September / October **2024**

SHIP & BOAT INTERNATIONAL

RIBs Yachts Ferries Alt-fuels

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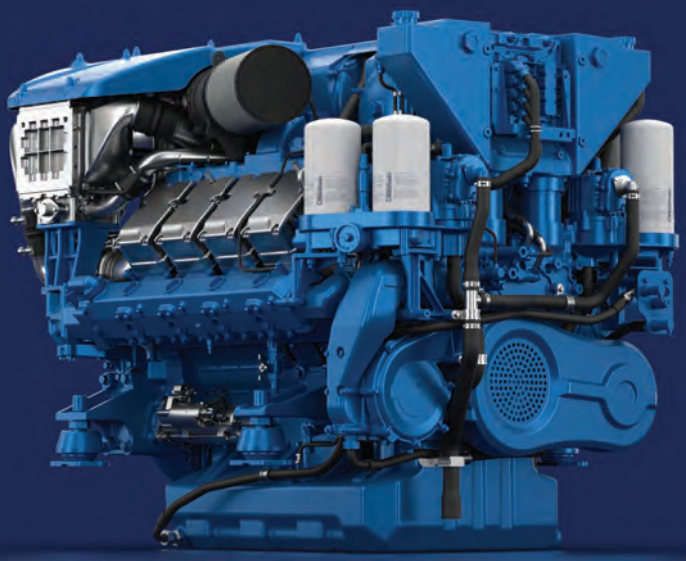

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The Royal Institution of Naval Architects Presents:

Technical Conference:
Managing CII and Associated Challenges 2025

21-22 January 2025, IMO HQ, London, United Kingdom

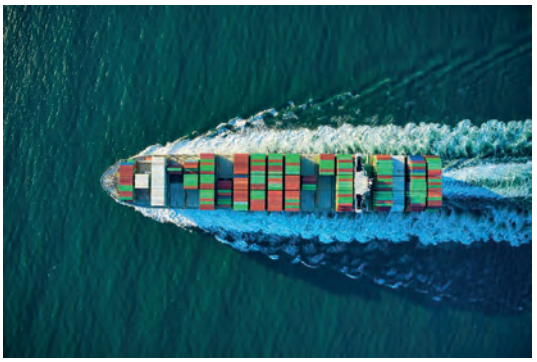
SAVE THE DATE

Carbon Intensity Indicator (CII) – What is it?

The Carbon Intensity Indicator (CII) is a mandatory rating measure for ships, developed by the International Maritime Organization (IMO), that came into effect on 1st January 2023.

As part of its commitment to addressing climate change, the IMO has been working on the development of a Carbon Intensity Indicator (CII) for international shipping. The CII is intended to measure the carbon efficiency of ships and assess their relative carbon emissions performance. The concept of the CII was introduced in the IMO's Initial Strategy on Reduction of GHG Emissions from Ships, adopted in 2018. The strategy sets out a vision to reduce total annual greenhouse gas emissions from international shipping.

The CII is intended to be a key tool to assess and monitor the carbon intensity of ships, providing a standardized and transparent measure for evaluating their energy efficiency and emissions performance. It is expected to be a dynamic indicator that can be updated periodically to reflect technological advancements and best practices. However many sectors of the maritime industry have expressed concerns regarding the unintended consequences of implementation of CII.



Scan the QR Code
for more information

In January 2024, the Royal Institution of Naval Architects (RINA) hosted the first Technical Conference on Managing CII and Associated Challenges at the IMO Headquarters in London. The conference resulted in bringing together 90+ industry stakeholders who exchanged feedback and insight on CII's first year. The 2024 conference, supported by SPNL and the Nautical Institute, allowed the delegates an opportunity to hear from two keynote speakers – Mr. Tianbing Huang, Deputy Director, Sub-Division of Protective Measures, Marine Environment Division, IMO and Julien Boulland, Global market leader for sustainable shipping within Bureau Veritas Marine & Offshore, head-office commercial team, among many other presentations including from companies such as Ardmore Shipping; d'amico società di navigazione spa; MSC Cruise Management (UK) Ltd; DNV; Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping; International Chamber of Shipping; Royal Caribbean Group; and many more.

The IMO must conduct a review of the CII before 1 January 2026, and following initial feedback, changes are expected to CII, though it is not yet clear on what the final outcome will be. The Royal Institution of Naval Architects is proposing a follow up conference in January 2025, and is inviting companies to share how they manage performance as a system, and to explain how continuous improvement in energy efficiency may be achieved.

Conference Topics:

- Experience with managing and complying with CII
- Challenges with implementation of corrective actions
- Experience with effectiveness of corrective actions
- Lessons learnt
- Intersection with commercial and contractual issues
- Best practice energy efficiency management approaches

https://rina.org.uk/events/events-programme/technical-conference-managing-cii-and-associated-challenges-2025/

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NEWS

SUPERYACHTS AND MEGAYACHTS

IRYNA LEADS B.NOW 67 FAMILY

Benetti's Livorno yacht factory has launched the first model in the builder's B.Now 67 series. Designed by RWD, the 66.2m x 11.2m, six-deck vessel, *Iryna*, features a steel hull, an aluminium superstructure and a maximum draught of 3.1m, and displaces 1,150tonnes at full load. *Iryna* offers her owner and guests 500m^2 of useable outdoors space, while interior features include a 65m^2 main salon and a full-beam owner's suite on the upper deck. With two VIP cabins on the main deck and four cabins on the lower deck, the yacht can accommodate up to 15 guests.

Iryna also incorporates Benetti's Oasis Deck concept. Spanning 190m^2 of surface area, the Oasis Deck features open-out wings to extend the deck's width, and comes with a built-in infinity pool. "Owners and guests enjoy an unobstructive 270° view towards the stern," Benetti says of this zone. At the owner's request, *Iryna* was fitted with a sauna and a gym on the main deck. The colouring of the hull and superstructure takes in three different shades of grey, and "the boat is also characterised by extensive, mainly curved glazing that covers up to 70% of the overall vertical surface area," Benetti adds.

The six-deck *Iryna* has a range of 5,000nm at a cruise speed of 12knots

Powered by twin Caterpillar 3512E engines, *Iryna* has a range of 5,000nm at a cruise speed of 12knots. The vessel has also been equipped with a Naiad 200kW bow thruster. Onboard capacities include 115,000litres of fuel oil and 33,000litres of fresh water. ■

RESEARCH AND SURVEY VESSELS

FOILING RESEARCH CRAFT FROM AAM

A rendering of University of North Carolina Wilmington's forthcoming research cat, currently under build at AAM

Washingtonian boatbuilder All American Marine (AAM) has been contracted to build a research catamaran for the University of North Carolina Wilmington (UNCW). Designed by New Zealand's Teknicraft Design, the 22m x 8m aluminium vessel will be used to conduct scientific missions, such as oceanographic surveys and marine mammal monitoring, and to offer educational day trips to both students and the public. The boat will primarily operate in waters off the US East Coast and offshore.

AAM says: "The design incorporates Teknicraft's hydrofoil-assisted hull, ensuring reduced drag, enhanced fuel efficiency and superior passenger comfort…in various sea conditions." Power will be provided by two Scania Di16-082M engines – each rated 588kW at 2,100rpm and compliant with EPA Tier 3 emission requirements – driving propellers. This engine arrangement will grant the vessel a transit speed of 21knots, though it is expected to spend much of the surveys running at a fuel-efficient 1.5knots. An onboard fuel capacity of 5,678litres should guarantee good range, AAM adds.

The vessel layout will comprise both wet and dry lab spaces, plus accommodation for up to 10 crew/personnel, and will have the capacity to take 20 passengers out on day trips. The boat will also be configured to support diving operations and launch/recover ROVs and AUVs. Onboard equipment will include a Kongsberg ADCP electronics suite and a fixed WASSP multibeam system. The boat is being built to US Coast Guard Subchapter T standards for small passenger vessels under 100gt. ■

TUGS

GREEK TUG ORDER BOOST FOR MED MARINE

Med Marine launched its 25m tug newbuild for SVS Maritime in August

Turkish boatbuilder Med Marine reports that its Ereğli Shipyard facility has been abuzz with tug production activity over the past few months, thanks to a series of orders placed by customers based in Greece.

August saw the launch of a tugboat in Med Marine's MED-A2575 class, ordered by SVS Maritime, a subsidiary of Greek tug fleet operator Vernicos Scafi Group. Designed to the specs of Robert Allan Limited's (RAL's) RAmparts 2500W class, the MED-A2575 tug measures 25.2m x 12m; has a depth of 4.6m and a draught of 5.75m; accommodates an eight-person crew; and has a bollard pull capacity of 75tonnes and a speed of 12knots. The tug has been designed to meet FiFi1 standards and features an aft towing hook and capstan.

Prior to this, June saw Med Marine launch a MED-A2800-type tug built on behalf of another Greek client, Igmar, a subsidiary of Spanopoulos Group. That vessel, a RAstar 2800-series terminal escort tug, features a length of 28.4m, a breadth of 13m, a depth of 5.4m and a 5.7m draught, as well as a bollard pull of 75tonnes and a speed of 12knots. Its design also incorporates an advanced rear towing hook. The MED-A2800 is scheduled for delivery to Igmar in September. ■

JACK-UP RIGS

SEATRIUM DELIVERS BORR'S JACK-UP NO. 4

Singapore's Seatrium has delivered a jack-up rig, *Vali*, to offshore operator Borr Drilling, reportedly one year earlier than its planned 2025 delivery date. Seatrium, which was formed in Q1 2023 through a merger between Sembcorp Marine and Keppel Corp's Offshore & Marine division, says *Vali* is the fourth rig that it has built for Borr Drilling, following the deliveries of three KFELS B-class rigs that the operator sold on to ADNOC Drilling for more than US$350 million, according to some sources.

The newer *Vali* is a KFELS Super B-design rig, designed to operate in water depths descending to 122m and capable of drilling down to 10,668m. This rig type also has the capacity to drill deep wells both vertically and horizontally. Seatrium comments: "[The rig's] cantilever structure is designed with a maximum combined load of 3,700kips and is equipped with a fully automated, high-capacity rack and pinion jacking system." *Vali* has the capacity and amenities to accommodate up to 150 offshore personnel.

Borr Drilling says that *Vali* has been assigned to a contract in Africa. Meanwhile, Seatrium says that it expects to complete the fifth jack-up for Borr Drilling, to be named *Var*, in Q4 this year. As with the previous four rigs, this jack-up is under construction at Seatrium's Pioneer Yard, in Singapore's south-west. ■

Seatrium completed and delivered the jack-up rig *Vali* a year ahead of schedule

MARKET NEWS

INFLATION IMPACTS ON BOAT SALES

New boat sales increased by 5.3% between the first half periods of 2023-2024 (image: Van Der Valk Shipyard)

While new boat sales are on the up, used boat sales have tailed off somewhat since last year, according to the *Mid-Year Market Index Report* issued by online sales platform provider The Boats Group. According to the report, overall global boat sales dropped by 9.1% in the first half of 2024 compared to the corresponding period in 2023, mainly due to "persistently high interest rates and inflation", the report says, adding that the lifting of COVID lockdown restrictions has given potential boat buyers a wider range of leisure outlets.

The report records that new boat sales increased by 5.3% in this period, in sharp contrast to a 12.4% decline in used boat sales. However, The Boats Group says: "Despite this increase in demand for new boats, they are taking longer to sell, with an average increase of 53 days on the market compared to the same period last year. Boats that are just one year old are particularly affected, spending an additional 75 days on the market. This trend can be attributed to increased new boat inventory and stabilising prices, motivating buyers to opt for new vessels."

However, used boat prices are holding steady, the report indicates: sellers who offloaded their used boats saw an average price increase of 4.2% (to US$211,500) within this period, while new boat prices fell by 3.4% (to US$174,000) on average. Boats longer than 24m were the likeliest to sell, and at better prices. ■

BOATYARD BUSINESS

A ROYAL MATCH IN VIETNAM

The Nam Trieu boatyard in Vietnam has partnered with Royal IHC

Dutch dredger builder Royal IHC may have finally found its overseas dream partner, having entered into a collaboration with Vietnam's Nam Trieu boatyard. According to Royal IHC CEO Dirk te Bokkel: "Nam Trieu will basically be our overseas yard…in the past, [we have] built ships at foreign shipyards but each time it was at a different yard. Many times this worked well, but not always. We want an experienced shipyard that knows exactly how we work and think".

Nam Trieu, which employs upwards of 700 local workers at present, is currently building a 2,300m^3 trailing suction hopper dredger for Royal IHC, for delivery to operator De Boer-Dutch Dredging. Royal IHC will supply materials from the Netherlands and will supervise construction on site.

"The collaboration with Nam Trieu is the concretisation of our two-pillar strategy," te Bokkel continues. "In Vietnam, we can build to the same quality level with lower labour and energy costs, and our yards in Krimpen and Kinderdijk [in the Netherlands] allow us to build much more quickly. When we have discussions with large customers about projects, they should have a choice." ■

EQUIPMENT

AUGMENTED REALITY

LOOKOUT LAUNCHES AR-VIEW CAM SYSTEM

US-based AI solutions developer Lookout has launched a new camera system of the same name, developed with the claimed ability to "detect hazards beyond human capability". The system reportedly uses advanced computer vision algorithms to detect and track objects in the water – ranging from buoys, logs and debris to other vessels, humans, whales and marine wildlife – to make life easier for crew navigating in restricted- and zero-vis conditions, as well as in crowded harbours.

The Lookout camera system is designed to collect data from charts, AIS, NMEA-compatible sensors, radar targets, smartphones and online sources, and to display it in a 3D augmented reality (AR) view. The idea, the company says, is to enhance the captain's situational awareness while reducing his/her cognitive load while the boat is underway.

In full, the system comprises: a camera, featuring 360°, high-res and infrared night vision-enabled views; the Lookout Brain, powered by NVIDIA, which converts all data into the AR view; and the Lookout Cloud, described as "an optional service for boats with Starlink or other internet connection, enabling community-driven data-sharing". The Lookout Camera retails for US$3,995, while the Lookout Brain comes in a US$4,995 version and a brainier US$9,995 'Pro' edition, the latter offering higher frame rates and resolution for the detection of "smaller and more distant targets", the company states. ■

The Lookout camera system tracks objects in the water, using an AR view

3D PRINTING

TURNING NETS INTO PRINTING POWDERS

UK-based Fishy Filaments has launched a Crowdcube campaign to fund the growth of its business: turning end-of-life fishing nets into materials for 3D printing and injection moulding. The company, formed in 2016, has previously recycled old gillnets into nylon for use in advanced engineering and manufacturing, and claims that it could save fishing fleets "hundreds of pounds a year for every tonne of net recycled".

