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SHORE POWER CONSULTATION IS A POSITIVE STEP, BUT NO VOTE OF CONFIDENCE

By **Richard Halfhide**

You could be forgiven for not being aware – and apologies to our international readers if this Editorial Comment is somewhat parochial – but on the morning of 31 January, hours before blustering his way through his statement to Parliament in response to Sue Gray's report into lockdown parties at Downing Street, British Prime Minister Boris Johnson could be seen careering around Tilbury Docks, Essex, in a forklift. He was officially there to open Tilbury2, the UK's largest freight ferry terminal and proclaimed by Johnson as a symbol of the new opportunities created by post-Brexit Britain. Not to mention a photo opportunity that probably didn't prove as much of a distraction as he would have liked.

The PM has never been coy about his grand ambitions of revitalising the British maritime industry, but thus far it has seldom been channelled into meaningful action. Last year, many will recall his plans to build a new £200 million 'national flagship', which drew a predictably cool response but hitherto no further developments. Elsewhere, recent Government efforts to stimulate British maritime are best described as modest. A week after Boris's Tilbury jaunt, the Ministry of Transport announced the Government's plans to explore shore power as a means of accelerating maritime decarbonisation.

'Vessels could one day plug into onshore power sources while berthed, lowering emissions' proclaimed the bullet point at the top of the press release on the gov.uk website, followed by 'Maritime Minister Robert Courts launches call for evidence to gather information on shore power's benefits for the shipping sector'. I couldn't help conjuring an image of a bored civil servant somewhere in Whitehall typing those words while they idly browsed the Situations Vacant and hoped the recent wave of resignations might create an opportunity for career advancement.

Mr Courts' speech was formally delivered at the UK Chamber of Shipping's annual dinner, with the consultation running until the end of April 2022. The minister also took the opportunity for some virtue signalling by highlighting that Britain is one of the few countries in the world to have a Clean Maritime Demonstration Competition (CMDC), which was launched last year and has awarded funds to, among others, the Dover Clean Ferry Power (DCFP) project currently exploring viable scenarios to electrify channel crossing ferries (see *TNA*, Nov/Dec 2021).

When it comes to decarbonising shipping then, the electrification of ports and facilitation of cold ironing is a no brainer, but to date there's been a disappointing amount of prevarication.

Nearly two years ago, in May 2020, the British Ports Association (BPA) published its report 'Examining the Barriers to Shore Power', a technology-agnostic study that there were significant barriers to implementation of shore power in the UK. Of these, it noted the primary barrier was capital costs and that no shore power project anywhere in the world had been undertaken without public support, stressing the need for a green maritime fund to support the development of shore power.

ROBERT COURTS HAS SERVED AS THE UK'S MARITIME MINISTER SINCE 2020

So far the extent of the government's commitment has been a paltry £23 million for the aforementioned CMDC. This is compared to the £3.8 billion cost of the Crossrail development or £100 billion spent on the HS2 high-speed railway; both projects whose value has been open to question. It's hardly surprising that shipping is the poor relation here, it's simply not enough of a vote winner, but the disparity in funding is laughable.

There is perhaps an expectation that the private sector will fill the void, something that happened with Tilbury2, but probably shouldn't be counted upon. While the UK isn't unique in grappling with the challenge of port modernisation, neither is there the support structure previously offered by the EU. Moreover, the BPA report notes the price of electricity is significantly higher than in countries where shore power is provided, something that's obviously been further exacerbated in the two years since 2020.

The final problem is, of course, the ships themselves and the chicken and egg paradox of justifying investment in electrifying ports without the confidence of having ships that require shoreside power, which in turn won't electrify without the assurance of being able to charge. If the DCFP can deliver on its long-term ambition to electrify Dover it will mark an important proof of concept, and P&O's commitment is clear in its order of two diesel-electric ferries for the Dover-Calais route due for launch next year.

However, the key will be clearly incentivising other shipowners to make the same investments in emissions abatement technologies. If nothing else, perhaps we might at least hope the current consultation comes up with some viable suggestions. ■

NEWS

AUTONOMOUS SHIPS

ONESEA APPOINTMENT ADVANCES AUTONOMOUS AGENDA

CAPT. MARKO RAHIKAINEN, ECOSYSTEM LEAD, ONESEA

OneSea, the industry alliance aiming to establish the first autonomous maritime ecosystem by 2025, has appointed Captain Marko Rahikainen as ecosystem lead.

Rahikainen brings with him a wealth of maritime and maritime administration experience, with a particular focus on safety, security and facilitation, according to OneSea.

During his early career at sea, Rahikainen gained practical shipping experience working onboard different ship types. He joined the Finnish Maritime Administration in 2003 as maritime inspector, and from 2010 he was employed by the Finnish Transport and Communications Agency, Traficom.

Amongst other duties, Rahikainen was the Representative of Finland to the EU Committee of Safe Seas from 2011-2019 and was heavily involved in the work to introduce Maritime Autonomous Surface Ships (MASS) at IMO level.

Senior ecosystem lead Päivi Haikkola says: "I am delighted to welcome Marko to the OneSea team. Regulatory work will remain a primary focus for OneSea in 2022 as the need to develop and agree an internationally acceptable framework for autonomous ship operations intensifies. There are many benefits to using autonomous technologies onboard, and regulatory oversight is key to ensuring that their ability to enhance safe ship operations is fully realised. Marko's regulatory expertise and involvement in MASS development will prove invaluable to this process."

Rahikainen says: "I look forward to working with OneSea members, industry partners and the IMO in developing regulatory guidelines for MASS operations and helping to achieve OneSea's autonomous shipping ambitions."

LNG

BRITTANY FERRIES' LNG-FUELLED NEWBUILD CLASSED

Brittany Ferries' new LNG-fuelled *Salamanca* cruise ferry has entered Bureau Veritas (BV) classification.

Built at China Merchants Jinling in Weihai, China, the 1,015-passenger ferry will enter service in March 2022, operating between Portsmouth, in the UK, and the ports of Bilbao and Santander in Northern Spain.

The 214.5m vessel is the second 'E-Flexer' to enter service with Brittany Ferries – sister ship *Galicia* joined the fleet in December 2020 – and the first to be fuelled by LNG.

THE *SALAMANCA*

The vessel is equipped with twin Wärtsilä 12V46DF (dual-fuelled) engines, each generating 13,740kW, and features a fuel-efficient design that includes a long, slender hull and bow, as well fine lines for providing improved seakeeping in all weathers.

The ferry will be supplied with LNG in the ports of Bilbao and Santander, enabling round trips between Spain and Portsmouth.

Brittany Ferries plans to deploy three more LNG-fuelled vessels in the coming years: *Santoña* will join the fleet in 2023 on the Portsmouth-Santander-Bilbao route, and two hybrid LNG-electric ships will enter service between France and the UK in time for the 2025 season.

Bruno Dabouis, VP Southern Europe, North Africa and North America at Bureau Veritas Marine & Offshore, says: "We are proud to partner with Brittany Ferries as an environmental frontrunner, and we are looking forward to supporting *Salamanca*'s operational life on the route across the Bay of Biscay from the United Kingdom to Spain, Brittany Ferries' longest route."

SHIPBUILDING

LLOYD WERFT'S FUTURE HANGS IN THE BALANCE

The provisional insolvency administrators responsible for the future of the Bremerhaven, Germany-based shipyard Lloyd Werft are working to secure the long-term future of the site.

Christoph Morgen for the owning company and Per Hendrik Heerma for the operating company say the common goal is to achieve the best possible purchase price for the owning company and to secure as many jobs as possible for the operating company.

Lloyd Werft, which was founded in 1857, filed for bankruptcy on 10 January, along with MV Werften in Mecklenburg-Western Pomerania. Both are owned by Genting Hong Kong. Genting's cruise division has been in financial difficulty as a result of the Covid-19 pandemic.

The filing will impact more than 300 employees currently working at Lloyd Werft.

"We want to secure the long-term future of the site. The site is designated as a shipyard, and Lloyd Werft is efficient," says Morgen.

The shipyard, acquired by Genting in 2015, is a key cruise ship drydock. In recent years its focus has been increasingly on building luxury yachts (the build of the 139m superyacht *Solaris* was completed in 2021), however it has also received a large number of contracts for regular docking as well as upgrades and interior conversions of cruise vessels.

PER HENDRIK HEERMA (LEFT) AND DR CHRISTOPH MORGEN AT THE LLOYD WERFT SHIPYARD IN BREMERHAVEN. SOURCE: LLOYD WERFT/SCHEER

There have been several rumoured parties interested in the shipyard, with Bremerhaven-based steel and shipbuilding group Rönner the most recent to express interest, according to media reports in Germany.

CONTAINERS

CONTAINER LOGISTICS INDUSTRY DOWNBEAT ON YEAR AHEAD

JOHANNES SCHLINGMEIER, CO-FOUNDER AND CEO OF CONTAINER XCHANGE

An already-strained ocean freight logistics sector looks set for a bumpy start to the first quarter of 2022 with Chinese ports operating at low capacity as a result of Chinese New Year celebrations, according to the latest Container Logistics Report from container trading and leasing tech company Container xChange.

Johannes Schlingmeier, co-founder and CEO of Container xChange, says the added disruption of the Omicron variant, with some major ports, including Ningbo, facing lockdowns, is likely to fuel the volatility.

Another event for the sector to make note of is the Winter Olympics being hosted in Beijing throughout February.

"Schedule reliability and vessel capacity will continue to pinch a little harder than the previous usual years pre-pandemic. In the aftermath of all the disruptions caused in during the past 21 months, it is important to work much in advance, book containers and plan journeys," the report warns.

The report also includes results of a global survey that shows that majority of the container logistics industry (75%) is rethinking its logistics strategy in the year ahead.

The survey, released to 800 container logistics players, indicates that the industry is downbeat about the supply chain performance in 2022. Out of the total respondents, 65% said that the performance will either deteriorate further (11%) or remain the same (54%) in 2022. The top challenges for the industry remained finding a spot on the vessel and surcharges by carriers. One-way leasing emerged as the most sought-after alternative as compared to getting equipment from the carriers.

IN BRIEF

ALTERNATIVE FUELS

DNV TO LEAD AMMONIA STUDY

The Global Centre for Maritime Decarbonisation (GCMD) has selected DNV to lead a study on ammonia bunkering safety in Singapore. The classification society will team up with Singaporean infrastructure developer Surbana Jurong and the Singapore Maritime Academy to develop a new set of safety guidelines and operational envelopes that will establish the basis of a regulatory 'sandbox' for ammonia bunkering trials at two local sites. "With Singapore being a population dense island nation and a major bunkering hub, the stringent guidelines developed in this study will likely be extensible to ports elsewhere," says Lynn Loo, CEO of GCMD.

WIND PROPULSION

IMO GRANTS IWSA CONSULTATIVE STATUS

The International Maritime Organization (IMO) has formally granted full consultative status to the International Windship Association (IWSA) in its first consultative status intake since 2019. "This is of course an important step for our organisation, but also recognition by IMO that the wind propulsion technology segment is an important one in the drive to decarbonise the shipping industry," says IWSA secretary-general Gavin Allwright.

AUTONOMOUS SHIPS

AVIKUS AND ABS TRIAL AUTONOMOUS TECH

Hyundai Heavy Industries (HHI) Group subsidiary Avikus has entered a memorandum of understanding (MoU) with the American Bureau of Shipping (ABS) to obtain the Approval in Principle (AiP) for the implementation of autonomous ship capabilities. The MoU was signed at the CES 2022 tech show in Las Vegas, US, and will see the two parties collaborate on real-life trials for autonomous ship technologies in compliance with the ABS Guide for Autonomous and Remote Control Functions published in July 2021.

ALTERNATIVE FUELS

BP AND MAERSK TANKERS TRIAL 'DROP-IN' BIOFUEL

BP and Maersk Tankers have successfully completed trials using biofuel-blended marine fuel in product tankers.

The trials, held to demonstrate that sustainable biofuels can be used as a marine 'drop-in fuel' to help reduce carbon emissions in shipping, were completed on *Maersk Cirrus* and *Maersk Navigator* – product tankers on time-charter to BP from Maersk Tankers.

Each vessel was supplied with BP Marine B30 biofuel, consisting of 30% fatty acid methyl esters (FAME) blended with very low sulphur fuel oil (VLSFO).

FAME is a renewable alternative fuel largely produced from recycled cooking oils and renewable oil sources, according to BP. It has physical properties similar to conventional diesel, and is also non-toxic and biodegradable, the company says.

The trials saw the vessels sail from Rotterdam to West Africa. Throughout the trials, tests were carried out to assess the reliability and performance of the B30 biofuel blend in each ship's main engine, auxiliary engine and boiler, and any impact on fuel tanks to determine the level of interchangeability with other fuel types.

BP says that no modifications to the engine or infrastructure were required and that no adverse effects to equipment or machinery were observed during or after the trials, demonstrating the suitability of sustainable biofuels for use as a drop in fuel.

BP aims to regularly supply biofuel blends for its operated and time-charter vessels when they refuel in the Netherlands, subject to owners and flag state approval.

SOURCE: MAERSK TANKERS

ALTERNATIVE FUELS

MOL COMPLETES CONCEPT STUDY FOR AMMONIA FSRU

Japan's Mitsui OSK Lines (MOL) and Mitsubishi Shipbuilding have completed a concept study on floating storage and regasification unit (FSRU) for ammonia fuel.

The two parties have now entered a memorandum of understanding (MoU) with Kansai Electric Power to conduct a study to introduce the ammonia FSRU, which they see as a major step in adopting ammonia as clean energy.

"Currently, the maritime transport volume of ammonia is limited as it is mainly used as a raw material for fertiliser. However, it is drawing global attention as a next-generation clean energy source that emits no CO_2 during combustion. Strategic moves to adopt ammonia as an alternative fuel are underway around the world," explains MOL.

Conventionally, FSRUs are used as floating facilities that receive LNG offshore for storage, regasify it onboard, and send it to shore. It offers the advantages of shorter construction time and lower costs in comparison to construction of onshore storage tanks and regasification plants. MOL says it believes their use will speed up the adoption of ammonia fuel and contribute to its wider use as a lower-environmental-impact next-generation fuel.

In the concept study, the team examined specifications of several cases with different conditions such as tank size and regasification method to meet a broad range of needs. In addition, the team developed a design concept of a lower environmental impact FSRU that would be powered by electricity generated with ammonia fuel.

The newly signed MoU will look at introducing ammonia FSRUs in various regions of the world.

In November 2021 MOL announced plans to develop a large-size ammonia carrier that will operate on ammonia fuel.

AMMONIA TRANSPORT VESSEL AND AMMONIA FSRU. SOURCE MOL

NEWS ANALYSIS

DECARBONISATION – OPPORTUNITIES AND CHALLENGES

By **Malcolm Latarche**, Correspondent

LNG CARRIERS ARE IN GROWING DEMAND. SOURCE: NAKILAT

A winter of discontent around energy costs – especially in Europe – has yet to translate into a potential walk back by politicians from the march to decarbonise every aspect of industrial and domestic life, but the disconnect between aspirations and actuality is getting more visible.

The lack of power generated by Europe's growing array of wind farms, coupled with low stocks of natural gas would have been enough of a problem on its own. But it has been exacerbated by tensions with Russia over Ukraine which has delayed opening of the Nord Stream 2 pipeline and posed questions over future supplies from pipelines running through Ukraine.

With Asia in general and China, India and Japan demanding more fossil fuels than ever as the wake up from the Covid pandemic gets underway, the prices of oil, gas and coal are on the way up. High demand should promise plenty of work for tankers, LNG carriers and bulkers although there are some obstacles.

Indonesia, the world's second largest exporter after Australia, ended 2021 with domestic coal stocks at worrying lows, causing the country's government to ban coal exports until stocks were replenished. Major importers of Indonesia coal include all of Asia's major economies. Coal was not the only commodity that the Indonesian government restricted exports of, with nickel ore, LNG and palm oil also being affected.

On the newbuilding front, shipowners across all sectors other than containers appear to be holding back, doubtless because of the regulatory arena and the development of new fuels. There has been no shortage of approvals for ammonia- or methanol-fuelled designs in various sectors, but with virtually no bunkering infrastructure in these fuels it should come as no surprise that owners who are committing are looking at conventional oil-fuelled engines or dual-fuel versions able to run on LNG and the other alternatives as and when they become available.

