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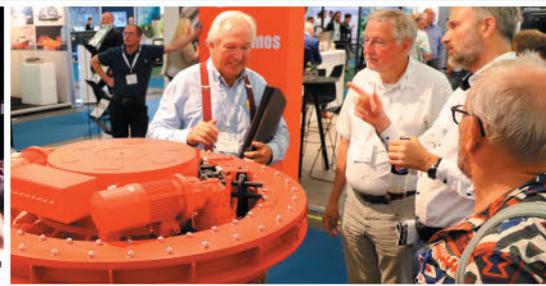
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COAL, CARBON CAPTURE AND THE FALL OF A COALITION

By Richard Halfhide

Recently I reconnected with an old school friend I've not seen in more than 26 years; he moved to Australia around the turn of the century, where he works as a schoolteacher in Melbourne. Even a generation ago emigration to the other side of the world was to effectively say goodbye to much of your old life forever, nowadays it's no more than an email or video call away. Of course, by its very nature the maritime industry was always ahead of the curve when it comes to globalisation and as it grapples with the transition to low- and zero-carbon shipping Australia is set to play a central role, particularly for the Asia-Pacific region.

Previously in the pages of this magazine we've looked at Japan's ambitions to place hydrogen at the centre of its future energy needs, with exports of hydrogen and ammonia from Australia being a key part of that strategy. In January this year, Japanese prime minister Fumio Kishida and Australia's then-premier Scott Morrison signed the Australia-Japan Clean Hydrogen Trade Partnership. These plans mainly focus around the creation of liquid hydrogen from brown coal and biomass at AGL's Loy Yang plant in the Latrobe Valley, from whence it is transported from Victoria's Port of Hastings to Kobe. Japan's inaugural liquified hydrogen carrier, *Suiso Frontier*, took delivery of its first cargo there at the start of this year.

Given that estimates suggest that by 2040 over three billion tonnes of hydrogen could be exported from Australia annually, with a value of AUS\$10 billion (US\$7.2 billion) to its economy, the attraction is self-evident. But as I've highlighted in this column before, the environmental credentials of so-called 'blue' hydrogen are contentious, if not downright fallacious. Detractors of the plans point out that emissions for hydrogen derived from brown coal are reckoned to be double those of natural gas.

Proponents, on the other hand, will point to the abundance of carbon capture and storage (CCS) projects being developed round the world, of which Australia has several. The regularity with which concept designs for liquified CO₂ carriers have been popping up recently (e.g. p.8) tells you all you need to know about how the commercial potential many have identified in this emerging segment. But it's worth bearing in mind that of the 93 active CCS facilities worldwide currently only two currently produce hydrogen, the best of which (in Canada) has a CO₂ capture rate of 80%. In fact, even a best case scenario suggests no more than 90-95% of CO₂ could ever be captured from fossil fuels.

Australia's only completed CCS facility to date, the Chevron-led Gorgon LNG project in Western Australia



LIQUIFIED HYDROGEN CARRIER *SUISO FRONTIER* ARRIVING AT PORT OF HASTINGS IN JANUARY. SOURCE: HYSTRA

– which doesn't produce hydrogen – had a lamentable capture rate of just 32% during its first five years of operation. Gorgon is the largest dedicated CCS project in the world and its advocates point to the fact that some six million tonnes of CO₂ have been stored since operations began proper in 2019, but research conducted by the Australia Institute estimated that if the plant was operating at full capacity over five years then 260m tonnes of CO₂ would be emitted while only 20m tonnes would be captured.

What does this really mean for shipping? Notwithstanding that some clean fuels are anything but, there are also some awkward questions in terms of the carbon capture technologies being touted for use onboard vessels. Back in October of last year, to give one example, Japan's 'K' Line said it had successfully operated a small-scale CO₂ capture plant onboard the coal carrier *Corona Unity*, but there was a conspicuous absence of details as to exactly what proportion of emissions it had actually captured.

The involvement of petrochemicals in CCS strikes me as akin to that of tobacco companies and their pursuit of 'safe' cigarettes; it often appears to be a stalling tactic to continue with business as usual before the full facts emerge. But for politicians it's a dangerous game particularly, as in the case of Australia, when the impact of climate change is already being felt. Morrison's government pinned much of its hopes, and billions in taxpayers' money, in supporting gas projects it hoped could kickstart economic recovery.

It's a gamble that failed and last month the Morrison-led Liberal-National coalition was supplanted by Anthony Albanese and the Australian Labor Party. Although Albanese has declined to phase out coal use he has said that climate change will be a priority and pledged his commitment to renewable energy resources, something the country undoubtedly has in abundance. While that probably won't spell the end of Australian involvement in CCS it may, eventually, put it on safer ground. ■



NEWS

FERRIES

DELTAMARIN AND FENNORAIL TO COLLABORATE ON ECO-FRIENDLY TRAIN FERRY

Finnish naval architects Deltamarin have signed a contract with compatriots Oy Fennorail Ltd for the conceptual design of a train ferry capable of carrying both train and truck cargo.

Dubbed the Eurocarrier, the train ferry would connect Finland to the European TEN-T railway networks, thereby creating a connection from eastern Europe to the Mediterranean. Operating in the Baltic, the Eurocarrier would boast a 1,000 lane metre (lm) capacity for rail cargo and an additional 1,500lm for trucks. It's estimated that some 400,000 annually (1,100 trucks per day) travel on car ferries between Finland and Estonia, with the emissions of road transport five times greater than that on rail, adding up to significant emissions reduction.

In addition, the two companies have set themselves the challenge of creating 'the world's green train ferry' by

optimising the design and selecting machinery compatible with alternative fuels.

Fennorail board member Kaj Jansson explains: "The train ferry will have multi-fuel marine engines that can run on either pure LNG, a mixture of LNG and green hydrogen or Marine Gas Oil (MGO). [The] Ships' propulsion system is arranged by two 360-degree rotating pods which increases the propulsion efficiency and ships manoeuvrability."

Jaakko Lappi, Deltamarin sales manager, adds: "We are very happy that Fennorail with its partners have selected Deltamarin to design this unique vessel, which aims to connect Finland to the European railway network and support the goals of the Paris Agreement by moving part of the road cargo onto rail, offering significant emission cuts per transported cargo tonne-kilometre."

DECARBONISATION

MAERSK ZERO CARBON CENTRE OFFICIALLY OPENS AND ANNOUNCES MORE PARTNERS

After delays of nearly two years caused by Covid, the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping (MMMCZCS) was finally officially opened by CEO Bo Cerup-Simonsen at a reception in Copenhagen in May.

Founded in 2020 by a donation from the A.P. Moller Foundation, the MMMCZCS is a non-profit independent research hub that aims to work with industry, academia and authorities to identify viable decarbonisation pathways. Corporate partners currently include Alfa Laval, American Bureau of Shipping, A.P. Moller – Maersk, BP, Cargill, DP World, Hapag-Lloyd, MAN Energy Solutions, Mitsubishi Heavy Industries, Mitsui, Norden, NYK Line, Seaspan Corporation, Siemens Energy, Stolt Tankers, Sumitomo Corporation, Swire Group, Topsoe, TotalEnergies and V.Group.

Speaking at the opening, Cerup-Simonsen said: "In two years, we have grown into a remarkable mission driven collaboration platform for dedicated people and partners across the ecosystem. We want to use this opportunity to thank our fantastic partners for their engagement, trust and support... This mission has attracted the best people and the best companies from around the world."

Among the latest to sign a Corporate Strategic Partnership with MMMCZCS are Royal Caribbean Group. Jason Liberty, Royal Caribbean Group president and CEO said that by



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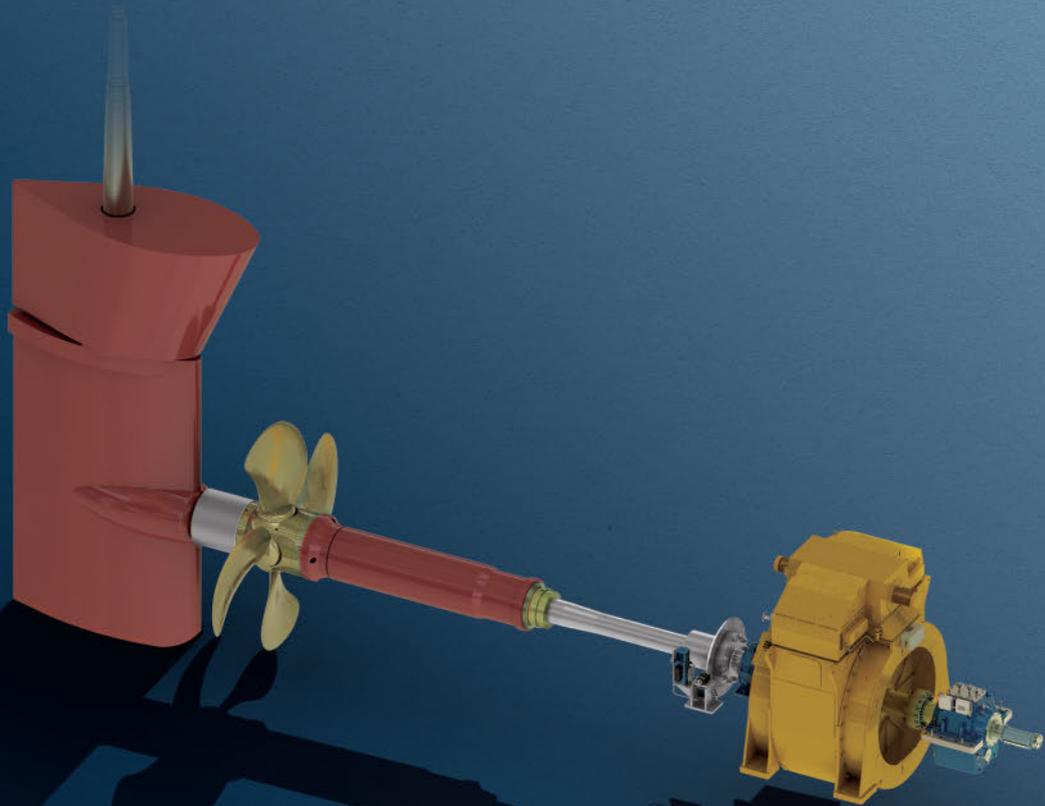
joining the network the cruise operator was aligning itself with "like-minded companies with an unrelenting drive to find solutions for a sustainable future".

Another recent signatory is mining group Rio Tinto, which has said it expects to introduce net-zero vessels into its portfolio by 2030.

"As a cargo owner and leading charterer, Rio Tinto is in a position to make real influence in the industry by acting as a first mover, pushing for change and establishing sustainable value-chain solutions," said Cerup-Simonsen.

At the end of December, RINA and MMMCZCS will partner for the 'Scaling Decarbonisation Solutions – Reducing Emissions by 2030' conference in Rotterdam. Further details can be found at: www.rina.org.uk/Reducing_Emissions_2022





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CARBON TRANSPORTATION

CLASSNK ISSUES AIP FOR MITSUBISHI AND NYK LCO₂ CARRIER

Mitsubishi Shipbuilding and Nippon Yusen Kaisha's (NYK Line) ambitions of building a fleet of large liquid CO₂ (LCO₂) carriers took a further step forward in May with the announcement that ClassNK has issued an Approval in Principle (AiP) to their jointly developed designs.

As has been regularly reported in *TNA*, liquified CO₂ transportation is a rapidly growing niche in merchant ship design with numerous various projects in different stages of development. CO₂ capture, utilisation, and storage (CCUS) is widely seen as one of the most effective means of curbing accumulation of greenhouse gases in the atmosphere.

ClassNK undertook a design review of the LCO₂ carriers developed by Mitsubishi Shipbuilding and NYK Line based on its Part N of Rules for the Survey and Construction of Steel Ships incorporating the IGC Code. AiPs were issued



CONCEPT ILLUSTRATION FOR THE LCO₂ CARRIER. SOURCE: MITSUBISHI

to both the medium and large-scale vessel designs, confirming that the cargo tank systems conform with the requirements of the respective tank pressure settings, as well as the hull design.

CREWING & COMMUNICATIONS

MARITIME LABOUR CONVENTION AMENDMENTS LEARN LESSONS FROM COVID

The Maritime Labour Convention (MLC 2006), the 'seafarer bill of rights' drawn up by the International Labour Organization is to undergo a series of amendments with the aim of improving the working and living conditions of mariners, following a Special Tripartite Meeting of the MLC that took place in May.

Various stakeholders - including governments, seafarers and shipowners from the global shipping industry - have agreed the amendments, subject to approval at the International Labour Conference. They include:

- Ensuring seafarers have appropriately-sized personal protective equipment, in particular to suit the increasing number of women seafarers;
- That good quality drinking water is available free of charge for seafarers;
- States further facilitate the prompt repatriation of abandoned seafarers;
- States provide medical care for seafarers in need of

immediate assistance and facilitate the repatriation of the remains of seafarers who have died on board;

- Seafarers are provided with appropriate social connectivity by shipowners and States provide internet access in their ports;
- Seafarers are informed of their rights relating to the obligation of recruitment and placement services to compensate seafarers for monetary losses; and
- All deaths of seafarers are recorded and reported annually to the ILO and the relevant data is published

Around a quarter of a million seafarers found themselves stranded during the Covid-19 pandemic, when travel restrictions left them unable to be repatriated. A similar number were likewise unable to join ships and thereby provide for their families. The problems highlighted how onboard connectivity has become a necessity for modern seafarers, something now endorsed by the MLC.

SHIP TRANSFERS

OCIMF PUBLISHES FINDINGS OF SHIP TRANSFER STUDY

Trade association the Oil Companies International Marine Forum (OCIMF) has published a new study analysing ship-to-ship (STS) transfers under different environmental conditions.

Mooring Load Analysis during Ship to Ship Transfer Operations is intended to provide support for relevant stakeholders in assessing suitable weather criteria for STS operations. The study used advanced mooring line simulation technology for enhanced assessment

of mooring line loads under different environmental conditions and a variety of shiptype combinations, including LPG and LNG carriers. OCIMF says the study supports the KPIs listed under Element 5 of its Ship-to-Ship Service Provider Management Self Assessment, 2nd edition (2020).

The study is available for download at: www.ocimf.org/publications/information-papers/mooring-load-analysis-during-ship-to-ship-transfer-operations

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GREEN SHIPS

US-GERMAN CONCEPT CONVERTS PLASTIC WASTE INTO CLEAN HYDROGEN

US-based H2-Industries Inc, a global hydrogen generation and energy storage solutions company, has joined forces with German naval architecture firm TECHNOLOG Services GmbH in creating the concept design for a vessel that would collect plastic waste from the oceans and convert it into clean hydrogen.