"Globally, 200,000 tonnes of end-of-life nets are either burnt, buried or discarded at sea each year," Fishy Filaments comments. "Nets that are burnt release vast amounts of CO_2, while nets that end up in the sea represent a significant and long-lasting danger to both wildlife and shipping, taking up to 600 years to biodegrade."

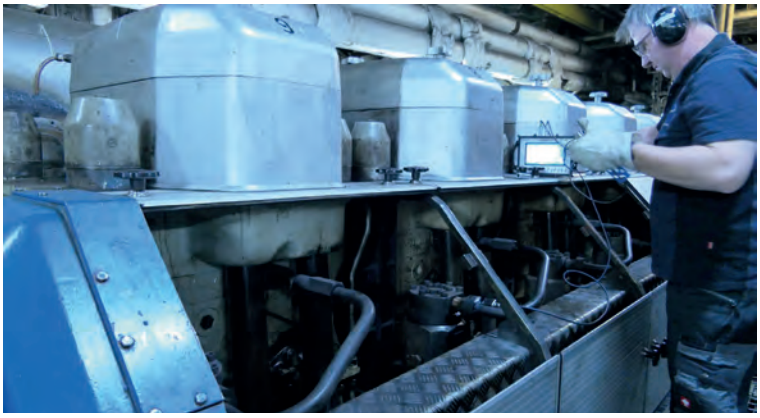
The company wants funding to set up an international network of fishing net recycling plants. "Fishermen in unregulated parts of the world will be able to recycle their nets locally, using [our] plants," the group claims. "Fitting into a 40' container, these chemical-free plants can be transported to remote parts of the world, requiring only water and power to operate."

The group will also use this funding to further develop its range of carbon fibre-reinforced 3D-printing powders, including variants produced for selective laser sintering (SLS) – a methodology in which a laser is used to fuse powdered material into a solid object, layer by layer. ■

Fishy Filaments is recycling old gillnets into nylon, for use in advanced engineering and manufacturing

CONDITION MONITORING

LISTENING OUT FOR ENGINE PROBLEMS



CMT's new fuel injector sensor uses ultrasonic technology to detect problems with fuel injectors, nozzles and pumps

CM Technologies (CMT) has unveiled an acoustic emission sensor for marine diesel engines, designed to capture the acoustic signature of the engine's fuel injection system, to warn crew in advance of any problems with leaking fuel injectors, clogged nozzles and/or damaged fuel pumps.

Matthias Winkler, CMT MD, comments: "Atomisation and fuel injection timing [correlate] directly with the amount of fuel consumed and carbon emitted. By monitoring fuel injection frequencies in the 300-700kHz range, we can get invaluable insight about problems with fuel injection and combustion. If not detected in time, less than perfect atomisation can lead to excess fuel consumption, afterburning or critical component damage."

The sensor has a built-in amplifier and uses electromagnetic acoustic transducer (EMAT) technology – a non-contact, ultrasonic solution – meaning it does not need to be mounted on any internal components. Its magnetic tip enables the user to attach it to any metallic surface. CMT says: "Depending on where the sensor is placed, different aspects of the fuel injection process can be monitored. For example, if the sensor is placed on the cylinder head, the injection and exhaust valve timing can be monitored; while the performance of each nozzle can be gleaned by placing the sensor on the relevant tie rod." ■

ADDITIVE MANUFACTURING

SINGAPORE LAUNCHES 3D-PRINT PROJECT

Class society ABS is leading a project in Singapore to accelerate the adoption of additive manufacturing (AM) within the maritime industry. The project aims to develop a "model-based qualification framework" to streamline the approval process for AM (or 3D-printed) parts to make it faster and cheaper – and thus more attractive to boatbuilders – compared to traditional physical testing schedules.

ABS will work alongside the Agency for Science, Technology and Research (A*STAR) and Mencast Marine, supported by the Maritime and Port Authority of Singapore (MPA). A*STAR's Singapore Institute of Manufacturing Technology (SIMTech) division will develop data-driven models to predict potential defects in AM parts, while Mencast will provide industrial use cases to validate the developed models. Mencast previously worked with ABS when developing Singapore's first class-approved 3D-printed propeller (see *Ship & Boat International* November/December 2023, page 12).

Kenneth Lim, MPA assistant chief executive for industry and transformation, says he hopes the initiative will enable Singapore's marine sector to "grow its AM ecosystem", boosting the island state's reputation as a maritime innovation hub. According to Next Move Strategy Consulting, Singapore's AM market was valued at US$30.8 million in 2022 and is projected to reach over US$201 million by 2030, which also covers its adoption by the aerospace, construction, medical and manufacturing sectors. ■

ABS, the MPA, A*STAR's SIMTech division and Mencast Marine hope to streamline the process for validating additive-manufactured marine parts

LAUNCH AND RECOVERY SYSTEMS

COAST GUARD CONTRACT FOR VESTDAVIT

Vestdavit has secured a contract to deliver a series of davits for six multipurpose vessels for the Canadian Coast Guard, currently under build at Seaspan Shipyards, Vancouver. Each newbuild will be fitted with one of Vestdavit's FF-15000 motion-compensated davit systems, though the contract includes an option for a further 10 such units.

The FF-15000 is hydraulically operated and features a safe working load (SWL) capacity of 15,000kg (15tonnes). Mounted on deck, the davit can operate in both single- and dual-point configuration. Vestdavit comments: "The FF-15000 is based on the F-frame system that comprises a large frame with no structure behind or underneath the daughter craft. This allows for greater flexibility in the shape and volume of the boat being handled, with the main structure aft/forward of the boat."

Vestdavit adds that the davit can handle both a 9m self-propelled barge and a 7.5m RIB, plus a 20' ISO container. The system features adjustable lifting points to enable the handling of boats and containers with different lifting points, size and weight. The davit has also been fitted with shock absorbers and an anti-pendulation device with guide arms, to make it easier and safer to launch and recover boats in rough seas and harsh weather.

Each of the six multipurpose vessels will feature a length of 99.9m, a breadth of 20.3m, accommodations for up to 50 crew members and a 1,000m^3-capacity cargo hold. ■

Each of the six Canadian Coast Guard newbuilds will be fitted with an FF-15000 davit system

SAIL SYSTEMS

GREENPEACE NEWBUILD OPTS FOR DYNARIG

Greenpeace International has contracted yacht sailing system manufacturer Southern Spars to provide two DynaRig masts to the environmental NGO's forthcoming 75m sailboat. The vessel, designed by Dykstra Naval Architects, is due to be constructed at Freire Shipyard in Spain, and is planned to commence operations in 2027.

The masts will feature a sail area of 2,000m^2, supplied by North Sails. The boat will also make use of battery packs, solar panels, green hydrogen and e-methanol for its onboard power requirements. These alt-fuel systems will be provided by Longitude Engineering, which comments: "Together with the vessel's sail power, the hydrogen and methanol energy generation capabilities will enable the vessel to operate emissions-free under all conditions."

Developed in the 1960s, and installed on yachts such as the 88m *Maltese Falcon* and 106.7m *Black Pearl*, the DynaRig system comprises a free-standing, rotating mast (or masts) and a fully automated sail handling system, designed for ease of deployment. The system was also devised to significantly reduce the risk of persons on deck being hit by highly loaded sheets or blocks. Southern Spars says: "From a single control panel, the ship can be sailed by one crew member, allowing safe, high average speeds in ocean conditions."

Dykstra Naval Architects previously supplied the design for the 58m Greenpeace vessel *Rainbow Warrior III*, launched in 2011, which features a 55m-high A-frame mast system. ■

The forthcoming, 75m Greenpeace vessel will feature a DynaRig system (pictured aboard the yacht *Maltese Falcon*)

DRONE TECH

SEARCH AND RESCUE

DRONES LINK UP IN SPANISH RESCUE DEMO

Spain's ITG Technology Center (ITG) has hosted a demonstration in the Port of A Coruña to show how the use of unmanned aerial vehicles (UAVs) can assist marine drones in rescuing casualties in the water. The demo, which was hosted in collaboration with the Red Cross and drone operators Aeromedia, Aerocámaras and Nordés Tech, included six instances of a UAV detecting a person in the sea and activating various autonomous marine rescue drones. The event was conducted as part of the EU-funded U-ELCOME initiative, coordinated by the EUROCONTROL Innovation Hub.

ITG explains: "Localisation with DroneFinder technology allows the exact coordinates to be sent so that another drone can launch a float to the person who has fallen into the water, and a maritime drone can travel to that point and bring the victim to the dock." The demo also assessed how the drones could assist with crane, parameter and breakwater inspection tasks, as well as port logistics.

Additionally, ITG says it has reached an agreement with the Port Authority of A Coruña to deploy the port's first autonomous drone station. Described as a "robotised hangar", this station, called the DroneSafeBox, will serve as a "nest" for any aerial drones that the port chooses to integrate into its processes, ITG says. ITG adds that it hopes to have an automated AUV service in place in A Coruña in 2026. ■

ITG's DroneSafeBox serves as a 'nest' for aerial drones at the Port of A Coruña

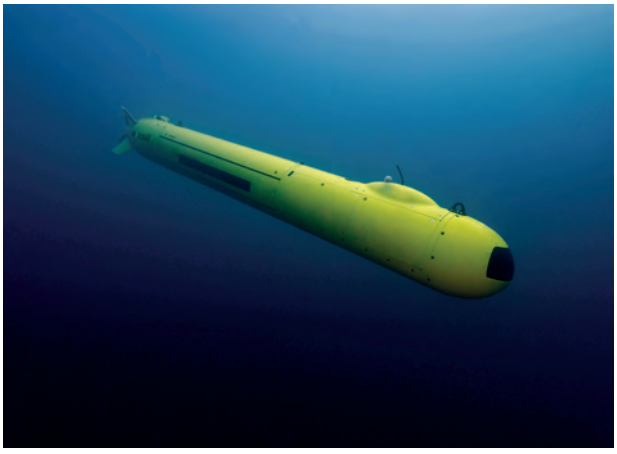
SEAFLOOR MAPPING

INSTANT CARMA ON THE SEABED

Subsea tech companies Exail, RTsys and ABYSSA have joined forces on a French project seeking to revolutionise deep-seafloor mapping through the utilisation of AUV swarms, working in coordination to gather environmental data. The CARMA project intends to establish a multi-sensor drone, capable of descending to depths of 3,000m, which will lead a swarm of AUVs to explore vast areas underwater. As part of the project, the partners will research, design and create advanced navigation, communication and positioning systems specifically for collaborative swarm operations.

Exail will enhance its A18-D deep-water AUV to act as the swarm's leader throughout the project, while RTsys will contribute its COMET-3000 AUV, modified to operate at 3,000m, and multiple follower units. RTsys will also design a dedicated launch and recovery system for the swarm. ABYSSA, meanwhile, is tasked with developing exploration strategies for deep-sea AUV swarms and processing magnetic data to map seabed anomalies.

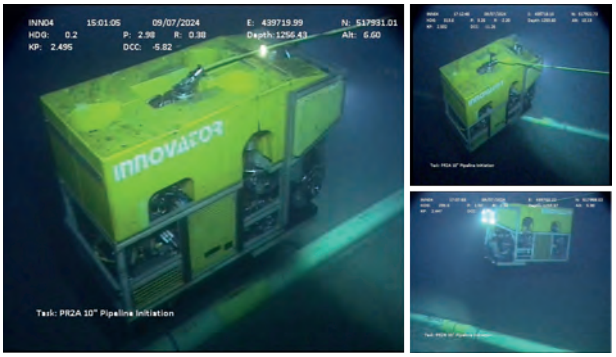
The plan is to deploy an operational demonstrator at sea by 2026, with a view to subsequent commercialisation. The project will also explore the possibility of extending subsea exploration capabilities to depths of 6,000m. Marine Postec, RTsys project manager, comments: "The studies conducted thanks to the AUV swarm will contribute to the inventory of underwater heritage". ■



Exail is contributing its A18-D deep-water AUV to the French CARMA project

INSPECTION, REPAIR AND MAINTENANCE

SAIPEM SCOOPS GREENSTREAM CONTRACT



Saipem will oversee subsea intervention services for the 516km-long GreenStream gas pipeline

Saipem has been awarded a contract to oversee subsea intervention services for the GreenStream pipeline, recognised as the longest underwater pipeline in the Mediterranean Sea. Measuring 516km in length and just over 800mm in diameter, GreenStream links the gas terminals at Mellitah in Libya and Gela in Sicily, and passes through water depths reaching 1,150m off the coast of Malta.

This subsea intervention work will be managed by Saipem's robotics hub, Sonsub, working in tandem with the Saipem Engineering Hub in Fano, Italy. Saipem states: "The scope of work streamlines the integrated management of survey data and critical spares; the provision of specialised engineering services related to asset integrity; and readiness services for repair interventions in case of a wide range of damage scenarios." To handle such scenarios, Saipem will deploy its remotely operated, fully diverless SiRCoS deepwater pipeline repair bot, which can operate in water depths of 2,200m. The SiRCoS is equipped with four 60tonne handling frames, a pair of 65tonne jacking clamps, plus cutting and coating removal tools capable of penetrating through 100mm concrete thicknesses.

Launched in 2004, the GreenStream pipeline has the capacity to transport up to 11 billion m^3 of gas annually. Saipem describes the new contract as building on the asset integrity, maintenance and emergency pipeline services it has been providing to GreenStream since 2008. ■

CLEANING SOLUTIONS

CLEAN-UP BOT HEADS FOR SINGAPORE

ECOsubsea has received a US$3.19 million growth loan to commercially advance its hull-cleaning bot in the Port of Singapore

Norwegian tech firm ECOsubsea has been granted a NOK 35 million (US$3.19 million) growth loan from Innovation Norway to scale up and commercially roll out its robotic hull-cleaning ROV in the Port of Singapore. The ROV is designed to clean vessel hulls by moving across the hull beneath the water's surface and using soft jets to remove and collect foulings "like a vacuum cleaner", without damaging existing coatings. The collected fouling debris is then taken ashore for conversion to biogas, ECOsubsea says.

