CONTAINER SHIPS CLASSIFICATION COMMUNICATIONS ENVIRONMENTAL REGULATIONS

THE NAVAL ARCHITECT

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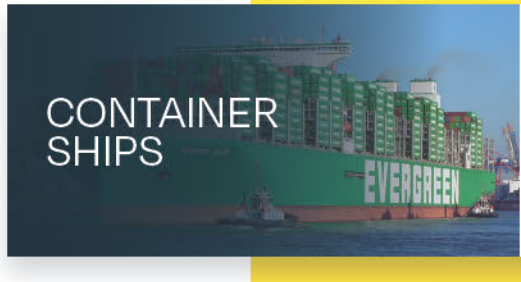

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ENCLOSED SPACES: A COMPLICITY OF SILENCE?

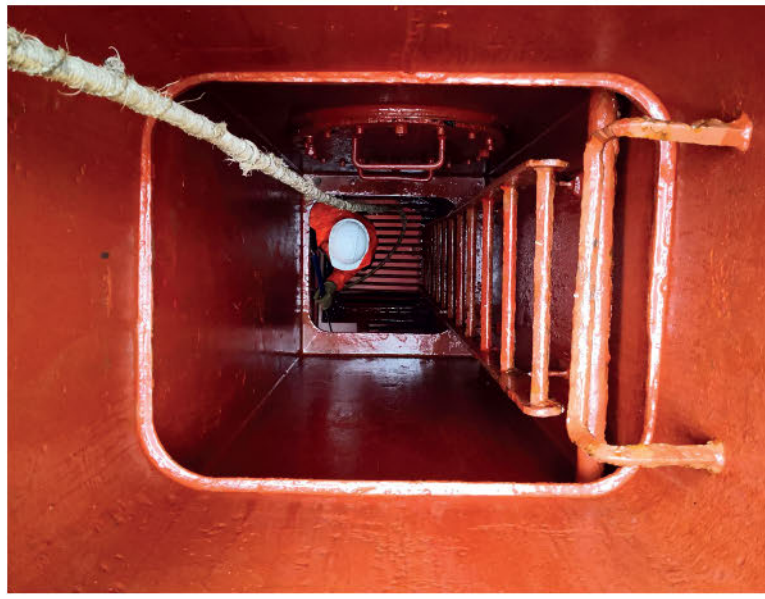
By **Richard Halfhide**

Amendments agreed in May this year to the Maritime Labour Convention (MLC), the International Labour Organization (ILO) convention sometimes referred to as the seafarers' bill of rights, were a long-overdue acknowledgement of the injustices suffered by mariners during the pandemic. As hardly needs repeating, at the peak of the crisis an estimated quarter of million were left working onboard vessels beyond their stipulated contracts and the amendments include a requirement that 'abandoned' seafarers should be promptly repatriated. Further amendments include that shipowners should provide 'appropriate social connectivity', ship signatory countries should provide internet access at ports. There is also a requirement that the deaths of all seafarers should be reported and recorded annually by the ILO.

Of course, such instruments are only as good as the vigilance with which they are protected. In December last year, the International Maritime Organization underlined its own commitment at the 32nd meeting of the IMO Assembly with the inclusion of a new specific strategic direction on the human element as part of its Strategic Plan. As part of this work, a Joint ILO/IMO Working Group was announced to identify and address seafarers' issues. Although clearly a step in the right direction there's no guarantee that port state control inspections are doing all they should to ensure MLC compliance. Nor is it applicable to the open oceans, which are 'governed' by the United Nations Convention on the Law of the Sea (UNCLOS); legislation that's actually more about protecting fish than people. Moreover, as data published by RightShip in June highlighted, there are currently roughly at least 3,600 seafarers abandoned around the world, some of whom are the victims of disputes that have been continuing for more than a decade.

Another issue which brutally highlights the extent to which crew and shore-based workers are treated like so much collateral is the perennial safety problem of enclosed spaces onboard vessels. In the most recent incident, in early July, three stevedores were killed in the cargo hold of the Isle of Man-flagged bulk carrier *Berge Mawson* during coal loading operations at the Bunyu anchorage, Indonesia. This followed the deaths of two labourers from suffocation at the Port of Karachi in May when they mistakenly entered a hatch of a ship carrying soya beans.

It's tempting perhaps to look upon these as operational failures, shortcomings in safety training or a shortage of PPE, and to some extent this is true. While serving as the editor of a maritime safety publication I became acutely aware of how negligence or a half-hearted commitment towards safety culture can have devastating consequences. I would certainly encourage readers to take a look at accounts published under the Mariners' Alerting and Reporting Scheme (MARS) by our colleagues at the Nautical Institute to get a better insight into how accidents occur, not to mention the more forensic investigations undertaken by organisations such as the MAIB.



SOURCE: SHUTTERSTOCK

But it's also facile. Industry trade group InterManager, which has been keeping statistics on enclosed spaces incidents since 1999, says that 104 seafarers and 55 shore workers have been killed during that time, but these figures may actually be much higher due to underreporting by the maritime authorities. IMO's own Global Integrated Shipping Information System (GSIS) only has records for 26% of the incidents InterManager is aware of. It stands to reason that a failure to even report these accidents undermines any attempt to understand the underlying causes, with InterManager identifying poor ship design as one factor, along with time pressures and confusing regulations.

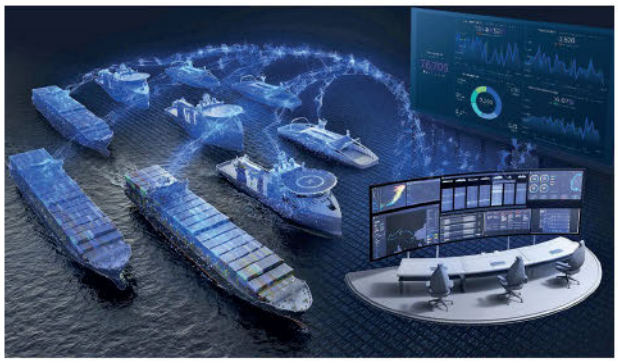
Depressingly, there seems to be an unwillingness among naval architects to engage with this subject despite my repeated attempts to raise the topic within these pages. Perhaps it's preferable to lay the blame at the door of shipowners not prioritising safety in their specifications, or to wait for SOLAS (and consequently class) requirements to change. Perhaps it's easier to simply label it 'human error' from the comfort of a shore-based office.

There's also an argument that shipyards and designers are in a far better position than beleaguered mariners to leverage their influence and achieve positive change. It's remarkable that for all the focus and investment given to ship hydrodynamics so little thought appears to be given to ventilation. Or am I mistaken? ■

NEWS

CLASSIFICATION SOCIETIES

PILOT PROJECT LOOKS TO ADVANCE AUGMENTED SHIP SERVICES



MODERN SHIPS INCREASINGLY USE SMART SYSTEMS DESIGNED TO IMPROVE THEIR OPERATIONAL EFFICIENCY

Classification society Bureau Veritas (BV) has embarked on a pilot project with Laskaridis Shipping and METIS Cyberspace Technology to develop and apply a new BV SMART 3 class notation covering the use of augmented data in ship operations.

BV has developed a framework of SMART notations for ships, which provide consistent and uniform standards for the 'smart' techniques used to monitor and improve fleet performance. In the new Smartship pilot project, BV is working with Laskaridis Shipping and METIS to develop a range of additional class notations adapted to the latest advances in digitalisation technology, with a focus on the augmented ship. The SMART 3 notation will also cover ship to shore connectivity, remote decision support and remote operations.

Paillette Palaiologou, vice president for Southeast Europe, Black Sea & Adriatic Zone at Bureau Veritas Marine & Offshore, says: "Digitalisation is transforming the maritime industry, bringing new challenges and opportunities. The new range of notations will help advance the journey towards more digitalised and autonomous ships. We are delighted to partner with Laskaridis Shipping and METIS Cyberspace Technology on this new project. Collaboration is essential to help progress new technologies and to support the industry's transition."

Drawing on BV's expertise in the certification, implementation and survey of data infrastructure, the new SMART 3 class notation is expected to provide added value for owners, shipyards and manufacturers of digital solutions for the maritime industry.

ALTERNATIVE FUELS

KR GRANTS APPROVAL TO METHANOL DUAL-FUEL VLCC

Classification society Korean Register (KR) has granted approval in principle (AiP) to a methanol dual-fuel 300,000dwt very large crude oil carrier (VLCC).

The vessel, which was developed under a joint project between KR and Hyundai Heavy Industries (HHI), is powered by methanol and marine gas oil (MGO).

HHI has developed the vessel so that the methanol fuel tank can be placed in either the open deck or the cargo area and KR has verified the safety and suitability of the vessel's design, ensuring it complies with domestic and international regulations.

REPRESENTATIVES FROM KR AND HHI AT THE AIP AWARDING CEREMONY

"As more shipping companies place orders for vessels that use methanol as dual fuel, interest for methanol as a ship propulsion fuel is growing," says KR. "Methanol is considered to possess high potential for commercialisation because it offers fewer technical difficulties than LNG and relatively less toxicity than ammonia."

Methanol can be stored in a liquid state at room temperature, similar to bunker oil, making it easier to store and transport compared to LNG, hydrogen and ammonia, which turn into liquid state at -162°C, -253°C, and -34°C respectively.

Although most methanol produced today is derived from fossil fuels, the proportion of e-methanol is expected to increase as its fuel supply sources continue to expand, making it a much more competitive next-generation marine fuel along with green ammonia.

The 10th DRY DOCK CONFERENCE and ADVANCED TRAINING FORUM

22-23 September, 2020

Virginia Beach Convention Center
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The tenth in this highly successful series of International Dry Dock Conferences/Advanced Training Forums. There will be opportunities for all involved in the industry to take part in discussions and share knowledge and experiences. The conference provides advance training for those in the dry dock industry.

The goal of the conference is to stimulate the transfer of drydocking knowledge and information to personnel in the drydock industry. Presentations given by various experts in the field will cover unusual, unique and problem drydockings, with opportunities for all attendees to take part in discussions and participate at the conference.

2022 Conference Topics

(Topics are subject to change)

- Dry Dock Construction
- Dry Dock Equipment
- Dry Dock Spatial Assessment Tool
- Dry Dock Upgrade
- Drydocking/launching with airbags
- Drydocking/Undocking Accidents
- Drydocking/Undocking from the Vessel Operator Perspective
- Economic Aspects of Drydocking
- Emerging Dry Dock Technologies
- Floating Dry Docks - Civil/Structural Design Aspects and Applications
- Heavy Lift Operations
- Ship Loading Issues for Drydocking
- Special Drydocking Situations
- Unique Drydocking Operations
- Wooden Ship Drydocking

Networking

There will be areas for displays and tables for handouts/brochures for attendee engagement.

Schedule

Thursday 22 - Friday 23, September 2022
Check-in at 7am. Presentations run 8am - 5pm with a break at 12pm for lunch both days.

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The 20-22 September 2022 Fleet Maintenance and Modernization Symposium (FMMS) precedes the 2022 Dry Dock Conference at the Virginia Beach Convention Center.

Conference Fee and Registration

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WIND POWER

MARIN RETHINKS DESIGN AND CONTROL OF COMMERCIAL SHIPS WITH WIND PROPULSION

THE PROJECT WILL INVOLVE THREE OPERATIONAL USE CASES, INCLUDING A BULK CARRIER WITH ANEMOI ROTOR SAILS

The Maritime Research Institute Netherlands (Marin) has initiated an EU-funded research and innovation project to demonstrate energy savings using wind propulsion and hydrodynamic improvements for commercial ships.

"Our overall ambition is to develop and employ holistic design and control methods for ground-breaking new ship concepts utilising wind propulsion while considering realistic operational scenarios," says Marin. "With these methods we expect to realise average energy savings between 30% and 50% when compared to equivalent conventional ships while ensuring operational feasibility in a realistic wind climate."

The Optiwise HORIZON project will involve extensive simulations where different disciplines, such as aerodynamics, hydrodynamics, routing and energy management will be brought together. It will then deliver open guidelines for integrated system optimisation with wind propulsion and smart measurement and control for best operation.

Partners in Optiwise include Core IC, SSPA, Ayro, Chantiers de L'Atlantique, Flikkema Innovation Management & Consultancy, Wärtsilä Netherlands, Universita Degli Studi Di Genova, Euronav and Anemoi Marine Technologies.

The project will consist of three operational use cases: a bulk carrier with Anemoi rotor sails; a tanker with Ayro OceanWings; and a passenger vessel with a Chantiers de l'Atlantique solid sail.

Rogier Eggers, project manager at Marin, says: "Wind propulsion is so far mostly applied without reconsidering the overall ship design and operations. Whereas that fits within a 'business as usual' scenario, it does limit the attainable savings. With Optiwise we are building on R&D already under development among the consortium partners in the last years and re-thinking the design process and energy management of ships with wind propulsion."

OFFSHORE

VALLIANZ SELECTS ULSTEIN FOR HYBRID HEAVY TRANSPORT VESSEL

Ulstein Design & Solutions has been contracted by Singapore-based Vallianz Holdings for the development of a hybrid heavy transport vessel (HTV) that will serve the growing transport demand in the offshore wind industry as well as for LNG modules and offshore structures.