The novel design, which is currently expected to be around 150m in length, would be capable of travelling at 4knots and work in collaboration with two small vessels towing a 3.2km net which would funnel waste plastic from up to 10m below the waterline. The main vessel's open bow would then collect the plastic and transport it to the storage hold using conveyors.

Then, using the same thermolysis process H2-Industries is already developing for onshore use, the hydrogen would be stored as a liquid organic hydrogen carrier (LOHC) in 6m containers for transportation back to land on smaller vessels. Since this LOHC can only be hydrogen-charged and discharged in combination with H2-Industries' proprietary catalyst technology the stored hydrogen would not be volatile.

It's estimated that for every 600kg of waste plastic around 100kg of hydrogen would be produced. Given the concentration of plastic waste, and the need to calibrate

the processing of this feedstock with the processing capacity of the rotary kilns generating the LOHC, it is anticipated that the vessels will be equipped with multiple kilns.

Typically, a vessel would be expected to operate in one particular plastic-heavy area for around a year, before moving on to the next site. To ensure the protection of marine life during waste collection it is said the vessel will use the same technology that is used for seawater intake for desalination plants.

In addition, the companies claim that since it will be cleaning up the environment, the process can be classified as 'greener than green'. Propulsion would be provided by electric motors powered by the LOHC produced via fuels, which would create electricity using H2-Industries' racks. Each of these racks is capable of holding 48kW of installed power, with multiple racks delivering the roughly 2MW required by a vessel of this size. H2-Industries has separate plans to use this technology for use by large tankers, cruise ships and container ships.

H2-Industries is currently seeking investors for the project, after which it anticipates the first vessel could be delivered within 24 months.

FUEL CELLS

PRELIMINARY APPROVAL FOR HYDROGEN-BASED FUEL CELLS

Class society DNV has awarded preliminary approval to a hydrogen-based energy system developed by Norwegian company HAV Group ASA, complementing similar approval from the Norwegian Maritime Authority (NMA).

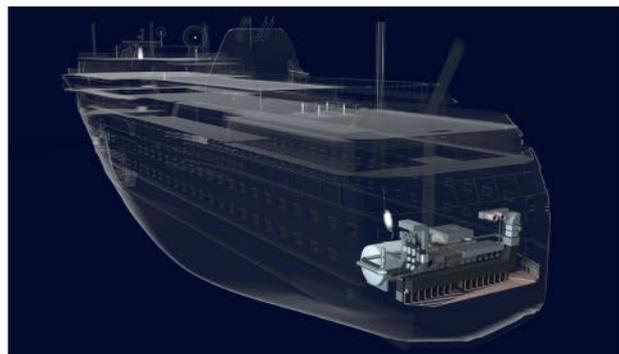
In early May, HAV Hydrogen became one of the first companies to receive approval for a liquid hydrogen tank located below the main deck in compliance with IMO guidelines on alternative design (MSC.1/Circ.1455). The research was funded under the FreeCO2ast Project, a NOK95 million (US\$10.1 million) collaboration also involving Sintef Ocean and Prototech, currently developing a high-capacity hydrogen energy system that will be retrofitted onboard one of Havila Kystruten's coastal cruise ships.

As well as providing third-party verification for the NMA, DNV advisory experts supported HAV Group ASA with a HAZID study and Quantitative Risk Analysis for every aspect of the hydrogen fuel system, including bunkering, storage tanks, the fuel supply system and other auxiliary systems.

Gunnar Larsen, CEO of HAV Group, comments: "Getting a hydrogen energy system off the ground is a complex and very challenging undertaking, and we are very proud to have come this far. Getting to this stage has been the result of four years of cooperation with

our internal and external partners in the FreeCO2ast project and excellent support from experts at DNV. Their guidance has been essential in successfully navigating the Alternative Design process."

The project will now enter its final design stage. HAV Group ASA was formed last year when four established companies – HAV Design AS (formerly Hayward Design & Solutions AS), HAV Hydrogen AS (formerly Hayward Hydrogen AS), Norwegian Electric Systems AS and Norwegian Greentech AS – agreed to join forces.



HAV GROUP ASA'S HYDROGEN ENERGY SYSTEM



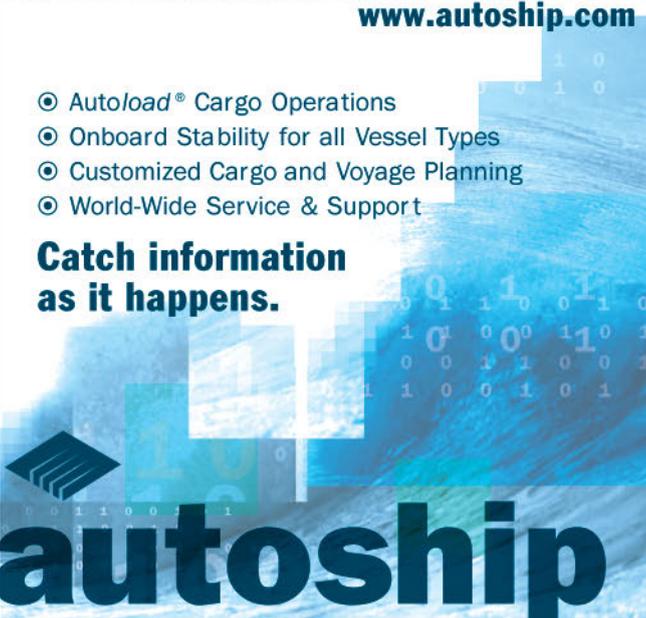
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NEWS ANALYSIS

GETTING GRAIN MOVING AND INCREASING RISKS MATCHES GROWTH IN VESSEL SIZE

By **Malcolm Latache**, Correspondent

Personnel in the shipping industry, both at sea and on shore, can be forgiven if they find themselves becoming weary of overcoming challenges being thrown at them. Coping with increased regulation and increasing demand to move to net-zero would be bad enough, but after two years of restrictions on shipping caused by the Covid pandemic, the resulting congestion to the container sector, increased fuel prices which began in the middle of last year, and which are now exacerbated by events in Ukraine, there appears no end in sight.

At least it seems there is some respite on the cards for seafarers trapped on ships in Ukraine's ports as Russia's apparently taking full control of Mariupol has led to an announcement that foreign ships may soon be permitted to leave. Russia has also reportedly offered to allow ships into Ukraine's ports to load grain in what it describes as a humanitarian move to alleviate global food shortages. Until now, what Ukrainian grain that has moved has been shipped through Constanta in Romania, but that route is limited in capacity and the new harvest will likely cause even more bottlenecks. However, Russia said it would expect some sanctions to be lifted in return.

Meanwhile, there is talk of some nations providing military escorts to any ship that does load, although there has not yet been any firm commitment by any nation. Ukraine remains dubious of Russia's offer believing that if it removes mines laid in Odessa, the port would be vulnerable to an amphibious assault by Russia.

On other fronts, congestion in the container sector may be causing headaches for cargo interests and consumers but it appears to be a golden goose for the liner operators. The latest McCown Container Results Observer report showed six consecutive quarters of record high incomes for the sector. The first quarter of 2022 giving a spectacular US\$59.3 billion profit alone – three times that achieved in the same period in 2021.

May also saw the publication of the annual Safety and Shipping Review by the Allianz Group. The publication offers a valuable insight into shipping casualties and their causes. Last year (2021) showed another improvement in a long term trend which has seen that number of ships lost each year reducing from around 200 in the 1990s to between a quarter and a third of that number.

Last year saw just 54 reported total losses compared with 65 a year earlier. Annual shipping losses have declined by 57% over the past decade since 2012



THE GROUNDING OF CONTAINER SHIP *EVER FORWARD* LED TO A 35-DAY SALVAGE OPERATION IN MARCH AND APRIL. SOURCE: GEORGE MASON UNIVERSITY DEPARTMENT OF POLICE AND PUBLIC SAFETY

(127), while 2021 represents a significant improvement on the rolling 10-year loss average (89), reflecting the increased focus on safety measures over time, such as regulation, improved ship design and technology and risk management advances. Focussing on particular problems, this year's report centred on the problems of larger ships. Values at risk have increased, while the environmental bar has been raised. However, regulation, safety management systems and salvage capabilities do not always appear to have kept pace.

In the past year, fires on board the car carrier *Felicity Ace* and container ship *X-Press Pearl* both resulted in total losses. The large container ship *Ever Forward* ran aground in Chesapeake Bay in the US and was stuck for a month, almost a year to the day after its sister vessel the *Ever Given* blocked the Suez Canal for six days in March 2021.

Fires on container ships and car carriers are, according to the report, emerging trends. There have been over 70 reported fires on container ships alone in the past five years often linked to mis-/non-declaration of hazardous cargo, such as chemicals and batteries. It is estimated about 5% of containers shipped consist of undeclared dangerous goods.

For car carriers, Allianz identified the growing risk associated with Electric Vehicles (EVs). The report said that EVs represent a significant difference in risk profile for shippers when compared with traditional vehicles and may require changes in vessel design, fire detection and fighting capabilities and cargo loading procedures. Fires require a large volume of water to extinguish and cool the surrounding area, which can, in turn, endanger the stability of the ship. ■

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NEWS EQUIPMENT

CAD/CAM

AUTOSHIP SOLUTIONS ASSIST TURKISH DESIGN OFFICE

In addition to producing world-class loading instruments and load planning systems for the shipping industry for more than 40 years, Vancouver-based software solutions provider Autoship Systems Corporation (ASC) is also well known for its highly regarded CAD/CAM suite. The suite consists of a number of integrated programs, each of which performs specific functions for vessel design and construction.

Recently, naval architects Tomay Design of Istanbul has successfully deployed Autoship Pro (hull design & surface modelling) for hull modelling, and its counterpart Autohydro Pro (hydrostatics & stability) in several major engineering projects for its clients. Among these are a multi-purpose vessel, oil spill recovery vessel, mooring boat and a heavy lift accommodation barge (pictured) which is currently under construction.

The company says that the CAD/CAM approach speeds up engineering time, offering higher accuracies of fully faired ships using Autoship Pro, then enhancing that with better definition of the tankers using Autohydro's Modelmaker. The resulting stability report is then submitted to the classification society for approval.

Tomay's founder, Mr T Tombak, and lead naval architect, Mr B Kabasakal, comment: "We feel fortunate as a naval architecture and engineering office to be using these powerful software tools. As an engineering office we need to compete against other firms to deliver quality engineering drawings both in the bid phase and in the final package of drawings for the client. By using Autoship Pro first to define the hull shape and then a seamless import into Autohydro Pro, we're working at a high level of efficiency that pleases our growing client list."



THE SP-HLVA-02 SELF PROPELLED HEAVY LIFT ACCOMMODATION BARGE

EMISSIONS CONTROL

STORMGEO LAUNCHES CII SIMULATOR

Weather intelligence and decision-support solutions provider StormGeo, a subsidiary of Alfa Laval, has announced a new tool that simulates a vessel's carbon intensity.

The Carbon Intensity Indicator (CII) Simulator is said to present a complete view of the ship's CII rating and its commercial impact, allowing shipowners and operators to decarbonise their operations more efficiently while remaining both compliant and competitive.

StormGeo used feedback from clients and shipowners to develop the solution, which is said to be the first on the market. Its functions include assessing environmental performance and computing the compliance status of vessels; providing decision support on meeting environmental goals and commercial obligations; comparing vessel trading patterns against carbon intensity limits; estimating the impact of operation measures on CII performance; and providing a reliable CII through validated and secure data management from ship to shore.

Given the complexity and strict standards of the new

regulatory scheme, StormGeo's CII Simulator is claimed to make it easier to improve environmental performance and achieve decarbonisation targets. Unlike other CII products in the market, it not only monitors the compliance status over the course of a year but also computes any deterioration to forecast next year's CII ratings.

A number of StormGeo's clients are already using the new tool, notably Norwegian pool operator Hansa Tankers, which plans to use the simulator to improve the environmental performance of its fleet.

Torfin Eide, Hansa Tankers' COO, says: "[StormGeo's] out-of-the-box tool makes it easy to measure the CO₂ impact of both pre-fixture and post-fixture emissions results and allows us to readily calculate the final CII based on validated data per voyage and year, including projections for future compliance."

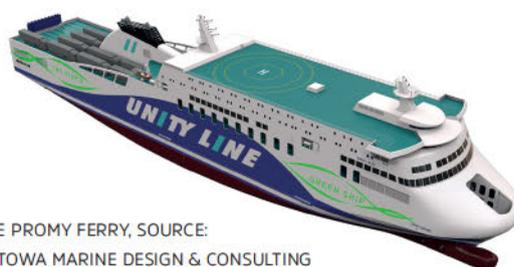
The CII Simulator is available as part of the Environmental Performance Module in StormGeo's s-Insight fleet performance management solution.

CARGO AND DECK EQUIPMENT

MACGREGOR LANDS TRIPLE RO-PAX CONTRACT

Cargotec subsidiary MacGregor has won an order to provide what it calls “comprehensive packages” for a trio of low-emission hybrid ro-pax ferries to be constructed at Poland’s Remontowa shipyard.

The vessels, which are being built for Polskie Promy, will each be 195.6m long, with capacity for 4,100 lane metres and 400 passengers. Each vessel will be equipped with four LNG dual-fuel engines and a battery pack. MacGregor will be responsible for the design, manufacturing, transport and providing installation assistance for the bow and stern equipment, along with internal ramps and doors.



POLSKIE PROMY FERRY, SOURCE: REMONTOWA MARINE DESIGN & CONSULTING

Magnus Sjöberg, SVP for MacGregor’s merchant solutions division, comments: “Remontowa is known for its professionalism, high quality, and long-term environmental efforts, and we are delighted that our know-how and long experience have led them to choose us to deliver this comprehensive set of RoRo equipment for these three RoPax vessels.”

REGULATIONS

HELPING HAND FOR UK EQUIPMENT MANUFACTURERS

The Maritime and Coastguard Agency (MCA) is to provide greater assistance to equipment manufacturers seeking UK Flag State approval ahead of the deadline on 1 January next year.

Previously the certification of marine equipment was covered under EU regulations, with Conformity Assessment Bodies (CAB) conducting the assessments. However, at present there are not enough of these that have passed the UK’s accreditation process. The MCA has therefore relaxed requirements so that CABs currently going through the process will be able to do the work on the proviso they achieve full accreditation by June 2023.

The United Kingdom Accreditation Service will carry out an initial assessment of the CABs who have already applied based on certain sections of the marine equipment regulations. These are all organisations that had previously acted as EU CABs, meaning that providing the necessary evidence to prove compliance should be a formality. However, the MCA will also allow provisional appointments to CABs that haven’t yet applied in the interests of fairness. The additional time granted the CABs should give equipment makers enough time to obtain UK approval and ensure UK flagged ships are able to source UK approved equipment.

Katy Ware, director of UK Maritime Services, says: “We still need manufacturers to keep pushing ahead with the work they need to do to get UK approval for their equipment. This is just a helping hand to help them get across that line.”