The company claims that its ROV could contribute to annual CO_2 savings in the realm of 10 million tonnes. "Because ECOsubsea also collects the waste from cleaning, the ocean is spared from toxins, heavy metals and microplastics, while avoiding the spread of unwanted species," the group says. "Currently, ships can be delayed by up to 24 hours due to washing. They will avoid this with ECOsubsea's solution." The bot has previously been employed in the Port of Southampton, UK and has also been utilised to clean the hulls of various vessels operated by Siem Offshore.

Håkon Haugli, CEO of Innovation Norway, comments: "The new technology facilitates far more frequent hull washing, which causes less damage to the environment and reduces greenhouse gas emissions." ECOsubsea says that its planned expansion in Singapore will include new hires. ■

NEW VESSEL DESIGNS

FISHING FOR ENERGY

DRIFT Energy's Most Valuable Yacht concept is designed to convert wind energy into green hydrogen while on the move, care of wind-assisted propulsion, a submerged turbine and a unique wind-hunting algorithm

The 58m Most Valuable Yacht will produce approximately 150tonnes of green hydrogen annually

You know you've hit on an innovative vessel design when you're not *quite* sure how to go about describing it. For example, the Most Valuable Yacht (MVY) concept devised by UK start-up DRIFT Energy could be categorised as a hydrogen production and bunkering vessel or, alternatively, as a "green, self-filling tanker" or a "fishing boat for energy", founder and CEO Ben Medland tells *Ship & Boat International*. Whatever the handle, Bath-based DRIFT has ambitious plans to push this new design to fulfil an extremely ambitious, critical mission; namely, "to abate a gigatonne of CO_2 by 2050 by having a flotilla of MVYs on every ocean", Medland predicts.

The MVY is a 58m, high-performance sailing catamaran, intended to work along the same lines as a mobile floating wind turbine: it captures deep-ocean wind and uses it to produce green hydrogen (generated by using only renewable energy sources, without fossil fuels) while at sea. The MVY then sets sail to deliver its home-brewed hydrogen – not just to maritime and offshore operators, but to heavy industry located close to ports, as well as small island communities in hard-to-reach locations, across the globe.

"We go where the action is, while other renewable energy-capturing devices stand still and wait," says Medland. "We're the world's first mobile renewable energy class – the MVY is what happens to a floating offshore wind turbine when you get rid of the anchor and go free-range. We've combined energy generation, storage and distribution into one centralised asset.

"70% of our planet currently lacks renewable energy technology. But we do have a mode of transport that's helped to grow the global economy, and one with an entire supply chain of talent and technologies. We're just leaning into all that proud heritage that we can share."

Wind energy capture

The MVY is fitted with a sail system, used to propel the vessel forward. As the boat moves through the water, it turns a turbine beneath the waterline – similar to a hydrogenator on a yacht – which converts the kinetic energy into the electric energy required to feed the MVY's onboard megawatt-electrolyser. The process of electrolysis then splits water into hydrogen and oxygen.

Medland likens the vessel's sail/turbine relationship to "attaching a kite to the front of a Tesla; it effectively regenerates just by being pulled along by the wind". While wind power serves as the MVY's 'fuel', solar panels harvest additional clean energy for the boat's batteries, powering the onboard air-con and other hotel load components.

Each hull will essentially serve as the MVY's 'production plant'. Medland adds: "We went down the catamaran route as it created extra space for storing hydrogen, and it also creates the righting moment and seakeeping abilities to generate the performance that's required from the boat." In its current form, the boat will have the capacity to store up to 4tonnes of hydrogen and to produce between 2-3tonnes of hydrogen every seven days, adding up to approximately 150tonnes per year, depending on season, location and the needs of the customer.

The latter can vary wildly, depending on whether the customer's requirement relates to heavy industry, grid power or marine transportation. "For example, one customer may want fuel cell-grade hydrogen; another may want lesser-grade hydrogen for combustion;

A combination of sails and underwater turbine generate the power to undertake onboard electrolysis

they may want higher or lower pressures," Medland says. "Through modular, scalable design, we can produce a vessel that fits a broad range of those use cases, while the final fit-out can be modified to be more customer-specific."

And, if the design of the wheelhouse is reminiscent of a futuristic bomber, it may reflect Medland's background as an aerospace engineer. "When I stepped into the world of naval architecture, there was some overlap with my aerospace background," he reveals. "The design loop at DRIFT is very different from most naval architectural challenges, though. We're designing an energy-harvesting ship and, through the interplay between all those different forces, we're learning a lot about boat design. We have a simple mantra: to adopt whatever can make the boat go greener."

Unique algorithm

While the MVY concept looks impressive, there's some equally spectacular technical innovation taking place out of sight. As Medland puts it: "The digital and physical sides of the business are intertwined in how they work and operate together." Working in collaboration with London-based Faculty AI, DRIFT has developed what it calls the 'Goldilocks algorithm'. This algorithm is designed to hunt for optimum weather conditions, to ensure that the boat plots routes into zones where it can harvest the right amount of wind energy, instead of randomly floating around during a lull or automatically 'chasing the wind' when a more efficient, effective option is available.

"It enables the boat to strategically assess options and make sure we're not sacrificing near-term gains for long-term performance," Medland adds.

"The algorithm plays off those different trade-offs between generating where to go to find the right weather. Using that info, we feed that back into the vessel and figure out what we can achieve in terms of power output." This also benefits the overall boat design process, helping the DRIFT team – including Neal Pawson, head of vessel programme, and Mike Mackay, head of vessel design – to fine-tune future generations of the MVY.

As you might expect, given the benefits of using this algorithm, DRIFT's goal is for the MVYs to operate autonomously. "Step one is that we make the boats remotely operable," says Medland, "and then, over time, as the regulations and technology improve, we get to a place where full autonomy is more of an option.

"But for the first fleets, we envisage a crew: things happen at sea, so having a crew on board to monitor or take control of the boat, and to understand and learn about this unique vessel type, is going to be important. Also, we don't want to have to wait for autonomous technology to catch up with what we're building."

Global flotillas

For now, the MVY remains a work in progress, with DRIFT consulting class societies to determine the boat's technical particulars and crew complement.

However, Medland stresses, the MVY is far from being a 'one-boat project'. "This isn't a project; it's a business," he says. The aim is to launch flotillas comprising literally "hundreds, if not thousands" of MVYs delivering hydrogen to all four corners of the globe: a coastal and offshore network with the potential to become as synonymous with global green energy production as the world's 341,000-and-counting wind turbines.

From left to right: Neal Pawson, head of vessel programme; Ben Medland, CEO and founder; and Mike Mackay, head of vessel development, DRIFT Energy

Each hull will effectively serve as the catamaran's hydrogen production plant

This will mean partnering with a wide range of boatyards and component manufacturers. "We've adopted the 'And' philosophy," says Medland. "DRIFT doing well means that other companies can scale with us too. We're looking for partners and companies interested in contributing not only to the development of the first boats in the series, but to the thousands we'll be building afterwards." This cooperative spirit extends to participation in ocean conservation programmes, such as the International SeaKeepers Society's Seabed 2030 mapping initiative.

Medland adds that the group is currently in confidential talks with international yards. "Shipyards are interested in the MVY because this is a new class of vessel," he says "We envisage the yards building the boats on a scale like that of the Liberty-class cargo ships in WW2, where many ships are built in multiple places. The yards are very excited about this because, typically, multiple orders for ships sized 24m+ are infrequent."

These newbuilds would not necessarily limit themselves to hydrogen production and storage. "We have plans for vessels that can produce other e-fuels, such as green ammonia and green methanol," Medland says. "Green hydrogen currently represents the most fungible commodity, and the easiest to move back to shore from a cost and technology perspective. We're fuel-agnostic; the MVY is essentially a platform for renewable energy."

'Technology of now'

Things appear to be taking off for the group. In August, DRIFT announced the close of its seed funding round, led by Octopus Ventures and supported by Blue Action Accelerator, which has gifted the company £4.65 million to commence MVY production. DRIFT has also received funding from Innovate UK to accelerate the design process for the first vessel.

Medland predicts another 12 months or so of design refinement. Then, the plan is to lay the keel for the first MVY in late 2025 and to get it built within approximately 18 months, meaning we may get to see the debut unit on the water by summer 2027.

"If designing a boat is tough, designing a sailboat is really tough," Medland reflects. "And then, designing one that generates energy that relies on a routing algorithm, where the algorithm is teaching us things about how to design the boat properly, is a very interesting design challenge from a naval architect's perspective.

"The industry has already designed and built hydrogen-powered ships: the MVY uses the same chemistry, only in reverse. The precedent of what we're doing exists. I've described DRIFT as incorporating the 'technology of now'; if we'd tried to start up this company 10 or 15 years ago, we wouldn't have been able to benefit from the leaps made in wind-assisted propulsion system [WAPS] technologies, nor the supply chains around them. Also, we wouldn't have had the computing power and data available to develop the algorithm we're using. We feel there's a real renaissance in shipbuilding, especially when it comes to wind-assisted propulsion." **SBI**

SIGNIFICANT SMALL SHIPS OF 2024

In early 2025, The Royal Institution of Naval Architects will publish the 25th edition of its annual journal *Significant Small Ships*, profiling first-in-class, innovative and/or unique vessels sized between 5-100m and delivered during 2024. We cover a wide range of international newbuilds, ranging from yachts and small recreational craft to fast ferries, patrol boats, workboats, CTVs, AUVs and tugs.

The Editor invites shipbuilders, designers and owners to submit details of vessels for possible inclusion in *Significant Small Ships of 2024*. Presentation will follow on the established two-page format, with a colour photograph, descriptive text and tabular details (including major equipment suppliers) on the first page, followed by a full-page general arrangement. Initial potential entries should comprise a short technical description (100 words) of the proposed vessel highlighting the special features and the delivery date.

All entries should be addressed to:

Editor, Significant Small Ships of 2024,
Email: sss@rina.org.uk
Tel: +44 (0) 20 7235 4622 Fax: +44 (0) 20 7245 6959

BORDERLINE GENIUS

In the second of two opinion pieces on the benefits of using USVs, Matthew Ratsey, MD of Zero USV, argues that autonomous craft can assist maritime border patrols who find themselves overwhelmed by illegal migration, smuggling, overfishing and terrorist threats

Every border in the world is under threat, daily. Organised crime groups look for potential vulnerabilities at ports and airports, and likewise, they seek out corrupt individuals who are willing to facilitate crimes at border points. A report from UK Defence & Security Exports highlights eight 'capability areas', with technology being a key driver. Paul Lincoln, then (2021) director general of UK Border Force, said: "Government and industry must collaborate to develop technology and procedures which, for example, can improve the quality and timeliness of information available at the border's primary control points."

The UK ports industry handles almost 500 million tonnes of freight and more than 60 million passenger journeys annually. The sheer volume of traffic challenges capacity to intercept all but a fraction of suspicious consignments, given that the UK, as Europe's second largest port sector, is processing more than 95% of the UK's international trade. In 2020, more than 15,000 firearms and weapons and more than 23,000kg of Class A and B drugs were seized at borders. Clearly, our waters here in the UK (and, of course, every nation's near and open water operations) pose logistical challenges never seen before, heightened in recent years by higher-risk modes of entry, including refrigerated HGVs and small-boat crossings, and the increase in illicit goods smuggled into legitimate consignments.

Finally, there is the geopolitics of hostile nation states testing or interrupting critical national infrastructure, from data cables supplying the internet and telephony to oil and gas pipelines. The demand for border surveillance and control is becoming exponential.

Cost-effective

Fully equipped with high-spec cameras and cutting-edge sensors, USVs can patrol sensitive areas, delivering real-time data to coastal authorities, enhancing national security in tandem with law enforcement agencies. The advantage of the 'unmanned' component is clear: complex tasks can be accomplished with only a small team of trained technicians, while modern platforms can easily be reconfigured to support a wide variety of payloads, making them highly cost-effective in contrast to conventionally crewed alternatives.

Armed forces worldwide have already acknowledged the potential of unmanned systems to bolster naval operations. In addition to Ukraine, the US, UK, France and China are at a mature point in utilising advanced USVs for maritime border protection, and are developing suites of USV technology to accomplish a range of mission types.

Uncrewed border surveillance can be highly cost-effective compared to conventionally crewed alternatives (image: Saildrone)

One of the primary benefits of AI-enhanced USVs in border control is their ability to operate autonomously in diverse and sometimes challenging environments. Equipped with advanced sensors (including radar, sonar and both high-resolution daylight viewable and IR cameras), these vessels can patrol vast maritime borders with minimal human intervention. AI algorithms enable USVs to detect, track and classify potential threats in real time, ensuring a rapid response to unauthorised activities such as those already mentioned.

Highly adaptable

USVs are also highly adaptable, capable of performing surveillance missions and monitoring of environmental conditions, and can assist in search and rescue operations. Their ability to operate continuously and tirelessly (zero crew means minimum replenishment/return to port requirement) ensures consistent monitoring, reducing the risk of gaps in border security.

Moreover, USVs can be deployed in swarms, creating a networked ecosystem that enhances coverage and optimises situational awareness. This collective, aggregated intelligence allows for better-coordinated efforts in tracking and intercepting suspicious vessels. Meanwhile, the integration of machine learning enables these systems to improve over time, refining their capabilities based on accumulated data and experiences.

And, by dint of their much lighter payload (no crew with all their attendant food, water and accommodation) USVs help reduce carbon emissions, so they are greener, as is their energy source, the sun, meaning that they can travel further, and longer, without shifts and other human dynamics. **SBI**

ELECTRIC PROPULSION

FLY-BY-WIRE THROTTLE

RAD Propulsion's RAD40 outboard brings together throttle steering and trim, but also additional interfaces with chart plotters, generator sets and other systems, writes Stevie Knight

Marine electric propulsive systems have now been around for a while, says Dan Hook, CEO of RAD Propulsion. However, he adds: "Many engineers trying to interface with these systems found them really very difficult, with proprietary bits of code that you couldn't open and random alarm messages that you couldn't understand.

"When there was a problem, we'd find the propulsion supplier would point the finger at the NMEA junction supplier, who in turn pointed the finger at someone else. It was always everyone else's fault." That's an issue for a sizeable workboat segment. Firstly, there are newer hybrid systems with clean-running alternatives, which will likely require shoreside monitoring and support. Then there are autonomous and remote operations, which usually require numerous elements, such as launch and recovery systems, to work together.

