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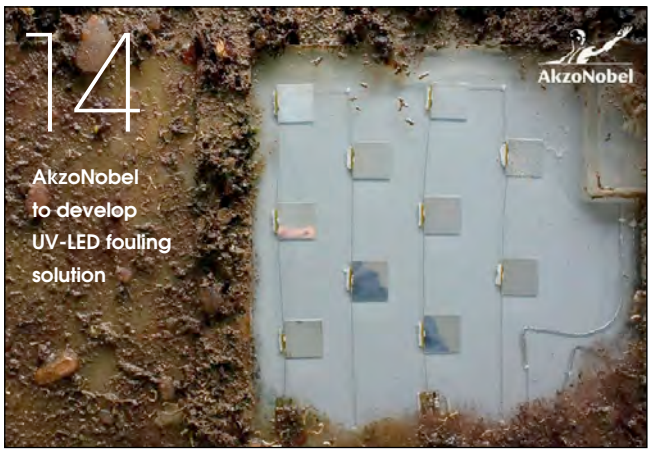

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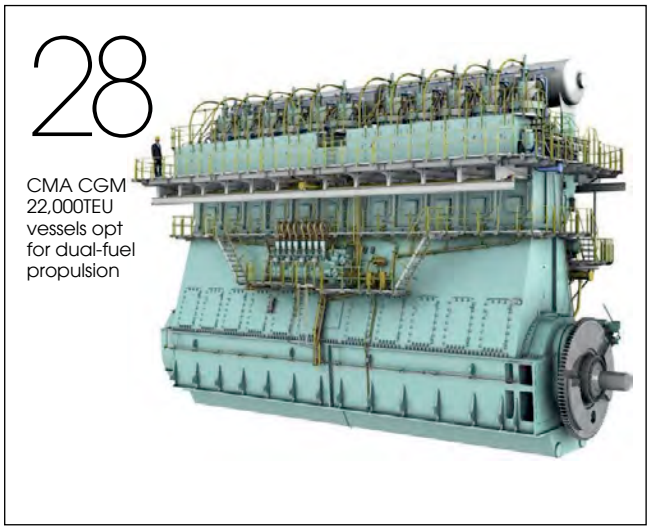

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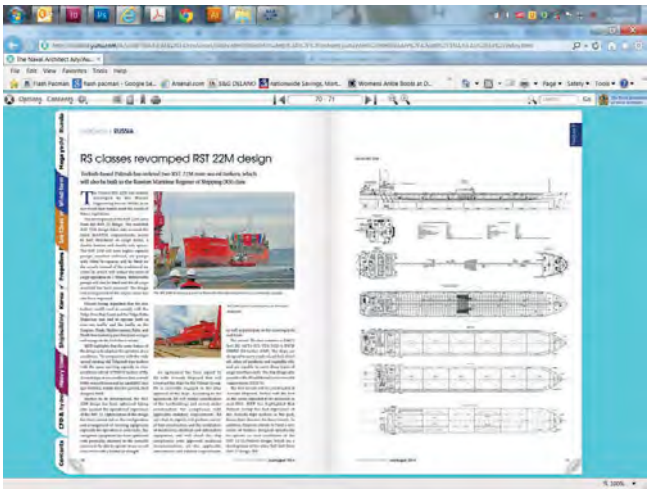

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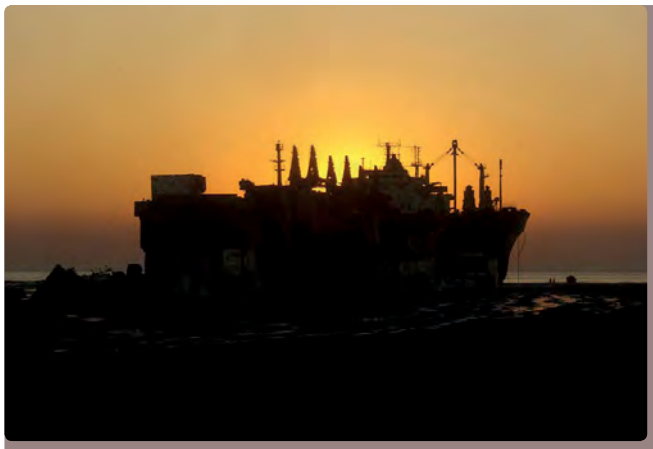

Hong Kong blues

Could the sun finally be setting on irresponsible ship scrapping?