The 173.8m-long vessel will feature a hybrid power system consisting of dual-fuel engines and a battery energy storage system. The HTV's electric battery system will be provided by Canada-based Shift Clean Energy, while Bureau Veritas will be responsible for the overall classification of the vessel.

THE NEW VESSEL WILL FEATURE DUAL-FUEL ENGINES AND A BATTERY ENERGY STORAGE SYSTEM

With a deck area of over 6,000m^2 and a draught of 7m, the DP2 vessel design is optimised to support Vallianz's business case for not only transporting offshore wind structures such as monopiles, jackets, transition pieces and turbine blades, but also carrying out floatover operations of offshore structures, according to Ulstein.

The company adds that the new HTV, a customised Ulstein HX120 design, will feature Ulstein's inverted bow concept, X-BOW®, contributing to reduced energy consumption, as well as to more comfortable and safer operations when sailing through waves.

Construction is expected to take up to 26 months, with planned completion by the end of 2024.

CRUISE SHIPS

RECORD-BREAKING CRUISE SHIP SCRAPPED BEFORE MAIDEN VOYAGE

The partially built *Global Dream II*, which was to be one of the world's biggest cruise ships by capacity, is being scrapped before sailing a single voyage.

Designed to hold more than 9,000 passengers, the Global class vessel was under construction at MV Werften's Wismar shipyard on Germany's Baltic coast. However, MV Werften filed for bankruptcy in January 2022 and the administrators have not been able to find a buyer for *Global Dream II* as a going concern, according to media reports in Germany.

Christoph Morgen, an insolvency administrator at Brinkmann & Partner, is reported to have told a press conference that the ship needs to be moved out of the shipyard by the end of the year because the yard had been sold to Thyssenkrupp AG's naval unit, which plans to build military vessels there from 2024. The machinery and fittings will be sold off as they are, while the hull will be sold at scrap value.

Global Dream II and sister ship *Global Dream*, which is not being scrapped for now, were on order for Asia-based Dream Cruises. Dream Cruises collapsed along with its parent company Genting Hong Kong earlier this year after its revenues crashed due to Covid pandemic-related shutdowns. MV Werften was also part of Genting Hong Kong.

The administrators are hopeful that a buyer for *Global Dream*, which is 80% complete and floating in the dock in Wismar, can be found.

Along with their record-breaking passenger capacity, at 208,000 gross tonnes the vessels would have been tied for the world's sixth-largest cruise ships by size when complete, just behind Royal Caribbean's five Oasis class ships.

Among other notable features, the two ships were to have the largest cinemas at sea with eight theatres each and the first theme parks atop a cruise ship with the longest roller coasters at sea.

RENDERING OF THE DESIGN FOR THE *GLOBAL DREAM* CRUISE SHIP. SOURCE: DREAM CRUISES

AUTONOMOUS SHIPS

AUTONOMOUS-READY CONTAINER VESSELS TO CONNECT NORWAY AND THE NETHERLANDS

Samskip, the Netherlands-based logistics company, has partnered with US marine robotics firm Ocean Infinity to develop two zero-emission, remotely operated 500TEU container vessels that will operate between Norway and the Netherlands.

The 'SeaShuttle' vessels will be autonomous-ready and integrate hydrogen fuel cells, delivering up to 3.2MW of power, according to Samskip.

Partial funding of NOK150 million (US$15million) towards the SeaShuttle programme will be provided by Enova, a Norwegian state-owned enterprise focused on the reduction of greenhouse gas emissions.

"Samskip is very proud to take the lead role in pioneering the SeaShuttle initiative, as part of its 'making green logistics easy' strategy," says Are Gråthen, CEO, Samskip Norway. "Securing this funding provides a platform to make emissions-free container shipping a reality.

"Together, Samskip and Ocean Infinity will also accelerate their plans to advance autonomous ship technologies, and remote operation of ships and cargo handling equipment. These ships are the first part of an exciting collaboration with Ocean Infinity."

Christoffer Jorgenvag, Ocean Infinity CCO, says: "Ocean Infinity's enabling technologies can facilitate green corridors but also the broader decarbonisation and transformation of maritime operations. The emphasis today is on the SeaShuttle vessels, which are just part of Ocean Infinity's overall strategy of unlocking innovation to deliver truly sustainable maritime operations."

ALTERNATIVE FUELS

CMA CGM AND ENGIE INVEST IN LARGE-SCALE SECOND-GENERATION BIOMETHANE PRODUCTION

French shipping line CMA CGM Group and compatriot utility company ENGIE have announced plans to co-invest in an industrial and commercial unit for second-generation biomethane production.

The Salamander project will be the first of its kind and is intended to produce up to 200,000tonnes of renewable gas annually by 2028, to meet the needs of CMA CGM and the shipping industry.

The project is the application on an industrial scale of 10 years of research and development conducted by ENGIE within the framework of the GAYA project, which has demonstrated the technical, economic and environmental viability of producing renewable gas.

Majority-owned by CMA CGM and ENGIE, the project site will be located in Le Havre, France, with support from the investment programme Le Havre, ville portuaire intelligente (Le Havre, a smart port city). The unit will be fuelled by dry biomass from local wood-waste sources, along with solid recovered fuel, and will produce the biomethane via pyro-gasification.

The US$150 million site will aim to produce 11,000tonnes of biomethane annually from 2026, with production ramping up to 200,000tonnes per year by 2028.

CMA CGM and ENGIE plan to finalise their investment decision in late 2022.

The announcement is the first tangible project under the strategic partnership signed by CMA CGM and ENGIE in November 2021.

By developing the renewable gas industry and the Salamander project, both CMA CGM and ENGIE aim to achieve the energy independence and energy transition goals set out by the European Commission in the RepowerEU plan.

CMA CGM, which aims to achieve net-zero carbon by 2050, already has a fleet of 30 dual-fuel "e-methane ready" ships in operation – a figure that will rise to 77 by the end of 2026. The dual-fuel engine technology developed by CMA CGM, which currently runs on LNG, is already capable of using bioLNG, as well as synthetic methane.

NEWS ANALYSIS

MEPC ROLLS BACK R&D FUND AND UPDATES GUIDELINES ON EEXI, CII AND WASHWATER

By **Malcolm Latarche**, Correspondent

SOURCE: IMO

Unsurprisingly, events in Ukraine have continued to dominate world news headlines but shipping is, in its own way, beginning to learn to live with the consequences of changed trade patterns and higher fuel costs. What it may find harder to live with is an impending global recession brought on by the rising price of energy that has its origins in reasons predating the Russian invasion of Ukraine by much longer.

Inflation is rising across the western world and expected to run into double figures in the second half of the year in major economies, having already surpassed that in many of the eastern EU states. Politicians are having to appease angry electorates and to keep costs down by bringing back mothballed coal-fired power stations to help slow the energy cost rises. Even so, the public will have considerably less disposable income and that will impact the liner trade which relies heavily upon consumer goods from Asia being shipped to Europe and the US.

While it is too early to discern any definite trend, there does appear to be signs that across the board the green agenda and net-zero policies are being rolled back or put on the back burner. Economists are split as to whether the current disruption is transitory or long term, but analysts are taking an increasingly gloomy view of world economic prospects.

It was against this backdrop that the 78th meeting of IMO's Marine Environment Protection Committee (MEPC 78) took place in early June. There was no actual rowing back on green commitments at MEPC aside from some EEDI refinements being postponed due to lack of time caused by the constraints of holding the meeting partially online. The EEXI regulations will still come into effect on 1 January 2023 and ships will need to comply at the first annual, intermediate or renewal survey after that date.

The survey is part of the scope of the IAPP (International Air Pollution Prevention) survey, and compliance is documented by issuance of the IEE certificate. Likewise, the CII rules are still on course but as an operational measure they will have no immediate effect on ships.

There was, however, a number of amendments to the guidelines for both EEXI and CII that were adopted at MEPC 76. Six new resolutions have been adopted replacing those issued after MEPC 76. These affect the method of calculation, survey and certification. There has been criticism of the correction factors and voyage adjustments to be used in CII, especially those factors that address port waiting time and adverse weather conditions, as many believe these to be market distorting. The meeting invited interested parties to collect relevant data and to report to the Committee ahead of the review of the CII regulations and guidelines to be completed at the latest by 1 January 2026.

Efforts to force the shipping industry to decarbonise beyond anything needed to comply with IMO regulations have been growing over recent years. It does however need to be pointed out that there is no universal embracing of such moves by shipowners beyond a small number of the larger operators.

In 2019, the industry itself came up with a measure to raise funds for technological research. Supported by some of the leading shipping organisations, but again not actively supported by the majority of shipowners, the planned IMO Maritime Research Fund (IMRF) was intended to raise US$5billion over 10 years by way of a US$2 per tonne levy on bunkers taken by all ships.

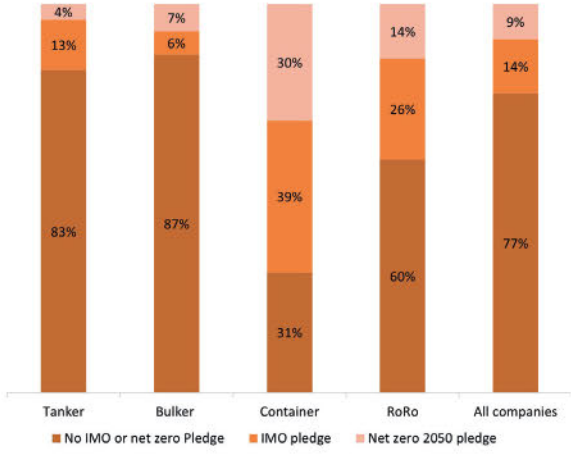


FIG 1: SHARE OF COMPANIES WITH DECARBONISATION PLEDGES. SOURCE: MMMCZCS

At MEPC 78, the IMO decided not to proceed with the idea and drew a lot of criticism from the International Chamber of Shipping (ICS), which had played a leading role in the initiative. After MEPC closed, ICS issued a statement with Guy Platten, ICS secretary general, commenting: "By refusing to take forward the shipping industry's proposed research and development fund, the IMO has wasted its opportunity to kick-start a rapid transition to zero-carbon technologies which will be vital if we are to decarbonise completely by 2050. Despite the support of many IMO states, we have been frustrated by short-sighted political manoeuvring which has led to the proposal in effect being killed. The signal this sends means that the financial risk associated with green investment will remain high, slowing down efforts to switch to zero-carbon fuels as soon as possible."

Of course, the IMO itself cannot make any rules without the approval of member states' governmental delegates and it would therefore appear that the majority of member states do not want to increase shipping costs and living costs for their electorates any further at this moment in time.

Platten went on to say in the ICS statement: "Despite the lack of government leadership at the IMO, the shipping industry remains committed to finding ways of achieving net zero carbon emissions by 2050. Funding for R&D will be top of the agenda at the Shaping the Future of Shipping Summit, to be hosted by ICS in London on 21 June. We will bring together leading CEOs from across our global industry to find ways to practically decarbonise shipping."

While it is true that a fair number of industry leaders have voiced agreement to the 2050 goal, the reality is that the industry may not be as committed as the ICS believes. At the very end of June the Maersk McKinney Moller Centre for Zero Carbon Shipping (MMMCZCS) issued a statement concerning the plans of top shipping firms to meet 2050 GHG reduction targets.

It appears that of the top 94 shipping firms only 33 have committed to the target of halving GHG emissions. The statement said, the state of decarbonisation in the maritime industry shows that while real progress has been made, there is a long way to go for the industry to reach net zero within the limited time left to transition. The 35% of shipping firms ready to meet the targets compares badly with other industries. For example, a 2020 KPMG report looking at the top 100 companies by revenue across industries found that 66% of automotive, 45% of transport and leisure and 56% of oil and gas companies had sustainability reports with carbon reduction targets.

The analysis by MMMCZCS found that the container sector has the highest level of ambition, with 16 of the 30 largest operators having set emission targets to a 2050 timeline. This equate to 69% of the total container fleet capacity in terms of owned deadweight tonnage.

Of course it could be argued that the shipping industry's reticence is due more to a lack of genuinely available technologies to meet the target than indifference. A lot of trust is being put in the future availability of fuels such as ammonia and hydrogen but it is understandable

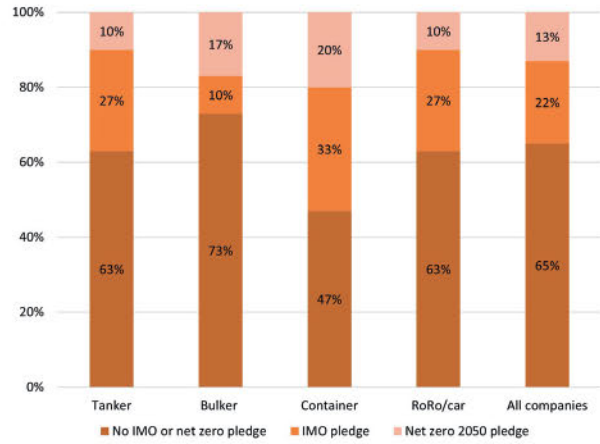


FIG 2: PLEDGING COMPANIES' SHARE OF TOTAL SEGMENT CAPACITY. SOURCE: MMMCZCS

that shipowners are not yet prepared to commit to constructing new vessels with unproven technology. It has been noticeable that more LNG-fuelled vessels are being constructed but the number of orders has, according to DNV, apparently fallen off in June when just two new vessels were added to the order book after 30 orders in May and 51 in April.

