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**October** 2022



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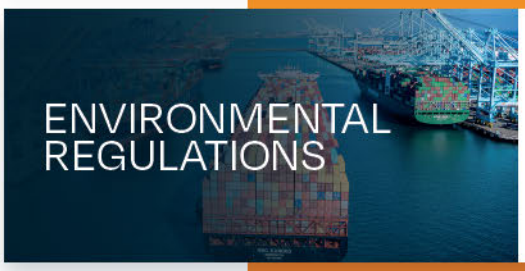

SOURCE: SHUTTERSTOCK

# HER MAJESTY QUEEN ELIZABETH II

A personal tribute to RINA's patron by **Dr Stephen M. Payne** OBE, FRINA

Her Majesty Queen Elizabeth II both pledged and devoted her life to public service in promotion of the United Kingdom, associated Dominions and the Commonwealth. For more than seven decades HM The Queen tirelessly opened buildings, bridges, railways and other public works, whilst as Head of State she held audiences with an unprecedented 15 British Prime Ministers. HM The Queen also had strong affiliations with the maritime world, including the naming of ships of the Royal and Merchant navies.

Although present at Clydebank with her mother Queen Elizabeth at the launch of Cunard Line's second transatlantic Queen, RMS *Queen Elizabeth* on 27 September 1938, Princess Elizabeth's first public engagement in her own right was the naming of another Cunard Line ship. Accompanied by her future husband, Lt. Philip Mountbatten, Princess Elizabeth named newbuilding 635 as *Caronia* at Clydebank on 30 October 1947 a few weeks before her marriage. *Caronia* was a special ship designed to attract wealthy Americans with luxury cruises and thereby earn valuable US dollars. A few years later, now crowned Queen Elizabeth II, she returned once again to Clydebank on 16 April 1953 to launch her own ship, Her Majesty's Yacht *Britannia*. On this ship Her Majesty travelled the world; undertaking 85 State visits, 90 Commonwealth visits and 162 overseas non-State visits, along with countless domestic voyages.

The following year on 17 August 1954, Her Majesty would become the first British reigning monarch to name a merchant ship, when she travelled to Harland & Wolff in Belfast to confer the name *Southern Cross* to Shaw Savill's revolutionary new flagship. This ship was to operate an around the world passenger service and was strikingly different in having an 'engines aft' design and in carrying no cargo whatsoever, thus shortening the time required to stay in port and overall length of passage.

Her Majesty's association with Cunard ships continued with the naming of *Queen Elizabeth 2* (20/09/1967), *Queen Mary 2* (08/01/2004) and *Queen Elizabeth* (11/10/2010), whilst on 4 July 2014 she bestowed her own name to the Royal Navy's flagship aircraft carrier HMS *Queen Elizabeth*, whilst finally naming P&O's cruise ship *Britannia* on 10 March 2015.

The author had the honour and privilege to meet HM The Queen on several occasions including an investiture, the naming of *Queen Mary 2* and at a Buckingham Palace Garden Party. She was always very kind and keen to put those introduced to her at ease. Conversation was focused and at times witty, but always displayed genuine interest. Encounters would be all too brief, but recipients were left with an aura and recognition that Her Majesty was truly a remarkable person.

The passing of Her Majesty The Queen signals the end of an era and the dawn of a new age. As a Past President The Royal Institution of Naval Architects, on behalf of the Institution and members worldwide, we give thanks to Her Majesty Queen Elizabeth II and salute her and all she achieved during the period of the Second Elizabethan epoch. ■

**Dr Stephen M. Payne**
**OBE FRINA FREng**

Past President The Royal Institution of Naval Architects 2007-2010

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# COLLABORATION IS CRUCIAL FOR DECARBONISATION GOALS

By **Daniel Johnson**

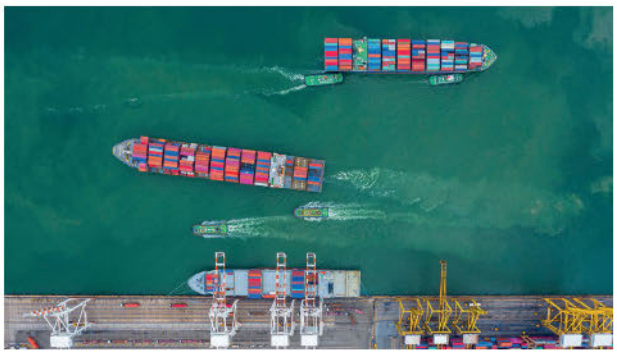
These are exciting times; both for me personally and on a much larger scale for the shipping industry. I am delighted and enormously proud to take on the editorship of *The Naval Architect* this month. However, I would be lying if I said that my excitement wasn't mixed with a drop of trepidation – Richard Halfhide's accomplished five-and-a-half tenure leaves me with plenty to live up to. Thankfully RINA members and I will not be losing Richard's valuable skills and insights as he is now taking the lead in lifting the Institution's online editorial offering to the next level and will continue to contribute to these pages.

Apropos the shipping industry, it is currently undergoing the greatest transformation in a century as it strives to meet the mammoth task of decarbonisation and the decade ahead should be filled with opportunities for all involved and promises technical development in a way that we have not seen for some time. It is very easy to get despondent when thinking about the size of the challenge the industry faces, but I was heartened by the positivity on display at the recent SMM trade fair in Hamburg. Despite the industry's 'conservative' reputation, my takeaway from the show was that an immense amount of progress is being made to make ships more efficient.

While at SMM, I was fortunate to get the opportunity to speak to Eirik Ovrum, DNV's principal consultant in Maritime Environmental Technology, who was there, as lead author, for the launch the classification society's latest Maritime Forecast to 2050 report. The forecast is in its sixth edition, and this year, as well presenting an in-depth outlook on regulations, drivers and future technologies, considers the production, distribution and bunkering infrastructures required to enable the industry's shift to carbon-neutral fuels. Eirik emphasised that while the key fuel technologies needed for the fuel transition should be available within the next three to eight years, the transition hinges on fuel availability and that onshore supply chains will need to change radically if decarbonisation goals are to be met.

This will be a Herculean task. It will demand huge investments – DNV estimates between US$30 and US$90 billion per year to 2050 for a full decarbonisation pathway – and a dramatic increase in cross-industry and governmental collaboration. Coordinated plans by all stakeholders, including major energy and fuel providers and ports, is crucial while public incentives must encourage first movers to participate in a nascent global network of green shipping corridors, the forecast suggests.

At last year's COP26, 22 national governments signed up to the Clydebank Declaration, announcing their intention to establish at least six of these corridors by the middle of the decade. Whilst the Declaration was an important first step, it would have been meaningless without action. So it has been encouraging to have seen announcements this year that a number of corridors have been set in



THE ROUTE TO DECARBONISATION LIES VIA GREEN CORRIDORS. SOURCE: SHUTTERSTOCK

motion, including most recently between Singapore and Rotterdam, two of the largest bunkering ports in the world. Seeking to realise the first sustainable vessels sailing on the route by 2027, the project will bring together a broad coalition of shippers, fuel suppliers and other companies to collectively work towards transitioning low- and zero-carbon alternative fuels, including synthetic methane, hydrogen, and hydrogen-based fuels including ammonia and methanol.

Eirik also highlighted the DNV-led 'Nordic Roadmap' partnership which aims to supercharge the introduction of zero-carbon fuels across the Nordic region through the launch of green corridors and necessary fuel-related infrastructure. DNV is working with partners that include Chalmers University, IVL Swedish Environmental Research Institute, MAN Energy Solutions, Menon Economics and Litehauz, and the initiative has already received strong support from a range of other parties across the region. As well as assessing regulatory and safety issues, the partners will focus on sustainable zero-carbon fuels from a well-to-wake perspective.

The project's key advantages are the Nordic region's numerous shipping routes and an already well-established close maritime cooperation and it will hopefully move the roll-out of sustainable zero-emission fuels several steps further.

Of course there are many barriers to forming green corridors. It will require merging local and regional economics, supportive local, national and international politics, international and domestic regulations that work to reduce emissions, and large investments and creative financial incentives. And bringing the frameworks to scale will require shared visions of zero-carbon emissions. No easy feat. What is clear is that while establishing green corridors may be the solution the industry needs to decarbonise, it will take time and a great deal of collaboration – without which the transition will be much more challenging and could be delayed by decades. ■

# NEWS

RO-RO

## AURELIA SECURES AIP FOR 100% HYDROGEN-POWERED RO-RO DESIGN

A new 100% hydrogen-powered ro-ro vessel design from Aurelia Green Ship Concept Design has secured a certificate of approval in principle (AiP) from Italy's classification society RINa.

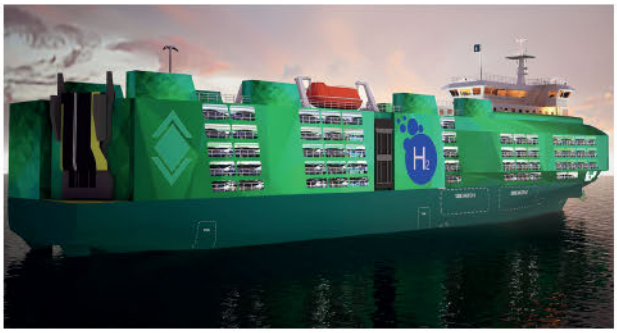
The ACD01 1000 features electric propulsion using highly compressed $H_2$ as fuel. The ship's hydrogen-based engine system is said to be suitable for application to other ship designs.

The AiP has been issued by RINa based on the society's newly published Rules for Hydrogen Fuelled Ships and Guide for the Approval in Principle of Novel Technologies.

The fuel to operate the vessel is 100% compressed hydrogen, which generates no environmentally harmful emissions with a design that can be considered as zero-emission not only in port, but also during navigation, according to RINa.

The hybrid propulsion is based on battery and fuel cell power modules and is not supported by internal combustion engines. The batteries are also used as an energy storage source to supply power for the hotel load.

Furthermore, the new design complies beyond the limits set by EEDI Phase 3 according to MEPC.203(62), the ballast water treatment plant is in accordance with the latest amendments of the International Ballast Water Management Convention, and the hull is designed to ensure hydrodynamic and maximum propeller efficiency.




THE ACD01 1000'S HYDROGEN-BASED ENGINE SYSTEM IS SAID TO BE SUITABLE FOR CRUISE AND RO-PAX VESSELS

"This new design for a compressed hydrogen ro-ro is part of a long-term cooperation between Aurelia and RINa in which we will develop liquefied hydrogen propulsion systems that could be used for heavy-lift, cruise and ro-pax vessels," says Raffaele Frontera, founding partner of Aurelia Green Concept Design.

CONNECTIVITY

## STUDY REVEALS SURGE IN MARITIME DATA USAGE

Data usage on commercial maritime vessels has jumped more than threefold since 2019, according to new communications analysis by Inmarsat that underlines the shipping industry's reliance on digital connectivity to enhance operating efficiency and crew welfare.

BEN PALMER, PRESIDENT, INMARSAT MARITIME

The internal study reveals that maritime demand has continued to rise as commercial shipping recovers following the peak of the Covid-19 pandemic – with data usage among Inmarsat maritime customers rising almost 70% in the 12 months to mid-2022.

Analysis of data usage by vessel operators shows year-on-year demand for data was highest among container shipping companies, more than doubling (108%) in June 2022 compared to June 2021, while use of connectivity increased by 70% among oil tanker operators and by 47% on bulk carriers over the same period.

Ben Palmer, president of Inmarsat Maritime, says:

"Maritime data usage is a leading indicator of economic activity and international trade in the shipping industry, which carries 90% of all global trade. More and more shipping companies are upgrading their satellite communications services and adopting new technologies for applications including route-planning, ship-to-shore broadband data transfers and to maximise fuel efficiency."

"They are also ensuring that their crews remain connected with family and friends while at sea, the mandatory requirement now recognised by the Maritime Labour Convention. Our study shows data usage is on the rise among all commercial vessel types," he adds.

CRUISE SHIPS

# NORTHERN XPLORER SELECTS WEST SEA TO BUILD ZERO-EMISSION CRUISE SHIP

Northern Xplorer (NX) and Portugal's West Sea Viana shipyard have signed a letter of intent for the construction of a 250-passenger emissions-free luxury cruise ship.

The ship is expected to be delivered at the start of the 2025/2026 cruise season.

Cruise venture NX was launched last year by Rolf André Sandvik. He says: "This is a new milestone on our journey towards emission-free cruising. Having approached yards worldwide for tenders, we're delighted to be embarking on this exciting project with West Sea. They are a modern, professional yard with a good track record."

The 140m ship will be built at West Sea's Viana do Costelo shipyard which has experience of cruise ship construction, delivering *World Explorer* (in 2019) and *World Voyager* (in 2020) for Mystic Cruises plus *World Navigator* for Atlas Ocean Voyages last year.

The vessel features a fully electric propulsion system, including the battery and hydrogen fuel cell technology that will enable it to sail emissions-free, from NX's technology partner, ABB.

DESIGN RENDERING OF NORTHERN XPLORER'S ZERO-EMISSION CRUISE SHIP

NX and ABB are currently in dialogue with multiple sub-suppliers for vessel systems. "We haven't made any final decisions yet because we want to go with the newest technology as it becomes available. Where possible we also aim to select the most sustainable materials available in the market," says Sandvik.

ALTERNATIVE FUELS

# BV RELEASES BIOFUEL READY NOTATION

Bureau Veritas (BV) has issued a new 'biofuel ready' notation to support the wider deployment of biofuels in the shipping industry.

According to BV, the notation will help the maritime industry address the main challenges related to the use of biofuels by ships, providing requirements to ensure ship safety and environmental compliance.

The classification society says the notation aims at helping shipowners to be prepared for the use of biofuels or biofuel blends by providing a set of requirements and outlining a comprehensive methodology for the required documentation and testing, taking into account the fuel's technical specifications.


USE OF BIOFUELS IN THE SHIPPING INDUSTRY IS ON THE RISE. SOURCE: BV

The notation, which can be applied to both new and existing ships, certifies that the conditions to use biofuel onboard a ship have been successfully met – and any testing to check NOx emissions (if applicable) has been completed satisfactorily.

BV expects that this new notation will enable shipowners to take advantage of their preliminary work with the use of biofuels, while also helping them to be prepared in order to obtain Flag Administration acceptance with regards to MARPOL Annex VI requirements on NOx emissions.

"As one of the few fuel options available today to reduce greenhouse gas emissions from existing fleets, the use of biofuels by the shipping industry is growing rapidly. I am proud that we can now help shipowners deploy these innovative fuels on their vessels, while ensuring that all safety and regulatory requirements are met," says Laurent Leblanc, senior vice president Technical & Operations at Bureau Veritas.

The notation comes shortly after the latest meeting of the IMO's Marine Environment Protection Committee (MEPC 78) approved an interpretation of regulation 18.3 of MARPOL Annex VI aimed at clarifying and streamlining the use of biofuels in the maritime industry.

DECARBONISATION

# DESIGN FOR LCO2 CARRIER GETS APPROVAL

Norwegian classification society DNV has awarded Japan's Mitsui OSK Lines (MOL) and Mitsubishi Shipbuilding (MHIMSB) an approval in principle (AiP) for their new liquefied $CO_2$ (LCO2) carrier design.

The companies concluded their joint concept study for a 50,000m³-class vessel in November 2021. After conducting a HAZID risk assessment, both parties applied for the AiP which was granted by DNV according to the Class notation "1A Tanker for Liquefied $CO_2$". The main focus of the DNV assessment has been the DNV Rules on Liquefied Gas Tankers (Pt.5 Ch.7 July 2021) as well as the IGC Code.

The vessel integrates tank pressure specifications for larger ships in the future.

"The AiP award is an important milestone in our group strategy to achieve net-zero GHG emissions by 2050. Through this demonstration project, we will further accelerate our R&D initiatives on liquefied CO2 transport, contributing to the realisation of a low- and de-carbonised society," says Makoto Yamaguchi, executive officer and chief technical officer at MOL.

"We are very pleased to be awarded the AiP from DNV through collaborative development with MOL," says Toru Kitamura, president of MHIMSB. "We believe that LCO2 carriers are essential pieces in the carbon capture, utilisation and storage value chain, which will contribute to achieving a decarbonised society in the near future. We will continuously move forward the technology development of LCO2 carriers in cooperation with partners seeking to achieve the shipping industry's decarbonisation goals."