Given all this, Hook teamed up with others who'd been subject to similar frustrations to create the team behind RAD Propulsion – though it remained under the radar until they'd done their homework. "We operated in 'stealth mode' for the first couple of years, laying the foundations," he explains.

In fact, the first product, the RAD40, is a 40kW fully integrated, fly-by-wire electric drive suitable for sub-13m boats. The RADbus backbone brings together throttle steering and trim, but there are additional interfaces with chart plotters, generator sets or fuel cells, as well as other systems. RAD's head of embedded systems, Harry Beadle, explains: "Things like batteries or hydrogen fuel cells tend to have safety-critical parts – while these are managed internally, we can monitor them via the RADbus. We can switch on or off any sort of actuator, crane, hatch or connection...anything digital."

'Waterjet-like'

Usefully, the RAD40 also yields 'waterjet-like' manoeuvrability as it has a 180° steering angle; this effectively means it can spin on the spot.

The RAD40 weighs in at 98kg and is more compact than a conventional outboard: "You don't have the big power head where the engine would normally be," says Hook. Further, the motor doesn't intrude into the vessel's deck space: "It's slightly different to traditional outboards and more suited to over-the-stern operations," says Beadle. "You can install two drives and work between them, tuck them away under a platform, or install a hatch so you can trim up out of the water but still have a flush deck when operating."

The applications are numerous and the first have already begun to see the light. There's a niche for cruise ship daughter craft, especially those used for whale-watching and ecotourism, where the clean running, silence and manoeuvrability of the electric RAD40 is a preferred fit to diesel applications. It's not that slow, either: the 5.8m RIB has demonstrated 16knots with 11 people on board. The console – which also houses the battery – can be removed and, when the boats aren't inflated, it can all be stowed away.

The solution is also useful for emergency packaway boats; the kind required for flood relief, especially in clean-water environments. These relief boats might not be used for years, but the maintenance programme is easier to manage with a modular, electric drive and battery than it is with diesel power. The connectivity and monitoring aspects of RAD's system is also delivering results for propulsion research. Innovate UK's Zero Emission Network Of Workboats (ZENOW) project has begun to deliver 20 RAD-powered workboats, produced by boatbuilder RS Electric, to harbour masters around the UK.

It appears there is also interest from the wind sector for SOV daughter craft, and even from the ROV/USV sector. For example, the RAD40 has been adopted by Zero USV's 11.5m autonomous Oceanus12 USVs (see *Ship & Boat International* May/June 2024, pages 20-22). A 120kW drive is in development for "considerably bigger, faster boats", Beadle says.

Likewise, the company has a range of fast-charging batteries tailored to fit the various vessel spaces. For example, the 61kWh version has a long, narrow shape and low height, so it can fit down in the V of a typical powerboat hull – and it's expandable up to 244kWh. At the other end of the scale, the 21kWh version is more of a box that can fit under seats or consoles. **SBI**

The compact RAD40 outboard was designed not to intrude into the vessel's deck space

RIBS

COPING WITHOUT THE WALL

Since the inclined metacentre cannot be consistently derived for many modern hullforms, should GM be abandoned in favour of KN when evaluating inclining experiment results, asks Richard Dunworth?

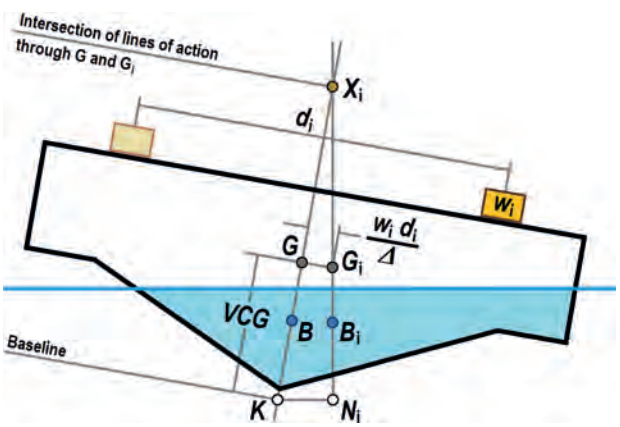
The following paper is a revised update of Richard Dunworth's article Scaling The Wall, published in the November 2021 issue of The Australian Naval Architect.

The 11m air-drop rigid-hull inflatable boats (SF-ADRHIBs) used by The Australian Army Special Forces were certified for stability in accordance with the requirements of the National Standard for Commercial Vessels (NSCV); in service, VCG was monitored by in-water inclinings, evaluated by the prescribed use of GM. In 2019 an in-air inclining showed a marked difference in VCG with no significant change to the vessels. The Australian Naval Technical Bureau conducted inclining experiments on a scale model to investigate this issue.

VCG was first measured by suspension and an air inclining gave good agreement. A water inclining experiment, worked up by three typical GM methods, gave widely varying estimates for VCG; none close to (and two grossly under) the measured value. Further investigation was undertaken using numerical models. The explanation of the error, and its resolution by an accurate alternative work-up method using KN, suggests that it may no longer be appropriate to nominate the use of GM for deriving VCG from inclining experiment results.

GM-related problems

Some ship-related terms, like K (the vertical reference point at or near the keel), are physical points in space. Others, such as G and B, are imaginary but meaningful, with their locations identifiable by calculation. The metacentre M is not only imaginary, but its meaning can be obscure and its location mistaken. In practical terms, M represents the maximum height of the centre of gravity for a vessel to retain positive stability: if G lies above this limit, either capsize occurs or a state of loll exists.



Generalised inclining experiment after move i

Today, GM may have little value other than as a convenient label for the stiffness of a ship: it can be found directly from the slope of the GZ curve as it passes through upright.

One of the last strongholds of GM is in the evaluation of an inclining experiment where it is traditionally used to find VCG (or KG) from inclining experiment results via the relationship *KG = KM – GM*.

Discontinuities such as chines, collars, asymmetry, etc. can cause abrupt changes in waterplane inertia which has a corresponding knock-on effect on BM and, in turn, on KM.

There are several problems with a GM analysis, which can only be relied upon to give a good result if:

- the vessel is effectively wall-sided;
- inclining heel angles are small (eg, less than one degree, maximum); and
- a linear relationship exists between the applied moments and resulting heel angles.

Once heeling occurs (and it is difficult to conduct an inclining without), these problems begin to affect the accuracy of VCG found via GM.

Inclining analysis without M

An accepted definition of the metacentre is the point of intersection of the verticals through the centre of buoyancy and through a new centre of buoyancy when the vessel is offset by a small heel angle. This is interpreted in the diagram by point X, rather than M, at the intersection of the verticals, using the vertical through B at upright as the reference.

The method of calculation is generally quite different: BM is found as *I / V* where I is the transverse moment of inertia of the waterplane and V is the volume of displacement. If the hull is not upright then B_iM_i, being normal to the waterplane, should be rotated into ship coordinates and corrected for any vertical shift of B to B_i; then M is a distance KB + BM, vertically above K.

The definition and calculation appear quite disparate yet, for an upright wall-sided form, and with a sufficiently small heel offset, are entirely consistent and deliver the same value of KM.

The metacentre will move as the ship heels, particularly if discontinuities pass through the waterplane. If the evaluation of an inclining experiment relies on KM but ignores this movement, some degree of error will inevitably result.

From the inclining experiment diagram, if KN is known then all information necessary to calculate KG at any heel is available, without reference to the shape of the waterplane (or to the centre of buoyancy). An accurate calculation of VCG, using KNs, rather than GM can be therefore be derived.

After move $_i$:
- $KX_i = KN_i / sin(heel_i)$
- Heeling moment is $w_i . d_i$

So:
- Shift of G, moment / displacement, is $w_i . d_i / \Delta$
- $GX_i = GG_i / \tan(heel_i)$ and
- $KG = KX_i - GX_i$

After substitution and rearranging:
- $KG = (KN_i / \cos(heel_i) - w_i . d_i / \Delta) / \tan(heel_i)$

More detailed explanation and implementation can be found in the paper *Scaling the Wall* in the November 2021 edition of *The Australian Naval Architect*.

Validation of the KN method

Beyond the Wall (STAB2015) used a model of a section through a hard-chine craft, 1.2m-wide x 0.3m-long, to investigate the issues associated with GM and to verify the KN method. The chine flat was somewhat wider than normal to ensure that the immersion point could be observed and could be expected to have a noticeable effect on the results. A light aluminium pylon allowed a pair of pendulums to be hung.

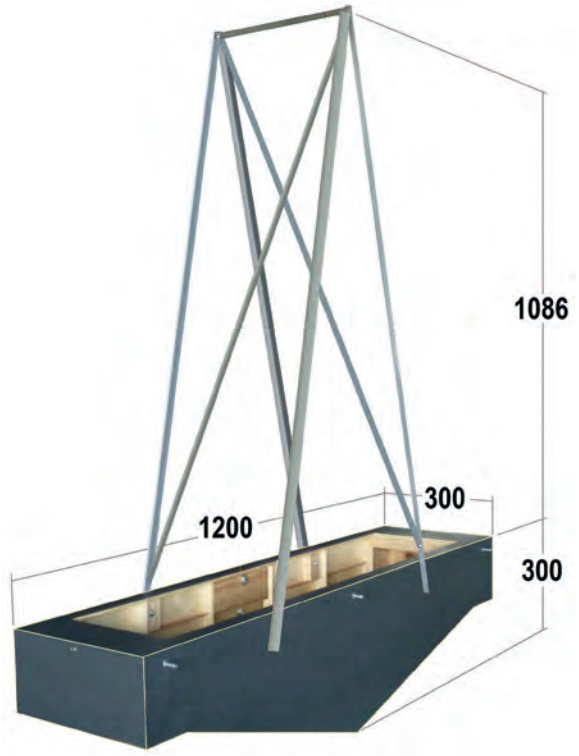
An inclining weight was moved progressively on rails inside the hull to port and starboard, in 50mm steps, to give a series of 26 weight moves: the maximum heel attained was just over 5°. Inclining experiment scenarios were then generated by selection of appropriate sets of data from this list:

- Typical, upright to +/- 2 degrees;
- Large initial list, small range;
- Restricted heel, upright to +/- 1 degree; and
- Small initial list, large range.

The inclining experiments were evaluated by three recognised GM methods, each using the relationship *VCG = KM – GM*, and by KN. The GM methods were:

(a) GM via linear trendline slope
The slope of *Moment vs Δ tan(heel)* gives GM

(b) Average GM
GM is calculated after each weight move as *Moment / Δ tan(heel)*; mean GM value is used



Hull section inclining model

(c) Use of heeled KMs
Using the GMs calculated in (b) and values of heeled KM, VCG is calculated at each move. The average VCG value is reported.

Other than when using very small heel angles, none of the VCGs calculated by GM on any of the inclinings gave a good result. One gave a negative VCG.

Scaling the Wall (*ANA,* Nov 2021) used the same cross-section model which was remeasured and VCG determined by suspension from three different points. New inclinings were conducted, both in air and water, with the air inclining giving an accurate VCG result.

There was a wide range of VCGs from the physical inclining when calculated by GM. Use of individual heeled KM values (c) gave a high VCG. The two most common methods, determining GM by linear trendline slope (a) and by average GM over all mass movements (b), gave alarmingly low values of VCG with the trendline slope method giving VCG only 11% of the measured value.

None of the three GM methods stands out as consistently better or worse than the other two. A small maximum inclination angle is likely to deliver a relatively good result by GM; however, such angles may be hard to achieve and measure accurately at an in-water inclining experiment, particularly on smaller craft.

When evaluated by KN, the resulting VCG was good: only 0.1mm higher than the measured value.

With the model at level trim, the chine immersed and emerged throughout its entire length instantaneously,

generally representing the worst case for erratic derivation of VCG. As the short length of the model precluded meaningful investigation of trimmed states, a numerical model was extended into a recognisable hull form. First stretched from 0.3 m to 1.5 m long to form the aft LBP/2 with constant cross-section; then extended forward to a common point on the deck centreline, LBP/2 forward of midships, with sheer, chine and keel lines as circular arcs. This model allowed more extensive inclining simulations, including trimmed states.

At level trim, the results followed the same trend as the in-water inclining. Evaluation by GM gave better VCG results when the model was trimmed, but a good result was only achieved consistently when heel angles were restricted to about one degree and below. Evaluation by KN continued to give exactly correct results throughout.

Resistance to change

Despite known problems using GM, and with the KN method delivering consistently accurate results for any hullform, there are several reasons why the GM method is still being used:

- The GM method still appears in text books, so becomes familiar to student naval architects;
- References to the GM method on the internet will never be completely eliminated;
- There is a lack of appreciation of how evolving hullforms can introduce significant errors;
- No known alternative has been widely recognised and made readily available;
- The GM method is nominated by some statutory authorities in their inclining experiment instructions; and
- There has been, and continues to be, an attitude of 'why change something that has worked for the last 250+ years?'

A collection of papers, assembled into *A Treatise on the Stability of Ships,* was compiled in 1885 by Sir Edward J. Reed and shows how well the principles of stability were understood by then. However, the volume of calculations needed to fully implement these ideas was unrealistic at the time and was often confined, for illustration, to simple shapes such as square prisms. The mechanical integrator, developed in the 1880s, was a welcome tool, but it was only with the arrival of modern computers that it became possible to generate accurate numerical hullforms, and to readily produce a set of free-trimming KNs, for any but the simplest shapes.

The concept of an inclining experiment was first proposed over 300 years ago but it was nearly another 50 years before a practical method of conducting an inclining experiment was described by the French astronomer and mathematician Pierre Bouguer.

Two years later, in 1746, the first inclining was conducted at the Brest naval shipyard on the 74-gun ship *Intrépide*. This was at a time when the French navy had recently suffered defeats by the British: gaining an advantage through the ability to carry more sail was of great importance to both naval and commercial shipping.

Metacentric height was already used as a measure of a ship's stiffness and, hence, of sail-carrying capacity. The traditional calculation associated with an inclining experiment leads directly to a value of GM, and it was not until the concept of GZ had been developed that it became necessary to take the matter further and find the position of the centre of gravity itself. By then, Bouguer's GM calculation method was well established and continues to be used to this day.

The way ahead

One issue can be readily resolved, and the associated risk mitigated, by regulatory authorities removing any reference to GM in this context and requiring instead that a consistently correct workup method be used to derive the centre of gravity from inclining experiment results.