Despite being demonised by the World Bank last year, LNG as a marine fuel is gathering support, perhaps as a stop gap but no doubt many owners will see it as a mainstream fuel for decades to come. At a DNV webinar on 'Future-proofing Shipping' held in January this year, BHP's vice president Maritime & Supply Chain Excellence, Rashpal Singh Bhatti, said: "From a mindset point of view the majority of the industry were still waiting for a silver bullet." However, he went on to say that LNG represented the best option for delivering a reduction in carbon and was a well-proven alternative to oil.

Bhatti pointed out that support for LNG is growing, as evidenced by the fact that gas-fuelled ships now account for 30% of the world orderbook – although he decried the fact that the remaining 70% were still oil-fuelled.

LNG was again in the news in January, but this time it was the LNG carrier fleet that was being discussed and how the impending CII rules coming in next year would impact the fleet. Lloyd's Register's Panos Mitrou, global gas segment manager, writing in a blog repeated some opinions that are widely held throughout the industry. Among these was the fact that two out of three LNG carriers would have difficulty in becoming compliant with CII ratings in the A to C range.

Worst affected are older steam turbine types and those with four-stroke dual-fuel engines. These account for some 400 ships from the 610-vessel world fleet. The remaining ships have more efficient two-stroke engines that are less prone to methane slip if they are dual-fuel variants.

The growing demand for LNG carriers is highlighted by the numbers ordered recently with around 130 ships on order at the end of January. That represents almost a 20% increase for the fleet in ship numbers due within the next few years.

Meeting the CII requirements will likely mean that many LNG carriers will either have to reduce speed, incorporate some form of energy saving system or look at the possibility of replacing engines. This does not make them unique among ship types, but it will impact on the carrying capacity of a fleet that is already under pressure to meet growing gas use. ■

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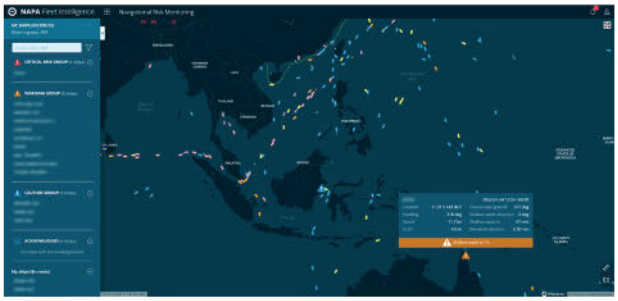
NEWS EQUIPMENT

RISK MONITORING

MOL FLEET ADOPTS NEW NAVIGATIONAL RISK MONITORING SYSTEM



THE SOLUTION IS BASED ON NAPA'S CLOUD-BASED MONITORING PLATFORM NAPA FLEET INTELLIGENCE, WHICH DOES NOT REQUIRE ANY ONBOARD HARDWARE INSTALLATION OR CREW INPUT

A navigational risk monitoring system jointly developed by Finnish maritime software specialist NAPA, Japanese shipping company Mitsui OSK Lines (MOL) and class society ClassNK has been adopted in MOL's fleet of more than 700 ships.

The solution is based on NAPA's cloud-based monitoring platform NAPA Fleet Intelligence, which does not require any onboard hardware installation or crew input, and aims to increase safety across MOL's fleet by predicting the risk of grounding in advance and alerting the shoreside teams, giving them greater situational awareness of navigation risks.

By combining several data sources, such as position data, ship data, sea depth and navigational charts, with NAPA's data on typical operational patterns, the solution provides users with a robust, reliable, easy-to-use fleet-wide platform to reduce mainly grounding risk, according to the three organisations.

The system also incorporates carefully calculated alerts and notifications to shore-based safety operations teams whenever the increased navigational risk is detected, in turn, enhancing the ability to avoid and mitigate incidents, they add.

Pekka Pakkanen, EVP shipping solutions at NAPA, says: "The deployment of the solution to a global fleet of over 700 vessels truly shows how far cloud-based solutions have come in recent years. It also shows the benefit they can bring to solving critical operational issues, with the ability to roll out throughout a large fleet without any additional hardware installation."

ALTERNATIVE FUELS

KRISO GETS DESIGN APPROVAL FOR LIQUID HYDROGEN FUEL TANKS

The Korea Research Institute of Ships and Ocean Engineering (KRISO) has been awarded two Approvals in Principle (AiPs) from the Korean Register for the design of liquid hydrogen fuel tanks for ships.

Once developed, the technology will facilitate the transport of liquified hydrogen in large volumes aboard ship and the award is "an important first step in the development of hydrogen powered eco-friendly ships", according to KRISCO.

KRISO has partnered with the POSCO Group, Korea Shipbuilding & Offshore Engineering (KSOE) and Hylium Industries to develop the technology.

The AiPs were awarded for two different types of 400kg liquid hydrogen fuel tanks, made from different kinds of stainless steel: 316L and 316HN.

Currently in industrial use, 316L can be immediately applied to the production of liquid hydrogen storage containers able to withstand extreme cold up to -253°C.

316HN stainless steel has been newly developed by POSCO and is engineered to minimise the problem of hydrogen embrittlement occurring in ultra-low temperatures.

Other design features include a special breakwater panel that prevents the degradation of fuel caused by liquid hydrogen phase change. This is a risk when the level of liquid hydrogen changes or when the ship experiences turbulent movements.

KRISO senior researcher Hyun-seok Kim says: "We plan to further develop the technology toward commercialisation, with hydrogen-powered eco-friendly ships using the liquid hydrogen fuel tank being tested in the new eco-friendly ship R&D facilities being constructed in Mokpo, Jeollanam-do Province."

Nor-Shipping 2022

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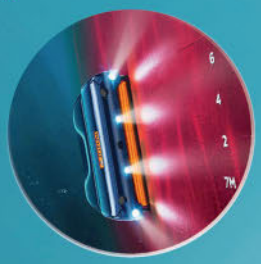

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ENGINES

WÄRTSILÄ POWER PACKAGE FOR DUAL-FUEL ARCTIC SHUTTLE TANKERS

THE SEVEN VESSELS WILL EACH FEATURE SIX WÄRTSILÄ 31DF DUAL-FUEL MAIN ENGINES, RECOGNISED BY GUINNESS WORLD RECORDS AS THE MOST-EFFICIENT 4-STROKE DIESEL ENGINE

Finnish technology group Wärtsilä is to supply the main and harbour engines for a series of seven new Arctic Shuttle Tanker vessels being built at the Samsung Heavy Industries (SHI) yard in South Korea.

The order is valued at more than €100 million (US$113 million).

The vessels will each feature six Wärtsilä 31DF dual-fuel main engines operating primarily on liquefied natural gas (LNG) fuel, and two Wärtsilä 20 harbour engines. All will be fitted with selective catalytic reduction (SCR) systems for emissions abatement.

"The Wärtsilä 31 series of engines has set a benchmark in efficiency for the industry," says Östen Lindell, sales director East Asia & China, Wärtsilä Marine Power. "The diesel version has been recognised by Guinness World Records as the world's most efficient 4-stroke diesel engine, and all versions of the Wärtsilä 31 engine series have the same high focus on efficiency."

This is important for vessels such as these operating in Arctic waters, where operational reliability and environmental sustainability are of critical importance, Lindell adds.

The 120,000dwt vessels are Arc 7 classified and have icebreaking capability.

The Wärtsilä engines are designed to operate reliably at temperatures as low as -45°C.

The Wärtsilä equipment is scheduled for delivery to the yard commencing in Q4 2022, and the ships are expected to be ready for commissioning between 2024 and 2027.

ULTRASONICS

COLTRACO ULTRASONICS AND DURHAM UNIVERSITY FORMALISE PARTNERSHIP

UK-based ultrasonic technology manufacturer Coltraco Ultrasonics and Durham University have signed a Memorandum of Understanding (MoU), formalising the commitment of the two organisations to work together and combine expertise.

The MoU sees the launch of the Durham Institute of Research, Development and Invention (DIRDI) and will enable collaborative research and innovation, as well as staff development and student placement opportunities, according to Coltraco Ultrasonics.

Chairman Carl Hunter says: "We have always recruited heavily from Durham and, for eight years, have run our 'Rolling Internship' programme which has seen students acquire part-time and full-time employment with Coltraco. We believe we have been fortunate enough to work with some of Durham's finest young scientific minds, allowing us to maintain our status as an innovative, science-led company."

"In launching DIRDI, we aspire to generate genuine discovery and innovation of the kind that is essential to create new business and ultimately grow prosperity at home and abroad," he adds.

DIRDI comprises undergraduates, postgraduates and academic staff at Durham University as well as Coltraco Ultrasonics R&D professionals. Unlike typical research institutes, it is primarily commercially-funded.

Without the inhibitors of grant-seeking processes and the pressure to produce publishable results, DIRDI members are encouraged to pursue curiosity-driven research that will drive world-changing innovation, says Coltraco Ultrasonics.

"In the years to come, DIRDI aspires to grow and nurture its members throughout their academic and commercial careers, identifying and supporting the 'Newtons' and Nobel Prize winners of the future, and delivering a critical mass of new research and scholarship," the company concludes.


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CHINA

CHINA RECLAIMS TOP SPOT FOR SHIPBUILDING

By **Daniel Johnson**

PACIFIC INEOS BELSTAFF, THE WORLD'S FIRST IMO TYPE-B TANK VLEC

China regained its position as the world's biggest shipbuilder in 2021, overtaking long-standing rival South Korea for the first time since 2017. The country's shipyards took the number-one spot last year for the highest number of completed orders, new orders and orders on hand, according to data released by the China Association of the National Shipbuilding Industry (CANSI) this January.

"This first is hard-won, and the gold content is very high," stated CANSI secretary-general Li Yanqing, adding that the achievement marked an auspicious start to China's 14th Five-Year Plan (2021-25).

CANSI's data shows that China's shipbuilding output amounted to 39.7m dwt in 2021, an increase of 3% year-on-year and accounting for 47.2% of the world's total new tonnage, up 4.1% compared to 2020. The newly received shipbuilding order was 67.07m dwt, an eye-catching increase of 131.8% year-on-year and making up 53.8% of the global market share. At 95.84m dwt, the Chinese shipbuilders' orderbook on hand showed a 34.8% increase on 2020, which accounted for 47.6% of market share globally.

China's number-one rank is backed up by recently released data from Clarksons. According to the shipbuilding and shipping industry analyst, the global newbuilding volume last year was 45.73m compensated gross tonnage (cgt), with China accounting for 22.8m cgt (49%) of that figure, thus surpassing South Korea which is reported at 17.35m cgt (38%).

CSSC Powers Ahead

Notably, China State Shipbuilding Corporation (CSSC) was ranked the world's largest shipbuilder for the year, the first time it has outshone South Korean behemoth Hyundai Heavy Industries. The Chinese state shipbuilder completed and delivered 206 ships in 2021, 20.2% of the of the global order, and at US$20.5billion, the value of its new orders is at its highest since 2008, according to CANSI.

CSSC-owned shipyards were involved in a number of significant deliveries and construction projects throughout the year, recording several firsts. In May 2021, Guangzhou International Shipyard (GSI) delivered the first Ice Class 1A Post Panamax dry bulk vessel, the M/V *Nordic Nuluujaak*, to Pangaea Logistics Solutions subsidiary Nordic Bulk Carriers. The 95,758dwt vessel is the first in a series of four ships being built for Pangaea Logistics Solutions at GSI and, according to Pangaea Logistics Solutions, is currently the most efficient ship trading in the Arctic, with a high cargo lift and a fuel-efficient design.

M/V *Nordic Nuluujaak* carries the DNV 'CLEAN' citation, meaning the ship fully complies with all MARPOL requirements and other requirements to help prevent air and water pollution. The engine room is fitted with TIER III NOx reducing technology to control nitric oxide emissions and the ship has been coated with modern

paints which enhance fuel efficiency and reduce environmental impact by minimising underwater friction.

LNG Firsts

In July 2021, Hudong-Zhonghua Shipbuilding delivered China's first 174,000m³ floating liquefied natural gas storage and regasification unit (LNG-FSRU), *Transgas Power*, the first of two units developed and built for Greek shipping company Dynagas by the shipyard. A naming ceremony for the second, *Transgas Force*, was held in November 2021.

The 294m-long vessels have both been classified by the American Bureau of Shipping (ABS) and meet the IMO NOx Tier III emission requirements. Each have send-out capacities of around four million tonnes per year and feature GTT's Mark III Flex+ membrane containment system.

In October 2021, the shipyard delivered the first LNG bunker vessel to be based in France. The 135m, 18,000m³ *Gas Vitality* is Hudong-Zhonghua Shipbuilding's second collaboration with Japanese shipowner MOL and French oil and gas supermajor TotalEnergies. The three parties first collaborated in 2018 to design and build sistership *Gas Agility*, which has been operating in the Port of Rotterdam since November 2020.

The *Gas Vitality* is a GTT Mark III membrane vessel capable of loading and bunkering at a rate of 2,000m³/hr and comes fitted with technology that allows for onboard reliquefaction of the boil-off gas, which is used for propulsion and onboard power generation. Classed by Bureau Veritas, the vessel entered operational service in December 2021 and is based in the Port of Marseille Fos, Southern France, where it will perform LNG bunkering services to CMA CGM's LNG-fuelled containerships and MSC Cruises' upcoming LNG-powered cruise ships. It completed its maiden ship-to-containership LNG bunkering operation in January 2022.

World's largest containership

Hudong-Zhonghua Shipbuilding boasted another milestone in December 2021, when it floated the first of six identical 24,000TEU boxships being built for Taiwanese owner Evergreen Group. The newbuild, named *Ever Alot*, is 399.9m in length, 61.5m in width and 33.2m in draught and is being called the world's largest containership, based on nominal box intake. Featuring a design developed by the shipyard, it will have a rated capacity of 24,004TEU, taking it through the 'magical' 24,000TEU capacity threshold.

According to CSSC, the vessel is equipped with a hybrid scrubber system and uses cutting-edge technology in terms of environmental protection, energy conservation, efficiency and safety. A unique bow design, large-diameter propellers and energy-saving ducts have been incorporated to ensure minimal energy usage.

To accommodate the building of the vessel, Hudong-Zhonghua Shipbuilding took over Changxing Shipbuilding's number one drydock, lengthening it from 518m to 700m.

M/V *NORDIC NULUUJAAK* IS THE FIRST VESSEL IN A SERIES OF FOUR BEING BUILT FOR PANGAEA LOGISTICS SOLUTIONS BY GSI

World's first VLEC using B-tanks

Also in December, CSSC subsidiary Jiangnan Shipyard delivered the world's first IMO type-B tank very large ethane carrier (VLEC). The 230m-long, 60,000dwt *Pacific Ineos Belstaff* has a total capacity of 99,000m³ and features a Jiangnan Shipyard-developed type-B cargo quartet containment system, named 'BrilliancE'. Part of the new Panda series being built by the shipyard, the vessel is designed for long-haul ethane transportation but can also handle other liquified gas cargoes such as LPG and ethylene. It is equipped with dual-fuel technology that can use ethane as fuel through a shaft generator that helps it meet emission requirements.

"The innovations behind this type-B VLEC design open a new chapter in mass ethane transportation," proclaimed Hu Keyi, chief of corporate technology at Jiangnan Shipyard, on the launch of the vessel in September 2021.

Classed by the American Bureau of Shipping and China Classification Society (CCS), while meeting the international code of the construction and equipment of ships carrying liquefied gasses in bulk (IGC Code), the *Pacific Ineos Belstaff* was delivered to operate under charter to the INEOS Group carrying ethane from the United States to the Belgian port of Antwerp.

Readers may also be interested to know that *Pacific Ineos Belstaf*, and most of the vessels mentioned above, will be further profiled in RINA's *Significant Ships of 2021*, to be published later this spring.