KATY WARE, HEAD OF UK MARITIME SERVICES



LUBRICANTS

INFINEUM LAUNCHES SINGLE OIL SOLUTION FOR MAN ENGINES

Lubricant supplier Infineum has received a Main No-Objection Letter (NOL) from MAN Energy Solutions (MAN) for its recently formulated Infineum M8040 additive package.

The Infineum M8040 additive package is specifically designed to enhance operational efficiency as a single oil solution for two-stroke engines running on VLSFO. This means that ship operators don’t need to switch between 40 and 100BN lubricants to maintain a high standard of engine cleanliness. Its optimised feed rate achieves the same level of detergency and cleanliness performance of a 100BN cylinder oil at the same feed rate, helping to lower oil consumption and carbon emissions.

MAN’s NOL follows successful field testing of 2,500 running hours on Very-Low Sulphur Fuel Oil (VLSFO) operations, conducted in collaboration with MES. Additionally Infineum conducted a field test of 1,500 running hours on marine distillate fuel (DMA).

The tests demonstrated the M8040 additive package provides excellent piston cleanliness, achieving the new category II lubricant standards set by MES for its B&W two-stroke Mark 9 engines and subsequent generations. Its detergent and dispersant capabilities control deposit build-up, which in turn reduces wear rate on pistons and liners, translating into improved engine efficiency and less maintenance.

Andrea Ghionzoli, Marine Lubricants Strategic Marketing Manager, Infineum, comments: “We are delighted to receive the Main NOL from MAN ES. We collaborated with MAN ES to conduct rigorous tests on the performance of our Infineum M8040 additive package, which proved to have superior protection, excellent cleanliness and minimum wear rate.”



HRH QUEEN ELIZABETH II

IN CELEBRATION OF HER MAJESTY QUEEN ELIZABETH II'S 70 YEARS OF SERVICE

By Daniel Johnson and Sophie Collingwood

This year, Her Majesty Queen Elizabeth II became the first British monarch to celebrate a Platinum Jubilee, marking 70 years of service to the people of the United Kingdom, the Realms and the Commonwealth. A remarkable achievement and one unlikely to be repeated. Her Majesty's historic reign has had a varied and bountiful impact on the country and its industries, and her influence on maritime is not to be overlooked.

Several significant vessels in the history of British maritime have been named, launched and blessed by the Queen. Notably, Her Majesty embarked on the Royal Yacht *Britannia* for the first time in 1954, for the final stage of her Commonwealth Tour. *Britannia* sailed over a million miles collectively for the Royals, carrying out 968 official voyages across the globe over its 44 years' service.

Britannia's decommission was first announced by John Major's government in 1994, and the ship ultimately set sail for the last time in 1997. *Britannia* departed from Portsmouth, taking a farewell tour around the United Kingdom, calling at six major ports along the British coastline. The Queen was said to be deeply saddened by the occasion; *Britannia* had originally been designed for her late father, King George VI, who had taken a keen interest in the vessel's design.

On the day Her Majesty was piped ashore from *Britannia* for the final time, in a ceremony to mark the occasion (accompanied by the band of HM Royal Marines playing



THE ROYAL YACHT *BRITANNIA* ON HER FAREWELL TOUR AROUND THE UNITED KINGDOM. SOURCE: CREATIVE COMMONS

'Highland Cathedral'), it was reported to be one of the only occasions the Queen shed a tear in public.

Following the ship's launch on 16 April 1953, held at the Clydebank Shipyard of Messrs. John Brown & Co. (Clydebank) Ltd, HM The Queen expressed the importance of the vessel, both to herself and the Royal Family: "It has been a great pleasure to come to Clydebank today and once again to launch a ship in John Brown's yard. This time it means more to me than ever before, because the *Britannia*, which is now floating in the waters of the Clyde, is not only the most modern addition to a long line of royal yachts which goes back to the reign of King Charles



SEVENTY YEARS AFTER THE TREATY ESTABLISHING THE UNITED NATIONS IMO WAS ADOPTED, HER MAJESTY QUEEN ELIZABETH II MARKED THE OCCASION AT IMO HEADQUARTERS IN LONDON. SOURCE: IMO

THE ROYAL FAMILY, INCLUDING THE THEN PRINCESS ELIZABETH, WITH GUARD OF HONOUR ON THE DECK OF HMS VANGUARD IN CAPE TOWN, SOUTH AFRICA, 1947. SOURCE: THL IMAGE COLLECTION

the Second, but she is to be at times the home of my husband and myself and of our family.

"I am sure that all of you who are present here realise how much the building of this ship meant to the late King, my father. He felt most strongly, as I do, that a yacht was a necessity and not a luxury for the head of our great British Commonwealth, between whose countries the seas is no barrier but the natural and indestructible highway. With the wise advice of the Admiralty and of your firm, he laid the plans of a vessel which should wear the Royal Standard in days of peace and which, in the event of a war should serve the cause of humanity as a hospital ship."

The Queen has also been involved in a number of major passenger vessels. In 1967, she christened Cunard's *Queen Elizabeth 2*, her first role as godmother. In 1995, she named P&O *Oriana*, her first P&O Cruises ship. She also officially named P&O Cruises' *Britannia*.

Her Majesty has a deep, personal connection to the Royal Navy and was born into a family steeped in service with the Royal Navy. She is the daughter and granddaughter of monarchs who served as young men in the Royal Navy. Her grandfather, King George V, served from 1877-1892. His son, the future King George VI, followed in his footsteps, and whilst a sub-lieutenant he saw action during the Battle of Jutland in 1916 onboard HMS *Collingwood*.

She later married Prince Philip, a serving naval officer, and has spoken affectionately and publicly of her time spent as a naval wife in Malta during 1949-1951. Two of Her Majesty's sons, the Prince of Wales and the Duke of York, served with the Royal Navy from 1971-1976 and 1979-2001 respectively.

To mark the Queen's Platinum Jubilee, an exhibition celebrating Her Majesty's loyal service to the Royal Navy, both official and personal, has opened at the



National Museum of the Royal Navy, Portsmouth Historic Dockyard. Scheduled to run until October 2022, it captures the wide variety of duties, from the launching of ships, visits to personnel and the presentation of Queen's Colours to the aforementioned world tours on the Royal Yacht and fleet reviews.

Since childhood, the Queen has visited countless naval warships and shore establishments meeting sailors, Royal Marines and their families. She launched her first naval vessel, the fast battleship HMS *Vanguard*, in 1944, aged just 18. Since then she has launched numerous others, including HMS *Dreadnought*, the Navy's first nuclear-powered submarine, on 21 October 1960.

There have been seven fleet reviews during the reign of Queen Elizabeth II including one in 1953 to celebrate Her Majesty's coronation. Held at Spithead, just off the coast of Portsmouth, it is remembered for its sheer scale and spectacle. On HMS *Surprise*, the Queen sailed past more than 300 ships, including two squadrons of submarines, and watched a fly past from the Fleet Air Arm. The most recent fleet review was held in 2005, to mark the bicentenary of the Battle of Trafalgar.



HER MAJESTY THE QUEEN TAKES THE SALUTE AT THE COMMISSIONING OF HMS QUEEN ELIZABETH. SOURCE: ROYAL NAVY



THE SHIPS IN PROCESSION SAILING THROUGH THE LINES OF ASSEMBLED WARSHIPS AT SPITHEAD DURING THE CORONATION REVIEW OF THE FLEET BY HM THE QUEEN, 15 JUNE 1953. OIL ON CANVAS BY PE GARBUTT. COURTESY OF THE NATIONAL MUSEUM OF THE ROYAL NAVY



The Queen has been a regular visitor to Nelson's famous flagship HMS *Victory*. Launched in 1765 at Chatham Dockyard and commissioned in 1778, the *Victory* stands today as the world's oldest commissioned warship – still manned by officers and ratings of the Royal Navy, the *Victory* has seen 244 years' service as of 2022.

Her Majesty paid testimony to her close, emotional connection to the Royal Navy at the commissioning ceremony of HMS *Queen Elizabeth* on 6 December 2017, declaring: "As the daughter, wife and mother of naval officers, I recognise the unique demands our nation asks of you and I will always value my special link with HMS *Queen Elizabeth*, her ship's company and their families."

The £3 billion aircraft carrier is one of the most advanced warships ever built by the Royal Navy and will be on operations for the next 50 years. Six shipyards were commissioned to build the vessel with 11,000 people involved in the construction process.

"Like HMS *Victory*," proclaimed Her Majesty, "HMS *Queen Elizabeth* embodies the best of British technology and

innovation – a true flagship for the 21st century. The most powerful and capable ship ever to raise the White Ensign, she will, in the years and decades ahead, represent this country's resolve on the global stage."

Her Majesty has also been a figurehead for events crucial to the maritime industry. In 1983, the Queen opened the International Maritime Organization (IMO) headquarters in London, England. Years later, in 2018, she was once again in attendance at the headquarters, marking 70 years since the treaty establishing the United Nations IMO was adopted. During his speech to mark the visit, current IMO secretary-general Kitack Lim spoke of Her Majesty's links with the IMO and of the Queen's "deep personal interest in ships and the sea".

As Royal Patron or President of over 600 charities, military associations, professional bodies and public service organisations, the Queen is integrated into every faction of British life. The Royal Institution of Naval Architects is honoured to have the Queen as a patron and we extend our warmest wishes to Her Majesty on the momentous occasion of her Platinum Jubilee. ■



THE ROYAL FAMILY, INCLUDING HRH PRINCESS ELIZABETH, ARRIVING AT PORTSMOUTH ONBOARD THE HMS VANGUARD AFTER A TOUR OF SOUTH AFRICA, 12 MAY 1947. COURTESY OF THE NATIONAL MUSEUM OF THE ROYAL NAVY



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GREEN SHIPS

GSI LEADS CHINA'S MOVE INTO METHANOL

Building China's first methanol-fuelled newbuilding is GSI's latest step on its journey with new fuels



STENA PRO PATRIA, THE FIRST METHANOL POWERED DUAL-FUEL TANKER CONSTRUCTED IN CHINA, UNDERTAKING SEA TRIALS APRIL 2022

Guangzhou Shipyard International (GSI) made headlines in April when it began sea trials with its latest newbuilding, the 49,999dwt tanker *Stena Pro Patria*, the first methanol-fuelled ship to be built in China.

After nearly four weeks and 3,000 miles of tests, as this issue went to press the ship was due to be handed over to Proman Stena Bulk, a joint venture between Sweden's Stena Bulk AB and Switzerland-headquartered Proman. Two sisters are due to be delivered later this year and three more have been ordered to the same design.

GSI has already established itself as a prolific builder of dual-fuelled ships, with 32 such vessels among its references, including its current orderbook. Yet even though it has gained experience from building LNG and LPG capable vessels building these methanol-fuelled ships "is a massive achievement for all parties involved", said the yard's vice president William Zhou in a statement to mark the start of sea trials.

"GSI is absolutely committed to leading innovation in alternative fuelled ships and these [newbuildings]

can go a long way in showing how methanol can be deployed safely and at relatively low cost", he added.

Speaking to *The Naval Architect* after the trials had ended, Mr Zhou comments they had taken five times as long as normal – 25 days instead of the usual five – which he says underlined the challenge presented by this first ship to use methanol technology. The additional time was spent tuning all the various systems to ensure they were all working at their best,



GSI SHIPYARD VICE PRESIDENT WILLIAM ZHOU

GSI HAS ALREADY BUILT OR RECEIVED ORDERS FOR 32 DUEL-FUELLED VESSELS

he explains. Sea trials on the remaining ships in the series will not take so long, he adds.

Supply chains and safety

Despite being familiar with dual-fuelled tonnage, building this first ship for methanol propulsion required some changes in the yard's established routines, in particular its supply chains, to source the specific systems needed for the new propulsion and fuel arrangements. For example, different pumps and automation controls were needed.

As a result of its experience of sourcing equipment for these ships, its newly-formed Marine And Technology Research Centre (see 'Research team' box) is planning to design and produce a methanol fuel oil supply unit. "We need to control costs and provide a good product to the market, so we decided to design and even supply the system", Zhou explains.

It has been safety-related factors that have formed the main area of yard investment, specifically prompted by the move into methanol-fuelled ship construction. Because it is a new fuel to the marine sector, "people are not as familiar with its characteristics" as those who use it in shore-based industries, Zhou says. So being safety-conscious "is very important for people handling the new fuel on board, during bunkering and during commissioning".

Design innovation

As far as the ship design and construction was concerned, compared with a single-fuel ship, the location of the methanol storage service tanks had to be considered and the engine room layout had to be arranged to suit such requirements as double-walled piping and ventilation.

But "the most outstanding difference is of course the main engine", along with its methanol supply system,



Zhou says. And because methanol is a low-flashpoint fuel, "the whole system required a serious third-party risk assessment".

GSI designed the ship and the risk assessment Zhou refers to was carried out by DNV Maritime Advisory, specifically to review the methanol fuel system's design to confirm that it met the requirements set out in the International Code of Safety for Ships Using Gases or Other Low-Flashpoint Fuels (known as the IGF Code).

Yet despite these potential risks, "methanol-fuelled ships systems are less complicated than those of LNG and LPG-fuelled vessels", Zhou tells *TNA*, echoing a comment he had made at the start of the sea trials when he observed that "these ships can go a long way in showing how methanol can be deployed safely and at relatively low cost."

His comparison is founded not only on its latest newbuilding project but on extensive earlier investigations. "As soon as classification societies drafted rules on using methanol as fuel, GSI began to get involved," Zhou says. "We did research on methanol in advance and communicated with equipment manufacturers and class," which enabled it to take on this first Chinese-built methanol-fuelled ship, "and no one has followed us yet," he adds.

RESEARCH TEAM FOR FUTURE FUELS

GSI has recruited a research team of more than 100 people to develop "more sophisticated ship designs, mainly for new fuels", the yard's vice president William Zhou tells *The Naval Architect*.

They form the staff of a GSI-owned Marine and Technology Research Centre, which began work in March. Its work is exclusively for the yard, but Mr Zhou does not rule out that, in the future, it could accept third-party work.

It is based in offices nearer to Guangzhou than the yard – which is about 70km from the city – and in a more urban setting. Its location was chosen because "it is easier for the company to pick up the talented and higher-educated people" needed for such work, he explains.

Both the research department and the yard are located within Nansha District, which was identified nearly 30 years ago as an area for high-tech investment, initially being part of the Panyu District and called the Nansha Technology Development Zone. It became a district in its own right and renamed Nansha District in 2005.





GSI SHIPYARD CHINA

Other fuels

Methanol is not the only fuel GSI has been exploring. In his statement at the start of Stena Pro Patria's trials, he compared methanol with other alternative fuels, such as ammonia, bio-methane and hydrogen, saying: "those fuels will have their place in the future and GSI is working on developing these technologies, having secured AIPs [Approvals in Principle] from class societies."