THE AWARD CEREMONY (FROM LEFT): MARTIN CARTWRIGHT (BUSINESS DIRECTOR GAS CARRIERS & FSRUS, DNV MARITIME), NAOKI UEDA (EVP CHIEF STRATEGY OFFICER, MHIMSB), MAKOTO YAMAGUCHI (CHIEF TECHNICAL OFFICER, MOL), JOHAN-PETTER TUTTUREN (SPECIAL PROJECTS MANAGER GAS, DNV MARITIME), AND VIDAR DOLONEN (REGIONAL MANAGER KOREA & JAPAN, DNV MARITIME)

PROPULSION

# KR AND DSME TARGET GREEN SHIP PROPULSION SYSTEMS

Korean Register (KR) and Daweoo Shipbuilding & Marine Engineering (DSME) have signed a memorandum of understanding (MOU) to collaborate on the development of propulsion systems capable of handling green fuels including ammonia and hydrogen.

The move follows announcements that the two South Korean organisations would be jointly developing a liquefied $CO_2$ carrier.

Whilst the global maritime industry is introducing operational measures such as limiting engine output and installing energy-saving devices to meet stringent greenhouse gas regulations, in the longer-term green fuels will be needed to achieve substantial emission reductions.

The joint research agreement between the two parties will build on the unique strengths and accumulated technology of each company, according to a spokesperson.

DSME aims to commercialise ammonia-powered container ships by 2025 based on its advanced technology and is at an advanced stage in developing eco-friendly fuel technologies, including low-carbon ammonia carriers and liquefied $CO_2$ carriers.

KR has also been actively seeking better options for decarbonisation pathways. As well as publishing guidelines for ammonia-fuelled ships, the classification society is developing its own hydrogen-powered ship rules and is working on enhanced decarbonisation initiatives to ensure ship safety and a greener future.

"The added value of eco-friendly ship propulsion technologies is expected to increase further in the future amid the strengthening of environmental regulations. Besides this collaboration with KR, we will continue to develop advanced eco-friendly ship propulsion technology and strive to speed up the commercialisation of decarbonised ships," says Dong-kyu Choi, head of DSME's R&D Institute.


This has been a tough period for the entire cruise industry.
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# NEWS ANALYSIS

## LNG AS A FUEL UNDER FIRE AGAIN

By **Malcolm Latarche**

At a time when LNG finally seems to be making inroads into the marine fuel arena, a new report by UCL Energy Institute once again questions its potential and warns of LNG-fuelled ships becoming stranded assets.

It has taken almost two decades for LNG to be taken seriously as a marine fuel but today there are ships of every type running on it. The number of ships may not be as high as was once predicted, but according to DNV there are presently 319 ships other than LNG carriers able to run on LNG in service and a further 510 on order. UCL says in its report that 65% of the newbuilding deliveries by 2025 could run on LNG up from only 10% a couple of years ago.

While choosing to run on LNG might be thought to demonstrate a commitment by ship operators to meet the environmental obligations the industry has long been accused of ignoring, this hasn't been the case.

In April 2021 the World Bank published a report that was scathing on the use of LNG saying that its use would be limited to niche applications and a small number of ship types. The report also said that support for LNG as a fuel should be avoided by governments although that view was ignored when the EU approved its use. Environmental groups mostly welcomed the report but it was widely condemned by the shipping industry, especially bodies that promote its use.

UCL Energy Institute's new report claims the world's rapidly growing fleet of LNG-fuelled ships are at risk of financial losses of US$850 billion by 2030. It said if policies that incentivise shipping to decarbonise in line with the Paris Agreement were in place by the decade's end, the fleet would compete against zero-emissions shipping, whilst also being incentivised to switch away from the use of fossil fuel.

Whilst policy and competition would affect all ships built to use fossil fuels, the analysis suggests that more expensive dual-fuel assets would see reductions in their value to match the value of similar aged but lower cost conventional vessels designed to use fuel oil. The potential loss would be reduced if LNG-capable vessels were retrofitted to run on scalable zero-emission fuels such as hydrogen and ammonia.

The report went on to say that there is growing scientific evidence that shows the environmental benefits of LNG are limited, if not negative, compared to LSHFO when considering a full lifecycle analysis of emissions and accounting for greenhouse gases emissions. It also said the least-cost pathway for shipping to shift away from


SOURCE: GASUM

fossil fuels is a mix of electrification in short-sea shipping, and use of scalable hydrogen and hydrogen-derived fuels such as ammonia and methanol for deep-sea shipping.

The study argues that governments should not use public funding to exacerbate the creation of stranded value. Shipowners and financiers should consider not ordering LNG-capable ships and invest instead in conventionally fuelled ships which are designed for retrofit to zero-emission fuels. For existing LNG-capable ships, investors should consider ways to manage the risk of stranded value.

Industry body SEA-LNG has called the report a flawed academic exercise, detached from reality. It said the UCL report authors make innumerable contestable and unsupported statements and have ignored the fact that LNG dual-fuel engines already provide shipowners with an insurance against stranded assets, as they can burn traditional marine fuels.

The SEA-LNG statement added the UCL analysis is based on an assumption that the decarbonisation pathway offered by LNG via bioLNG to synthetic or e-LNG will be less "competitive" than ammonia or other electro-fuels. It said that predicting the future production costs of e-ammonia, e-methanol and e-LNG is extremely difficult given that 80% of the cost is associated with the cost of producing the common renewable hydrogen feedstock from renewable energy sources which will take years to develop to the necessary scale.

In closing, SEA-LNG described the results reported in the UCL study as "meaningless, based as they are on subjective, negative assumptions on LNG". It added: "Such flawed analysis can confuse the industry, potentially providing shipowners and investors with justification to sit back, wait and continue to emit GHGs rather than invest in a technology like LNG that offers immediate GHG reductions today together with a clear and competitive pathway to decarbonisation in the decades ahead. Waiting is not an option." ■

# NEWS EQUIPMENT

ENGINES

## ALFA LAVAL AND WINGD COLLABORATE ON METHANOL FUEL SOLUTION

Swedish engineering company Alfa Laval has entered into an agreement to develop the fuel supply system for methanol engines designed by Swiss engine designer WinGD.

WinGD says it expects to have methanol-fuelled engines ready by 2024.

Under the agreement, Alfa Laval will provide a fuel supply system as well as the control system, the fuel valve train and auxiliary functions like the purging system. A prototype will be delivered for tests of the methanol engine, which will take place at WinGD facilities in Winterthur, Switzerland.

"Many of the vessels purchased today will be sailing in 2050, so the engine solutions for carbon-neutral methanol cannot wait," says Dominik Schneiter, vice president R&D, WinGD. "To bring reliable solutions quickly to WinGD customers, we need a knowledgeable partner in the fuel supply application. We are confident in the expertise Alfa Laval will bring to this collaboration."

The two companies intend to have a methanol engine and fuel supply system design prepared and tested during 2023. Under the terms of the agreement, Alfa Laval will be an approved manufacturer and supplier of the commercial low-flashpoint fuel supply system product resulting from the joint R&D.

Further, the agreement paves the way for similar cooperation on ammonia, targeting WinGD engines that can use ammonia as fuel by 2025.

POWER SYSTEMS

## ABB UNVEILS SOLID-STATE CIRCUIT BREAKER

ABB has introduced a new solid-state circuit breaker to enable the next generation of safe, energy-efficient direct current (DC) power systems.

With DC power distribution at the forefront of strategies to make shipping and marine vessels more sustainable and energy efficient, the SACE Infinitus circuit breaker makes it simpler to integrate, protect and control these new DC network architectures for ships of all types and sizes, according to the company.

SACE INFINITUS IS OPTIMISED FOR LOW LOSSES, PROVIDING AN ALL-IN-ONE DEVICE FOR DC POWER PROTECTION AND CONTROL

DC power systems improve fuel efficiency by up to 20%. Removing AC power's losses and limitations, DC networks enable ships to match the electrical output of onboard diesel-electric gensets with the power required for propulsion and other loads. DC electrical architectures also simplify the integration of battery storage and hydrogen fuel cell systems into the ship's electrical system and help maximise their efficiency.

"SACE Infinitus is the world's first IEC 60947-2 certified circuit breaker with semiconductor technology, optimised for low losses, providing an all-in-one device for DC power protection and control," says ABB. "The device will be available with DNV certification for low-voltage maritime applications, providing ultra-fast protection to enable new DC network architectures, making them safe and easy to integrate for vessels."

The SACE Infinitus detects and responds to short circuit faults 100 times faster than traditional mechanical circuit breakers, the company adds.

"As the vessel's all-important, bus-tie breaker, the solid-state circuit breaker allows fault zones to be isolated, even in cases with extremely high short circuit currents, maximising system availability. The ultra-fast device also interrupts fault currents without an electric arc, reducing arc flash risk to almost zero," ABB concludes.

BWTS

# BIO-UV GROUP TO SUPPLY BWTS FOR TWO RITZ-CARLTON CRUISERS

Chantiers de l'Atlantique has contracted BIO-UV Group to supply BIO-SEA ballast water treatment systems (BWTS) to a pair of LNG-fuelled super cruisers the French shipyard is building for luxury hotel group Ritz-Carlton.

When delivered in 2024 and 2025 respectively, the 240m-long *Ilma* and *Luminara* will join the smaller Astander Shipyard-built *Evrima* – the first ever Ritz-Carlton Yacht Collection vessel – which set sail earlier this year.

"We are immensely proud to supply BIO-SEA systems to these prestigious vessels," says Maxime Dedeurwaerder, business unit director, BIO-SEA by BIO-UV Group. "These premium cruise ships are at the cutting edge of environmental technology and an advanced UV-based ballast water treatment means they are safeguarding our oceans from invasive, non-indigenous organisms."

*Ilma* and *Luminara* will each be fitted out with a BIO-SEA 'B'-Series B02-190 system capable of treating ballast water flow rates of 190m³/h from just two high intensity, low-energy UV reactors. The system incorporates a mechanical filtration system that is backflushed automatically to ensure continuous and effective performance.

A SKID MOUNTED BIO-SEA 'B' SERIES BWTS WILL BE INSTALLED ABOARD RITZ-CARLTON'S NEW CRUISERS

To further reduce emissions, each 456-passenger capacity vessel employs four dual-fuel engines that use LNG as the primary fuel. They also have an efficient heat recovery system, LED lighting and other features to reduce the environmental impact.

BIO UV Group's technical director, Florian Cortes, says: "For the operator and crew, BIO-SEA operation and UV dosage is automatically controlled, and treatment performance is not impacted by either water temperature or salinity. The compact skid systems selected for the Ritz Carlton Yacht Collection also incorporate a user-friendly interface for operational and maintenance simplicity."

SHORE POWER

# BWTS SPECIALIST BRANCHES OUT WITH COLD IRONING OFFERING

Greece-based ballast water treatment system (BWTS) specialist Erma First has diversified into the cold ironing market with the launch of a high-voltage shore power solution.

According to the company, Blue Connect is designed to seamlessly facilitate a vessel's connection to a port's electrical grid in order to power the vessel's systems and equipment while at birth.

This enables the ship's diesel generators to be switched off, with a resultant reduction in noise and emissions, such as particulate matter, nitrogen oxides, sulphur oxides, carbon oxides and volatile organic compounds.

The vessel is connected to shore through the solution's cable management system. Erma First currently offers standard Blue Connect models for ro-ro and ro-pax, ferries, container vessels and tankers. Custom-made systems are also available.

Blue Connect includes a power transformer, which transforms high to low voltage, as well as the required switchgear to protect crew and equipment. The operation is controlled and monitored by a shore connection main control panel. Power changeover supports shore-to-vessel

KONSTANTINOS STAMPEDAKIS, MANAGING DIRECTOR AT ERMA FIRST

synchronisation to avoid black-out upon connection. The system can also be integrated to a vessel's AMS or/and PMS.

"The launch of Blue Connect represents another key technological milestone for the Erma First Group," says Konstantinos Stampedakis, managing director at Erma First. "We now boast an array of game-changing engineering solutions and products for the maritime community globally."

"Blue Connect is a highly advanced cold ironing solution that can help significantly reduce emissions in ports around the world," he adds.

# SAFETY

## SPACE-SAVING LIFEBOAT SETS NEW BOUNDARIES ON CRUISE SAFETY

By **Daniel Johnson**

Although rarely required, lifeboats are an essential component of a cruise ship. As the last line of defence in extreme emergencies they are subject to stringent regulations regarding the number onboard and their upkeep is of central importance for a ship to meet and pass safety standards. The trend over the last decade or so to treat the cruise liner as a floating resort, rather than means of transport, has led to larger vessels that are required to evacuate increasing numbers of passengers and crew – designs that present a number of challenges, not only for safe and rapid evacuation, but also for space to accommodate the required number of lifeboats.

To meet these challenges, the size and capacity of lifeboats have also evolved over time. According to Life Saving Equipment (LSA) code 4.4.2.1: "No lifeboat shall be approved to accommodate more than 150 persons." However, a provision on equivalent safety set down in SOLAS and advances in lifeboat manufacture and technology have resulted in high standard 'mega' lifeboats to serve the evacuation requirements of modern cruise ships.

The latest of several proposed designs to enter this field is the 2 x 530-person Seahaven advanced evacuation system (AES), "the world's largest inflatable lifeboat", developed by safety provider Survitec. The solution, which is self-launching, similar to that of a modern marine evacuation system (MES), provides a totally different outlook on evacuation at sea, according to Richard McCormick, Survitec product manager AES and MES.

"This advance in technology will see the inflatable lifeboat as the main means of evacuation in the coming years, bringing with it a revolution not just in the way in which passengers evacuate in an emergency but also how cruise ships are designed," he tells *The Naval Architect*.

### Tests and certification

Survitec was presented a Certificate of Type Approval for Seahaven by classification society Lloyd's Register at last month's SMM trade fair meaning it is now ready to be installed on cruise vessels. Certification follows the successful completion of heavy weather sea trials (HWST) – carried out in line with the SOLAS requirements for Novel Appliances with tests performed in conditions not dropping below six on the Beaufort Scale – and the International Maritime Organization (IMO) A.520 physical tests as required by Lloyd's Register.

"The certification is the culmination of six years of R&D work with operators, yards and particularly with the regulatory bodies," says McCormick.

"The solution is a breakthrough in innovative space-saving design and will present significant opportunities for cruise ship owners whilst prioritising safety at sea," notes Mark Darley, chief operations officer at Lloyd's Register.

The two-craft, 1,060-capacity system is stored in a container with a footprint of 16.3m x 3.6m that fits onto a single deck. Once deployed the 27m-long, 9m-wide lifeboats can sail independently at 6knots for 24 hours. A single-release button – either on the bridge or locally at the station where the lifeboats are stored – unrolls, lowers and inflates each lifeboat in under four minutes. The system is served by multiple


RICHARD MCCORMICK, SURVITEC PRODUCT MANAGER AES AND MES, WITH A MODEL OF THE SEAHAVEN ADVANCED EVACUATION SYSTEM AT SMM


SEAHAVEN DEPLOYED FROM THE OFFSHORE SUPPORT VESSEL *EDT JANE* DURING THE HWST PROGRAMME

helical slides, a solution pioneered and evolved by Survitec for more than 20 years.

"The slides allow quick evacuation for both able bodied and mobility impaired persons. It also permits family groups to descend together, including the mobility impaired, reducing stress during the evacuation process," explains McCormick.

An evacuation time of under 22 minutes was achieved during the A.520 tests. According to SOLAS regulations, the evacuation time should not exceed 30 minutes.

"Seahaven has none of the risks or hazards associated with lifeboat deployment. You're not putting her over the side, filling her with evacuees, and then lowering her down to the waterline. That risk of human error is removed," says McCormick. "Another benefit in terms of safety is that it's heavy weather sea trial proven. HWST is something that lifeboats don't do."

## Reliability built in

Seahaven is unusual in that it is the first lifeboat that has passed an exhaustive reliability testing programme that far exceeds the testing requirements set out by SOLAS, adds McCormick. "In SOLAS there's not even a nod to reliability," he says. "There are strict rules for what defines a lifeboat, liferaft, MES and lifejacket, and if you pass those tests you get a certificate. Because you've passed the test once doesn't mean your equipment is reliable."

The last of 10 successive reliability test deployments to prove component reliability was completed in August.

The system has been designed on a 30-month service interval and from an operator's perspective is relatively maintenance free. "No longer will crew have to carry out launch and evacuation drills or spend time maintaining hooks, blocks, winches and paintwork," says McCormick. "The unit comes off the ship every 30 months and a fresh unit, just like a cassette, goes into its place. The replaced unit goes to the workshop where it is serviced and repacked to meet the next service cycle."

Survitec has teamed up with Norwegian Cruise Line Holdings, Independent Maritime Advisors, and a major shipbuilder to deliver a cruise ship design incorporating Seahaven. The companies have established an industry working group with a view to installing the system as the primary means of evacuation onboard Norwegian Cruise Line's next Prima class of ships.

