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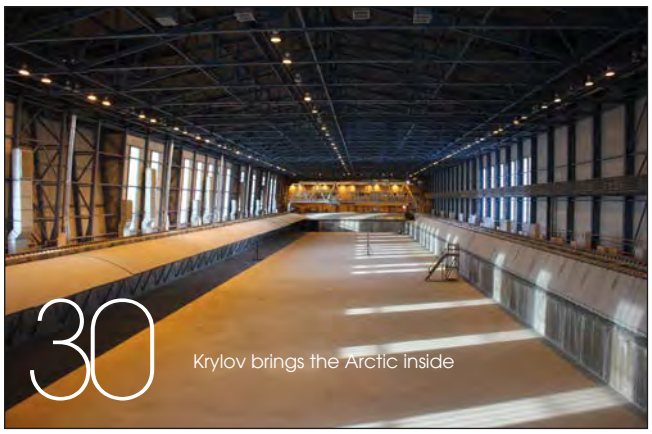

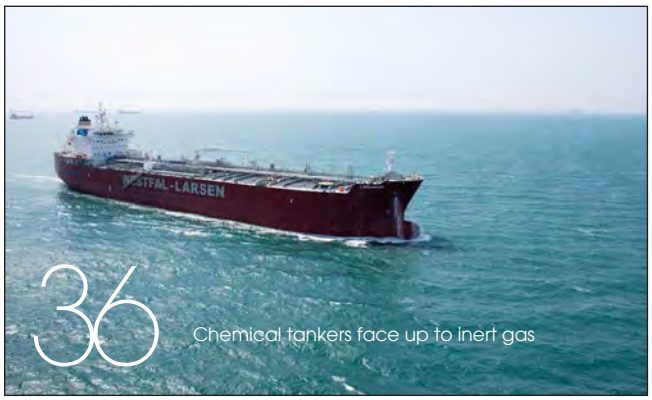

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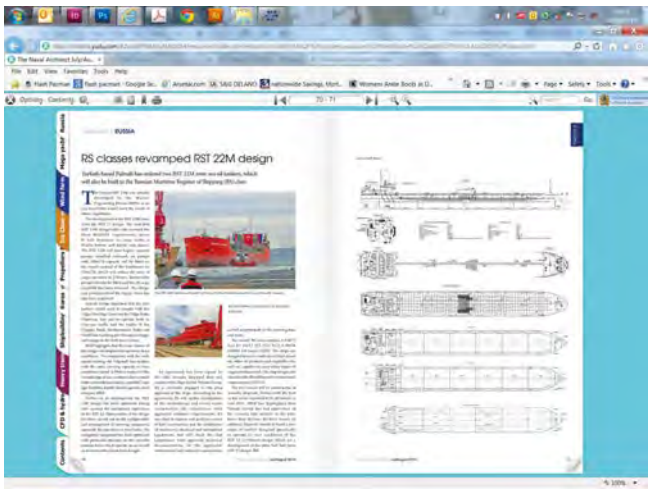

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GHG challenge provides new impetus to MEPC

IMO Secretary-General Kitack Lim addressing delegates at MEPC 73

Having caught the mainstream headlines with its target of cutting greenhouse gas (GHG) emissions by 50% by 2050 back in April, the follow-up meeting of IMO's Marine Environment Protection Committee (MEPC) was never likely to be quite so dramatic. However, there was a certain sense of anticipation about how achieving these goals may begin to influence overall strategy at MEPC 73.

It was stated in April that a strengthening of the existing requirements for the Energy Efficiency Design Index (EEDI) would form part of that strategy. Nonetheless, it was something of a surprise the Committee is already proposing that for some ship types – namely container ships, gas carriers, refrigerated cargo ships, combination carriers, LNG carriers and cruise ships – the implementation date for EEDI Phase 3 be brought forward to 1 January 2022, three years earlier than planned.

The value or otherwise of the EEDI has of course been a point of contention for some time, with a study published by CE Delft in 2017 concluding vessels built in 2016 (when new ships were expected to start achieve efficiency within the Phase 1) were on average less efficient than those of the preceding year, while also concluding others vessels (14% of bulkers, 52% of container ships, 23% of tankers, 21% of gas carriers) were already well within the Phase 3 baseline. Moreover, it was also mooted that the Phase 3 baselines for container ships could be increased to 40% more efficient than the 2008 reference. The proposed amendments will be discussed further at MEPC 74 in May 2019.

What's implicit in this is that shipping has set the bar too low when it comes to efficiency requirements and while frontrunners have taken it upon their own initiative to extend the boundaries of what's achievable, it's been the carrot of cost savings rather than the prodding of a regulatory stick that's encouraged them. The difficulty remains that in certain sectors laggards continue to dictate the pace of technical development; the Committee also listened to concerns that bulk carriers and tankers would be unable to meet the 2025 targets, let alone see them brought forward. Market pressures are in part to blame for this, of course, but so is the failure of shipowners to invest in newer technologies when times were more profitable.

The GHG strategy itself will be subject to a plan of follow-up actions with a variety of short-, mid- and long-term measures of which some are already underway. It will also consider the impact of any measures on the States, factoring in their geographical locations and socio-economic status. It's encouraging that IMO is keen to foster more technical co-operation between developing nations and those with developed economies although it's unclear what form this may take at this stage. Among the early measures mooted are optimal routing and speed optimisation (i.e. slow steaming, and just-in-time arrival at port), presumably looking at passing into regulation what savvier ship operators may be doing already.

In addition to scrubbers, seemingly the gift that keeps on giving when it comes to MEPC debate (see News Analysis, p12), the Committee also considered the issue of marine plastic litter from ships, with the resolution for an action plan to prevent its occurrence, including both larger plastic rubbish and microplastics (particles 5mm or less in size). The action plan is particularly focused on fishing vessels, but also includes the development of a long overdue mandatory system for the reporting loss of containers at sea. Meanwhile, a correspondence group will discuss the best approach for an official IMO study of the plastic problem.

Another subject was electronic record books, in lieu of paper records. The Committee has approved in principle their use for a number of MARPOL-required documents, including the oil and cargo record books. Again, formal adoption is expected to follow in April, with entry into force in January 2021, but you can read about one digital log book solution, created by Cypriot company Prevention at Sea, on p45-46.

That article begins by reflecting how the winds of change are hitting the shipping and that includes both RINA and the maritime media. A few weeks ago it was announced that one of the industry's oldest dedicated magazines, *Fairplay*, is to cease publication in December. My personal best wishes to go to journalist colleagues affected by the news along with my hope that their talents won't be entirely lost to shipping.

Finally, I'd like to draw readers' attention to RINA's just-launched eNewsletter App, a free-to-use platform for curated content from *The Naval Architect* and our sister titles *Shiprepair & Maintenance*, *Ship & Boat International*, *Warship Technology* and *Offshore Marine Technology*. To download, visit either the App Store (for iPhone users) or the Google Play Store (for Android devices) and search for 'RINA eNewsletter'. *NA*

Tankers

Kairos to secure Baltic LNG bunker supply

The world's largest LNG bunker vessel departed South Korea last month, making its way to the Baltic Sea where it will secure the supply of LNG as a marine fuel.

Kairos, which is owned by Babcock Schulte Energy and will be operated on a time charter basis by a joint venture between Nauticor and Klaipėdos nafta, was built by Hyundai Mipo Dockyard starting February this year. The 171m vessel has an LNG capacity of 7,500m^3, making it the largest of its type.

It is of a 'ballast-free' design, exempting it from installing a ballast-water treatment system, and features a compressed natural system (CNG) system which will utilise boil-off gas from the cargo tanks as fuel. The vessel is classed by Lloyd's Register, achieving notations certifying the use of methanol in the type C tanks and a minimum cargo temperature of -165°C, as well as Finnish-Swedish Ice Class 1A. These features have led to *Kairos* being selected for RINA's *Significant Ships of 2018*.

LNG uptake has been tempered by concerns over a reliable bunker supply. As such, *Kairos*' arrival in the Baltic is set to provide a significant boost for LNG-fuelled shipping in Europe. The fuel is seen as an attractive option for operators seeking to comply with the 2020 sulphur cap and Emission Control Area rules.

Kairos will initially be stationed in the Port of Klaipėda in Lithuania. The CEO of minority chartering partner Klaipėdos nafta, Mindaugas Jusius, comments: "The main advantage and ambition of the new vessel is to ensure more competitive pricing for the LNG reloading station users. It will not only reduce the cost of the LNG supply chain, but will also ensure the smooth and reliable service to distribution station users in Klaipėda."

Kairos will feature in RINA's *Significant Ships of 2018*, to be published early next year

Emissions control

ClassNK updates MRV Portal to support IMO DCS

Japanese classification ClassNK has updated its MRV Portal – originally launched in 2017 to aid shipowners with EU MRV (monitoring, reporting, verification) regulations – to reflect the upcoming global IMO DCS (Data Collection System) requirements, which apply from the 1 January 2019.

EU MRV entered into force on 1 July 2015, mandating shipowners with vessels larger than 5,000gt calling at EU, Norwegian and Icelandic ports to monitor, report and verify their CO_2 emissions. Verification is undertaken by third parties such as class societies, with the data ultimately sent to the European Maritime Safety Agency. 2018 marked the first reporting period.

IMO DCS is essentially an extension of EU MRV, applying to ships of the same size trading globally. Under IMO DCS, vessels must use a Ship Energy Efficiency Management Plan (SEEMP) and create a yearly fuel consumption report for submission to either a flag state of class society. The reporting period for IMO DCS begins on 1 January 2019.

ClassNK's newly updated MRV Portal (IMO DCS) allows vessels to send data, shore-side offices to manage this data, and submit the annual fuel consumption report. The platform can also connect with external logbook software. Existing users of ClassNK Portal do not need to re-register for use to comply with IMO DCS.

Chemical tankers

ABS unveils new support tools for chemical tankers

ABS has launched new guidance and software platform to allow owners and operators of chemical tankers to check the chemicals they may plan to carry.

Chemicals are often known under different names or brand names, which can cause particular problems when new products are launched. Differing safety requirements in terms of monitoring, temperature control mean that operators must consult with their classification societies to obtain an addendum to a ship's Certificate of Fitness before they are allowed to carry a new chemical.

In response ABS, which has the largest chemical tanker fleet among the class societies, has unveiled ABS CHEM, a version of software used by its engineering department which cross references ship characteristics with the storage requirements for a particular cargo. The tool gives operators an

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at-a-glance view of carriage permissions. While they will still need formal verification by the class society before departure, it will allow them to proceed with scheduling and loading of cargo with confidence.

In addition, ABS has also published its *Guide for Materials and Welding for Stainless Steels*, which provides information on the requirements for the properties, manufacturing processes and fabrication techniques. ABS says the new guidance is particularly applicable to the stainless steel tanks used on chemical tankers.

For a demo of the ABS CHEM tool, or to download the guide visit ABS's website at: www.eagle.org

Bulk carriers

Project Forward concept design meets IMO CO_2 target

An industry project has proven that it will be possible to meet the IMO target for a 40% reduction in carbon intensity by 2020 after putting their LNG-fuelled concept design through model tests.

Project Forward – also known as Forward Ships – is a joint development project founded in 2013 by Arista Shipping, which counts Wärtsilä, ABS and Shell amongst its partners. The initiative aims to develop a merchant ship design that is much more environmentally friendly than conventional vessels, but offers low OPEX and CAPEX.

The resulting concept design (see *The Naval Architect* June 2017) features an optimised hull courtesy of partner Deltamarin, two efficient LNG-fuelled Wärtsilä 31DF engines without auxiliary gensets, and a GTT-supplied LNG membrane containment system. Following model tests, it has been confirmed that these features situate the vessel below EEDI Phase III, and would allow shipping to meet the IMO's carbon intensity targets.

The multi-company Project Forward initiative has been running since 2013

Project Forward's concept design is further stated to enable the achievement of the IMO's longer-term goal of reducing CO_2 emissions per transport work by up to 70% by 2050. This would require the use of carbon neutral fuels mixed with LNG on the vessel, but would avoid the oft-mooted prospect of speed reductions, which would have a 'serious impact on the chain of logistics', says the partners.

In April this year Forward Maritime Group, an affiliate of Arista Group, penned a deal with Jiangsu Yangzijiang Shipbuilding that will see 20 bulkers of the 'Forward Bulker 84-LNG' design delivered between 2020 and 2023. It is planned for the vessels to trade under the Forward Ships brand.

Smart ships

Intel and Rolls-Royce to design systems for smart shipping

Technology companies Rolls-Royce and Intel announced in mid-October that they intend to collaborate to design 'intelligent shipping systems that will make commercial shipping safer.' In particular, it is hoped that these systems will contribute to the safe operation of autonomous vessels, and enable a higher degree of automation on existing ships.

The pair plans to adopt technology associated with smart cities, drones and self-driving cars, applying it in a shipping context. This technology places an emphasis on connectedness, leveraging the operational insights to be gained from data and artificial intelligence. Tasks expected to be improved with the new systems include independent navigation, obstacle detection and communications.

An array of Intel programmes will be utilised in the project, such as Intel Xeon Scalable Processors to manage the modelling of ship functions and ultimately apply learning models to allow for autonomous operations; Intel Field Programmable Gate Array (FPGA) technology, to solve design challenges surrounding intelligent shipping via a flexible platform for operations such as obstacle detection; and Intel memory and storage products, including Intel Optane DC Persistent Memory, which will support the reliability and responsiveness of ship intelligence systems.

Speaking on the agreement, Rolls Royce's director of ship intelligence, Kevin Daffey, said: "We're delighted to sign this agreement with Intel, and look forward to working together on developing exciting new technologies and products, which will play a big part in enabling the safe operation of autonomous ships. Together, we'll blend the best of the best, Intel and Rolls-Royce, to change the world of shipping." *NA*

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Taking sides in the scrubber debate

An expedient solution or short-term panic buying? Despite a late surge in orders the jury is still out, writes Malcolm Latarche

In advance of almost every one of the IMO's major committee meetings, a variety of announcements are made by various organisations setting out positions in support of or against anticipated regulation. The run up to MEPC 73 has been no exception and if anything the tone of some of the announcements – even those coming from inside the industry – has been quite belligerent. This is particularly true of the debate around the 2020 global sulphur cap.

The options open to ship operators for meeting the requirements are well known having been discussed almost continually in the two years since the IMO decided to adopt the findings of the CE Delft report that there would be sufficient compliant fuel available in 2020 rather than 2025. Every shipowner is free to make their own choice but the option of using scrubbers seem to be polarising opinion far more than might have been expected.

For a long time, scrubber manufacturers looked to have missed the boat as take up was at quite low levels but a surge throughout this year and the last few months in particular has seen even some of the most vocal opponents rethinking their positions. Back in April, a report by Drewry suggested that owners were shunning scrubbers and only 2,000 ships were likely to have them fitted by 2020. Over the last six months that has changed and in a webinar in the week before MEPC 73 was due to begin, DNV GL said that around 1,850 ships were now confirmed as having scrubbers either fitted or on order with 1,000 orders having been made in the last six months.

There has been hostility towards the idea of scrubbers going back over a decade but since the IMO took the decision to allow them and has guidelines on their use and wash water standards, the argument should have been resolved long ago. At the end of September, Intertanko's technical director Dragos Rauta was quoted as saying that scrubbers do not have a future beyond 10 years because of problems with acidity.

More recently the Union of Greek Shipowners have taken an even more hostile stance. Speaking at the Marine Money Forum and in a later press release, UGS president Theodore Veniamis was of the opinion that only the use of compliant fuels should be allowed. "It's obvious to everybody the use of scrubbers is only a short-term option, driven by clear fast-profit motives, and against the IMO's main target and the industry's environmental commitment," said Veniamis.

The UGS sees scrubbers as undermining the level playing field so beloved of shipping organisations, but with tankers and many Greek-owned ships of all types being among those that are being fitted with scrubbers, it would seem that some members of both organisations do not share the opinions being expressed on their behalf.

The animosity against scrubbers has a foil in a new organisation that has been founded by a conglomerate of shipowners interested in using them to meet the 2020 rules. The Clean Shipping Alliance 2020 (CSA2020) was formed at the end of September with a mission to provide information and research data to better inform industry, national and international authorities, NGOs and the public on the environmental performance and benefits of open- and closed-loop scrubbers and associated air and water emissions. By mid-October the number of members had increased to 25.