Zhou says that he was referring to an AIP from ABS for ammonia fuelled tankers "and we are working on the R&D of hydrogen-fuelled vessels and hope to

receive AIP certification soon."

Hydrogen is the ultimate green fuel, he believes, since it produces only water, but it is difficult to store and its energy density is low. He views methanol and ammonia as hydrogen carriers and says that they can be green fuels if they are produced from green hydrogen and waste CO₂, in the case of methanol, and with green nitrogen, separated from the air, to make ammonia.

This technology is neither new nor complicated, he concludes; "I'm sure this will be the future." ■

GSI GOES GREEN AND CLEAN

It is not just its latest ships that are using green technology; for the past three years, GSI has been upgrading its systems and retraining its management to improve its environmental standing.

Those efforts have already borne fruit, with the yard awarded Green Shipyard status by Guangzhou's local government last year. The scheme recognises efforts made across the industrial sector, but GSI is the only shipyard in the region to meet its requirements.

In a statement in April, the yard listed some of the environmental improvements it had made, which contributed to its successful assessment:

- Better sewage and rust treatment systems;
- Collection systems for volatile organic compounds (VOCs);
- Industrial garbage treatment systems;
- Recycling contaminated coatings buckets;
- Fume extraction systems for steel cutting and painting; and
- Reducing industrial waste by 2,000 tonnes per year.

That final pair of initiatives enabled the yard to meet two Chinese environmental standards: the Shipbuilding Air Emission Control Standard and the Zero Waste Factory Standard.

Speaking to *The Naval Architect*, yard vice president William Zhou explains how some of these improvements had been achieved, highlighting one operation in particular that formerly created significant waste material: grit blasting. GSI now uses high pressure water, which not only leaves no waste grit but also eliminates steel dust caused by the previous abrasive method.

More than RMB30M (US\$4.5M) have been invested in machinery to deal with a variety of wastes, including the used paint buckets. In addition, much of the yard's paint is now stored in stainless steel intermediate bulk containers (IBCs) which typically hold about 1m³ of liquid and have their own mixing equipment. These IBCs can be reused, reducing the number of individual paint buckets required.

GSI's fume extraction systems address both welding and painting, in particular to remove the VOCs produced when painting construction blocks in enclosed painting rooms. The fumes are passed through a treatment plant that removes pollutants from it so that it meets Guangdong Province's standards for air pollution, Zhou says. A third party regularly tests the emissions at the exhaust outlet, he adds.

To ensure that all these technical initiatives are effective, GSI's management strategy has also been brought into line. Two years ago, an environmental

manager was appointed, with PhD-level expertise, who is dedicated to ensuring that the yard's green and clean policies are introduced effectively.

ABOUT THE YARD

GSI has a long history dating from 1914 but its facilities are modern and it is the largest shipbuilder in South China. It is a state-owned company, part of China State Shipbuilding Corporation.

It is located in Longxue Island in China's Nansha District, about 70km from Guangzhou, which is near Hong Kong and Macau. The yard covers an area of 300ha, with two large docks, four berths and four 600tonne gantry cranes.

GSI specialises in building the full range of crude, products and chemical tankers, VLOCs, large container ships, high-tech ships such as, semi-submersible ships, ropax/Roro/PCTC vessels and polar ice-class vessels.

It can design, construct and repair vessels up to 400,000dwt and its annual shipbuilding output can reach up to 3.5Mdwt.

Every manager has been trained in the importance of environmental progress through a series of courses that all executives have attended, with more to come. Zhou confirms their value, noting that his own management approach has changed as a result.

In addition, taking an environmental approach has an impact beyond the yard, he says, with customers increasingly looking for partners that share their own environmental, social and governance (ESG) objectives.

Zhou points to the number of high-profile international companies that have worked with GSI, saying that they "feel very comfortable cooperating with a shipyard like us". It is not just its direct customers who must be satisfied, however; charterers who supply tonnage to such operators may also have to demonstrate they are using acceptable contractors, such as GSI.

He is confident that its environmental initiatives set GSI apart and match its customer's standards. Taking all its initiatives together, he asserts, "I am sure we are the number one in China". ■



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FUEL CELLS SET TO BE A KEY INSTRUMENT IN DECARBONISING THE SHIPPING SECTOR

By Daniel Johnson

Of the various clean fuel alternatives currently being piloted to help reduce the maritime industry's climate impact, it would appear that hydrogen is an early favourite; the latest edition of the Getting to Zero Coalition's 'Mapping of Zero Emission Pilots and Demonstration Projects' shows an increasing focus on hydrogen-based fuels – of the 203 projects examined, nearly half of these initiatives focused on hydrogen as a low-carbon fuel source. It is argued that a key advantage of hydrogen over other fuel alternatives is the relative ease of retrofitting existing ships with hydrogen fuel cells.

"Thanks to their success in heavy-duty land vehicles, fuel cells are now finding their way into vessels," Thomas Therkild Peterson, product line manager, Marine, Ballard Power Systems Europe, tells *The Naval Architect*. "Being a viable, true zero-emission option, fuel cells are the solution that will put the marine industry on a zero-emission path. The technology will play a big role in helping ship operators and owners reach the requirements set by the IMO and other bodies."

"Already now hydrogen fuel cells can power ships over medium distances and progress is being made to make this technology capable of powering large ocean-going vessels," he adds.

While no large ocean-going vessels have been tested with hydrogen yet, hydrogen-powered coastal and inland ferries and smaller shipping vessels have been piloted around the globe, including in Belgium, France, Norway, Japan and the United States.

With some maritime organisations looking to batteries to power the shipping sector of the future, Therkild Peterson argues that although batteries can be a good zero-emission power solution for smaller vessels that operate with short duty cycles, they are heavy and have a relatively low power density, therefore their practicality is limited for many applications.

Longer range, flexible refuelling and scalability

The key benefits of fuel cell solutions, he says, include a longer range, fast and flexible refuelling and a modular design for scalability. "Hydrogen has a much higher energy density than batteries," he says. "Fuel cell-powered vessels have a longer run time and travel farther before the need for refuelling. The vessels can be refuelled quickly and hydrogen can be stored in large gaseous or liquid hydrogen facilities allowing for convenient refuelling when you get to port.

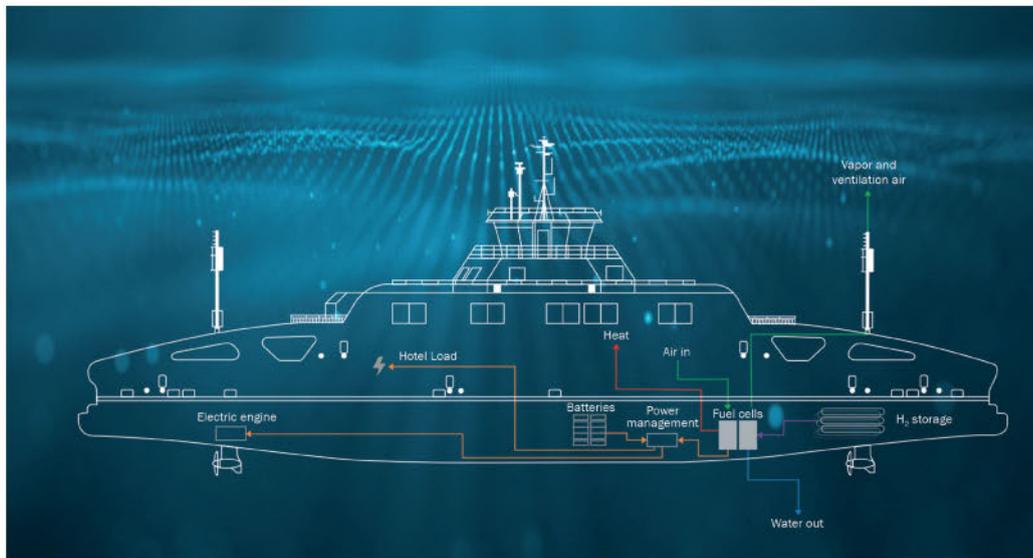
"Also, with a modular design for scalable solutions, the fuel cell modules are installed in parallel, dispatchable configurations to meet variable power requirements. These flexible solutions adapt well to vessel space constraints."

A fourth benefit is that they offer stable, reliable power. "Hydrogen fuel cells have proven their performance in thousands of heavy-duty vehicles for many years," explains Therkild Peterson. "They require very little maintenance, have low maintenance cost and an extremely long service life.

"As long as fuel is available in the hydrogen storage, the fuel cell power systems will produce electricity as a



THE FCWAVE IS A 200KW MODULAR UNIT THAT CAN BE SCALED IN SERIES UP TO THE MULTI-MEGAWATT (MW) POWER LEVEL



FCWAVE MODULES
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generator. The only emissions from a fuel cell are water, water vapour and heated cooling water. When fuelled by renewable hydrogen, a fuel cell power system is a true well-to-wake zero-emission power solution."

When combined with batteries in a hybrid architecture, fuel cells provide all the positive operation and fuelling aspects of ICE/batteries combinations – without the emissions, he adds.

First type approval

Ballard Power Systems' proton exchange membrane (PEM) fuels cells are already used in the electrification of other transport modes, including buses, trucks, trains and cars, and boast a record of having powered commercial heavy- and medium-duty motive applications for a total of more than 100 million kilometres on roads around the world. Now, the company has received Europe's industry first type

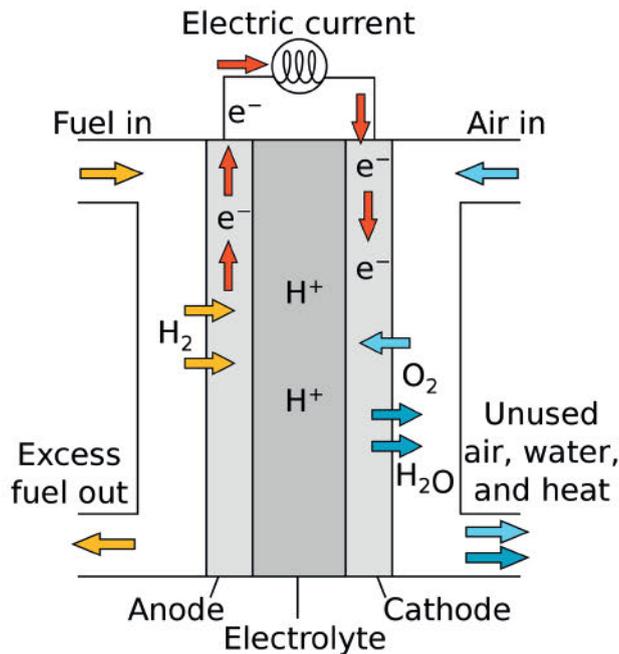
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SCHEMATIC PICTURE OF THE OPERATING PRINCIPLE OF A TYPICAL PEM FUEL CELL

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"For shipowners, the FCwave offers an ease of integration, shorter implementation and vessel approval processes and therefore a reduction in overall costs through proven and certified technology. For operators, it is the first implementation ready solution with a viable potential for economies of scale paving the way for volume applications including larger fleets," Østergaard Hansen tells *The Naval Architect*.

FCwave onboard

Two of the 200kW FCwave modules have been delivered to ferry operator Norled, one of Norway's largest ferry and express boat operators. The modules will power the world's first liquid hydrogen-powered ferry, the MF *Hydra*, later this year.

approval by DNV for its new marine fuel cell module FCwave. The type approval marks an important step in commercialising the fuel cell technology for marine applications, according to Søren Østergaard Hansen, general manager, Marine, Ballard Power Systems Europe.

"Type approval from DNV is highly important in building market confidence in hydrogen fuel cells and validates that FCwave is designed, tested and prepared for installation. The module enables us to deliver the first deployment-ready fuel cell solution, capable of helping the marine sector take the next steps in implementing zero-emission operations," he says.

FCwave has been developed at the Ballard Power Systems' Marine Center of Excellence in Hobro, Denmark, where manufacturing will also take place. It is designed to run on both liquid and gas hydrogen. "FCwave is built on proven components from Ballard's heavy duty module portfolio to deliver reliable performance, high power density and favourable economics. Its size and weight is minimised to make the product easy to integrate in different types of vessels," says Østergaard Hansen.

The product is a 200kW modular unit that can be scaled in series up to the multi-megawatt (MW) power level. It has a compact footprint, with up to 1.2MW (six modules) on a single skid taking up less than 5.5m² of floor space. A low total-cost-of-ownership is achieved through product performance optimisation, common components across product platforms and low maintenance requirements, according Østergaard Hansen.

Designed hand-in-hand with industry to withstand the rigors of the marine environment and meet stringent safety standards, FCwave includes a secondary protection barrier, which separates ATEX Zone Class 2 zones from non-hazardous zones. This means the entire installation room would not require a 'Hazardous

Delivered to Norled by Westcon shipyard last summer, MF *Hydra* is the first hydrogen-powered ship to be approved by the Norwegian Maritime Directorate, the Norwegian Directorate for Civil Protection and Emergency Planning (DSB) and DNV. The vessel has a capacity of up to 300 passengers and 80 cars and will sail on the triangular route between Hjelmeland-Skipavik-Nesvik in Norway.

The Norwegian government has introduced an action plan for green shipping with an ambitious goal to reduce emissions from domestic shipping and fishing vessels by 50% by 2030. This also includes the introduction of requirements for zero-emission cruise ships and ferries in its World Heritage fjords no later than 2026.

"This is a pioneering project. It represents a significant turning point for both Norled and the rest of the maritime sector. We believe that hydrogen will play a significant role in the future of zero-emission ships," Erlend Hovland, chief technology officer at Norled, comments. "The delivery of the fuel cell modules from Ballard enables us to continue our work to deliver and operate the world's first ferry to be fuelled by liquid hydrogen."

"We are delighted that FCwave is onboard, offering uncompromised performance, reduced fuel consumption and an overall zero-emission passenger experience," says Østergaard Hansen.

"There is absolutely no doubt the FCwave is the long-awaited breakthrough in commercialising fuel cell modules in the maritime. As a commercially available product it can act as a catalyst in accelerating net-zero technology and unlock fuel cell power for vessels operating both in short-sea and also the longer demanding long-haul routes through faster implementation time and increased confidence in fuel cells as a zero-emission solution," he concludes. ■

ZEEDS TACKLES THE LOGISTICS OF CARBON-FREE SHIPPING

By Daniel Johnson

As the shipping industry moves towards cleaner fuels, it is clear that in addition to transforming the shipping fleet, it will also need to address the logistics aspects of its operations. Today's alternative fuels aren't able to compete with heavy fuel oil (HFO) for mileage, and green ships will have to deviate off course repeatedly to refill, resulting in increased congestion in already overcrowded ports.