Another item on the agenda at MEPC was the discharge of washwater from exhaust gas cleaning systems (EGCS). This is a topic that has seen much debate in recent years as some blame scrubbers as just a means of moving pollution from air to sea. However, the question is somewhat more complex than that and has still not been scientifically settled.

At MEPC 78, circular MEPC.1/Circ.900 providing guidelines to address the proper management and disposal of exhaust gas cleaning system (EGCS) waste types into port reception facilities was approved.

Within the new guidelines terminology is introduced to distinguish between EGCS residue, washwater and bleed-off water. In sea areas including ports, harbours and estuaries where the discharge of EGCS discharge water is prohibited, ships should keep their discharge water on board for delivery to port reception facilities. However, outside these areas, the temporary stored discharge water could be discharged into the sea in accordance with the discharge criteria given the 2021 EGCS Guidelines (MEPC.340(77)).

It also clarified that EGCS residues (material removed from washwater or bleed-off water by a treatment system or discharge water either of which do not meet the discharge criterion for EGCS) should not be discharged to the sea, mixed with other waste streams or burned in the ship's incinerator, but should instead be appropriately managed onboard and delivered ashore to adequate reception facilities.

Another circular MEPC.1/Circ.899 was approved to provide guidelines for assessing impacts and risks associated with the discharge water from EGCS. It contains recommended methodology for risk and impact assessments that states should follow when setting local or regional regulations to protect sensitive environments from the discharge water from EGCS. ■

NEWS EQUIPMENT

PROPULSION

WÄRTSILÄ SUPPLIES PROPULSION SYSTEMS FOR WORLD'S LARGEST HYBRID VESSELS

Three new ro-pax vessels being built for Stena RoRo will feature hybrid propulsion systems from Finnish technology group Wärtsilä.

Two of the ferries are to have a battery capacity of 11.5MWh, making them the marine industry's largest hybrid vessels to date. This battery power is approximately double that typically being used currently for hybrid propulsion.

The vessels are under construction at the China Merchants Jinling (Weihai) Shipyard and will be equipped with the latest generation Leclanché energy storage system – the Navius MRS-3 – which has both a size and weight advantage versus comparable marine batteries, according to Wärtsilä.

"The extensive battery size will allow the vessels to operate with full power, using both propellers and all thrusters to manoeuvre emissions-free in and out of ports, even in bad weather," says Håkan Agnevall, president and CEO, Wärtsilä.

He adds that a built-in shore power solution will charge the batteries while berthed and Wärtsilä's Energy Management System will optimise the total hybrid propulsion system.

The ships, which will be capable of operating with either LNG fuel or batteries, have been designed and developed by Stena RoRo and Brittany Ferries and will be long-term chartered to Brittany Ferries.

Delivery of the ferries is expected to take place in 2024 and 2025.

CARBON CAPTURE

X-PRESS FEEDERS ADDS CARBON CAPTURE TO CONTAINER VESSELS

Singapore-based X-Press Feeders has awarded Value Maritime of the Netherlands a contract to install carbon capture and clean-loop systems onboard two container feeder ships.

The emissions reduction equipment, which captures carbon, sulphur and particulates, will be fitted to the 868TEU *Atlantis A* and the 1,036TEU *X-Press Elbe*.

The contract was awarded by Eastaway, a member of the X-Press Feeders Group, and the retrofitting projects are expected to be carried out in late summer. The ships will then operate with a 20% reduction in emissions on voyages in their northwest Europe schedules, according to Value Maritime.

The installations follow an earlier 2021 project in which a Value Maritime carbon capture module and CO_2 battery were installed on Visser Shipping's 1,036TEU feeder vessel, *Nordica*.

The two X-Press feeder vessels will be outfitted with Value Maritime's carbon capture module and CO_2 battery to capture and store CO_2 onboard. The system will capture carbon from the vessel's exhaust and in turn charge the vessel's CO_2 battery. This battery acts as an onboard storage facility, enabling the charging and discharging of CO_2 indefinitely. The CO_2 batteries will be offloaded and discharged at greenhouses in Europe where the CO_2 will be reused to grow crops or flowers.

With the clean-loop system, the water used to clean the ship's exhaust gases is filtered through Value Maritime's smart filtration system and the water's ph levels are neutralised before the water is discharged.

THE CARBON CAPTURED ONBOARD THE VESSELS WILL BE USED TO CHARGE CO_2 BATTERIES WHICH ACT AS STORAGE FACILITIES. SOURCE: VALUE MARITIME

WEATHER ROUTING

G2 OCEAN SIGNS WITH STORMGEO FOR VOYAGE OPTIMISATION SERVICES

G2 OCEAN HAS PARTNERERED WITH STORMGEO FOR WEATHER ROUTING AND VOYAGE PERFORMANCE SERVICES

Vessel operator G2 Ocean has partnered with StormGeo for weather routing and voyage performance services, including the BonVoyage System (BVS) and s-Insight platform for on-the-spot weather insights and route optimisation.

G2 Ocean covers 37 trade lanes and operates over 120 open hatch and conventional bulk carriers, transporting wood pulp and other forest products, aluminium, steel, granite and industrial minerals.

"We're very satisfied with StormGeo's services. Through the s-Insight platform, we gain good insight into current and historical voyage routing and performance, which help us make better decisions," says Trond Aga Haug, fleet performance manager at G2 Ocean.

BVS is a user-friendly route optimisation, voyage planning, and weather forecasting application.

"We have installed the BonVoyage System onboard our vessels. This tool gives our crew high-quality and accurate weather maps at their fingertips – assisting the master and officers in making good routing decisions and safeguarding the vessel, crew and cargo," says Haug.

Rolf Reksten, VP of Route Advisory Services at StormGeo, says: "StormGeo is very excited to have G2 Ocean onboard and provide actionable decision support with our advanced tools and route analysis experts.

"We have deep experience in routing bulk carriers and offer a future-proof solution that not only provides weather routing and fleet performance services but also lays the foundation for an environmentally compliant operation. We look forward to being G2 Ocean's partner in the digital future of shipping."

ENGINES

WINGD AND HHI COLLABORATE ON AMMONIA-FUELLED TWO-STROKES

WinGD is collaborating with Hyundai Heavy Industries' (HHI) Engine Machinery Division to deliver the first WinGD engine capable of running on ammonia. The two parties aim to deliver a first engine by 2025, in line with WinGD's previously announced timeframe for bringing ammonia-fuelled engines to market.

The project will explore ammonia concepts for both diesel-fuelled WinGD X-type engines and dual-fuel LNG X-DF engines.

"This project will give WinGD and HHI an important advantage in the development of ammonia-fuelled marine engines," says Dominik Schneiter, vice president R&D, at WinGD. "It will set the path for a new generation of two-stroke engine technology applicable to a wide range of cargo vessels in the coming decades."

"There is strong market demand for commercialised ammonia-powered vessels in the near future," says Kwang-Hean An, president and COO at Hyundai Heavy's Engine Machinery Division, adding that the collaboration with WinGD would ensure that the division is ready to support that demand with the required engine technologies.

The project will include developing relevant safety, emissions abatement and fuel supply solutions for ammonia engines.

DOMINIK SCHNEITER, WINDDG VICE PRESIDENT R&D

CONTAINER SHIPS

BOXSHIP BOOM SHOWS LITTLE SIGN OF SLOWING... YET

By **Richard Halfhide**

PORT CONGESTION IS ANTICIPATED TO LAST WELL INTO NEXT YEAR, IRRESPECTIVE OF ANY LOOMING RECESSION. SOURCE: SHUTTERSTOCK

While the Covid era brought huge changes to many of our lives, for the container ship sector it very quickly turned into a boom cycle that continues to show little sign of slowing down, at least not yet. Despite concerns when the pandemic first struck that demand for goods would slump and freight rates likewise, Chinese production very quickly returned to normal and, coupled with government stimulus packages and an abundance of housebound consumers keen to splash out, conditions for container operators were suddenly very favourable.

However, these once-in-a-century circumstances also put the logistics infrastructure under an impossible strain, leading to congestion that's still being felt today and unlikely to abate until next year.

"There's enough ships but the problems are staff shortages at ports, trucks, railroads, warehouses. Every aspect of the supply chain was basically stripped of capacity," Simon Heaney, senior manager for container research at maritime markets consultancy Drewry, tells *The Naval Architect*. "The mismatch means ships are waiting weeks on end for a berth, because the ports can't clear containers quick enough, so everything is elongated. Without Covid there were enough ships and equipment but it couldn't handle the snafus on the supply chain.

"You can't build a supply chain that can weather that sort of surge. If there was a miracle way of doing it the investment would be astronomical and the returns zero, because outside these events the market would be hugely oversupplied."

What these delays have done is driven an appetite for container ship tonnage that's almost unprecedented. According to Drewry's data, up to 1 April 2022 there had been orders for 864 vessels due for delivery between now and 2025, accounting for just under 6.6 million TEU, or 26.4% of the current container fleet's capacity. Vessel scrappings, meanwhile, have reached zero and it's well publicised that there have even been instances of bulk carriers being repurposed for container shipping.

Supply chain fragility

If Covid represented the perfect storm for challenging container logistics then the situation with *Ever Given*, the 20,124TEU boxship that became grounded in the Suez Canal in March last year, was at least a salutary reminder of the supply chain's fragility. It's estimated that around US$60 billion of trade was held up during the week-long incident, but Heaney is doubtful anything much will change as a result.

Heaney comments: "From memory the last incident like this was 20 years ago, the difference this time was it was one of the world's biggest container ships and the time it took to get cleared, but the risk is always there... [*Ever Given*] was another contributing factor in the increase in freight rates, so in effect operators actually gained from it."

The practice of capacity management, by which operators deliberately remove vessels from service to stimulate the market, is essential to maintaining healthy freight rates. During the 2008-2009 financial crisis around 10% of the container fleet was kept in anchorage for months on end, but in the current situation it's more a case of managing port congestion and has led to freight rates at exceptional levels.

Drewry's analysis suggests this bull run is now coming to an end, although port bottlenecks are expected to continue into 2023. However, forecasting is far from scientific and largely dependent on anecdotal evidence and surveys. While the expectation is that the economy will remain broadly in growth there's every possibility demand could fall rapidly in the event of a major recession.

By their nature such trade cycles are insidious. The newbuilding orders that cash-rich owners are currently placing – often without long-term charters – won't translate into in-service vessels for another two years, by which point it's widely anticipated that, coupled

with inflation escalating globally, there will be a global recession. Any demand slump will inevitably lead to excess tonnage, but likely most owners would sooner hedge their bets than request costly cancellations. When one then considers other factors in this 'polycrisis' such as climate change, US-China trade tensions and the sanctions imposed upon Russia following the invasion of Ukraine, it's unsurprising that many container operators fear their salad days may be drawing to an end.

Smaller vessels?

A noticeable trend of the current orderbook, Heaney notes, is that owners are opting for slightly smaller vessels than the 20,000TEU-plus mega ships. The world's current largest container ship, by capacity, is Evergreen's 24,004TEU *Ever Alot*, delivered earlier this year, and while an as-yet-unnamed 24,232TEU MSC vessel should take that record in 2023, Heaney doesn't expect the size to increase much further in the foreseeable future.

While such ships do offer economies of scale there are obvious disadvantages in terms of where the ships can be deployed, since only the largest ports can accommodate them and the protracted time it takes to unload such large numbers of boxes. On aggregate, the largest number of vessels (222) due for delivery between now and 2025 are the so-called Maxi neo-Panamax (vessels with a beam of around 48-51m, with capacity of 12,500-18,000TEU).

With scrapping rates flatlining, the question arises whether older vessels might risk undermining efforts to reduce carbon emissions in the fleet, although Heaney says many of the most aged vessels tend to be at the smaller end of the scale.

Heaney comments: "Obviously there are new regulations coming into effect from 1 January next year – namely EEXI and the Carbon Intensity Index (CII) – but we've done some analysis and found that very few ships won't be compliant with EEXI. That's partly because most container ships are already operating well below design speed, which has been the case for well over a decade now. We identified two classes, basically the very small feeders, of which there were perhaps 1,000-1,200 ships which might be slightly afoul of the regulations, but they would only need to slow down a touch to be acceptable.

"If those vessels had been scrapped [freight rates] would be even higher, but we've identified about 400,000TEU that we expect to see demolished from next year onwards to meet equity rules. CII won't be measured until the end of the year when they calculate the average speed and how much cargo they've moved. The older ships that are less likely to pass those carbon intensity rules will disappear first and as the market changes and earnings potential diminishes, as we expect to happen, then the incentive to scrap increases."