One piece of IMO legislation that may soon be stirring back to life is 2009's International Convention for the Safe and Environmentally Sound Recycling of Ships, or Hong Kong Convention (HKC). The HKC was intended as an all-encompassing agreement to address all the issues surrounding ship recycling, taking into account the disposal of hazardous materials which may be contained within ships sold for scrap and the sometimes appalling working conditions of those employed at recycling facilities. It also has implications for ship construction, given builders and owners will be expected to produce Inventories of Hazardous Materials (IHM) for their vessels.

Under the terms of the HKC's adoption it must be ratified by 15 Member States, representing 40% of global gross tonnage, yet hitherto only 10 countries have formally signed up, an estimated 21% of global tonnage. But with the EU's own Ship Recycling Regulations (EU SRR) – which are closely aligned to the HKC and come into effect at the end of this year – expected to see publication of an extended list of approved recycling facilities, possibly including Asian recycling yards (as well as defining a greater number of hazardous materials), there is growing confidence progress may be imminent.

"In real terms the push has already begun," John Stawpert, the International Chamber of Shipping's spokesperson on Environment and Trade, recently told me. "The efforts by the recycling yards in India and Bangladesh to meet or exceed requirements mark significant progress towards making the HKC a reality."

Stawpert explained that Member States' reluctance to ratify is partly due to the balancing act inherent in the HKC's Entry Into Force criteria; put simply there are insufficient suitable recycling facilities to process the scrapped tonnage that would be affected, meaning that realistically ratification needs to be a stepped process. Nonetheless, he adds, after a sluggish start the "big players" in the industry are showing real determination to make the HKC a reality.

In 2016, ICS published an update version of its guidance 'Transitional Measures for Shipowners Selling Ships to Recycling' to reflect the experience of the changing landscape and the implication of the EU's Regulations. As further evidence of that commitment Stawpert points to the escalation in development of the IHM.

But much still depends both upon the owner's capacity to initiate this process and the resources of the facility to which the vessel is eventually sold for scrap. Moreover, the provisions of the HKC become murkier with regard to the sale of a vessel to a third-party scrap dealer, otherwise known as a 'cash buyer'. Technically when the cash buyer becomes the legal owner of the vessel then the previous owner is relieved of all responsibility.

In fact, the real problem with the HKC, and reason for its stalling, appears to be that it never went far enough, leaving all parties frustrated. "We have strongly criticised the HKC for not providing adequate solutions to the global shipbreaking crisis, and for setting a standard that will simply rubberstamp the practice of breaking apart end-of-life vessels under conditions that cause harm both to the environment and the workers" explains Ingvild Jenssen, founder and director of the NGO Shipbreaking Platform.

Jenssen notes that these concerns extend to the Statements of Compliance (SoC) some classification societies are issuing to facilities such as the Shree Ram yard in Alang, India. Recent vessels to be sent for recycling there include the *Maersk Wyoming* and *Maersk Georgia*, in what is widely perceived as a U-turn of the Danish shipping company's much-vaunted progressive recycling policy. Jenssen notes that Shree Ram outsourced its environmental monitoring of the facility to a third party consultant, Cherry Green Environment, whose data results from soil and water sampling there indicated nil copper – an impossibility given the high copper content of anti-fouling paints.

Class societies, in their defence, will argue that they are service providers and facilitators, not legislators. Vessel scrapping cannot be put on pause, not least because other regulatory pressures make it impossible to operate them profitably, and the result is a muddy compromise.

In effect the EU SRR is poised to become the de facto global standard, particularly given its tougher stance on downstream waste management and possibility the EU will decide to adopt a financial incentive in the form of a return scheme for vessels trading in its waters. Given the EU is also threatening the industry about its failure to fix CO_2 targets, or the widespread embarrassment many feel about the debacle of the Ballast Water Management Convention, there's a growing sense the industry needs to start acting more affirmatively. *NA*

Classification

Bureau Veritas to offer e-certificates

Following the path of e-certification pioneers ClassNK and more recently DNV GL, Bureau Veritas has announced that it too intends to offer e-certificates, after DNV GL's scheme has reportedly been taken up by over 50,000 vessels since October last year. BV's e-certificates, which it has been issuing for services such as shipping container inspection since 2017 and are complaint with IMO guidelines FAL 5/Circ.39/Rev 2, will now be extended to vessels.