Three years ago, six companies in the Nordic countries launched a joint project to pool their maritime expertise to tackle this dilemma. Initiated by Finnish technology group Wärtsilä, founding partners of the Zero Emissions Energy Distribution at Sea (ZEEDS) initiative also include ferry and logistics specialist DFDS, shipowner Grieg Maritime Group, engineering expert Aker Solutions, multinational energy major Equinor, and engineering, procurement and construction (EPC) leader Kvaerner.

The consortium's concept was to create a chain of offshore clean energy hubs strategically located close to Northern Europe's busiest shipping corridors capable of producing, storing and distributing renewable fuels to vessels in transit, thus eliminating the need for clean-powered vessels to make frequent shore deviations to refuel.

"If successful, the same model could be scaled up to serve global trade lanes supplying the world fleet," explains Matt Duke, CEO of Grieg Maritime Group.

Since its launch in 2019, ZEEDS has attracted participation from over 60 different companies and added three new workstreams: green ammonia propulsion, green ammonia distribution vessels and a green ammonia onshore supply chain infrastructure, which will serve as a pilot concept for the offshore energy hub concept.

Green ammonia supply chain

The initiative has now moved a step closer to the realisation of a project to develop its first green ammonia supply chain for shipping after securing a key class approval for a proposed newbuild bunkering tanker to transport the fuel, with classification society DNV granting Approval in Principle (AiP) for the *MS Green Ammonia*, which will both run on and carry the fuel as cargo.

"That means the vessel concept being developed by Wärtsilä and Grieg Edge is feasible and can now be realised, with planned delivery of the newbuild in 2024," according to Nicolai Grieg, head of Grieg Edge, the innovation arm of the Grieg Maritime Group.

"Getting the approval was not unexpected," he adds, "but still something we are happy to announce. It is a major milestone in getting one of the first green ammonia-fuelled vessels in operation."

The 120m-long tanker will have a cargo capacity of



GREIG EDGE'S AMMONIA-FUELLED TANKER CONCEPT HAS RECEIVED AN AIP FROM CLASS SOCIETY DNV

7,500m³ ammonia and will be able to load up to 1,000m³ per hour. It will be powered by a Wärtsilä W25DF ammonia engine.

Making the Arctic emission-free

The ZEEDS Arctic project is looking to build a combined green hydrogen and ammonia plant at Berlevåg in northern Norway. The facility, with initial capacity of 100MW, would produce green ammonia from water and renewable power supplied by the nearby Raggovidda wind park and is planned to be up and running by the end of 2026, having passed a feasibility study and concept phase. The project hopes to cut about 200,000 tonnes of CO₂ emissions per year.

Green ammonia produced by the hydrogen plant, which is being developed jointly by Aker Clean Hydrogen and local energy company Varanger Kraft, would be able to supply shipping as well as offshore installations and off-grid power plants in the remote Arctic region. The new ice-classed tanker, designed by LMG Marine, is a vital element in the value chain as it would be used to transport green ammonia produced at the plant to Longyearbyen on Svalbard, where it would replace energy supplies from a coal-fired plant nearing the end of its lifetime.

In addition, the vessel will provide green ammonia for ship-to-ship bunkering as well as for onshore storage facilities along the Norwegian coast to supply clean energy for local industry.

Having made significant progress on the technical side, the ZEEDS consortium is now working on the commercial element by lining up industrial consumers for green ammonia supplies. Governmental support will be vital to kickstart the market, according to Duke.

"To ensure a quick transition in shipping, we need policymakers to support the development of a market for alternative fuels," he says. "We need arrangements to reduce the opex gap between clean and carbon-rich fuel, such as differential contracts." ■



ACTING NOW FOR A BETTER FUTURE

By **Jon Halvard Bolstad Olsen**, strategy & business development director, Yara Marine Technologies



YARA MARINE TECHNOLOGIES STRATEGY & BUSINESS DEVELOPMENT DIRECTOR JON HALVARD BOLSTAD OLSEN

While shipping has achieved a landmark consensus on the urgency of decarbonising ship operations to achieve net zero, the practicalities of this process continue to be debated. While I believe it is essential to discuss key issues to speed up change including financing, regulation and the research and developments of new technologies as an industry, awaiting a single consensus on these topics is not an option. Delaying the decision to act based on available information will only leave us racing to catch up to our green goals further down the line.

The urgency to act is clear: the Intergovernmental Panel on Climate Change (IPCC) urged immediate action if we are to stay in accordance with Paris Agreement limits on global warming in its sixth report in April 2022. Beyond those limits lies an increasingly chaotic climate blighted by drought, famine and supply chain disruption – issues that will have marked effects for our world as a whole, and our industry in particular.

Acting on good information

Although the temptation to await the ideal solution is strong in a cost-sensitive industry such as shipping, where owners and investors must forecast the profitability of assets over decades, this must be resisted. I urge shipowners and operators to consider that between the vast divide of immediately investing in future fuels and technologies so they can be effectively trialed and waiting for the results of these trials lies a third, more prudent option – ensuring that existing technology that has proven effective in cleaner operations be installed and utilised today.

It is vital that we act on good information we have available to us to enhance ship operations. There are

effective technologies already in the market working with existing vessels to reduce emissions, usage of fuel, and streamline operations, such as a fuel and propulsion optimisation system. These are all factors that are likely to be essential even in a future where low-carbon fuels and better technology are customary. Therefore, technology of this nature is likely to continue to act as a beneficial investment in a more advanced future.

This is also vital to supporting ongoing efforts at sustainability. Streamlining the efficiencies of existing vessels ensures we are not discarding them before the end of their life cycle in favour of the latest available newbuild. We must account for the fact that these vessels, many of which will still be operating in 2050, will need to contribute to the IMO's target of a 50% reduction in total greenhouse gas emissions and a 70% reduction in carbon intensity.

Waiting is risky business

The realities of Net Zero mean that we are already in the process of re-evaluating how risk will be assessed within maritime. In its recent 'Safety and Shipping Review 2022', Allianz Global Corporate & Specialty noted that decarbonisation will "alter the risk landscape" of the industry. As shipping plots its course through a decades-long transition, it will need to ensure those risks are contained within acceptable limits.

Great focus and attention must be given to ensure safety is embedded at every step when introducing new technologies and fuels, with special focus on the human element and training. However, inaction to introduce new solutions at the pace and scale required brings its own risks of missing decarbonisation targets and minimising the effects of climate change.

We must ensure that we are not only prepared for these advances, but that we are consistently creating the right conditions for these advances to be possible. This means being bold and investing in greener operations as an industry as well as working cohesively to lower our collective emissions at pace. Let's try and beat our current decarbonisation targets rather than idle towards them.

Solutions that we can trust

In the timeframe in which shipping needs to act, no single decarbonisation solution will emerge to encompass all stakeholder requirements. The





YARA MARINE TECHNOLOGIES' FUELOPT DELIVERS AUTOMATED AND REAL-TIME PROPULSION OPTIMISATION

IMO's Carbon Intensity Indicator (CII) is itself an acknowledgement of this fact, with its increasingly stringent limits on operational emissions. Rather than waiting for one perfect solution, shipowners and operators have to find efficient solutions that can be used in combination and add up to higher overall emission reductions.

The good news is that many solutions in the market have already proven to be efficient and beneficial. The better news is that technology providers are constantly improving these technologies. These can help shipowners and operators to take feasible step to progress towards cleaner operations and greater efficiency; whether it is proven digital vessel optimisation or advanced hybrid technologies such as wind assisted propulsion. These solutions offer substantial benefits. And from this promising base, they are being extended to deliver even greater environmental performance.

Another good example of this tried and tested solution is shore power, where ships at berth have access to shoreside electrical power that allows them to shut down their main and/or auxiliary engines and directly consume less fuel. This is already widely deployed by ports serving cruise vessels and ferries, reducing both air pollution and greenhouse gas emissions while at berth, as well as allowing for charging to reduce emissions while sailing if vessels have energy storage capability.

The advantages, which are particularly evident if the shoreside electricity is generated renewably, are now being noticed by ports and vessel owners in other segments. At the One Ocean Summit held in France in February, several governments and port authorities signed a joint commitment for the

electrification of ports by 2028. Shore power will also be a requirement on ports in Southern California from 2025 for car carriers and tankers with rest to follow by 2027. These developments demonstrate clear recognition of shore power as an enabler of decarbonisation.

Taking steps to a better future

The answer to shipping's decarbonisation will be to employ multiple solutions to achieve maximum energy efficiency. Every single change will add up to larger effects in the journey towards decarbonisation even before clean fuels emerge as widely available options. Those fuels will eventually have a vital role to play. Meanwhile, selecting the right technologies enables shipping to play its part in the global drive for decarbonisation while minimising the risks of waiting for the perfect solution.

As the IMO's target dates get closer, the industry is likely to face bottlenecks in the supply chain and installation of technologies that will take time, effort and global cooperation to address. It is therefore responsible to make sure that the process of change – change being demanded by the public, by regulators and by charterers and freight owners – begins as soon as possible.

We no longer have the luxury of bemoaning the lack of a silver bullet while we sit waiting for one to emerge. Such wishful thinking will erode our chance of having a meaningful impact on climate change while it counts. When it comes to choices for greener shipping, if we are not bold enough to rapidly implement technologies with a proven record, what hope will we have of accomplishing the larger transition to lower emissions? The time to act and save our planet is now. ■



EVERY DROP OF (NEW) FUEL COUNTS

By **Simon Potter**, director of sustainability advisory, Houlder

The shipping industry is witnessing a period of deeply impacting regulation that will require major investment and technological innovation. The prospect of IMO-led regulations from 2023, the likely potential for ETS as part of the EU Green Deal, and ancillary drivers such as the Poseidon Principles and the Sea Cargo Charter mean that waiting for new-fuel solutions is not an option for shipowners.

Beyond this, all maritime stakeholders have a social and commercial responsibility to make maritime decarbonisation a reality.

No single solution

Currently, regulations are encouraging the industry to derate engines, so vessels are forced to slow down and save fuel, and to gradually switch to more sustainable fuels, such as green hydrogen, methanol, ammonia, or biofuels. While important and impactful, focusing only on a narrow set of measures means missing the opportunity to make big improvements now, and later.

Shipowners need to integrate available energy efficiency technologies into their roadmap to provide the opportunity to immediately drop emissions and fuel consumption while alternative fuels continue to scale up and to provide their current fleet with an opportunity to keep pace with the rapidly accelerating environmental objectives coming from regulators, the market and the end consumer.

It's not a question of choosing one over the other. Energy efficiency and renewable propulsion technologies will complement low and zero carbon fuels, and we need them to create the zero-carbon ship of the future and to reduce costs in the short term and long term.

We already have a huge range of options that complement future fuels and reduce carbon emissions. These include wind propulsion, air lubrication, battery energy storage, hull coating technology, hydrodynamic energy saving devices, and voyage optimisation software, to name a few.

A tight timeline for compliance

The IMO's Energy Efficiency Existing Ship Index (EEXI) and Carbon Intensity Indicator (CII) requirements enter into force on the 1st January 2023, and vessels will need to demonstrate compliance at the first International Air Pollution Prevention Certification (IAPPC) survey after this date. Therefore, some owners may have as little as 18 months to check their vessel's current EEXI and CII and, where necessary, plan and implement energy efficiency measures to improve it and achieve compliance.

While slow steaming might meet initial EEXI requirements, it is a stop-gap measure that is



SIMON POTTER

unlikely to remain effective for long. A more sophisticated approach is required. Understanding the regulation, calculating a vessel's current EEXI and CII, and assessing successful compliance measures are all essential to on-going compliance and business success.

It is important to seek advice on the multitude of effective adaptations that could be suitable for different vessel profiles and operations. The process involves:

- Calculation of attained EEXI and CII – Houlder, for example, can provide an initial calculation of a vessel's attained EEXI and CII using its in-house calculation tool.
- Reference Speed Determination – many vessels will not have available and suitable speed-power curves from which a reference speed can be taken for use in the calculation of EEXI. Consultants can support owners in determining this data through model tests, sea trials or CFD to avoid the use of the conservative statistical method provided by the regulation.
- Improvement Measures – experts can evaluate the most suitable measures to improve a vessel's attained EEXI and CII, support their implementation and verification of their performance.
- EEXI and CII Technical File – once the vessel has achieved a compliant EEXI and CII we will prepare its Technical File for submission to the verifier.

A package of solutions

At Houlder, we believe there is no single best energy efficiency solution for EEXI compliance or for shipowners looking to proactively control their own decarbonisation agenda. There are a multitude of effective energy efficiency adaptations that can be deployed today, but it is critically important to determine how they can be packaged together for the greatest effect and to achieve the best return on investment.

It is important to research your options in detail. For example, North Star Shipping (NSS) needed a comprehensive study to help develop of a greenhouse gas reduction strategy across its fleet of over 40 vessels. An expert team first established the greenhouse gas emissions and carbon intensity of the

current fleet and its operations before identifying the most suitable technologies and operational measures to reduce carbon emissions. This includes defining the cost, benefits and timeline for implementation of these technologies.

ALL MARITIME STAKEHOLDERS HAVE A SOCIAL AND COMMERCIAL RESPONSIBILITY TO MAKE MARITIME DECARBONISATION A REALITY

The first phase of work involved a practical workshop to kick start the analysis process. The specific operational challenges faced by the NSS fleet of Emergency Response and Rescue Vehicles, Platform Supply Vessels, as well as the future Service Operation Vessels, were all explored. The team established the fuel consumption of each vessel in different operational modes, as well as total annual consumption, to help target the most effective technical and operational improvement measures. The impact of anticipated changes to the construct of the fleet is also considered over the next 10 years.

Phase two of the process assesses all possible energy efficiency and low emission propulsion technologies that could be applied to the existing

fleet. The viability of each solution is considered in line with the vessel's operational requirements, available space, displacement, power demand and endurance requirements. The analysis will also evaluate the associated implementation costs alongside the resulting fuel efficiency and emissions savings.

Work concludes by forecasting the fleet greenhouse gas emissions through the next 10 years for different investment scenarios, helping NSS to prioritise and plan for the implementation of the different improvement measures across the fleet with consideration given to timescales for engineering, procurement and installation of technologies as well as vessel operational demands and dry-docking schedules.