Greener ships

Like other sectors, container ships are gradually transitioning towards greener fuels, with Drewry's data indicating that as of the end of June 54% (approx. 750,000TEU) of orders placed this year are for vessels that will run primarily on alternative fuels, with LNG inevitably being the dominant choice. Although it's not something that Drewry actively projects for outside of bespoke Heaney says this is in line with expectations and should eventually reach 100%. Although such vessels demand greater capex it's further incentivised by the rising price of traditional fuels. Moreover, since many of the largest customers are public-facing companies keen to promote their green credentials, there is pressure coming above and beyond regulatory requirements.

In recent years there has been significant speculation that advances in manufacturing technology, such as 3D printing, could lead to radical changes to the supply chain, with the possibility that consumer goods could be produced much closer to their intended market, but Heaney says there's little evidence of any changes in the foreseeable future.

"In terms of hard numbers China is still the dominant player. Everybody wants a bit more resilience in the container sector, but how to go about it? They're just responding to what the market wants. If it was decided all of a sudden that European goods were going to be produced in Turkey that would clearly be a problem for liner shipping because they've invested heavily in big ships, then all of a sudden it would be much smaller ton-mile journeys. But we've not seen any evidence of it." ■

EVERGREEN LINE'S 'A-CLASS' VESSELS ARE CURRENTLY THE WORLD'S LARGEST, BEGINNING WITH *EVER ACE*, DELIVERED LAST YEAR. SOURCE: WOLFGANG FRICKE/ CREATIVE COMMONS

CLASSIFICATION SOCIETIES

LNG: SHIPOWNERS ADVISED TO TAKE LONG-TERM APPROACH TO VESSEL DESIGN

By **Daniel Johnson**

With the increase in demand for natural gas as a source for fuel propelling growth in the LNG carrier market, orders for newbuildings are continuing to flow into shipyards. Technical advancements in the segment mean that vessels ordered today have the opportunity to continue trading efficiently under current regulations deep into the 2030s and possibly the 2040s regardless of stricter IMO regulations coming into play. However, classification society DNV is advising shipowners to take a longer-term view on ship design to increase the profitability and longevity of the modern vessel.

"Demand for LNG is only going to grow and we're going to see a large volume of vessels coming online in the coming years. And with volumes on the rise, it is time to strategise," says Martin Cartwright, DNV's global segment director, Gas Carriers & FSRUs.

Cartwright explains that even with the most modern vessels, owners may have to take action from 2035 to 2040 if they want those assets to be efficient and to be utilised as long as possible and therefore it would be prudent to build vessels with strategies for retrofits of both current and nascent efficiency technologies in mind.

Newbuild concept study

DNV has recently released the results of joint industry project (JIP) which studied an LNG carrier newbuild concept to determine feasible approaches to achieving compliance with the IMO decarbonisation path towards 2050. Carried out in partnership with TotalEnergies, Hyundai Heavy Industries and a major shipping company, the JIP evaluated a current design for a 109,000dwt LNG carrier with a 174,000m^3 capacity to chart a practical path enabling the vessel to comply with the carbon reduction trajectories.

In particular, the project aimed to identify the best time to implement a retrofit. Different decarbonisation options, including measures related to energy efficiency, energy harvesting, onboard carbon capture and storage (CCS) and alternative fuels, were investigated.

The JIP assumed two trade routes (Houston-Antwerp and Houston-Japan) as well as two operational profiles, normal trading speed and a slow-steaming profile. Typical annual operational data for the two routes, such as operational carbon intensity and annual fuel consumption, were used for reference. According to the study, the cut off for retrofitting energy saving measures and carbon-abatement technology and/or start using blend-in of carbon neutral fuels so that the ship continues to comply with emission limits for 2050 would be 2038 for the first operational profile, and 2040 for the slow steaming profile.

The JIP then evaluated the benefits and economic feasibility of four different strategies towards achieving compliance with the IMO decarbonisation goal: A) operating the vessel as designed and built throughout its lifetime and blending in progressive amounts of bio/e-LNG to remain compliant from 2037 onwards; B) equipping the ship with three rotor sails (Flettner rotors) as well as shore power equipment from the day of delivery and beginning to blend in bio/e-LNG and bio/e-MGO from 2038; C) installing a CSS system onboard in 2035 to extract CO_2 emissions from the exhaust (an optimistic CO_2 abatement potential was assumed, meaning there is no need to blend in bio/e-fuel); and D) retrofitting a modular fuel cell system and waste heat recovery system in 2035 and from 2037 progressively blending in bio/e-LNG and bio/e-MGO.

Retrofitting measures

"Rotor sails are a proven wind-assisted propulsion technology and can be installed from the get go," says Cartwright, explaining the technical implications of the different retrofitting measures. "They are estimated to reduce fuel consumption and CO_2 emissions by almost 6%

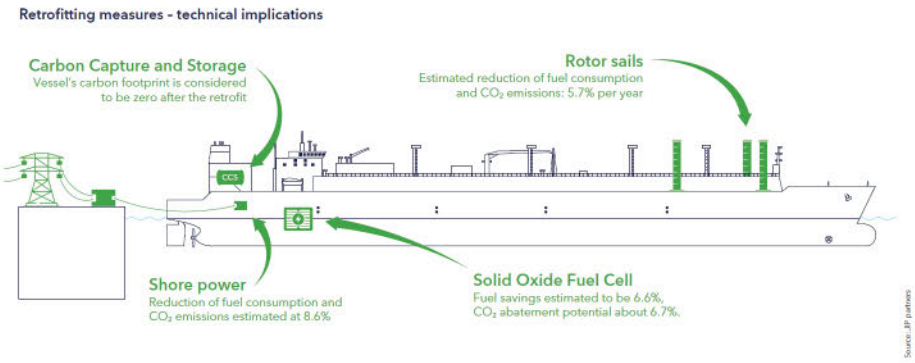
Strategies to meet the target carbon intensity trajectory

Strategy	Energy efficiency, energy harvesting, and onboard CCS measures (apart from those already included in baseline)		Measures applied to reduce carbon intensity
	At newbuild stage	Future retrofit	
A STRATEGY A - BASELINE	Baseline technologies	None	Progressive blend-in of bio/e-LNG and bio/e-MGO
B STRATEGY B - WIND AND SHORE-POWER	Baseline technologies 3 x Flettner Rotors (35 x 5) Shore power	None	Progressive blend-in of bio/e-LNG and bio/e-MGO
C STRATEGY C - RETROFIT OF CCS	Baseline technologies	CCS retrofit in 2035	None
D STRATEGY D - RETROFIT OF FUEL CELLS*	Baseline technologies (apart from shaft generator)	Auxiliary SOFC system retrofit in 2035 with WHR system	Progressive blend-in of bio/e-LNG and bio/e-MGO

*SOFC system to provide auxiliary power

Source: JIP partners

THE JIP EVALUATED FOUR DIFFERENT STRATEGIES TOWARDS ACHIEVING COMPLIANCE WITH THE IMO DECARBONISATION GOAL. SOURCE: DNV/JIP PARTNERS



OPTIONS FOR OWNERS INCLUDE VARIOUS CARBON ABATEMENT TECHNOLGIES. SOURCE: DNV/JIP PARTNERS

per year. Using shore power when doing cargo operations will further reduce fuel consumption and CO_2 emissions by up to nearly 9%.

"Onboard CCS requires significant modifications onboard, for example an extra deck to accommodate the system and CO_2 tank. The extra fuel needed to power the system will not affect the vessel's carbon footprint, which is considered zero after the retrofit.

"And a modular solid oxide fuel cell system running on LNG combined with waste heat recovery system can provide auxiliary power and increase efficiency. Fuel savings are around 6% to 7% and the CO_2 abatement potential is in the same range."

The JIP applied DNV's FuelPath Model to evaluate the economic performance of the various design options, with the performance expressed as total cost of ownership (TOC) and other economic parameters. As future fuel prices are hard to predict, the study accounted for three different fuel price scenarios – high, baseline and low.

For strategy A, it was shown that fuel expenditures rise steeply when carbon-neutral fuel is added progressively from 2037. The rotor sails and shore power mitigate this effect for strategy B. While strategy C must invest a substantial amount in the CCS system in 2035, this investment keeps fuel costs constant during the remaining years. Strategy D ends up with the highest overall bill as the estimated fuel savings do not compensate for the investment in fuel cells.

In general, strategies B and C show the lowest TOC throughout the lifetime of the vessel. Strategy C is least sensitive to the different fuel price assumptions applied, as it does not utilise carbon-neutral fuels. The TCO of strategy A was found to have the greatest sensitivity to fuel prices because of its reliance on carbon-neutral fuels and relatively high energy consumption compared to strategies B and D, for example.

Cartwright says that a future CO_2 price will have a significant effect on the coast scenarios by "punishing" the solutions with the highest fuel consumption, and that this should be taken into consideration when choosing the carbon reduction strategy for a newbuild. The JIP accounted for this parameter, assuming a carbon tax scenario believed by industry stakeholders to be realistic. For strategy A, a carbon tax will increase the TCO by approximately 20%. Strategy C performs relatively better when a CO_2 tax is introduced.

Design considerations

The JIP also carried out an overall review of design and safety considerations. It notes that rotor sails require free inflow of wind to maximise the forward thrust of the Magnus effect and their arrangement on deck must account for factors such as rudder action, ship turning ability, cargo-deck operations, line of sight from the bridge and structural strengthening for sail foundations.

To use shore power, appropriate electrical installations are required onboard and a range of considerations – the location of equipment relative to hazardous zones, emergency departure, and switchboard arrangements, for example – will need to be addressed.

The necessary modifications for CCS technology onboard are significant and onboard CO_2 management has important implications for safety and crew training. The CCS system requires extra power generation and port infrastructure to collect the captured CO_2.

A fuel cell system requires a safe space, an exhaust for the waste heat recovery system, as well as access to fresh air and fuel. If this approach is chosen, the JIP recommends it should be accounted for in the design of the engine room and funnel as well as some deck reinforcements.

Overall, the study concluded that for the fuel price scenarios, CO_2 pricing and timelines scenarios considered, strategy B (rotor sails and shore power) and strategy C (CCS) result in the lowest cost of ownership. "Surprisingly, CCS is the most robust under these assumptions, provided this solution achieves a 100% carbon abatement rate and an appropriate CO_2 onshore infrastructure is established," says Cartwright.

"Hypothetically, CCS has the potential to be a real kicker down the line," he adds. "Infrastructure will be very important. CCS needs support from the ports to make sure we can offload the CO_2 that is stored onboard. And we will need the technology to develop to a higher level of efficiency so that more CO_2 can be captured."

Cartwright concludes that an unequivocal recommendation for any particular fuel or carbon abatement technology cannot be made at this time, considering the uncertainties involved. Instead, the JIP should be seen as a structured process that will help owners keep a range of options open. ■

CLASSNK TAKES DATA-DRIVEN APPROACH FOR NEW STRUCTURAL RULES

ClassNK explains the reasoning behind, and benefits of, its new data-driven approach to structural rule development

Like other industries, the maritime industry is facing rapid digital technological evolution and the need for significant decarbonisation. In order to solve the complex challenges arising, more innovative concepts and technologies are expected to be implemented in shipbuilding design.

The classification rules related to hull structure, which provide the foundation for ship safety and which used to consist of empirical formulas, have so far evolved based on long-term predictions of wave loads and the use of finite element method (FEM). ClassNK rules have also incorporated evolutions in design technology. However, taking into account the benefits of digitalisation and the need to apply more innovative technologies to ships, ClassNK decided to implement a complete revision of its structural rules to enable safer and more rational hull structural design and strength assessments.

ClassNK's development policy, and the features and advantages of its new structural rules are explained below.

Development Policy

ClassNK has been continuously revising parts of its Structural Rules for more than 100 years in order to respond to the emergence of new vessel types and various damage problems.

For example, ClassNK maintains its high level of safety and reliability through partial revisions of its structural rules every year. The society continuously provides structural strength evaluation using the latest technology and computer analysis such as EDW (Equivalent Design Wave) load concept, which was introduced into 'Guidelines for Tanker Structures' in 2001 and subsequently brought into IACS' Common Structural Rules (CSR).

In order to evolve coherent, data-driven structural rules which align with the 'Design by Analysis' principle and respond to a revolutionary period in digitalisation and the zero-emissions imperative, ClassNK decided to renew its structural rules.

The project involved joint research with universities and research institutes to incorporate the latest technologies and thinking on ship and ocean engineering, and verify the technical background of any new rules. In addition, shipping companies and shipyards were invited to participate in the project from the initial stages, so that their knowledge, insights and opinions were also incorporated.

ClassNK made significant contributions to the development of IACS CSR, basing much of its insight on the participation of ClassNK engineers in joint industry initiatives to develop new technologies. These experiences were also utilised in this comprehensive revision.

The key feature of the comprehensive revision is the data-driven rule development that utilises Big Data. Analysing AIS data or plate thickness measurement data, for example, represents a significant expansion in the knowledge base for rulemaking. Again, with the introduction of Digital Twin technology, various facts about vessels in navigation will become clearer in the future, and the development of structural rules can be expected to make dramatic progress: the foundation for this has already been laid in ClassNK's new structural rules.