In the week before MEPC 73, CSA2020 released a paper addressing ten of the main concerns and criticisms of scrubber use. The arguments used in the paper contain nothing that has not been said before but in almost every case, the points made were backed up by references to peer reviewed and published scientific papers. Among the points covered were the negligible amount of sulphates that will be released into the sea from scrubber equipped ships, the additional pollutants removed from exhaust streams and the limited acidification effect.

There is a growing consensus among industry observers that low-sulphur fuels are likely to be considerably more expensive than perhaps may have been the case three years ago when oil prices were at their lowest. That makes scrubbers with a payback period of around 20 months or less a way of owners gaining a considerable competitive advantage – more so because finance, either from banks or scrubber makers, seems to have become easier to obtain.

MEPC 73 is not planning to ban scrubbers and it is highly unlikely that the IMO will do so in the future either. The longevity of scrubbers will ultimately depend upon fuel prices and availability of both high- and low-sulphur types of fuel.

These considerations are likely to be the biggest cause of debate through to 2020 with demand for an experience building phase immediately after 1 January 2020 growing. At the moment those in favour of the idea are holding back from demanding a delay to the commencement date but are asking for recognition that supplies of fuels – especially at ports away from the main bunkering centres – are likely to be variable, with compliant fuel not always available. *NA*

LNG tanks

GTT's LNG Brick to be built by Dongsung Finetec

French LNG containment system manufacturer GTT and Korean thermal insulation expert Dongsung Finetec signed a memorandum agreement last month that will see GTT's nascent LNG Brick technology built by the Korean company.

The LNG Brick is a compact LNG fuel tank with a capacity of between 1,000 and 3,000m^3, intended to be an easy-to-install solution for newbuilds and existing vessels opting for the alternative fuel. The unit features GTT's Mark III membrane system, a cryogenic liner integrated with the vessel's inner hull. It is further stated to enable simple management of boil-off-gas for small volumes, owing to the higher-than-average pressure inside the tank.

Dongsung Finetec was previously tasked by the French company to create a prototype for the LNG Brick, which was satisfactorily tested in March. The new memorandum of understanding, signed at the France-Korea Business Leaders Summit, focuses on the construction and commercialisation of the tank, and its promotion to commercial vessels such as bulk carriers and pure car and truck carriers.

GTT CEO Philippe Berterottière said at the summit: "It is a great occasion for GTT to contribute to the development of LNG as marine fuel and we are delighted to do it in partnership with Dongsung Finetec with whom we have been collaborating for numerous years on the LNGC market."

gtt.fr / dsfinetec.co.kr

Exhaust gas recirculation

New EGR blower from MAN Energy Solutions

Engine and turbomachinery manufacturer MAN Energy Solutions – formerly MAN Diesel & Turbo – has brought to market a new exhaust gas recirculation (EGR) electrical turbo blower, dubbed the ETB40.

The unit overcomes the pressure difference between exhaust gas and the scavenging air receiver by raising exhaust gas pressure, achieved by actively controlling the flow of exhaust gas. MAN's EGR systems aid vessels in meeting IMO Tier III compliance, with the ETB40 ensuring optimal performance of the technology. The effectiveness of the new blower is put down to its high level of thermodynamic efficiency, realised with the expertise MAN has gained across its turbocharger range.

MAN launched the ETB40 at a ceremony in Shanghai last month, hosted by two-stroke licensee CSSC-MES Diesel Co (CMD). The event also saw the Chinese company place the first order for the unit as part of the construction of a number of MAN B&W two-stroke 7G60ME-C9.5 main engines.

Commenting on the launch, MAN Energy Solutions' head of exhaust gas systems sales, Ralph Klaunig, said: "Our development of the ETB series is a strategic decision and a significant addition to our existing, proven EGR technology that will play an important role in maintaining IMO Tier III emission standards. This will enable customers to achieve sustainable value creation in the transition towards a carbon-neutral future."

man-es.com

Simulators

Warsash opts for Wärtsilä simulators

The Warsash Maritime Academy, which is set to open the UK's largest marine simulation training centre early next year, has ordered a full range of Wärtsilä marine simulators developed by subsidiary Transas.

Wärtsilä will provide bridge, engine room, crane operation, liquid cargo handling and GMDSS simulators. These will open up training opportunities utilising real-time vessel and shoreside data, supported by decision support and analysis functionalities.

Warsash's Dean of Maritime, Science and Engineering, Syamantak Bhattacharya, said of the contract: "The simulation centre will be a central pillar of our maritime education, training and research programme. We are very pleased to be able to call on the global experience and extensive industry know-how of Wärtsilä in making this project a success."

Part of Southampton Solent University, Warsash has been established since 1902 and offers both degrees and training programmes for mariners. The new facility is set to enhance the college's training capabilities by giving students access to the latest digital technology.

warsashacademy.co.uk / wartsila.com

Syamantak Bhattacharya (right) with Warsash colleagues and Wärtsilä area sales manager Alex Ponomarev (second left) at a bridge simulator

Water monitoring

Rivertrace launch smart water in oil sensor

UK-based water monitoring specialist Rivertrace has launched a 'smart' water in oil sensor that monitors lubricating and hydraulic oil's dissolved water content to lower the risk of engine and machinery corrosion.

The sensor utilises capacitive measurement of absorbed water content, monitoring humidity percentages with regard to oil temperature. Depending on the humidity, crew receive different alerts: at 50%, a pre-alarm is triggered to incite crew to take preventative action to reduce water content, whilst at 90% a main alarm is sounded, requiring immediate action. The sensor thus enables preventative maintenance, and fits in with the move towards condition-based monitoring.

All oil has what is known as a 'saturation point' for dissolved water, which when exceeded poses a corrosion risk as free water settles on the machinery. This can vary depending on oil age, cleanliness, and composition.

rivertrace.com

The new Rivertrace smart oil in water sensor

Cyber security

Naval Dome Endpoint installation begins on 55 Stamco PCTCs

Stamco Ship Management has undertaken the first of 55 installations of Naval Dome's Endpoint cyber defence system on its fleet of pure car and truck carriers (PCTCs).

The first vessel to receive the software is chartered to Wallenius Wilhelmsen Lines. Installation reportedly took one hour during a scheduled port call at Piraeus, where Stamco is based. The software was optimised to the vessel's particular systems and operational profile, a process to be repeated for the remaining 54 vessels.

Features of the system include anomaly analysis, secure remote access, online updates and a cloud-based network. Stamco stated: "The decision to select Naval Dome was because its system has been designed specifically for shipboard application and requires little intervention from ships' crews".

Following a number of high profile cyber-attacks, the impetus to protect vessels has grown. Considering on this, Stamco's head of operations said: "Our commitment to ship safety underpins the decision to protect our customers' assets with the Naval Dome solution. We cannot underestimate the operational, financial and safety implications a cyber-related incident – whether by design or by default – would have on operations, especially given the high-value cargo our ships transport. With Naval Dome we are better prepared to prevent any unauthorised access to our ships' systems."

navaldome.com / stamco.gr

Scrubbers

Demand prompts ME Production expansion

Danish scrubber manufacturer ME Production (MEP) is expanding its facilities in Denmark and China, to meet increased demand for exhaust gas cleaning systems.

The company has rented 2,000m^2 of further space to complement its 6,000m^2 headquarters in Frederikshavn, and will open a factory of similar size in Jiaxing. The latter will allow them to be close to Chinese newbuild projects, whereas the Frederikshavn facility will specialise in retrofits.

Clients for MEP's range of U-Turn and Inline scrubbers, available in open, closed and hybrid loop configurations, include dry cargo/tanker operator Norden and freight/passenger specialist DFDS. Following a contract signed this summer for 12 systems, the latter will use MEP scrubbers on 29 of its 49 vessels.

MEP has reportedly sold 31 scrubbers this year, a huge increase on the six sold in the previous four years. This is attributed to the rapidly approaching deadline for the 2020 sulphur cap, which has seen many owners prevaricate as they decide between switching to alternative or low sulphur fuel, or continuing to operate on HFO with a scrubber.

meproduction.dk

ME Production employees with an inline scrubber system

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China's cruise tourism industry enters an adjustment period

Is overcapacity posing a threat to China's much-vaunted 'cruise boom'? A recent summit in Qingdao addressed concerns of stagnation

Over the past 10 years, the global cruise tourism market and cruise capacity deployment have maintained a strong growth trend, with the Chinese cruise industry in particular being a bright spot, far outpacing the rest of the world. During this period, the world's major cruise companies entered the Chinese market one after another, and the development prospects of the cruise tourism industry were highly optimistic.

However, since 2017, China's cruise tourism industry has encountered a bottleneck. Not only has the number of cruise passengers dropped sharply, but some cruise ships have been unable to make ends meet. Some international cruise giants have even begun to reduce their ships and voyages into China.

China's cruise tourism industry has now entered an 'adjustment period', which it is hoped will lay a solid foundation for further development. Recently, at the 6th China (Qingdao) International Cruise Summit, government authorities, industry associations, cruise lines, tourism authorities, ports, travel agencies, design and manufacturing industry experts gathered together to make suggestions for the future development of China's cruise industry.

They believe that in the 'adjustment period', China's cruise industry will shift from its phase of accelerated growth towards more steady development, but the country's prospects of becoming the world's largest cruise tourism market will not change. As an important link in the cruise industry chain, under the national background of 'Made in China 2025', the realisation of local large-scale luxury cruise ship construction will represent a powerful engine for the development of the cruise and shipbuilding industries.

Costa Fortuna recently became the first large cruise ship to call at Qingdao

Slowing growth rate

In the past decade, China's cruise tourism industry has progressed in leaps and bounds: international cruise companies have rushed to gain a stake, and the construction of international-level cruise home ports has continued. According to China Cruise Industry Development Report (2017) data, China's cruise industry has maintained a growth rate of 40- 50% or higher per annum in the past 10 years, including an increase of 87.8% in 2016 alone.

But the following year it came to an abrupt end. In 2017, the number of cruise ships in China, and the arrival and departure of Chinese tourists from major and second-level ports, as well as Hong Kong, all declined. At the same time, some cruise companies adjusted their operating strategies in the Chinese market. After three years of operation, domestic luxury cruise line Tianhai Cruises officially withdrew from the Chinese market, while in July Norwegian Cruise Line announced that *Norwegian Joy*, built specifically for the Chinese cruise market will be withdrawn and relocated to the US in 2019 after only a year of operation.

For a time, pessimism about the development of China's cruise industry began to spread, with negative reports appearing in the Chinese media. However, speaking at the cruise summit, Chen Ranfeng (Roger Chen), chairman of Carnival Corp in China, said that he did not agree with the bleak prognosis and was very optimistic about future development. Shortly before the cruise summit, Carnival's *Costa Fortuna* had carried about 3,500 passengers from Qingdao, marking the first time the Qingdao International Cruise Port has berthed a 100,000ton vessel. In November of this year, Carnival's *Costa NeoRomantica* will also come to Qingdao. Chen believes that although the Chinese cruise industry has expanded rapidly, its development is still in its infancy compared with the maturity of the European and the US markets. "The development of China's cruise industry also needs to follow normal market rules. This 'adjustment period' is quite normal," said Chen.

Liu Zinan, president of Royal Caribbean International Cruises' China and North Asia Pacific regions, concurred. The Chinese cruise industry has undergone a development process in the past 10 years that took the European and American markets decades to achieve. As market

capacity increases, Liu said, competition will inevitably become more and more fierce, but he remains very optimistic about the future of the Chinese cruise industry. He suggested that cruise companies that want to retain a foothold should adopt a strategy that is more appropriate to the Chinese market.

Flawed model

One of the most important reasons for this adjustment period is the current imbalance between supply and demand. Chen said that, in the past few years, major cruise companies have taken various measures to open up the Chinese market. The most significant is undoubtedly the number of large luxury cruise ships such as Princess Cruises' *Majestic Princess* (Chinese name *Shengshi Shi Gong Zhu Hao*) and the aforementioned *Norwegian Joy*, now serving the region.

However, with the slowdown in growth, the supply and demand imbalance in the domestic cruise market has become increasingly prominent. Chen believes that it's less that there is insufficient demand, but that potential opportunities have not been identified or exploited. At present, the cruise lines in China generally operate on a charter basis, with sales basically monopolised by domestic travel and online travel agencies. The class of one voyage will be contracted by one or several travel agencies and then resold to the consumer. This model can maximise the advantages of cruise companies and travel agencies and played an important role in the early development of Chinese cruise tourism. However, as the market has matured, this model has gradually revealed some drawbacks, such as the frequent occurrence of low-priced cabins and the lag in response of cruise companies to fill these spots.

Another problem facing the development of China's cruise tourism industry is that routes and destinations are too monotonous. Liu said that the domestic cruise destinations were mainly centred on Japan and South Korea. The products were too similar, which limited the diversified development of the cruise route and also dampened the enthusiasm of cruise passengers.

The construction of home ports in major Chinese cities also proceeded rapidly due to confidence in the industry's expansion. However, supporting the development of a cruise port requires a sufficient population and spending power. As a result, cruise home ports have been built in many areas, but see few dockings. At present, except for Shanghai, Guangzhou, Tianjin, Shenzhen, Qingdao and a few others, most of the cruise ports are in a situation where they can't make ends meet.

From the perspective of development space, the current penetration rate of the North American cruise market is about 3.2%, the penetration rate of the European cruise market is about 2%, and the penetration rate of the cruise market in the Asia-Pacific region is less than 0.1%. The penetration rate of the Chinese cruise market is only 0.08%, which is far lower. In Europe and America, there is still huge room for growth.

Good long-term prospects

Experts at the cruise summit generally agreed that the adjustment period will not last too long, as China's cruise market still has huge growth potential, and its goal of becoming the world's largest cruise ship market is unlikely to change.

Chen said that the Carnival Group is very optimistic about the future of the Chinese cruise market, and will continue to increase the promotion of cruising as a leisure activity. At the same time, through the enrichment and innovation of routes and products, the cruise sales network will be broadened to promote gradual development.

Chen believes that the healthy development of China's cruise industry requires the construction of an all-round, high-quality cruise ecosystem, including new ship construction, new products and destinations, transportation, distribution systems, infrastructure, ship management and more. Establishment of this system, Chen said, is inseparable

The *Majestic Princess* operated in East Asia over the summer

One of the Quantum class series, *Spectrum of the Seas* will serve the China and Asia Pacific markets from delivery in 2019

from the efforts of all parties in the cruise industry chain to cultivate markets, foster culture and develop supply chains. Chen highlighted Carnival's *Costa Venezia* for the Chinese market, the first cruise ship designed by Costa Cruises (and built by Fincantieri shipyard in Monfalcone, Italy) specifically for the Chinese market. Following in the footsteps of 13th century explorer Marco Polo, on its inaugural voyage it will travel a route from Trieste, Italy, to China and is scheduled to arrive at its homeport of Shanghai on 18 May 2019.

Liu added that the potential and capacity of China's luxury cruise market is huge, with Royal Caribbean taking a number of steps to exploit this. The first is to cultivate a cruise culture; China's cruise consumption continues to be dominated by 'early adopters', whereas European and American cruises reach more holidaymakers. Secondly, it will look to stimulate market vitality by providing diversified booking platforms such as websites, hotlines and expanding its direct sales channel. In 2015-16 Royal Caribbean invested in its Quantum class, including *Quantum of the Seas* and *Ovation of the Seas*, marking the first time the international cruise industry has deployed new ships in the Chinese cruise market. Next year, the 189,000ton *Spectrum of the Seas*, built for China and the Asia-Pacific market, will be launched, marking another breakthrough. Finally, Royal Caribbean will launch four new 'extraordinary' major routes: the warm winter route, long route, weekend route and holiday route, in 2019.

In order to continue to meet the service needs of passengers and cruise companies, the Asia-Pacific Cruise Port Service Standards Alliance was formally established on November 2017 in Shanghai. Wang Younong, chairman of Shanghai Wusongkou International Cruise Development Co, said that the world cruise industry has formed a number of "cruise circles" such as the Caribbean Sea and the Mediterranean Sea. To further enhance competitiveness, domestic cruise ports must strengthen cooperation and deepen communication and coordination with all parties involved in the cruise economy. At the same time, he added, it needs to establish standardisation to improve the overall service level of cruise port services.

Domestic cruises are ready to go

The construction of large luxury ships has always been called the 'crown jewel of the shipbuilding industry'. At present, cruise design, construction and the supporting industry chain is mainly concentrated in Europe. Italy's Fincantieri Group, Germany's Meyer Group and the STX Shipyard in France are currently the most powerful cruise construction companies and account for more than 90% of the global large and medium-sized cruise market. The construction of luxury cruise ships combines the most advanced shipbuilding technology and management technology, and must meet the most stringent specifications and standards for ship comfort, safety, reliability and environmental protection in the international maritime field. These quality standards were long considered were long considered an "impossible" thing for China's shipbuilding industry to achieve.