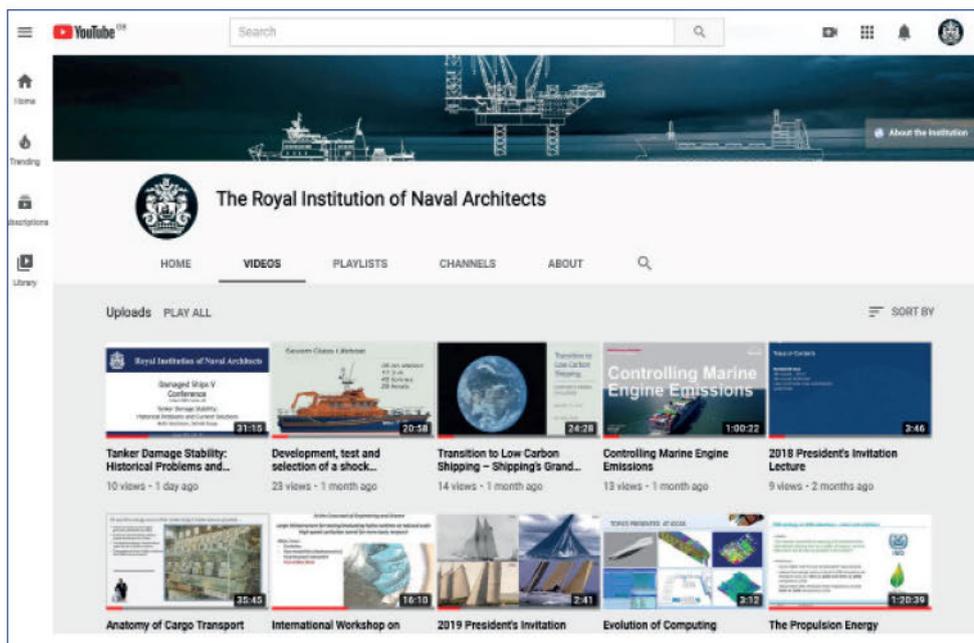
Every drop counts

Regulation may be setting milestones in the shipping industry's decarbonisation journey, but the damage done by our carbon emissions is cumulative and won't be reversed by future fuels. Every drop of fuel saved matters, and all measures taken now to reduce emissions through clean technologies provide owners with a more optimised path forward. Houlder is committed to helping them find that path. ■

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NORWAY

ZERO-EMISSION VESSELS OPEN THE WAY FOR A NEW STYLE OF CRUISING

By Daniel Johnson

Norway has long been an innovator in renewable energy. The Nordic country has been harvesting energy from the myriad of rivers that cascade into its famous fjords since the 19th century and the nation now utilises more eco-friendly hydropower than any other country. It is also a front runner in the charge to clean up the maritime industry, with ambitious plans for greener shipping. Where better, then, to launch a new kind of cruise ship experience, one that is not only emissions-free, but also sustainable.

"I think we are at that stage in the cruise industry where we have to take that step ahead and not just look back to what we have done in the past. We really have to take responsibility for the environment and we have to be more accountable for what we are doing. In Norway we are set up to do this," Rolf André Sandvik, founder and CEO at Norwegian start-up Northern Xplorer, tells *The Naval Architect*.

For Sandvik, that step ahead involves bringing "experience tourism" to the cruise forefront under the slogan 'Destination Discovery'. "A new type of cruising providing immersive, enriching experiences for those interested in responsible travel with a minimal footprint," he explains.

Sandvik adds that regulations are increasingly reflecting these priorities, with zero-emission requirements for the Norwegian World Heritage fjords set to take effect in 2026, and limits on the number of calls and passengers allowed ashore soon to be enacted in many locations around the world.

Sandvik is a master mariner with extensive experience with cruise lines NCL and Crystal Cruises, including senior roles in destination development. In 2014, he founded travel company The Fjords, based in Flåm in western Norway, where as CEO he ushered in a new era of environmentally friendly sightseeing, commissioning the ground-breaking hybrid electric vessels *Vision of the Fjords* (built 2016) and *Future of the Fjords* (built 2018). Constructed by specialist Norwegian shipbuilder Brødrene Aa, both vessels won the 'Ship of the Year' award during maritime trade fair SMM in Hamburg in their respective delivery years.

The next step

"Northern Xplorer represents the next step of my own journey to green the waterborne tourist industry," he says. "We want to walk the talk on green maritime innovation. Scaling up what we seeded at The Fjords to sustainable cruising on brand-new vessels compliant with the strictest global regulations is, I believe, the best way to show discerning visitors the amazing nature and breadth of



NORTHERN XPLOER
FOUNDER AND CEO
ROLF ANDRÉ SANDVIK

culture we have up here in Northern Europe."

Switching to smaller vessels, Northern Xplorer's cruise ship concept will feature fully electric propulsion, battery energy storage, hydrogen fuel cell technology and auxiliary renewable energy supply (wind and solar power), as well as being performance-optimised for maximum energy efficiency. State-of-the-art HVAC systems will safeguard against pathogen spread while extensive use of recyclable materials will promote circularity. They will also feature advanced LiDAR technology to detect marine plastic debris and raise awareness of marine pollution.

To further reduce the carbon footprint, onshore power for charging batteries will largely come from renewable hydropower.

The company's current plan is to have a series of 14 identical ships accommodating 250 to 300 passengers in 125 to 150 cabins served by up to 100 crew. The first is planned to be operational from 2024/2025. The 130m-long, 22m-beam design, which features a hull designed for optimal stability and performance through water, has been undertaken by Norwegian ship design company Multi Maritime. A specialist in offshore vessels, trawlers and ferries, Multi Maritime had never designed a cruise ship before.

"We wanted to challenge the industry and move forward," says Sandvik. "If we had gone to any of the renowned cruise companies, they have a set of standard solutions that they think is the law – it has to be like this. So we went to someone who built ferries, fishing boats and oil tankers.

"It was a tough process to begin with because they also have their set way of thinking. The first renders looked like ferries with more cabins on. The second looked like a fishing boat with some cabins. It was a tug of war, but then they came back with the current design which is

sleek and modern and also signals that this is something different. It's not a traditional cruise ship."

The ships' interiors will be a contemporary Nordic design. "Cool and airy in the summer and cosy and warm in the winter. Guests will feel instantly at home," says Sandvik, adding that emphasis has been put on high-comfort and five-star luxury for maximum enjoyment of the Nordic scenery.

Technology development

According to Sandvik, an early partner in the project is technology company ABB, which is already well advanced in the collaborative development of fuel cell systems for ships and has considerable experience in integrating energy storage. He adds that the technology going into the first ship will be the last contract that Northern Xplorer signs. "We have to be flexible. If we sign a contract today, we know that in a year or two's time development in fuel systems, fuel cells and energy storage will have gone much further," he explains. "This also means that the technology chosen for the first vessel might not be what goes into the second, and for sure it won't be what goes into the 14th."

Hydrogen has been chosen as the energy carrier because it offered a better 'right-now' solution to reach zero-emissions over other alternative fuels such as LNG, biofuels and ammonia. "Ammonia is very unlikely to be viable option for a passenger ship, given its toxicity and smell," Sandvik says.

"We will of course have to work with class societies and maritime authorities regarding new safety and operational regulations for hydrogen as the energy carrier," he adds. "But using IMO's alternative design procedure, and with their support, it's something we can certainly solve."

Northern Xplorer is already planning an itinerary for its first vessel. It will be built around destinations that have, or are planning to have, shoreside recharging infrastructure. A hydrogen supply for the fuel cells will be crucial too. Sandvik says Norway is making great strides in the development of a green hydrogen supply chain, with green electricity producers increasingly seeking to take

advantage of the country's abundance of hydropower to produce green hydrogen. Northern Xplorer has already signed letters of intent with a number of these companies.

Minimising the imprint

Northern Xplorer's turnaround ports will be connected to railways rather than airports. "In line with our message on sustainability, we plan to implement a 'Train-Sea' programme to lessen the imprint. Of course, we realise that guests, especially those from North America, will have to fly into major airports. We will encourage those guests to use airlines that have carbon offset programmes and sustainability goals that match Northern Xplorer's," says Sandvik.

He adds that the itineraries will not be about giving guests whistle-stop visits to marquee destinations teeming with tourists, and instead will focus on harbours that large ships cannot access. "Somewhere between ocean and river cruising, it's for those who want a more intimate onboard experience, to get insights into a new culture up close, and leave feeling their holidays have contributed positively to local communities and the planet," he explains.

He continues: "As a company we will be part of the local fabric offering compelling activities that support local employment and innovation. We will perform strict due diligence of sub-suppliers to ensure our green philosophy spans the value chain."

The first ship will start in Norway, with future expansion planned for other Nordic regions, including the east and west coast of Sweden and the Baltics, and eventually other European destinations as more green energy becomes available and stricter emissions regulations are introduced.

"Our routes have been planned on what shoreside infrastructure is available, which is key for zero-emissions," says Sandvik. "We have undertaken not to hook up to charging stations delivering electricity from diesel oil or coal, that would defeat the purpose. We are very much ahead on this in Norway, but I believe similar infrastructure will be increasingly rolled out across Europe before too long, so there's scope for Northern Xplorer to go up to 14 vessels relatively quickly." ■

NORTHERN XPLOER'S CRUISE SHIP WILL FEATURE FULLY ELECTRIC PROPULSION, BATTERIES AND HYDROGEN FUEL CELL TECHNOLOGY



SHIPBUILDING TECHNOLOGY

DIGITAL DNA WILL HELP EVOLVE THE NEXT GENERATION OF SUSTAINABLE SHIPS

As shipyards strive to develop the greener ships demanded by their clients and needed by the planet, they must make the most of a new asset: real-life operational data, which is a goldmine of insights that can now be harnessed to optimise designs, maximise efficiency and curb emissions

By **Olli Puustinen**, director, product management at NAPA Design Solutions



SOURCE: NAPA

The process of designing a ship has always been guided by an ambition to deliver cost-effective, safe vessels that will be adapted to the routes and purposes they serve. In recent years, an additional consideration has come to the forefront: sustainability. Tighter environmental regulation, higher fuel prices and growing pressure from customers and investors have all converged to increase the industry's appetite for cost-effective designs that cut fuel consumption and reduce greenhouse gas emissions. As shipping's decarbonisation journey begins, shipowners want to 'future-proof' their fleets, and ensure their upcoming additions will meet environmental regulations, such as CII requirements, now and for decades to come.

This is a pivotal moment for shipyards. Not only have the goalposts shifted, with an unprecedented focus on sustainability, but the tools at their disposal have also evolved dramatically. Thanks to increased digitalisation, there is now a wealth of operational data that can be fed back to shipyards, and they must seize this opportunity to optimise their designs and create the sustainable ships of tomorrow.

Turning operational data into more efficient designs

The day a vessel leaves a shipyard used to be the end of the story. Once the ship was delivered, naval architects and engineers would move on to the next project, and

very little information on their design's performance would be fed back to the shipyard. This is changing rapidly, as we get to understand how real-life operational data can provide vital insights to create more efficient designs.

Real-life voyage data links theory and practice, providing shipyards with the unparalleled ability to analyse their vessels once they have been deployed at sea. Data on fuel consumption, GHG emissions, and speed profiles, for example, help understand how models behave in real-life conditions. For naval engineers, this is a formidable opportunity to iterate and improve their concepts to increase the efficiency of the future fleet.

Crucially, operational data can now provide granular insights into how to optimise each new design. For example, historical data from thousands of real-life voyages at sea can be analysed to give a statistical picture of the weather conditions that a ship is likely to encounter on specific routes. Based on that, naval architects and engineers can determine the level of engine power that will be needed for any given vessel depending on the routes where it will be deployed. This makes a valuable difference, enabling ship designers to make smart decisions and choose engines that will be sufficient to meet operational needs, while avoiding installing a more powerful engine that would increase emissions unnecessarily.

In the future, these calculations will be able to integrate even more data on the performance of various clean technologies, such as batteries and wind propulsion solutions, as more of these systems are deployed in real-life conditions at sea. This will add certainty to the critical choices that must be made about what technologies will be installed on board, with a fact-based picture of their effectiveness and return on investment (ROI). Having access to the best possible information will enable shipyards to fully account for the contribution of these systems in their calculations, and level up sustainability and efficiency even more.

The same data can also be used to better understand how newbuilds will comply with CII requirements, from their entry into service to their retirement, and predict when the vessel's CII rating will fall to an unfavourable class. This gives owners and operators the long-term visibility they need to make the best possible choices from the initial design stage.

Unlocking data-driven efficiencies at sea

The "data bridge" that is emerging between ship operations and design goes both ways: while operational data is used to create more efficient ship designs, the digital models used to design the ships can also be harnessed to optimise operations at sea.

The 3D models used to design a ship constitute its "digital DNA", containing a wealth of information on its unique characteristics and systems on board. In other words, a vessel isn't just the steel-made physical structure; its Digital Twin is equally important, helping understand and predict its behaviour in various conditions.

These vessel-specific insights can take voyage optimisation to the next level. By using the ship's Digital Twin, we can model and simulate hundreds of possible routes and their impact on ETAs, fuel consumption and emissions. From this, we can calculate optimal routes and speed profiles depending on weather conditions as well as the ship's specific profile, design, and operational needs. This gives captains and operators better visibility on all possible options, which enables them to choose optimal routes to minimise their impact on the environment without compromising operational efficiency. For example, our NAPA Voyage Optimization solution cuts fuel consumption and emissions by an average of 5-15%. This is a key example of how data continues to support sustainability throughout a vessel's lifecycle.

Incorporating clean tech

The capacity to optimise operations for each vessel will be even more important in years to come, as ships are becoming even more complex. No two ships are the same, and this will be even more true in the future, as alternative fuels and a broader range of clean technologies are deployed. Using ship-specific digital models will help vessels make the most of innovative clean technology on board, such as wind propulsion solutions.

Advanced weather routing is essential for all ships, but it is particularly important for wind-assisted vessels, helping them catch optimal wind conditions to deploy their sails or wings. Recognising that the combination

of voyage optimisation and wind propulsion provides significant potential for increased performance compared to either of the two technologies alone, we recently announced a partnership with wind propulsion leader Norsepower to help owners maximise the benefits of their Rotor Sails technology by using our Voyage Optimization software.

As shipping incorporates new fuels, wind power, batteries, automation and other new efficiency technologies, having a clear picture of the vessel's technologies and set-up will be essential for efficient operations – helping operational teams understand the specificities of their vessel, make sense of all the systems on board and use them in the best possible way to optimise operations and reduce emissions.

Sustainability and safety go hand in hand

The current digital era will not only make ships more efficient, but also safer. Data-powered insights enable ship owners and operators to take a proactive approach to safety, where safety risks are monitored and assessed constantly, and can be addressed before they escalate.

This approach combines operational data with advanced stability models, often based on the same models that were used to design the ships. A range of variables that may affect a vessel's stability, from deadweight changes to weather conditions, to the number of doors left open on the ship, are monitored constantly. This operational data is fed into a cloud-based system continuously, where a wide range of calculations related to hydrostatics, intact stability, damage stability and longitudinal strength can be made in real time.

This creates a continuous risk assessment that can be monitored by crew and shoreside teams alike, and where any issues can be flagged before they ever become a serious problem. This shared situational awareness between ship officers and shoreside teams is also key to a swift and efficient intervention in case of an emergency.