Survitec has also been engaged with a number of other operators throughout the six-year journey. "As you would expect, they've been keeping their powder dry because we're breaking new ground in terms of innovation. Now we've got the certificate the conversation is very different. It's not just conceptual, we've proven it and now it's time to have a serious conversation around when and how they use it," McCormick says.

## Pushing the boundaries of vessel design

According to McCormick, work undertaken by Survitec shows that replacing conventional lifeboats with Seahaven can free up to an additional 85% of existing lifeboat deck space, yielding up to around US$8 million in increased revenue per year for cruise operators.

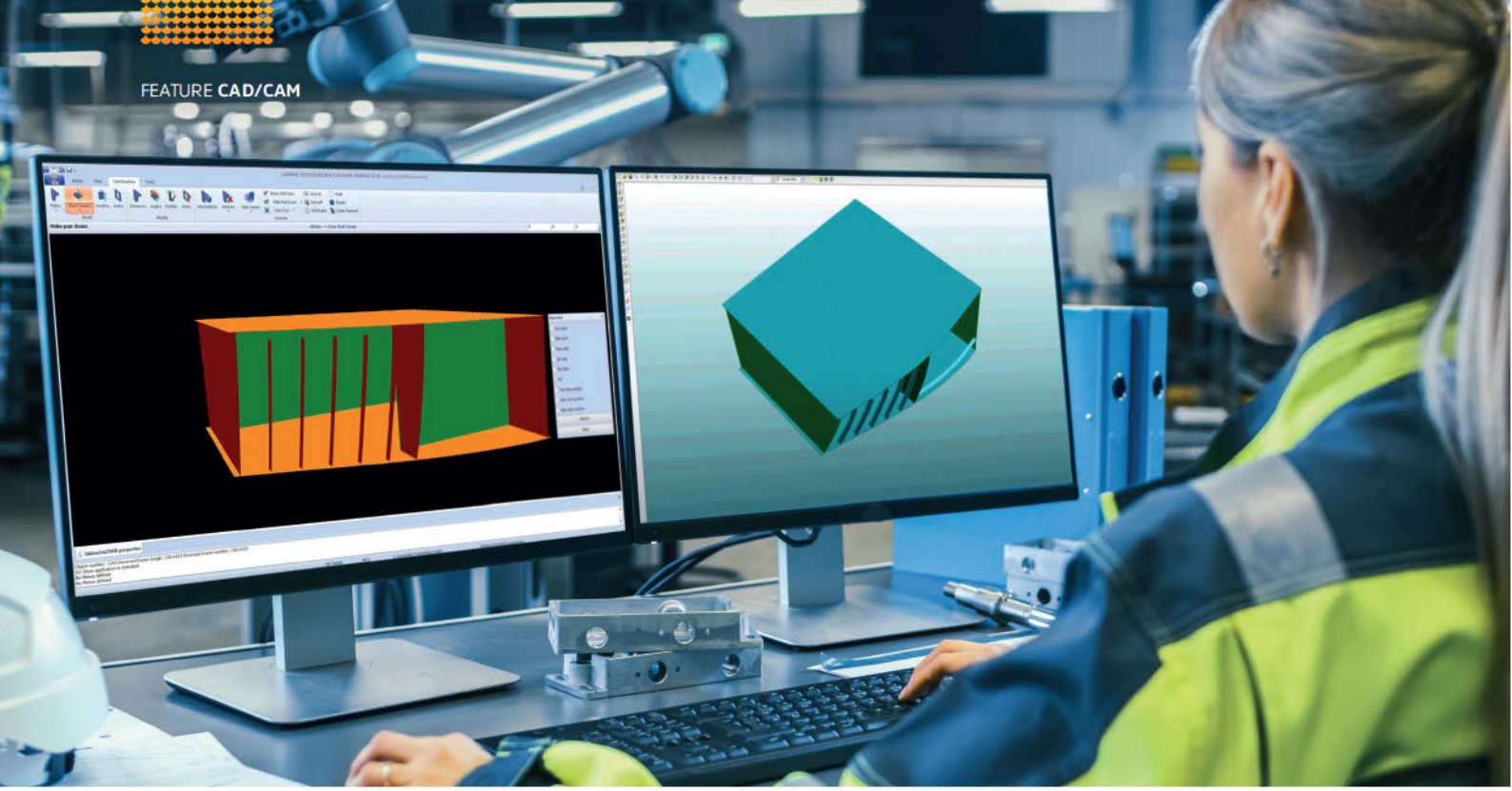
He says: "The traditional lifeboat and davit arrangement usually takes up two deck spaces of what is premium real estate on the outside of the ship. Because this solution fits on a single deck we're freeing up essentially a top row. Some of those obscured cabin views could be turned into balcony cabins and some restaurant spaces could be expanded into an alfresco feature.

"And again, at the lifeboat deck we're taking up considerably less space. Every ship design will be unique, but that's space that can be turned over to retail, casino or restaurant space for example."

As well as operators and shipyards, McCormick says Survitec is looking to engage further with naval architects, people for whom space matters. "That's been missing to date. As a safety provider, we've been mainly focused on the safety and technical side. Now we need the creative side of the business to start thinking about how they're going to move forward with this technology in terms of vessel design," he says.

Seahaven is being targeted at newbuilds and older vessels requiring upgrades, with McCormick noting that retrofitting the system to existing ships should be straight forward during a scheduled drydock.

And despite the conservative nature of the industry, he believes that it is ready to consider news ways of approaching safety. "We're very confident that the first installation will be the wedge in the door. I think ships that we see today, with lifeboats bow to stern, are going to look like a pony and trap in about 10 years' time. That concept will be gone. Instead, you'll have Seahaven or a competitor's equivalent which will be a leap to the art of the possible in terms of what else you can do with that space. It's going to lift design constraints and really enhance passenger experience and revenue generating opportunities," he concludes. ■



# CAD/CAM

## INFORMATION FLOW FROM 3D DESIGN TO PRODUCTION DATA

By **Ludmila Seppälä**, Cadmatic

The complexity of modern shipbuilding, along with changes in the business environment and the growing capabilities of digital solutions, challenges work processes and enables efficiency gains by eliminating gaps in information flows. This article discusses the changes in modern ship design and production and the interconnections between these two phases of the shipbuilding lifecycle from an information management point of view. It offers several examples of shipyard practices and outlines the development direction for digital transformation in this area.

### 3D design in shipbuilding

Modern shipbuilding CAD software allows users to enrich the 3D data with production information already in the early stages of design. A safety net of settings and predefined values surround the designer's actions to assist with the regulations of the classification society and to ensure the readiness of the design data for production. There are thousands of automatic functions that assist ship designers in creating 3D data and setting the stage for production data output.

Besides the primary functional considerations, the main trends shaping modern ship design via digitalisation and sustainability goals include the following:

- Increased demand for flexibility and speed in the early design stages to evaluate design variants and estimate the economic feasibility of different powering options.
- Automation of routine design tasks and a high level of embedded rules and settings, based on requirements or best practices, to assist the designer.
- Interoperability of data formats to enhance concurrent execution of calculations, design, simulation, and production output.

### Modern shipbuilding production

The primary goal of the shipbuilding process is to manufacture the vessel according to the defined specifications and deliver it on time and without defects. Therefore, the engineering and design process must provide the required production data and not only focus on fulfilling design and functional goals. Historically, technical departments were concerned primarily with the vessel function, and production information was developed later by draftsmen in production departments, such as the steel or piping production department.

This process changed in modern shipbuilding. The impact of productivity requirements, economic returns, and IT system development has changed the shipbuilding production landscape as follows:

- Production flow became the basis for the shipyard's layout and served as the primary productivity improvement area for modernisation in the last decade.
- Production strategy, dictated by economic

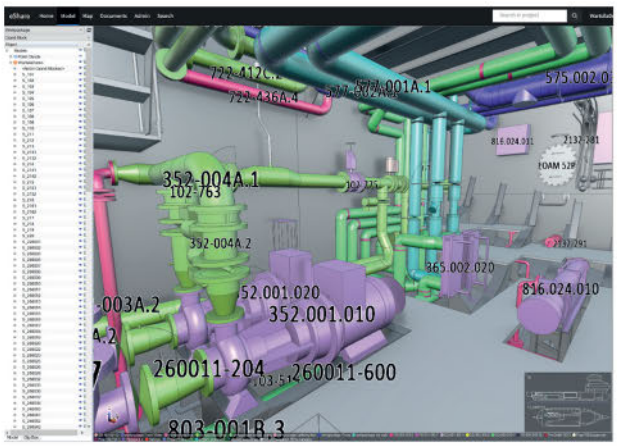



FIGURE 1. EXAMPLE OF COLOUR CODING AND DATA VISUALISATION FOR PRODUCTION IN CADMATIC ESHARE

reasoning, disconnected the design and production processes. It may be a "design from stock" or modular engineering process when the design is created before the production site is selected and production requirements are known. It can be an "offshoring" strategy for using a remote construction site for steel construction due to cheaper labour costs and lower requirements for quality while keeping outfitting production at the yard. Initiatives, such as shared production facilities, require specific production data output to support high volumes of production that will be assembled in micropanels and later used in the construction of different projects and shipyards.

- Machinery and automation equipment of production lines – advanced robotics and computational tool applications leaped forward in the last decade resulting in more connected manufacturing and automated assembly lines in shipyard production processes.

Due to these changes, production needs for data cannot be satisfied with a set of 2D documents and material take-offs from the design stage. In most cases, the required data is adaptable output for the design stage, with a high degree of flexibility in the definition of the work breakdown structure and data presentation and the ability to take the required machinery output into account. Besides design data, production needs consolidation with planning and project management to facilitate the whole process.

## Examples of data flow gap mitigation between engineering and production

The examples below originate from shipyards' experiences in optimising their work processes by implementing modern shipbuilding technology, such as Cadmatic ship design applications and its information management platform. Addressing and improving information and data flows between existing systems provides tangible gains in productivity and a gradual increase in digitalisation gains.

*Placing data in the context of production tasks with colour coding*: Access to information does not guarantee that it can be used in time. For example, work package information may be available in a manufacturing system, but it is disconnected from the 3D model and provides only textual status updates to production teams. The ability to visualise this data in 3D and provide access to any other data in the required format, such as on a tablet or via a VR/AR set, is a gamechanger for the production process due to the ability to visualise the data in digital format and thus enhance interactions. It also opens the gate to industrial metaverse applications and provides for the use of 3D digital data residing in physical environments in the production process.

An example from ship production practice concerns the weight of equipment information for installation teams. For on-site teams, it is critical to have information about the weight of equipment scheduled for installation before planning activities. It can be solved by merging available data from several sources and visualising it for planning on-site activities: the ERP system containing the weight information after the procurement and the 3D engineering model. The design of the information flow included access to the ERP data, the selection of equipment for which it is required (with weight over 25kg), and comparison criteria for engineering defined weight and data from the ERP system. Results for the planning and installation included a pre-set visualisation style in the information management platform with one-click coloured 3D models according to the weight data. This way, on-site work can be planned to take access to heavy lifting machines and cranes into account and avoid situations where installation teams must make unplanned hull cuts or wait for heavy equipment lifting.

*Planning of installation packages*: A typical modern shipbuilding project includes 500-1,000 piping work packages for installation. Manufacturing and installation planning for the production based exclusively on engineering data may result in delays and disruptions due to the lack of information about deliveries from pipe shops or suppliers. Including the data from ERP (or another type of system) enables data merging: engineering and work breakdown, and delivery

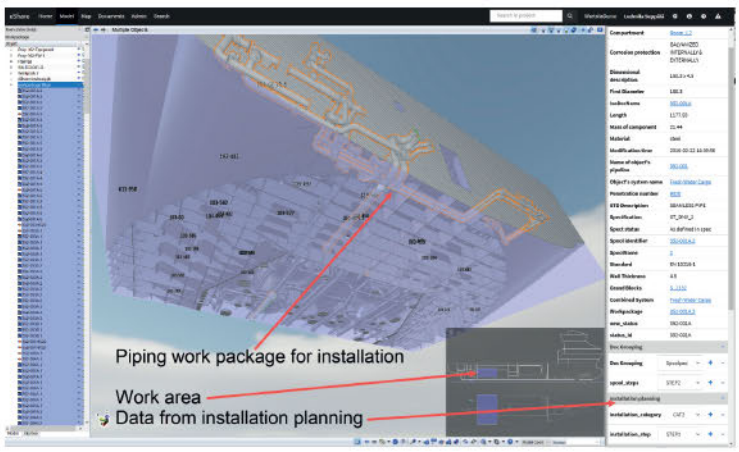



FIGURE 2. EXAMPLE OF 3D MODEL AND INSTALLATION PLANNING DATA IN THE CONTEXT OF WORK PACKAGE VISUALISATION

progress from workshops or subcontractors and placing it in the context of the work process.

This example represents a case where consolidating data from engineering and installation planning using innovative technology can significantly save time. It is a laborious task if there is only one project, while if a shipyard has several subcontractors delivering pipe packages and tens of simultaneous projects – it becomes essential for production planning and control.

*Communication between design and production in the shipbuilding network*: Providing information "on-demand" and in context reduces the number of paper drawings and creates an interactive digital environment. Having "single-source-of-truth" data can significantly increase the quality of decisions and reduce the time spent searching and verifying information. At the same time, providing the context for production execution can increase production quality and at least partially address the lack of skills or understanding of the overall process by production teams. Adding a link between the design model and nesting status provides a solution to track the hull building process accurately. It allows designers to instantly see what parts have been cut and welded. The progress of building and inspection is also visible, which reduces the number of uncertainties and questions.

## Information flow: benefits of digitalisation and flexibility for work processes

Digitalisation is not just the use of digital technologies. It is a way of transforming work processes and providing new possibilities – the vision of seamless information flow and drawingless production is already becoming a reality in modern shipbuilding. Besides robust functionality to support design and production phases, intelligent technology should support data integration with existing systems and allow companies to engage in a step-by-step digitalisation process. Addressing the gaps in information flows grounds the development of digital solutions around shipbuilders' needs. This approach embraces Industry 4.0 concepts and goes toward the Industry 5.0 concept of developing IT solutions – including sustainable goals and skills in the equation of digitalisation. The digital solutions are thus not only developed in functionality according to the possibilities of data handling by IT systems, but follow and challenge the work patterns and serve the goals of the overall shipbuilding process. ■

*The screenshots for the figures in this article are taken from the Cadmatic Information Management platform using a demo environment project courtesy of Wärtsilä Ship Design Norway AS.*

# NETHERLANDS

## NEWBUILD INLAND WATERWAY VESSEL TO RUN ON GREEN HYDROGEN

By **Daniel Johnson**

In recognition of the important role that inland shipping can play in helping to reduce freight transport-related greenhouse gas emissions, the Dutch government is making significant investments to accelerate the sector's decarbonisation and has committed itself to reduce $CO_2$ emissions from the country's still largely diesel-fuelled fleet by between 40% and 50% in 2030 compared to 2015.

With some ships already running on batteries, liquefied natural gas or with cleaner engines, next year will see an entirely new vessel enter service sailing on green hydrogen.

"There will not be one single way to reduce emissions in our sector, but hydrogen is an important sustainable alternative to fossil diesel fuel to power inland vessels," Femke Brenninkmeijer, CEO of Rotterdam-based NPRC, the largest cooperative charterer in European inland shipping, tells *The Naval Architect*.

With a member base of 145 inland shipping entrepreneurs, at least 200 vessels are underway every day on behalf of NPRC, delivering 14 million tonnes of cargo per year.

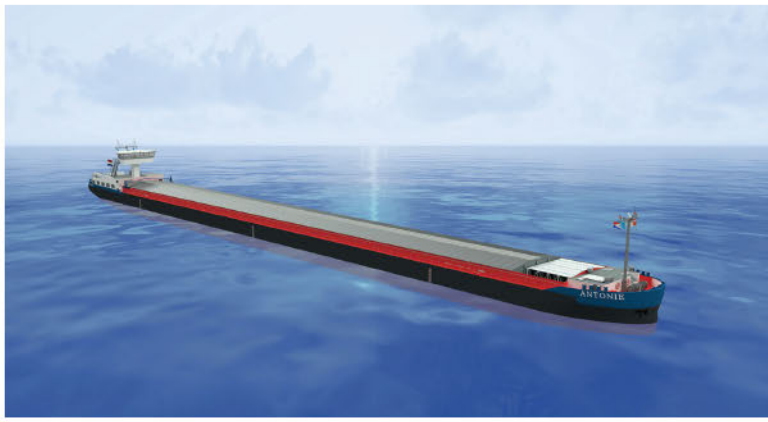
### WEVA

A demonstration project – WEVA (an abbreviation for Hydrogen Electric Freight Vessel Antoine) – supervised by NPRC has recently been given the go-ahead by the Dutch Ministry of Infrastructure and Water Management to build the Netherlands' first newbuild inland waterway vessel to run on green hydrogen. The ship is expected to embark on its maiden voyage in mid-2023, transporting salt from the Nobian salt factory in Delfzijl to the company's Botlek chemical plant in Rotterdam.