Features of the Rules

Loads: Combining calculations of sea-keeping analysis of around 80 vessels in this project, and about 100 vessels previously used in the development of CSRs, as well as ClassNK guidelines for tankers, bulk carriers and container ships, new Equivalent Design Wave (EDW) load formulae were derived that can be applied to all types of vessels from 'sharper' vessels such as container ships to 'blunt' vessels such as ore carriers.

The maximum predicted load during a ship's service period is also more accurate, based on long-term prediction due to its basis on investigating and statistically analysing actual sea states encountered by ships – from AIS data generated by approximately 8,000 ships.

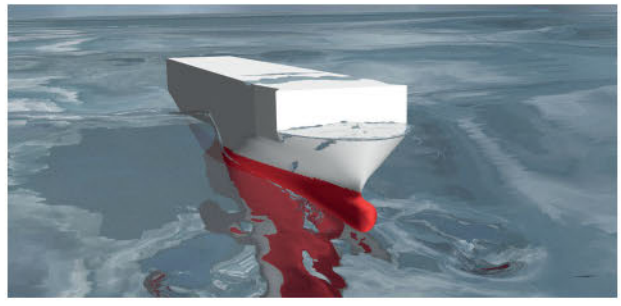


FIG 1: MODELLING OF MAXIMUM PREDICTED LOAD

Corrosion Margin: Thickness measurement data of more than 200,000 locations of plating, from ships built since the late 1990s, were newly compiled and statistically analysed to establish a corrosion margin thickness for each corrosive environment – reflecting the recent maintenance quality after the introduction of the ESP (Enhanced Survey Program).

Strength Criteria: Some strength evaluation methods were developed to derive threshold values directly linked to damage, such as residual deformation, by combining the results of a large series of nonlinear FE analyses with

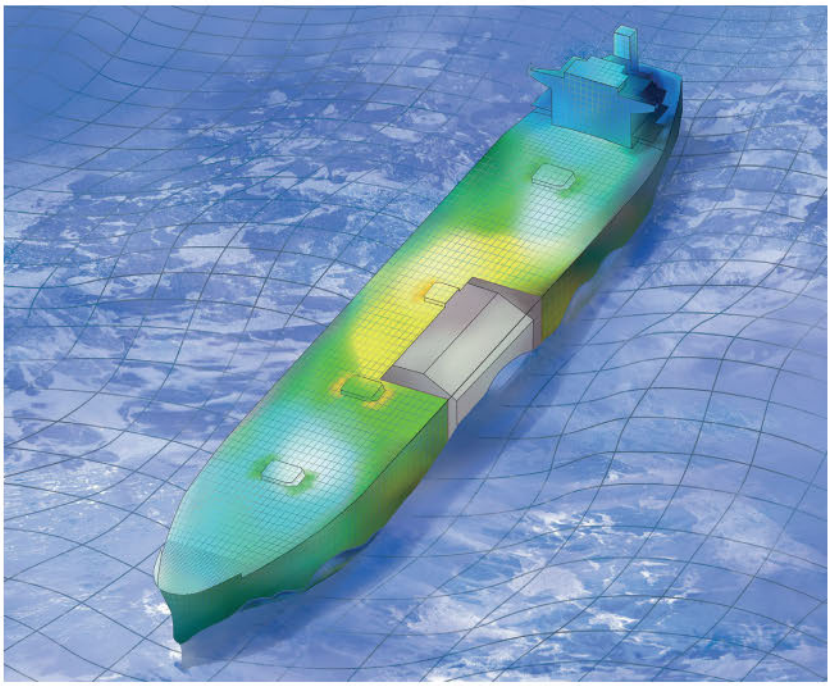


FIG 2: INDEPENDENT SQUARE LIQUEFIED GAS CARRIER

structural mechanics theories. The method establishes safer and more reasonable required scantlings by combining appropriate and consistent safety factors.

Cargo hold analysis: Based on calculation results of the full spectrum analysis for the entire ship, a strength evaluation method using a partial cargo hold model with EDW loads has been developed; it provides results similar to an entire ship analysis.

Fatigue strength: Based on route data obtained from AIS for about 25,000 vessels, fatigue strength criteria were established to sufficiently suppress the occurrence of fatigue cracks for vessels that regularly cross the Atlantic and Pacific oceans and are subjected to relatively severe repeated loads. By reviewing the calculation method of hot spot stress and the method of considering mean stress effects, a more accurate evaluation has been achieved.

New Structural Rules benefits

As mentioned, the introduction of loads that actually occur on ships and strength criteria closely linked to damage and the provision of an appropriate safety factor improve the accuracy of strength evaluation. The approach also means that excessive scantlings can be reduced, while scantlings of the members where more strength and a greater corrosion margin are needed can be increased. These steps will be reflected in lower construction costs, lower fuel consumption, less maintenance requirement and fewer repairs.

In addition, the comprehensive revision unifies the concept of strength evaluation and – by doing so – clarifies the technical background of each strength requirement. This will enable highly accurate strength evaluations to be performed for novel structures such as hydrogen-fueled and ammonia-fueled vessels, and will enable safe and highly rational design.

The strength evaluations required by the new structural rules can be performed with the dedicated software PrimeShip-HULL. This software is an evolution of ClassNK's highly acclaimed strength evaluation software for CSRs, with improved compatibility with 3D CAD software, operability, and visibility, and an excellent UI/UX that enables a more efficient shipbuilding design processes. ■

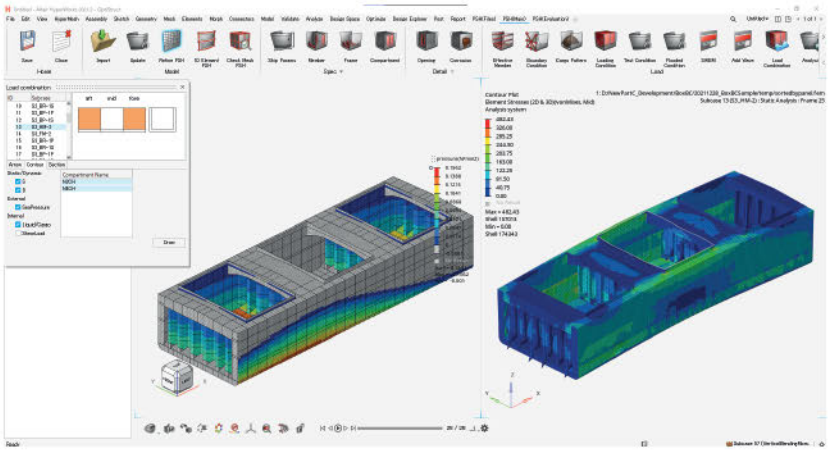


FIG 3: DIRECT STRENGTH ASSESSMENT

CLASSNK UPS SUPPORT FOR SHIPPING'S TRANSITION TO ZERO-EMISSION

By **Daniel Johnson**

In light of the acceleration in initiatives toward zero-emission shipping, ClassNK has been stepping up its services to help customers in the maritime transportation business manage their reduction in greenhouse gases (GHG). Restructures in the organisation have seen the establishment of a Zero-Emission Transition Center and Marine GHG Certification Department, and the society's extended Zero-Emission Transition Support Services now address an array of customer needs.

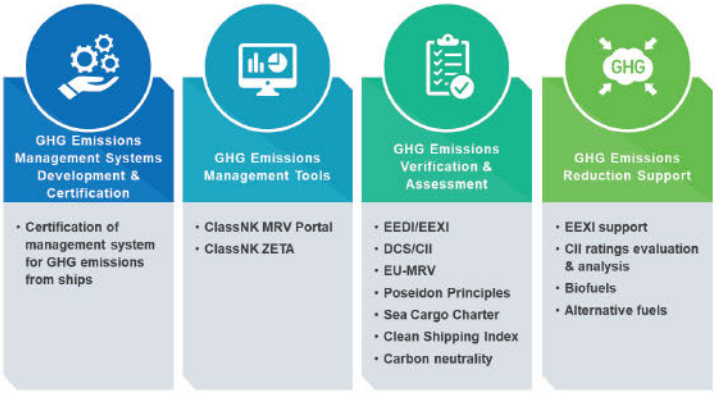
"A number of leading companies in the shipping business, particularly in Japan, have committed to reach net-zero emissions by 2050. To do this, it's important that they establish an emissions reduction plan. We expect strong demand from companies wishing to introduce management services for GHG emissions," Mr Katsuya Naito, general manager, Zero-Emission Transition Center, Planning Division, tells *The Naval Architect*.

According to Mr Naito, the centre's extended services build on services already introduced by the society to help with emissions reporting requirements for the International Maritime Organization Data Collection System for fuel oil consumption (IMO DCS) and EU-MRV (monitoring, reporting and verification) schemes, and now provide customers with a comprehensive menu that includes: GHG emissions management system development and certification; GHG emissions management tools; GHG emissions verification and assessment; and GHG emissions reduction support.

Advanced emissions tracking

He adds that with an eye on the new Carbon Intensity Indicator (CII) energy efficiency regulation, the society has enhanced its offering with the addition of the ClassNK ZETA (Zero-Emission Transition Accelerator), a GHG emissions management tool to track accurate CO_2 emissions and confirm and simulate CII ratings.

ClassNK Zero-Emission Transition Support Services



"You can check the CO_2 emissions and CII rating results of an individual ship or fleet at any time," he explains. "It also lets you simulate how CO_2 emissions and CII rating results would change when slow steaming and other operations are implemented."

ZETA links with data sent to ClassNK's MRV Portal. Launched in 2017, the MRV Portal supports compliance with schemes such as the IMO DCS and EU-MRV regulations. "Support with creating emission reports in compliance with IMO DCS and EU-MRV is provided by gathering and monitoring data and documentation sent by ship management companies from onboard a ship or onshore to ClassNK's server," explains Mr Naito.

The new ZETA tool has four main features: Vessel Monitoring; Fleet Monitoring; Simulation; and Periodical Report.

"The Vessel Monitoring feature allows you to check CO_2 emissions and CII ratings on a real-time basis for each individual vessel. Users can also check the estimated annual CO_2 emissions and CII ratings based on the current operation status at any time and consider any necessary measures," Mr Naito says.

He adds that the Fleet Monitoring feature displays CO_2 emissions and CII ratings of the entire fleet for each company or team in charge.

Simulation allows users to simulate the changes in CO_2 emissions and CII ratings for an individual ship or fleet that would be seen by slow steaming, installing energy-saving devices, or switching fuels. Various simulations enable users to consider measures for reducing CO_2 emissions.

The Periodical Report feature outputs CO_2 emissions by voyage, cargo, ship and fleet. "In the future, it will also allow you to meet the reporting needs of various stakeholders, such as financial institutions, cargo owners and insurance companies," says Mr Naito.

ClassNK is currently developing ZETA features that can be used for frameworks such as the Poseidon Principles and the Sea Cargo Charter and plans to implement them during 2022.

In addition to ship management companies and other data holders, ClassNK ZETA is also available to shipowners and charterers, subject to data usage permission by the data holders. Worldwide, approximately 80 companies have already signed up for ZETA with more in the pipeline, Mr Naito concludes. ■

CLASSNK'S ZERO-EMISSION TRANSITION SUPPORT SERVICES HAVE BEEN EXTENDED TO ADDRESS A VARIETY OF CUSTOMER NEEDS.

COMMUNICATIONS

HYBRID CONNECTIVITY SOLUTIONS PROVIDE SECURE ROUTE TO OPERATIONAL EFFICIENCY AND REGULATORY COMPLIANCE

By **Daniel Johnson**

Faced with enormous efficiency and compliance challenges, the shipping industry is increasingly turning to digital tools and services to help balance the complex needs for performance monitoring, meeting regulatory requirements and commercial agility.

The capability of traditional satellite networks to meet these demands is being tested, leading to the emergence of hybrid networks that combine a high degree of service flexibility with guaranteed bandwidth and security, according to Tore Morten Olsen, president of maritime at smart network group Marlink.

TORE MORTEN OLSEN, PRESIDENT OF MARITIME, MARLINK. SOURCE: MARLINK

"There has been a noticeable acceleration in the adoption of digitalisation among shipowners, operators and managers," Olsen tells *The Naval Architect*. "We see a lot of effort going on right now, particularly with some of our larger customers. They have decided to invest in digitalisation because they understand that increased data capture and analytics helps vessels to operate more efficiently and economically, while also helping to significantly reduce the carbon footprint."

More cloud-based applications are finding their way into the IT infrastructure of maritime customers, he adds.

Olsen points to two such clients, MSC and Scorpio Ship Management, as cases in point. Marlink has been a long-term partner of MSC, the world's largest container shipping line, supporting the organisation's ambitious digitalisation goals through its hybrid network solutions and secure IT management.

Marlink deploys a fully managed hybrid network solution, bundling its VSAT connectivity with L-band backup and global 4G connectivity to a fleet of 127 vessels, providing MSC with "seamless, secure connectivity" to run its critical business and crew applications.

This hybrid network solution is fully secured by Marlink's Cyber Detection Service which scans real-time outbound and inbound network traffic for targeted cyber threats and takes immediate countermeasures to remediate incidents.