Ending a winning year for Chinese shipbuilders, Jiangnan Shipyard began construction on "the largest and most advanced new generation of super large green ro-ro ships", according to reports from the Science and Technology Bureau of Yangzhou City, Jiangsu Province. Jointly designed by the shipyard and the Marine Equipment and Technology Institute of Jiangsu University of Science and Technology, the ship has a length of 238m, a width of 34m, a design draught of 7.2m, a speed of 20.8knots and a load of 17,000tons. It is equipped with seven layers of vehicle deck and the lane is 7,800m long, 1,100m more than the current largest ro-ro ship lane internationally. ■

JIANGNAN-BUILT HYBRID MARKS AN ADVANCE FOR PCTC'S

By **Richard Halfhide**

UECC'S *AUTO ADVANCE*

United European Car Carriers (UECC) broke new ground for the pure car truck carrier (PCTC) segment in 2016 when it took delivery of the first LNG-fuelled PCTCs, the 'E-Class' *Auto Energy* and *Auto Eco*, built at Cosco's Nantong Zhongyuan Chuanqi Shipping Engineering Co. The Norwegian-based shortsea ro-ro operator (which is jointly owned by NYK LIne and Wallenius Lines) returned to China once again for the world's first dual-fuel LNG battery hybrid solution, *Auto Advance*, which was delivered by Jiangnan Shipyard in November 2021, with two sister ships due to follow this year.

Designed specifically for UECC by Jiangnan's in-house ship designer Shanghai Merchant Ship Design & Research Institute (SDARI), *Auto Advance* is said to deliver significant gains in energy efficiency and emissions reduction.

Auto Advance will predominantly operate on a regional route between northern Europe and the Mediterranean. Built as an oceangoing single-screw, dual-fuel diesel engine driven flexible PCTC, it's suitable for carrying rolling cargo such as cars, trucks, buses and other vehicles, as well as dangerous and hazardous cargoes.

The vessel has an erect stem, a bow thruster, transom stern and full spade rudder with bulb. Total effective car deck area including ramps is about 30,600m^2, giving it capacity for 3,580 Corona RT43-L standard units spread across 10 car decks, including two electric operated hoistable decks and eight fixed decks which are connected by movable and fixed ramps. Its cargo hold is divided into four gastight/watertight compartments, equipped with a low-pressure CO_2 fire extinguishing system.

Auto Advance incorporates an S-bow, a kind of erect invisibility bulb-bow and lower wind resistance superstructure, designed and developed by SDARI. Hull lines were optimised in operational profile at 16.0knots and 17.8knots on 8.30m draught, while optimum trim tests at two draughts, two speeds and four trims were undertaken.

The controllable pitch propeller at combined mode, the optimal rotate speed and pitch are automatically matched to improve the propulsion efficiency. The daily fuel oil consumption of the main engine is 29.1t/day at service speed, and fuel gas consumption 23.5 t/day. Its cruising range at 16.0knots using LNG will be about 3,500nm and using low-sulphur MGO about 4,000nm at design draught 7.70m.

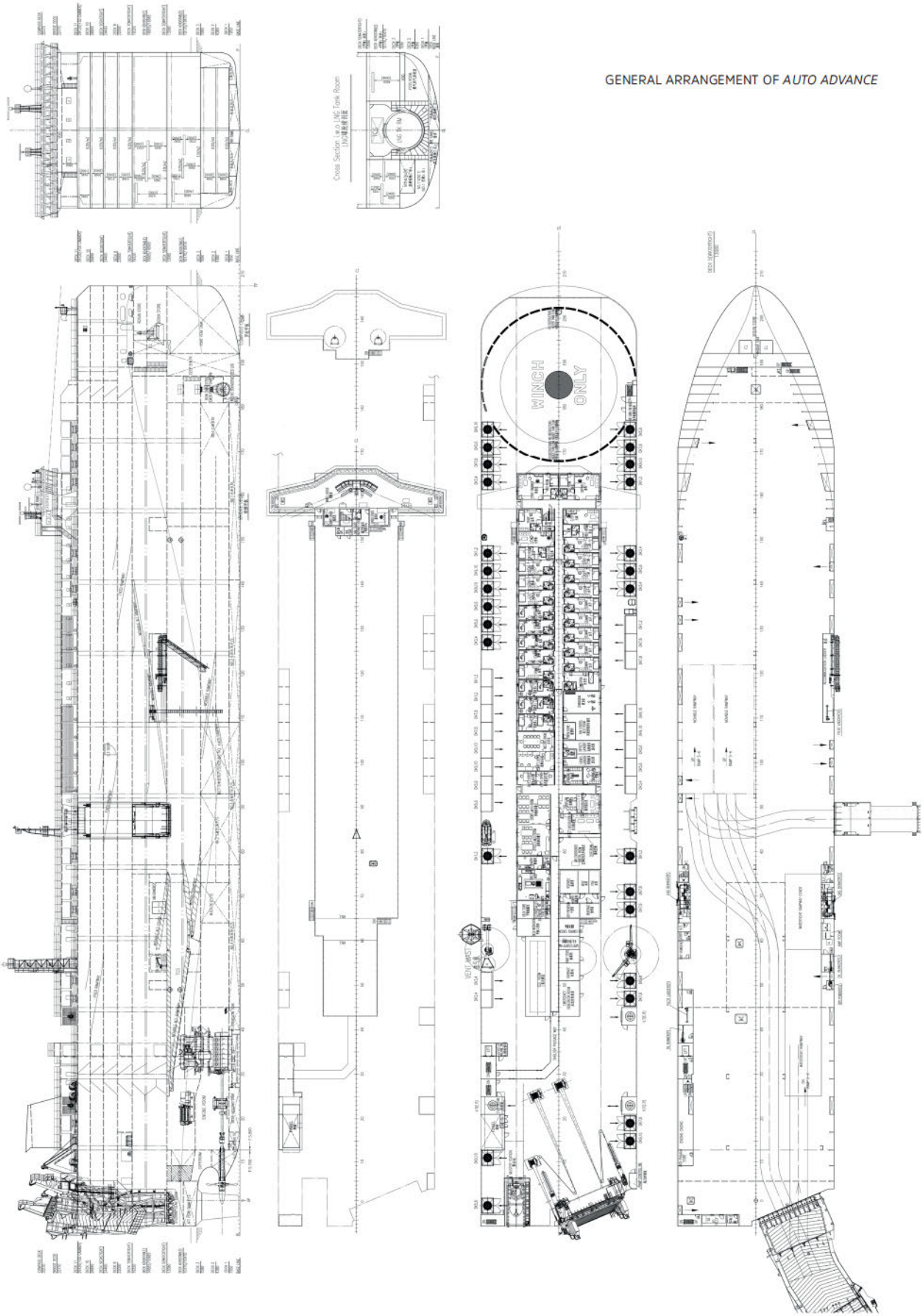
Combined with this dual-fuel engine technology is an energy storage system (ESS) supplied by Finnish company WE Tech, incorporating a battery package from Corvus Energy, that can be charged by a permanent magnet, directly driven shaft generator or the dual-fuelled generators.

The 510kWh capacity NCM lithium-ion batteries, which have been awarded the Battery Safety notation by classification society DNV, can be charged at sea using the shaft generator, allowing them to be at full strength when deploying the bow thrusters for port manoeuvring.

According to UECC, the use of LNG will cut emissions of CO_2 by around 25%, SOx and particulate matter by 90% and NOx by 85%, while the vessel will also meet the IMO's Tier III NOx emissions limitations for the North Sea and Baltic Sea. With an attained EEDI score of 16.661 g-CO_2/(tonnes per nm) against a required (Phase 2) score of 18.146 g-CO_2/(t.nm), meets IMO's requirements for a 40% reduction in carbon intensity by 2030. ■

PRINCIPAL PARTICULARS	
Length overall	169.10m
Length between perpendiculars	164.50m
Moulded breadth	28.0m
Moulded depth	13.08m (main deck); 29.12m (upper deck)
Design draught	7.70m
Gross tonnage	35,667gt
Deadweight tonnage	8,222.9dwt
Total loading car capacity	3,580(RT43)
Main engine	WinGD 6RT-flex50DF
Complement	10 officers, 10 crew
Classification society	DNV
Flag registry	Portugal

GENERAL ARRANGEMENT OF *AUTO ADVANCE*



CONTRACTS

HOW ENVIRONMENTAL CONSIDERATIONS ARE CHANGING SHIPBUILDING CONTRACTS

By **Richard Halfhide**

Since the implementation of the Poseidon Principles – the agreement between the finance sector and maritime industry to integrate IMO's climate goals into ship financing decision-making – in 2019, there has been increased scrutiny of shipbuilding's green credentials. But how does that translate into the shipbuilding contract?

The Naval Architect asked Kenneth W. Fisher, whose Contract Management courses have been hosted by The Royal Institution of Naval Architects for many years and whose expertise has long been held in high regard by the industry. Mr Fisher points firstly that, as many readers will be aware, applicable regulatory compliance is primarily accomplished during the formation of the Contract Technical Specifications and the Contract Drawings.

"Those documents – key parts of the Shipbuilding Contract – are typically prepared by the naval architects and marine engineers working for the shipowner," explains Fisher. He adds that in certain circumstances a shipyard's technical team may assume this responsibility when a standard or semi-standard ship design is being marketed by the shipyard.

"In either case — Owner's or Shipyard's technical team preparing the Specs and Drawings — the technical team has the obligation to incorporate the design features that are both (i) consistent with applicable regulations, and (ii) consistent with the Owner's preferences. That is, the interaction between contracts and environmental regulations occurs while the technical team is preparing the Contract Technical Specifications and the Contract Drawings."

However, he adds: "What is also interesting is the range of environmental considerations that have to be addressed to concurrently satisfy both regulations and owner's preferences," and highlights the concerns listed in the box below.

The increased imperative to secure green financing is also compelling owners to include additional environmental clauses such as sustainability in the supply chain to ensure that sections of the vessel subcontracted to a third party (e.g. hulls built in a low-cost country) are subject to the same rigorous checks.

A further consideration in light of the Energy Efficiency Design Index (EEDI) is the increased applications of energy saving devices. Traditionally shipyards are responsible for the majority of equipment procurement but with specialist machinery such as wind assisted propulsion systems, with shipyards reluctant to engage directly with providers that may have limited actual manufacturing experience, the shipowner may be required to liaise directly and the wind system might be excluded from the main contractual terms. ■

ENVIRONMENTAL CONSIDERATIONS DURING SHIP DESIGN

Choice of Propulsion
Diesel
Steam
Gas Turbine
Combined Diesel/Gas Turbine
Wind Assist Via Sails
Wind Assist via Kites
Wind Assist via Flettner Rotors
Battery/Electric Only via Shore Charging
Battery/Electric with Fuel Cell
Battery/Hybrid with Diesel
Nuclear

Choice of fuel (consider adequacy of supply on intended routes)
Diesel with Scrubbers on Ships
Marine Gas Oil/Marine Diesel Oil
Bio-Diesel (e.g. waste cooking oils, algae, plants, etc.)
Eco-Fuel (from fish & aquaculture products)
Low Sulphur Fuel Oil
Ultra-Low Sulphur Fuel Oil
Emulsified Low Sulphur Fuel Oil
Liquefied Natural Gas
Green Ammonia
Hydrogen
Methanol

Choices of Construction Materials
Fuel Storage Concerns: Temperature, Pressure, Ventilation*
Hull Coatings to Minimise Marine Growth
Avoidance of Hazardous Materials (who defines what is hazardous?)
Choice of Steel Grade for Arctic Service
Maximise recycling opportunities upon end of ship's life

*Green Ammonia is stored in bulk at pressures of 10-15 bar or refrigerated to -33°C. Hydrogen storage requires either cryogenic tanks or high-pressure cylinders.

Note that ammonia combines with water and slowly evaporates. The vapour is quite hazardous to breathing. It is hazardous to marine life that encounters the solution before evaporation. In contrast, diesel floats atop water and can be collected.

CFD & HYDRODYNAMICS

WHY PRECISE SHIP POWERING PREDICTIONS REMAIN AN EXPERT'S TASK

By **Florian Kluwe** and **Jörn Kröger**, Hamburg Ship Model Basin (HSVA)

PREDICTION MODELS, BE THEY EXPERIMENTAL INVESTIGATION OR NUMERICAL SIMULATIONS, ARE ALWAYS SIMPLIFIED

The often cited phrase "democratisation of CFD" is coined on the widespread availability of end-user friendly simulation frameworks for the numerical analysis of flow problems. Where in the past most development effort was devoted to the underlying numerical models, it was recognised that user-interaction and the integration into industrial processes are also key for commercial success. Today, these frameworks usually offer a well-prepared interface and templates for typical application cases. At first sight, the well-supported workflow might suggest that anybody with access to such tools can achieve accurate and reliable results for the analysis of complex flow problems. While there is no doubt that the maturity and stability of the available simulation solutions has reached an impressive level over the last decade – both in terms of the numerical models as well as their end-user friendliness – their application for the reliable analysis of marine flow problems still requires relevant expertise from the CFD expert.

Specifically, for marine application cases, the recent trend to advocate full-scale powering prognosis purely based on the outcome of numerical simulations is seen critically. The aspects presented in the following are intended to shed light on the potential pitfalls and the uncertainties associated with them, when performing full-scale performance predictions solely based on numerical simulations.

Accumulated errors and simplified modelling

Fundamentally, it is important to keep two aspects in mind when dealing with ship resistance and performance predictions. First, the mathematical setup of the problem is ill-conditioned by nature, as part of the resistance of a vessel is represented by a small difference of very huge values obtained from the pressure-integral over the wetted surface of a hull. For everybody familiar with error propagation laws, this setup obviously results in an error accumulation in the resistance leading to high

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uncertainties in this number. Secondly, as a trivial yet important aspect, all prediction models, no matter whether one chooses experimental investigations or numerical simulations, represents a simplified model of the real ship.

One good example is the surface quality, i.e. roughness of ships, and its influence on a ship's performance. At model-scale, the hull roughness is often of lesser importance, the hull surface is considered hydraulically smooth. For Reynolds numbers associated with full-scale, the boundary layer characteristics differ considerably from the model-scale conditions. Here, assuming a hydraulically smooth surface is usually not valid anymore. Hence, at full-scale the typical hull roughness has a significant impact on the frictional resistance of the vessel.

Also, imperfections from manufacturing, marine growth and aging of the painted surface need to be translated into an associated average hull roughness and included in the numerical model. Going to a slightly larger geometrical scale, attachments to the hull, such as e.g. sea chests, hoisting brackets and anodes, are features that need to be dealt with when aiming for accurate full-scale results. Still, these are usually not resolved during numerical simulations.

JÖRN KRÖGER, SENIOR SCIENTIFIC CONSULTANT AND SENIOR PROJECT MANAGER, HSVA

Predicting with accuracy

From these specific examples it becomes obvious that the numerical and the geometrical models, usually exploited for the numerical simulation, include simplifications and uncertainties when aiming for the prognosis of absolute values. While this may be disregarded for relative comparisons during the design process of a ship's hull, or for the comparison of certain modifications such as fitting energy saving devices, this must be taken into account when predicting absolute values e.g. for controlling contractual and regulatory risks (e.g. EEDI, CII). Reliable predictions of absolute values may only be obtained by augmenting simulation results and/or measurements by correlation factors derived from physical observation.

This strategy is in agreement with the classical field of expertise of towing tank facilities, where model test data is exploited to perform full-scale prognoses by applying correlation factors. These approaches are based on extensive data sets that allow correlating predictions with observations from sea trials. Systematic geometrical simplifications or effects of hull roughness – as addressed above – are implicitly included.

'COMPLEX DESIGN TASKS REQUIRE A HIGH LEVEL OF EXPERTISE FROM THE CFD ENGINEER'

Complex design tasks require a high level of expertise from the CFD engineer. Examples such as e.g. unconventional propulsor arrangements, including the propeller with associated up- and downstream components such as e.g. pre-swirl stators, PBCF or (twisted) rudders, require an accurate prediction of the flow conditions at the aft ship of the vessel. Here – among other aspects – the selection of appropriate turbulence models in combination with an appropriate discretisation of the flow field is crucial. Dynamic meshing techniques, such as automatic grid refinement, have certainly simplified the process of generating numerical meshes for specific, complex flow conditions. Still, the quality of the result relies on the well-educated selection of the relevant refinement criteria for the specific application case.

Problem-specific approach

As discussed above, the potential complexity of marine flow problems still makes it a necessity for the CFD engineer to possess a deep understanding of the associated physics. This is a prerequisite to be able to define the correct simulation approach for a specific problem. Performing an accurate and reliable full-scale performance prognosis is achieved only after augmenting simulation results with correlation factors obtained from the systematic evaluation of full-scale sea trial data.