However, in recent years the construction of domestic luxury cruise ships has become a policy direction, with Made in China 2025 stating that it is necessary to achieve a breakthough in luxury cruise design and construction technology. Under the impetus of China's large-scale luxury cruise construction 'leader', China State Shipbuilding Corp (CSSC), the project has entered the formal implementation stage. In February 2017, CSSC signed strategic cooperation agreements with Fincantieri and Carnival to actively promote the goal of local construction of large luxury cruise ships. Witnessed by China's President Xi Jinping, the letter of intent agreed the construction of two Chinese-built large luxury cruise ships, with an option for four more.

However, many experts at the conference emphasised that the construction of large-scale luxury cruise ships needs more than a single solution. South Korea has made little progress in the construction of large-scale luxury cruise ships, while lack of construction experience means the building of luxury cruise ships in Japan has resulted in nothing more than a dream. Experts suggest that China's construction of such ships needs to draw on the experience and lessons of the development of the international cruise industry, and advance tentatively in the areas of cruise operation, design and construction, supporting supply chain and shipyard transformation, with fewer detours and rapid development.

Additionally, to establish a firm backbone, China's cruise shipbuilding requires investment in science and technology research to promote innovation and empower domestic cruise shipbuilding to deliver market-oriented solutions. Through the establishment of the cruise industry development fund, the capital market will be used to raise funds to jointly invest in the development of the cruise industry chain and help China's large-scale luxury cruise ship construction achieve its great leap forward. *NA*

Full-scale CFD joint research project is calling for participation

A new Joint Industry Project involving MARIN and partners wants to improve understanding of ship hydrodynamics and develop a truly industry-recognised benchmark for energy efficiency solutions

G.D. Struijk, MARIN, The Netherlands
D. Ponkratov, JoRes Project, UK

With the implementation of new environmental regulations, the shipping industry is challenged and increasingly driven to explore new energy efficiency solutions. A well-designed ship hull, appendages, propeller and/or ESDs (Energy Saving Devices) are of paramount importance to this.

While Computational Fluid Dynamics (CFD) is a flexible and relatively low-cost tool, its results are subject to validation. Model tests are often used for these purposes as they provide a well-controlled, physical measured value. However, the uncertainty in both scaling effects and the modeling of full-scale flow in CFD is seldom addressed.

Model test challenges

Model tests were introduced in 19th century and there is an enormous knowledge database built by many towing tanks and research facilities since then. This knowledge was assessed and summarised in a systematic way by the International Towing Tank Conference (ITTC) in recommended procedures [1]. Model tests have become common practice and a ship is never built before these tests are completed successfully.

Nevertheless, the scaling effect means that it is a practical impossibility to simultaneously satisfy the Froude and Reynolds numbers, even though there are some practical solutions on how to minimise the impact this challenge should always be kept in mind. Another issue is related to the correlation allowance coefficient. Although the ITTC recommended procedures are well established, the final scaling technique depends on each facility's experience and is usually implemented by the correlation allowance. The values of this allowance may vary quite significantly between towing tanks.

As mentioned before, the ITTC procedures were developed based on many model tests. However, they are mainly related to conventional designs. As soon as a ship owner decides to tests an unconventional design (for example a vessel equipped with an ESD) the accuracy and repeatability of these tests may be questioned.

The importance of this challenges has been highlighted by the industry leaders in many occasions. For example, in 2010 MARIN initiated the REFIT-2-Save Joint Industry Project [2]. The main outcomes are summarised in Table 1.

Based on the results it can be concluded that in both cases the model tests did not predict the reality correctly.

Full-scale test challenges

Ship scale tests have always been seen as the ultimate verification of the design and confirmation whether it is good or not. For instance, the famous trials performed in 1845 between HMS *Rattler* equipped with a propeller and HMS *Alecto* equipped with the paddle wheel [3] helped to make a quantitative conclusion about the superior performance of the propeller. However, separating the impact of environmental factors like current, wind and waves from the ship performance characteristics has always been a challenge.

Nowadays, there is the recognised industry standard ISO15016 [4]. Considerable effort was put into addressing as many uncertainties as possible: reciprocal runs heading into and following the dominant wave direction to take into account environmental effects, deep seas to avoid shallow water effects etc.

However, due to the practicalities of a sea trial and the (limited) availability of suitable measurement techniques, the procedures and analysis methods still contain large uncertainties. For example, paragraph 9.6.5 of the standard

Table 1 – Main outcomes of the Refit-2-Save JIP. Efficiency gains from ESDs.

ESD type	Model tests predictions	Sea trials confirmation
Duct (Vessel A)	+1.5% laden prediction for full scale -2.0% ballast prediction for full scale	0% at full scale -14% from monitoring
Duct (Vessel B)	+5.1% at model scale +6.8% prediction at full scale	+1 to +3% at full scale Confirmed from monitoring

states: "the encountered wave heights, periods and directions of both wind waves and swell may be determined from observations by multiple experienced mariners". But subjective estimation of the wave conditions may potentially lead to uncertainty related to the power corrections. The best approach would be an employment of the wave buoy but many practitioners do not use it, as it is not easy to deploy or collect the buoy from the vessel while at sea.

Other uncertainties are related to accurate draughts marks readings and hull/propeller roughness assessment. This may lead to a situation when two independent teams derive different speed-power curves from the same trials. In addition to that, the ISO standard mainly focused on speed/power curve, so it does not provide the necessary insight on other characteristics (propeller thrust, wake data) needed for the development of energy efficiency solutions.

Computational Fluid Dynamics challenges

With the increase of computational power, numerical methods have become more reliable and hence more popular. Indeed, with the use of CFD it is possible to predict a ship's performance at the conceptual stage. It can also be used to identify causes of poor performance in existing vessels, and furthermore to predict the effectiveness of energy saving measures that improve the hydrodynamics as well as aerodynamics associated with the vessel in question.

Nevertheless, in order to make CFD tools more accurate and reliable, validation is required. Ideally, this validation should be done in ship scale. However, a hurdle in this is the reluctance of ship designers to disclose their IP and make the actual ship geometry data available in the public domain.

At present, the only ship scale CFD case available in the public domain is MV *Regal* (Figure 4), made available by Lloyd's Register (LR) in 2016. In order to access the current CFD capabilities LR organised a blind comparison of numerical results with ship scale measurements, which revealed a noticeable spread of CFD results [5].

It is understood that one of the causes of this spread is the ballast draught condition of the vessel – the propeller was too close to the free surface and it significantly challenged the calculation convergence by ventilation effect. Other reasons were related to the case setup, for example, some participants used very coarse mesh, which is not recommended in ship scale calculations. It's clear therefore that additional validation work and best practice development are required to increase confidence in CFD methods.

It is due to a lack of good data on full-scale that the industry has not been able to close the loop between model tests, CFD and the full-scale reality. With this understanding, a group of key companies and research bodies have now stepped up to close this knowledge gap and proposed the JoRes JIP (Joint Industry Project). Again all measurements will be performed for the vessel used for the LR's CFD Workshop, the MV *Regal*, but in order to develop more general recommendations and extend the validation 'fleet', another vessel, MV *Yupeng* (Fig. 5), is proposed as an additional candidate.

Figure 2 - Current industry practice

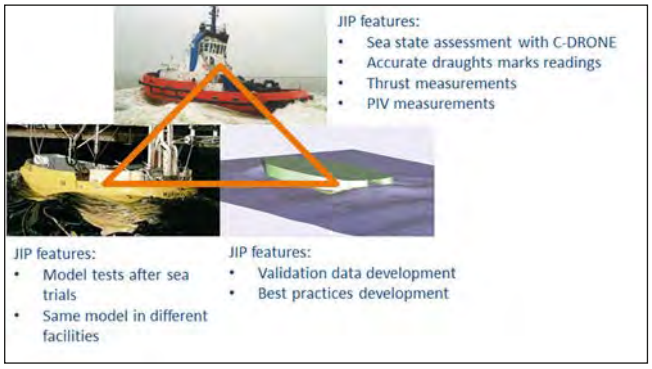

Figure 3 - Challenges addressed by the JoRes JIP

Figure 4 – MV *Regal* – the primary vessel for JoRes JIP

Issues to be addressed

As discussed above, the current practice is to conduct model tests before the vessel is actually built (Figure 2) to predict its performance characteristics. When delivery trials are performed by the yard, the trial conditions (draughts, speeds) and even the hull and propeller geometry may be different compared to model test conditions. This makes it difficult to feed trial results back to model tests practice

Figure 5 – MV *Yupeng* – an additional vessel for JoRes JIP

and address towing tanks uncertainties.

The JoRes JIP proposes to perform the model tests after completion of the sea trials to ensure identical conditions (draughts, speeds). Moreover, it is intended that the models will be tested in two facilities to cross-check the results and ensure repeatability of test data.

For the full-scale testing, shaft power and ship speed will be recorded using the latest techniques available. Propeller thrust is a further candidate parameter for inclusion. For this, the innovative TT-Sense technology developed by VAF Instruments is planned to be used. This would create the possibility of determining the propeller performance separately from the hull performance, and thus gain a better understanding of the contributions from the different components in the total propulsive efficiency.

For wave measurement, a self-propelled wave buoy developed by MARIN, the C-DRONE, will be used. Additionally the vessel's loading condition and draughts will be accurately determined and the propeller and hull condition will be documented.

The full-scale flow field before the propeller will be captured by a newly developed PIV technology, allowing for 2D, 3-component velocity fields to be resolved at the inflow plane of the propeller. Combined with an uncertainty study, this will deliver the project's most unique dataset for CFD validation. Figure 8 shows the window which was installed by MARIN on MV *Regal* in the aft peak tank above the propeller for PIV measurements.

Results and workshop

The sea trial conditions as well as the prepared geometries will initially be made available for JoRes participants. The JIP participants/CFD practitioners will then be encouraged to participate in an internal JIP CFD workshop similar to that organised by LR in 2016 [5].

Based on the results obtained in this workshop, a document will be developed to provide practical, clear and reliable 'Best Practice' for the preparation, conduct and analysis of ship scale CFD computations. In addition, the findings of the project will be analysed, collected and uploaded to the JIP website (details below). It is intended to collect the information in a dashboard or visual wiki format with cross references to the actual reports including the results. This will make it easy and intuitive to navigate and search for relevant information.

The JoRes JIP aims to increase the understanding of the ship hydrodynamics in full-scale. A comprehensive set of full scale, model scale and CFD will become available to the participants to better understand potential for energy efficiency solutions. These participants include several ITTC members and it is hoped it may establish the basis for further cooperation and engagement with ITTC and ISO with regard to that development of practical recommendations that can be beneficial for the entire industry. *NA*

For further details, including the full JIP proposal, please visit:
https://jores.net/

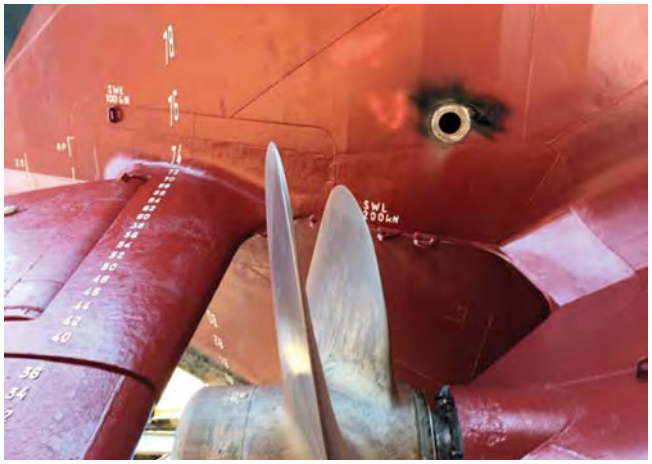

Figure 6 – The window for ship scale PIV measurements installed by MARIN on MV *Regal*

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A case for Flettner rotors on tankers

Maersk's trial of two 30m Norsepower Rotor Sails on a product tanker marks the first installation of wind propulsion equipment in the segment. Given the particular suitability of the technology for tankers, it may herald more

Maersk Pelican's Rotor Sails following installation in the port of Rotterdam

Auxiliary wind propulsion technology has only recently become a viable option for shipowners looking for ways to ease the dual pressures of high fuel costs and emissions reduction demands. Numerous solutions ranging from rigid sails to rotors to kites are now being marketed by a plethora of start-ups, some supported by significant government and private funding. Despite their varied technologies, the companies make similar claims of delivering efficiency improvements and therefore lower emissions.

Solutions are at different stages of development, with many still at concept level, some ready to be tested, and a select few installed on vessels. At present, two technologies – towing kites and Flettner rotors – fall into the latter category.

With regard to towing kites, Germany's SkySails currently has systems installed on board the Wessels Reederei vessel *Theseus* and Briese Schiffahrts' *Beluga Skysails*, although neither is still in active use according to a 2016 CE Delft report. The solution features a kite flown from the stern, operated by an automated control system which optimises angle and height in the wind to generate propulsion.

The second technology – the Flettner rotor – has seen wider uptake, with a number of companies developing and installing systems. Despite minor differences, all versions are based on a now century-old concept: a large, electrically-spun metal cylinder which utilises the Magnus effect to create thrust, aiding propulsion (see June's *The Naval Architect*, p.24). Modern Rotor Sails are usually constructed from light composite materials and use an automation system to optimise operation based on wind speed and direction.

At present, there are four rotors on *E-Ship 1*, developed by German wind turbine manufacturer Enercon; four rotors on M/V *Afros*, by British company Anemoi; an 'Eco-Flettner' on *Fehn Pollux*, developed by German-Dutch green innovation project MariGreen; and five rotors across three vessels – the ro-ro *Estraden*, the cruise-ferry *Viking Grace* and, most recently, the LR2 product tanker *Maersk Pelican* – produced by Norsepower.

Finnish frontrunners

Half of all vessels with Rotor Sails and over a third of all installed Rotor Sails are therefore claimed by Norsepower. The company arguably also has the most significant clients in Maersk and Viking Line, the latter of which is currently signed up for two more rotors on board a newbuild LNG-fuelled ferry under

construction at Xiamen Shipyard, which will operate between Turku, the Åland Islands and Stockholm.

The installation in August of two 30x5m Norsepower Rotors Sails on board *Maersk Pelican* represents the first use of auxiliary wind propulsion on board a tanker. The Energy Technologies Institute and Shell Shipping & Maritime are also taking part in the project, with rotor performance data set to be captured and verified by Lloyd's Register's Ship Performance team. At present, the rotors are forecasted to reduce fuel consumption by 7-10% when the ship is in use on typical global routes.

Although the installation may be the first in this segment, Norsepower CEO Tuomas Riski tells *The Naval Architect* that the company's "long-term ambition is that this technology becomes a standard component for certain ship types, so that it's a no-brainer to have a Rotor Sail on board a tanker, for instance." Vessel type has a significant impact on the viability of different auxiliary wind propulsion solutions, for reasons of design, operation and economics. As Riski implies, Rotor Sails are highly suitable for tankers, to the extent that they could become a common piece of equipment.

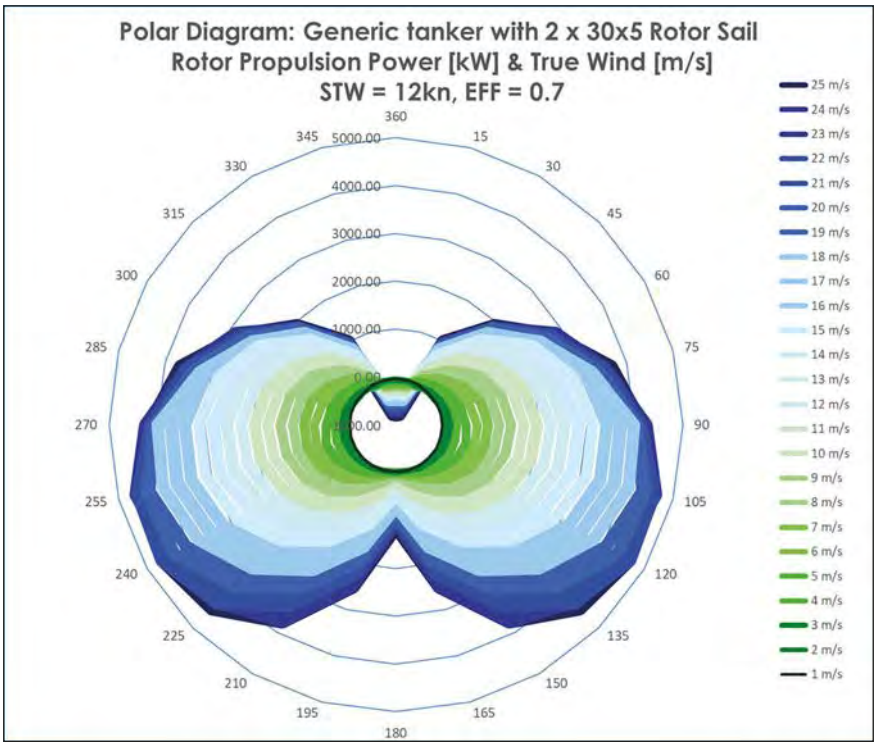

Figure 1: Polar diagram, plotted for a generic tanker, showing the propulsion power generated by two 30m rotors

Tailored for tankers

Structurally, tankers have available deck space on which to situate rotors and their foundations, because their cargo tanks are located below deck. Tankers also tend to be comprised of basic steel structures, meaning that major modifications are unlikely to be required to accommodate the equipment.