WEVA is a partnership between NPRC, Nobian, vessel operator and NRPC member Lenten Scheepvaart, shipbuilder Concordia Damen, fuel cell producer Nedstak, and hydrogen sector consultancy HyEnergy TransStore.

According to Brenninkmeijer, construction of the *Antonie* will contribute to further development of hydrogen technology aboard ships and also help accelerate the drafting of legislation surrounding the use of hydrogen in inland shipping. The experiences gained during the development phase, construction and launch will contribute to determining the viability and costs of comparable projects in the future, she adds.

At over €10 million (£8.8 million), the costs for the construction and development of the 135m-long *Antonie* (the maximum length for inland shipping vessels) are about double that of a regular ship, says



RENDERING OF THE 135M-LONG *ANTONIE*

Lenten Scheepvaart owner Harm Lenten. With Lenten Scheepvaart contributing just over half, the additional costs are covered by a €4 million (£3.5 million) subsidy from the Ministry of Infrastructure and Water Management.

"It's a big investment for us, but I believe this project will be the breakthrough towards the use of hydrogen in inland shipping," explains Lenten.

Lenten says that although not everything has crystalised architecturally yet, locating living quarters in the foreship of the vessel will make way for the hydrogen. "New construction benefits over retrofitting because you can integrate the hydrogen installation and storage in the ship in the best way and you don't have to give up cargo space," he adds.

### Emissions free

WEVA estimates that *Antoine* will transport approximately 3,700tonnes of salt per voyage, the equivalent of 120 trucks, entirely free of emissions. The hydrogen used by the vessel will be produced by Nobian. It is created as a by-product in the production of chlorine and lye, based on salt water electrolysis. Because Nobian uses renewable energy for the electrolysis, the hydrogen is certified as green.

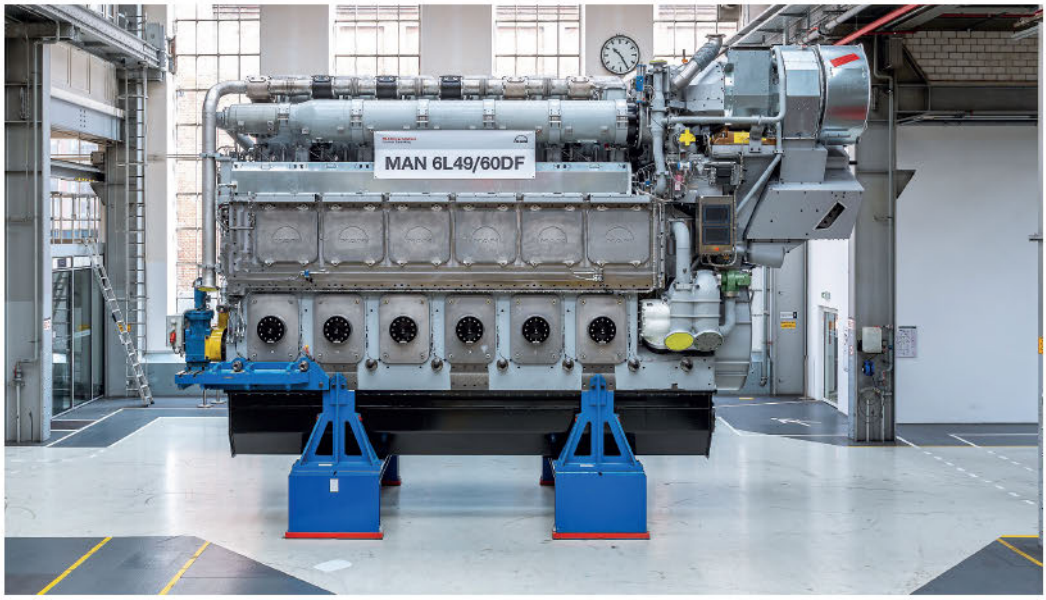
The shipper's commitment to work with NPRC and Lenten Scheepvaart over the long term, both for ship transport and for the supply of green hydrogen, was decisive in NPRC and Dutch central government moving ahead with the WEVA project, according to Brenninkmeijer.

She notes that the availability of the gas is not a problem for this test, but in order to facilitate hydrogen sailing on a larger scale afterwards it will have to be available in many inland ports, which will require major investments. ■

# ENGINES

## EXPO RETURN HERALDS NEW ENGINE LAUNCHES

By **Malcolm Latarche**, Correspondent




ONE OF THE NEW ENGINES ANNOUNCED IN 2022, THE MAN 6L49/60DF. SOURCE: MAN ENERGY SOLUTIONS

After two years when the exhibition circuit came to a juddering halt, 2022 has seen three exhibitions take place in Europe alone and new engine debuts and development announcements coming thick and fast. Even before Nor-Shipping in April there had been a steady stream of engine related announcements mostly related to developments connected with new fuels including a methanol version of Wärtsilä's 32 engine. Making its debut at Nor-Shipping was BeHydro's new BEH2YDRO dual-fuel hydrogen engine. BeHydro is a joint venture between Belgium-based engine maker ABC and ship operator CMB. The company's local distributor exhibited a six-cylinder dual-fuel hydrogen engine, running on 85% hydrogen gas and delivering 1,000kW of power. The engines were developed for heavy-duty applications and are very flexible in usage. Operating on 85% hydrogen gas and 15% conventional fuel, they make the owner or user less dependent on fossil fuels. The engines can operate on 100% conventional fuels if hydrogen is not available.

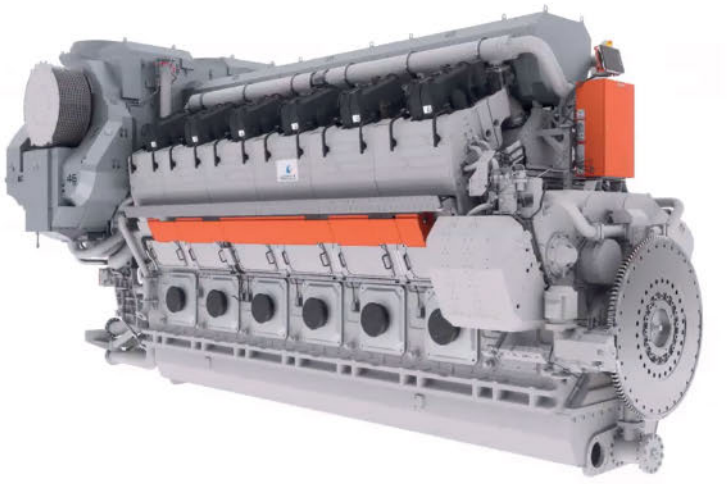
The following month, BeHydro demonstrated the same engine type at the World Hydrogen Summit in Rotterdam but this time operating on hydrogen alone.

The engines are available with six or eight cylinders in line and 12 or 16 cylinders in vee and have a power range from 1,000 up to 2,670kW. As well as propulsion they can be used as auxiliaries and in genset configuration.

Although Wärtsilä was present at Nor-Shipping it waited until a few weeks later to announce its new medium speed engine the 46TS-DF. The company said that the overriding basis for this new engine was to be able to offer a future-proof solution for owners and operators to reach decarbonisation targets. It also said that six of the engines will be installed or Royal Caribbean Cruises' *Utopia of the Seas* under construction in France at Chantiers de l'Atlantique.

The Wärtsilä 46TS-DF has a two-stage turbocharging to deliver high levels of efficiency and power density across a wide operational range for vessels in all segments of the industry. This level of efficiency reduces fuel consumption and lowers emissions, while being easily retrofittable for future carbon-neutral and carbon-free fuels as they become widely available. Although a dual-fuel engine and aimed at future fuels as well as LNG, Wärtsilä has said it is thinking about developing a pure diesel version of the engine.

Development of the Wärtsilä 46TS-DF engine has been based on experience gained from the company's 46, 46F, and 50 engine families. It is available in six- to 16-cylinder configurations with four inline variants and three vee variants, corresponding to a power output range of 7.8 to 20.8MW at 600rpm and 1,300kW per cylinder. The 460mm bore is expected from the engine's designation and the engine has a 580mm stroke and a 27bar mean effective pressure. Switching between gas and diesel modes causes no loss of power or speed, and the engine adapts automatically to the fuel in both normal and emergency modes.



WÄRTSILÄ'S NEW 46TS-DF ENGINE CAN RUN ON SEVERAL DIFFERENT FUELS INCLUDING METHANOL OR AMMONIA

The two-stage turbocharging system that gives the engine its TS suffix is supplied by Napier and consists of one low-pressure and one high-pressure turbocharger arranged in series, combined with two charge air coolers per cylinder bank. Another innovation claimed for the engine is stepless valve timing on both inlet and exhaust valves. The ability to infinitely adjust the timing of both valves optimises air supply and combustion. It also requires a sophisticated control system to process the huge amounts of data in real-time.

## MAN power

MAN Energy Solutions may have most of its eggs in the two-stroke basket but it also has an extensive four-stroke portfolio. With the EEXI and CII regulations in mind for its marine customers and environmental demands also featuring in the shore-power sector, MAN PrimeServ, MAN Energy Solutions' after-sales brand, announced in July that it is offering the opportunity to retrofit older MAN 48/60 marine and power-plant engines to state-of-the-art MAN 51/60 types as part of its new 'lifecycle upgrade' offering. Converted engines will effectively be equivalent technically to newly built MAN 51/60 units and, as a result, achieve significant savings in fuel consumption, $CO_2$ and pollutant emissions, and increase reliability. As a further option, newly converted engines can be upgraded for operation on synthetic fuels for a low premium.

According to the company, MAN 48/60 engine types (variant A or B) already in operation, and which have more than 80,000 operating hours, are particularly suitable for a lifecycle upgrade. Post-upgrade, the engine becomes as reliable as a new MAN 51/60 engine, while future conversion to dual-fuel operation is straightforward as 80% of all necessary adjustments are already performed during the lifecycle upgrade.

Calculations have shown that upgrading a 9L48/60 engine to a 9L51/60 type can save around 500tonnes of fuel and 25tonnes of lubricating oil per annum – based on an annual operating time of 6,000hours under full load.


BEHYDRO HAS SUCCESSFULLY RUN ITS ENGINE ON 100% HYDROGEN FUEL

MAN used SMM in September as the launch pad for its latest four-stroke engine which could be competing in the same sector as Wärtsilä's 46TS-DF. The MAN 49/60DF is capable of running on LNG, diesel and HFO as well as a number of more sustainable fuels including biofuel blends and synthetic natural gas. MAN Energy Solutions states that it sets a benchmark in terms of fuel efficiency within four-stroke engines – both in gas and diesel modes – and therefore minimises fuel costs.

Marita Krems, head of Four-Stroke Marine & License, MAN Energy Solutions, said: "The MAN 49/60DF is making its debut at a time where – while the number of LNG projects is still growing – alternative fuels like methanol, ammonia and hydrogen are continuing their rise, albeit with none having established market dominance as of yet. Increasingly, it is crucial for new vessels to be driven by engines that provide options for emission compliancy over the vessel's lifetime. Fuel flexibility and efficiency are the key features. In this respect, the 49/60DF distinguishes itself by offering a number of various emission paths. It also has a level of efficiency that ensures best fuel costs in many applications, especially within the cruise, ro-pax, ro-ro, dredger, and LNG carrier segments."

The 49/60DF is already available for order and is based on the new 49/60 engine platform that features MAN's latest technologies, including two-stage turbocharging, second-generation common-rail fuel injection, SaCoS5000 automation system and MAN's next generation Adaptive Combustion Control ACC 2.0 that automatically sets combustion to optimum levels. The engine also retains existing MAN technolgies such as the gas-injection system, pilot-fuel-oil system and MAN SCR (Selective Catalytic Reduction) system.

The 49/60 can start in gas mode where it complies with IMO Tier III without secondary measures. In diesel mode, it complies with Tier III combined with MAN's SCR system. Soot emissions are halved in diesel mode due to MAN's new common rail system 2.2, while the 49/60DF's methane emissions also drastically reduced in gas mode compared to its predecessor. The engine's benchmark efficiency and fuel-flexible design offers multiple paths to emission compliancy leading up to 2050, as per the current Fuel EU draft.

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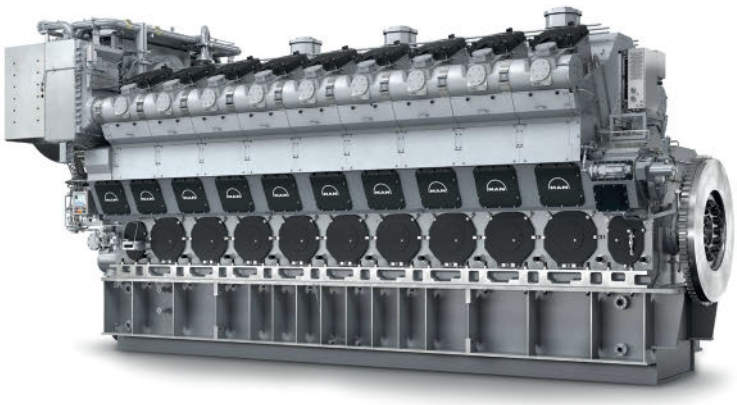
## SIGNIFICANT SHIPS OF 2022

The 33rd edition of our annual Significant Ships series, *Significant Ships of 2022*, will be published in February 2022. As in previous editions we shall be including up to 50 of the most innovative and interesting commercial ship designs (of mostly 100m length and above) which will be delivered during the forthcoming year.

The Editor invites shipbuilders, designers and owners to submit details of vessels for possible inclusion in *Significant Ships of 2022*. Presentation will follow on the established two-page format, with a colour photograph, descriptive text and tabular details (including major equipment suppliers) on the first page, followed by a full page of technical general arrangement plans. Initial potential entries should comprise a short technical description (100 words) of the proposed vessel highlighting the special features and the delivery date.


**All entries should be addressed to:**

**Editor, Significant Ships of 2022,**
**Email: editorial@rina.org.uk**
**Tel: +44 (0) 20 7235 4622 Fax: +44 (0) 20 7245 6959**



MAN HAS LAUNCHED A PROGRAMME TO UPGRADE ITS 48/60 ENGINE TO 51/60 SPECIFICATIONS. SOURCE: MAN ENERGY SOLUTIONS

MAN plans to introduce a pure diesel engine based on the 49/60 platform in 2023 that will inherently be retrofit-ready for running on methanol and LNG should the demand arise at a later stage.

### Wärtsilä 25

Also at SMM Wärtsilä announced its new Wärtsilä 25 medium-speed four-stroke engine. Based on the company's modular technology platform, this latest addition to its engine portfolio is designed to accelerate and support the maritime sector's efforts in achieving decarbonisation.

The engine is capable of operating on currently available diesel, LNG, or on either gas or liquid carbon-neutral biofuels and can easily be upgraded to operate with future carbon-free fuels as they become available. The flexibility of having different valve timing options as on the earlier announced 46TS-DF is a key enabler for future fuels and emissions optimisation. It is intended to be the first Wärtsilä engine to run on ammonia as a fuel – technology development is currently underway with a technology concept readiness slated for 2023, followed by planned product release soon thereafter.

When operating with natural gas the engine is IMO Tier III compliant, as it also is with diesel when integrated with a Wärtsilä NOx Reducer (NOR) emissions abatement system. Furthermore, it enables economically viable compliance with regulations such as the IMO's CII and EEXI protocols that enter into force in 2023. It is designed for long periods of maintenance-free operation and it supports drydocking schedules with a time-between-overhauls (TBO) of up to 32,000hours. Data-driven dynamic maintenance planning and predictive maintenance services can extend the TBO even further.