The KN method requires no change to the inclining experiment procedure, only to the analysis. It can be used to revisit past experiments and compare the results by the two methods. The only additional overhead is a set of free-trimming KNs, at the measured displacement and trim, for each heel angle.

The disparity between KM and KX implies that errors must exist when using GM for vessels with hull discontinuities or asymmetry and, to a lesser extent, to almost all other hullforms. There is a real risk of these errors going undetected.

The magnitude of any error is best determined by comparison with a method known to be accurate—in which case it would seem logical to have used that method at the outset. Since the KN method will deliver a correct VCG for any hullform, at any angle, it has much to commend it over one which depends on an improbably wall-sided vessel being inclined to impracticably small heel angles to give imprecise results.

About the author

Richard Dunworth emigrated with his family from the UK to Australia in 1964, completing his final year at school in Adelaide. First employed as a draughtsman with the Department of Navy in Sydney and Canberra, Richard returned to Kent in 1972 where, after a short while as a designer with the Tyler Boat Company in Tonbridge, he spent the next 15 years with Murray, Cormack Associates designing pilot boats and police launches. Returning to Australia in 1987, Richard worked at the Department of Transport, reviewing stability submissions for commercial shipping, before forming a partnership with David Baron. Initially investigating stability issues and preparing stability handbooks, Baron & Dunworth went on to design and supply their Mariner loading instrument software. In 2007, Richard rejoined the Department of Defence in Canberra, where he specialised in naval ship stability and inclining experiments until retiring from his position as a senior naval architect in 2022. For more information and a dedicated spreadsheet on this topic, please contact: richard@apex.net.au **SBI**

THE X FACTOR

Years of extensive testing are paying off for Slovenia's EJET, which is soon to expand its all-electric jet tender business with a larger, more powerful model

The EJET 4X was designed to balance lightweight manoeuvrability with high-performance speed and range

Slovenian boatbuilder EJET is on a mission to prove that pure-electric small boats can not only rival traditional, petrol-powered craft, but have the potential to surpass them when it comes to power, performance and speed.

That motivation has led to the production of EJET's electric jet tender, the EJET 4X – soon to be followed by the larger EJET 9X model. While the look and layout of this RIB type seem deceptively simple, each EJET is the result of years of testing, conducted to optimise the hull, the powertrain and the endurance of the battery, dating back to the company's inception in 2016. The tender design was developed in partnership with Ljubljana-based naval architect Jalen Vogelnik, founder of VOM Creations, and yacht designer Andrej Justin.

"We're witnessing a significant surge in demand from clients who not only prioritise sustainable yachting but aim to reinforce their commitment to an eco-friendly lifestyle through their choice of tender," comments Žiga Jarc, CEO of EJET. However, he adds: "When it comes to electric boating, most often, people turn to the automotive industry for inspiration. We quickly realised that this approach comes with limitations.

"A boat, being on the water, presents a completely different challenge. The density of water is 830 times higher than that of air, which means it's like constantly climbing uphill. This led to a host of problems that demanded a different approach and exploring uncharted options."

Smooth navigation

As a result, EJET specifically engineered the hull design of the 4X and 9X to fit around the jet drive, to maximise performance. "We've collaborated closely with top naval architects and engineers, running extensive simulations to achieve a hull design that enhances efficiency, range and overall performance," Jarc tells *Ship & Boat International*. The 4X incorporates an Alamarin-Jet system, running off a 60kW or 70kW pure-electric powertrain, removing the possibility of oil leaks or harmful emissions and offering a top speed of 30knots or 33knots respectively.

Jarc says: "This waterjet technology is outstanding, offering exceptional manoeuvrability." This jet type is matched to an actuator control unit to enable reverse operations, even at high speeds, while providing "some fun, dynamic handling on the water."

Combined with its optimised hullform, this arrangement grants the tender stable and smooth navigation, even at its top speed, and a range of up to 40nm. Jarc adds: "The jet propulsion system stands out for its shallow draught compared to outboard or sterndrive options, making beach landings and exploration of hard-to-reach areas much easier". The 4X has also been fitted with a ski hook to enable watersports activities such as waterskiing and wakeboarding.

Battery plan

EJET has also taken an interesting approach to the installation of the tender's batteries, wherein the boat design takes priority over the power supply. "We source our battery cells from a leading manufacturer and then build our own battery packs in-house," Jarc explains. "This approach, though challenging, has allowed us to develop battery packs tailored specifically to our tenders in terms of shape, capacity and voltage. By taking control of this process, we've created packs that are significantly lighter than those used by our competitors."

As an example, Jarc estimates that the 4X is "100kg lighter than its nearest competitor", while

The tender's 7" touch display warns crew when battery power levels are low, or if the battery management system detects a problem

simultaneously offering approximately 15% more battery capacity and delivering double the continuous power output from the electric motor. The boat's custom powertrain is managed by an electronic control unit, offering various driving modes, such as 'Eco', 'Normal' and 'Power'. The cox can set these modes using a 7" touch display, which has been incorporated for ease of use, "allowing less-experienced sailors to enjoy their time at the helm", Jarc highlights.

If the battery management system (BMS) detects a low battery level, the 4X switches into 'Eco' mode to ensure a safe return to either shore or the mother yacht. The BMS also alerts the crew immediately, via the touch display, if any issues arise. Additionally, the touch display features integrated GPS. "We're also developing a mobile app that will allow users to monitor the tender remotely and share data with us to prevent malfunctions before they occur," Jarc reveals.

Customers can specify a 6kW charger with a 9m portable charging cable, which will top up the batteries within up to eight hours. Alternatively, a 12kW charger enables fast-charging within four hours. Jarc says: "The 4X can be charged either from the shore or from the mothership, with EJET offering dedicated charging stations that ensure the tender is always ready for use."

The 4X packs in a hydraulic steering system for comfortable navigation across a range of weather conditions, Jarc says. In an emergency, the boat's actuator control unit, which operates the jet's reverse bucket, permits rapid stops at high speeds. The tender is also equipped with LED navigation lighting, for enhanced safety during night-time manoeuvres. "Optional underwater lights allow for night swimming," Jarc says, and customers can also request a retractable bathing ladder.

To protect its electric components from contact with seawater, the boat's electronics are housed in a hermetically sealed compartment. With a view to overall safety, Jarc comments: "I would say our most significant safety feature is the years of rigorous testing we conducted before bringing these models to market."

The hulls on both the 4X and 9X models are constructed from GRP, and the tubes can be produced in white or black carbon. The upholstery aboard each tender type features water-resistant embossed patterns, while the deck is fashioned in Permateek, a synthetic, sustainable alternative to traditional teak. Customers can equip the boat with a Garmin Fusion sound system, and the tender comes with a contactless RFID key as another neat touch.

9X variant

Next up is the launch of the debut EJET 9X, scheduled to hit the water in Q1 2025. This unit will be powered by a 270kW electric engine, complemented by a dynamic 223kWh battery and a Hamilton jet drive – sufficient to grant the model a speed of 35knots, and extending the range to 50-60knots.

TECHNICAL PARTICULARS

EJET 4X

Length, oa	**3.95m**
Breadth	**1.76m**
Draught (fully loaded)	**0.35m**
Weight	**670kg**
Speed	**30-33knots**
Electric motor	**60kW/70kW**
Battery capacity	**46.2kWh**
Range	**>40nm**
Persons on board	**>6**

EJET 9X

Length, oa	**9m**
Breadth	**3m**
Draught (fully loaded)	**0.6m**
Weight	**3,700kg**
Speed	**35knots**
Electric motor	**270kW**
Battery capacity	**223kWh**
Range	**>60nm**

The 9X will be offered in two variants, with or without a rigid T-top, though Jarc says that the most notable feature will be its hydraulic stern platform, which can be adjusted to create "a small private beach". He adds: "In the neutral position, the platform is flat, but it can be easily raised or lowered thanks to a mechanism that turns it into steps, making access to the tender extremely easy." Customers can use the extra space to install amenities such as an ice maker and a refrigerator. Looking beyond the 9X, EJET is also planning a 7m version of the tender.

If the 9X and future models sell as well as the 4X has, Jarc will be a happy man: EJET sold out its 2023 production slots for the 4X amid a surge of demand. "We aim to collaborate with yacht manufacturers who share our vision for a cleaner and more sustainable yachting industry," he concludes. "One possible solution that we highly appreciate is the integration of solar panels into the mother yacht's design, enabling the use of clean and renewable energy to power the yacht and charge the tender." **SBI**

The EJET 9X, due for launch in Q1 next year, will be powered by a 223kWh battery

YACHTS

CLEAN BREAK

A combination of hydrogen fuel cell power and hydrogenated vegetable oil has massively reduced the carbon footprint of the Project 821 gigayacht – Feadship's fresh challenge to years of diesel dominance

The gigayacht known as 'Project 821' broke two records upon its launch in May 2024: not only as the largest yacht constructed in the Netherlands to date, but also as the world's inaugural hydrogen fuel cell-powered yacht. Designed by RWD and built by Feadship as part of a five-year effort, the newbuild has been championed as a major step forward by those keen to shed the perception of yachts as luxurious, high-end diesel-guzzlers.

It has taken a yacht sized 118.8m x 19m to accommodate the necessary systems and tanks to burn green hydrogen as a fuel, and to store it safely in its liquid form. All the same, Feadship stresses, it is important to remember that Project 821 "cannot carry enough liquid hydrogen to power a crossing": the electricity produced by this alt-fuel will be used primarily to serve the vessel's hotel load.

For Feadship, though, that's a breakthrough in itself. The shipbuilder comments: "According to the Yacht Environmental Transparency Index [YETI], 70-78% of a yacht's total energy use per year is to supply its hotel load, with heating and air-conditioning making the largest demands. Supplying that electrical power via non-polluting hydrogen fuel cells has a swift and significant impact." Feadship adds that Project 821 should be viewed as one of many steps towards its goal of solely producing net-zero yachts by 2030.

Supply package

The yacht's liquid-hydrogen gas-fuel supply system was supplied by MAN Cryo, a division of MAN Energy solutions. The system will grant the yacht "a full week's worth of silent operation at anchor, or clean navigation when departing harbours or transiting in environmentally sensitive marine areas, with pure water being the only emission", MAN Cryo says. The system has been designed to store hydrogen in liquid form, before heating it until evaporation and then directing the gaseous hydrogen to the vessel's fuel cell.

The Project 821 gigayacht is using hydrogen to power its hotel load

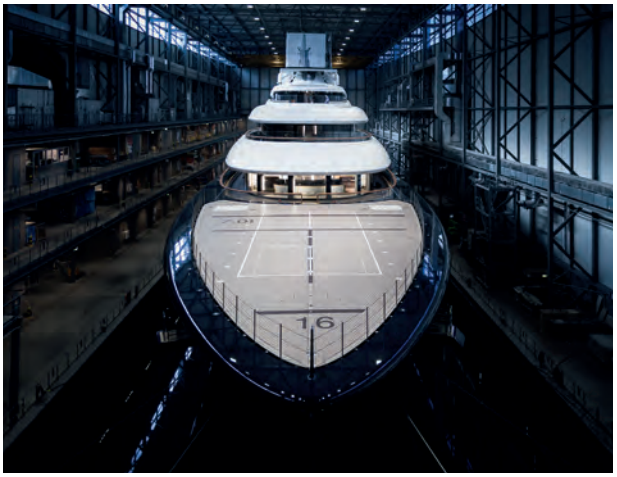
"[We] faced a number of challenges during the project…owing to the lack of existing design codes and standards to follow to get approval for the system's tank design," a spokesperson for MAN Cryo comments. "Normally, type-C LNG tanks are designed according to the International Code of Safety for Ships using Gases or other Low-flashpoint Fuels [IGF Code], but this is not fully applicable to hydrogen."

So, the company presented a risk assessment-based design to classification society Lloyd's Register. The system has now been approved for placement below deck – a step that MAN Cryo hails as "a first of its kind in the world" and "the second ever for a marine liquid-hydrogen project".

The MAN Cryo supply package for Project 821 included: a 92m^3-capacity, vacuum-insulated type-C tank, capable of storing liquid hydrogen at a required temperature of -253° C; a tank connection space, complete with vaporisers, control valves and safety valves; and a bunker station, to permit shore-to-ship bunkering of liquid hydrogen. MAN Cryo also supplied the yacht with a vent mast and interconnecting hydrogen piping, plus various control and automation systems – one being a tool designed to simulate tank pressure and tank-filling levels, to help crew to plan bunkering operations.

Design alteration

Unsurprisingly, this added to the vessel's weight, while occupying a fair chunk of onboard space. "Hydrogen is light: 1m^3 of liquid hydrogen weighs 70kg, versus some 800kg per m^3 of non-fossil diesel equivalent, such as hydrogenated vegetable oil [HVO] or e-diesel," Feadship says. "However, safely storing it on a vessel requires a double-walled cryogenic storage tank…it takes eight to 10 times more space to store hydrogen than the energy equivalent in diesel fuel."



The 118.8m newbuild, pictured at Feadship's Amsterdam shipyard, was five years in the making

The implementation of the cryogenic fuel tank, 16 compact fuel cells, the switchboard connection to the DC electrical grid and the vent stacks for the escaping water vapour – the hydrogen fuel cell's only form of 'exhaust' – meant that the Feadship team had to add an extra 4m to the yacht's original specification length.

Propulsion-wise, Project 821 incorporates ABB pod drives, rated 3,200kW. When green hydrogen is not available, these drives will be powered by MTU generators burning HVO, which has the potential to slash carbon emissions by 90% compared to yachts running on traditional fossil fuels. Feadship previously utilised HVO as a complementary fuel aboard its 2023-delivered, 84.2m megayacht *Obsidian*, which was fitted with a 4.5MWh battery bank.

Alt-fuel flexibility

Feadship comments: "Although there are hydrogen fuel cell-powered cars, and fuel cells have been used as the primary source of electrical power on human spaceflight for more than six decades, nothing existed in the maritime sector. There were no regulations for hydrogen storage and fuel-cell systems at class, flag-state or even IMO level." As with MAN Cryo, Feadship consequently drew on assistance from Lloyd's Register to develop these regulations, with the long-term aim of making them available to the wider maritime sector.

"From the beginning, one of the biggest hurdles would be developing a reasonable way to store compressed liquid hydrogen below deck at -253°C aboard a luxury yacht," Feadship continues. "But investing in the required technology is necessary to make the transition away from fossil fuel, and hydrogen is one of the most efficient and cleanest options. When hydrogen is processed in a fuel cell, the only by-products are electricity and water in the form of steam."