Moreover, says Riski, "the main deck of tankers is located so low compared to the sea level that rather tall Rotor Sails can be installed without compromising the ship's ability to pass under bridges." This contrasts with cruise vessels, for instance, which must situate rotors on the upper deck, making height considerations more critical. *Maersk Pelican*'s two rotors, at 30m tall, are the largest currently in operation on any vessel.

A further positive aspect of tanker design for rotor installation is that the decks are largely unobstructed, allowing a strong wind flow around the rotors. Figure 1, plotted by Norsepower for a generic tanker with a service speed of 12/kn and two 30m rotors, shows that at favourable wind angles, the rotors can generate between 4,000 and 5,000kW of propulsion power at wind speeds over 20m/s. The only point at which rotors result in inefficiency is when faced with a headwind, which Norsepower account for in their figures.

From an operational perspective, tankers' pipe-based loading and unloading means that the rotors will not obstruct cargo lifting operations as they might do on a bulker or container ship. Tankers, in particular LR2 tankers, also often conduct long voyages with a high time-at-sea ratio, meaning more opportunity for the rotors to reduce fuel consumption. Wind speeds are also higher on the deep water routes where tankers operate, opening up the possibility of higher savings; according to Riski, "[Norsepower] can already see that on routes with favourable wind conditions like the Northern Atlantic route you can reach up to 20% average savings."

Finally, there is a strong economic case for installing rotors on tankers. Ongoing overcapacity issues have seen competition amongst owners and consequently low chartering rates. Therefore, installing a technology that makes a ship cheaper to operate – and more environmentally friendly – would make that vessel more attractive to prospective charterers, as suggested by Shell's co-operation in the project. Furthermore, as the majority of tankers currently operate on HFO, most owners not opting for scrubbers are likely to switch to LSFO post-2020, meaning a further increase in fuel bills. Rotor sails can help offset some of this expense.

Maersk Tankers itself appears to have taken note of the above arguments; the company has claimed that, if this installation proves successful on *Maersk Pelican*, it will roll out rotors across half of its fleet of 164 vessels, signalling a strong belief in the fledgling technology.

Maersk order or not, Riski highlights Norsepower's goal to "deliver 100 Rotor Sails by 2024." Ambitious, perhaps, but Riski believes his optimism is justified in the face of shipping as it stands today: "The entire trend is very positive – we have high fuel prices and regulations increasing. We couldn't have a better market for this kind of hybrid technology." *NA*

Enhancing energy efficiency at the source

FuelSave's FS Marine+ unit enables cleaner combustion in diesel-fuelled engines, reducing fuel consumption and emissions. The technology offers a way forward to operators sceptical of LNG's benefits

Efficiency enhancement has traditionally been realised in the shipping industry through improved vessel and engine design.

As naval architecture has become increasingly productive with the advent of CAD-based design, parametrisation and improved simulation software, significant gains have been achieved through optimised hull shapes and lower resistance, to the extent that further gains are becoming increasingly difficult to come by on conventional vessel designs.

This problem is even more prevalent for engines, which have traditionally offered a reliable efficiency boost with each new generation of units. Engine manufacturers have begun to find that they are approaching 'peak efficiency,' a concept highlighted in January's *The Naval Architect* (p.20) which noted that engines have largely reached their highest safe engine pressure ratio (between firing pressure and mean effective pressure). Ever-smaller single figure gains are thus becoming the norm, most of which now involve mechanical improvements such as friction reduction.

The result is that many efficiency-minded shipowners are now instead looking to improved hull coatings, waste heat recovery and alternative fuels such as LNG to stay ahead of the pack. However, as the majority of the world shipping fleet is outfitted to burn fuel oil, many owners are choosing not to switch, citing poor infrastructure, the high cost of converting vessels to burn LNG, and the inconvenient truth of methane slip throughout the supply chain.

It is these reluctant – or perhaps pragmatic – shipowners continuing to use fuel oil but seeking efficiency gains that German company FuelSave GmbH hopes to target. Founded in 2012, the company offers efficiency enhancement technologies ranging from waste heat recovery systems to green energy units for industries including road transport, land-based industry and shipping. Its main maritime offering is a 2017-patented hydrogen synthgas generator and injector, dubbed FS Marine+, which combines syngas injection with water and methanol injection to achieve cleaner, more complete and cooler combustion. This is claimed to reduce fuel consumption and thus CO_2 emissions in analogue relation, as well as further reducing air pollutants including NOx, filter smoke number (FSN) and particulate matter (PM). Reduced engine wear and tear, and the requirement for less lube oil, are also cited as benefits.

An FS Marine+ unit installed in the engine room of an SAL Heavy Lift vessel

The Naval Architect spoke to FuelSave co-founder Marc Sima about FS Marine+ during SMM, at which the company showcased a containerised version of the technology. Describing the system, Sima said: "Depending on the load profile and the engine, we're injecting hydrogen, oxygen, water and methanol in different quantities and combinations depending on the effect that we would like to achieve." This effect, Sima explains, relates to the degree of fuel savings versus emissions reduction: "There's always a trade-off – you can dial in for higher fuel savings but then emissions may increase". However, the system's standard configuration is claimed to save between 10-15% in fuel consumption, reduce CO_2 by 8-15% and FSN/PM by up to 40%. NOx reduction is more dependent on configuration, but falls between 30-80%.

To validate FS Marine+, FuelSave partnered with SAL Heavy Lift (now owned by Harren & Partner), engine service company Carl Baguhn Hamburg (CBH), and DNV GL – which has since certified the solution – conducting a three-year, 5,000-hour trial on heavy lift cargo vessel M/V *Annette*'s auxiliary, MDO-fuelled engine. The average reported fuel saving throughout the trial was 16%, with CBH service engineers noting far cleaner combustion. Particularly of note was the visible FSN reduction; Sima said that "the chief engineer went down into the engine room to check it was really running!" Following the successful performance, SAL Heavy Lift has since chosen to fit four more FS Marine+ units across its fleet, with the contracting process coming to an end last month.

With a verified saving above 15%, FS Marine+ therefore represents an attractive proposition. However, shipowners currently pre-occupied with decisions surrounding the 2020 sulphur cap are sure to recognise that, by itself, the system is unable to achieve compliance for vessels using fuel oil, as it only reduces sulphur analogously to the amount of fuel saved.

Where it can help, though, is by allowing a smaller scrubber to be installed. Sima picked up on this point at SMM: "Very often the problem is that you lack the space for a scrubber. In our case have emissions savings

already, so the scrubber can be downsized – it can work less, using less energy. This means a better scrubber ROI." This relationship works both ways, added Sima: "If you dial in more on the fuel efficiency side [using FS Marine+], the scrubber takes care of the emissions."

Of course, installing both the FS Marine+ system and a scrubber will prove costly, despite the fuel savings the former generates. Depending on how this cost balances out against alternative fuels such as LNG, owners may be tempted to convert their vessels to gas operation to achieve compliance. For Sima, however, the case for LNG is diminished by its dubious environmental credentials: "No LNG ship has ever been built without high financing. It was thought to be greener, but now they've spent the money, done the studies and realised it is a disaster because of methane slip." For Sima, fuel oil burned cleanly is therefore preferable to LNG, which some believe to be more polluting across its entire supply than conventional marine fuels due to the potency of methane; according to the Intergovernmental Panel on Climate Change (IPCC), its comparative impact over 100 years is 25 times worse than CO_2.

The total impact on the climate of LNG use in shipping has yet to be fully accounted for, with the industry far from a consensus. What is certain is that the majority of shipowners are motivated by cost rather than environmental responsibility. As such, FuelSave hopes to encourage installation by offering FS Marine+ with a guaranteed ROI based upon each customer's usage profile, coupled with a performance guarantee by which the warranty is extended following any system downtime. For shipowners less keen to commit, a leasing option is also being explored that will offer flexible payback depending on the amount of fuel saved, but always with a "positive cash flow for the customer."

For shipowners sticking with fuel oil, rising prices are likely to provide a further incentive, particularly those with large, fuel hungry fleets. Sima relayed a conversation he'd had with Maersk, for example, which explained that its annual bill is US$8-15 billion depending on how much it charters, noting: "We already have a business case if they save 2%. That's a US$160-300 million fuel saving."

Many of the vessels chartered by the likes of Maersk feature two-stroke engines, which FuelSave is yet to work with. However, an FS Marine+ unit large enough to handle the demands of a two-stroke is currently under development according to Sima, as is a unit for four-stroke main engine use, financed by a €1.6 million grant from EASME (EU Executive Agency for SMEs).

It is likely that when FS Marine+ is used in conjunction with the engines of the ultra-large vessels fast becoming the backbone of seaborne trade, the most convincing case will be made regarding the to the benefit to both shipowners' wallets and our shared environment. *NA*

ClassNK plans for a smarter future

The Japanese class society's recently published guidelines for the concept design for automated and autonomous operations aims to ensure the risks of automation don't go unchecked

The rapid advances being made with artificial intelligence (AI) and ship automation are compelling class societies to keep pace with developments and support clients keen to explore the potential advantages of these emerging technologies. But one of the difficulties for shipowners, designers, class and IMO alike is the varying degrees of autonomy. Is the technology in question truly autonomous or rather remotely operated? Does it apply to the entire vessel or just certain shipboard systems? What are the operational parameters? What contingency measures are in place?

IMO's Maritime Safety Committee (MSC) will meet again in December to further discuss automation definitions and frameworks, with the full results of analysis expected in 2020. But irrespective, it's clear that no single set of requirements will be adequate to govern all permutations.

Japanese classification society ClassNK arrived at the same conclusion while developing its provisional Guidelines for Concept Design of Automated Operation/ Autonomous Operation of Ships, published earlier this year. Building upon the research goals it outlined in last year's R&D Roadmap (*The Naval Architect*, November 2017), the guidelines detail the elements that need to be considered during the concept design development of automated ship systems, with a particular emphasis on safety.

Man and machine

The challenge is that the human-machine interface is often a blurred line when it comes to automation, and often a broad 'task' such as navigation is achieved through a combination of machine and human elements. ClassNK determined that it was necessary for each task to be broken into a series of 'subtasks'. Of these subtasks, some are 'decision making', meaning that they draw upon external information and what would traditionally be human skills or attributes such as situational awareness.

The idea is to clearly set out the division of roles between human and machine and under what conditions responsibility transfers with each subtask, including the provision of fallback measures if something goes wrong and making clear exactly when these would take effect. Automated systems are to be defined according to their Operational Design Domain (ODD), the specific environment under which the system is intended to function.

To explain this process, ClassNK has devised a set of groupings by which all autonomous operations can be categorised (Table 1), ranging from scenarios where a limited number of subtasks are handled by automated systems (Group I), to full automation where there is no human involvement at all (Group IV). ClassNK stresses that these are only the prime examples and there may be further updates.

In developing its model, ClassNK referred to the automation philosophy being applied to automobiles and taking into consideration the characteristics that are specific to ships. It states: "As objects of automation, ships are complex and involve a variety of tasks and functions. We decided to apply the tasks/subtasks concept because it is crucial to factorise the objects of automation to the related onboard operations and works, and to have a common understanding for everyone involved with ship operations."

The human-machine interface therefore is critical, with the risk that ambiguities may arise as automated operation systems grow more complex and their information relayed becomes more challenging to decipher.

Appropriate standards

ClassNK believes these interfaces must be based on "appropriate standards for human-centred design" that are easy to

Table 1: Typical example of grouping/identification of automated operations. Source: ClassNK *Limitation on automated operation systems

Group	Definition	Decision-Making subtasks	Fallback	Limitation of ODD*
	All Decision-Making subtasks are executed by human	Human	Human	-
I	In the specified ODD, some Decision-Making subtasks are executed by automated operation systems. The other Decision-Making subtasks are executed by human	Human / Automated operation system	Human	Limited
II	In the specified ODD, all Decision-Making subtasks are executed by automated operation systems. Fallback is executed by human	Automated operation system	Human	Limited
III	In the specified ODD, all Decision-Making subtasks are executed by automated operation systems. Fallback is executed by other automated operation systems	Automated operation system	Automated operation system	Limited
IV	All Decision-Making subtasks are executed by automated operation systems. Fallback is executed by other automated operation systems	Automated operation system	Automated operation system	Not limited

use and familiarisable. "We referred to appropriate standards for designing this kind of interface, such as ISO 9241-210:2010 (Ergonomics of human-system interaction – Part 210: Human-centred design for interactive systems)," it explains. A forthcoming set of guidelines will outline the operational requirements for automated systems and how this must correlate with procedures outlined in the vessel's Safety Management System.

Anticipating flaws in the human-machine interface is specified as one of the necessary considerations when conducting risk assessments. Others include the impact of automated operation to the function of the overall ship, resilience of the communications network, computer systems and sensors, and any vulnerability to cyber or physical attacks.

Where some or all part of a vessel's operations are remotely controlled, i.e. subtasks carried out from onshore, then ClassNK will exercise its discretion if it doesn't believe the provisions made for each subtask are practical. Moreover, the guidelines expect that the person(s) in charge of the remote operation will have the same abilities as crew performing the same subtask(s). This doesn't necessarily mean an onshore operator must be trained to full mariner standards, but with tasks such as navigation they would be expected to have the same skills and capability. The society says at this stage there have been no consultations regarding the development of training standards for remote operation but will consider this as required.

Further ahead

Taking a broader outlook, ClassNK says that while the past 18 months have seen a number of headline-grabbing trial projects involving smaller, remotely controlled vessels, it is actually receiving more enquiries with regard to the automation systems for larger oceangoing ships, particularly with regard to navigation technology.

It believes also that it is essential for the IACS members to exchange opinions with each other and develop "appropriate common ground on the basic perspective of verification for automated operation."

Indeed, while the basic skeleton for an automated future is now being pieced together, the society anticipates that the role of AI systems in particular will need to come under closer scrutiny. "With all of the various onboard tasks and duties, the practical use of an 'automated ship' with an operation system that can specifically propose actions, and provide information to crewmembers, as the final decision-maker, will be a major challenge," it says.

"These guidelines target the concept design of automated and autonomous operation of ships. The next stage will establish technical requirements and verification processes on all stages of automated/autonomous operation involved in the design/development, construction and entry into service, and release them as further guidelines." *NA*

Krylov's multi-purpose offshore basin and its role in Arctic developments

The Krylov State Research Centre's newly completed model facility can simulate the full range of polar wind and sea conditions

Economic development of the Arctic regions is becoming an issue of significant interest and likely to have global repercussions. On the one hand, the northern territories are rich with fossil minerals as well as other valuable resources, and evolving transport passages, such as the Northern Sea Route (NSR), offer attractive logistic solutions. Given time, NSR and similar passageways promise to grow into busy transport thoroughfares to support export of mineral resources from the northern fields, as well as to provide worldwide transport network for year-round supply of goods and cargoes. On the other hand, the Arctic regions are still underdeveloped and will receive a significant impetus for further growth through implementation of ambitious large-scale projects entailing all necessary infrastructure assets like ports, terminals, supply depots, etc.

However, in view of the modern global trends for year-round operation and 24/7 uptime of offloading terminals, ports and other infrastructure facilities are required to withstand the harsh metocean environment prevailing in the Arctic regions. This requirement stimulates continuous design innovations and improvements given that the slim safety margin, or even a slight omission of some detail or factor, could result in major financial losses due to a ship's downtime or, in the worst case, ecological disasters for the fragile Arctic environment.