The Wärtsilä 25 is now available in 6L, 7L, 8L and 9L cylinder configurations, while the dual-fuel version has a power output ranging from 1.9 to 3.1MW, and the diesel version from 2.0 to 3.4MW. The common-rail high pressure fuel injection technology optimises combustion and the fuel-injection settings at all loads. This in turn promotes smoke-free operation. Other features include a self-learning proportional, integral, derivative (PID) control to reduce calibration needs, and the gathering of critical engine data for predictive maintenance, reporting and analysis purposes. The modules can be replaced 'on the fly', which eliminates the need for separate software downloads. Optional and easy-to-apply adjustments for arctic or tropical conditions and for reducing emissions to the level of a pure gas engine are also available. ■

# VERSATILITY LOOKS TO SECURE DIESEL FUTURE

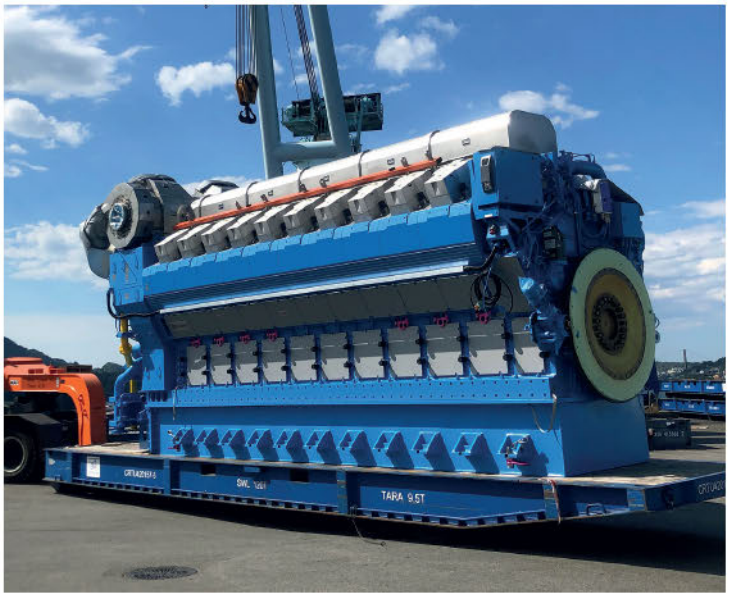
By **Malcolm Latarche**, Correspondent

Around a decade ago many analysts were forecasting the demise of the diesel engine as a means of ship propulsion with it being replaced most likely by fuel cells. That has not happened and as things stand the future of the diesel engine looks to be very secure thanks to its unique ability to operate on many types of fuel aside from oil.

Engine makers have been refining and improving their products for around a century and although there may be some more efficiencies to be squeezed from all types of engine, the focus on recent years has been on adapting them to run on different fuel types with methanol, ethanol, ammonia and hydrogen having been added to the ability to use LNG. That does seem to have slowed the number of new models coming to the market but that has hardly limited the choice of engines for any ship.

Perhaps a bigger problem for the engine makers is the number of newbuildings being ordered. Market conditions may make some ship types look attractive investments at various times but the boom years of the first decade of the 21st century have disappeared, and yard output is down to between a third and half of what it was.

That has repercussions and one of those is the demise of the MaK name and others are the sale of the Bergen Engine business by Rolls-Royce Power and Wärtsilä's decision to close its Trieste engine manufacturing division and move it to Finland. Caterpillar had announced in 2021 that it was ending production of the MaK range of medium-speed engines by the close of 2022 and the engines were indeed excluded from the latest catalogue of Caterpillar marine products. Wärtsilä made no secret of the causes for its decision which was to reduce costs and consolidate production.




BERGEN ENGINES HAVE A NEW OWNER AFTER ROLLS-ROYCE POWER SOLD THE BUSINESS TO LANGLEY MARINE. SOURCE: LANGLEY MARINE

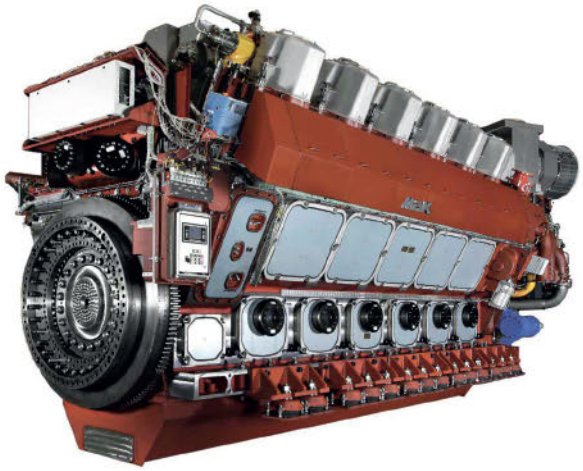
The company said the closing of the plant will result in annual savings of €35 million by 2025.

Commenting on the decision, Roger Holm, president of Wärtsilä's Marine Power business, said: "Under the challenging circumstances of the past years, our employees in Trieste have done a commendable job. However, we need to centralise our manufacturing footprint in Europe to further improve our competitiveness. I would like to underline that Italy and Trieste will remain very important for Wärtsilä. Going forward our site in Trieste will focus on R&D, sales, project management, sourcing, service and training activities.

The future for Bergen Engine looks brighter since being acquired by UK-based engineering and industrial group Langley Holdings on 31 December 2021 after a proposed earlier sale to Russian interests was blocked by Norway where the engines are produced. In April 2022, Bergen Engines and Kongsberg Maritime announced that the agreement between them whereby Kongsberg Maritime provides the exclusive route to market for Bergen engines and parts in the commercial marine sector, was to terminate in June 2022. The two companies had entered into a five-year agreement in 2019, when Kongsberg acquired the commercial marine division of Rolls-Royce. Kongsberg Maritime will continue to distribute Bergen's marine engines on a non-exclusive basis going forward.

All three of the companies mentioned are active in the medium-speed sector which is fiercely competitive, with the European makers also including MAN Energy Solutions and ABC battling for sales against Asian rivals. In the two-stroke sector competition is still fierce but with only MAN and WinGD in the frame along with JEC, which has a very small but very loyal band of followers, and engines being mostly constructed by licensees the need for economies may be less pressing.

That said, MAN Energy Solutions' future as part of the VW Group was in question a few years back although the parent company said in 2020 that it would remain part of the group until at least 2024. In 2021 MAN took full control of Germany-based hydrogen technology company H-Tec Systems and has diversified into hydrogen energy.




THE MAK ENGINE NAME WILL DISAPPEAR AS CATERPILLAR DISCONTINUES PRODUCTION OF LARGE MEDIUM-SPEED ENGINES

In March this year, MAN said it will invest up to a further €500 million into hydrogen production technology. Gunnar Kilian, chairman of the Supervisory Board of MAN Energy Solutions and member of the board of Volkswagen AG, underlined that the Volkswagen Group supports these growth plans saying: "On the path toward achieving climate neutrality, hydrogen plays a key role for sectors such as international shipping or industrial processes in which direct electrification is not possible. It is therefore essential for our subsidiary MAN Energy Solutions to continue to strengthen its strategic position in the future market for power-to-X technology and synthetic fuels with investment in hydrogen production."

While engine manufacturers are obliged to make commercial decisions, shipowners ordering vessels need to decide the best engine choice to future proof newbuildings and what options are available for existing in service ships to meet EEXI and CII rules. Without exception the diesel engine is the favoured options although in what guise varies. Many owners are continuing to opt for a straightforward oil-burning diesel engine and in many cases linking it with a scrubber to take advantage of cheaper high sulphur fuels. Others are sticking with oil burning variants but planning to run on 2020 compliant fuels.

Other alternatives are dual-fuel engines capable of running now on oil or LNG but with the potential in future to de adapted to burn ammonia or hydrogen. For those staying with the more conventional basic engine, there is the comfort of knowing that bio and synthetic fuels will almost certainly be available should a ban on fossil fuels come into effect sometime in the future. Developments over the course of the last year have only served to confirm that diesel's dominance is ensured for a long time to come. ■

# UPGRADES, EXTENSIONS AND FIRSTS BUT NO NEW ENGINES

By **Malcolm Latarche**, Correspondent

Two-stroke engines are the favoured option for almost all large container ships and despite there only being a limited number of engine developers with just MAN Energy Solutions, WinGD and J-ENG in the picture, the range of engines available is extensive.

It should come as no surprise that after a period when development was dominated by adding dual-fuel variants able to run on LNG to existing lines, the most recent focus has been on extending the ranges further to other alternative fuels. MAN has been the front runner introducing methanol burning engines back in 2016 and propane fuelled variants in 2018. Today the focus is on ammonia and hydrogen as future fuels but with expectations that engines running on either fuel will be available if not in service within the then next five years. All three of the makers in this sector are exploring ammonia and hydrogen fuelled variants.

J-ENG, the smallest of the three two-stroke makers last announced a new engine in 2020 with its UEC33LSH becoming the successor of UEC33LSII. Compared to the earlier engine which has the same bore and stroke, the new version increases mean effective pressure from 17.6 to 22.5bar, engine speed from 215rpm to 230rpm but increases power output of a six-cylinder version from 3,400kW to 4,650kW and reduces SFOC at 100% loading from 179g/kWh to 172g/kWh.

Completion of the first 6UEC33LSH-C2 was done by licensee Zhejiang Yungpu Diesel Engine (YDE) in Ningbo, China in September 2022. It will be installed on a coastal bulker built by Yizheng Yangzi Shipbuilding. This engine was developed and launched into the market in a very short period with close cooperation between J-ENG and YDE in order to capture the booming demands for replacement of coastal vessels in China, and YDE already has secured 10 engine orders. J-ENG has said it aims to further expand its UE licensing business and market share by targeting the coastal vessel markets based on strong cooperation with domestic and overseas licensees.

Earlier in 2022, J-ENG had announced that its UEC42LSH engines announced in 2020 and developed for middle/small size chemical tankers and handy-size bulk carriers was proving popular with more than 50 orders already secured. The first engine of this type was delivered in July 2021 and entered service in March 2022. A large proportion of the orders covering 20 units has come through new Chinese licensee Guangzhou Diesel Engine Factory.

## WinGD

Chinese-owned but Swiss-based WinGD has added no new engines to its range in the last year but has introduced an on-engine version of its emission reduction iCER system, enabling the technology to be installed without impact on engine footprint.


WINGD HAS INTRODUCED AN ON-ENGINE VERSION OF ITS EMISSION REDUCTION TECHNOLOGY ICER. SOURCE: WINGD

iCER was the first X-DF2.0 technology introduced to further boost the emissions performance and efficiency of the company's dual-fuel X-DF two-stroke engine series. The addition of iCER delivers a 50% reduction of methane slip in gas mode. Combined with better fuel efficiency, this reduces total greenhouse gas emissions by up to 8% in gas mode. Running on diesel, iCER improves the emissions performance of X-DF engines by 6%.

The on-engine version offers the same advantages while simplifying testing, building and installation of the engine, as well as reducing the engine room space needed for emissions reduction equipment. The exhaust gas cooler and all exhaust gas flow control components are installed on the engine, offering significant engine room design flexibility.

On-engine iCER is initially available on WinGD's X72DF engines, which have become popular on modern LNG carriers. Minimising methane slip on LNG carriers has an added benefit for operators using their cargo as fuel, allowing them to maximise the value of the LNG delivered. The technology will be rolled out to other models in the X-DF engine range.

The principle behind iCER, which stands for intelligent control by exhaust recycling, is to minimise emissions by regulating air and exhaust gas flow. By cooling

and recirculating exhaust back to the engine, more gases which can contribute to climate change are combusted without escaping into the atmosphere. As well as reducing methane slip and total greenhouse gas emissions, both on- and off-engine iCER enable compliance with IMO's Tier III NOx limits, whether using LNG or diesel fuels.

In July, WinGD's X92-B engine passed its upgrade Type Approval Test (TAT) at engine builder HHI-EMD in Korea with all eight of the leading classification societies in attendance. The upgrade TAT addressed the increased firing pressure which provides further improvements to overall efficiency. The X92-B engines have been designed to allow a later conversion to a X92DF to use LNG as fuel. A month prior to the test, Evergreen's seventh A-class vessel and the first vessel in the world to have a capacity in excess of 24,000TEU, the *Ever Alot*, was delivered by Hudong-Zhonghua Shipbuilding. The ship features an 11-cylinder earlier version of the X92-B engine.

## MAN consolidates

MAN Energy Solutions has also not added new engines to its range of two-stroke engines over the past year beyond extending the number of bore sizes that will now be available in the ME-LGIM series. However, the leading company in the two-stroke sector has seen strong demand for its ME-GA Otto cycle dual-fuel engines announcing in February this year that orders for the engine had reached three figures since its launch in May 2021. Simultaneously, the company revealed that the first ME-GA-powered LNG carrier will enter service in the summer of 2023.

Each ME-GA engine comes equipped with Exhaust Gas Reduction (EGR) that reduces methane-slip emissions by up to 50%, compared to first-generation Otto-cycle engines without EGR. The increased focus on methane-slip reduction – as well as other operational/technical benefits – has essentially established EGR as a new standard in contemporary, LNG carrier designs with Otto-cycle engines.

MAN Energy Solutions' proprietary EGR system began development more than a decade ago and was applied to a commercial project for the first time in 2013. Initially focused on achieving NOx Tier III compliance, the system has since accumulated orders for more than 275 engines.

Along with many other engine manufacturers, MAN has developed many of their newer engine types in a modular fashion so as to be easily upgradeable to meet ever stringent environmental regulation. In January 2022, the company reported that it has already carried out 16 dual conversions since the first in 2015 and sees great potential for the future as shipping progresses towards decarbonisation.

MAN Energy Solutions' engine designs currently drive some 22,000 vessels globally, of which 3,500 are fully electronically controlled and with the potential for conversion to operate on alternative, green fuels. It has further evaluated that approximately 2,300 or so of these vessels are appropriate candidates for retrofitting, resulting in savings as much as 86 million tons $CO_2$ emissions annually when fuelled by carbon-neutral fuels. In particular the company believes that its in-service S/G50-, G95- and G80-bore engines are particularly suited for conversion to methanol running as ME-LGIM units.

*EVER ALOT*, THE WORLD'S LARGEST CONTAINER SHIP WHEN LAUNCHED, FEATURES A WINGD X92-B ENGINE

In June, a contract was signed with US-based Matson Navigation for the retrofit of the main engine aboard the 2018-built container carrier *Daniel K. Inouye*. MAN PrimeServ will retrofit the 3,600TEU vessel's MAN B&W 7S90ME-C engine to a MAN B&W 7S90ME-GI type capable of operating on LNG and fuel oil. The contract includes an option for a second vessel.

As part of the retrofit solution, MAN Energy Solutions will also provide a high-pressure pump and vapouriser for MAN B&W ME-GI engines, which will be integrated into the *Daniel K. Inouye*'s Fuel Gas Supply System. The new system pressurises LNG to 300bar and vapourises the liquefied fuel to gaseous form for supply to the main engine. Its control system is based on that of the MAN B&W ME-GI engine and thus offers seamless integration and high performance in gas-mode. ■


MAN PRIMESERV WILL RETROFIT *DANIEL K. INOUYE*'S MAN B&W 7S90ME-C ENGINE TO A MAN B&W 7S90ME-GI TO RUN ON LNG

# LUBRICANTS

## 'LAB-ON-A-CHIP' OFFERS RAPID OIL ANALYSIS FOR REAL-TIME MACHINERY CONDITION MONITORING

A former PhD student is turning his research results into a time- and cost-saving technology

Dr Rotimi Alabi sets out his ambition to reduce "lubrication-related machinery failure by 95%, downtime by 45%, machinery operating and maintenance cost by 30%," while increasing machine availability by 25% using a new technique he developed to analyse machinery lubricating oil.

In an exclusive interview for *The Naval Architect*, he describes how his PhD studies in microfluidics at the University of Aberdeen in Scotland led him to develop what he calls a 'lab-on-a-chip' that can deliver rapid analysis of lubricating oil samples onboard a ship so that engineers can use its results to identify problems before they become serious.

To make his point, he cites a situation that arose during pilot tests with a customer that had suffered an engine breakdown in early 2021 because of an undetected fault which cost £250,000 to repair. But during trials in November and December, his device picked up tell-tale signs that the fault had returned, allowing it to be addressed, "and that saved the customer another £250,000 of repair costs", he says.

Dr Alabi set up a company, RAB-Microfluidics, after his university research into applying the microfluidic process, a process widely used in life science applications to analyse fluids at the microscale, to heterogeneous mixtures such as crude oil. It was a topic that his supervisor – and now shareholder in RAB-Microfluidics – Dr Stephen Bowden had been exploring since 2006.

When Dr Alabi joined the project in 2011, he started by replicating Dr Bowden's work to extract target compounds from crude oil and then sought to expand on this capability. This led Dr Alabi to develop a system that could make end-to-end chemical compositional analysis of crude oil on a 30cm by 30cm breadboard without needing the large and expensive instrumentation used in conventional laboratory analysis.

The process Dr Alabi had created was the first step in automating manual traditional wet chemistry protocols for separating pure compounds from heterogenous mixtures like crude oil. This essentially reduced the processing time of some of these traditional methods from days to minutes.