The latest phase of MSC's digitalisation strategy has seen the roll-out of Marlink's ITLink management solution across the fleet. "MSC has moved decisively to increase the standardisation of its onboard IT systems and to meet IMO requirements, enabling fleet managers to monitor operating IT systems and software from shore," Olsen says.

He adds that ITLink enables MSC fleet managers to remotely access their onboard IT networks for monitoring and troubleshooting in a secure environment and allows software updates and patches to be applied fleetwide.

New approaches and procedures

Recent advances in its digital strategy have seen tanker and bulker ship manager Scorpio Ship Management adopt new approaches and procedures for its operations, embracing video, data sharing and remote access to IT and OT networks for monitoring, maintenance and real-time decision-making. This need drove the company to upgrade the Marlink VSAT network solution on all vessels in its fleet, adding fresh bandwidth to enable more data, L-Band and 4G, new applications and enhanced reporting.

To meet Scorpio's needs, Marlink applied its 'Network of Networks' approach to create a solution optimised for the maritime environment. "In this case, the network was constructed with service layers and solutions designed to connect Scorpio's fleet of ships, operating globally and all requiring a consistent quality of service," Olsen says.

The service extension provides Scorpio with higher bandwidth services to meet an increasing level of business need for higher data rates and usage volumes, according to Olsen. Scorpio's managed fleet will be able to satisfy current and future requirements from charterers and regulators, while also providing cost-efficient crew communications, he adds.

"This kind of demanding scenario requires a deep integration with the customer so that the solution provided has the functionality and scalability it needs, with an eye on future-proof operations too. Marlink's hybrid network solution enables Scorpio to gain the benefits of digitalisation with the connectivity to support its business now and give it room to grow," Olsen concludes. ■

PROPULSION

SCHOTTEL TAKES NEXT STEP ON PATH TO A GREENER FUTURE

By **Daniel Johnson**

This summer propulsion specialist SCHOTTEL celebrated its 100th anniversary with a party for its staff at the company's headquarters in Germany. Postponed from the autumn of 2021 because of the pandemic, the gathering was an opportunity for the firm to reflect on an eventful history and dynamic present, but also to look to the future, according to SCHOTTEL chief executive officer Stefan Kaul.

"It was a great pity that we couldn't mark the occasion as we wanted to originally, but now the world has opened up again we decided that we must celebrate," he tells *The Naval Architect*.

Founded in November 1921, in the years since SCHOTTEL has established itself as one of the world's leading manufacturers of vessel propulsion systems. The company's products can be found on almost all types of vessels – from tugs, ferries and passenger ships to merchant vessels and the navy and governmental segments. Automation, propulsion control and hybrid propulsion systems extend the company's product range which is supplemented by marine services.

"SCHOTTEL's propulsion solutions have made the seven seas their home. What we do, we do wholeheartedly – in all areas, according to the same high standard, all over the world," says Kaul.

"However, we would very much like to celebrate the next hundred years, and in order to do that we cannot maintain the status quo," he adds. "We have to look to the future and rethink our company, always. Our history is marked by bold decisions at the right time and having the courage to take bigger and bigger steps."

STEFAN KAUL, SCHOTTEL CHIEF EXECUTIVE OFFICER

Complete system supplier

SCHOTTEL has taken the next big step in its evolution with the recent acquisition of a majority stake in Elkon Elektrik (elkon), the Turkey-based specialist in marine electrical system integration. "The takeover will allow SCHOTTEL to grow even stronger from a strategic point of view," says Kaul.

"It's important to combine both efficient propulsion and good energy and power management of the ship," he explains. "elkon is a well-known and very successful supplier of electrical power system engineering, design and integration for vessels. With the acquisition, we will expand our portfolio to include everything regarding generation, distribution, storage and management of electrical energy onboard of vessels. SCHOTTEL becomes a complete system supplier for electrical and green propulsion."

In the overall scope of both companies, energy-efficient propulsion concepts, hybridisation and electrification will be offered in a complementary way, according to Kaul. There is a particular overlap in the field of propulsion hybridisation in the newbuild and conversion business, he says, and customers can continue to benefit from the usual agile and independent services of both companies in the market.

"The customer advantage lies in the expansion of both portfolios and the possible commissioning of turnkey solutions for propulsion systems and system integration. On both sides, the option to integrate respective market partners remains available," he adds.

Green propulsion solutions

The development of green propulsion solutions is a key long-term business strategy for SCHOTTEL. "With more and more environmental rules and regulations coming into play, I think a lot of the answers will be found, to a certain extent, in the electrification of ships," says Kaul. "It is becoming increasingly popular for any vessel type. We are already seeing this in the ferry and passenger ship market."

For example, he says, SCHOTTEL has recently supplied azimuth thrusters to the latest addition to Finland-based FinFerries' fleet, the 100m-long, 17m-wide *Altera*. The electrically powered hybrid ferry, which is scheduled to enter operation in 2023, is currently under construction at the Polish shipyard Crist.

THE ECOPELLER'S HYDRODYNAMICALLY OPTIMISED DESIGN ALLOWS IT TO GENERATE MAXIMUM STEERING FORCES AND ENABLES TOP VALUES IN TERMS OF OVERALL EFFICIENCY AND COURSE STABILITY

The ferry's propulsion system consists of two electrically driven SCHOTTEL EcoPellers type SRE 430 (950kW each). The SRE 430 features a propeller diameter of 2.35m. The azimuth thrusters are ice-strengthened according to Finnish-Swedish Ice Class 1B. As a result, the ferry will be able to be deployed in the icy waters of Southwest Finland at any time of the year.

Equipped with a battery capacity of 2 x 0.6MWh, *Altera* will service its route using only its own batteries which are charged directly from shore while loading and unloading. Diesel generator sets will serve as a backup source of power.

Thanks to an effective combination of powerful propeller thrust and a course-stabilising fin, the EcoPeller fulfils all the requirements of a modern high-performance propulsion unit. The hydrodynamically optimised design allows the EcoPeller to generate maximum steering forces and enables top values in terms of overall efficiency and course stability.

Model tests

A pair of electrically driven SCHOTTEL EcoPellers also feature on a new 'eco-friendly' bitumen tanker for France-based Rubis Group. Designed by Swedish FKAB Marine and under construction at China Merchants Jinling Shipyard, the 15,000dwt vessel will be deployed in West Africa for asphalt transportation services.

The main propulsion of the carrier consists of two EcoPellers type SRE 560 (2,050kW each), featuring fixed pitch propellers with a diameter of 3.1m. With this configuration, the 145.8m-long and 26.2m-wide vessel will achieve a maximum speed of 13.5knots at design draught. Beyond this, one SCHOTTEL TransverseThruster type STT 2 (600kW) will ensure maximum manoeuvrability.

Project-specific model tests carried out at the maritime consulting company SSPA Sweden confirm the effective performance of the EcoPeller: when compared to a conventional rudder propeller with nozzle, it demonstrated a 17% increase in propulsion efficiency at an operational ship speed of 12.5knots throughout testing.

To achieve the maximum ship speed of 13.5knots at design draught, the SRE requires 11% less propulsion power than a conventional rudder propeller with nozzle, the tests found.

Powerful heritage, bright future

With marine propulsion and electric system integration expertise combined, SCHOTTEL and ekon are positioned to benefit from each other enormously moving ahead, especially on the path towards green propulsion, says Kaul.

"At SCHOTTEL our goal is to be the first choice in marine propulsion solutions. To this end, we use our entire wealth of experience and all our innovative strength to improve existing areas and expand into new ones. This and our powerful heritage will help us to stay on course for a bright future," he concludes. ■

CONFERENCES

COMPIT 2022: COMBINE AND CONQUER – THE TRENDS IN MARITIME IT APPLICATIONS

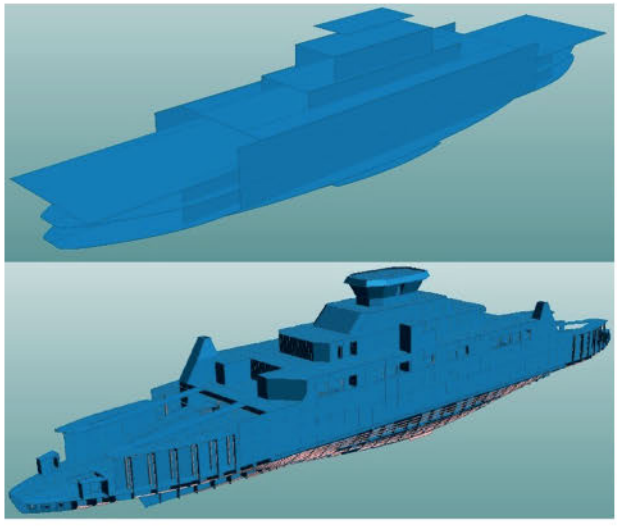
By **Volker Bertram**, WMU & COMPIT organiser

The digital transformation of our industry is a fluid process; it is a journey, not a destination. The COMPIT conference, which this year took place from 21-23 June in Pontignano, Italy, is a traditional yearly occasion to determine the current position and direction in this journey. The process is an evolution, not a revolution. The rate of progress seems to have been unaffected by Covid-19, but the mix of participants at the conference is at least as 'fluid' as the digital transformation process.

The megatrends in a nutshell were:

- Getting 3D+ – from design to operation, we move from 2D to 3D, and from 3D to 4D, adding time as a dimension, i.e. tracking the changes of 3D objects in time, from production to operation.
- Digital twins and artificial intelligence get merged – the digital twin adds virtual experience for the AI machine learning, the machine learning boosts efficiency in digital twin simulations. Combine, rather than divide, and conquer. The young field of autonomous ship operation adds a multitude of potential new applications for the maritime R&D community.
- Smart is green – decarbonisation and digitalisation are the two megatrends *per se* in our industry. In some cases, they overlap. The maritime work force is about to enter new, uncharted territory and smart guidance (or decision support systems) are very welcome as we embark on the decarbonisation journey, from design to operation.

The COMPIT conference gives a few waypoints and markers allowing us all to check that we are on track and not falling too far behind the competition.



CADMATIC'S STANDALONE INTELLIGENT GENERAL ARRANGEMENT TOOL FOR HOLISTIC BASIC DESIGN

3D and more

The theme of 3D CAD is as old as COMPIT. Already at the first COMPIT, in the year 2000, there were discussions on whether to model in 2D or 3D – that question has been decided in favour of 3D a long time ago in our industry. Ships are 3D objects, and it is advantageous to model them from the very beginning in 3D.

But now the vision of COMPIT 2000 is becoming reality – we move from 3D CAD to 3D everything: scan, view, print, etc. For example in conceptual design, Florean *et al.* (CADMATIC) describe a standalone intelligent general arrangement tool for holistic basic design. This tool generates 3D hull structure layouts based on 2D sketches using a parametric approach with high topology. The result can be exported in an open standard format, for 3D hull definition process and approval.

In production, De Vries (Floorganise) presented automated detail planning using CAD/PLM-metadata for 4D visualisations. Here the CAD/CAM software meets the production planning software, where shipyard specific parameters, (machine) learned from having monitored the production process, are combined with the detailed design information, to derive planned automated sequencing, budget setting (hours/duration), resource allocation, as well as tracking actual building process. The assembly process is modelled and visualised in a 3D production facility (workshop) and simulated in time, leading to the 4D in the title. But not always, the planning is as nicely straightforward as in newbuilding projects.

IMO regulations for ballast water management and emissions to air have led to a multitude of retrofit projects in the past two years; and with current decarbonisation goals, we can safely assume that frequent retrofitting and upgrading will stay with us. A recurrent headache in these projects is that the ships nearly never are as they were once designed. And in some cases, detailed plans or 3D CAD models of engine rooms are not available at all. Or, in modern parlance, the digital twin is either out of date or doesn't exist at all.

Fortunately, there are efficient and affordable ways to recreate detailed 3D geometries now and bring this information into the commonly used maritime CAD world. BLOM Maritime and AVEVA presented some pioneering work in this field, exploiting digital point clouds [generated by BLOM's scanning] in [AVEVA's

CAD software] E3D Design. The icing on the cake is that the scan does not only yield 3D geometry information, but also photorealistic color and texture information. Similar scanning solutions are now being tested for underwater robotic inspection of ship hulls, e.g. for tracking the progress of fouling on hulls and propellers.

3D+ also applies to the world of XR, the new buzzword encompassing virtual reality and augmented reality. At the heart of any virtual reality (VR) application lies a 3D model which the users may explore and interact with. A key application of VR technology is training in the widest sense. Kil *et al.* (Korean Register) show, for example, a practical approach for ship familiarisation training based on VR using 360-degree imagery, where crew and passengers alike may explore a ship before setting foot on it. It is easy to imagine that such an application is particularly attractive for cruise ships and larger navy vessels.

But we should not forget the cost factor in setting up good VR applications, which has been prohibitively high for many potential maritime applications. The good news: costs are coming down, at least if you play it smart like Koelman *et al.* (NHL Stenden & AVEVA), exploiting easily available game engines in industrial and academic scenarios.