There is also a degree of 'alt-fuel flexibility' to this approach. For example, Feadship has noted that the fuel cells developed for Project 821 could also run on methanol. The big advantage of methanol, of course, is that it can be stored in liquid form at room temperature. "Steam reforms methanol into hydrogen before the electrochemical reaction in the fuel cell," Feadship adds.

Still, one gain is that the yacht's fuel cell technology gifts the owner the ability to sail emissions-free at 10knots for approximately a week, without having to install battery packs to comply with regulatory restrictions in environmentally sensitive waters. The vessel also features a waste heat recovery system, which can be used to heat the pool, jacuzzi and guest cabin bathroom floors. "Further savings in the hotel load come from a Smart AC system linking sensors to an energy management system that automatically reduces air-conditioning or heating in unoccupied guest spaces," Feadship explains.

Seven decks

Let's not forget, though: as worthy as the yacht's green powertrain may be, Project 821 was still designed for opulence and luxury. The vessel features seven decks, five above the waterline, with the owner's deck positioned 37m above the water. "The full owner's deck above the bridge is essentially an apartment with two bedrooms, twin bathrooms, a gym, a pantry, two offices – each with a fireplace – and a living room," says Feadship.

The builder adds that Project 821 has "the most hull openings of any Feadship to date", including 14 balconies. Unnoticeable when closed, the balconies slide out from the 'tweendeck space, complete with railings or walls, at the touch of a button. The yacht also features seven large opening platforms to help persons on board to feel closer to the water.

The walkaround deck features shaded areas forward and aft, to protect guests from the elements. "The 19m beam allows wide corridors inside and gracious sidedecks outside where guests can easily walk side-by-side," Feadship says. Other internal features include a library on the main deck and a private dining room with a sea terrace and adjacent en suite stateroom on the lower deck – a layout that Feadship likes to "a secluded four-level townhouse-by-the-sea within the much larger yacht".

Future innovations

For Feadship CEO Jan-Bart Verkuyl, fuel cells are bound to make further inroads aboard larger yachts in the future. Speaking shortly after the Project 821 launch, Verkuyl commented: "We have now shown that cryogenic storage of liquified hydrogen in the interior of a superyacht is a viable solution. Future innovations on fuel cells and onboard reforming of methanol to hydrogen are on the near horizon.

"For Feadship, the bottom line is that the decarbonisation of Feadship's upstream process, such as our extensive use of aluminium produced in a more environmentally sensitive way, and the production of net-zero carbon-free fuels or hydrogen carriers, deserves utmost priority." If Verkuyl is proved correct, that may be excellent news for those aiming to satisfy both the regulators and the new generation of eco-conscious yacht owners. **SBI**

FERRIES

NEW SOLUTION FOR NIGERIA

Team Nawasena of ITS won this year's Worldwide Ferry Safety Association student design competition with its proposal for a 50m, pre-cut ferry designed specifically for operations on the River Niger

The 4,200km River Niger, recognised as the third largest river in Africa after the Nile and the Congo, was the backdrop for the Worldwide Ferry Safety Association's (WFSA's) 11th Annual International Student Design Competition for a Safe, Affordable Ferry. Having previously encouraged student naval architects, designers and engineers to devise workable, safe and affordable ferry solutions for waterways including the Amazon, the Brahmaputra, the Pasig River, the Chao Phraya and the Singapore Strait, this year's Nigeria-focused event represented the contest's second foray into Africa, following the 2019-2020 call for a design for Lake Victoria, Kenya (see *Ship & Boat International* September/October 2020, pages 14-18).

For the 2023-2024 contest, WFSA executive director Dr Roberta Weisbrod was assisted by David Okafor, a naval architect with the Nigerian Navy who has also just commenced a Ph.D course at the University of Strathclyde, UK. Okafor explains: "The Niger is the major part of Nigeria's inland waterways, which have very serious issues. In 2023, approximately 1,000 people died on the inland waterways, including 92 in the State of Lagos."

It's a shocking death toll, one that would provoke outrage in the land or aero sectors, but the problem is consistent. Okafor adds that the Nigerian Inland Water Authority, which has regulatory authority over "an extraordinary portfolio" of 3,000 waterways, has identified the causes of these incidents as including: the poor state and design of many of the existing wooden ferries; passenger overcrowding, and the resultant reduction in vessel stability; lack of adequate lifesaving equipment, including lifejackets; and insufficient enforcement of safety regulations.

TECHNICAL PARTICULARS

Queen Nneka

Length, oa	50m
Length, bp	45.25m
Breadth	13m
Depth	2.1m
Draught	0.8m
Displacement	209.6tonnes
Deadweight	78.76tonnes
Lightweight	131tonnes
Passengers	191

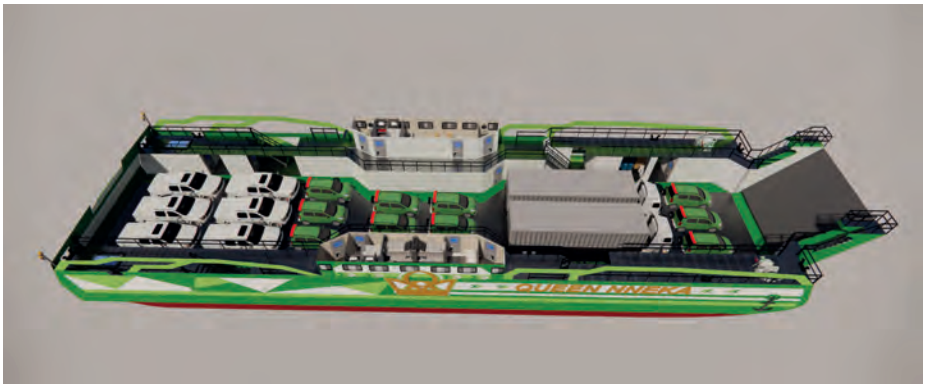
One prime example is the incident that has come to be known as the 'Kwara boat disaster', in June 2023, in which a party of 108 wedding attendees lost their lives when the ferry they were travelling on, in Kwara State. capsized in heavy rain and then split into two. In January this year, 20 passengers died when their ferry was struck with a wave on the Andoni-Bonny waterway in Rivers State. There have also been several near-misses on Lagos waterways, a few caused by the overgrowth of water hyacinths around key jetties and terminals. Other accidents have been attributed to ferry owners operating at night, in contravention of regulations, or taking passengers out during storms.

Government action

As Nigerian paper *The Guardian* highlighted in November 2023, the problem is all the more worrying given that increasing numbers of Nigerians are choosing to travel by ferry as an alternative to the increasing cost of road transportation, particularly higher fuel prices.

It's not all doom and gloom, though. Weisbrod says: "As one who advocates for ferries, Nigeria is the place to be. I was attracted by Nigeria's growth and dynamism; my impression from those we have met is that the people are innovative, imaginative, entrepreneurial and innately technically adept.

Team Nawasena of ITS, Indonesia won the WFSA student design contest with its proposed 50m ro-pax ferry *Queen Nneka*



The team kept the ferry's draught to 0.8m, even with a full passenger and vehicle complement

"The recently re-elected governor of the Lagos State, Mr Sanwo-Olu, is highly committed to ferry transport to decongest the Lagos transportation system, and to alternative power. The policy goals that he has been implementing since the early 2020s are called THEMES, which stands for 'Traffic Management and Transportation, Health and Environment, Education and Technology, Making Lagos a 21st Century Economy, Entertainment and Tourism, as well as Security and Governance'." As such, Lagos State is taking a proactive approach to constructing newer, safer ferries and mandating the carriage and wearing of lifejackets on private as well as public ferries. The Sanwo-Olu regime has also launched a mobile app, LAGferry, to simplify ferry ticket purchases.

Okafor explains: "The Lagos State governor recently commissioned 15 additional ferries, built to international standards in accordance with Bureau Veritas' class rules by Caverton Marine Ltd., a Lagos-based Nigerian company, with 10 more ferries to be commissioned by the end of the year. The governor of Lagos State also unveiled the 'Climate Action Plan 2020-2025' to reduce emissions in the energy, transport and waste management sectors, which account for 90% of the total greenhouse gas emissions in Lagos State. This is a game changer for Lagos and Nigeria's inland waterways, as this fleet of vessels will mitigate the operation of low-quality and unsafe boats."

Weisbrod adds: "There has been much discussion of the value of investing in expanding shipbuilding in Nigeria. Furthermore, and importantly, Nigeria this past year activated the Ministry of Marine and the Blue Economy – taking shipping out of the Ministry of Transport, where it was eclipsed by the other modes, and connecting it to sources of wealth that are not petroleum-based. So, opportunity and hope abound."

River conditions

Of course, as with all of the previous waterways selected for the WFSA student design contest, the River Niger has its own set of unique features – and challenges – which must be considered when designing a safe and efficient vessel to work this route.

"In contrast to rivers like the Nile, the Brahmaputra and the Mississippi, the Niger doesn't carry a lot of sediment, but does have its share of obstructions and shallow depths," says Weisbrod.

"Security is also an issue, so the ferry services are limited to daytime hours." Other potential issues include the risk of seasonal flooding – though, Okafor underlines, weather conditions are not a significant problem in this part of the world. However, one big question that budding boat designers must ask is "what is the vessel construction capacity in this part of Nigeria?" he says. This is an important consideration given Nigeria's relatively limited shipbuilding facilities – and one that would significantly influence the design of the contest winner's entry.

The winning design was supplied by Team Nawasena from Indonesia's Sepuluh Nopember Institute of Technology (ITS) – incidentally, the team that won the WFSA's ninth student competition for a ferry design for the Brahmaputra River with the 35.5m *Lakshmi* (see *Ship & Boat International* September/October 2022, pages 44-49). This year's team was captained by Quito Abian Iqtarib, supported by fellow students Afwan Izzul Muttaqqin, Dewi Diaz Gitasari, Fahri Ramadhan, Nita Wahyuni Dwi Puspitasari, Rafi Maulana and Raif Adhi Ramadhan.

The team's winning entry is *Queen Nneka*, which roughly translates in Igbo as 'mother is great' – selected as the team hopes the design may serve as "the mother of future ferries on the Niger River," Iqtarib explains. He tells *Ship & Boat International*: "Each of the seven team members had a specific role: project planning; machinery and electrical; hull and hydrodynamics; construction; safety; 3D modelling;

***Queen Nneka* and her sister would be supplied to local Nigerian yards in pre-cut blocks, and then assembled**

Items	Headings and RMS Value		Status
	Heading Wave 180°	Following Wave 0°	
Fore: Abs. Vert. Accel	0.039	0.048	Not Uncomfortable
Fore: Long. (Due to pitch) Accel	0.027	0.018	Not Uncomfortable
Aft: Abs. Vert. Accel	0.037	0.045	Not Uncomfortable
Aft: Long. (Due to pitch) Accel	0.027	0.018	Not Uncomfortable

Figure 1: The vessel's seakeeping characteristics, calculated through Maxsurf Motions

and economic engineering. Our professor served as a mentor, offering advice and potential solutions, but the final decisions were made by the team."

The result is a 50m ro-pax catamaran concept, featuring a low draught of 0.8m, even with a full passenger and vehicle complement. This was crucial so as to work around the aforementioned 1m depth restrictions in some sections of the Niger. "We optimised the hull shape, designing a wide, flat catamaran hull," says Iqtarib. "This design proved to be effective for weight distribution, and minimises wake wash, helping to maintain a low draught." The team ran a CFD simulation to calculate the ferry's resistance, which was logged at 52.9kN at 13knots. The vessel was also developed in accordance with Lloyd's Register's rules for ferries, ro-ro carriers and passenger ships, and the team used the Maxsurf Motions software package to simulate the ferry's seakeeping capabilities (see Figure 1).

Pre-cut package

Queen Nneka would theoretically utilise Onitsha as its home port, and operate in tandem with a twin ferry, serving two routes: a 'yellow' route between Onitsha and Ndoni, served by *Queen Nneka 1*, and a 'green' route linking Onitsha to Idah, served by *Queen Nneka 2*, with services running from 6am to 6pm to avoid potentially riskier night-time trips.

Designed to displace just under 210tonnes, the ro-pax can carry 191 passengers, 10 cars, six SUVs and two trucks, as well as passenger luggage and other cargo. In terms of vessel weight, Team Nawasena calculated that *Queen Nneka*'s overall deadweight would come to 78.76tonnes – the bulk of this comprising the hull and payload (76.5tonnes), with machinery and electrical systems adding 1.51tonnes, pipework contributing 0.5tonnes and liquids adding 0.25tonnes to the overall load.

Taking Okafor's advice on board, the team opted for an alternative method of producing the vessel 'in Lagos' in an affordable and viable manner: namely, providing the ferry pre-cut, with the ship being built in sections or modules that are supplied to local yards and then assembled together.

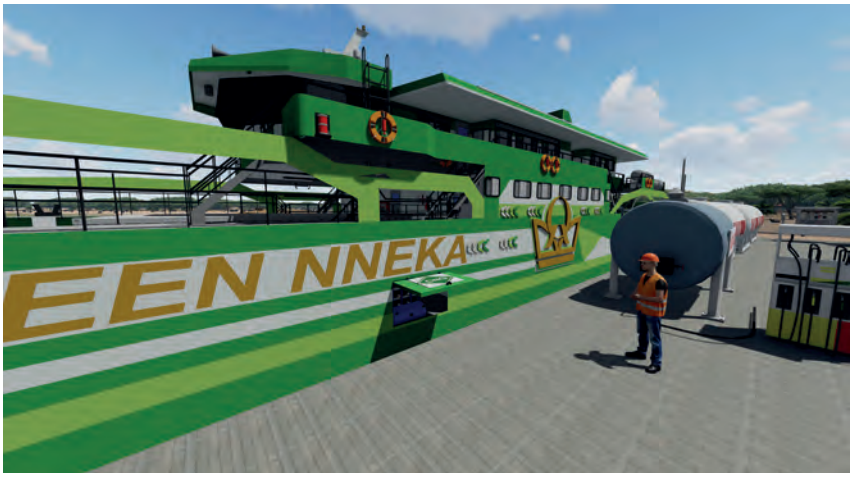
Iqtarib elaborates: "The pre-cut vessel design was the most efficient option because there are no advanced shipyards around the Niger River. The process involves dividing the ship into several blocks that can be transported by truck, with construction happening simultaneously, allowing different blocks to be built concurrently." In all, *Queen Nneka* (and any potential sister ferries) comprises 89 blocks, which would amount to a total of 38 truck trips to the shipyard for the complete build project, the team estimated. As a rough plan, the team considered the assembly of blocks at local builders West Atlantic Shipyard and West African Ventures, before trucking these units to HM Yard for final outfitting.