The collaboration challenge

Data is building new bridges between design and operations, however, for these bridges to achieve their full potential they need to be supported by greater cooperation on information sharing. The more high-quality data we have from real-life operations at sea, the more we will be able to accelerate the development of designs and operational patterns that will meet the planet's (and the industry's) needs for greater sustainability.

Improving the sustainability of shipping requires a partnership that ranges from shipyards to class societies, to shipowners, operators, charterers, cargo owners and more; and by bringing this data together, NAPA provides the tools for all stakeholders to innovate and collaborate, now and in the future.

The sustainable ships of the future will be made of data just as much as steel – created from real-life insights, and assembled by a collaborative spirit. ■





VIKING GLORY. SOURCE: VIKING LINE

RO-RO'S AND FERRIES

THE BALTIC CRUISE FERRY REINVENTED

Nine years after the introduction of the game-changing *Viking Grace*, the then world's largest dual fuel ferry powered by LNG, Viking Line surprises the world once again with its somewhat larger and different 'cousin' *Viking Glory*. Built by China's Xiamen Shipbuilding Industry, *Viking Glory* is equally LNG-powered and comes with all the bells and whistles to further reduce the fuel bill and the emissions footprint. Besides its green credentials, this truly unique cruise ferry sets new standards in ferry travel between Sweden and Finland

By **Philippe Holthof**, Correspondent

Cruise ferries are a typical Baltic phenomenon, characterised by the fact that a large number of passengers don't take the ferry to travel from A to B. The ferry itself has become the destination, largely on account of the duty-free status of the Åland Islands which these ferries crisscross.

The €194 million *Viking Glory* joined *Viking Grace* on the 160-nautical-mile Stockholm-Åland-Turku route in early March (the intermediate call at Åland sees the ferries dock in Mariehamn, the islands' capital, during the day and Långnäs during the night). Sailing through the fairly well-protected Stockholm, Åland and Turku archipelagos for a good part of the sailing, this route is way shorter than the Stockholm-Mariehamn-Helsinki overnight service, allowing for the Stockholm-Åland-Turku ferries to make a 24-hour roundtrip.

Notwithstanding the very tight 65 to 75-minute turnarounds at either end of each crossing, the

Stockholm-Åland-Turku route is a well-oiled traffic machine. The 15-minute stop in Mariehamn is crucial with the ferries coming from opposite directions docking simultaneously. Strange as it may sound, it is paramount that the Stockholm-Turku ferries meet in Mariehamn as they offer connecting sailings. So-called picnic cruisers who board *Viking Glory* in Turku in the morning and *Viking Grace* in Stockholm swap ship in Mariehamn to sail back to their original port of embarkation for arrival in the evening. Upon arrival in Stockholm and Turku, an army of cleaning persons board the respective vessels to clean cabins and public spaces in just one hour!

Building in China

Viking Glory replaced the 1988-built *Amorella*, now temporarily cascaded to the Stockholm-Mariehamn-Helsinki route. The first plans to replace *Amorella* were unfolded in 2015, just two years after the introduction of *Viking Grace*. Part of a Finnish-Swedish EU project aimed at further reducing particulates, SOx, NOx and

TWO OF THE SIX
WÄRTSILÄ W10V31DF
FOUR-STROKE
ENGINES. SOURCE:
PHILIPPE HOLTHOF



GHG emissions, the *Viking Glory* newbuilding project has been granted EU aid from the Connecting Europe Facility (CEF) programme for the NextGen Link joint EU project. Deltamarin has been instrumental in the concept design as well as assisting Viking Line with the tender and contract phases with an Lol signed in November 2016, followed by a conditional contract in April 2017.

While *Viking Grace* was built by STX Finland, now Meyer Turku, the builders of cruise ships and complex ro-pax ferries had full order books at the time when Viking Line's newbuilding project kicked off. Consequently, Meyer Turku – one of the 21 yards approached by Viking Line – quoted an unrealistically high price. There were long discussions with Brodosplit, builders of *Amorella* and sister ship *Isabella* (now Tallink's *Isabelle*) and Mitsubishi Shipbuilding, yet the latter shipbuilding conglomerate eventually didn't quote in the aftermath of the problems experienced with the construction of AIDA Cruises' *AIDAprima* and *AIDAprila*.



TWIN 295M3 TYPE C LNG TANKS ARE LOCATED AFT OF THE ACCOMMODATION. SOURCE: PHILIPPE HOLTHOF

Three Chinese yards were equally in the running, quoting similar prices. One of these was Guangzhou Shipyard International (GSI), the sole Chinese yard that had so far built ro-pax ferries for European interests. By virtue of being an LNG-powered cruise ferry with a high degree of complexity, not in the least from the outfitting of the public spaces, *Viking Glory* represented a first for Chinese shipbuilders. Xiamen Shipbuilding Industry (XSI) had not built any ro-pax or passenger vessels before and primarily won on price, yet at the time of the order it was already a prolific builder of PCTCs with Viking Line gaining positive feedback from Höegh Autoliners that had its New Horizon class PCTCs under construction at XSI, yet another Deltamarin design.

Pods instead of shafts

Besides the concept design, Deltamarin was also in charge of *Viking Glory's* basic and detail design. Following model testing at MARIN, the Netherlands, the decision was taken to add a ducktail and increase the engine power with six new-generation Wärtsilä W10V31DF medium-speed four-stroke engines powering the twin ABB XO 2100-type Azipods via six ABB synchronous AC generators of 5,780kVA each. A gas-electric solution was also favoured for *Viking Grace*, but back then Viking Line was hesitant to install pods and opted for a conventional shaft line and propeller.

With fuel efficiency at the heart of *Viking Glory's* design, the choice for pods is a natural one as it offers a lower water resistance of about 8% when measured against a traditional shaft line propulsion system. Supplemented by three 2MW Wärtsilä bow thrusters, the pods, with a combined output of 11.2MW, guarantee unprecedented manoeuvrability, allowing to minimise manoeuvring time and extent the time at sea by reducing the service speed by 1knot, corresponding to a 2MW energy saving.





ONE OF CLIMEON'S HEAT RECOVERY UNITS.
SOURCE: PHILIPPE HOLTJOF

Owing to the almost zero noise and vibrations levels, pods have become well-established on cruise ships, yet the flipside of the coin is that *Viking Glory's* turnaround times are too short to perform maintenance of them. For this year alone, eight service days are scheduled with eight daylight sailings annulled. These service days are on Mondays outside the summer season, when passenger and freight demand is low. But with *Viking Glory* remaining tied up in port for maintenance, *Viking Grace* must also remain in port so as not to disrupt the sailing pattern.

Energy efficiency

When *Viking Grace* was ordered in late 2010, IMO's IGF Code for low-flashpoint fuels had not been published yet and as there were uncertainties as to the location of LNG tanks below deck, *Viking Line* opted to install the twin LNG tanks on deck, aft of the accommodation. On *Viking Glory*, the two Type C Wärtsilä tanks, with a capacity of 295m³ each, are located closer to the engines, just forward of the ECR and aft of the ship's main preparation galley on Deck 2. Bunkering operations are in Stockholm. With a bunkering rate of 600m³/hour and the cryogenic tanks having a combined capacity of 590m³ at 90% filling level – more than sufficient for three consecutive days of operation – bunkering is accomplished within the limited turnaround time.

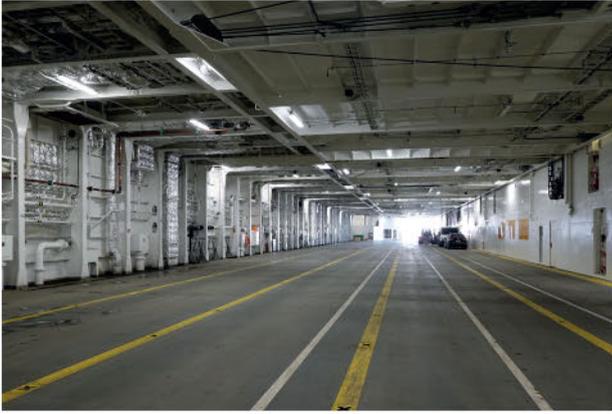
The general arrangement of decks 1 and 2 has been inspired from *Viking Grace* with a service corridor, starboard of the centreline on Deck 2, dissecting the

respective compartments and connecting the large shop store aft with the food stores and preparation galley forward. In compliance with Safe Return to Port (SRtP) rules, the engine rooms are separated, each engine room holding three engines with a combined power of 5.5MW.

In 2015, Viking Line pioneered Climeon's Heat Power System on board of *Viking Grace*. Based on Organic Rankin Cycle (ORC) technology, the system harnesses waste heat from the engines to heat the vessel and generate clean electricity. This energy recycling system has also been adopted on *Viking Glory*, consisting of two 300kW heat power units. Going one step further, Climeon also developed a steam turbine solution, using waste heat from gases produced during the combustion process, thus maximising the energy recovery from the engines. The two steam turbines can generate a maximum of 150kW each and it is estimated that the heat power and steam turbine solutions will generate about 40% of all electricity required for passenger functions and reduce CO₂ emissions by at least 4,000tonnes per year.

In yet another industry first, a waste cold recovery system has been developed in collaboration with Wärtsilä, Projektia and Deltamarin. The waste cold from the use of LNG is recycled for refrigeration appliances, cold stores, catering equipment and HVAC technical spaces. Last but not least, the booking system interacts with the onboard air conditioning and lighting; a non-occupied cabin





MAIN VEHICLE DECK STARBOARD. SOURCE: PHILIPPE HOLTHOF

remains in power-saving mode throughout the voyage, further reducing energy consumption.

Following disappointing fuel saving results using Norsepower's Rotor Sail on *Viking Grace*, primarily blamed upon the wind direction on the Stockholm-Turku route, Viking Line decided not to install a pair of Flettner rotors on *Viking Glory*, resulting in a weight reduction.

Vehicle and passenger decks

Viking Glory has a single freight deck with a total intake of 1,481lm, spread over nine lanes. This compares to 1,291lm and eight lanes on *Viking Grace*. A four-lane hoistable car deck, starboard of the centreline and casing, offers 514lm for cars with a clear height of 2.1m on and 2.4m below the lowered mezzanine deck.

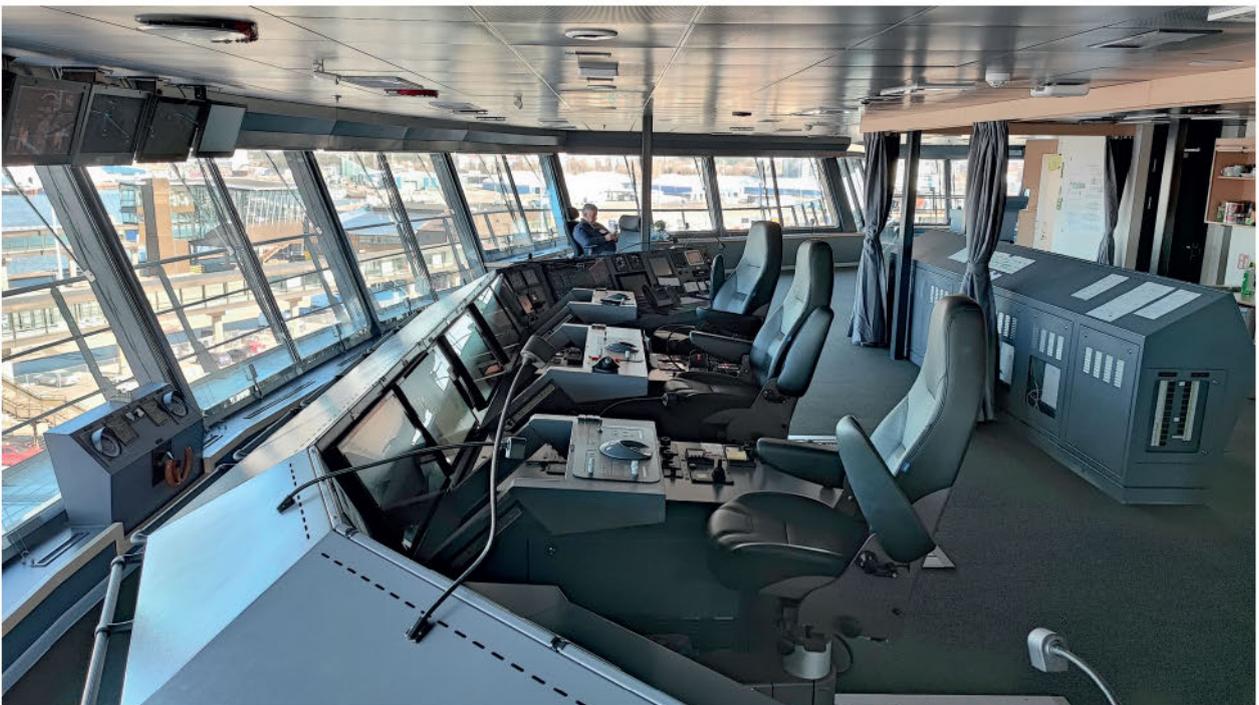
Access to the main deck is via a single 7.5m-long (excluding flaps) stern ramp with a 15m-wide driveway. All access equipment, ramps and covers were manufactured by TTS, now part of MacGregor, with the 19.5m-long

(excluding flaps) and 6m-wide bow ramp nested behind hydraulically operated two-section side-swinging bow doors. Up to 640lm of cars can be stowed on a separate car deck in the aft half of Deck 5. It is accessed through shell doors on both starboard and portside aft. For redundancy's sake, there is also a tilting ramp that connects Deck 5 with the hoistable car deck on Deck 4.

From a passenger perspective, it is in the accommodation where *Viking Glory* excels. Back in 2013, *Viking Grace* already represented a different approach to shipboard design with a departure from the general arrangement first adopted on Viking Line's *Mariella* in 1985 and subsequently repeated on many a Baltic ferry. With *Viking Glory*, Viking Line has further raised the bar. The general arrangement is a further evolution of *Viking Grace*'s with a stunning interior design from Stockholm-based Koncept, newcomers in the marine industry.

The 922 passenger cabins are spread over decks 5 to 8. Save for the captain and chief engineer, the crew is accommodated in individual cabins that are primarily located on decks 6 to 8 aft. As Finnish law requires outside cabins for all crew, a solution was found to let daylight in, in what would otherwise have been inside cabins, notably a three-deck-high athwartship trunk, dubbed 'Grand Canyon'.