To conclude, the democratised numerical simulation frameworks can help here, but their application and the exploitation of the achieved simulation results require high-level expertise – at least when considering the commercial risks that are related to the decisions made based on the outcome of such kind of analyses. ■

A WINNING FORMULA TO REDUCE EMISSIONS

As industry leaders in Computational Fluid Dynamics (CFD), Cape Horn Engineering specialise in hydrodynamic analysis, offering their consultancy services and state-of-the-art expertise in flow analysis for performance prediction and design improvement. The company has been at the core of four simulation-based America's Cup Campaigns and many Volvo Ocean Race design campaigns for over 15 years, helping three teams to win the race to circumnavigate of the globe. Whilst developing and refining industry leading tools and techniques in this performance-led environment, Cape Horn Engineering's reputation has been built on a racing pedigree and a winning formula.

More recently, the company has expanded the scope of their work to include the wider maritime sector, applying their CFD tools and expertise to a range of projects, from superyachts and foil-assisted high-speed vessels, to commercial ships and tankers. Using their extensive experience, they offer unique solutions and insight into how this revolutionary technology can assist designers to improve performance and efficiency, leading to considerable fuel and emission reductions.

Caring for the environment is something that managing director Dr.-Ing. Rodrigo Azcueta has always been passionate about: "Our niche area of expertise has so much potential to offer greener shipping solutions. It is not often that your interests align in such a way, so it is an exceptional and exciting opportunity for everyone. Collectively we can make a difference on a global scale," he comments.

"Embracing CFD technology gives ship owners a cost-effective means by which they can explore a range of solutions to ensure they are on target to meet with the upcoming EEXI regulations. It also provides the ideal environment to test and optimise novel energy saving devices, such as wing sails. There are several possible solutions which must be considered to reduce the environmental impact of the shipping industry, each of which has a very important role to play."

GHG strategy

Climate change has become an increasingly prevalent topic in recent years. With the international shipping industry accounting for 2.89% of global emissions [1] IMO has a considerable responsibility to regulate the sector. Efforts to reduce these emissions have accelerated rapidly, with a range of initiatives being introduced. In 2018 the Initial Strategy on the reduction of GHG was adopted, setting out a policy framework with the key ambitions of a reduction in carbon intensity of at least 40% by 2030, and a reduction in total GHG emissions of 50% by 2050, relative to 2008 levels.

The first of this framework's short-term measures are set to come into force on 1 January, 2023, in the form of the Carbon Intensity Indicator (CII) and the Energy Efficiency Existing Ship Index (EEXI). While CII is an operational measure, assessing how efficiently a ship transports its cargo by considering the real-time fuel consumption, EEXI is a technical measure that purely considers the design parameters of the vessel in a comparable way to EEDI for newbuilds.

Despite being defined by a rather complex looking equation, EEXI is simply a measure of the design CO_2 emissions relative to the vessels size and speed, producing a single value describing the emissions per cargo ton per mile. The IMO has developed limits on the allowable EEXI of a vessel based on size and type, with every ship being required to demonstrate compliance by producing an EEXI Technical File.

CFD: cost effective calculation

CFD has an important role to play in the calculation of EEXI. Firstly, it offers a cost-effective and quick solution to develop speed-power curves for older vessels whose documentation may not meet the strict requirements of the regulations. For a vessels existing model test or sea trial data to be used, it must consider the EEXI loading condition, which is not always the case. The IMO provides a statistical method which may be used in such circumstances, but this includes a conservative safety factor.

Given that less than 25% of bulkers and tankers are estimated to achieve EEXI compliance [2], employing this conservative calculation for the ships reference speed will highlight the inefficiencies and move the vessels further away from compliance. The existing data may be used to validate a CFD model, which can then then be used to develop an accurate speed-power curve for the correct loading condition for use in the EEXI calculation. The second situation in which CFD excels as a powerful tool is when energy saving devices are installed and it becomes necessary to calculate the efficiency improvements so their impact on EEXI may be determined.

Tank testing is the traditional method by which speed-power curves can be obtained; however, it is expensive and time consuming by comparison to CFD. The ability to rapidly update geometries to explore a range of solutions is lost, and complex scaling issues need to be considered. Converting model-scale results to full-scale relies upon empirical formulas, and the different scaling laws of hydrodynamics and aerodynamics makes accurately performing coupled experiments extremely challenging when investigating WASP devices (Wind Assisted Ship Propulsion). Alternatively, employing CFD allows the vessel to be modelled in full scale, completely mitigating these issues.

Verifying results

While CFD is a powerful tool for calculating speed-power curves, the IMO places strict conditions upon its use. For the results to be considered by a validator they must have been developed in accordance with ITTC Verification and Validation (V&V), and Quality

Control documentation. In fairness, this is good practice when using CFD and is something that all competent providers should be undertaking regularly to ensure that their methods are accurate. One of the main concerns facing the wider acceptance of CFD is trust in the results, and the solution to this is to consistently show your methods to be accurate and to quantify and understand the levels of numerical uncertainty through V&V processes.

Verification is the process of assessing a simulation's numerical uncertainty and determines whether a CFD simulation accurately represents the developer's conceptual description of the model. It investigates whether the set-up is 'solving the equations right' and quantifies the errors arising from factors such as spatial and temporal discretisation. Validation is the process of assessing a simulation's modelling uncertainty in relation to benchmark data and determines how closely a CFD simulation represents the real-world condition, investigating whether the set-up is 'solving the right equations'. Both validation and verification are vital to ensuring that confidence may be held in the results of a simulation.

EEXI project

The levels of accuracy that may be expected when employing CFD to calculate an EEXI speed-power curve are demonstrated by Cape Horn Engineering's showcase EEXI project. This was undertaken using the general cargo vessel, the *Regal*, for which detailed sea data was published as part of the Workshop on Full-Scale Ship Hydrodynamics organised by Lloyd's Register. In these simulations the vessel was moving at a constant speed whilst free to sink and trim.

The thrust of the propeller was balanced with the resistance of the vessel to obtain the Torque, RPM and Delivered Power. The propulsion was modelled both using the Virtual Disk method, in which the propeller is modelled as an actuator disk, and with the more computationally demanding Rotating Propeller method in which the rotating 3D geometry of the propeller is modelled (Figure 1).

Both configurations performed well with the virtual disk results differing from the sea trial results by 1.5% for RPM, 3.4% for torque and 1.8% for shaft power. The higher fidelity rotating propeller set-up performed even better, with 1.8% for RPM, 1.1% for torque and 2.9% for shaft power. The following V&V study showed both set-ups to be considered valid by the International Towing Tank Conference (ITTC) definitions, with uncertainties of 0.2% for RPM, 2.1% for Torque and 3.7% for Delivered Power. The level of accuracy with which CFD is able to replicate the sea trial results gives a good idea of how powerful this tool is in determining the performance of a full-scale ship.

In the likely event that a vessel's EEXI limits are exceeded, the owner is required to implement measures that moderate its emissions. Often the simplest and most effective solution is to limit the main engine power and operate the vessel at a reduced service speed. At times however, this is infeasible and Energy Saving Devices (ESD) such as enhanced propellers or additional propulsion technology must be investigated.

This is the second situation in which CFD is a powerful tool, capable of calculating a new speed-power curve that fully accounts for the effects of the ESD and quantifying the reduction in emissions. Given that a well set up CFD process allows for rapid, or even automated geometry modifications, it provides the perfect environment in which to test several solutions, or even undertake full optimisation studies to ensure that the full potential of the ESD is realised and that the maximum emissions reduction is achieved.

WASP simulations

One of the most promising technologies that is receiving a lot of attention is Wind Assisted Ship Propulsion (WASP) devices such as wing sails, suction sails, Flettner rotors, or any other wind-powered devices. These systems have been seen to offer fuel savings in the 10 to 30% range when retrofitted to existing vessels [3].

Cape Horn Engineering has developed a simulation workflow to directly compare the efficiency of WASP devices and to determine the potential power saving. These are highly complex simulations that model both the hydrodynamic and aerodynamic effects simultaneously in a single simulation. To further increase the accuracy, the wind conditions above the water surface are modelled with a realistic wind profile considering the atmospheric boundary layer wind gradient.

These simulations are as realistic as possible, with six degrees of freedom (6DoF) being considered. The vessel

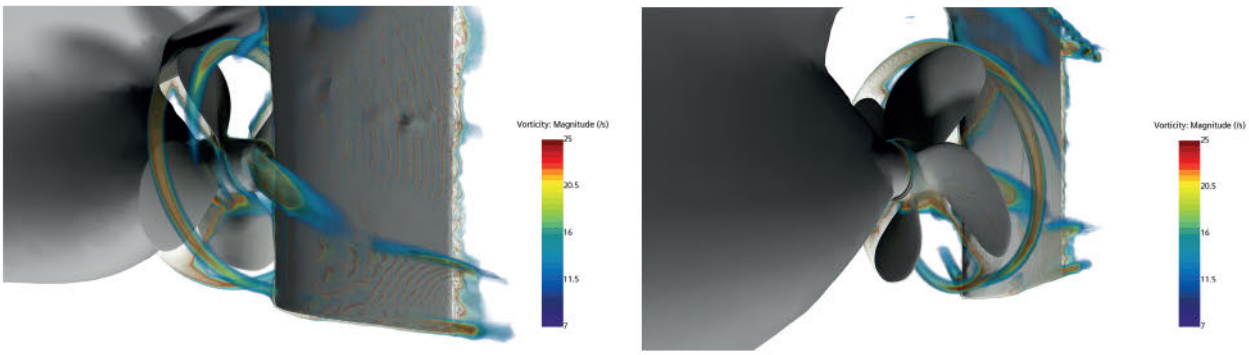

FIG 1: ROTATING PROPELLER GEOMETRY

FIG 2: THE GENERAL CARGO SHIP MV *REGAL* IS BEING USED TO GATHER A FULL SET OF SHIP PERFORMANCE DATA AS PART OF THE WIDER JO-RES PROJECT

is sailing at constant speed, with either an actuator disk or a rotating region containing the propeller geometry modelling the propulsion. This calculates the propeller torque and RPM, and thus the delivered power. The simulation further considers the waves generated by the vessel, the dynamic sinkage and trim, the drift or leeway angle, the heel angle, and the rudder angle to keep a constant course.

Both the apparent wind resulting from the vessel's motion and the input wind conditions result in aerodynamic forces acting upon the WASP devices and the hull topsides and superstructure. These forces induce drift and heel angles. To balance the yaw moment of the whole system and ensure that the vessel's course does not deviate, the rudder angle is altered during the simulation with the application of a PID controller.

The vessel speed is fixed, while the propeller responds to the drag of the hull and thrust from the WASP devices. The thrust produced by the propeller balances the degree of freedom in direction of travel. When the simulation converges to a quasi-steady solution, different WASP configurations can be directly compared by looking at the delivered power of the propeller. This offers a direct measure by which the fuel (and emissions) saving potential can be assessed.

Demonstration

To demonstrate this workflow, two WASP configurations were fitted to a 138m general cargo vessel, the MV *Regal*. This vessel was once again selected as the benchmark data is readily available for the all-important V&V work. The first configuration consisted of two solid wing assemblies mounted on the deck which are similar to WindShip Technology's patented three-wing-three-flaps design. For the second configuration the wing sails were replaced by a pair of Flettner rotors of approximately the same size.

It should be noted that no attempt was been made in trimming the angles of the wing's main assemblies and flaps for best performance and the trim angle was chosen such as the flow was attached, and a reasonable amount of thrust was produced. Likewise, the rotor operating speed was taken as a nominal value with no optimisation study performed. The case study did not aim to give a quantitative comparison and show the merits of one type of device over the other, but rather demonstrate the capabilities of the developed simulation set-up to compare different types of WASP devices with a highly accurate all-in-one 6DoF hydrodynamic and aerodynamic simulation.

From the representative results it was shown that even for these unoptimised configurations there was a 14 and 24% power reduction due to the inclusion of the WASP devices (Table 1). The potential of this tool is seen clearly, allowing owners to make informed decisions about what the best course of action is when considering a range of ESD solutions.

Artificial Intelligence

Building upon knowledge and developing cutting edge methodologies is something that those working at Cape Horn Engineering have always prided themselves in, and being at the forefront of modelling wing sails is no different. The company has recently turned its eyes to the future, working in collaboration with multiple companies and universities to advance the use of

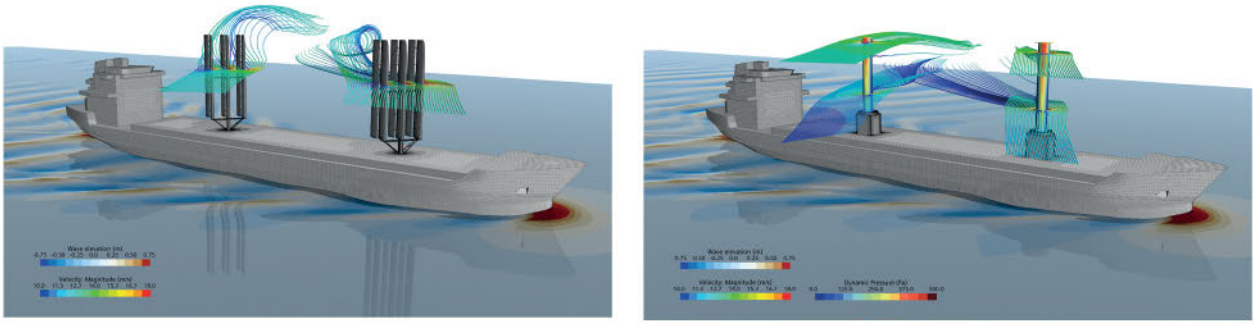

FIG 3: MV *REGAL* IN THE WINDSHIP TECHNOLOGY (LEFT) AND FLETTNER WASP CONFIGURATIONS

Artificial Intelligence (AI) techniques to help reduce the emissions of ships.

While modelling wing sails with CFD produces accurate results, running these simulations is computationally demanding, requiring the use of a powerful commercial supercomputer. This problem is highly exacerbated when the objective of analysis turns to optimisation, for which hundreds or even thousands of simulations would be run to fully explore the design space in an ideal world. This of course, is infeasible in most cases.

Training AI models with data sets created using CFD presents a solution to this and is something that Cape Horn Engineering has seen initial success with. We have trialled the use of Reduced Order Modelling and Neural Networks, with both producing models capable of calculating the aerodynamic forces in seconds rather than hours. This opens vast possibilities in optimising the design of wing sails, and in developing intelligent control systems to ensure that the wings are optimally trimmed when in service to ensure the largest reduction in emissions.

As environmental concerns are influencing a greater need for sustainable energy across the world, specialist technologies are at the forefront of new designs and solutions. CFD technology has become a crucial support for naval architects and design engineers to optimise designs for critical elements such as performance predictions, resistance optimisation and emissions reduction.

Cape Horn Engineering are renowned for providing best in class services to many international clients around the world. They use the most comprehensive and best CFD packages on the market, STAR-CCM+ from Siemens PLM. They are proud to be involved in innovative projects to help reduce emissions for the shipping industry. ■

For more information, please visit www.cape-horn-eng.com

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TABLE 1: PERFORMANCE OF THE WASP DEVICES ONBOARD THE *REGAL*

Configuration	Driving Force [kN]	Side Force [kN	Rudder Angle [deg]	Heel [deg]	Drift [deg]	Rotor Power [kW]
No WASP	-	-	-1.65	-	0.67	-
2 Solid Wings	53.6	61.5	-2.96	0.12	1.64	-
2 Flettner Rotors	35.2	37.9	-1.79	0.09	0.98	37.9

Configuation	Propeller Speed @ 12kn [RPM]	Propeller Delivered Power [MW]	Power Reduction with WASP [%]
No WASP	105	2.35	-
2 Sold Wings	97	1.78	24
2 Flettner Rotors	100	2.03	14

STANDARD PROCEDURE: ACHIEVING ISO 19030 COMPLIANCE

By **Richard Halfhide**

Since its introduction in November 2016, ISO 19030 has become firmly established as a method for quantifying hull and propeller performance and it's estimated that several thousand vessels worldwide have been analysed with a compliant system. The standard has proven particularly influential within the coatings sector – unsurprisingly since it was heavily involved in its development – and as stakeholders such as charterers take a growing interest in performance monitoring it's not uncommon for coatings upgrades to be requested on the basis of ISO 19030 data.

But what exactly is ISO 19030, why do shipowners need it and what is required to achieve compliance? That was the subject of a recent webinar hosted by Danish consultancy FORCE Technology, whose maritime division has been working with the standard for the last five years and provided ISO 19030 related services to hundreds of vessels to date, with clients including shipowners and coatings manufacturers.