In the context of the best design practices it is essential to obtain the most accurate insights into the impact of the region-specific metocean challenges on the project early in the design process. These tasks are supported with advanced research studies using state-of-the-art test facilities configured to simulate specific Arctic metocean conditions.

In response to these growing demands, the Krylov State Research Centre is implementing a road map for introduction of advanced experimental facilities and equipment to enable comprehensive and thorough investigations of prospective Arctic projects.

Recent examples are newly commissioned Ice Basin and Landscape Wind Tunnel facilities (see Figs 1-3) providing valuable data for on-going projects.

The Multi-Purpose Offshore Basin (MOB) marks the final stage in a family of unique experimental assets designed to address Arctic engineering tasks. Combined with the facilities already commissioned (the Ice Basin and Landscape Wind Tunnel) the basin will enable Krylov to span the entire spectrum of research tasks to support year-round fail-free operation of offshore facilities in even the most severe Arctic conditions.

Apart from combining the functions of manoeuvring, seakeeping and offshore test basins under one roof, the new research facility is notable for its capability to concurrently simulate waves, winds, currents and water-depth conditions. In cooperation with the new Ice Basin (modelling ice environment) and the Landscape Wind Tunnel (simulating wind loads with due account of terrain features and ground layer) the MOB facility enables the Krylov Centre to simulate the entire range of metocean conditions structured as the real Arctic environment for all types of model tests.

Fig. 1 – Landscape Wind Tunnel: test section

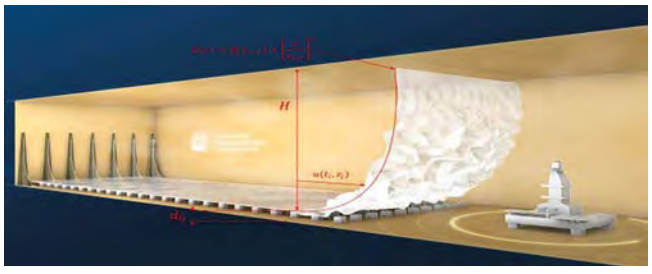

Fig. 2 - The wind tunnel's ground-layer modelling setup

Fig. 3 – New Ice Basin

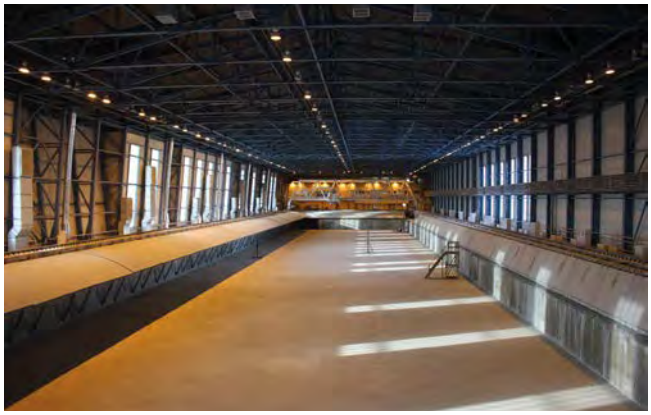

Fig. 4 – Manoeuvring/ seakeeping test facility (w/t water)

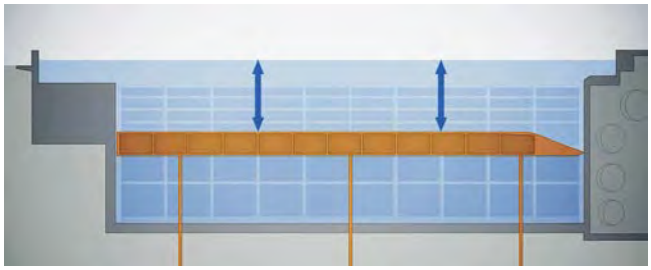

Fig. 5 – Longitudinal section with raised floor

The Basin is made up of two adjacent sections (tanks): a manoeuvring/ seakeeping test tank (Fig. 4) measuring 162x37x5m (LxWxD) and an offshore test tank measuring 53x44x10m (with a 20m deep pit). The tanks are sized to cater for experiments with large-scale models of ships and platforms (up to 10-12m). The water depth of the offshore facility enables researchers to cover in their simulations 100% of the Arctic waters and 70-80% of the global ocean conditions. A further increment in the water depth would require a significant increase of the offshore basin's planform dimensions because the existing mooring systems (except TLP) feature widely spaced mooring points distanced by tens of kilometers. However, even with this maximum water depth it is necessary to use truncated mooring systems in modelling. Depending on the research tasks, this can be a passive or an active truncated system. The offshore basin is equipped with a raised dummy floor spanning the entire bottom area to adjust the water depth from 0-10m at a selectable step, saving a lot of test preparation efforts. It is particularly helpful in experiments on fixed platforms with global force measurements (Fig. 5). A current generation system with six independent layers makes it possible to produce both uniform and stratified currents.

Another important design task is to find out the optimum location for the installation under design. A clever choice of the location could reduce wave load levels by half or even more. A good case for illustration is the studies undertaken to select the best layout of ship berthing facilities for an LNG production plant (Fig. 6). The local bathymetry pattern was effectively exploited to reduce design wave loads 2.6 times.

Fig. 6 – Example of marine terrain modelling studies in the old seakeeping basin

One of the core tasks in the design of oil producing platforms, offloading terminals and other offshore structures is the evaluation of the larger and more localised forces generated by simultaneous effects of waves, winds and currents of variable repeatability. It should be noted that all marine structures are non-linear systems and, therefore, their responses are also non-linear and the normal distribution law is not applicable. Thus, the entire spectrum of metocean exposures has to be investigated to obtain reliable load data for a given installation. For critical high-risk facilities the design loads should be calculated based on low probability assumptions (100-year or 1,000-year recurrence period). As good design practices and ITTC guidelines have it, a representative wave time series should be at least three hours in full scale.

The wave generation system in the Multi-Purpose Offshore Basin is able to produce long-crested regular and irregular waves, as well as short-crested irregular waves with the maximum wave heights of 0.8m. The control system enables researchers to generate desired sea spectra found anywhere in the world ocean, including multidirectional seas and abnormal or freak waves. For restriction of wave field dispersion during long-time modelling the basin wavemaker is equipped with an active suppression system to automatically adjust the wavemaker control signal, while beach-type wave absorbers of innovative surface profiles are engineered to effectively damp 98% of wave energy.

The unique capabilities offered by MOB in generating wave spectra typical of any location around the world ocean make it possible to develop control signals for active ship motion suppression systems as well as to work out the most efficient design solutions for this purpose. Combined with wind and current modelling capabilities it enables us to devise self-learning algorithms for crewless vessels and other robotic systems for both surface and subsea applications, as well as to optimise their interaction.

Completion and commissioning of the Multi-Purpose Offshore Basin marks the culmination in the creation of a robust experimental cluster at the Krylov State Research Centre, one which Krylov believes will raise model test studies to a qualitatively higher level. *NA*

TESTING AND FLUSHING OF HYDRAULIC SYSTEMS USING PORTABLE STANDS

NIKOLAI V. PETROV, NIKOLAI V. ROZOV

Hydraulic systems are used to actuate and control shipboard equipment and mechanisms. Metaphorically speaking, hydraulic systems are "heart and arteries driving ship's muscles". To ensure reliability, both hydraulic equipment and associated systems must be tested and flushed with hydraulic liquid after assembly.

Cleanliness of hydraulic system affects its operation and durability. Should solid particles remain inside the hydraulic system upon manufacturing and assembly, they will move along hydraulic lines, inflicting damage to various components of the same.

As per worldwide statistics, 70-80% failures of hydraulic systems are caused by pollution of working medium. To prevent such damage, one must ensure the required purity level of working fluid and inner surfaces of the hydraulic system.

The main method to remove impurities is flushing, i.e. turbulent circulation of fluid in hydraulic system lines in order to capture and bring impurities to filters.

For the purpose of testing and flushing of hydrauliuc systems or equipment in mechanical shops of shipyards and dockyards, JSC "Shipbuilding & Shiprepair Technology Center" (JSC "SSTC") has developed various special-purposed test stands.

Portable stands Q48, Q24 and Q12 are purposed for testing strength of pipelines and leak tightness of hydraulic systems or equipment, for flushing of hydraulic systems to remove mechanical impurities (of metal or non-metal origin) and reach the required cleanliness rate (fig. 1). Specifications of stands are given in table 1.

Parameter	Value		
	Q12	Q24	Q48
Flushing and test fluid	Water-glycol fluid/mineral and synthetic oil		
Flushing fluid consumption, m³/h	Max. 12	Max. 24	From 1.8 to 48
Maximum flushing pressure, MPa	12.5		15
Maximum test pressure, MPa	20		22.5
Flushing fluid temperature, °C	From +40 to +50		

Table 1 - Specifications of stands Q48, Q24 and Q12

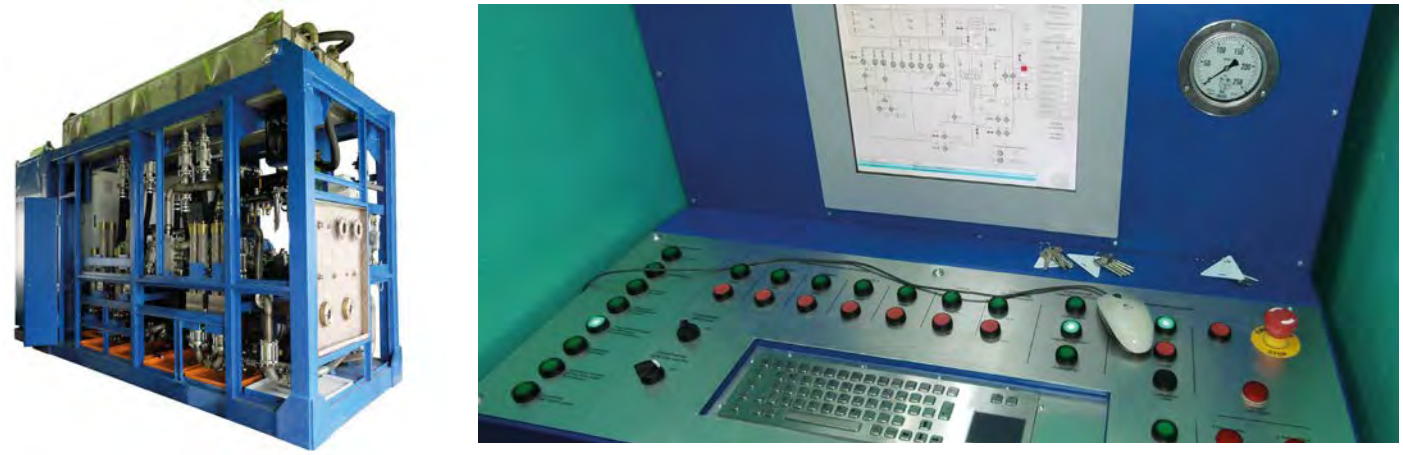

Fig. 1. Portable stand Q48 for testing and flusing of hydraulic systems
a – overall view, no cover; b – control console

Main stands operation modes:

– putting pump into supply tank for further loading/unloading/filling of working fluid from external storage;

– self-flushing – pump-driven circulation of working fluid through pressure and drain filters for preliminary flushing of stand and purification of working fluid in supply tank;

– filling up the hydraulic system to be flushed with working fluid before actual strength test, leak tightness test

and flushing. This to be done with use of pump for loading/unloading/filling of working fluid from external storage;

– testing system strength and leak tightness using test pump;

– flushing the systems with flushing pumps with regular change of flow direction;

– blowing off the sytems after testing and flushing;

– draining the supply tank – draining working fluid from the supply tank to the external storage using pump for loading/unloading/filling of working fluid.

Stand Q48 is composed of two modules: "Pump station" and "Control cabin" both mounted on the same bed frame. "Control cabin" module has additional noise insulation and stands on damper. Control cabin is equipped with control console and operator's workplace.

Control, monitoring and diagnostics of status of Q48 stand are performed with mnemonic board located on control panel of operator's cabin. This board contains hydraulic diagram which displays: real-time status of controlled stop valves and instruments, equipment sensor readings, current level and temperature and working fluid in the tank, pump operation parameters, sections of stand's hydraulic lines involved in certain operation mode.

Design of stands Q24, Q12 and Q48 is identical.

Portable stand P15 is designed to test leak tightness, to adjust and check operability (stand trials) of hydraulic equipment (fig.2).

Specifications of stand P15 are given in table 2.

Stand P15 can operate in the following modes:

– filling up the supply tank from external storage with use of pump for loading/unloading of working fluid;

– cleaning – circulation of working fluid through pressure and draining filters and subsequent taking of samples from stand draining line before filters in order to remove mechanical impurities from the working fluid;

– leak tightness of hydraulic systems and devices (under static pressure and device operation);

– adjustment of hydraulic devices;

– blowing off the hydraulic system and devices;

– draining working fluid from the supply tank to the external storage using pump for loading/unloading of working fluid.

Parameter	Value
Working fluid	Water-glycol fluid/mineral and synthetic oil
Working gas	Air/nitrogen or argon
Flushing fluid consumption, m^3/h	5.5
Maximum pressure, MPa	15
Flushing filter fineness, μm	5 and 10
Supply tank capacity, m^3	0.8
Air collector capacity, m^3	0.6
Hydropneumatic accumulator capacity, m^3	0.1×2
Maximum power, kW	50
Dimensions (L×W×H), mm	4000×2500×2500
Weight (w/o working fluid), kg	10 000

Table 2 - Specifications of stand P15

Fig.2. Portable stand P15 for testing and adjustment of devices with hydraulic drives
a – overall view; b – space inside stand

Stand equipment is placed in one case. Air collector is designed as pipe structure and placed outside of closed stand space. Removable sandwich panels ensure free access to the equipment.

Air collector and hydropneumatic accumulator of P15 stand are designed to compensate sudden peak loads and hydraulic impacts to ensure effective trials and to extend pump life.

To prevent corrosion, the flow-exposed parts of stand hydraulic equipment are made from corrosion-resistant steel or other materials suitable to operate with water-glycol liquid. Flow-exposed parts of pneumatic systems are also made from corrosion-resistant steel.

To prevent penetration of impurities during staind maintenance (filter replacement, sampling, opening inner cavities of hydraulic equipment), the stand purifies the incoming air and maintains excessive pressure inside stand space.

These stands ensure removal of working fluid from inner cavities and switching of operation modes for various working mediums.

Stand filters are equipped with regenerative and replaceable filter elements.

Stands Q48, Q24 and Q12 are recommended for flushing and testing of hydraulic systems. Stand P15 is recommended for testing and adjustment of hydraulic devices during construction/repair of modern ships.

Design and technological solutions acquired in course of development of stands allow to modify their parameters to meet specified requirements of the Customer.

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RINA - Lloyd's Register
Maritime Safety Award

The safety of the seafarer and protection of the maritime environment begins with good design, followed by sound construction and efficient operation. Naval architects and engineers involved in the design, construction and operation of maritime vessels and structures can make a significant contribution to safety and the Royal Institution of Naval Architects, with the support of Lloyd's Register, wishes to recognise the achievement of engineers in improving safety at sea and the protection of the maritime environment. Such recognition serves to raise awareness and promote further improvements.

The Maritime Safety Award is presented annually to an individual, company or organisation that in the opinion of the Institution and Lloyd's Register, is judged to have made an outstanding contribution to the improvement of maritime safety or the protection of the maritime environment. Such contribution may have been made by a specific activity or over a period of time. Individuals may not nominate themselves. Nominations are now invited for the 2018 Maritime Safety Award.

Nominations of up to **750 words** should describe the nominee's contribution to:

- safety of life or protection of the marine environment, through novel or improved design, construction or operational procedures of ships or maritime structures
- the advancement of maritime safety through management, regulation, legislation or development of standards, codes of practice or guidance
- research, learned papers or publications in the field of maritime safety
- education, teaching or training in maritime safety issues

Lloyd's Register

The closing date for nominations is **31st December 2018.**

The Award will be announced at the Institution's 2019 Annual Dinner.

Nominations may be made by any member of the global maritime community and should be forwarded online at:
www.rina.org.uk/maritimesafetyaward

or by email to:
maritimesafetyaward@rina.org.uk

Queries about the Award should be forwarded to the Chief Executive at:
hq@rina.org.uk

The Royal Institution of Naval Architects
International Conference:
Historic Ship 2018
5-6 December 2018, London, UK

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From the trader junks of China to the battleships of WW2, historic ships are an important link to our seafaring past. And as the skills and techniques used to construct and operate our historic ships fade out of living memory, now is an important time to highlight the struggles of researchers, enthusiasts and engineers as they preserve and restore our maritime heritage.