But there are more applications waiting in the wings. David Thomson (AVEVA) looked at how the latest trends in social VR and emerging metaverse protocols like webXR are enabling new ways of working, socialising and, most importantly, collaborating when we are no longer collocated. In Thomson's words, we see an emerging "digital superpower that can come in handy in the marine industry where shipbuilders regularly need to collaborate with equipment manufacturers, class societies, owners and subcontractors on complex three-dimensional challenges".

Combine and conquer

New technologies aren't always that new. Machine Learning used to be called numerical statistics, the digital twin is a reincarnation of simulation models. And the discussion whether we should use experience or first-principles, i.e. machine learning or digital twin, in our brave new IT world is also as old as the COMPIT conference.

In many cases, smart people do the smart thing – namely combining the two approaches to exploit their respective advantages. For example, Hildebrandt *et al.* (Numeca) use machine learning on CFD simulations to derive a propeller design tool that is 99% as accurate as several hours of CFD simulations, but gives the results in mere seconds.

But AI can do a lot more than 'just' machine learning. Robotics and machine vision are other powerful artificial intelligence techniques that are entering the maritime arena. Erik Stensrud (DNV) reported how drone inspections can be combined with image processing to identify cracks and corrosion in cargo holds, avoiding the need for expensive and time-consuming scaffolding in classification society work. Tani *et al.* (University Pisa) have a similar application for in-water robotic inspection for fouling, albeit at an earlier and less mature research state.

REGULAR *TNA* CONTRIBUTOR RODRIGO PEREZ PRESENTED ON SMART TECHNOLOGIES FOR IMPROVING DESIGN TOOLS ON BEHALF OF SIEMENS DIGITAL INDUSTRIES SOFTWARE

Connecting the dots may seem like child's play, until you have to do it yourself. The devil lurks in the details, also in maritime IT applications. We all have a lot of data and digital models, and we have the internet, even the Internet of Things (IoT). But when we take a closer look, there is a multitude of incompatible and often incomprehensible native (= company internal) data formats. "Having something in a digital format does not mean you can process it digitally in your world", as Herbert Koelman (SARC) points out.

But we are making progress in connecting the dots and the software solutions. One of the positive examples is the OCX standard facilitating 3D model exchange between designers (yards) and classification societies. A whole session is dedicated to it this year, highlighting success stories and limitations.

Smart is Green

Digitalisation and decarbonisation are the two megatrends in our industry, and sometimes they go hand in hand. The quest for decarbonisation often means entering terra incognita, both in design and operation. Our traditional experience-based approaches fail for radically new concepts. Fortunately, we can use the power of computer simulations to create virtual experience in many cases.

For example, Terün *et al.* (TU Delft) present a tool for assessing alternative fuel types for ultra-large container vessels in face of uncertainty. Stephan Procee (NHL Stenden) focusses on onboard decision support for (future) cargo ships with wind-assisted ship propulsion (WASP) systems, and Mikkelsen and Stochholm (University of Southern Denmark) present experience with supporting crew of inter-island ferries that were converted from conventional propulsion to battery-driven propulsion. ■

For further information about COMPIT please visit: http://compit.info

ENVIRONMENTAL REGULATIONS

MARPOL ANNEX VI AND ITS PARTICULARITIES IN THE APPLICATION ON SEAGOING VESSELS

By **J M Pernas Urrutia, PhD**, UDC, **R Villa Caro, PhD**, **R Pérez Fernández, PhD**, UPM and **J Pérez Martínez, MSc**, UPM

Among IMO regulations, the MARPOL Convention is concerned with preserving the marine environment by preventing pollution by oil and other harmful substances and minimising the accidental discharge of such substances. Its technical content is presented in annexes covering pollution of the sea by oil, from noxious liquid substances in bulk, to sewage and garbage from ships, as well as air pollution (IMO, 2021b).

Annex VI on air pollution control includes a series of rules covering different types of pollutants emitted by ships, differentiating between ODS ("Ozone Depleting Substances"), NOx ("Nitrogen Oxides"), SOx ("Sulphur Oxides") and PM ("Particulate Matter"), VOC ("Volatile Organic Compounds") and products associated with shipboard incineration.

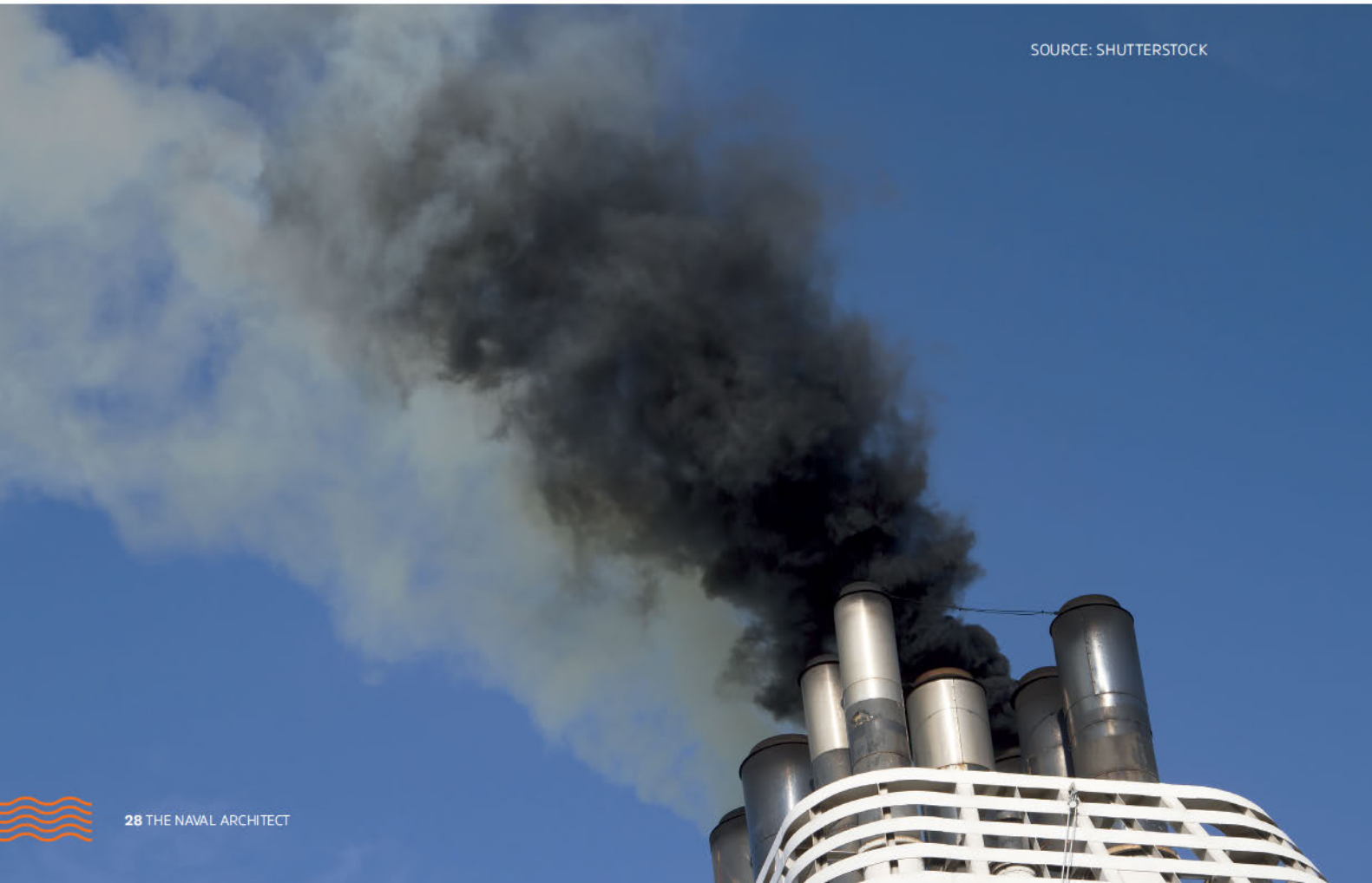
In addition to the MARPOL Convention, classification societies within the IACS have additional standards to comply with the MARPOL Convention, both for civil and military ships. In this respect, the class societies have for many years ensured the full implementation of all applicable IMO standards, including those contained in both SOLAS and MARPOL Conventions.

MARPOL 73/78 Convention

The MARPOL Convention is concerned with the protection of the marine environment by preventing pollution by oil and other harmful substances, and minimising the accidental discharge of such substances (IMO, 2021b). Its technical content is presented in six annexes, the first five of which have been adopted by the 1973 Convention, amended by a 1978 Protocol (MARPOL 73/78).

While the MARPOL Convention was adopted on 2 November 1973, the 1978 Protocol was adopted in response to the considerable number of tanker accidents occurring between 1976 and 1977. As MARPOL 1973 had not yet entered into force, the 1978 Protocol effectively incorporated the original Convention. The new Convention entered into force on 2 October 1983.

Over the years, the MARPOL Convention has undergone numerous updates through the incorporation of numerous



SOURCE: SHUTTERSTOCK

amendments. Although it is mandatory for any ship flying the flag of one of its States Parties, it does not derogate the sovereign rights of the signatory states to the Convention over their waters, notwithstanding voluntary compliance with MARPOL for warships of the States Parties.

In 1997, a new Annex VI was added which entered into force on 19 May 2005: 'Regulations for the Prevention of Air Pollution from Ships'. It establishes limits for SOx and NOx emissions from ships' exhausts, while deliberate emissions of ODS and VOC are prohibited. For ECA areas (SECA and NECA), stricter emission standards were set for SOx, NOx and PM. From 2011, technical and operational mandatory energy efficiency measures aimed at reducing greenhouse gas emissions from ships were introduced.

MARPOL Annex VI on emission control

In contrast to pollution from oil spills, bulk pollutants, etc., air pollution from ships causes a cumulative effect resulting in widespread air quality degradation mainly in coastal populations.

Annex VI restricts the main air pollutants contained in exhaust gases from ships' internal combustion engines, mainly SOx and NOx. It also bans the deliberate emission of ODS, regulates the incineration of products aboard ships and restricts VOC emissions.

Following its entry into force, it was agreed by Resolution MEPC.129(53) of 22 July 2005 to revise Annex VI and the NOx Technical Code (NTC) Consequently, amendments MEPC.176(58) and MEPC.177(58) of 10 October 2008 revised both Annex VI and the 1997 NTC, which entered into force on 1 July 2010 (MEPC, 2005), (MEPC, 2008a), (MEPC, 2008b).

Overall, the main changes to Annex VI introduced by Resolutions MEPC.176(58) and MEPC.177(58) have been the global phase-out of SOx and NOx emissions and ECA zones' introduction further reduce emissions of these air pollutants in specific sea areas. It was also the first time that emissions of PM were addressed. Regarding the type of pollutants emitted into the air, Annex VI includes the following provisions (IMO, 2021b):

- Regulation 12. - ODS, deliberate release is prohibited. Installations with ozone-depleting substances are banned on ships built or equipment delivered after 19 April 2005.
- Regulation 13. - NOx, applicable to any marine diesel engine with a power output of more than 130kW (except emergency engines). Three Tier levels are defined.
- Regulation 14. - SOx and PM, defines the maximum permissible sulphur content in fuel oil.
- Regulation 15. - VOC, only applicable to tankers and gas carriers where the cargo loading and containment systems allows the safe retention on board of VOCs not containing methane or the safe return of VOCs to shore.
- Regulation 16. - Shipboard incineration. It defines the operating limits for incinerators, as well as the substances prohibited from being incinerated.

Regulation 13 of Annex VI on emission control of NOx

Following the resolutions which entered into force on 1 July 2010, amendments to Annex VI affecting NOx emission control for marine diesel engines include a three-tier structure for new engines, which establishes allowable emission levels depending on the engine's installation date.

It also establishes controls on existing engines where there is a procedure for approval certified by the certifying Administration sanctioned by IMO. The Tier structure includes progressive reductions in NOx emissions from marine diesel engines, with a Tier II emission limit for engines installed in a ship built on or after 1 January 2011, as well as a more stringent Tier III emission limit for engines installed in a ship built on or after 1 January 2016 operating in ECA areas (see Table 1).

Marine diesel engines installed in a ship built on or after 1 January 1990, but before 1 January 2000, are required to comply with Tier I emission limits if an Administration has certified an approved procedure for that engine. Accordingly, Resolution MEPC.251(66) of 4 April 2014 incorporates amendments to Regulation 13 of Annex VI regarding, among other issues, the date of entry into force of the Tier III rules (MEPC, 2014a).

These amendments provide for the application of the Tier III standard to marine diesel engines installed on ships, built on or after 1 January 2016, which operate in both present and future ECA areas. Marine diesel engines installed in vessels built before 1 January 2021 of less than 500GT, of 24m in length and over, which are specifically designed and used for recreational purposes only, are excluded from Tier III requirements.