Prior to its creation, coating providers had each been working to their own formulation for measuring performance, meaning that the definition of a severely or moderately fouled hull was somewhat in the eye of the beholder (generally the underwater inspectors). ISO 19030 removed this ambiguity by simplifying it into a relatively simple matter of a vessel's speed loss percentage against the baseline of its expected speed, represented by the equation:

$$V_d = 100 \cdot \frac{V_m - V_e}{V_e}$$

Here, V_m represents the measured speed and V_e the expected speed, resulting in a speed difference which is expressed as negative value. The vessel's speed power relationship will have been determined by model tests, speed trials or CFD and compared against the measured speed. For example, a vessel travelling at a shaft power of 1.750kW might be achieving a speed of 8knots, when the expected speed is 10knots, which would represent a speed loss of -20% (see Figure 1).

"Speed loss for a vessel can vary a lot; we have seen between 1 and 10% per year," explains Arnbjørn Maressa, ship performance specialist for FORCE Technology. "If you have 10% you should definitely react, but if you monitor speed loss you have the possibility to react and take some action. If you're a shipowner and speed loss is increasing you should order a cleaning or at least inspect the hull. Or if you're a coating provider and the coating has a guaranteed level of performance you need to do something."

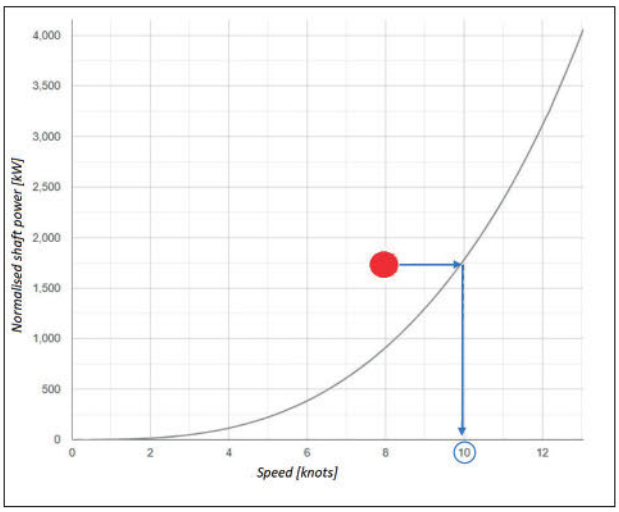


FIGURE 1: MEASURED SPEED (RED CIRCLE) IS COMPARED AGAINST THE MODELLED SPEED TO DETERMINE SPEED POWER LOSS

Performance monitoring of any kind is never a question of absolute values, but rather the average over a prolonged period, typically illustrated using scatter diagrams, to monitor the long-term degradation and determine the optimum point for action (e.g. hull cleaning). Needless to say, a drop in vessel performance also equates to increased bunkering costs.

Obtaining ISO 19030 compliance

Obtaining ISO 19030 compliance is a three-stage process: (1) data acquisition, (2) data storage, (3) data preparation. Because the standard is ostensibly a hull and propeller index it differs somewhat in its required parameters (see Figure 2) from other performance monitoring methods, notably the absence of flow meters, which are notoriously troublesome due to sensor errors. Although there are separate provisions for manually logging data, ISO 19030 is largely based around automated logging.

For collection and storage of the data, Force Technology has developed a dedicated hub, SeaLogger, which is installed onboard the vessels of its clients, often by the crew themselves. "We ensure that the client has all [the necessary] instruments onboard and they meet the right protocol so we can connect to it," says Maressa. The ISO standard further stipulates that the data should be stored in UTC time format and easily readable and retrievable.

Analysing the data is broken down into four subcategories: (i) compiling data, (ii) filtering and validation, (iii) environmental correction, and (iv) the actual calculations. The standard prescribes that for the first step the automatic sensors, where they may not give a value at the exact same time, should be

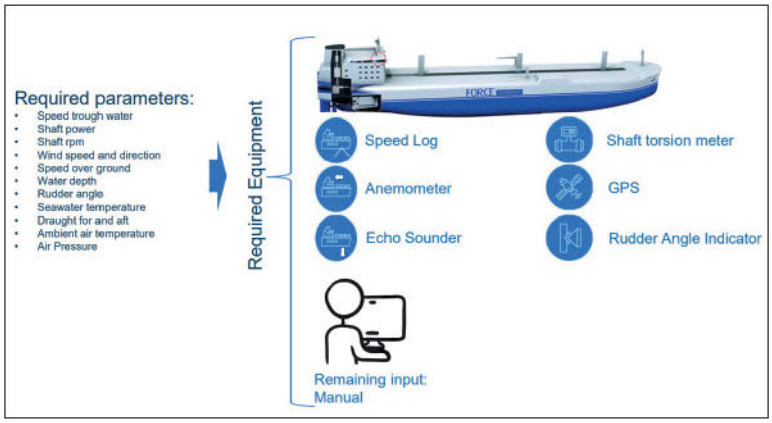


FIGURE 2: REQUIRED PARAMETERS FOR ISO 19030

aggregated by their mean, while for manual data the last value should be taken and moved forward towards the other time steps.

"Instead of having all the different sets of values at different times you now have them in the same time row, then you can start doing some filtering and validation. This is of course to ensure that you're not doing any analysis or conclusions based on data when the ship is either manoeuvring or in heavy weather or shallow water. What the ISO standards define as filtering is you bin [data] at 10-minute intervals, starting by looking at the max standard error and the rpm standard error has to be under three minutes," explains Maressa.

He adds that the primary concern is the stability of the sensors and how much variation is acceptable. Other factors include the depth of water (shallow water will compromise the analysis) and its temperature, while the wind speed should not be greater than 7.9knots (BF4) (see Figure 3).

Environmental correction differs from other standards in that it only corrects for wind, not waves, based on the assumption that the vessel will on average have received on average the same levels of waves each time it is evaluated.

Maressa notes that this method is probably not the best. "We all know that waves have a big impact on the consumption, even at waves under BF4. The reason for omitting the effect of waves is probably to make the analysis and documentation needed on the ship simpler, but if the ship changes operational profile, so trading area or speeds, during the monitoring period this could lead to a wrong interpretation of the performance because of neglected wave effects," he comments.

Calculations

The calculation itself follows the formula mentioned above and comparison with the baseline speed-power curves. Maressa says that the value of these baselines is sometimes called into question and to illustrate his point he transposed the data analysis of a modelled to a larger one, revealing the relative values suggested it's not always necessary to work with absolute values.

"The standard is pretty strict on which test experiment can be used as baseline, but what happens if you deliberately get the baseline completely wrong? In the experiment we measured the actual speed, power etc. of a Medium Range tanker (172m) and then processed the data as if it were belonging to a Suezmax tanker (275m). The absolute values of the calculated speed loss were of course much higher, as the MR needs way less power to move, but if we looked the relative decrease over time the results are comparable. So you can use a 'wrong model' and still analyse the performance decrease over time. It is important to note that this went well because the ship was sailing at similar draughts and speed during the entire period."

Then why bother with speed trials or towing tank tests when you can simply draw upon any model to determine hull performance? "Because in many cases the ship will change its operational profile over the five

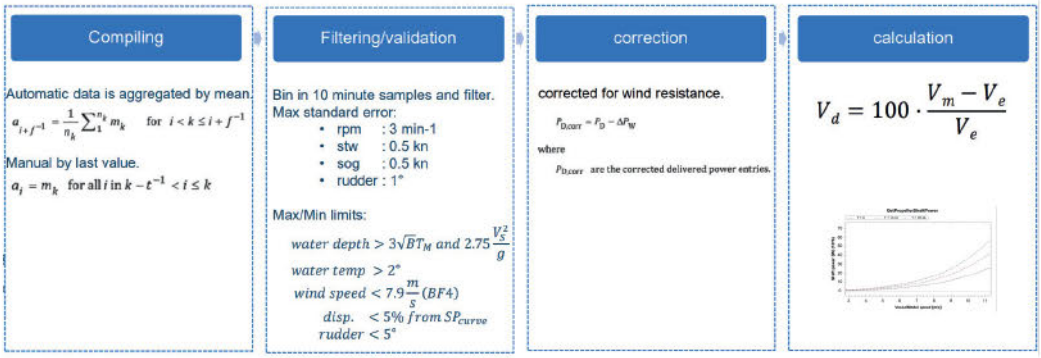


FIGURE 3: THE FOUR-STEP PROCESS FOR ISO 19030 DATA ANALYSIS

years [between dry dockings]. Typically, the market will change, so that in the first two years the vessel is sailing very slow and the last two years fast. This will mess up the index and you can't trust it unless you have a more or less reliable model."

The onset of the Covid-19 pandemic, when many ships were forced to temporarily suspend operations, provided an ideal opportunity to demonstrate the efficacy of hull performance, and Maressa illustrated this with a further example from a vessel that spent several months in anchorage during the spring and summer of 2020. Having performed with a respectable speed loss index score of -15% up to April 2020, it dropped to -35% on resuming service in July of the same year, amounting to around 15 extra tonnes of fuel per day [see Figure 4].

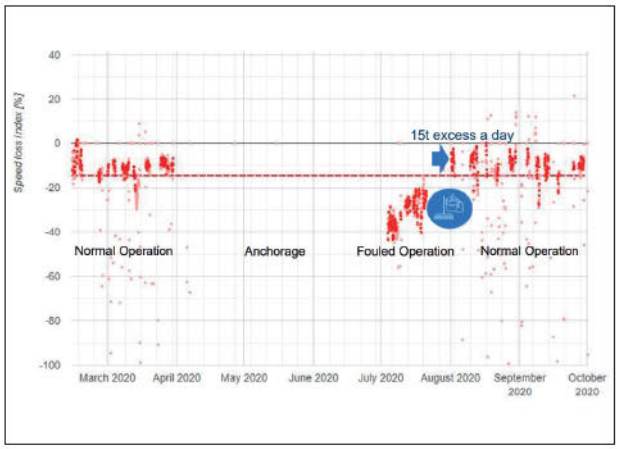


FIGURE 4: SPEED LOSS INDEX FOR A VESSEL IN ANCHORAGE DURING THE COVID-19 PANDEMIC, WHICH SUSTAINED HEAVY HULL FOULING

"The owner got an alert from us, although in this case the crew could see straight away when it started sailing again. Which meant that he ordered a cleaning of the hull and propeller and after the cleaning it returned to normal operation."

Under normal circumstances, a well-performing paint should start with a base of around -3.5%, dropping to -4.6% by the end of the first year. By the second that would be expected to fall to around -6.5%, i.e. an average loss of 1.5% per year. Conversely, a suboptimal paint may drop by around 3% per year. In the case of a Suezmax with a typical operational profile this could add an extra US% million in bunkering costs [see Table 1].

The advantage of a shared standard that correlates into hard cash is self-evident, but is the speed loss indicator really the best available method? Maressa comments: "The good thing it has going for it is it has been the standard for some years, but there are many ways of doing performance indicators. We at FORCE Technology would say that it makes poor use of the sensors. It logs values with struct rules about how much it can vary, but it doesn't use anything else that it filters out.

"For instance, if you see that your speed over ground is consistently going over 3knots faster than your speed through water then a good performance standard should send a warning out saying there's a difference here and you should calibrate your speed log. So it's a bit theoretical still in the way it assumes a perfect world with perfectly calibrated and maintenance-free sensors."

Room for improvement?

Although Maressa rejects the suggestion that the standard is weighted in favour of either coatings providers or shipowners, he does think there are ways it might be further improved in the future, the first of which being the introduction of wave correction in the calculations.

Second would be the inclusion of additional hard criteria for situations when sensor is believed to have gone wrong. "For instance, we know that if a torsion meter has reported 8000kW for the last two days it is not because it is super precise, it is because the hardware is frozen," he comments. A third potential improvement he suggests is a split between propeller and hull performance by incorporating rpm and open water curves.

ISO 19030 is currently at the first revision phase of its five-yearly review and while nothing has changed as yet, Maressa notes that shipowners are becoming more inclined to invest in quality performance data and increasingly want the capability to transfer that data to shore on a continuous basis.

That's only likely to add to the demand for specialist services such as those offered by FORCE Technology. Maressa notes in closing that the company has experienced a high interest in this topic and there are plans to repeat the webinar later in the spring. ■

TABLE 1: THE CUMULATIVE EFFECTS OF HULL FOULING

Speed loss 5 years [%]	Extra consumption [t]	Extra CO_2 [t]	Cost of speed loss [$]
0	0	0	0
-5	4,248.8	13,231	1,699,500
-7.5	6,373.1	19,846	2,549,250
-15	12,746.2	39,692	5,098,500

SAFETY

SHIPPING SAFETY IS ADVANCING BUT THE INDUSTRY WILL NEED TO MIND THE GAP

By **Daniel Johnson**

By its very nature, shipping can be a risky business. The unpredictability of the sea makes for a harsh, unforgiving medium where the potential for loss of life and damage to the environment and the vessels is ever-present. Safety must always come first, and thankfully great strides have been taken in this respect in recent years thanks to higher standards of ship construction and operation. But as the industry enters a period of unprecedented transformation, can it afford to be complacent, and what safety role will the human play in an increasingly digital word?

The significant progress made in shipping safety is highlighted in a comprehensive new report by class society DNV and Lloyd's List Intelligence. Analysis in the report, 'Maritime Safety 2012-2021: a decade of progress', shows a marked decline in casualties, losses and detentions over the period, with annual casualties falling by 20%, ship losses resulting from casualties down by 56%, and the number of detentions falling 60% by the end of 2020.

These statistics can be viewed in an even more positive light if you consider the global fleet expansion over the same period; according to the report, the world fleet increased by 46% in dwt and 16% in vessel numbers, with ships over 100 gross tons now totalling more than 130,000 vessels compared with 116,000 in 2012.

MARIANNE VALDERHAUG, DNV MARITIME CLASS DIRECTOR FOR TECHNICAL SUPPORT

ØYSTEIN GOKSØYR, DNV HEAD OF DEPARTMENT, SAFETY ADVISORY

"The decline in the number of vessel casualties and losses over the past decade is testament to the shipping industry's efforts to improve safety standards towards the overarching goal of safeguarding life, property and the environment," writes Knut Ørbeck-Nilssen, CEO Maritime, DNV, in his introduction to the report, adding that that measures such as increased digitalisation and automation of ship systems, modern class rules, better vessels and tighter regulatory supervision have contributed to this welcome safety trend.

However, despite a decade of improving safety statistics, the report warns that it would be foolish to think that it will be all smooth sailing from here on. As the industry pushes toward decarbonisation, the emerging risks associated with new fuels and digital technologies will need to be addressed if the progress of the last 10 years is to be maintained.

Green Fuels

"A major cause for future concern is the potential safety risk, such as fire and explosion hazards, from the alternative fuel technologies required to meet IMO requirements to halve emissions from the global fleet by 2050," says Marianne Valderhaug, DNV Maritime Class director for technical support.

"There are so many challenges ahead of us," she adds. "For example, ammonia is highly toxic, while hydrogen is easily ignitable and difficult to contain as it has the smallest gas molecules. Battery fires are also difficult to contain due to the extreme heat generated."

Valderhaug notes that there is a further risk from derating of engines for slow steaming, as well as newbuilds with less engine capacity, as this could lead to a lack of power for manoeuvrability in safety-critical situations.

"This is an evolving area in which we need to assimilate operating experience with new fuels like hydrogen and battery technology, in order to determine the risk picture and develop appropriate rules. The regulatory framework needs to be upgraded in line with new technology," she says.

DNV has already issued classification rules for the use of LNG, ammonia, fuel cells, methanol, ethanol and LPG to safeguard against fire and the release of toxic

gases. Its new Fuel Ready notation, released in 2021 and a revision to the Gas Fuel notation, covers future conversion. It is applicable for ammonia, LNG, LPG and LFL (methanol) as a ship fuel, either individually or for more than one fuel at the same time.

The classification society has also taken the lead in a number of joint industry projects to advance safety guidelines for the use of hydrogen and batteries, such as MarHySafe, which aims to develop a roadmap for hydrogen safety in shipping, and Battery Safety, which is addressing the risks related to batteries in vessels.