RINA's Historic Ships conference returns for a fourth instalment that will not only focus on the restoration and preservation of historic vessels, but also the research and investigation into the engineering and efficiency of historic designs through modern naval architecture techniques.

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Meeting classification demands in the Russian Arctic

As the Northern Sea Route gets busier and vessels more complex, the Russian Maritime Register of Shipping is ensuring ships are fit for polar waters

Shipping operations in the Russian Arctic (also known as the Northern Sea Route) are normally associated with severe ice conditions during the winter season, with a mixture of ice-strengthened commercial vessels and dedicated icebreakers continuously in use in the region.

Arctic technology is a primary focus in the activities of Russian Maritime Register of Shipping (RS). The society has classified numerous ice class ships since the 1960's, developing a solid and trusted regulatory framework. A look at RS's current fleet profile reveals that over 70% of recent newbuilds have some form of ice class notation, including 13 icebreakers and 50 Arctic class vessels.

The shipping industry is keen to undertake bigger and more ambitious Arctic projects, as promising as it is challenging, by designing and building high-tech vessels with state of the art capabilities. In recent years, RS gained considerable experience working with the major shipyards on innovative ice class newbuild projects for the Arctic environment.

These multi-lateral partnerships, with RS serving as a link between the various parties concerned, consolidating solutions, is likely to expand further in the future. Driven by the market's need for new Arctic vessels, RS is responding by updating its requirements in order to accommodate the very latest designs and technologies into classification rules.

In terms of size, the Arctic fleet loosely comprises of two groups: support vessels and large tonnage commercial ships, mainly oil and gas tankers. For tankers of large capacity, the starting point is the 70,000dwt Arctic shuttle tankers with the Arc6 ice class notation that are designed for year-round operation in the eastern Barents Sea.

However, the 170,000dwt LNG carriers (LNGC) serving the Yamal LNG project, which carry the Arc7 notation, have been a game changer. These extraordinary newcomers to the Arctic seas are capable of operating independently in ice of up to 2m thickness and temperatures as low as -50°C. The design features 45MW propulsion power coming from three podded units.

Tankers serving the Yamal LNG project have been certified to RS's Arc7 notation

Building and operating a vessel with such capabilities obviously poses unprecedented risks and challenges with regard to the key aspects of ice class: hull structural strengthening, LNG cargo containment, propulsion power and manoeuvrability and damage stability, etc., as well the need to strike a reasonable balance between design and functional considerations. The wide range of the LNG carrier associated analyses need to be supplemented with further criteria for structural and fatigue reliability of cargo tanks under a combination of loads.

In addition to ice class, there are additional sets of requirements under the 'ANTI-ICE' and 'WINTERIZATION' notations in effect to address the risks associated with long-term operations in harsh environments at very low temperatures. Between them, these class requirements are comprehensively aligned with the provisions of the IMO Polar Code.

In view of the new stricter MARPOL limits to the NOx and SOx emissions, along with local protective measures to the vulnerable polar waters, LNG as a fuel is rapidly developing not only for gas carriers but also for other commercial vessels, including icebreakers. RS is currently in the process of classifying a series of Aframax tankers equipped to use LNG as fuel, as well as having a number of similar newbuilds on the agenda. To complement the industry's fuel innovation, RS has introduced specific notations aspects: GFS (Gas Fueled Ship) and GRS (Gas Ready Ship).

Consequently there is growing demand in the trading areas of Russian fleet for LNG bunkering facilities. In response, RS has updated its regulatory standards with regard to the requirements for LNG bunkering barges and ship-to-ship operations. *NA*

Chemical tanker inert gas compliance

Amendments to SOLAS regarding inert gas systems on chemical tanker newbuilds have led to market repercussions

You only have to glance at Chapter 17 of the IMO's IBC Code to get a sense of the complexity of the chemical tanker segment. The chapter lists the minimum requirements for the safe carriage of almost 200 chemicals, with notes pertaining to the fire protection measures, gauging equipment, and tank vents, etc., needed in each case.

The hazardous nature of many chemical tanker cargoes necessitates such stringent vigilance, especially given the highly variable nature of the chemical segment; some vessels change cargoes often, whilst others carry a single product throughout their lifetime. To coin an apt phrase from Rune Damsgaard, business director at Air Products: "the chemical trade is specialised in diversity."

As with any shipping segment, however, there are regulations pertaining to common safety issues that apply across the board. In contrast to the listings in the IBC Code, which relate to the properties of specific chemicals, these universal regulations are often drawn up or amended in response to actual or forecasted incidents deemed severe enough to warrant an intervention by the IMO and its Marine Safety Committee (MSC).

One recent example regards the installation of fixed inert gas systems. This common piece of equipment delivers inert gas – usually nitrogen – to cargo tanks in order to keep the oxygen level below a percentage at which combustion is possible, preventing explosion. On chemical tankers, inerting can be undertaken after loading but must be done before unloading, at which point inert gas is constantly applied until all flammable vapours have been purged.

Until 1 January 2016, the only tankers required by SOLAS to have fixed inert gas systems were oil tankers above 20,000dwt, which face the risk of self-ignition. However, a series of incidents – including the tragic explosion on Odfjell Seachem's chemical tanker *Bow Mariner* in 2004, which killed 21 crew members – prompted an inter-industry working group to come together and make recommendations to improve tanker safety.

These were debated at MSC 92 in 2013, one crucial recommendation being that fixed inert gas systems be required on all tankers above 8,000dwt – keel-laid after 1st January 2016 – when transporting low flashpoint cargoes (<60*C). The amendment was accepted by MSC, and was written into SOLAS II-2/4.5.5 and II-2/16.3.3, coming into force on 1st January 2016. Further amendments included the lowering of the oxygen limit in inert gas from 8% to 5%.

Westfal-Larsen-owned *Lindanger* is a 186m, 50,000dwt chemical tanker delivered in 2016 that transports and can be fuelled by methanol

The significance of these new amendments is that the majority of new chemical tankers must now be fitted with an inert gas system, in almost all cases using nitrogen. Vessels solely transporting vegetable oil are not technically required to do this, but would be restricted from transporting low flashpoint cargoes in the future. Given the changeable operating patterns alluded to above, the amendments have therefore resulted in almost universal installation of inert gas systems on newbuild tankers above 8,000dwt.

However, as the amendments only affect vessels built from 2016 onwards, there is now what some consider to be an unfair imbalance between older vessels and newer vessels. Pre-2016 vessels, even when transporting the same flammable cargoes as newbuilds, are fully compliant without a system on board. This has an impact on operating costs, as newer tankers must burn more fuel to run the tank inerting system, and may therefore be less attractive to prospective charters. As Damsgaard puts it: "It's rather unfair that ships could be better off taking on cargoes and offloading them without having the extra cost of paying for and operating a nitrogen system. The rules favour less safety-minded operators."

The fact that the amendments don't apply retrospectively isn't unusual in legislative terms. However, in this case the problems are exacerbated due to the unusually long life-span of chemical tankers, which according to Damsgaard can be up to 35 years. Older, less safe vessels will eventually be phased out, levelling the playing field, but for those built in 2015, this could take up until 2050.

Ultimately, the *force majeure* of commercial pressure may offer its own solution. Damsgaard points to "market demand for safer vessels with inert gas systems installed," taking an example from the oil industry of Repsol's requirement that ships loading/unloading at its terminals be fitted with inert gas systems, regardless of size (other well-known oil majors, by contrast, only *recommend* the use of inert gas at their terminal at present). It is certainly possible that chemical producers may similarly require all vessels, even if they are exempt, to be fitted with an inert gas system.

Operators voluntarily retrofitting an inert gas system will also benefit from greater peace of mind, the value of which is easy to understate. As Damsgaard says: "If you inert the tank, it will forgive human error." Whatever size or age a chemical tanker may be, simple mistakes can easily be made when seafarers are faced with an ever-changing cast of chemicals. By reducing the explosion risk, operators similarly reduce the chance of explosive consequences. *NA*

Damage stability considerations for chemical and product tankers

Keith Hutchinson, of Safinah Ltd., and Andrew Scott, of the Maritime and Coastguard Agency, discuss the intricacies and issues associated with establishing the damage stability performance of chemical and product tankers

The transportation of hydrocarbons of various grades and other liquids by product tankers is covered by the International Maritime Organisation's (IMO) International Convention for the Prevention of Pollution from Ships (MARPOL) [1] Annex I 'Regulations for the Prevention of Pollution by Oil', but obviously The International Convention for Safety of Life at Sea (SOLAS) [2] also applies to elements of the design and construction of such ships.

The transportation of chemicals in bulk by sea is covered by SOLAS [2] Chapter VII 'Carriage of Dangerous Goods' and MARPOL [1] Annex II 'Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk'. These oblige chemical tankers built after 1 July 1986 to also comply with the International Bulk Chemical (IBC) Code [3], while for chemical tankers constructed before 1 July 1986, Regulation 11 of MARPOL Annex II requires compliance with the Bulk Chemical (BHC) Code [4], which preceded the IBC Code but remains as a recommendation under SOLAS.

All tankers are excluded from complying with SOLAS [2] Part B-1 (probabilistic damage stability regulations) if they comply with the other specific IMO deterministic damage stability requirements. For chemical and products tankers, the specific instruments are respectively:

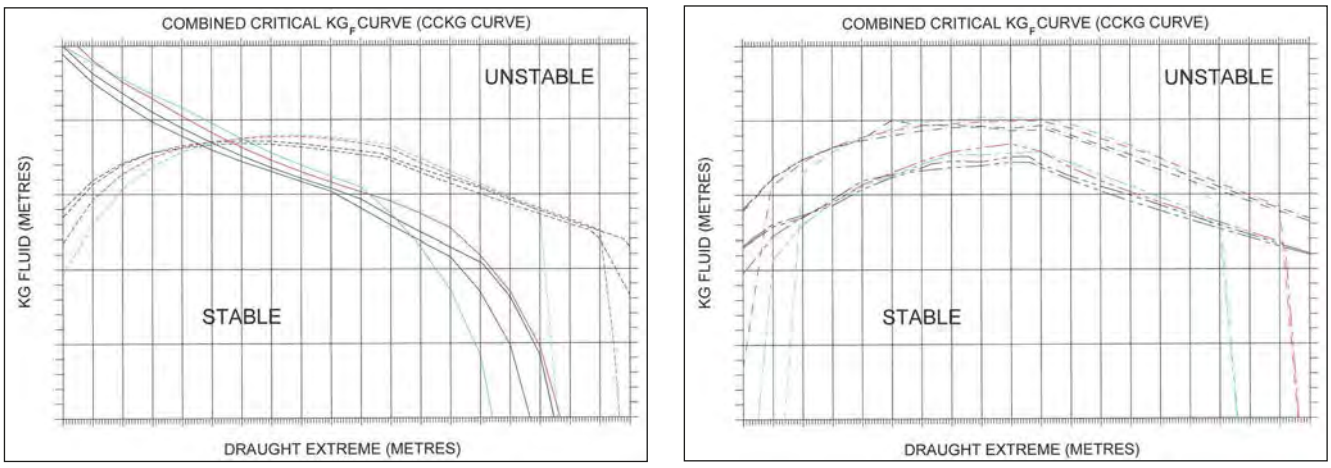
- Chemical tankers: Chapter 2 of the IBC Code [3] – note that under Chapter 17 cargoes are categorised according to their associated environmental and safety hazards; namely Type 1 (very severe), Type 2 (appreciably severe) and Type 3 (sufficiently severe). Hence a Type 1 chemical tanker is expected to survive the most severe standard of damage and its cargo tanks be located at the maximum prescribed distance inboard from the shell to preclude cargo loss whereas Types 2 and 3 have progressively lesser requirements;
- Product, and general oil tankers (except combination carriers with Type B freeboards): Regulation 28 of Annex 1 to MARPOL [1] – noting that tankers of more than 150m in length with Type A freeboards must also comply with the damage stability provisions of Regulation 27 of the International Convention on Load Lines (ICLL) [5].

Fluid loss and cargo specific gravity

Damage scenarios required by the IBC [3] Code and MARPOL [1] are numerous, however the major issue with chemical and product tanker damage stability lies with the complexity of dealing with fluid loss, or fluid deadweight 'drop-out', from damaged tanks which may be filled to various levels and carrying liquids with a wide potential range of Specific Gravities (SG).

For example, if the SG of the liquid in a damaged tank, initially assumed full, exceeds that of seawater then the ship could list away from the damaged side in certain circumstances. Conversely, if the SG of the liquid in a damaged cargo tank, initially assumed full, is less than that of seawater then the ship could list towards the damaged side in certain circumstances. Combining full or partially filled ballast tanks with the above and different extents of damage it can be appreciated that establishing damage stability compliance involves many permutations and hence is complex and time consuming.

Figure 1: Typical intact and side damage critical envelope KG curves, various trims



Loading patterns

For some ships, such as crude oil tankers, the loading pattern, cargo SG and tank filling levels are often predictable and mean that the damage stability can be verified against pre-approved loading conditions in the Stability Information Book (SIB, or Trim and Stability Book) with some confidence.

However, as soon as any tanker loading condition deviates 'significantly' [6, 7, 8] from these fixed conditions, which is quite common for chemical and product tankers, then, strictly speaking, a new damage stability verification calculation is needed which should be approved by the certifying authority before the ship sails. Hence, when such different 'non-standard' loading patterns, consisting of combinations of empty, part-filled or full tanks with possibly different cargo SGs, are allied to an extensive variety of multi-compartment side or bottom damages it is obvious that demonstration of compliance with the damage stability criteria for all potential damage scenarios required in regulations such as the IBC [3] Code and MARPOL [1], etc. is all but impossible other than through use of a Loading Instrument. This is due to the complexity and subsequent volume of information required to adequately convey the damage performance of the ship to the Master.

Some products and chemical tankers are designed to carry a range of cargoes, with a possible range of SGs from 0.7 to 2.1 tonnes. metres^{-3}, in any given tank. For such ships use of a Loading Instrument is again the only solution.

However, for other ships it is possible that intact and complex damaged critical limiting maximum Fluid Vertical Centre of Gravity (KG_f) or minimum Fluid Transverse Metacentric Height (GM_T) curves, such as Combined Critical KG (CCKG) curves as shown in Figures 1 to 3 and discussed below, could be constructed but they are not 'simple' or quick to use by the crew.

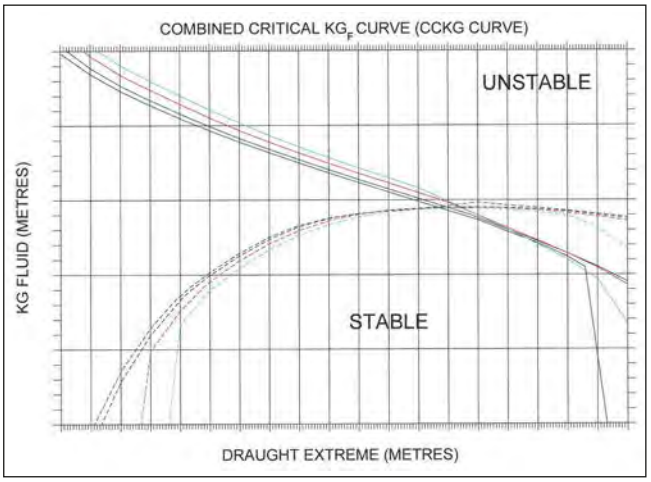


Figure 2: Typical intact and raking damage critical envelope KG curves, various trims

Presentation of damage stability performance

Figure 4 shows a group of critical limiting maximum KG_f curves for a tanker for one assumed degree of filling and SG. The figure is complex and congested as it contains both intact and damage critical limiting curves covering the operational trim range of the ship but all cases of side, bottom and raking damage together with 'exception' cases required to allow the developed loading conditions to be proved compliant against the combined (intact and damage) critical limiting maximum KG_f curves, rather than just by 'direct calculation'. The identification of such exception cases is a complex and time-consuming process and highly dependent upon the range and extent of loading conditions developed. Other similar groups of curves would be required to adequately cover the fill range of the cargo oil and water ballast tanks, namely: nine for 0% / 50% / maximum fill steps; and, 25 for 0% / 25% / 50% / 75% / maximum fill steps; etc.