"Supplying a pre-cut vessel is more cost-effective than building a large boatbuilding facility near the Niger River," Iqtarib continues. "While some training is needed, the assembly process is relatively straightforward, requiring workers to understand how to assemble the pre-cut blocks. As long as quality control is maintained, there is no increased risk of flooding or leakage since assembling a pre-cut vessel is similar to building a regular ship."

CNG-fuelled

Ferries have arguably been at the forefront of green innovation, having been early adopters of battery power and alternative fuels. While last year's WFSA student design contest specifically called for an electric powertrain (see *Ship & Boat International* July/August 2023, pages 30-33), the choice of propulsion this year was left to the teams to decide. Interestingly, Team Nawasena opted

Roof-mounted solar panels, batteries and compressed natural gas would cut emissions on the River Niger



Team Nawasena's plan would include a CNG bunkering facility at the ferry's home port, Onitsha

for compressed natural gas (CNG) to fuel *Queen Nneka* and factored in four onboard CNG tanks, providing a combined stored power capacity of 1,024kW.

"These would allow the ferry to operate for 24 hours," says Iqtarib. Each tank would measure 230mm in diameter and 910mm in length, and would store 144kg of CNG. "While the tanks add some weight, it is not significant compared to the weight of construction, vehicles and passengers," Iqtarib adds. "We've also designed a CNG bunkering facility at our home port in Onitsha to support the ongoing development of CNG-powered ferries on the Niger River."

The ferry would be powered by a diesel-electric engine, supported by four CNG-powered generators feeding the vessel's four shallow-water thrusters. "This solution addresses one of the key challenges posed by the river's shallow areas," Iqtarib notes. The proposed battery type would be Praxis Automation's GreenBattery brand, which has the capacity to store up to 160kWh. "This energy would be dedicated to powering the communication and navigational systems, as well as emergency lighting," Iqtarib explains. Additionally, the ferry would carry a roof-mounted set of 56 JinkoSolar panels, enabling it to capture an estimated 155kWh of clean solar energy each day.

The propulsive set-up would include a Twin Disc thruster with a propeller diameter of 585mm, fashioned from Ni-Al-Br (Cu3). Based on the above, *Queen Nneka* would enjoy a range of up to 315nm, with a maximum speed of 13knots, Iqtarib says.

Safety considerations

Given its choice of fuel, incorporating a CNG-focused safety system was a top priority for the team. As another safety measure, *Queen Nneka*'s hull would feature watertight compartments packed with expanding urethane foam (with a density of 32kg/m^3), to maintain vessel stability should flooding occur.

"We conducted a damage stability analysis by simulating flooding in three scenarios – aft, mid, and fore positions – and tested this against IMO MSC 36 and HSC 2000 criteria," says Iqtarib. These simulations showed that the ferry was in full compliance with the required standards. The ferry would also feature a transverse steel structure, with the fore strengthened to support landings at certain ports and in particular seasons.

An evacuation plan was also developed for the ferry using Thunderhead's Pathfinder crowd movement simulation software, and based on the muster area being positioned close to the passenger deck. "The longest evacuation time simulated was 1 minute and 45 seconds, which meets the SOLAS Chapter III Regulation 21.1.4 standard of a 30-minute evacuation time," Team Nawasena was pleased to confirm.

Cost and returns

So, how much would the ferry cost? According to the team's figures, the Capex required to produce *Queen Nneka* would be US$2,773,573. About 42% of this total would comprise material costs, with labour (and similar overheads) accounting for 29%, trucking of the pre-cut blocks accounting for 11%, classification taking 11% and procurement costs amounting to 7%.

The bulk of the Opex, meanwhile, would comprise the crew's wages, followed closely by fuel costs, consumables and maintenance-/insurance-related costs. Overall, the team believes that the return on investment period could be between 3.95 to 4.19 years for each ferry produced and operated along these lines.

While the ferry remains a concept for now, the design contest has at least demonstrated that innovative solutions are not in short supply. Iqtarib says: "It would be a dream come true if our design could be implemented... we are open to collaborations with interested parties," offering something of an invite to investors.

Meanwhile, Nigeria continues to try to improve its ferry safety record, though reports of accidents and incidents continue. As we were preparing this article in August, news came through of another 20 fatalities in southern Nigeria after the engine aboard a wooden ferry exploded, causing an onboard fire and the boat to sink (tragically, the lack of a telephone network in the area prevented a swift emergency response). It is exactly here that investment, government action and the efforts of activities such as the WFSA student design contest can step in to save lives and transform communities. **SBI**

ALT-FUELS

COULD SUPERYACHTS LEAD THE NUCLEAR SURGE?

Modularisation of small nuclear reactors, enabling a 'plug in and play' ethos for onboard installations, could make superyachts the ideal frontrunners for the marine sector's adoption of nuclear energy, law firm HFW tells *Ship & Boat International*

Tomorrow's yachts may prove ideal frontrunners for the adoption of small modular reactors, if the pace of technology and regulatory change continues

Is nuclear energy shedding its unfairly earned reputation as a fearsome, dirty and dangerous alt-fuel? The past three to four years certainly indicate a shift in perception, even if the maritime industry, the mainstream media and the public are still not *completely* sold on the concept – but, compared to five years ago, or even when we covered the topic two years ago (see *Ship & Boat International* January/February 2022, pages 28-30), attitudes appear to be softening.

The cost-of-living crisis and the energy price hikes of 2022 may have greatly helped to drive this mind shift. Public anger over inflated gas and electric bills, accompanied by a round of protests across cities in the UK and Europe (including the memorable sight of Italian citizens burning their energy bills in the street) has led some to reconsider nuclear power as a cheap, sustainable energy source – not to mention a safe one, if handled correctly. And, in most cases, nuclear power *is* handled correctly and in accordance with long-established, meticulous regulations, as the previous article highlighted.

Nuclear energy is no longer limited to warships and subs, however. Work is underway on the 140m Cape Nagloynyn nuclear barge, to be stationed offshore Russia, while Ulstein has unveiled its THOR concept, a 149m, Thorium-powered vessel equipped with a molten salt reactor, that could be utilised to recharge the batteries aboard passing ferries, cruise ships and research vessels. While these projects are on the larger end of the size scale, Norway's Institute for Energy Technology has also undertaken a project to develop a 70m, nuclear-powered shrimp trawler, utilising a small modular reactor, or SMR (see *Ship & Boat International* November/December 2022, pages 38-40). Many of these initiatives have been supported by the Nuclear Energy Maritime Organization (NEMO), which has attracted IACS-affiliated class societies to its growing ranks.

Regulatory updates

Chapter VIII of the International Convention for the Safety of Life at Sea (SOLAS) provides basic requirements for the design, construction, maintenance and operation of nuclear ships. In 1981, IMO adopted the A.491 Code of Safety for Nuclear Merchant Ships to supplement SOLAS Chapter VIII.

However, both Chapter VIII and the Code are very much 'products of their time', based on the reactor technologies and safety stipulations of the 1970s. Since then, reactor technology has evolved considerably, with SMRs and 'microreactors' offering power ratings that can scale down from 300MW to as little as 10MW. Consequently, the IMO Maritime Safety Committee's 108th session, chaired in May this year, saw the World Nuclear Transport Institute and class society Lloyd's Register (LR), among others, urge revisions to the Code, especially concerning its contents on the design and safety assessment of nuclear merchant vessels.

Additionally, progress is being made by individual countries. For example, in December 2022, the UK's Merchant Shipping (Nuclear Ships) Regulations came into effect, accompanied by Marine Guidance Note on nuclear ships MGN 679 (M), which addresses areas such as safety assessments, design and construction, radiation safety and reactor installation suitability. The 2022 regs transpose Chapter VIII and the Code into UK law, though they are limited to consideration of old-school pressurised water reactors (PWRs). The wording of MGN 679 (M) states that, for now, the UK's Maritime

Tom Walters, HFW: "I think one of the first commercial maritime adopters [of nuclear power] is going to be somebody in the superyacht industry"

& Coastguard Agency will assess nuclear-powered vessels "on a case-by-case basis", in the absence of "extensive guidance".

Johanna Ohlman, associate at global law firm HFW, tells *Ship & Boat International*: "From a UK perspective, we've certainly seen the regulators catching up. We have those regulations and the new port guidance that's foreseen by them.

"In the 1960s, there really was a push for international regulation of nuclear-powered merchant ships. There was the Brussels Convention from 1962, but this was never ratified and never entered into force. Now we see a move for relevant international regulation to be effectively enshrined in UK law. Hopefully we'll see new regulations on the international level as well, but certainly national regulators have put the UK at the forefront of nuclear-fuelled vessel operations" (see Box, page 35).

Class input

Some classification societies are clearly working to get to grips with nuclear energy. For example, in its *Fuel For Thought: Nuclear Power* report, published in July this year, LR comments: "To facilitate international movement of commercial nuclear-powered ships, and deployment of mobile floating nuclear power plants, both IMO and the International Atomic Energy Agency [IAEA] need to revisit and adjust existing requirements.

"In MSRs, for example, the non-pressurised nature of the reactor limits dispersion of any radioactive material in the event of a failure. MSR designs use various means to initiate passive shutdown in the event of a temperature rise by exploiting the inherent characteristics of the molten salt."

Interestingly, the LR report adds: "Nuclear reactor modules have to conform to IAEA requirements for 'Safety, Security, and Safeguarding' – the IAEA 3S's – with which conventional power sources do not have to comply. This makes the nuclear-powered vessel more resistant to bad actors than conventional vessels."

Tom Walters, partner at HFW, confirms: "We've seen technology move at quite a pace, from high-pressure water reactors using Uranium to different isotopes in more stable conditions and in different configurations. As is always the case, technology is leading the law, and the law's having to run to catch up.

"The technology for the third or fourth generation of reactors is already there. The next generation of SMRs, whether based on molten salt or some other form, are coming on very, very quickly."

Yachts: the ideal sector?

Until relatively recently, even enthusiastic advocates of nuclear energy as a maritime fuel conceded that it may take decades to appease the regulators and insurers and to win the public's trust. The consensus was also that SMRs would predominantly fuel larger ships, leaving smaller yachts, fast ferries and workboats out of the loop. However, Ohlman and Walters view smaller nuclear-propelled boats as being entirely feasible, and their development likely within a shorter timeframe, and have identified superyachts as possible forerunners of SMR adoption.

Why yachts in particular? As reported in previous issues of *Ship & Boat International*, the superyacht segment is largely keen to 'green up' its image, having come under increasing fire from environmental activists (and from a few supply chain insiders) for its carbon-intensive activities. Like the nuclear industry, the superyacht sector has frequently been scapegoated and targeted despite its best efforts, with much of the criticism ignoring the fact that a new generation of affluent, younger yacht owners are steadily moving away from the fume-belching builds of old.

> "A lot of yacht owners are very aware of their environmental footprint"

Walters adds: "For superyacht owners, it's as much about having the newest technology aboard one of their yachts; it's almost kudos to say, 'I've got a nuclear-powered yacht, what have you got?' A lot of yacht owners are very aware of their environmental footprint. I think one of the first commercial maritime adopters is going to be somebody in the superyacht industry who's got relatively deep pockets, and who thinks 'I'm prepared to foot the bill for this'."

Walters cites billionaire philanthropist Bill Gates – who has allegedly commissioned the world's first hydrogen-powered superyacht, Project 821 (see pages 26-27) – as an example of one high-worth individual pushing for SMRs; in this case, through his Terrapower business. Walters continues: "Another example is Lürssen Yachts,

Johanna Ohlman, HFW: "Nuclear-powered yachts would also be able to sail into remote locations in need of renewable energy"

which has been working with Rolls-Royce to develop methanol propulsion for large yachts: methanol could be the stepping stone between where we are now, energy-wise, and a future power source."

Lease model

The next question is: how would nuclear-powered superyachts work in practice? After all, even for well-heeled yacht owners, the Capex involved in installing a SMR is exorbitant, on top of other yacht-related maintenance costs. Walters and Ohlman suggest that leasing the reactor, instead of buying it, may be the most cost-effective means of installing it on board.

"If you could modularise the reactors so that they're all a standard size, you could basically 'plug in and play'," says Walters. "Essentially, the reactor is just a steam generator; you have cold water in and steam out, and then a control system – that's all you need." The whole package could be scaled to fit inside a 20' container and stored below the superyacht's deck – though, Walters points out, "in due course, smaller versions may well be developed".

"You'd own the yacht but lease the reactor," Walters continues, "and you'd have a dedicated reactor technician on board, trained by the reactor manufacturer. He or she would stay on board and integrate with the yacht's crew, but be solely responsible for the reactor while the crew do everything else they need to do. If there's an issue with the reactor, that technician is trained and able to deal with it."

Not only that, but if future reactors are developed to a standard size, they can easily be replaced. "The yacht can pull into a dry dock to commission a new reactor, pull out the existing one and slide in the new reactor," Walters says. "By leasing the reactor, you remove that huge investment cost at the beginning of the project and you substitute what the owner would usually pay for fuel with a fixed sum payable over the yacht's lifetime."

Walters continues: "In theory, the reactor's fuelling cycle can be up to 15-20 years, so you may only need to refuel it once." At the end of the yacht's life, the reactor would be removed and recycled according to the country's regulations – any small amount of residual waste could be stored deep underground in protective structures in the UK, for example –while the yacht would be disposed of in the usual way, according to the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, he adds.

"Five to six years"

Nuclear power could massively benefit yacht owners and designers in various ways. For a start, there are size and weight gains to be realised. "The weight of an SMR will be much less than that of a diesel engine," says Walters, "and, if you build at the same size as a conventional superyacht, there's a huge amount of extra space to play with – or the owner could opt for a much smaller yacht as a large engine room wouldn't be required."

Then there are the benefits of the nuclear yacht's capability to generate surplus power, which can be put back into the grid. "The owner can generate power for the kiosks, shops and port/marina infrastructure," says Walters, highlighting one additional money-spinner. "These reactors don't run cold: they tend to run at between 280-850° C, so there's a source of heat there as well. Most of that heat gets used to turn water into steam, then steam drives the turbines and the turbines turn that into electricity, to power electric motors and propulsion."