The system developed uses a glass microchip incorporated with optical sensors to separate and quantitatively analyse target compounds from mixtures.

DR ROTIMI ALABI, CEO, RAB-MICROFLUIDICS

The glass microchip was created by using strong acid to wet etch an H-cell pattern on glass to create an H-cell patterned micro-channel where the separation occurs. This separation chamber allows for rapid fractionation of pure compounds from complex mixtures in minutes rather than days when compared to using manual traditional wet chemistry techniques. By incorporating sensors on this separation chamber, Dr Alabi's PhD evolved away from simply separating out the compounds for offsite analysis to performing whole analysis onsite. Instead, "we do the analysis on the glass microchip itself", he explains.

### A solution looking for a problem

When he set up his company to exploit this process, his plan had been to automate wet chemistry protocols performed in laboratories. "But once we started looking deeper into industrial applications, we had a sense that there were more pressing far-reaching issues that the technology could help address," he says.

What those were, however, was not immediately obvious. "We had a solution, we didn't know what problem we were going to solve," he recalls. "I stumbled on lubricating oil analysis and realised this was a significant industrial challenge that demanded ongoing monitoring." It is also a topic that covers many sectors: any industry that uses rotating machinery, in fact. "It's almost ubiquitous in the world we live in," says Dr Alabi.

Investigating the chemistry of these oils further, he realised that "the microfluidic platform is robust enough to conduct lubricating oil analysis", so his company has focused on that type of industrial problem.

He has patented the 'lab-on-a-chip' concept and has received over £1.1 million in development funding from various grant-awarding bodies, including £100,000

## OIL ANALYSIS: THE PROBLEM AND ITS SOLUTION

Onboard oil analysis can be challenging, according to Dr Alabi. While other analysis kits are available, the complexity of using these and their oil characterisation limitations discourage wide adoption. Along with a regulatory requirement, this encourages asset owners to send lubricating oil samples to the laboratory for analysis as a default option for oil condition monitoring to better understand the condition of their valuable assets, he says. In contrast to existing portable devices, Oleum Oracle simplifies the end-user interface with just four steps to perform lubricating oil analysis, Dr Alabi tells *The Naval Architect*. "The rapidity in which measurements are made using Oleum Oracle ensures more frequent measurements can be performed and the generated data trended for more insightful indication of a machinery's condition or deterioration. This data trending provides the 'value-add' of the technology," he adds.

Presently, he explains, most shipping vessel engineers take oil samples from lubricated machinery and send them ashore for laboratory analysis. The logistics involved in accumulating samples from the various machinery onboard a shipping vessel and the days to weeks it takes for onshore laboratories to turnaround measurements ensure that the process of oil condition monitoring is performed quarterly by most vessel operators. Thus, ensuring any maintenance undertaken because of such results are reactive.

Furthermore, the current process results in only four data points annually. "There's no granularity in the lubricating oil results obtained using the current onshore laboratory analysis process," Dr Alabi says. "Trending on four data points across 365 days in a year provides very little information and as a result rotating machinery experience failures because the current process does not provide the level of data required to identify incipient faults."

He believes that "by automating that process where the machinery lubricating oil is measured accurately and frequently," it becomes possible to trend machinery condition parameters. Armed with that data, "you can predict machinery behaviour, based on the way it had operated in the past and operates in the present, thus fostering predictive maintenance", he adds.

Oleum Oracle will initially be offered as a portable device on lease contracts, enabling engineers to sample lubricants separately from all onboard lubricated machinery. This portable version will measure four parameters: viscosity, acid number, base number, and insoluble content – principally soot. An automated version that could be integrated onto an individual machine will be developed in the next 24 months. A prototype has been tested and a patent application is due to be filed, according to Dr Alabi. This machine integrated version will be able to measure more parameters, including metal and water content.

from the Net Zero Technology Centre and a £90,000 Enterprise Fellowship by the Royal Society of Edinburgh as well as several Innovate UK grant awards.

Most recently, the company received a £2.2 million equity injection in August from Par Equity, a Scottish early-stage investment firm that invests in innovative technology companies with high growth potential.


RENDERING OF THE P-OCM, SOURCE: RAB-MICROFLUIDICS

His technology portfolio currently consists of a portable oil condition monitoring device, initially dubbed a P-OCM, and a machine integrated system. He has now registered a new name for the unit, Oleum Oracle. It is being marketed now and some orders have been received, but its formal launch is expected towards the end of Q4 2022. An automated version that could be integrated onto operational machinery is also being developed and undergoing testing (see 'Oil analysis' box).

### Technology testing

Onboard tests of both the portable and machine integrated systems have been carried out with several customers, one of which is NorthLink Ferries, which serves Orkney and Shetland from the Scottish mainland. "We started working with Northlink Ferries in 2018 and we've developed the technology together," Dr Alabi says.

In September, the company had a stand at the SMM exhibition in Hamburg where it met a senior representative of a leading lube oil supplier amongst other potential customers. "The representative had heard what we were doing and is planning a follow-up visit to the office," Dr Alabi says. RAB-Microfluidics is already working with two other major lubricant manufacturers, he adds, saying that they recognise the depth of the data that the Oleum Oracle can provide. ■

# NOISE & VIBRATION

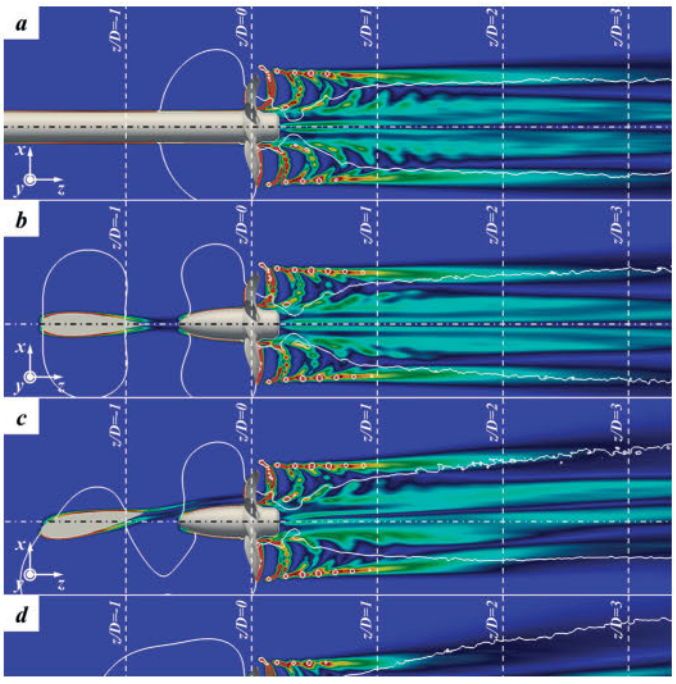
## HORIZON 2020 PROJECT REACHES FOR SATURN

By **Richard Halfhide**

Although the effects of Underwater Radiated Noise (URN) caused by ships on marine life have been a cause of concern for many years it's a nebulous, multi-faceted problem where evidence may be contentious and remedial action difficult to put into practice. Part of the challenge has been forging relationships between stakeholders from quite disparate fields to develop not only solutions, but common methodologies and nomenclature.

In 2008, the European Union adopted the Marine Strategy Framework Directive (MSFD), an initiative put in place to protect the marine ecosystem and biodiversity. The MSFD consists of a series of descriptors orientated towards different aspects of the environment including one, D11, which specifically addresses underwater noise.

Under this umbrella, 2019 saw the launch of the Joint Framework for Ocean Noise in the Atlantic Seas (JONAS) project, an Interreg-backed initiative which addresses threats to biodiversity from underwater noise pollution through better risk management and monitoring. JONAS brought together various countries with coastlines bordering the north-east Atlantic, including the United Kingdom, Ireland and Spain, with the objective of arriving at a consistent and cost-effective approach to MSFD requirements through the adoption of common methodologies. This was closely aligned with a similar project, the Joint Monitoring Programme for Ambient Noise North Sea (JOMOPANS).




SATURN PARTNER CNR-INM'S CONTRIBUTIONS HAVE INCLUDED RESEARCH INTO THE INFLUENCE OF UPSTREAM HYDROFOILS ON A PROPELLER'S ACOUSTIC SIGNATURE. SOURCE: CNR-INM

While JONAS and JOMOPANS have now concluded, many of the partners involved have now joined a separate EU Horizon 2020-funded project: Solutions At Underwater Radiated Noise (SATURN). The SATURN consortium is a collaboration between marine engineers and naval architects – among them well-known industry players including class society Bureau Veritas and Netherlands-based consultants MARIN – alongside marine biologists from research-leading centres such as Leiden University, Netherlands, and Aarhus University in Denmark. These two groups are joined by a variety of specialist communicators and experts in marine spatial planning, including French consultancy Quiet-Oceans, an expert in sound propagation modelling.

SATURN's aim is to examine which sounds pose the greatest threat to aquatic species and how these are produced and propagated, what the effects of URN are upon aquatic life, and to determine the most promising options for reducing its negative impact. Beyond that, it also aims to standardise terminology and methodology across all disciplines concerned by URN.

### Irish-led

Spearheading SATURN is the Research Centre for Energy, Climate and Marine (MaREI) at University College Cork (UCC), Ireland, which had previously served a similar role with JONAS. Project coordinator Gerry Sutton, a hydrographer who originally became involved with URN through an earlier project to map Irish waters, tells *TNA* that Ireland is a good fit for leading such projects: "People trust the Irish. It's not always the case that different parties in Europe can work comfortably together. As generalists we can follow most of the discussions from different multi- and transdisciplinary perspectives without going down too many rabbit holes."

"Europe doesn't have an equivalent of [Canadian regulator] Transport Canada to act as a single responsible body to invest the amount that would be needed to try and build a proper monitoring system," he explains. "So it's fallen to projects such as JONAS, JOMPOPANS and BIAS in the Baltic, and all of those projects are linked in terms of the people and personnel. Which is important because it's where

science is meeting the policy and driving forward to find common approaches that can then become standards."

MSFD D11 has proven a far more complex task to implement than those who originally drafted it could have imagined, with countries taking quite different approaches depending on their own environmental sensibilities and biological habitats. Although EU existing regulations include a requirement for each member state to maintain a register for so-called impulsive noise, such as seismic surveys, there is no provision outside MSFD for continuous sound.

Sutton notes that the focus of the OSPAR Commission, which brings together the EU with the governments of the 15 north-east Atlantic countries, is to develop a broader definition of what represents good environmental status with regard to continuous noise, with the aim of tracking long-term trends.

By contrast, the Port of Vancouver's ECHO programme, with support from acoustic monitoring consultancy JASCO Applied Sciences, has proved enormously successful both as a testing ground for various types of practical modalities for sound mitigation and the communicating the scientific basis for doing so. By doing so it becomes more viable to develop an incentivisation programme for shipowners, such as reduced port fees for ships that reduce engine speed in the approach channel or have a 'silent' notation.

However, there remains a lack of clarity in terms of how these risks are assessed and even the 'silent ship' notations being issued by classification societies don't apply a consistent approach. One of the key barometers of SATURN's success will be the advancement and promotion of an ISO standard for shallow water URN.

"The key thing is it doesn't matter what you're doing, or what the regulations are, if you don't have high quality long-term broadband sound monitoring going on constantly. Otherwise you're never going to be any the wiser," he explains.

## Emerging solutions

Sutton notes that big strides are currently being made in allowing vessels to become more self-aware of their own acoustic signatures, with research currently being undertaken into the development of deck-based equipment when they are entering the cavitation inception zone. Other technologies are being considered that would warn ships when they are entering the vicinity of cetaceans.

The tradeoff in propulsive optimisation – achieving the balance of maintaining or improving efficiency while reducing noise – is another of the project's areas of focus. It's a topic that has been a particular concern for a team at SATURN partner CNR-INM – the National Research Council of Italy's Institute of Marine Engineering – led by Mario Felli. As well as studies focused on installations effects – such as the influence upon sound generation of non-uniform propeller inflow conditions and propeller/wake interaction with inflow vortices – more recently Melli's team has been studying the interaction between the propeller wake and the rudder using CFD. Several years ago, prior to SATURN's inception, CNR-INM developed an experimental methodology for establishing the 'cause and effect' relationship between flow characteristics and far-field acoustic perturbation involving the use of pressure fluctuation measurements and hydrophones, which is proving beneficial to the current work.

Meanwhile, a team at MARIN has recently been exploring the effectiveness of air bubble curtains to mitigate URN, injecting bubbles into the flows both below the ship hull to isolate machinery noise and upstream of the propeller disc to dampen the cavity collapse. After selecting a 94m coastal tanker as the reference ship, a variety of porous hoses for injecting the air bubbles were evaluated. Initial tests suggest that while thrust and torque decreased by several percent there was only a one percent decrease in propulsive efficiency. At the time of writing model testing is currently ongoing with the results expected to be published later this year.

While the implications of such research and technologies may not be felt in the immediate future a more pressing matter is arguably assimilating the outputs of broad-scale sound modelling into marine spatial planning and the prediction of future noise levels. Sutton notes that a growing emphasis is being placed upon the so-called excess levels – the sounds which can be attributed to shipping and other anthropogenic sources – and distinguishing these from other parts of the acoustic spectrum which are naturally occuring. This in turn may give rise to mitigations such as mandatory speed reduction and in some cases the rerouting of shipping lanes.

In 2020, alterations to the Kattegat shipping routes between Sweden and Denmark – for safety rather than environmental reasons – gave rise to the TANGO project, which investigated the soundscape and the impact of the changes on porpoise behaviour and distribution. Although TANGO reached the predictable conclusion that the changes led to commensurate increases and decreases in the sound pressure it provided further evidence that such changes should be assessed prior to implementation.

Elsewhere, the EU-backed SOUNDSCAPE project, an Italian-Croatian partnership, focused on the Northern Adriatic Sea ecosystem and concluded that while current levels with manageable to continue with a 'business as usual' approach – particularly given the trend towards vessel upscaling – was likely to prove hugely detrimental. At its conclusion in late 2021, the project published an extensive analysis of potential mitigation measures (environmental, technical, socio-economic, legal) and their feasibility.

SATURN itself is due to run until January 2025; while it's unlikely to prove the endgame in terms of concrete action in terms of URN, Sutton thinks success will be gauged by its ability to engage with shipping, increasing awareness and creating the scope for viable compromises. He cites the example of BC Ferries in Canada, which in 2018 set itself an ambitious target of reducing URN by 50% across its fleet, with URN performance requirements among the specifications for vessel procurement, as an example of a shipowner taking a proactive stance. There's nothing to stop European shipowners from becoming similarly engaged with SATURN. ■

**For more information visit: www.saturnh2020.eu**

# ALTERNATE FUELS

## EXPLORING ALTERNATIVES PICKS UP PACE

By **Malcolm Latarche**, Correspondent


MAERSK HAS ENTERED INTO SEVERAL AGREEMENTS TO PRODUCE GREEN METHANOL TO FUEL ITS FLEET OF METHANOL BURNING CONTAINER SHIPS

The advent of EEDI for newbuildings in 2013 drove a surge of interest in LNG as a fuel for all ship types, particularly as the impediment of bunkering infrastructure was gradually overcome. In early 2022, DNV stated that there were now 251 LNG-fuelled vessels in operation and 403 more on order.

But not without detractors. In early 2021, a report published by the World Bank suggested LNG was a dead end. The main criticism being that, as a fossil fuel, it could not be considered long term without conflicting with climate concerns over $CO_2$ levels. Pragmatists however argued than it was a less polluting option that fuel oil and, more to the point, viable alternatives were not then ready for commercialisation. A further boost came in 2022 when the EU accepted that LNG was a legitimate transitional fuel and gave it the green light for use on ships. Environmental groups were less than enthusiastic about the development, claiming that as many as one in four ships will be operating on LNG well into the 2040s.

LNG does significantly reduce $CO_2$ emissions compared to oil fuels, although by what percentage is a matter of debate (15-25% is usually quoted). However, methane slip is another source of greenhouse gas emissions and one which has arguably not been sufficiently researched. Wärtsilä, a pioneer in LNG burning four-stroke engines, claims to have virtually eliminated methane slip since it first began building dual-fuel engines at the turn of the century.

On the two-stroke engines, methane slip was considered more of a problem on Otto cycle engines than on diesel cycle units but both WinGD and MAN say that they have significantly reduced methane slip from their Otto cycle offerings to make it comparable to the higher pressure diesel engines.

In the summer of 2022, a report of a study led by Queen Mary University of London on GHG emissions from LNG carriers was released. In the study, undertaken in 2021, researchers measured emissions onboard *GasLog Galveston* on a roundtrip voyage from Corpus Christi, Texas, to Europe. This is said to be the first study to measure total methane and $CO_2$ emissions from LNG carriers. The vessel is fitted with WinGD dual-fuel main engines.