Obviously, the use of such curves is impracticable and hence, as with intact only curves, it is usual to deconstruct them and group them in 'damage specific' combined critical limiting maximum KG_f curves (see Figure 5). However, splitting the curves into such 'groups' can result in up to 75 separate curves, which would be increased again if consumables such as diesel and fresh water etc. are also considered. The curves described

Figure 3: Typical intact and bottom damage critical envelope KG curves, various trims

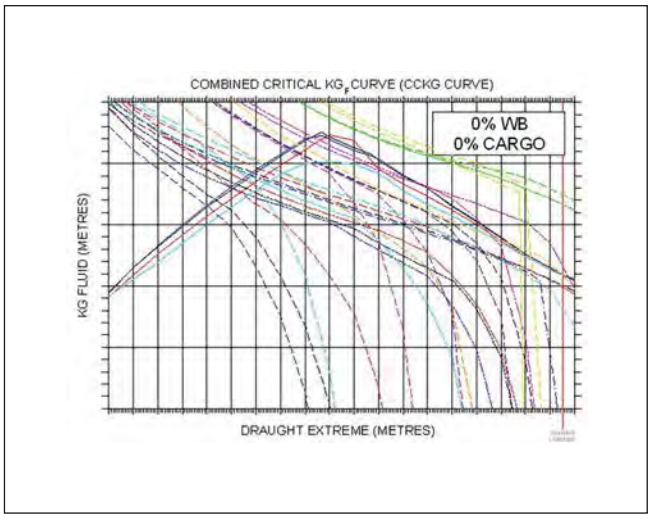


Figure 4: Typical intact and damage critical envelope KG curves, various trims (zone exceptions)

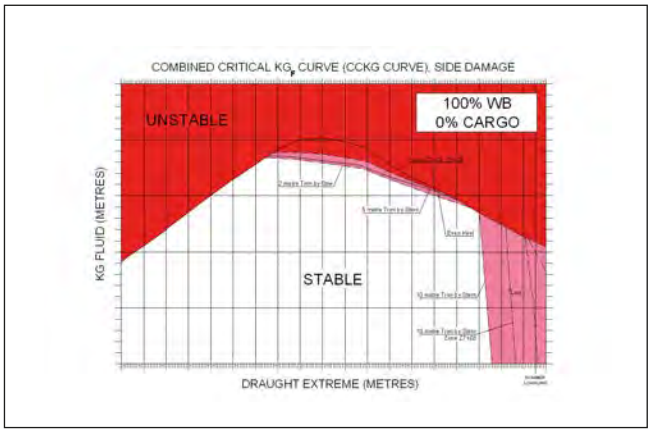
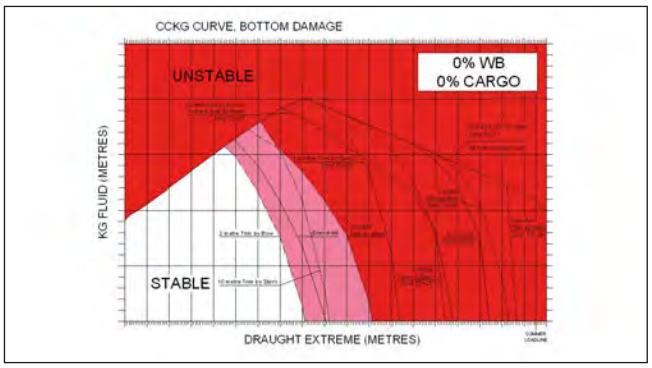
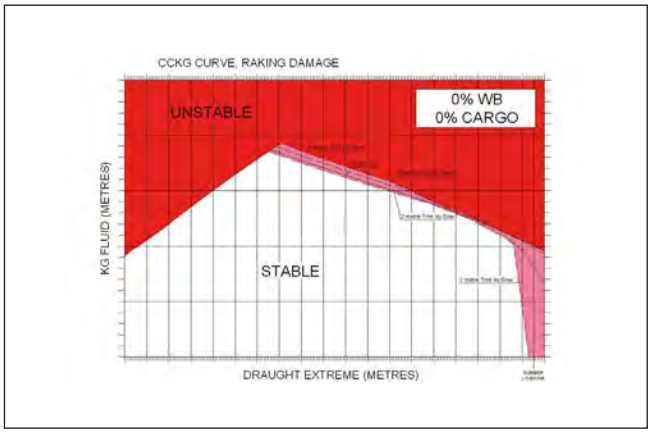


Figure 5: Typical 'generic' CCKG curves





above are 'generic' in nature as the fill levels in each zone can be checked individually and are hence independent of the loading conditions, which is one way that 'deadweight drop-out' curves are commonly produced. However, they are still dependent upon the SG of the cargo and if this varies then 'SG specific' curves would also have to be provided.

It is more common in tankers, if combined critical limiting maximum KG_f curves are presented, to do so in the form of 'condition specific' curves such as those shown in Figure 6. These graphs present specific sets of curves for 'typical' loading conditions and advise any specific requirements for loading, of either cargo or ballast tanks, to comply with damage stability. Also shown on these are curves for differing SGs.

It should be noted that this does not account for differing levels of consumables, such as fresh water and oils etc., but only cargo and water ballast. However, for some designs the level of these can be crucial regarding damage stability and the production of CCKG curves that accurately describe the maximum operational envelope of the ship.

Hence, the application of any CCKG curves obviously requires substantial time for interrogation, interpolation and calculation to ascertain if the ship is safely loaded. Therefore, many shipbuilders only give intact critical limiting maximum KG_f curves and only provide 'direct calculations' (in the Damage Stability Book, DSB) on the loading conditions given in the SIB which limits the loading of the ship to these conditions and promulgates the misconception among loading officers, as discussed previously in [9].

Developments and recommendations

It is the view of the authors, and the United Kingdom's Maritime and Coastguard Agency's (MCA), that a Loading Instrument capable of carrying out all the required damage stability calculations for the specific loading conditions in question, departure and arrival, is strongly recommended for all chemical and product tankers [10]. It should run Type 3 software using the actual hull and compartment model and fully account for any free surface effects in

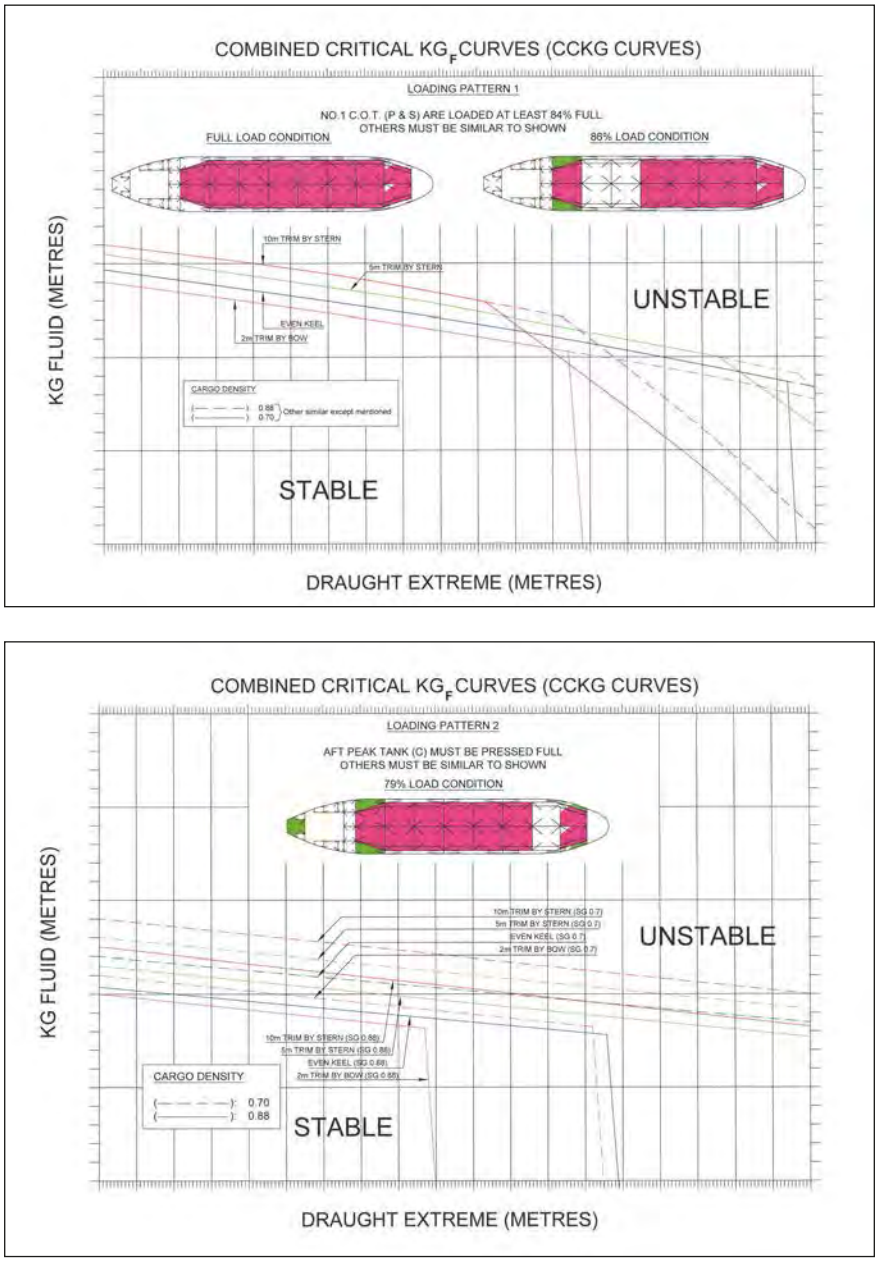


Figure 6: Typical 'condition specific' CCKG curves (with various fills and SG)

undamaged tanks. It is also felt that such systems should offer recommendations on how to change the loading condition if any of the damage cases fail. It should also have an 'off-line' training mode to train the crew using 'what-if' scenarios.

New guidelines regarding on-board stability Loading Instruments for tankers are being prepared by the MCA in the form of a Marine Guidance Notice (MGN). It is hoped that this will be published in 2019, upon which it will be outlined and discussed with readers of *The Naval Architect*.

Disclaimer

The views expressed in this article are those of the authors and do not necessarily represent those of the organisations with which they are affiliated and the professional institutions of which they are members. *NA*

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The perfect storm

Norwegian weather routing specialist StormGeo says its acquisition of chart provider Nautisk will bring together the best of both worlds in a single integrated platform

Route optimisation has become a critical component in the drive towards optimisation, particularly with the increased fuel costs that will come with the 2020 sulphur cap.

Weather routing has, in a manner of speaking, been a part of navigation for as long as ships have sailed the seas. However, the modern definition – that of providing mariners with a forecast of expected storm tracks in order that they might plot a favourable course – really began with the US Navy during the Second World War. The 1950's saw the introduction of weather routing for merchant shipping and aviation, and the market has grown exponentially.

The goal is not so much to avoid bad weather as finding the most favourable conditions in order to minimise transit time, fuel consumption and risk to the ship, cargo and crew. But in the nascent era of the digital ship, and constant streaming of data between ship and shore, it has become possible to integrate routing with navigation planning (a requirement under SOLAS) and companies are now seeking to incorporate it into a suite of navigation solutions.

Among these is weather intelligence provider StormGeo. Founded in Bergen, Norway, in 1997 as a spin-off of a TV broadcaster, it initially began by offering customised weather services for hydroelectric power generation, before expanding into offshore. StormGeo's move into commercial marine culminated in the takeover of Silicon Valley-based Applied Weather Technology (AWT) in 2014 making it the industry's largest provider of digitalised route optimisation services.

StormGeo's weather routing platform will soon be integrated with Nautisk's passage planning

Nautisk acquisition

At SMM in September, StormGeo announced the acquisition of navigational chart provider Nautisk, with a view of integrating weather routing with state-of-the-art chart publications into a single solution. According to Svein Kåre Giskegjerde, StormGeo Group's head of shipping, it was a natural move. "There's hardly any overlap between our businesses and given the presence we have onboard 9,000 vessels, plus an additional 3,000 with Nautisk, we have a fantastic base to build on," he says.

Nautisk is one of the biggest providers of paper charts, and most mariners still prefer to have some form of physical backup. But with the requirement for most large ships to be installed with an electronic chart display system, or ECDIS, nowadays charts are as likely to be downloaded during transit than physically delivered while a ship is portside. Hence in recent years Nautisk has adapted its chart expertise into navigation software.

Added to that, advances in technology are driving demand from shipowners to keep a closer eye on a vessel's activities at sea, with an increasing number of decisions now being taken shoreside, where previously the ship's master had greater latitude. "Although everyone will obey the captain in the end, they want the transparency to see as much on shore as they can at sea," explains Giskegjerde.

The first integrated package will be launched shortly, although a 'single screen' solution won't be available until around the middle of 2019. Giskegjerde says the platform will have a modular approach, allowing customers to take one or both of the navigation planning and route optimisation tools, as well as the option to link to services by other providers.

Seakeeping

StormGeo also has a strong involvement in seakeeping, having acquired Stockholm-based specialists Seaware AB eight years ago. Its BVS Seakeeping tool monitors relevant thresholds for acceleration, lashings and potential cargo damage during adverse weather and includes an optional sensor for real-time support. The motion data derived from these sensors is used to make recommendations to the Master in terms of adjustments to the speed and heading.

Giskegjerde says: "The Stockholm team are all naval architects and, compared to regular route optimisation software, the seakeeping element factors in more ship-specific data into the model. That makes it a little more demanding in terms of setup for the first vessel in a class, but the benefits are that much greater. At the moment it's primarily used on ro-ro's such as car carriers and container vessels. Wilhelmsen are a big user and it's been proved in specific cases where they've been afraid of parametric rolling.

"So this is another component that we'll integrate into the new platform, along with the navigation planning, route optimisation and ship reporting tools." *NA*

FORAN Users Meeting (FORUM) 2018

Eric Tupper reports from Spain on the latest in a series of biennial events focused on the latest development's with SENER's CAD/CAM platform

Delegates at FORUM 2018

SENER's FORUMs are an opportunity for users and developers to get together and discuss any problems with the current system, changes users would like to see and improvements proposed by the system designers. Much of the change, desired and proposed, is due to developing technology and modified regulations, coupled with the growing power of modern computer systems.

This year the meeting was held in Alcalá de Henares, Spain, on the 4 and 5 October. Roughly half the time was devoted to presentations by SENER staff on the features of the latest version of FORAN and future developments. The remainder was devoted to a series of round tables in which speakers introduced various topics considered of interest to users, followed by a general discussion. The general impression gained was that the clients felt they had been provided with a very good system but they would like more. This desire for more capability and applications reflects the considerable success of the system so far, for which SENER can justly take pride.

Delegates, nearly 90 from 10 countries, were welcomed by Rafael de Góngora, general manager of SENER Marine followed by Jorge Sendagorta, SENER Corporate general manager. Since the last FORUM, SENER has maintained its clear vision of the way ahead for FORAN and has continued to devote considerable resources to its development. This commitment will continue. FORAN is used internationally to produce many significantly different ships/structures, and with interest in design, construction and maintenance. The core systems must be adaptable and capable of linking smoothly with the varying design office and shipyard systems.

Following the welcoming address, Rafael Martinez-Abarca described the 'Main Features of the New Version of FORAN – V80r3.0' – due for release at the end of October 2018. Compared to V80r2.0 the system capabilities have been enhanced to provide users with the best tools available to improve their efficiency in design and reduce the total shipbuilding cost. The overall consistency and reliability have been improved and there is more automation of processes.

New features include multi-format import/export commands, new drafting software supporting automatic dimensioning, calculation of metacentric height (GM) in intermediate flooding states, and the new stability requirements for the Australian navy, DEFAUS 5000. FDEFIN includes automatic creation of a FORAN file from suppliers' definitions. Looking beyond this to later systems there will be a new visualisation engine, Intelligent Assistant Integration (with IBM) and access to FORAN from mobile devices with FORAN available in the Cloud.

Next, Alicia Ramírez Gutiérrez presented 'New Functionalities NAC/Hull Structure'. A major improvement for the NAC (Naval Architecture Calculations) modules is a unique space for solid models and interface shortcuts to improve system performance and visual appearance of spaces defined in FGA. It will also impact on other FORAN modules. New commands have been introduced to improve the FHULL module and drafting changes to improve productivity.

Following this, Benigno Villar reviewed 'New Functionalities for Outfitting/Electrical'. Improvements have been made in the exchange system which is the set

of mechanisms that enables FORAN to export its 3D model to CAD files in different formats and to import 3D data from files created by FORAN itself or other CAD systems. A library of models can be created from 3D CAD files of differing formats. The aim has been to have as versatile a system as possible. In the 'clash list' the system will tell the user the distance between each pair of FORAN entities.