Ohlman adds: "Going back to the philanthropic mindset, nuclear-powered yachts would also be able to sail into remote locations, such as small island communities, in need of renewable energy, and there connect to the grid to supply electricity to the port."

As to when we may see the first nuclear superyacht, Walters and Ohlman predict that it could take "five to six years, if not a decade" – an optimistic estimation, albeit one supported by the current rate of progress in SMR design. "If the technology moves at the pace it's moving at now, and the law can change to accommodate it, there's no reason why it couldn't happen sooner," Walters adds. "Regulations can change quite quickly." There's also the fact that the UK's Department for Energy Security and Net Zero recently launched funding grants for the design and construction of a new SMR type.

Regulations and insurance

One hurdle identified by Walters and Ohlman is the Convention on Limitation of Liability for Maritime Claims (1976). This "explicitly excludes nuclear ships from its scope…and it is therefore important to note that an owner of a nuclear yacht could face unlimited liability in the event of an incident," they recently wrote for HFW's quarterly newsletter. "Furthermore, the Vienna Convention on Civil Liability for Nuclear Damage [1963] and the Brussels Convention [1962] apply strict and exclusive liability for operators of nuclear installations and nuclear ships, respectively. The handling and disposal of nuclear waste, as well as the export of nuclear materials, is also strictly regulated.

"Port states and flag states will need to implement regulations for nuclear vessels. The UN Convention on the Law of the Sea [UNCLOS] explicitly requires nuclear-powered ships, and ships carrying nuclear substances, to 'carry documents and observe special precautionary measures' when passing through territorial seas of port states [UNCLOS article 23]." This would obviously affect larger yachts roaming around the world's oceans and visiting multiple territories.

"There also has to be a discussion with the insurers," Walters says. "Most P&I policies exclude damage as the result of a nuclear incident. The insurance industry is going to have to think quite carefully, which it is already doing: we're currently in discussions with brokers and underwriters who are looking at how they can review their insurance wording to accommodate nuclear vessels and to set the premium accordingly." This may inevitably involve changes to the limits in the existing Paris and Vienna conventions on liability in the event of a nuclear incident, which were primarily created for land-based nuclear powerplants, or updates to the Brussels Convention along with the necessary requirements for this convention to enter into force.

"The limits need to be reduced because they are currently prohibitively high, and would make the cost of insuring a nuclear vessel exorbitant," says Walters. Still, we are seeing change in this field too. For example, Waters points out: "The Akademik Lomonosov nuclear barge has been insured through the London market, so it's not impossible to do." Ohlman adds: "Several insurers in the London market are alive to the issue and are considering the position, with the potential for appropriate cover growing."

Safety perspective

On the safety side, reactor technology is well-known. Walters agrees with Vince Jenkins, formerly of LR (see *Ship & Boat International* January/February 2022) on the best onboard location for the reactor – "approximately two-thirds back from the bow, one-third up from the stern, and away from any impact areas…below deck but not too high up, as the weight may have an impact on stability", Walters says.

He also underlines some of the safety features of the new breed of SMRs. "Much of the technology, and certainly so with molten salt reactors, is meant to be passive. The reactors are designed with a freeze plug on the underside, so, if the reactor shuts down or if there's a fault, the freeze plug melts and the molten salt then drains into containment vessels underneath, and it just solidifies. If this happens, the yacht owner will have to recommission the reactor, but nothing bad will necessarily happen to it."

There is also the fact that water acts as "a very good shield for radiation," Walters continues. "So in fact, if you've got a nuclear vessel that's in distress and/or badly damaged, one option would be to flood the reactor compartment, because the water then acts as a barrier to the radiation. If you look at the big land-based nuclear reactors, they all have spent fuel rod pools filled with water that are outside."

Ohlman and Walters contrast these considerations with the risks of handling ammonia, which can cause "potential damage and harm", and Li-ion batteries; at the time of writing, HFW was working on several cases of onboard Li-ion fires, arising from 'misdeclared cargo', one involving a fatality. Some yacht designers, such as Brythonic Yachts, have specified gel-based batteries rather than their Li-ion equivalents in new designs, purely to avoid this risk scenario. Ohlman says: "How many lives have been lost as a result of nuclear energy, compared to other alt-fuel sectors? We need increased discussion on the safety of all alternative fuels, so that we can compare the nuclear sector on a level playing field."

With these boxes ticked, the task of winning over the public may be made significantly easier. What's for sure is that, while nuclear-powered commercial and leisure vessels might not, as the cliché goes, come about 'overnight', we're a lot closer to realising the first examples of SMR-fuelled ships than we were at the start of the decade. And, as a bonus, the fact that superyachts might lead the charge on this particular alt-fuel would be a glorious achievement for the sector, potentially changing its reputation for the better. **SBI**

UK AT THE FOREFRONT

The UK's Merchant Shipping (Nuclear Ships) Regulations, and MGN 679 (M), include the following points:

- Onboard nuclear reactor installations must be approved by the MCA prior to vessel construction
- A Quality Assurance Programme (QAP) needs to be put in place for all stages in the nuclear-powered vessel's lifespan, from design to decommissioning
- A detailed, continually updated operating manual must be made available to all personnel
- Where a nuclear vessel is at a fixed-point mooring or alongside a berth, and where there is work on the ship involving ionising radiation, the Radiation (Emergency Preparedness and Public Information) Regulations 2019 apply
- International yachts must submit their safety assessment and voyage plans to the MCA at least 12 months before arrival in UK waters/in a UK port
- Non-compliance with these regulations constitutes a criminal offence and may be punishable by fines or imprisonment

(Sources: MCA, Lloyd's Register, HFW)

PUMP UP THE VOLUME

The Methanol Superstorage system developed by SRC Group and Green Marine offers increased volume for methanol storage, possibly permitting smaller, lighter vessels to run on this green fuel

Methanol has several known benefits as a marine fuel, including the significant reduction in NOx, SOx and particulate matter emissions when burned, compared to traditional HFO/MGO. Producers can also create 'green' methanol through renewable sources and 'blue' methanol through carbon capture and storage.

However, methanol has a lower energy density relative to conventional marine fuel oils. This necessitates larger onboard fuel tanks to store an equivalent amount of energy – making methanol a tough choice for smaller vessels that need to keep their weight down

This conundrum has inspired maritime and offshore methanol advocates SRC Group and Green Marine to develop a new type of fuel tank to address these weight- and space-related concerns. The Methanol Superstorage tank is designed for scalability of size and a wide range of vessel types, targeting both newbuilds and retrofits. "From a technical perspective, there are no specific limits regarding dimensions or capacity – the tank can be as large as required," Alex Vainokivi, innovation manager at SRC Group, tells *Ship & Boat International*. "We are discussing some Methanol Superstorage tanks that offer 2m^3 and others that offer 700m^3."

This flexibility, adds Green Marine MD Chris Chatterton, makes the tank concept "a game changer on small vessels, where space is even more critical for lower-energy-content alternative fuels".

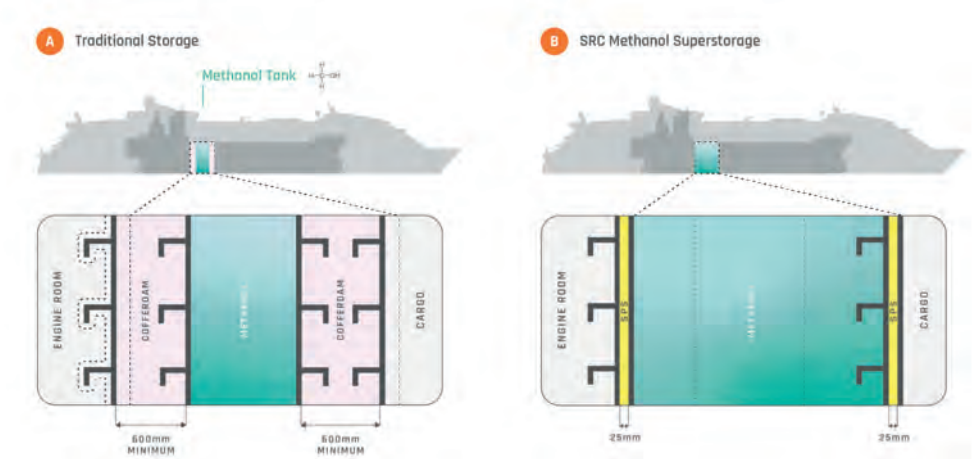
Sandwich plate system

So, how does one go about saving space and weight while guaranteeing a sufficient volume of methanol for trips out to sea? The partners say they have achieved this by replacing the traditional cofferdams that separate the gas tank walls with the sandwich plate system (SPS) developed by SPS Technology.

As covered in *Ship & Boat International* in the past, the SPS comprises two metal plates, bonded together with a solid polyurethane elastomer core. The system's reported advantages – which include lower weight and superior impact resistance – have led to the SPS being used to repair damaged vessel decks, bulkheads, side shells, bow sections and mooring points. The SPS can also be used to reinforce existing structure (including helidecks, control rooms and tanks) aboard vessels and offshore platforms, while its elastomer core helps to dampen noise and vibrations.

Vainokivi and Chatterton believe that, by applying the SPS to the Methanol Superstorage tank and subsequently removing all cofferdams, the unit could boost shipboard methanol tank volumes by 85%. Vainokivi says: "It takes around 2.5 times the methanol to achieve energy efficiency equivalent to HFO. The key difference with Methanol Superstorage is that the SPS does the same job as a conventional tank wall; we don't need the cofferdam around the internal tank. Cofferdams also require inspection and maintenance, which tanks constructed using the SPS do not."

Vainokivi also points out that the steel-polymer-steel barrier used in the SPS has been approved by members of the International Association of Classification Societies (IACS) for permanent repairs "for over two decades". Additionally, he says, class lab tests of the SPS have highlighted another interesting property of the system's polymer core: it boasts high levels of chemical resistance, making it suitable for long-term exposure to methanol. As a result,



The Methanol Superstorage solution has swapped traditional cofferdams for SPS' sandwich-plate system to increase tank volume

Vainokivi says: "It's entire feasible to install a Methanol Superstorage tank on board an aluminium vessel."

The marine sector's growing interest in alt-fuel adoption has prompted calls for revamped crew training regimes, to ensure that personnel handle these new 'green' solutions safely. Vainokivi remarks: "Our solution does not require any additional, special training – but, as a company with a focus on vessel refits, SRC Group is not only looking at the tank but at the whole fuel-handling and logistics set-up. This is one of the reasons why we teamed up with Green Marine, a leader in the field of methanol transition, whose services to owners include project supervision, technical management and training for crew."

Green Marine's Chatterton adds: "While no special training is formally required, class, Green Marine and the International Bunker Industry Association [IBIA] recommend crew are trained in the safe handling of methanol as a low flash-point fuel." As this factor could spell increased risk of ignition from sparks, heat or static electricity, there is an obvious need for enhanced fire safety training when dealing with the chemical.

Risk-based certification

Class society Lloyd's Register (LR) has granted Approval in Principle (AiP) status to the concept, in accordance with LR's Rules and Regulations for the Classification of Ships using Gases or other Low-flashpoint Fuels (July 2022), as well as Appendix LR1 – Requirements for Ships Using Methyl Alcohol (Methanol) or Ethyl Alcohol.

"Based on our discussions with owners, we expect the first retrofits to be initiated in 2025," Vainokivi predicts. "All methanol-fuelled vessels must undergo risk-based certification. Since Methanol Superstorage deviates from existing rules, the alternative design and arrangement process must be followed, to be conducted alongside risk-based certification. This parallel process ensures that no additional time will be required for the approval of Methanol Superstorage.

"In 2022, methanol accounted for 3% of the order book; by 2030, this could be close to 20%, representing up to 1,200 vessels. We've recorded lots of interest from owners and yards for vessels of under 100m length, including tugs, yachts, support vessels for wind farms and more." In terms of production costs for the new SPS-enhanced tank, Vainokivi says that, in most cases, "the overall cost will be similar to a solution featuring cofferdams". As for predicted weight savings, the numbers will be case-specific, he says, adding: "We are currently running an internal case study covering different types of vessels, which will give us a better understanding of the weight savings." **SBI**

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Job Brüggen, LVNL

Job Brüggen holds a masters degree from Delft University of Technology in Aerospace Engineering. In 1986 he started working for the National Aerospace Laboratory where he later became the head of the Air Transport Division. His particular interest in safety led him to Air Traffic Control the Netherlands, to become their first safety manager in 2002. He is particularly known for his activities in Just Culture developments and was one of the first to demonstrate the detrimental effect of prosecution of air traffic controllers on incident reporting. In 2003 he re-created the CANSO Safety Standing Committee and chaired it for six years. He also advises in the health care industry on safety matters with a particular focus on safety leadership. From November 2014 he was co-chairman of the Eurocontrol Safety Team, until 2019. For the Air Traffic Controllers academy of LVNL, he is the chairman of the examinations committee.

Dr Rafet Emek Kurt, Reader, in Maritime Safety and Human Factors, Department of Naval Architecture Ocean and Marine Engineering, University of Strathclyde

Dr. Kurt also serves as the Director of the Maritime Human Factors Centre, further demonstrating his commitment to advancing research in this field. Additionally, he holds the position of Associate Editor in Ships and Offshore Structures, showcasing his dedication to the dissemination of knowledge within the maritime community. Dr. Kurt is also a member of the International Ship and Offshore Structures Congress (ISSC), where he collaborates with peers to develop ship design criteria informed by human factors, further highlighting his commitment to the advancement of maritime safety practices.

Over the years, Dr. Kurt has worked on many research projects aimed at integrating human factors, safety, and risk into maritime practices. His work has been published in respected journals and conferences, igniting essential discussions in the maritime community.

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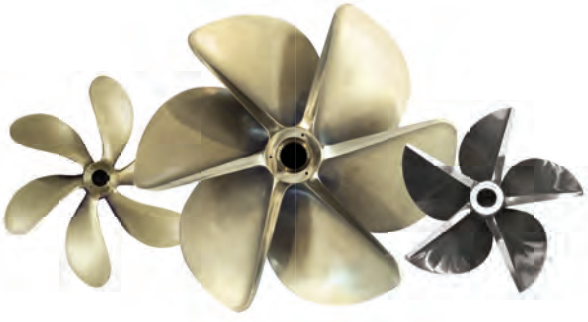

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