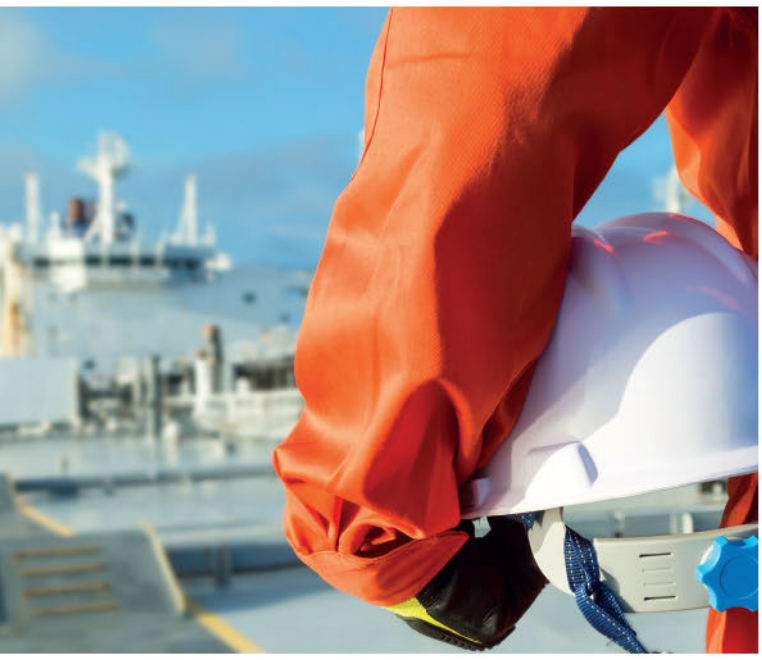
Safety Gap

Additionally, DNV has identified a looming "safety gap" between shipping's existing safety-risk approach and ambitions for greater digitalisation and the adoption of alternative fuels. "Decarbonisation and digitalisation are coming fast into the industry and that implies change," explains Øystein Goksøyr, DNV's head of department, Safety Advisory. "When you introduce new technologies and new ways of working, it is in that interface, between the old and the new, that you can get glitches in safety."

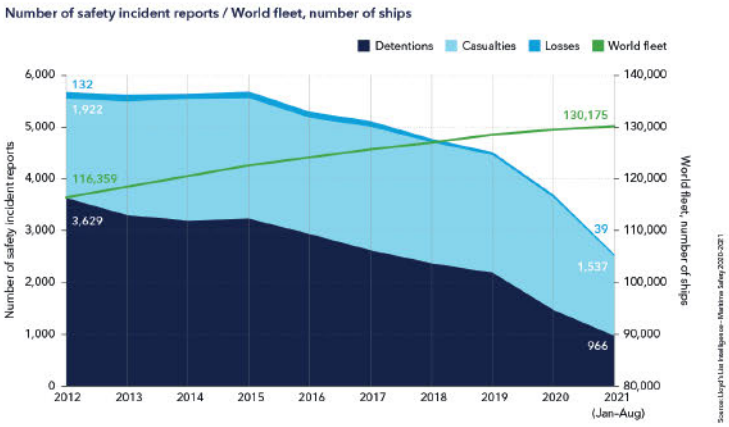
He adds that the longer industry waits to address this issue, the more the gap will grow.

Although digitalisation is intended to enhance efficiency, environmental performance and safety, Goksøyr believes that it will also pose new safety challenges due to potential system failure and cyber-security risks, which will need to be assessed and understood so they can be resolved.

"Increasingly complex and integrated systems call for a dedicated system integration role," he says. "This is a relatively new role in shipping and, together with standardised rules, it needs to be implemented and strengthened to close the safety gap with uptake of new technology in the industry, as any system failures could halt adoption at scale of vital technologies that can also benefit safety in the long run."



THE 'MARITIME SAFETY 2012–2021: A DECADE OF PROGRESS' REPORT COMES AT A TIME OF RAPID CHANGE FOR SHIPPING



ANALYSIS FROM 2012-2021 SHOWS AN OVERALL PATTERN OF IMPROVEMENT IN MARITIME SAFETY, WITH A MARKED DECLINE IN CASUALTIES, LOSSES AND DETENTIONS OVER THE PERIOD

DNV is addressing such issues with its new Data Infrastructure class notation to standardise data interfaces, including data from sensors, as well as the Cyber secure class notation to verify the security of IT and OT systems in line with IMO requirements and above.

In the loop

Digitalisation will also require an industry shift towards responsive real-time risk management and an open data platform for integration of ship systems as these become more automated and interconnected, aligned with a human-centred design of such systems, according to Goksøyr. "Changes in the human and organisational aspects are also needed, alongside the technical shift, to ensure maritime systems are robust and resilient with a process in place for continuous safety improvements," he says.

Goksøyr adds that this will entail different roles and responsibilities for seafarers who will be trained to provide vital safety support for the complex systems operating in a digital world, a philosophy that DNV calls 'humans in the loop'. From an organisational perspective, he says, it will be important for companies to have a digital transformation strategy in place to manage emerging risks across the entire organisation.

"It's very important to understand that the human will still be in the loop and that we will have more responsibility, because it's humans who have to take over when the machine fails - we have the right instincts to go in and handle critical situations. So the crew onboard will have really important jobs and also the onshore organisation will be really crucial to manage a ship safely," he concludes. ■

SURVITEC AT THE VANGUARD OF FIRE SAFETY TECHNOLOGY FOR A NEW GENERATION OF CREWLESS VESSELS

By **Daniel Johnson**

Interest in autonomous and remotely controlled ships is burgeoning, with some researchers predicting a not-too-distant future where 200m-plus cargo vessels ply the world's oceans without a crew. The implications of this are huge for shipping companies, shipbuilders and maritime systems providers. However, there are many challenges to overcome if the use of autonomous ships for commercial long-sea journeys is to become a reality, with none more central than proving the vessels and their enabling technologies can operate safely.

All eyes, therefore, will be on the *Yara Birkeland* in early 2022 as it prepares to carry its first fertiliser cargo on the Herøya-Brevik route in Norway. The 3,200dwt ship's maiden commercial operation will mark the start of a two-year technology test phase as the vessel aims to become certified as an autonomous, fully electric container vessel. Initially, it will operate with an onboard crew, before moving to a remote crew and finally to full autonomy.

Also onboard *Yara Birekland* for its first laden voyage will be a unique, automatic and remotely operated firefighting system designed and commissioned by survival technology specialist Survitec. The system will be monitored by crew from a virtual bridge and machinery control room ashore.

Survitec's scope of supply included a Novenco XFlow® water mist system for the vessel's eight separate battery rooms; an Inergen® fire extinguishing system for the switchboard rooms, pumps rooms, control rooms and electrical spaces; and a Novenco XFlow® water spray system for the cargo holds, open decks, superstructure and other compartments.

"Safety has been taken high up on the agenda with this combination of systems," Finn Lende-Harung, commercial director Fire Solutions, tells *The Naval Architect*.

In the areas where a gas solution was required, for example, the Inergen system was chosen not only for its excellent firefighting capabilities, but also because it is safe for human exposure at the system design concentrations. "Even though it will be a crewless vessel at some point, you will still get people such as service technicians on the vessel on a regular basis, and it was important to take this into account," he explains.

New approach

On the different approach required to extinguish a fire aboard a crewless ship, Mariusz Slotwinski, product manager Water Mist Systems, says: "Typically, fire systems are built for manual operation, so we had to redesign the system for automatic activation based on the signals received from heat and flame sensors and CCTV cameras located all around the vessel. The fire systems also had to send signals to seawater pumps, gas cylinders and valves, providing alerts to operators shoreside."

SURVITEC'S FINN LENDE-HARUNG (LEFT) AND MARIUSZ SLOTWINSKI

To facilitate activation from the virtual bridge and machinery control room onshore, the entire system had to be rethought. This new approach meant that Survitec had to redesign the Novenco system for 60 minutes of operation rather than the 30 minutes specified for conventional vessels. Additionally, as *Yara Birkeland*'s cargo holds are designed according to IMO MSC/Circ.608 requirements, which usually requires a manual firefighting approach, the NFF XFlow water spray nozzles had to be redesigned and sited for crewless operation.

Extra fire safety features have been built into the ship, including additional segregated fire zones and system redundancy. Drain valves have also been integrated into the system to allow for automatic opening and closing to prevent free-surface flooding.

System integration

Key to the project has been the extensive work carried out by the Survitec team to integrate the company's system with *Yara Birkeland*'s Kongsberg control system, according to Lende-Harung. Something that will be integral to the success of any new and advancing technologies deployed on unmanned ships in the future. "The link between the vessel's control system is crucial, becoming even more so on these unmanned systems. The systems need to talk together," he says.

Survitec is currently designing a similar firefighting system for a pair of fully autonomous ferries under contruction at a shipyard in India. "This is just the beginning. As the industry starts to see these autonomous, alternatively fuelled vessels operating successfully and safely, demand will speed up. We predict more autonomous vessel projects over coming years. But in terms of ship safety, we're already ahead of the curve," Lende-Harung says. ■

AS BATTERY PACKS GAIN POPULARITY, FIRE RISK COMES UNDER SPOTLIGHT

By **Kari Reinikainen**, Correspondent

Lithium-ion batteries are gaining popularity in marine because of their superior energy storage capacity and lighter weight than lead and acid batteries. However, a fire in such an installation can pose a significant risk at sea. But given there are no IMO rules to cover fire safety of battery installations at the moment, classification societies are playing a key role in providing regulatory framework in this area.

Lithium Safe, the Dutch manufacturer of firefighting systems designed to combat lithium-ion battery fires, states on its website that such batteries are 70% lighter and can store four times as much energy as lead and acid batteries. Conversely, their life span is also significantly longer.

"An increasing use of lithium-ion batteries leads to an increased risk for fire. In a report made by the European Union, scientists conclude that a lithium-ion battery fire onboard of a ship can be more deadly than a sinking ship. This is because a lithium-ion battery fire is one of the most dangerous and difficult fires to control and extinguish," the company says.

Unlike shore-based installations, battery packs onboard ships can be exposed to effects of slamming and vibration of the vessel in heavy weather. This can damage the structure of the battery casing, which again can trigger a short circuit and cause a fire.

"Without SOLAS regulations specifically addressing large battery installations, the Class notations are important when it comes to ensuring that battery installations maintain their integrity from a fire safety point of view," says Anders Tosseviken, principal approval engineer at DNV. But in practice, there has to be close cooperation between the classification society and the flag state of the vessel in question to ensure that all there necessary considerations are taken properly into account.

THE 2019 FIRE ONBOARD NORWEGIAN DOMESTIC FERRY *YTTERØYNINGEN* RAISED CONCERNS ABOUT THE INADEQUATE BATTERY DATA BEING RELAYED TO THE BRIDGE

Battery packs need extra protection

The starting point is that battery packs need extra fire protection on board, in the same way as e.g. engine room and galley spaces do. However, as the off-gases have a different chemistry we need to take a rather different approach to this problem. The solutions available for standard engine rooms are not always suitable for battery spaces.

"DNV made a comprehensive review of the available technology and concluded that only two types of fixed fire extinguishing systems should be accepted for battery spaces: fresh water-based water mist systems, or gas fixed fire extinguishing systems with two charges.

"Detailed specifications for each system are defined in the DNV rules. While systems frequently seen in use in standard engine rooms, such as inside air foam, high expansion foam and sea water-based water mist are not deemed suitable for battery spaces."

And with good reason, for example, using a sea water fire hose can cause massive short circuits in a damaged battery.

In the case of an electrical fire not involving batteries, the first thing to do is to cut the current off. However, in the case of a battery pack, this is not an option.

Battery packs require dedicated spaces of their own and ventilation of the room must be kept completely separate from the air conditioning system of other systems on the vessel to prevent toxic and hazardous fumes from reaching accommodation areas, Tosseviken points out.

While extinguishing a fire that has broken out is obviously important, it is also vital to try to reduce the chance of the fire spreading from where it broke out in the first place, says Sverre Eriksen, senior principal engineer at DNV. The class society's own certification procedure requires that a fire that has broken out in one cell of a battery pack must not spread to the other cells in the module and then outside of it. Electrical equipment must also be located well away from the battery pack, Eriksen adds.

DNV has issued class notations for battery packs to some 300 vessels since their first in 2011. The figure is roughly the same as for LNG-powered vessels. In this time, there have only been two battery fires, Tosseviken notes. "Owners are aware of the new risks introduced by battery packs and close contact between class, owners and makers of batteries and fire safety systems, especially in collecting incident and risk data, is essential for keeping the rules up to date," he points out.

SCANDLINES' ZERO EMISSION FERRY, DUE FOR DELIVERY IN 2024, WILL INCLUDE A COFFERDAMMED BATTERY ROOM TO INCREASE PROTECTION. SOURCE: SCANDLINES

This data provides a good platform to analyse risks involved with battery pack installations. In this regard Scandinavian culture, which is known for its informality and easy flow of information both up and down a hierarchy and between organisations, is helping in sharing insights and ongoing development of the class notations.

Thermal runway a risk

Current battery technologies based upon lithium chemistries come with the risk of a hazard called 'thermal runaway' which can happen due to ageing of individual cells or to multiple cells and modules due to exposure to temperatures above the limits imposed by the cell structure, explains Duncan Duffy, Lloyd's Register's (LR) global head of technology for electro technical systems.

This was illustrated by incidents such as the fire and subsequent explosion on a small Norwegian domestic ferry *Ytterøyningen* in October 2019, he notes. In the wake of the incident, the Norwegian Maritime Administration observed that it is extremely important that vessels are not operating without communication between the energy management system and the battery packs, as this may result in a breach in the transfer of important system data between the system and the bridge. It also recommended that all owners of vessels fitted with battery pack carry out a new risk assessment.

The Administration had published its fire safety guidelines regarding battery packs in 2016, which said testing should be carried out on cellular, modular and system level to identify the damage potential of a possible thermal runaway event in a specific battery system. It stated: "The results from the tests satisfying the acceptance criteria will determine the design of battery spaces with associated systems for fire extinguishing, explosion."

Duffy says that LR has developed a type approval procedure and rules for system integration to ensure that the risk of uncontrolled thermal runaway happening and its ability to spread are limited.

"Thermal runaway due to the heat from fires in the battery space or adjacent spaces remains a risk and while conventional gas-based firefighting techniques may suppress secondary fires they would not stop the 'uncontrolled exothermic chemical reaction' that this hazard represents," he tells *The Naval Architect*.

In the absence of techniques to address the chemical reaction directly, separating the space from areas with a high fire risk to prevent the condition developing may be the most effective mitigation. Cooling the batteries using approved water-based firefighting systems to slow the chemical reaction may be the most effective mitigation available if the situation has not been prevented.

"The application of water-based firefighting techniques on an electrical system that may have retained charge requires care during design and installation but at a certain stage the safety goal may relate more to the protection of the ship than to maintenance of battery function from a single space," he concludes.

Battery temperature charge rate and voltage limits

Battery packs have become popular in the ferry industry, either as the sole source of power or part of a hybrid propulsion system. Scandlines, which operates ferry services between Denmark and Germany, is among the pioneers in this area and it has recently ordered a 1,200-lane-metre zero-emission freight ferry for its Rødbyhavn–Puttgarden service. Its battery pack will be charged at the Danish port, where Scandlines already has a 50kV/25MW power cable.

The ship will be built at the Cemre shipyard in Turkey and the company is building and designing the battery rooms together with Lloyd's Register, the Danish Maritime Authoritiy and the shipyard, says Anette Ustrup Svendsen, head of corporate communications at Scandlines.

"The battery room will be insulated to resist heat from the room inside and outside by means of a cofferdam, and the bulkhead will be A-60 insulated. Furthermore, thermal runaway will be mitigated by means of controlling the battery temperature, charge rate and voltage limits in the Battery Management System," she continues.

Enhanced alarm strategies protect battery against abuse or potential thermal runaway, together with calculated algorithms to identify abnormal behaviour of battery cells and implement early warning strategies. "Detector and Fire Suppression Systems will be built into each battery rooms, including extraction fans from the battery room," she notes.

Dr John De Roche, CEO of aentron GmbH – Energy Solutions in Germany has pointed out that there are four main reasons for fires in lithium-ion battery installations. These are flawed electrical and mechanical design, production quality issues with the cells, faulty or no battery monitoring, and defective charging process.

In an article on Innovationetwork.com he warned that the risk of a fire at charging is often underestimated, with charging the pack too fast among the frequent reasons of fire. Overcharging, meanwhile, can trigger a thermal runway.