Roundtable discussions

The round tables were arranged in two simultaneous tracks, with delegates attending that which was most relevant to them.

1. 'New Technologies. Shipyard 4.0', chaired by Jesus Angel Muñoz. This considered the digital transformation (known as Industry 4.0 in industry generally) as applied in the maritime sector. There are many factors involved in selecting a suitable digital transformation strategy and these need to be discussed.
2. 'Outputs and Openness of the System', chaired by Rafael Martinez-Abarca. It has always been important that marine CAD systems should be able to interact as easily as possible with users' individual internal systems. Current FORAN systems give users several options but a new and innovative system is being developed (a FORAN Application Programming Interface) to give a real and deep openness.
3. 'Modelling. Rule Based Design', chaired by Alfonso Cebollero. The aim is to make the CAD system as smart as possible to reduce design errors, reduce time and increase overall efficiency. To this end, design rules may be embedded in the system from the design stage. The rules may be those of the regulatory bodies, shipyard standards, owner requirements or 'best practice'. Some are obligatory and others may be preferences. Discussion included a description of ARIADNA (Automatic Routeing in Accommodation by Numerical Analysis). Pipe systems can be designed to give runs of minimum weight. The overall aims are to reduce shipyard load and improve the quality of ships.
4. 'Applicability. Sister Ships', chaired by Rodrigo Pérez. This discussed the applicability, advantages, opportunities and challenges of revising processes and tools to manage and share information across all shipyard departments, taking as an example improving the management of sister vessels as well as the management of data during the total lifecycle. Aims include a reduction of design time and improvement of procurement management.

Day two

The following day opened with two special presentations. First, Luis Sánchez Fernández presented 'Immersive Virtual Engineering for Shipbuilding', Virtual Reality (VR) has been used in many branches of industry and has many practical applications – training, marketing, surgery, museums, robotics and so on. As part of the FORAN portfolio SENER provides FORAN-IC.IDO, a powerful solution for agile, high fidelity, virtual ship prototyping using real time physics and an advanced user interface. It provides an immersive product experience helping users gain a full understanding of the ship project and its environment from the early stages. Also presented was a new solution for Ship Walkthrough Computer Model (SWCM) that is being developed by SENER/OCC (Open Cascade/Cap Gemini) and is very useful for crew training sessions.

This was followed by 'Artificial Intelligence', presented by Jesus Angel Muñoz. There are many ways in which AI is used in marine CAD applications and SENER is in partnership with IBM to offer its customers a solution that integrates AI with FORAN. But there is clearly a long way to go before we achieve true AI in the sense of a machine actually thinking, reasoning and reacting as a human being and a large investment of time and money is needed. In the interim improvements are being made by systems responding more intelligently to questions posed. Machine learning uses statistical methods to improve performance with experience. One problem is posed by the desire to make use of the large amounts of legacy data available in a multitude of formats.

The final session of the meeting opened with a presentation by Roberto Fernández and Maria Estela Fernández on 'Quality Plan and Services'. One definition of quality is the degree to which a product provides customer satisfaction and full customer satisfaction is SENER's goal. The quality of FORAN internally is ensured by certification under ISO 9001 (SENER is the first engineering company in Spain to receive this certification), ISO 14001 and OHSAS 18001 (H&S in the workplace). It is important not only to follow approved procedures but to be able to demonstrate that this has been done. Aims include reducing time and effort to correct errors, and increasing effectiveness in detecting errors. Many tools are used to ensure things are done as well as possible. It costs to ensure high quality, but the costs of failure are higher.

Ongoing improvements

To complete the technical sessions Rafael Marinez-Abarca discussed the FORAN Development Strategy. CAD systems must be flexible and smart to meet the expectations off the marine industry. These include continuous improvements in processes, in cost savings and improved overall productivity. SENER's aim is to help industry produce better and cheaper ships more quickly. There are medium- and long-term (up to 2025) plans for developing FORAN. Although ORACLE has performed well as a database, alternatives are now being considered, such as greater use of virtual reality techniques and 3D printing. During FORUM 2018 there were virtual reality demonstrations of two main systems showing how users can interact with designs. Although SENER have clear ideas for the way ahead, and a programme for implementation, customer feeedback is welcome and may lead to changes in the prioritising of developments.

Rafael de Góngora closed the meeting by stressing SENER's continuing commitment to the development of FORAN. He had a clear vision of the way ahead. Customer wishes will be considered, but SENER will concentrate on the core system that can be adapted for diverse users. He thanked all those who had attended, those who had presented and contributed to the discussions and those who had made all the arrangements for such a successful meeting.

Overall SENER will regard this FORUM as a success although they might perhaps have liked more input from the users in the discussions and round table sessions. *NA*

Intelligent cranes for bulk carriers

A joint project between MacGregor and ESL Shipping has developed the world's first autonomous discharging cranes, with self-learning capabilities

As the Baltic is the location of some of the busiest ports in northern Europe, safe and efficient transit and delivery of cargo is critical to commercial success. One of the biggest players in the region is Finnish ESL Shipping Oy, which operates a fleet of more than a dozen dry bulk and general cargo vessels and prides itself on 'just in time' delivery of goods.

In August and September of this year, ESL took delivery of the sister ships *Haaga* and *Viikki*. Billed as the world's most eco-friendly bulk carriers, both the 160m, 25,600dwt Handysize vessels are fuelled by LNG, with the additional capability of ultimately being powered by carbon-free biogas when this is readily available. The two ships, which have now both traversed the Northern Sea Route to arrive at their base of operations in the Baltic, form part of the Bothnia Bulk project, an EU part-funded venture which aims to modernise the traffic between Luleå, Oxelösund and Raahe.

In 2017, while the two ships were already under construction at Jinling Shipyard in Nanjing, China, it was announced that ESL and marine cargo handling specialists MacGregor, a subsidiary of Cargotec, were undertaking a joint project that would see *Haaga* and *Viikki* become the first bulk carriers to be equipped with autonomous self-discharging cranes. Although the vessels haven't entered service with this function operative it is hoped to make it active following further testing in the latter part of this year.

Using a combination of advanced sensor technology, cameras and laser scanners, the cranes' software is able to analyse the topography of each cargo hold and determine the optimal lifting points. Meanwhile, an 'intelligent' self-learning algorithm will automatically adjust to ensure the bucket is not overloaded and to compensate for heeling so that the vessel is unloaded evenly. The algorithm can also calculate which shoreside hopper to discharge the cargo onto, based on that hopper's capacity.

ESL's newbuild bulker *Viikki* and its sister ship *Haaga* are equipped with MacGregor's advanced crane technology

Long association

Mattias Sundström, Director of Sales and Handling for MacGregor's Cargo Handling Division, tells *The Naval Architect* that when ESL (via Jinling) contracted MacGregor to provide the two ships' cranes, autonomous mode wasn't part of the plan, although MacGregor had been developing the system independently for several years. But the two companies have a long association, including several ESL vessels equipped with similar cranes

"Even though *Viikki* is a bulker we handle it like a general cargo ship because the hatch covers are foldable. The autonomous crane is part of our K-crane series," he explains.

Haaga and *Viikki* are each equipped with three electro-hydraulic cranes, with a safe working load (SWL) of 30tonnes and a reach of 30m. One of the major advantages of bringing autonomy to crane operation is the system can co-ordinate the movement of the cranes more efficiently than would be possible for a human carrying out the same task, avoiding safety issues such as collisions between cranes or pendulation of the grabs while moving cargo.

"An experienced crane operator might be able to unload quicker [than a computer] if there's just one crane, but when there's three they need to constantly consider where the other cranes are. Normally we have what we call an anticollision system, meaning the cranes reduce speed, but haven't previously had the capability to know exactly where they are," explains Sundström.

As well as avoiding the risk of an accident, MacGregor also believes that the autonomous system will extend the service life of the cranes, since it will always calculate the most efficient way of getting to the discharge point. "It's like a car, you don't push the full gas all the time. Similarly, an experienced crane driver will know exactly how to do this so that it's full power then reduce it by half, meaning that all the hydraulic and electric motors have soft controls."

Naturally, the technology is a little bit more expensive than conventional lifting equipment, but the two ships will be operating predominantly on short routes with lengthy spells at harbour, and the cranes have been designed to be capable of almost 24/7 operation, which mitigates for the additional investment. The agreement between ESL and MacGregor also dictated that the cranes should be remotely operable from the bridge or even, theoretically, shoreside.

The communication module, described as the backbone of the system, essentially mimics a crane driver's desk and can be located wherever the operator has a clear view of the crane position and topographic cargo map. Cameras located on the crane jib top and the top of the crane housing make it possible to look down directly into cargo

hold and surroundings. To ensure there are no human injuries while discharging, and in accordance with existing requirements, there are also safety systems to ensure people don't encroach the unloading zone.

Other applications

Beyond the partnership with ESL, Sundström says that several other companies have expressed some interest, although the overall weakness of the dry bulk sector at present means there have been few active enquiries. It's more likely that certain elements of the technology, such as the grab's learning capability, will be adapted for use with other systems, although the expense involved involved suggests it will be deployed on newbuildings rather than retrofits.

There may also be applications outside of dry cargo. "We foresee this might be the link to fully automated container terminals. There's a lot less space to work in than with a big grabber unloading onto a big pile or hopper, but it is possible. We've had some enquiries from container ship owners as well, both at land and on sea, as a means of controlling where they place the different boxes and their different weights. At present they're still in the Stone Age, working with big Excel files and trying to do it all themselves. So when they see something like this they go a bit crazy."

Another opportunity could be breakbulk. At SMM in September, MacGregor launched its Breakbulk Optimiser, an automated cloud-based application for the calculation and stowage of breakbulk and general cargo, making it possible to plan more effectively for last-minute changes in the itinerary and improve utilisation. The software can even be applied across multiple vessels.

MacGregor, like many other companies, has a vision in the future of a fully automated port where a ship might arrive at its destination in the middle of the night and start discharging immediately, without any need for stevedores or human intervention. Increasingly the obstacles are less those of technological readiness than the absence of a supporting regulatory framework to make it permissible.

Indeed, the cranes themselves are still awaiting formal classification in order to be able to operate autonomously. Sundström explains: "I know that DNV GL [which classed the two ships] are interested in discussing it, but so far nothing has taken place, and that was at the request of the shipowner.

"From our perspective it would be useful if the classification societies provided more advice on what we can and can't do. That's a little bit outside our box, because usually the class rules are the basis of everything we do and I know they're eager to learn and be involved. But we're confident that we've designed this system as we believe it should be." *NA*

DIGITALISATION

Log books enter the digital era

As digitalisation sweeps the industry even the humble paper log book is set to change, delivering benefits for both efficiency and compliance, writes Prevention at Sea's George Ellinas

The winds of change are hitting the shipping industry with executives being forced to re-evaluate the way they traditionally conduct business. Ongoing overcapacity coupled with a soft global demand, requirements for added-value deliverables at cheaper prices and faster delivery, along with new environmental regulations and security risks are just a few of the present-day challenges faced by the shipping industry.

However, it is commonly accepted that the operational model and practices of the shipping world have more or less remained the same over time. Daily routines and workflows remain unchanged, meaning complacency sets in which, on occasions, becomes a threat. It is also recognised that requirements and regulations that were put in force a long time ago are still valid to this day with only minor alterations, whilst new regulations are simply added on top of the existing ones, causing confusion.

Furthermore, the industry is facing a shortage of seafarers that is expected to increase in the future, and will most likely force academies to reduce the time spent on education and training, as the market pushes for a quicker turnaround of seafarers.

These developments have left ship operators with no option but to undertake the burden of monitoring every single task or operation and intervene when a risk is about to escalate.

And it does not stop there. Ship managers need to gather more and more data from vessels to optimise fleet or crew performance, while at the same time ensuring that any lack of knowledge is identified early through data analysis.

The above industry challenges have been identified by Cypriot company Prevention at Sea, which places its focus on updating the paper log book systems that create an unnecessary burden for shipowners and crew.

As we are all well aware, seafarers work, live and sleep onboard around the

clock, under noisy, dynamic and stressful conditions. Lack of adequate rest without a doubt results in fatigue which adversely affects the seafarer's performance, significantly increasing the likelihood of accidents, wrong actions and decisions.

Complying with rest hour requirements has proved to be a challenge for seafarers and vessel operators. Getting proper rest periods each day is not enough as this also needs to be proved to the authorities. The ISM code and Port State Control have in recent years become stricter on seafarer rest hour requirements, emphasising the need to record every event onboard including both rest and work hours. This adds to crew's administrative burden and adversely affects efficiency.

Beyond paper

Having identified gaps in existing paper based tools used for recording rest hours, Prevention at Sea developed and released RH Manager, a software application designed to assist seafarers in properly recording, calculating and monitoring their working and rest hours on board as set out in STCW, MLC 2006, OPA 90, 46 US Code 8102.

Users of the RH Manager software are able to visualise the various log books used for the ship's internal purposes by recording events connected to the seafarer's daily tasks as well as the ship's operations. This allows the user to identify whether the log book records coincide and whether recorded events across log books are date and time stamped. The software enables the user to easily insert data and instantly evaluate any rule violations, by providing accurate notifications of the time period of the violation and the relevant regulation.

Vessels are further required to keep manual records of all oil storage, discharges and incinerations in an oil record book (ORB). Traditional paper-based ORB recordings can result in illegal actions as crew enter incorrect information relating to date, time and actions performed. Regardless of whether these illegal actions and incorrect entries are intentional or not, they are inevitably detected by the authorities, and illegal discharges in the sea may have already occurred.

By having the right technology in place, such actions can be flagged well in advance as suspicious. This lead Prevention at Sea to create the ε-ORB software program.

Prevention at Sea's business development manager George Ellinas

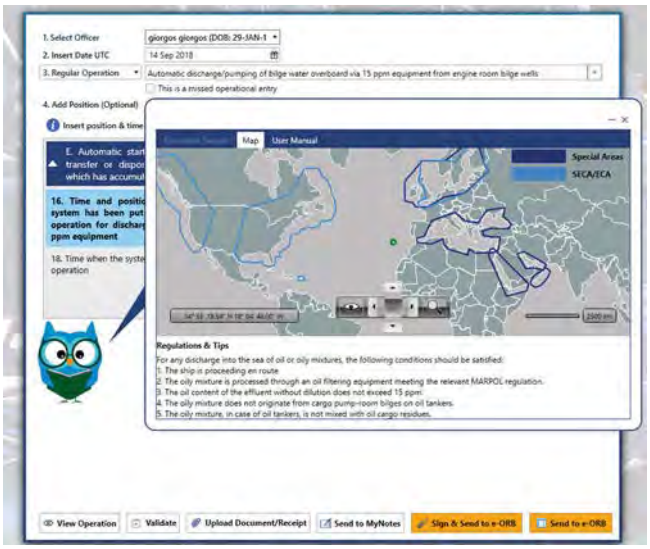
ε-ORB is Lloyd's Register certified and is the first electronic oil record book developed to facilitate compliance with the requirements of International Conventions and Flag Registries with regards to the ORB. The software was designed to assist seafarers in traditional paper ORB record keeping until such time as MARPOL amendments come into force (i.e. allowing for paperless record-keeping) when the ε-ORB will allow software transparency and traceability regarding ORB entries. By not allowing users to 'edit' records, actions not permitted by existing regulations cannot be entered, aiding owners with compliance.

Existing regulations and requirements with regards to ORB are based upon handmade entries; however, nowhere in MARPOL does it say that the ORB entries must be handwritten. In fact, the requirement for signing (using a physical signature) immediately once an operation has been completed is a frustrating obligation for shipowners, who will benefit from this process being handled digitally. The assurance that an action is legal before being signed off also helps to prevent uncertainty.

Facing change

The biggest challenge Prevention at Sea had to overcome in digitising paper log books was the human factor. The company states that the perception existed that the paper ORB was more secure and efficient than the electronic system. Some were afraid of the audit trail functionality that the technology offered. Others were afraid of the limitations faced during data transfer ashore. However, approval from all major flag registries reflects the secure nature of the solution.

Developing widely recognised maritime software products is not an easy task and the key to success is the will of maritime technology companies to heavily invest in learning how the shipping industry actually operates. Prevention at Sea has been working towards this aim for the last four years. Despite initial resistance by the industry, the current trend indicates a glowing future for maritime software product development as the operational benefits become more apparent. *NA*



Screengrab from ε-ORB advising on regulations surrounding automatic discharge

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