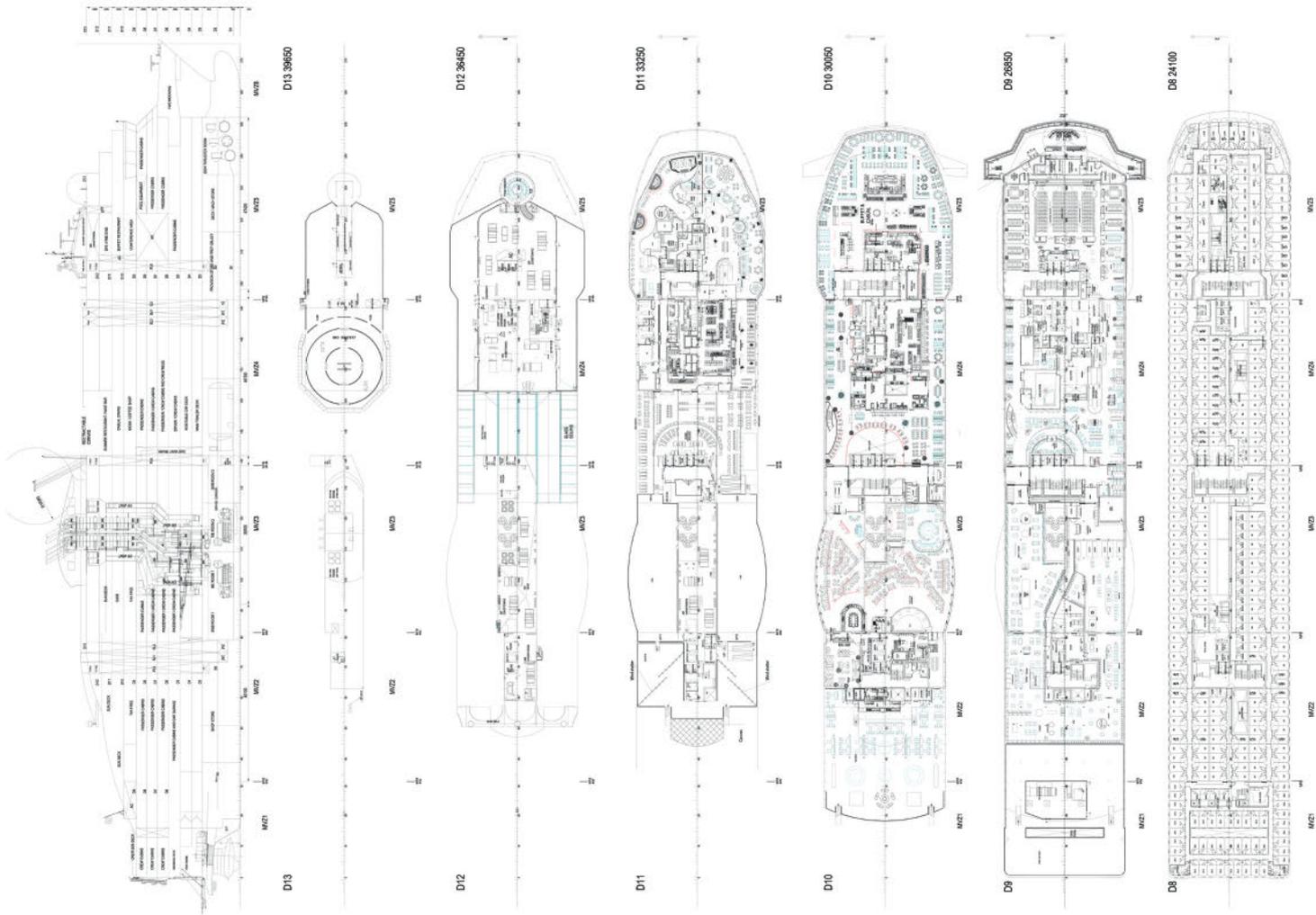
The public spaces are concentrated on decks 9 to 11. As passenger turnout can heavily fluctuate, a flexible layout of the public spaces is key with the possibility to create a lounge within a lounge to make for a more intimate feel in case of low occupancy. Three main staircases divide the public decks vertically. Passengers can equally move from one deck to the other using one of the nine KONE elevators, the permanent magnet synchronous motors of which consume up to 70% less energy than conventional elevator solutions.

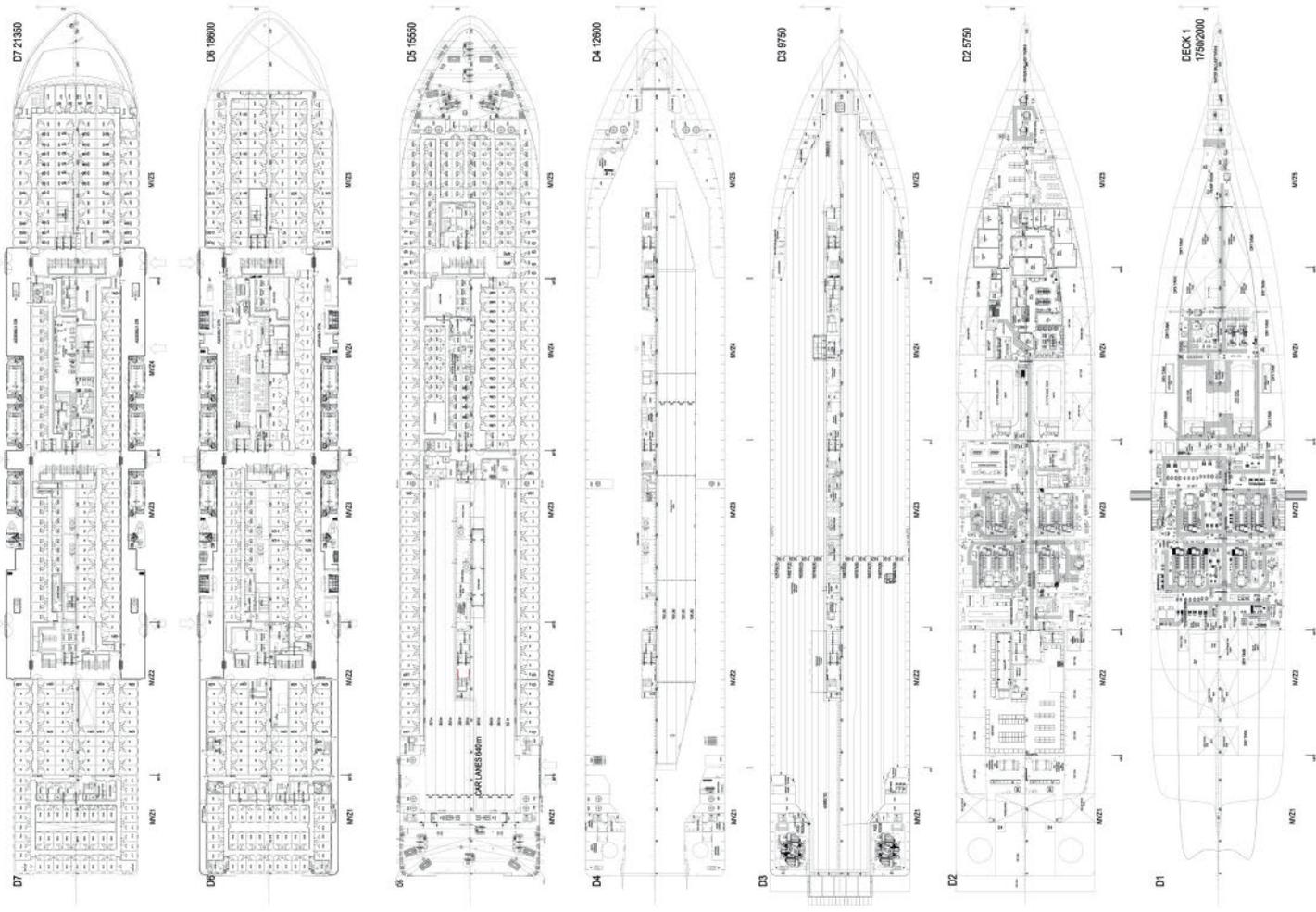


VIKING GLORY'S BRIDGE, LOCATED ON DECK 9. SOURCE: PHILIPPE HOLTHOF



GENERAL ARRANGEMENT OF VIKING GLORY. SOURCE: DELTAMARIN







DECK 12 FEATURES AN EXCLUSIVE REVOLVING DINING ROOM. SOURCE: PHILIPPE HOLTHOF

Deck 9, the bridge deck, holds a vast conference centre forward, the Torget piazza café with adjacent children's playrooms midships and the large, full-width duty-free shop aft. Torget comes with an atrium, being the ship's beating heart and functioning as kind of vibrant town square with a curved portside stairway leading to Deck 10 which holds Market, a food court with five different eating outlets. Forward on Deck 10 is The Buffet and to its portside the casual dining Mimmi's.

Aft of Market is Vista Room, the ship's main bar and lounge with a deck height equivalent to 1.5 decks. Uniquely, the public spaces have floor-to-ceiling windows throughout, but nothing beats the view from Vista Room. On busy sailings, a satellite bar behind glass screens is opened as is Algoth's, an intimate lounge-cum-bar just abaft Vista Room.

Kobba is the ship's à la carte restaurant with its own bar. Located starboard forward on Deck 11, its *pièce de résistance* is Fyren. Accessed via a curved stairway, Fyren is an exclusive separate restaurant on Deck 12, complete with a revolving private dining space for up to 12 persons. A spacious spa with gym and yoga rooms is located on the portside of Deck 11.

Yet another first, is the Viking Terrace. Well protected from the elements by windscreens and a retractable plexiglass roof, it offers al fresco dining but thanks to its outdoor-indoor function it can even be used on colder days using infrared heaters. There is extensive outer deck space on Deck 10 aft which has its own bar and comfortable patio furniture.

Altogether, *Viking Glory* is a truly unique vessel and a far cry from the 2006/9-built ro-pax cruise ferries competitor Silja Line operates on the Stockholm-Åland-Turku route. ■

TECHNICAL PARTICULARS VIKING GLORY	
Length oa	222.6m
Length,bp	203.1m
Breadth, waterline	33.7m
Breadth, max	35.0m
Depth to main deck	9.75m
Draught, design	7.15m
Gross tonnage	65,211
Net tonnage	42,626
Deadweight	8,087t
Lanemetres	1,481lm on Deck 3 + 640lm cars on Deck 5
Passengers	3,000
Passenger cabins/berths	922/2,934
Engines	6 x Wärtsilä W10V31DF
Power	18,850kW
Maximum speed	22.49knots
LSAs	6 x 150-person VIKING Norsafe lifeboats + 6 Survitec Marin Ark 2 MES for 632 persons
Class	DNV
Class notation	+1A Ferry(A) BIS BWM(T) COAT-PSPC(B) COMF(V-1) EO Gas fuelled Ice(1A*) LCS(DC) MCDK RP(3, 50%, +)
Flag	Finland



DECK & CRANE MACHINERY

MAXIMISING OPERATIONAL AVAILABILITY

MacGregor sees tipping point for condition-based maintenance

With today's uncertainty in the world, shortage of competence and higher costs, owners and operators realise the benefits of original equipment manufacturer support in the digital age.

Whilst condition-based information backed by responsive specialist support and technical expertise have become increasingly key to effective maintenance planning and maximising operational availability.

"In the past, the service organisation footprint and logistics management capabilities required to effectively support ships in operation and maintaining a schedule have perhaps not been fully recognised," says John Carnall, MacGregor's senior vice president, Global Services. "With the high demand on shipping goods customers are seeing the value of locally based specialists and remote technical expertise in ensuring that the right parts are available in the right place at the right time."

With 815 specialists and 60 service centres located in 31 countries worldwide, MacGregor fully understands the value of local specialists supported by 'centre of excellence' based technical experts, and an ability to supply original spare parts from regional warehouse stock.

"Customers are recognising the value of condition-based information as a maintenance planning advantage," adds Dennis Mol, vice president, Technology & Sustainability. "It provides peace of mind with respect to mission-critical systems and operational continuity, and is something we expect will be increasingly required by shipowners and operators to maximise the efficiency and value of expensive assets".

Condition based maintenance management

"As an industry, we are moving towards predictive tools, which will help to eliminate unplanned downtime, ultimately reduce maintenance costs and increase revenue and profitability," adds Mol.

He says MacGregor's extensive operational equipment knowledge is being channelled into developing algorithms that can predict when certain equipment requires maintenance based on use and condition, rather than relying on conventional time-based service schedules. Digital advances in this arena include OnWatch Scout, with contracted vessels nearing fifty which includes load handling cranes in Offshore plus Merchant market and deck machineries.

"High quality, accurate, predictive maintenance is



JOHN CARNALL (TOP),
AND DENNIS MOL



possibly one of the most important elements of service provision," says Mol. "OnWatch Scout is a predictive tool developed to ensure that equipment is able to operate more or less continuously. It detects variations in the behaviour of components and predicts if something might happen. We then have the ability to notify the customer and advise them of the preventative steps that need to be taken to avoid component failure."

"The crew and customer operation centres who entered into OnWatchScout agreements, are very happy with the ease of system use and information being made available, which is providing common visibility of the crane operating information. This, in turn, is supporting effective ship to shore communication and coordinated decision making. Especially in today's constrained logistical chains, actual and predictive equipment information (<2 min.) provides more time to prepare any required action onboard"

Future development plans include extension of the OnWatch Scout capability beyond cargo and load handling cranes to include quarter ramps, Gangways and other critical equipment and systems.



Making expert knowledge available to customers through simulation-based training is another information-based capability that enhances crew capabilities, operational safety and equipment reliability.

"Whereas OnWatch Scout provides real-time, condition based information, 'digital twin' services provide a dynamic environment that enable procedure demonstrations and training to take place, with the ability for this type of training to be undertaken by crew onboard being a planned development of MacGregor's," says Mol.

Close is good, even closer is better

Good maintenance practices positively support business operations, but John Carnall emphasises that saving costs does not mean cutting down on maintenance itself: "It means being focused on doing it the right way," he says.

"OEMs know their equipment better than anyone else. This enables us to more easily assess and determine its condition, ensure that parts are not replaced unnecessarily, and develop tailored, cost-effective plans for repair and renewal. Technical personnel can also make relatively small adjustments to operational parameters that deliver material performance benefits."

This is particularly important with reported shipping incidents on the rise and an increased level of scrutiny

applied to equipment failure-related insurance claims, particularly where genuine parts have not been used or maintenance not carried out.

"In many cases, these incidents could have been avoided through periodic visual inspection, but the prolonged industry downturn due to the Coronavirus crisis has meant that maintenance budgets have been impacted," Carnall notes.

"All equipment, if left unchecked, will gradually deteriorate in performance and efficiency, and ultimately fail. Shipowners and operators know this and that planned maintenance is more cost-effective because emergency repairs are almost always more expensive. Whilst it is understandable that longer term cost benefits may not be the highest priority when short-term survival is in question, ongoing operational reliability and potential reputational damage must also be considered.

"When we are able to have an effective dialogue with customers, jointly plan required work and then carry it out as agreed, we are the best at what we do," Carnall says. "With this being increasingly combined with the availability of condition-based information to support effective maintenance planning, we can further enhance the world-class operational support expected of MacGregor, even in the most challenging of times." ■

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