During the voyage, all sources of methane and $CO_2$ emissions including engine exhausts, venting and fugitive emissions were measured. The test results show that $CO_2$ emissions were lower than other studies have assumed, while venting and fugitive emissions of methane were also extremely low.

Methane slip from engine exhaust were in line with manufacturers' test data, but higher than other studies due to higher methane slip from the generator engines. It was suggested that one of the reasons for this is that on the voyage in question, the gensets were running at lower loads than is normally the case as for operational reasons more gensets than needed were being run. The study recommends installation of methane emissions monitors on engine exhausts to monitor and report more accurate methane emissions estimates and to support methane mitigation operational practices.

### Methanol

Engine makers have also been working on developing engines to operate on other fuels besides LNG as and when they became available. Methanol was already a contender having been in use since 2015 when the *Stena Germanica*'s was converted to run on it. Since then, MAN has developed methanol burning version of several engines in its range and these are distinguishable by the ME-LGIM suffix. It is engines from this range that make up the majority of methanol fuelled engines in operation, having been installed mostly in methanol carriers where fuel is drawn from the cargo.

Swiss engine designer WinGD has announced that its engines will be able to run on methanol from 2024. In September 2022, WinGD and Korean engine builder HSD Engine initiated a joint development project (JDP) to advance the development of WinGD's methanol-fuelled big-bore engines.

Under the JDP, WinGD will oversee combustion and injection research, exhaust aftertreatment requirements and engine concept design. HSD Engine will provide support on cost-effective manufacturing and assembly, provide engine testing capabilities and deliver fuel supply and exhaust aftertreatment systems. The JDP will focus on some of the largest engines in the WinGD portfolio, the X92 and X82. These engines will be suitable for the larger and ultra-large container ships in which WinGD sees rapidly growing interest in green methanol. Demand is also growing, albeit at a slower pace, in the bulk carrier and tanker segments.

J-ENG does not yet have plans for a methanol engine, but fellow Japan-based Hanshin Diesel has laid claim to be the first maker to produce a low-speed four-stroke engine able to run on methanol. The company is partnering with other Japanese organisations Mitsui O.S.K. Lines, MOL Coastal Shipping, Tabuchi Kaiun, Niihama Kaiun and Murakami Hide Shipbuilding in a strategic alliance aimed at reducing environmental impact through the development of a methanol-fuelled domestic tanker.

The vessel development project, which targets delivery of the ship in 2024, was also selected to receive public funding through the Japanese Ministry of Economy, Trade and Industry (METI) and Ministry of Land, Infrastructure, Transport and Tourism (MLIT).

No detail was released on the potential size of the vessel, but Hanshin's product portfolio includes three possible base engines for the project. All are six-cylinder models with a bore/stroke of either 320/680, 410/800 or 460/880. Power outs puts are 1,618kW, 2,647kW and 3,309kW respectively. Rpm ranges from 280rpm for the smallest engine to 220rpm for the largest. The engines are electronically controlled versions of earlier mechanical engines

Container ship operator Maersk has embraced methanol as a future fuel by ordering eight 16,000TEU methanol-fuelled containerships from Hyundai Heavy in 2021, with the order later increased to 12 vessels. The vessels are planned to be fitted with MAN ME-LGIM engines and will feature an unusual forward superstructure configuration that will increase cargo capacity as line of sight will not be obscured by cargo in front of the bridge.

Maersk will already have a methanol-fuelled 2,100TEU feeder ship in service when the first of the new 16,000TEU vessels is delivered. The feeder was ordered in 2021 and will feature a MAN B&W 6G50ME-LGIM main propulsion engine and will also be fitted with a pair of HiMSEN 6H32F-LM methanol burning gensets. These gensets will be the first methanol burning dual-fuel medium speed engines supplied by HiMSEN. Each engine is rated at 3,000kW at 720rpm.

In order to secure fuel for the vessel Maersk entered into an agreement with European Energy which will establish a new e-methanol facility in Denmark and provide renewable energy to fuel it. To boost the global production capacity of green methanol, Maersk has since made strategic partnerships with six leading companies with the intent of sourcing at least 730,000tonnes annually by the end of 2025. The six companies are CIMC ENRIC, European Energy, Green Technology Bank, Orsted, Proman, and WasteFuel.

A seventh agreement was made in August with Debo Energy in China. With this production capacity, by the end of 2025 at the latest, Maersk will reach well beyond the green methanol needed for the first 12 green container vessels currently on order.

Green or e-methanol is manufactured using a process whereby hydrogen produced by electrolysis using renewable energy is combined with biogenic $CO_2$. The process is thus considered carbon neutral even though combustion of methanol does produce $CO_2$.

## Ammonia

Ammonia is now touted as the most promising of future fuels as its combustion will produce no $CO_2$ apart from a small amount that may come from burning a pilot fuel. The race to bring ammonia burning engines to market is highly competitive but there are hurdles to overcome if it is to be accepted by ship operators.

The need for refrigeration is less of a problem now that LNG is becoming a mainstream fuel, but the unstable burning and lack of energy density are obstacles to its acceptance. Virtually all engine makers have accepted that the appeal of ammonia with regard to emissions means that they cannot afford to be left behind in developing engines that can run on it reliably and economically.

As a consequence, all are engaged in industry projects and seeking approval in principle (AiP) from classification societies for potential solutions. Many of the research projects have attracted funding on a national or regional level and there is a fair degree of cooperation across projects. While it is likely that ammonia burning engines will be available within a fairly short time span, it remains to be seen whether ammonia will replace any of the current fuels available.

A key factor for any fuel is whether or not it makes sense economically. Levies on carbon would be an immediate benefit for any fuel that reduces or eliminates $CO_2$ emissions, but the cost of e-fuels is often cited as a negative factor. Even with the recent rise in oil prices and an even sharper rise in natural gas costs, the alternative fuels cannot yet compete on price. The current economic conditions around the globe may well see operators committing to the cheapest fuels in order to survive.

In their favour could be technology advances that are already beginning to come to the fore. Just as scrubbers have allowed ships to continue to burn high sulphur fuels, reliable carbon capture technology could mean that continuing to burn fossil fuels will prove not only possible but also a very attractive proposition. ■

# ENVIRONMENTAL REGULATIONS

## TRADING BAN WARNING FOR SHIPOWNERS THAT MISS EEXI DEADLINE

By **Yuvraj Thakur**, vice president Commercial, Verifavia Shipping

Shipowners that fail to cut their vessels' carbon emissions to meet the Energy Efficiency Existing Index (EEXI) deadline of 1 January 2023 could face a bigger headache than partygoers waking up after a heavy New Year's Eve. Port detentions, fines and even trading bans are some of the likely consequences for maritime companies whose ships of 400gt or more produce greenhouse gas emissions that exceed the upcoming regulation.

With just a couple of months to go before the EEXI deadline, shipowners and operators have no time to waste. Even vessels built as recently as 2018 could be non-compliant – placing an even greater significance on the need to decarbonise. Those that drag their feet risk falling five to 10 years behind competitors who have made changes without delay after assessing their ships' energy efficiency.

The financial implications of negotiating long-term contracts with charterers presents another risk. A charter party agreement typically includes stipulations around the speed of a vessel and fuel consumption. For a lengthy agreement running to five years, a shipowner or operator could face an additional US$500 daily charge over that period, amounting to nearly US$1 million.

The challenge facing shipowners and operators is how to cut emissions to satisfy EEXI. Reducing engine power to slow the vessel down and limit its carbon output is perhaps one of the easiest methods, as lowering a typical merchant ship's speed by 10% can slash the $CO_2$ it generates by 27%. That is according to research by the Maritime Oslofjord Alliance, which also reveals a near 50% reduction in fuel consumption and emissions for a 14,000TEU containership that slows down from 15knots to 12knots. However, a crew should avoid taking their vessel below its optimum speed, which can have the adverse effect of increasing overall fuel consumption and carbon emissions.

Retrofitting clean technologies such as electric batteries, waste heat recovery systems, air lubrication technology and wind-assisted propulsion, or switching to low- or zero-carbon fuels are other actions maritime companies can take.

### Cutting emissions starts with calculating a vessel's carbon footprint

Understanding what steps to take is only possible if the shipowner or operator calculates the EEXI for their vessels. They must also prepare technical files detailing their carbon emissions and map out any actions required to lower their carbon footprint.

YUVRAJ THAKUR, VICE PRESIDENT COMMERCIAL AT VERIFAVIA SHIPPING

While the calculation can be done in-house, it is incredibly complex and arduous – which is why companies should always call in a specialist. Outsourcing the calculation and associated paperwork as the EEXI deadline looms larger in the ever-closing distance allows a shipping company's executives to focus on daily operations, giving them peace of mind that any compliance matters are being handled.

When acting for a shipping company, a specialist will collect and submit technical documents required for preparing the EEXI technical file. To start this process, paperwork covering a range of areas including the capacity plan, sea and shop trial report (for main and auxiliary engines), NOx technical file, certificate of registry, IAPP supplement certificate, EEDI technical file and IECC must be examined. Any necessary data not found in those documents can be gathered through other means such as statistical (conservative) estimates, computational fluid dynamics (CFD) simulations or, if necessary, sea trials.

Once all the relevant data has been gathered, it is applied to a formula from which the shipping company's EEXI is calculated and then compared to the International Maritime Organization's (IMO) required index reading. For vessels that do not comply, the owner/operator must make the necessary changes to improve their energy efficiency or face market barriers.

After the EEXI rules come into force on 1 January 2023, vessels have to be compliant before their next International Air Pollution Prevention survey or risk losing their licence to operate.

Given the potential operational and financial repercussions for non-compliance, some shipping companies have already employed an expert to start measuring their EEXI. This gives them time to see

which of the vessels in their fleet meet the criteria and whether others require an engine power limitation plan or design changes that can be carried out without disrupting the ship's schedule. However, making an accurate calculation and reliable recommendations for any necessary technical adjustments relies on having and assessing the correct information at the outset.

At the first annual or special survey after January 2023, a ship's efficiency will be compared against the EEXI benchmark set by the IMO. If the vessel makes the grade, the owner will receive an IEEC. If it fails, the owner has two options: make modifications to improve efficiency or risk an operating ban. An incorrect technical file will be sent back for amendments, leading to delays in completing the paperwork and putting the shipowner at risk of losing their operational licences.

For some shipowners and operators, the scale of the challenge is already clear. They recognise that it is essential to understand any gaps in meeting the requirements, as well as how to plug them, sooner rather than later. If vessels do not meet the requirements, an engine power limitation plan can be created and actioned, or energy efficiency technology installed within a timeframe that they control.

### Using the carbon intensity indicator to decarbonise shipping

The EEXI is part of the IMO's Greenhouse Gas (GHG) Strategy, which calls for the maritime industry to cut emissions globally by 40% by 2030 and 70% by 2050. Another aspect of the plan that shipowners and charterers must consider is the Carbon Intensity Indicator (CII), an operational index that can be calculated at the end of each calendar year.

The calculation, which applies to all cargo and cruise ships of 5,000gt or more, is made using information about a vessel's annual fuel consumption and distance travelled, which is gathered through the IMO Data Collection System.

During the 76th Marine Environment Protection Committee (MEPC 76) in July 2021, IMO members accepted CII and EEXI as measures for helping decarbonise shipping. Since then, they have agreed to revise the GHG Strategy, earmarking EEXI, CII and the Ship Energy Efficiency Management Plan (SEEMP) – an operational measure for improving a vessel's energy efficiency in a cost-effective manner – as short-term measures for steering maritime towards a greener future.

To comply with CII, which also becomes effective on 1 January 2023, a ship's actual annual operational carbon intensity rating must be documented and verified against the indicator's requirements. This determines the operational CII rating on a scale from A to E, showing the performance level, which is then recorded in a vessel's SEEMP.

AFTER THE EEXI RULES COME INTO FORCE VESSELS HAVE TO BE COMPLIANT BEFORE THEIR NEXT INTERNATIONAL AIR POLLUTION PREVENTION SURVEY OR RISK LOSING THEIR LICENCE TO OPERATE

A ship rated D for three consecutive years or E for one year must create a corrective action plan explaining how the required index of C or above will be achieved. The IMO has encouraged port authorities, governments and other stakeholders to offer incentives for ships with major superior A or superior B ratings. Meanwhile, leading cargo owners and charterers have strongly advocated the use of A- or B-rated vessels in their supply chains, offering them a competitive advantage over other operators.

As with EEXI, it pays to have a CII specialist onboard that can establish a shipowner's existing rating and help to make any necessary changes. In November 2021, Verifavia Shipping launched the world's first real-time Carbon Intensity Indicator Dashboard, allowing owners, operators and charterers of ships over 5,000gt to accurately measure a vessel's current and predictive CII rating.

The digital platform provides guidance for ship efficiency, generating data on the amount of carbon produced and, through the dashboard's calculator, insight into whether emission levels for a single voyage or reporting period meet industry regulation. Moreover, the dashboard's simulator can predict when vessels, and specific voyages, will comply with CII regulation, helping shipowners to simulate and plan for upcoming journeys. It also highlights areas where the vessel falls short of compliance and is required to meet carbon efficiency regulations.

With the January 2023 deadline for CII compliance fast approaching, shipowners and operators need a quick and cost-effective means of knowing how much carbon their vessels produce and the distance they travel each year. Using the dashboard enables them to do that and to anticipate any operational or vessel design changes that need to be made ahead of time.

The companies that dedicate time to addressing EEXI and CII right now will be far better placed to reap the financial and operational rewards once 2023 rolls round. Those that wait too long to act face a regulatory headache, which could cost them dear. ■

# LETTERS TO THE EDITOR

## ENVIRONMENTALISM, ECONOMICS... AND HEDONISM

ROMAN ABRAMOVICH'S 164M SUPERYACHT *ECLIPSE*, BUILT BY BLOHM+VOSS OF HAMBURG. SOURCE: SHUTTERSTOCK

Dear Sir,

I was delighted to read your editorial 'Environmentalism or Economics' in the September 2022 edition of *The Naval Architect* [which] reflects the dilemma that is facing all individuals and economic entities alike. I would like to share with you a few of my thoughts on the subject.

I too have a certain sympathy for Prof Roar Adland's statement that the best use of HFO is to use it as fuel in large ships, along with post-combustion treatment and recovery of pollutants and GHGs. After all, we are still going to need crude oil to process into other types of products for many years to come.

I was interested to read that the IMO is currently preparing its Life Cycle Assessment, but its assessment should not be limited to the choice of fuel, as important as it is. It should also assess the environmental performance of the whole fleet against the overall marine transport capability. Based on its development and implementation of the EEDI, and the nature of the shipping industry, I do believe that much can be accomplished.

You are absolutely right, the 'proverbial elephant in the room', namely that the shipping industry got exactly what it asked for, in what is now the IMO GHG strategy, is not as effective as it could be. But where were the naval architects when all this happened? Why was the naval architects' expertise not called upon, or more to the point why did naval architects, and RINA in particular, not become the noisy bearing that received the most grease, to come up with better solutions for addressing the issue? After all, this should be our specialist area.

I have long followed the development of MARPOL Annex VI and seen how it has evolved from addressing air pollutants to including GHGs. The development of the EEDI has been of special interest to me, and was entirely predictable that there would be shortcomings, since the methodology does not follow proven architectural principles. Also, it represents the latest embodiment in an ongoing concern I have regarding the design of ships in general.

During the 1970s I was working as a naval architect in the Technical Services Division of P&O Steam Navigation Company. This was a period when computerisation in ship design was just beginning, and which allowed techno-economic modelling of alternative ship designs to be evaluated and hence optimisation achieved. These developments were initially undertaken by universities and research institutions and built on much of the work of Ian Buxton in the UK and Harry Benford in the USA, and others, who have been my naval architectural heroes.

With my keen interest in preliminary ship design I was requested to undertake a project to evaluate these techniques to see how they might be applied within the P&O Group. I saw early on that they relied upon all the principal players sharing their information, if the most economic ship design for a particular transportation capability, was to be produced. But this sharing of information would never happen! Even within P&O there was a reluctance for the operational units within the Group to share its information and experience with the naval architects or know how they derived the design parameters that they set for the ship that they required. There was also a reluctance for marine engineers within TSD to share information with fellow naval architects. The project went nowhere but the general findings were not shared either within P&O or elsewhere. As far as I could assess, ships continued to be designed, contracted,

built and operated as they always had been, with some marginal improvements along the way.

