	11	23	22	24	29	22	48	24
4	4	4	7	3	8	32	19	34	32	31	8
6	4	13	22	10	31	45	22	34	45	58	24
5	3	1	2	1	7	24	13	10	24	16	4
28	50	49	60	56	60	46	41	39	46	50	30
3	1	8	4	0	2	15	2	4	15	7	0
14	12	12	35	30	44	58	36	39	58	72	30
29	24	22	13	13	25	43	14	15	43	54	4
40	56	38	46	42	65	40	39	51	40	51	29
68	62	35	57	40	72	54	40	73	54	44	24
42	42	20	19	4	1	3	2	5	3	0	0
119	98	101	144	122	123	125	94	117	125	50	14
80	96	66	101	84	83	101	45	61	101	59	19
0	0	0	0	0	0	0	0	0	0	0	0
13	14	19	16	16	15	34	18	20	34	46	34
16	14	14	25	40	49	34	33	43	34	26	14
33	59	41	59	62	37	48	26	33	48	74	12
29	26	24	19	6	2	15	0	2	15	18	0
17	22	27	27	35	39	73	24	34	73	106	29
19	31	30	25	14	25	53	22	19	53	58	27
0	3	2	5	1	8	4	2	7	4	16	19
6	12	5	12	6	6	16	15	20	16	30	14
80	72	62	66	47	50	118	58	42	118	95	43
901	660	719	603	773	643	775	589	731	1,003	1,009	402

All data taken as of 1 July 2017

Orderbook (DWT) by Builder region



Source: Clarksons Research

Arc flash hazard: electrical design considerations

Arc flash incidents can destroy equipment, start fires and injure or kill personnel. New guidance from Lloyd's Register (LR) and GSE Systems Ltd helps designers understand and minimise the risks

Under the right conditions, electrical energy can jump across an ionised air gap between two conductors, resulting in the explosive release of plasma fireball that can reach temperatures of 19,000°C. Even if the crew member is metres away from the source of the flash it can result in life changing or fatal injuries.

Arc flash incidents can be devastating anywhere, but the marine environment presents particular safety challenges. Personnel may have to work in close proximity to energised equipment, for example, escaping from a confined space can be difficult and vessels operate in remote locations a long way from suitable medical support.

Arc flash can have devastating effects if not handled correctly

Wherever electricity is transmitted or used, there is potential for arc flash. Poor electrical contacts, insulation failures, accidental contact with an item of energised equipment, ageing systems and poor maintenance are just some of the common circumstances. Nor are the hazards limited to high-voltage electrical equipment. Incidents can also occur in low-voltage AC systems, and DC equipment such as uninterruptablae power supplies and battery banks. The risks in low voltage systems can be particularly acute, since switching operations may be conducted more frequently and by less electrically-competent personnel.

But controlling arc flash hazards is a complex process that requires appropriate system design, equipment selection and configuration, as well as suitable operating and maintenance procedures.

Detailed information on those requirements is provided by a new LR guidance document for the marine sector, entitled 'Arc Flash. A Lloyd's Register guidance document', produced in collaboration with GSE Systems Ltd. The document provides a comprehensive overview of the three-stage approach needed to manage arc flash hazards: analysis, mitigation, and management of residual risk.

Analysis

An arc flash study should be carried out during the initial design of a vessel's electrical systems, and whenever subsequent modifications are made. Its aim is to evaluate the potential severity of arc flash incidents and inform mitigation work. Only circuits with a protective device below 3-phase 100A can be reasonably assumed to have a low arc energy potential.

The data gathered during the study can be used to calculate the incident energy levels that would be experienced at various distances from each point of utilisation in the electrical system in the event of an arc flash. Those energy levels determine the arc flash category, which ranges from 0, which means no arc flash issue is identified, to 4, which indicates a high flash energy level. A further category, designated as 'dangerous', may sometimes be assigned.

Further calculations are employed to identify the arc flash boundary for each location. This is the distance from the live parts within which a person could receive a second-degree burn. Approach boundaries are also set. These define minimum distances which untrained personnel must keep, and other limits which may be crossed only by qualified personnel wearing appropriate personal potective equipment (PPE).

Mitigation

Once they understand the arc flash risks, electrical system designers can evaluate the measures available to reduce them. Those measures fall into three main categories.

First, arc flash energy can be reduced. Arc flash current is always smaller than short-circuit current, so the system protection assessment should identify appropriate settings for fuses and circuit breakers, to sense arcing fault

current. Selectivity is another important consideration. Ideally only a small portion of the power system should have to be shut down in response to an event.

The latest fault detection relay technology uses dedicated relays, triggered by current, light or sound from the flash. This uncouples arc flash sensing from the normal protection scheme and provides extremely rapid fault clearing times, in the order of a quarter of a cycle or less.

Second, the impact of arc flash can be reduced through the installation of arc-resistance equipment that confines arc flash energy within a specific area. Such equipment uses pressure-relief mechanisms, such as arc venting chutes, to channel energy away from the front of the switchgear and thereby protect the operator. Personnel can also be protected by use of remote switching cabinets, placed well outside the arc flash boundary.

Finally, systems can be installed that automatically introduce an alternate current path, to transfer and ultimately eliminate the arcing fault. In the 'crowbar method', a bolted fault, introduced as an alternative current path, provides a current bypass to extinguish the arc. The 'lower-impedance arcing current path method' introduces the breakdown of an air gap between the phase electrodes and a plasma gun. In both cases an effective arc fault detection system is needed.

Managing residual risk

Once as much of the arc flash risk as possible has been engineered out of a vessel's systems, owners must conduct a comprehensive risk assessment and establish appropriate operations and maintenance procedures to manage the remaining risks. Key steps include clear labelling of equipment with the relevant risk categories, boundaries and PPE requirements. Training is also vital, to ensure that all staff involved in operating or maintaining switchgear are qualified to do so and understand the safety issues and procedures relating to arc flash.

Finally, fire detection and suppression systems should be installed, using non-conductive fluids or gases to minimise damage to equipment if an arc flash occurs. *NA*

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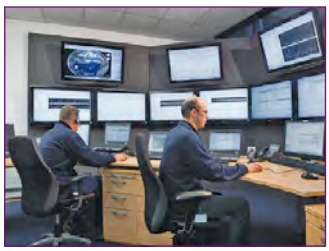

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