Applicable to 52 flag states, which make up 72% of the Bureau Veritas classed fleet, the e-certificates will, BV argue, "make life simpler for masters, ship owners and their staff as the related paperwork is time-consuming and can be expensive." The classification society plan to deliver the e-certificates through email as well as its Veristar digital platform, accessible via desktop or the My Veristar mobile app. To ensure security, the e-certificates host an electronic signature feature developed by Cert Europe. Their authenticity can be verified through a web portal accessible using a scannable QR code, private URL or tracking number search.

Laurent Hentges, VP of operational excellence and information systems, stated: "Our e-certification capability now provides the industry with the opportunity to benefit from further digital efficiency – reducing administration, reducing costs and improving accuracy with peace of mind, under-written by a secured solution."

It remains to be seen whether other classification societies, including LR, ABS, and CCS, will follow in the months ahead with their own e-certification schemes.

Methanol

Businesses invest in four new methanol-fuelled vessels

Four 49,000dwt vessels powered by clean-burning methanol fuel are to be constructed at Hyundai Mipo Dockyard in Korea for Waterfront Shipping Company Ltd., Marinvest/Skagerack Invest, IINO Kaiun Kaisha Ltd., Mitsui & Co. Ltd. and NYK Group. Waterfront Shipping Company, which already charters a fleet of seven methanol-fuelled ships, will be chartering the four new vessels, owning two of them in a partnership with Marinvest. IINO and Mitsui will jointly own one of the vessels, with the fourth owned solely by NYK.

The vessels will feature MAN B&W ME-LGI dual fuel engines that can run on methanol, fuel oil, marine diesel oil or gas oil. Methanol has been hailed as a promising alternative fuel which, according to DNV GL's 2015 report 'Methanol as marine fuel: Environmental benefits, technology readiness, and economic feasibility' creates life-cycle emissions 45% lower than conventional fuels if produced cleanly, the number dropping to just 8% for SOx emissions. Given the IMO's 2020 sulphur cap, methanol represents an attractive fuel option, with demand expected to increase as operators seek to meet increasingly stringent emissions regulations.

The new orders come after Waterfront Shipping Company celebrated a year's safe operation of their initial seven methanol-fuelled ships

Commenting on Waterfront Shipping's decision to charter four more methanol-fuelled vessels on top of the seven already in their fleet – bringing the total percentage of methanol-powered vessels up to 40% – Paul Hexter stated: "Our seven methanol-fueled vessels have been operating safely and reliably since 2016, and we expect these new vessels to benefit from ongoing technological advances that will continue to optimise performance and efficiency."

René Sejer Laursen, promotion manager at MAN Diesel & Turbo, suggested that "this new order confirms the ME-LGI concept as a mature technology. Since this dual-fuel engine entered the market in 2016 , its price has dropped considerably, which makes it an even more attractive option. Allied with its environmental credentials and convenience of use when employing methanol as a fuel, we are confident the ME-LGI will continue its promising progress."

Autonomous shipping

China to build autonomous ship test facility

In a first for Asia, China has begun the construction of a test field for autonomous and unmanned ships in Guangdong province. Dubbed the Wanshan Marine Test Field, the facility is located off the coast of Zhuhai and will span 225sq nautical miles. A collaborative team of academic, industry and government partners, including Zhuhau municipal government, CCS, Wuhan

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University of Technology and Yunzhou Tech, will be responsible for the project.

The steady development of autonomous ship technology has necessitated the establishment of dedicated facilities such as Wanshan, which allow researchers to test features such as autonomous steering, routing, and collision prevention in a safe and controlled environment. The Wanshan site will join Kongsberg/NTNU's Trondheimsfjorden site in Norway and the Jaakonmeri Test Area in Finland, managed by DIMECC. It will be substantially larger than the two European facilities when completed, making it the largest in the world.

As well as providing safe water for autonomous vessel testing, the facility will also feature navigation radar, a telecommunications network, and automatic mooring systems, which will be constructed on the small islands that fall within the test zone.

China's investment in the Wanshan Marine Test Field follows the launch of the first Chinese 'smart ship,' Great Intelligence, in December, and suggests that China aims to position itself as a marine technology leader to rival Europe in the near future.