## Stalled progress

However, with the development of EEDI I was hoping that those techniques developed in the 1970s would be resurrected, brought up to date, and adopted in the 2010s, but it is not obvious that this has happened. RINA held its International Conference on the 'Influence of EEDI on Ship Design' in 2014, which I did not attend and have not seen the papers or the discussion that ensued. But in many respects, it should have been entitled 'Expected Influence of EEDI on Ship Design' to be followed up with another Conference entitled 'Actual Influence of EEDI on Ship Design and Contracting'. I hope that later happens soon.

It would appear that it has not been too difficult to reduce the EEDI of the existing reference fleet of ships by 10% in the first phase, and I predict that reaching the 20% and later the 30% level need not be too challenging either. Ships designed, built and in operation in the period prior to 2013 were so inherently inefficient that most could easily be improved upon. Some reduction in EEDI has come from improvements in the combustion technology of diesel engines, to reduce their fuel consumption and hence emissions, but the overall design of ships appears not to have changed very much. I suggest that what happened from the 1970s onwards is that as engines of a particular physical size and weight increased in power, so that the cost of power got cheaper, allowing the fullness (block coefficient) of ships to be increased, to increase carrying capacity. This created ships that were in effect overdriven, compared with the traditional designs of the 1930s, 40s, 50s and 60s.

So why did the shipbuilders produce, and the ship owners purchase, such inefficient ships in the past 40 years? The short answer, I believe, is that everyone in the overall ship supply and operation chain was optimising their own contribution to that chain in order maximise their own profits. They were in effect in competition with their customers and suppliers in the chain, as much as with alternative operators and suppliers able to make the same or similar contributions. When all the individual contributions were added together, they did not produce the most economical ship design or transport capability. The people making these purchasing decisions never considered the overall situation; they were too busy competing, and naval architects never spoke up! The market has been truly dysfunctional and is now seen to be even more so when environmentalism is to be incorporated. Ships are being designed once again to satisfy a rule, but the EEDI/EEXI rule that is unsound.

To some extent, the EEDI initiative could have introduced some rationalisation into the ship design process and could have addressed these shortcomings in the procurement and operational chain, but old habits die hard in the maritime industry. Instead, it seems to have become yet another regulator requirement to be satisfied at minimum cost.

## Too specific?

I also found the inclusion of Edwin Pang's more detailed comments most interesting but the use of a fixed value within the EEDI and EEXI calculation for the specific fuel consumption of the diesel propulsion and generator engines is extremely inappropriate and leads to erroneous and misleading results in the calculation of these indexes and in verification. The specific fuel consumption (SFC) of an engine is a variable that will change over the whole operating range of the engine. There was a time when all the engine manufacturers published a diagram showing the maximum power and/or torque of their engines over the full RPM operating range of the engine, together with lines of constant SFC, sometimes referred to as a 'fuel consumption map' but rarely do so now. It was possible to compare the SFC of one engine against another and allow the determination of the SFC at any engine loading, i.e. any power/RPM combination, which along with propeller charts and hull resistance data could be used to calculate with some degree of accuracy the fuel consumption at any ship speed and displacement.

As an apprentice in the late 1960s and early 70s I was designing propellers, both fixed and variable pitch, and Kort nozzles for Kort Propulsion Company Ltd. Not only did this involve designing them to fulfil a particular design condition, either maximum bollard pull, maximum thrust at a particular towing speed or rarely a free running maximum ship speed, but intended owners also requested an estimate of the performance at various off-design conditions, including fuel consumption. It taught me about the interaction and relationship between engine, propeller and hull efficiency, and that overall efficiency, as reflected in actual fuel consumed, was determined through a combination of all these elements and not an optimisation of any one of them.

The easiest way to reduce the EEDI of a ship is to reduce its speed, but in doing so it reduces shipping capacity, with more ships having to be built, that will also create additional emissions. The IMO has set global targets for reducing $CO_2$ (but not NOx, which is also a GHG) but is addressing it by regulating individual ships. Something does not seem quite right.

I was interested to read the reference made to Frederik Hammer Berthelson's paper and that '*contrary to accepted wisdom, .... power is proportional to (at least) speed cubed .....*'. This cube relationship is not generally born out in practice – I could have told Mr Berthelson that from my work in the 1970s! But why is the 'accepted wisdom' so wrong and why has it gone unchallenged? It is also made worse because the assumption is that fuel consumption is directly proportional to the power generated by the engine(s). Instead, it has been allowed to be incorporated into the EEDI and EEXI methodology. The published IMO papers only contain the results of the work of its committees and plenary sessions, so it is not possible to see exactly what was said. One really needs to be in the room to find out.

As a student of naval architecture, I was always highly suspicious of the Admiralty Coefficient and the cube law. But the cube law is beloved by marine engine builders to make their lives easier, because they do not care to know about the intricacies of resistance and propulsion, ship design and propeller design. That is someone else's responsibility. If fuel consumption is incorporated

into the technical data supplied by engine builders, it is inevitably based on the cube law. However, it does have some limited relevancy to slow speed vessels of the type built prior to 1940 that operate in a speed range where Circular C is constant and QPC and SFC are constant, but elsewhere the cube law does not generally apply.

### Lessons learned

However, I think I might challenge your statement that '*vessel performance is an emerging [or nascent] science*'. It is a well-established science that has simply been ignored by many in the maritime industry over many years, and which others in the industry are not aware of. Of course, as time goes on, we all acquire new knowledge, and modern methods provide increased accuracy, but we should not discount the lessons learned from the past. So how has all this come about? I suggest that this is of our own making, and when referring to 'our' I mean naval architects themselves and the professional institutions that are supposed to represents them within the wider industry and society.

There is no doubt that the IMO's GHG Strategy will go some way towards reducing the quantity of harmful emissions produced by certain types of ships, but, in my view, it falls far short of what could have been achieved. Adopting the groupthink of the maritime industry, principally the ship owning community, shows up the weakness in knowledge and insight that exists within that community, and maybe in others.

It has always been my understanding that naval architects have a dual role. They are required to be knowledgeable in certain specialist areas of technology, as well as being the integrator of the technologies of other engineering disciplines incorporated into any ship design. I might also add that they have a role in establishing the aesthetics of any ship design. But over time, the industry and the public has come to regard naval architects only in their technology role and not as integrators or designers.

There is a marked contrast within industry and the general public between 'architects' and 'naval architects' which is encased within UK law, namely the Architects (Registration) Acts of 1931 to 1938, as replaced and amended by the Architects Act of 1997. It makes it clear that 'architect' is a restricted title, but anyone can call themselves a 'naval architect, whether trained, qualified and registered as a member of a professional institution, or not.

History has determined the present-day role and status of a naval architect, in the maritime industry and in the public perception. Unlike on major buildings, the name of the naval architect is not inscribed on the ship. Past RINA Councils could have done something about it, but if they did, they were not successful. Equally, the naval architecture educational establishments appear not to have educated naval architectural students in this integrator role once they take up employment. Instead, the education establishments aim to provide students with just excellence in the specialist areas that they think they will need in employment. They teach them about the different trees but not about the forest.

So, with naval architects no longer having that integrator or leadership role, it is no wonder that others with less relevant skills have come in and filled that space and allowed the EEDI and EEXI to be in the poor state that they are.

### The problem of leisure

There may be a third aspect that might be considered alongside environmentalism and economics. I have felt uncertain how best to define it but the word that sprang to mind is 'hedonism'. Why is it relevant here?

There is no doubt that individually and collectively we all benefit from world maritime transportation. The ability to cheaply transport raw and processed materials and manufactured goods from where they are extracted, processed and manufactured to where they are consumed, is essential in a modern world. We also need maritime transportation to transport people in order to support this primary need. However, to what extent should marine transportation, in the form of cruises and excursions, exist purely for pleasure? I have a son and his family living in New York City that I like to visit. Should I take the *Queen Mary 2* or the aeroplane to cross the Atlantic from the UK? Using the *QM2* is my preference but I do not have the information to know which is the least environmentally damaging.

In 2014, after retiring, I placed an order to have a motorboat built by a reputable UK boar builder, which was of a standard hull/deck design but fitted out internally to my own specification, which included the choice of engines, gearboxes and propellers. The powertrain was selected so as to be the most efficient available at the time. In 2019, I was diagnosed with a rare, slow developing form of blood cancer, which was then followed by lockdown due to the Covid pandemic. This regretfully resulted in me selling the boat in 2020. However, this was my first major experience of the UK recreational craft industry.

If commercial shipbuilding and ownership was seen to be lacking in relation to reducing emissions, as reflected in the development of EEDI and EEXI at IMO, the situation in the recreational craft industry and boat owners was found to be far worse! The standard BMF newbuild contract, for vessels up to 24m in length, does not provide the customer with any guarantee of lightweight/deadweight/displacement, minimum boat speed or maximum fuel consumption, and hence with no penalties for underperformance. The only thing that is guaranteed is that everything will work.

In addressing these issues to various players within the industry with a view of taking steps to reduce the emissions from recreational craft, such as boat owners' representatives (the RYA), trade associations (BMF), brokers, journalists, academics, and including RINA, I have been met with a wall of disinterest. In discussions with boat owners themselves, the prevailing attitude is that they have no concerns about the emissions that their craft produce and will continue using their boats in such a way as to give them pleasure. The only thing they complain about is the price of fuel, and not how much of it they use.

The amount of fuel consumed by the recreational craft sector is quite small compared with that consumed by

the commercial maritime industry. Nonetheless, this is an example of the prevailing attitudes that must be overcome if society is to have any chance of hitting the 2050 target.

Do the owners of superyachts, who have all the financial advantages of offshore incorporation, and hiding behind a veil of commercial operation, care too much about emissions? There is little evidence that they do, when the aim of a new superyacht build would appear to be to be bigger and look better those other designs. They would appear to be able to afford to indulge themselves in this manner. These owners compete socially to outdo each other, and they appear, with a few notable exceptions, not to compete on environmental performance. At the present time I see very little altruism or parsimony in this world.

In July 2019 the UK government initiated a call for evidence regarding domestic shipping air pollution. Although I contributed to this consultation, but the report has yet to be published.

During this period of the Covid pandemic both the recreational craft and superyacht industries have experienced substantial growth in the number and size of new boats that have been built, thus enlarging what will become the legacy fleet. But I find it interesting to note that it is the 'designer' who is given status on these superyacht projects, followed by the 'stylist' who determines the overall outside appearance of the vessel, and the 'interior designer' who designs the interior and yet maybe more familiar with the interiors of buildings. The 'naval architect' is usually mentioned in the new building project, but their involvement is limited to the underwater design of the vessel and meeting statutory requirements, which has little interest for the owners and the public at large, who only maintain a subjective interest.

However, my experience from commercial shipping and especially recreational boating, is an example of how IMO, governments, industry and the world's civil society appears not to be actively addressing all the threats imposed by climate change, and this does not bode well for the future. In 2050 I shall be 101, and probably not here to see whether the IMO GHG Strategy has been successful, so maybe I should not care too much about what happens next, but I do have three sons and four grandchildren and remain concerned for them.

I hope that you do not consider the above to be the ramblings of just another boring old naval architect. I have seen much change during my working life and beyond, but I hope the above might generate some enthusiasm, from people far more capable than me, to take up the mantle on various issues mentioned above. ■

**Jan van der Schans**
LIFE MEMBER

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**Presented by:**

Jorge Porres, Director of Technology and Supply Chain, BlueFloat Energy

As Director of Technology and Supply Chain at BlueFloat Energy, Jorge Porres is responsible for analyzing various floating technologies and assessing their suitability for each of BlueFloat Energy's projects under development. Jorge is also responsible for evaluating the supply chain, taking into consideration potential risks and opportunities.

**www.rina.org.uk/Presidents_Invitation_Lecture_2022**

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Keynote speakers:

- Claus W Graugaard, Head of Onboard Vessel Solutions, Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping
- Torben Nørgaard, Head of Energy and Fuels, Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping
- Octavi Sadó Garriga, Ship Design Manager, Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping

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The RINA has established an excellent reputation for producing Technical Magazines, Conference Proceedings and Transactions of the highest quality covering all aspects of naval architecture and the maritime industry in general.

Founded in 1860, THE ROYAL INSTITUTION OF NAVAL ARCHITECTS is an internationally renowned professional institution whose members are involved at all levels in the design, construction, repair and management of ships, boats and marine structures. The Institution has over 9,000 Members in over 90 countries, and is widely represented in industry, universities and maritime organisations. Membership is open to those qualified in naval architecture, or who are involved or interested in the maritime industry. Membership demonstrates the achievement of internationally recognised standards of professional competence. The Institution publishes a range of technical journals, books and papers, and organises an extensive programme of conferences, seminars and training courses covering all aspects of naval architecture and maritime technology.

## MAGAZINES

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- Regular reports on centres of shipbuilding activity worldwide.
- Comprehensive, technical descriptions of the latest new buildings.
- News, views, rules & regulations, technology, CAD/CAM, innovations.

### SHIP & BOAT INTERNATIONAL

- In depth coverage of small craft/small ship design, building & technology.
- Specialist sections include: fast ferries, tugs, salvage & offshore,patrol & paramilitary craft, coastal & inland waterway vessels, pilot boats, propulsion and transmissions.
- Advances in construction materials, electronics, marine equipment.
- Contract news and the latest market developments.

### SHIPREPAIR & MAINTENANCE

- In depth coverage of all aspects of shiprepair and conversion work and comprehensive technical descriptions of major conversion projects.
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- Contract news, appointments, industry views, new regulations.

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## TRANSACTIONS

### INTERNATIONAL JOURNAL OF MARITIME ENGINEERING (IJME)

Now published by and only available to purchase through The University of Buckingham Press:
(https://www.scienceopen.com/collection/UBP_IJME)

Published in March, June, September and December, the IJME provides a forum for the reporting and discussion of technical and scientific issues associated with the design, construction and operation of marine vessels & offshore structures.

FOR MORE INFORMATION ON CONFERENCE PROCEEDINGS OR A FULL PUBLICATIONS CATALOGUE, PLEASE CONTACT THE PUBLICATIONS DEPARTMENT ON:
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**PRESIDENT'S INVITATION LECTURE**
RINA event
London, UK

NOVEMBER 22-24 2022
**BIOFOULING 2022**
RINA workshop
London, UK

NOVEMBER 29 - DECEMBER 1, 2022
**SCALING DECARBONISATION SOLUTIONS - REDUCING EMISSIONS BY 2030**
RINA conference
Rotterdam, Netherlands

MARCH 14-17, 2023
**CONTRACT MANAGEMENT**
RINA training course
Online

JUNE 13-16, 2023
**DRY DOCK TRAINING 2023**
RINA training course
London, UK

For more information please visit:
**www.rina.org.uk/RINA_Events**

OCTOBER 17-21, 2022
**7TH SYMPOSIUM ON MARINE PROPULSORS (SMP)**
International symposium
Wuxi, China
www.smp2021.com

OCTOBER 17-21, 2022
**TECHNICAL COOPERATION COMMITTEE**
IMO meeting
London/Online
www.imo.org

OCTOBER 18-21, 2022
**EURONAVAL**
International exhibition
Paris Le Bourget, France
www.euronaval.fr

OCTOBER 20-21, 2022
**DESIGN & ANALYSIS OF FLOATING WIND TURBINE STRUCTURES**
Course
Online
https://asranet.co.uk/

NOVEMBER 2-11, 2022
**MARITIME SAFETY COMMITTEE (MSC)**
IMO meeting
London/Online
www.imo.org

NOVEMBER 9-10, 2022
**DYNAMICS OF FIXED OFFSHORE STRUCTURES**
Course
Online
https://asranet.co.uk/

NOVEMBER 21-22, 2022
**DESIGN OF SHIP STRUCTURES**
Course
Online
https://asranet.co.uk/

NOVEMBER 28 – DECEMBER 2, 2022
**IMO COUNCIL**
International forum
London/Online
www.imo.org

DECEMBER 6-7, 2022
**FLOATING OFFSHORE STRUCTURES**
Course
Online
https://asranet.co.uk/

DECEMBER 8-9, 2022
**FINITE ELEMENT FOR MARINE STRUCTURES**
Course
Online
https://asranet.co.uk/

DECEMBER 12-16, 2022
**MARINE ENVIRONMENT PROTECTION COMMITTEE (MEPC)**
IMO meeting
London/Online
www.imo.org

## 2023

APRIL 25-27, 2023
**SEA ASIA**
International exhibition
Singapore
www.sea-asia.com

MAY 31 – JUNE 9, 2023
**MARITIME SAFETY COMMITTEE (MSC)**
IMO meeting
London/Online
www.imo.org

JUNE 5-9, 2023
**NOR-SHIPPING**
International exhibition
Oslo, Norway
www.nor-shipping.com

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