Furthermore, upon entry into force of Annex VI, all marine diesel engines to which Regulation 13 of that Annex applied were obliged to comply with the provisions of the NTC. During MEPC 53 in July 2005, it

Tier	Date	NOx limits (g/kWh)		
		n < 130	130 ≤ n < 2000	n ≥ 2000
Tier I	2000	17.0	$45 \cdot n^{-0.2}$	9.8
Tier II	2011	14.4	$44 \cdot n^{-0.23}$	7.7
Tier III	2016*	3.4	$9 \cdot n^{-0.2}$	1.96
*In Emission Control Areas (Tier II standards apply outside ECAs)				

TABLE 1: NEW NOx LIMIT REQUIREMENTS. SOURCE: IMO, 2021B.

was agreed that the 1997 NTC would be subject to a revision. This revision was carried out during MEPC 58, by Resolution MEPC.177(58) of 10 October 2008 and entered into force on 1 July 2010 (MEPC, 2008b).

The current NTC is intended to provide mandatory testing, survey and certification procedures for marine diesel engines that will enable engine manufacturers, shipowners and administrations to be confident that all marine diesel engines are compliant with the NOx emission limits specified in Regulation 13 of Annex VI.

The Code encourages Administrations to test the emissions produced by marine propulsion and auxiliary diesel engines on a test rig, where accurate tests can be carried out under controlled conditions. Establishing compliance with the requirements of Regulation 13 of Annex VI at this early stage is one of the essential features of the NTC.

Any subsequent testing onboard the ship will inevitably be limited in scope and accuracy, and the purpose of such testing will be to infer or deduce the emission performance of the engine.

Regulation 14 of Annex VI on emission control of SOx

Following the entry into force of Annex VI, and after the amendments made in accordance with Resolutions MEPC.176(58) and MEPC.177(58), this Annex was further revised in accordance with Resolution MEPC.280(70), which entered into force 1 January 2020 (MEPC, 2016).

The new amendments to Annex VI contained in Resolution MEPC.280(70) include the progressive reduction of SOx emissions from ships based on the overall reduction of sulphur content in fuel oil. These also include the reduction of sulphur content in fuel oil for ships operating in ECA areas.

With these new amendments to Annex VI, the global limit for sulphur in fuel oil was reduced from 3.5% m/m on 1 January 2012 to the current 0.5% m/m (from 1 January 2020), while in ECA areas it was reduced from 1% m/m on 1 March 2010 to the current 0.10% m/m (from 1 March 2015).

With regard to SOx emission control areas, although in Annex VI they were known as SECA areas, after revision by Resolutions MEPC.176(58) and MEPC.177(58), the new concept of ECA emission control areas was introduced (Table 2). Those can be designated to control SOx, PM, NOx, or all three types of emissions. In other words, an ECA emission control area may be defined as one that regulates SOx/PM emissions, commonly known as a SOx-ECA area, one that regulates NOx emissions, commonly known as a NOX-ECA area, or one that regulates SOx/PM and NOx emissions, known as ECA areas since the revised Annex VI (MEPC, 2008a), (MEPC, 2008b), (MEPC, 2008a), (MEPC, 2008b).

On this subject, Resolution MEPC.320(74) of 17 May 2019, which comes into force on 1 January 2020, sets out guidelines to Administrations, States, shipowners, shipbuilders, and suppliers of petroleum products to ensure implementation of the 0.50% m/m limit by 1 January 2020 (MEPC, 2019).

Recently, ISO has published a new standard to comply with current regulations regarding the maximum sulphur content for marine fuel oils. Entitled 'Considerations for fuel suppliers and users regarding marine fuel quality in view of the implementation of maximum 0.50% sulphur in 2020', this new standard is not a revision of ISO 8217:2017, but a guide for application to the new regulatory fuel types (ISO, 2019).

The new sulphur ceilings have forced oil product suppliers to develop new types of fuel oils, called VLSFO for sulphur content ≤ 0.50% m/m and ULSFO for sulphur content ≤ 0.10% m/m, to comply with the current IMO MARPOL regulations.

In addition to limiting the sulphur content in the fuel, SOx emissions into the atmosphere can also be controlled by alternative methods, such as exhaust gas cleaning. For this purpose, Resolution MEPC.259(68) of 15 May 2015 introduces the document entitled 'Guidelines for Exhaust Gas Cleaning Systems' (superseded by Resolution MEPC.340(77) of 26 November 2021). The aim of these guidelines is to specify the requirements for the testing, certification and verification of Exhaust Gas Cleaning Systems (EGCS) in accordance with Rule 4 of Annex VI.

These guidelines allow for two strategies: an 'A-strategy', with unit certification based on parameter and emission controls, and a 'B-strategy', based on emission monitoring and real-time parameter control. In the case of ships intending to use an EGCS to comply with Annex VI 14.1

Global sulphur cap		
Effective date	**Old sulphur limit**	**New sulphur limit**
1 January 2012	4.5% m/m	3.5% m/m
1 January 2020	3.5% m/m	0.50% m/m
ECA sulphur cap		
Effective date	**Old sulphur limit**	**New sulphur limit**
1 March 2010	1.5% m/m	1% m/m
1 March 2015	1% m/m	0.10% m/m

TABLE 2: SULPHUR LIMIT REQUIREMENTS. SOURCE: IMO, 2021B

and/or 14.4, they must be in possession of an approved SOX Emissions Compliance Plan. To this end, EGCS type cleaning units can be approved subject to a periodic parameter and emission controls or with continuous emission monitoring systems, which need to be objective and performance-oriented.

Annex VI and Classification Societies

Classification Societies, as Recognised Organisations, have additional class ratings to comply with the MARPOL Convention, both for civil and naval vessels, and to be able to issue the corresponding statutory certification of MARPOL compliance. For example, among the Bureau Veritas (BV) notations for both general ships (Pt. F, Ch. 9, Sec. 2) and warships (Pt. E, Ch. 7, Sec. 2), the CLEANSHIP notation certifies compliance with the MARPOL Convention and, specifically, with Annex VI as from compliance with the following ((BV, 2021), (BV, 2020):

- Emission of NOx, Regulation 13 of Annex VI and NTC for the control of NOX emissions from marine diesel engines (MEPC, 2008a), (MEPC, 2008b).
- Emission of SOx and PM from Regulation 14, 18 and Appendix V and VI (fuel oil quality) of Annex VI and the guidance for fuel oil sampling according to Annex VI (MEPC, 2009d).
- Use of BV-approved incinerators that have been designed and constructed according to the following requirements:
  - Standard Specification for Shipboard Incinerators MEPC.76(40), as amended by Standard Specification for Shipboard Incinerators MEPC.93(45) (MEPC, 1997), (MEPC, 2000).
  - Appendix IV of Annex VI.

For the use of NOx reduction methods, such as water injection, air humidification and exhaust after-treatment, these must be BV approved. SOx reduction EGCS scrubbing systems can be used as an alternative to the use of low sulphur fuels according to Regulation 4 of Annex VI, following MEPC Resolution MEPC.184(59) of 17 July 2009 (MEPC, 2009a).

NOx control systems

NOx emission control of marine diesel engines is achieved through compliance with recognition and certification requirements leading to the issuance of the Engine International Air Pollution Prevention (EIAPP) certificate and subsequent in-service demonstration of compliance in accordance with the mandatory requirements from Regulations 13.8 and 5.3.2 of Annex VI and NTC 2008 (MEPC Resolution MEPC.177. (58), as amended by Resolution MEPC.251.(66)) for Tier II and III emission levels (MEPC, 2008b), (MEPC, 2014a).

As for Tier I emission level, most existing Tier I engines have been certified with the 1997 version of the NTC. Since 1 January 2011, all marine diesel engines are certified according to Tier II and III depending on whether the navigation areas are ECA zones or not. Therefore, certificates issued under the 1997 NTC will remain valid for the lifetime of the engine.

While SOx emission control can be achieved by limiting the sulphur concentration in the fuel oil, NOx emission control is not possible by improving the quality of the fuel oil. The precursors of NOX formation during the combustion process are nitrogen (N_2) and oxygen (O_2), which make for 99% of the engine intake air. O_2 is consumed during the combustion process, with the amount of excess O_2 depending on the air/fuel ratio of the engine. N_2 remains largely non-reactive during the combustion process, except for a small percentage that will oxidise to form nitrogen oxides, consisting of nitric oxide (NO) and nitrogen dioxide (NO_2).

NOx formation is dependent on the exposure of N_2 and excess O_2 to the high temperatures associated with diesel engine combustion, so the higher the combustion temperature (high peak pressure, high compression ratio, and high fuel delivery rate), the greater the amount of NOx formation. The efficiency of a diesel engine depends on the pressures and temperatures reached during the combustion cycle, so as these increase, the efficiency of the cycle increases. NOx emissions also show a direct relationship with the temperature reached in the cycle, so that as pressures and temperatures increase, so does the emission level.

Therefore, what is advantageous from an engine's thermal efficiency point of view, becomes an environmental disadvantage. This is the reason why a low-speed diesel engine (higher efficiency) is more prone to generate a greater amount of NOx than a high-speed engine (lower efficiency). While Tier I and II emission levels are achievable through combustion optimisation processes, to achieve Tier III (required for ECA navigation), other types of emission control technologies are required. The most widely used, Selective Catalytic Reduction (SCR) technology, is the only technology capable of achieving NOx Tier III compliance across all engine types.

SCR technology works by combining ammonia (NH_3), usually from an aqueous urea solution, with a ceramic monolith catalyst to reduce NOx by producing nitrogen (N_2) and water (H_2O). The latest generation SCR technology can reduce NOx emissions by more than 90% under certain conditions, allowing NOx control with little to no penalty in fuel consumption, as it is possible to tune the engine for maximum fuel efficiency and adjust the operation of the SCR.

A drawback of SCR technology is the risk of ammonia appearing in the exhaust system at varying engine loads. This is addressed by real-time regulation of the urea dosage according to the NOx concentration downstream of the SCR catalyst while maintaining the molar ratio of ammonia to NOx so that it does not exceed 1.0. Moreover, the exhaust gas temperature in diesel engines downstream of the turbocharger turbine varies from 300°C to 400°C, which is a temperature range sufficient to obtain the necessary energy to enable the SCR reaction.

IMO regulations in force on the use of onboard SCR systems must be in accordance with Resolution MEPC.291(71) of 7 July 2017, as amended by Resolution MEPC.313(74) of 17 May 2019 (MEPC, 2017), (MEPC, 2019a).

Conclusions

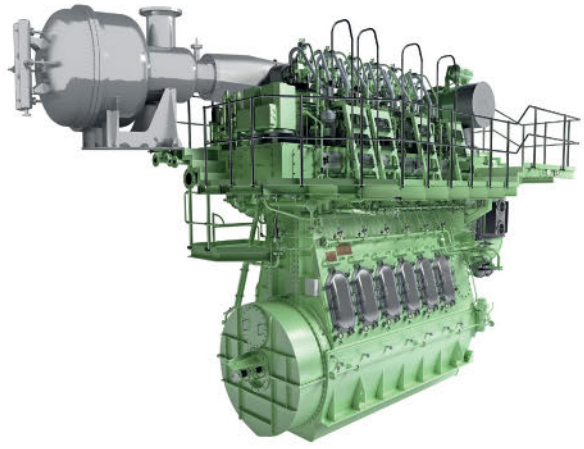
Under IMO regulations, the MARPOL Convention is concerned with protecting the marine environment

through pollution prevention. Annex VI of the convention deals with emission control, including pollutants such as ODS, NOx, SOx, PM, VOC, and products from the incineration of substances onboard ships. Resolution MEPC.129(53) provided for the revision of both Annex VI and the NTC, following the publication of amendments MEPC.176(58) and MEPC.177(58). The main changes introduced include the progressive reduction of NOx, SOx, PM emissions and the establishment of ECA zones.

For the control of NOX emissions from marine diesel engines, the amendments to Annex VI include the Tier emission level structure based on progressive emission reductions. Regulation MEPC.280(70) revises Annex VI on SOx emissions control, including a progressive reduction starting with the limitation of sulphur content in fuel oil. Furthermore, it introduces the new concept of an ECA zone for the control of SOx, PM, NOx emissions or all three types of emissions combined. Resolution MEPC.320(74) established guidelines to guarantee the implementation for sulphur content of the 0.50% m/m limit under Annex VI from 1 January 2020. SCR technology is the most widely used NOx emission control process, achieving more than 90% reduction, and is the only technology capable of achieving Tier III emissions compliance regardless of the engine and with minimal fuel consumption (performance) penalties.

At MEPC 78, held in June 2022, it was approved a proposal to designate the entire Mediterranean Sea as a SECA area, which means that ships will have to comply with stricter controls on SOx and PM emissions from 2025 onwards. The MEPC also approved proposals to amend MARPOL Annex V, pending adoption at MEPC 79, which will designate the Mediterranean Sea as a SECA area. The amendment could enter into force in mid-2024, and the new restrictions would come into force from 2025.

Additionally, during MEPC 78 guidelines on EGCS systems were approved and, more specifically, the circular for the assessment of the risk and impact of discharge water from exhaust gas cleaning systems and the circular on guidance on the delivery of EGCS waste to port reception facilities, in order to ensure the proper management and disposal of EGCS waste in port reception facilities. ■



MAN TWO-STROKE ENGINE FITTED WITH SCR

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Editor's note

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