De Roche concluded that all new technologies have bottlenecks and problems that need to be overcome and he called for action on both national and European level to iron out the problems. ■

STAYING SAFE AT SEA, WITH FIRE SAFETY GLASS

By **Steve Goodburn**, business development director, Pyroguard

PYROGUARD MARINE'S TOTAL SYSTEM APPROACH COMBINES STRUCTURAL FRAMEWORK AND GLASS IN A UNIQUE, BUT EXACTINGLY TESTED, SOLUTION

Fire safety glass is an important consideration during the design and specification process – it's just as important at sea as it is on land. Specified and installed correctly, it can be a key example of passive fire protection, used as a means of creating a safe route of escape in the unfortunate event of a fire. Fire safety glass is used for the purposes of compartmentation, whereby a vessel would be separated into numerous fire-safe compartments, constructed using fire-rated walls, doors, windows, corridors and partitions. These compartment barriers would help to isolate and contain a fire, preventing its spread.

When specifying and installing fire safety glass for marine applications, there are a variety of factors to consider to ensure the optimum solution is chosen. Fire protection and performance is the first and foremost concern, being the primary reason for the product's specification.

Within the marine sector and shipping industry, there are two main classifications of fire safety glass to be aware of. The first, A, provides 60 minutes of integrity protection against the spread of flames and hot gases. While the second, B, provides 30 minutes of integrity protection. 'A' classification glass is commonly installed in doors, stairways and evacuation routes, whereas 'B' is mostly used in and between cabins.

Form and function

Another key consideration from a safety point of view is impact resistance, with any glass installed required to have a specified impact safety rating. Impact resistance becomes even more important when the glass forms part of the vessel's structural design. Unlike a building, a boat is a dynamic and moving structure, which will be subject to a variety of unpredictable loads, forces and pressures. As such, it is imperative that the glass is both incredibly strong and also possesses a degree of flexibility.

The use of glass as a building material onboard luxury vessels is often due to its aesthetic value. Glass can have a big role to play in terms of both the boat's external appearance and the experience of passengers onboard; used to create a striking panoramic feature, offer a feeling of luxury and provide passengers with uninterrupted views over the surrounding waters.

Appearances are important. As such, specifying fire safety glass that is certified for butt-jointed applications – meaning the visible supporting framework is significantly reduced – can be ideal, helping to design a more elegant structure.

Finally, there is the issue of weight. Selecting lightweight building materials and not overloading at the design stage can help to reduce the structural weight and benefit the overall ship economy. Materials are needed that satisfy this balancing act between safety and design optimisation.

New design solution

It was a combination of all these five factors that led to the partnership between Pyroguard, the world's leading independent provider of fire safety glass solutions, and its globally respected structural partner and system supplier.

The structural partner wished to offer a fire safety glass wall system that delivered fire protection and an elegant design, all with a lightweight design philosophy. The previous system design was heavy in appearance with thick framework, which not only reduced the overall visual effect but also added a considerable amount of weight. As such, it was

hoped that the development of a new solution would help achieve elegance alongside performance and practicability.

Working with Pyroguard, the team first considered the engineering requirements of the structure needed to support the fire safety glass, followed by further discussions with leading ship designers to gain their guidance and input. From this, a solution was developed that offered both high levels of fire and safety performance, while still delivering a high-impact appearance.

Part of the product development process involved exploring the system design in a 3D environment and undertaking desktop studies, as well as carrying out physical tests, reviewed in collaboration with fire experts. Real-life testing was carried out to examine all aspects of the manufacturing process of the structure and glass system, ensuring compliance with the DNV/MED Product Quality Assurance System.

Unique offering

Following the successful development and testing process, Pyroguard was able to achieve a system certificate that covered butt-jointed fire safety glass from straight to 90-degree corners – a unique offering on the market. Further pushing the boundaries of design, the system is also available in glass pane sizes of up to 2,400mm x 2,400mm.

What does this all mean for the marine market today? Through the combination of Pyroguard Marine fire safety glass and the collaboration with its system supplier, the benefits of this new system are immense. Shipbuilders, designers and owners will be able to benefit from the assurances of fire protection and a full visual experience, as well as less overall structural weight. With the total-system approach, combining the structural framework with the glass as one unique design and build, clients benefit in terms of time and programme savings.

Fire safety glass is undoubtedly a key consideration, both on land and at sea. Within the marine market, glass as a material can be a great and impactful design tool. However, it is important to balance design with safety, performance and weight. With Pyroguard Marine, ship designers, specifiers and builders are now able to do just that. ■

For more information about Pyroguard Marine, please visit: www.pyroguard.eu

COATINGS

TANK COATINGS' ROLE IN SLASHING EMISSIONS AND IMPROVING VESSEL CAPACITY AND AVAILABILITY

The maritime industry is hyper-efficient, and generally there is the opportunity either to improve profitability or to reduce CO_2 emissions. In the vanishing number of cases where there is both, shipowners have generally availed themselves of the benefits already. An exception might be sails, which are expected to be relatively affordable, and can offset fuel consumption by double-digit percentages in some cases.

But the peculiarities of operating certain specific ship types still provide opportunities for a decisive saving. Product and chemical tankers provide one example. In this segment, the vessels must undergo intervals of intensive cleaning; it is inevitable that some small amount of the cargo, in constant contact with the wall of the ship's tanks, will absorb into it, and without an interval of cleaning in between, residues from the previous shipment will go on to contaminate the next. Besides this, a tank coating with absorbed residues from hundreds of different cargoes would be an environmental liability.

Tank-cleaning consists of blasting the tank wall with hot water, sometimes with cleaning chemicals added. The water containing the residues from this process, 'slop', is stored in a special tank onboard the vessel, later to be discharged at a port receiving facility along with other effluents.

This process requires gargantuan volumes of hot water, and this in turn necessitates a massive amount of heating, which can only be performed in-situ. The ship cannot transport anything during its cleaning interval, but it must continue to run its engines as though it is, in order to generate the huge amounts of hot water required for cleaning. It takes 4.2kJ of energy to heat 1kg of hot water by 1°C; producing enough hot water to clean a tank requires unfathomable amounts of energy, all drawn from the vessel's engines and supply of bunker fuel – with considerable efficiency losses, naturally.

A PRISTINE CHEMICAL TANK DOESN'T STAY THAT WAY FOR LONG AND REQUIRES EXTENSIVE MAINTENANCE

With a zinc-coated vessel, typical in the MR segment, crews can be expected to spend 56 hours, on average, hosing off tanks with hot water after each voyage. This means 64 hours' of labour, 56 of them using bunker fuel to generate hot water, and 56 hours of emitting CO_2 – sometimes more. On an annual scale, this means close three weeks out of every year is spent blasting CO_2 into the atmosphere, all while not going anywhere, not transporting anything, nor performing any of the functions for which the ship was built.

The cost of underinvestment

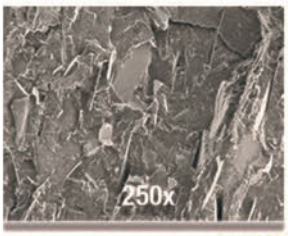
But that is not the end of owners' problems. Because of the dangers of cargo cross-contamination, shipments have to be rotated in a special order to compensate. If the right sort of cargo isn't available – tough luck. The effect on owners' bottom line varies too much on a case-by-case basis to be calculable, but it would be foolish to assume this lack of versatility is not having an impact.

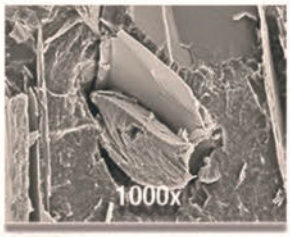
Cheap coatings are certainly available for ship tanks; the aforementioned zinc is a popular choice; phenol epoxy coatings are another. They certainly propose one way of saving on capex for yards, and to some extent for owners. That is, at least, unless they go catastrophically wrong, and generate millions of dollars in repair and recoating costs.

Advanced Polymer Coatings (APC) president David Keehan ought to know, as his company is routinely called in to repair these types of applications, which require patches and recoats of varying degrees of extravagance – and in some cases, a full reapplication from scratch. "We are not a generalist paint company attempting to coat the entire ship," he tells *The Naval Architect*. "That model is becoming less appealing, as operators are now much more aware that when tank coatings go wrong it can cost millions of dollars per ship to repair, plus disruption and lack of availability.

"We do a lot of recoats. A lot of the time it's not necessarily even that the previous coating failed, per se – it might simply be a case of underperforming compared with charterers expectations. We don't have to wait for some big catastrophic failure for the savings to be worth having."

APC's coating, MarineLINE, has been formulated to be less permeable than zinc, modified epoxies, and other





NOVOLAC EPOXY

MARINELINE©

tank coatings. On a microscopic level, it is possible to see this: using high-magnification images taken by the Scientific and Technological Research Council of Turkey, in Ankara, the comparative roughness and uneven surface of the phenol epoxy coating becomes more apparent. Ultimately, an uneven surface has a greater surface area than an even one, providing more for the chemicals to stick to – but it also leaves gaps for these undesired residues to seep into. Once the tank is emptied and the pressure evened out, the coating begins to sweat these residues out, in a process known as 'desorption' – but this can take several days.

But the more even surface of the MarineLINE high functionality polymer coating absorbs less of the cargo, and there is much less to be cleaned out. According to findings drawn from over 500 applications, it takes around 16 hours to clean an APC coating, a fraction of the time for a typical zinc or modified epoxy coating. The difference is stark: instead of incurring about three weeks of off hire time for tank cleaning, a ship operator can reduce this interval to as little as a week.

This is more than theory. Rather than relying on laboratory tests under ideal conditions, APC has made its calculations based on real-world findings, given by third parties – specifically, Guy Johnson, owner of L&I Maritime Ltd, MarinSpec Associates, who is himself drawing on findings from over 1,000 cases.

APC global marine manager Onur Yildirim says: "Obviously, we knew our coating would perform better because that's what we designed it to do, but in terms of our calculations, we based them on the data Guy Johnson has given us.

"On average a vessel consumes 0.6tonnes per hour of fuel oil in the boiler during tank cleaning. Let's assume the vessel has 16 cargo tanks, four of which can be cleaned simultaneously. For a zinc silicate coating, you will also need 200L of cleaning chemicals for each tank, which typically costs around US$3 per litre – MarineLINE does not require cleaning chemicals, depending on the cargoes.

"So, compared with a zinc silicate coating, we can say that cleaning time will be reduced by 48 hours, during which time, 44 hours of hot water washing will be saved. That equates to 26.4tonnes of fuel. There will also be a saving in the cost of cleaning chemicals.

"If we assume the vessel makes US$18,000 per day, typical for this sort of tanker, you're looking at a US$36,000 saving in terms of off hire time. But in this example, you'll also be looking at a saving of 86.3tonnes of CO_2 – about three percent of the ship's annual emissions."

If CO_2 savings are to be made, it is beyond question that the best time to make them is during these cleaning intervals, when the ship is not working. But there are other benefits too.

Changing it up

Each chemical tanker has a smaller tank for the cleaning effluent or 'slop'. But APC has found that with no slop to be stored, additional cargo can be carried in this tank, and sometimes is, providing a small but decisive bonus to profitability. But there is more than one way in which MarineLINE improves vessels' versatility and earning potential.

"What we mean by versatility is: MarineLINE's resistance to absorption makes it possible for owners to switch cargoes more frequently," explains Yildirim. "A typical MR can be expected to carry 85 different chemicals in a year.

Now recently, we've seen charterers making longer agreements, and that makes it less likely that MRs are going to be changing cargoes very often. But anyone who has been paying attention recently will have seen what happened with containers – there were so many ships locked up in long-term charters that the ones available for spot charters made a killing – owners bought them up and made their money back in weeks.

"This can happen in any sector, and there aren't many MRs to go around – certainly, not that many on spot. So, as you can see, equipping a ship with versatility to carry nearly any cargo at any time is not only a general advantage – but, if the circumstances are right, it can improve the profitability of the vessel," says Yildirim.

Future-proof

Shipping is currently facing up to the reality that decarbonisation will only be possible with the use of new zero-carbon or carbon-neutral fuels, and the cost of these is liable to be several times the price of today's fossil fuels. It is here that tank coatings can play their role in helping cut emissions, fuel use and costs and when set against an interval of time in which no revenue is earned, the benefits start to become much more pronounced.

The main benefit of having a proper tank coating, however – and the main factor in providing a return on investment greater than 500% over the coating's lifespan, with up to 10 years, or more, proving quite feasible, as well, is cutting cleaning intervals, reducing off-hire time, and getting MRs back to what they do best. ■

INTERIORS & ACCOMMODATION

THE GRANDEUR OF DANISH INTERIOR DESIGN

By **Bruce Peter**, Professor of Design History, Glasgow School of Art

THE SMOKING SALOON ONBOARD *KRONPRINS OLAV* (BUILT 1937), DESIGNED BY KAY FISKER

Commercial interiors of all kinds are usually ephemeral, few more so than those of modern passenger ships. Nowadays, in any case, the hierarchical organisation of contemporary culture tends to cause architecture and design to bifurcate between the 'artistic' practitioners who design cultural buildings, such as museums, and the 'commercial' ones who design seemingly nearly everything else.

Yet, in an earlier era, between the mid-18th and mid-20th centuries, commercial businesses of many kinds generously invested in the best architecture and design that could be afforded as they felt it important also to maintain high cultural profiles. Shipowners, indeed, were among the greatest patrons of architecture and interior design during this period.

Whereas in much of the shipowning world, it quickly became accepted wisdom that the best way of achieving respectability was to commission traditionally ornate design, in Denmark, almost uniquely, an entirely different approach was applied from an early stage. By the mid-20th century, modern Danish interior, furniture and lighting design was becoming internationally acclaimed for its understated elegance and comprehensive attention to the harmonious resolution of design details – and Danish ship interiors often were among the best examples of this.

But the existing mass of published works on Danish design pay scant attention to its manifestation in ships and so, realising that there was a major gap in the historical record to be filled, I decided to research and write a comprehensive book on the subject, which recently has been published under the Nautilus Forlag imprint of Polyteknisk Forlag in Denmark.

Carl Brummer

The narrative begins in the 1900s when Denmark was in the throes of its own slightly belated industrial revolution and, under the new chairmanship of the rather grand Admiral Richelieu, DFDS commissioned the Arts & Crafts architect Carl Brummer to design interiors for its forthcoming Copenhagen-Kristiania steamships *Dronning Maud* and *Kong Haakon*. Brummer was already known to the management of the shipbuilder Burmeister & Wain, for whom he had designed fashionably English-style villas in the upmarket northern Copenhagen suburb of Hellerup, where such wealthy industrialists tended to live. For the ships' interiors, Brummer used a neoclassical framework, understood also by shipbuilders, but also referred back romantically to the Danish 16th century baroque style of the Northern Renaissance.

As the outcome of this work was considered highly successful, soon Brummer gained further commissions not only from DFDS and B&W, but also from the East Asiatic Company, a rapidly expanding Danish conglomerate that controlled plantations in Thailand and ran a liner service from there to Europe to import raw materials such as hardwood, rice and copra.

For DFDS, Brummer not only drew up the saloons of further coastal steamships, but also provided designs for the entire passenger accommodation of a new Scandinavian-America Line trans-Atlantic liner, *Frederik VIII*, the First Class and Second Class accommodation of which was intended to

MID-CENTURY CHIC: PALLE SUENSON'S SMOKING SALOON FOR *KONGEDYBET* (BUILT 1952)

attract prosperous American tourists, many of whom were of Scandinavian origin and now wished to visit 'the old country' in high style. The East Asiatic Company, meanwhile, commissioned from B&W the revolutionary *Selandia* – the world's first ocean-going motorship – for which Brummer designed luxurious passenger accommodation in the manner of a Danish country mansion (or possibly even a tropical equivalent of such a residence, perhaps in the Virgin Islands, for instance). For what was quite a small combined passenger and cargo liner, *Selandia*'s appointments were indeed most impressive, its main saloon even having a clerestory and French doors on either side to give a cool and light ambience.

Frederik VIII, which was built in Stettin, and *Selandia* both entered service in 1912. These projects cemented Brummer's reputation as Denmark's leading specialist in ship interiors and he gained several other commissions in this field before and after the First World War, comprising further vessels for DFDS and EAC as well as designing for a fresh client, the Danish State Railway, DSB, for whom he produced interiors for the 1922 Denmark-Germany train ferry *Danmark*. A supply industry of specialist craft makers specialising in fine joinery, upholstery, flooring and decorative metalwork also developed, the leading suppliers of luxury fixtures and fittings being the established Copenhagen firms Lysberg & Hansen and C.B. Hansens Etablissement.

Modern design approach

It was in the inter-war era that the modern design approach that most people nowadays bring to mind when thinking of Scandinavian design first emerged. Despite general economic turbulence throughout the 1920s and 30s and the very negative sustained consequences of the Wall Street Crash, the period was characterised by rapid technological and aesthetic leaps forward. In a Nordic context, the Stockholm Exhibition of 1930 was a cathartic event in bringing avant garde design to wide attention in Sweden, Denmark, Norway and Finland – but in Denmark a more traditionally tinctured form of modernism was generally preferred, developed from the national vernacular.

In 1935, once economic recovery from the Great Depression was underway, the Danish domestic shipping company Dampskibsselskabet af 1866 paa Bornholm, which provided daily passenger, mail and cargo services between Copenhagen and Rønne on the Danish island of Bornholm in the Southern Baltic Sea, commissioned the prominent Danish modern architect and academic Kay Fisker to propose up-to-date interiors for its forthcoming new passenger ship *Hammershus*, which at that time was under construction at Burmeister & Wain's Copenhagen shipyard.

For this project, Fisker entirely superseded the standard neoclassical design language used hitherto for such vessels' interiors with a much more slick and up-to-date solution using smooth veneer panels with brass fixing strips and inlaid abstract marquetry murals on the bulkheads. For what until then had been 'Deck Class' passengers, there were saloons featuring photographic murals of aerial views of the island laminated on the walls. When placed in service in 1936, the *Hammershus* caused a sensation.

Very quickly DFDS also commissioned Fisker to produce interiors for its next new ship, the *Kronprins Olav,* which was due for delivery in 1937 from the Helsingør Shipyard for service between Copenhagen and Oslo. With bigger dimensions, there was space inboard for a much more spacious and dynamic treatment of the saloons than there had been on the *Hammershus*.

Post-war evolution

For Fisker and DFDS, the *Kronprins Olav* project was a great success and subsequently his firm was retained to produce an even more developed solution for the interiors for DFDS's forthcoming North Sea flagship, *Kronprins Frederik*, for the Esbjerg-Harwich route. It did not enter service until after the Second World War, however, at which point a sister ship, the *Kronprinsesse Ingrid,* was ordered. These vessels set the tone for the design of DFDS's other post-war new and rebuilt passenger ships – but due to heavy commitments to produce designs for buildings, Fisker no longer wanted to be involved.

Instead, another prominent Danish architect, Palle Suenson, was tried. While his work on the early-1950s DFDS domestic passenger ships *Jens Bang* and *H.P.*

DRONNING INGRID (BUILT 1980) TOOK A UTILITARIAN APPROACH TO DESIGN

Prior was considered very good, unfortunately he fell out with the senior staff of the Helsingør shipyard and so DFDS was forced to look elsewhere. Fortunately, the son of the DFDS chairman was an architect of considerable talent named Kay Kørbing who had earlier worked with Suenson on a project to refurbish the Norwegian North Sea vessel *Venus* after the war.

A decade thereafter, Kørbing produced very thorough designs for the interiors of the new Copenhagen-Oslo passenger ship *Prinsesse Margrethe* of 1957 – a project that attracted positive attention from the international architecture and design press on account of the very high standard achieved with the furniture and lighting, all of which was of bespoke design, and with the specially commissioned abstract murals on the transverse bulkheads.

Prinsesse Margrethe was considered the height of elegance and, in the years that followed, Kørbing produced interiors not only for nearly all of DFDS's subsequent ships, including the 1960s North Sea vessels *England* of 1964 and *Winston Churchill* of 1967, but also some of those in the magnificent Norwegian passenger liners and cruise ships *Sagafjord* of 1965 and *Vistafjord* of 1973, for which he was given responsibility to design the First Class saloons, hallway and suites.

The 1960s arguably was the 'golden age' of Danish design and, aside from Kørbing, other designers also produced fine work – for example Harry Gram Jensen, whom the Helsingør Shipyard employed in-house and who was responsible for, among others, the interiors of the Portuguese liner *Funchal* of 1961.

Democratic ethos

The advent of the Oil Crisis of 1973 caused shipowners all over the world to become much more cost-conscious. Thereafter, it was the Danish state that became the major commissioner of architect-designed interiors for the ferries of DSB and its sister companies. Exemplifying a social democratic political ethos, these were planned as 'public places' for the Danish people to meet and to enjoy the experience of travel.

New Bornholmstrafikken ferries, the Aalborg-built *Jens Kofoed* and *Povl Anker* of 1978-79 with interiors by Niels Kryger, first exemplified this approach – but the subsequent Great Belt train ferries *Dronning Ingrid*, *Kronprins Frederik* and *Prins Joachim* of 1981 were the best examples, being exceptionally rational in their layout and able to accommodate and feed very large numbers of passengers within the brief hour allowed for Great Belt crossings. Kay Kørbing was again responsible, working with DSB's own designers.

In addition to state-owned ferries, there were many built for private-sector commercial operators, such as Juelsminde-Kalundborg Linien, Grenaa-Hundested Linien and Mols-Linien, the latter of which was a DFDS subsidiary. Their interiors were invariably the work of another Danish architect, Mogens Hammer, who later moved on to specialise in the design of cruise ship interiors and, in the latter 1960s and early-70s was responsible for those of Norwegian Caribbean Line's *Sunward*, *Starward*, *Skyward* and *Southward* of 1966-1973 and of Royal Caribbean's *Song of Norway*, *Nordic Prince* and *Sun Viking* of 1970-1972, all of which operated from Miami.

Hammer was not a design ideologue and he sought to please American passengers with design solutions similar to those found in modern resort hotels there. The formula was very successful and, although cruise ships have since become very much bigger, the idea of 'thematic' postmodern interiors was perpetuated and remains the standard default approach of the mass market cruise industry even today.

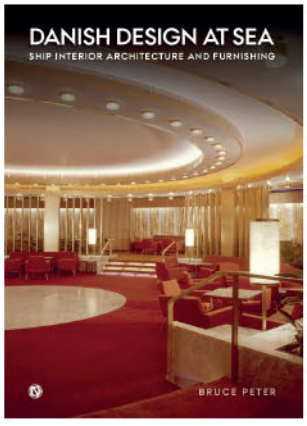
In the latter 1980s and early-90s, the last state-owned Danish ferries – the Aarhus-Kalundborg vessels *Peder Paars* and *Niels Klim* and the subsequent Helsingør-Helsingborg shuttle ferry *Tycho Brahe* – entered service. They were among the most impressively designed Danish ferries yet seen with passenger facilities far in excess of what one might have expected their routes to have required. In the decade that followed, however, the Great Belt bridge opened, superseding much of the Danish domestic ferry fleet, while politically there was a loss of faith in the importance of spending large sums of public money on high-quality design for public transport.

Full circle?

Taking ideas from British political culture, private sector operation of subsidised ferry routes by franchisees came to be preferred to the state operating them directly and this tended to result in cost-effectiveness taking precedence over design quality. In more recent times, however, there has been a revival of interest in what has come to be seen as 'classic' Danish design (meaning mid-20th century modernism) and design from the Nordic region more generally. With hindsight, what was achieved in the 1930s-to-70s period has come to be widely thought of as having been outstanding and so there is now a big international collectables market for modern furniture, lighting and textiles of this period.

The Danish passenger ship interiors of those years were, of course, among the most comprehensively thought through and enveloping examples of environments exemplifying the ideals of Danish modernism, typifying its rigorous planning, fine materials and elegantly understated good taste. ■

Danish Design at Sea: Ship Interior Architecture and Furnishing is a 336-page English language book with a 112,000-word text, fully referenced and over 500 illustrations, many of which have never previously been published. It is available from Nautilus Forlag: https://www.polyteknisk.dk/home/nautilus



HERITAGE

RINA FOUNDER'S FINAL RESTING PLACE

By **Larrie D. Ferreiro**

John Scott Russell (he took "Scott" as his middle name), founder of the Royal Institution of Naval Architects, was born in Glasgow in 1808, and spent his career at the intersection of science and engineering in the heady years of Britain's Industrial Revolution. Unusually for the era, he was both university-educated in mathematics, and apprenticed as a steam carriage maker, after which in 1838 he went into the shipbuilding business.

He studied wave physics and developed the "wave-line" principle for hull design, which became the basis for the clipper ships and fast racing yachts of the mid-19th century. He was most famous for building the passenger ship *Great Eastern* starting in 1853, under contract with Isambard Kingdom Brunel. In 1860, he proposed the establishment of the Institution of Naval Architects – it became 'Royal' in 1960 – and was one of its first vice presidents. Several years later he helped lead the successful drive to establish Britain's first permanent School of Naval Architecture, in London. Russell's remarkable life was chronicled by George S. Emmerson (1977) and more recently by Andrew Lambert (2011).

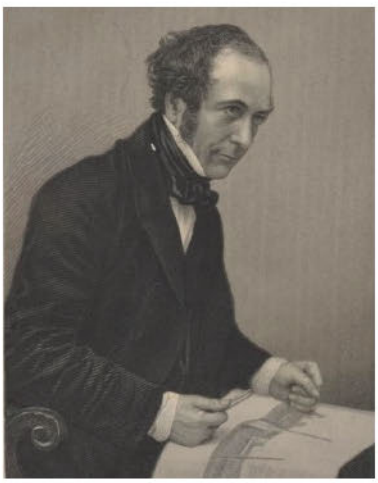


FIGURE 1: JOHN SCOTT RUSSELL (SOURCE: NEW YORK PUBLIC LIBRARY)

FIGURE 3: GRAVESITE MEMORIAL OF JOHN SCOTT RUSSELL (SOURCE: ISLE OF WIGHT COUNTY RECORD OFFICE – HERITAGE SERVICE)

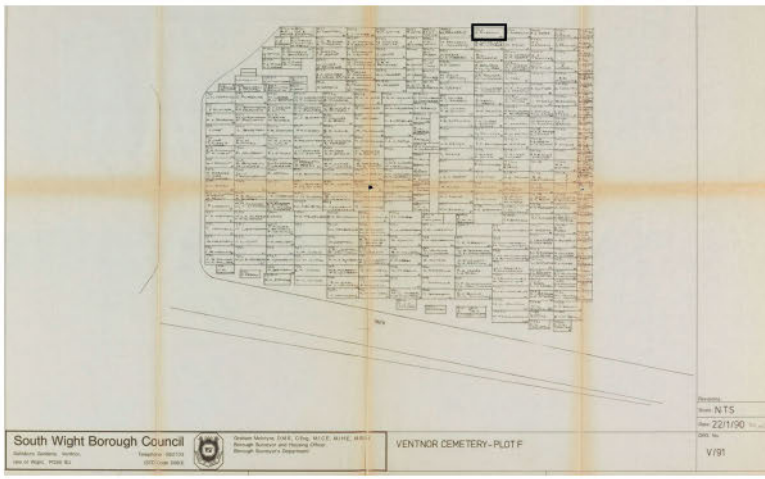


FIGURE 2: GRAVESITE LOCATION OF JOHN SCOTT RUSSELL (SOURCE: ISLE OF WIGHT COUNTY RECORD OFFICE – HERITAGE SERVICE)

Despite his achievements, stature and notoriety – he lived in the posh London suburb of Crystal Palace, and was good friends with Arthur Sullivan, of Gilbert & Sullivan fame – Russell was never offered a knighthood, and gradually saw his fortune wither away. In 1881 after a long illness, Russell and his wife Harriet sold their home and moved to Inkerman Villa on St Boniface Road in Ventnor, Isle of Wight.

He died there on Thursday morning 8 June, 1882, aged 74. He was buried in plot F, grave number 902 of the Ventnor Cemetery (Figure 2), whose entrance is on Newport Road where it intersects Down Lane. His wife was buried next to him, six years later. His grave was marked by a simple stone cross (Figure 3), whose weathered inscription "In Loving Memory of John Scott Russell" is now barely visible under the lichens and moss (Isle of Wight County Record Office, 2018).

It would be a mark of respect for RINA or one of its chapters to attend to Russell's gravesite, restoring its dignity as the final resting place of the founder of this professional society. ■

Larrie D. Ferreiro's book 'Bridging the Seas: The Rise of Naval Architecture in the Industrial Age, 1800–2000', published by MIT Press, is available now from all good booksellers.

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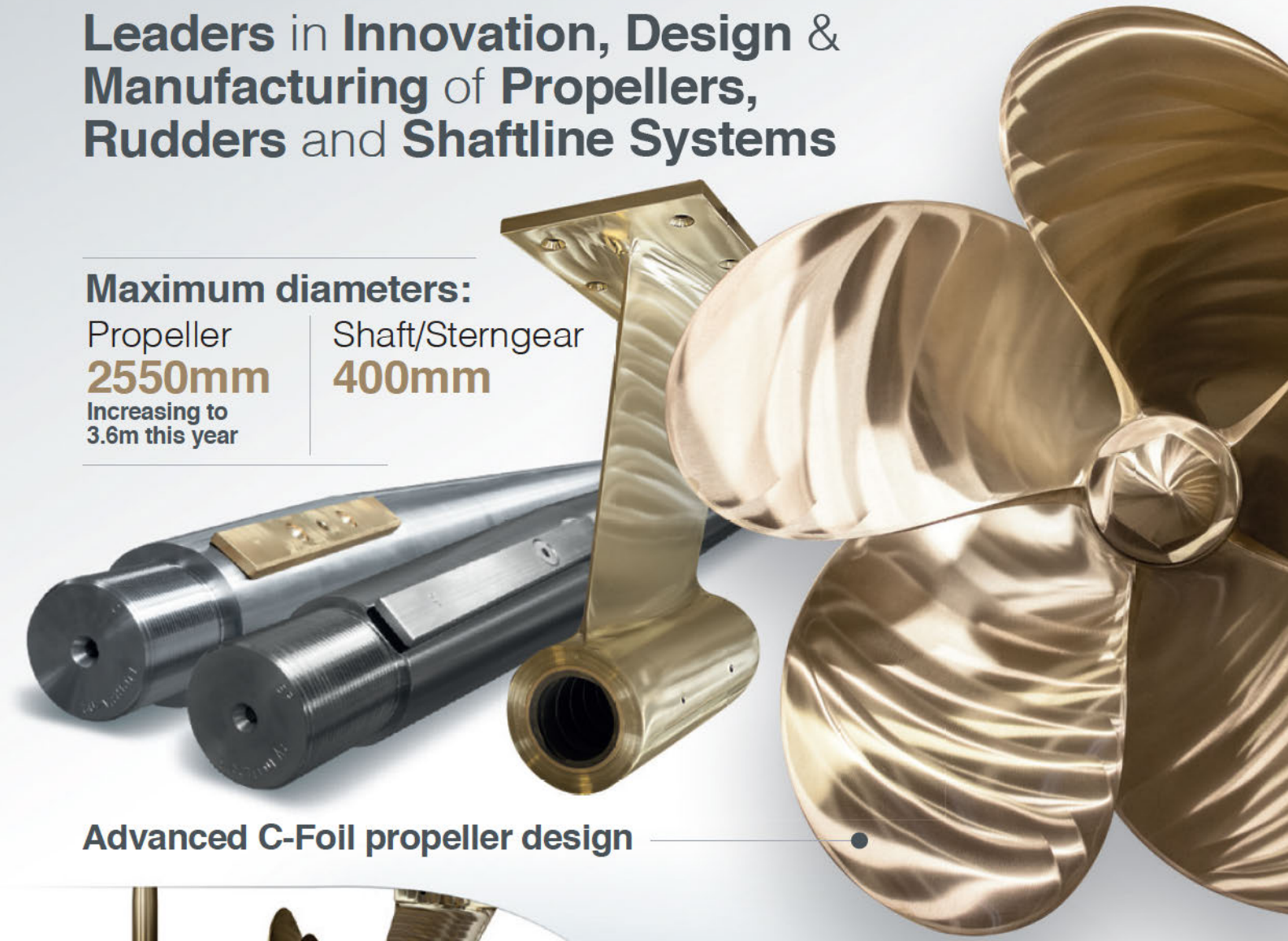

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