LNG

First LNG-fuelled bulk carrier delivered

The world's first ever bulk carrier fuelled by LNG, *Ilshin Green Iris*, has been delivered by Korean companies Hyundai Mipo Dockyard and Ilshin Logistics, completing a contract signed in July 2016.

Classified by Lloyd's Register and Korean Register, the 50,000 dwt vessel is compliant with the International Gas Fuel (IGF) Code, and represents the first milestone in a wider project to develop eco-friendly bulk carriers.

Notably, the vessel features a Type 'C' LNG fuel tank developed by POSCO, which is constructed with austenitic high manganese steel and located on the aft mooring deck, and has a capacity of 500m^3. With a high manganese content of 26%, the tank has been created with cryogenic LNG and liquefied gas storage application in mind. LR were involved in the development of this new tank material and design, certifying and approving the steel plus the necessary welding technology and tank design in July 2017.

The vessel will reportedly transport limestone cargoes in Korea for POSCO. Propulsion will be provided HYUNDAI-MAN B&W 6G50ME-C9.5-GI, a dual-fuel high-pressure gas injection engine, and the LNG supply system will feature both high and low-pressure vaporizers, a high-pressure pump, and a glycol water heating system.

JT Lee, LR's Chief Representative & Marine Manager for Korea, stated: "I am very excited and proud to see the successful delivery of the world's first 50,000 dwt LNG-fuelled bulk carrier with contribution from LR for the certification and approval. This outstanding achievement is also attributed to a concerted effort between industry partners, with their pioneering spirit and tenacity. The successful delivery of the vessel should be a significant indication to the market of a reasonable and solid solution to the preparation for emission compliant eco-friendly designs."

Ilshin Green Iris features a Type 'C' LNG tank

Ro Paxes

OSK-ShipTech to design RoPaxes for record order

Danish naval architecture firm OSK-ShipTech has created the concept design for four luxury RoPaxes which, once complete, will represent the largest ferry order to date.

Owned by MSC Group's GNV and Onorato Armatori, who will take two each, the ferries will be constructed at Guangzhou Shipyard International. Each will have a capacity of 3,765 lane meters, and will contain 536 cabins, hosting up to 2,500 passengers each. The contract also reportedly allows an option for four additional ferries, but even without the extra vessels, the order is a record-breaker. The ferries have so far been described as having a modern and clean look. They will also be clean environmentally; LNG-ready, they will feature a suite of energy optimisation technology.

Commenting on the order, OSK Group CCO Anders Ørgård said: "Our two largest clients are now doing business together, so to us, this is a dream-scenario, where we are appointed designers on the basis of earlier projects and long-term successful cooperation with all parties. This is such a significant project, and this order is a fantastic opportunity to bring our competencies, the yard's strength and the owners' joint pool of many years of experience into play." Adding to Ørgård's comment, CEO Jacob Thygesen stated: "Both in Danish standards, but on a global scale as well, this is in any possible way a significant order in the current RoPax market."

2021 will see the delivery of the first vessel to GNV. *NA*

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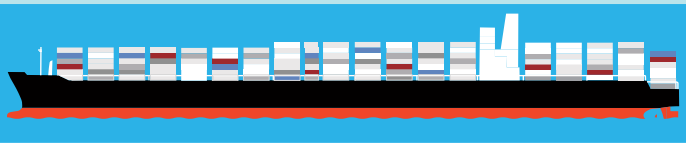


ClassNK

What next for Rolls-Royce?

Rolls-Royce's planned restructure follows a rollercoaster decade of growth and decline. With Commercial Marine now up for review, Malcolm Latarche considers the division's future

It is no secret that the reversal of fortunes in the offshore sector that began five years ago has had an adverse effect on Rolls-Royce Marine's and the Rolls-Royce Group's own bottom line. So the announcement in January that Rolls-Royce was once again restructuring its set-up and that the future of the Commercial Marine division was being considered probably came as no surprise to some analysts.

In 2013, offshore oil and gas accounted for over 60% of the Marine division's revenue and a decade or more of continued growth had put the business in a relatively healthy position. With offshore having been virtually the only profitable sector in shipping since the 2008 crash, Rolls-Royce's lack of involvement in other sectors was considered a strength against its competitors.

In Norway, Rolls-Royce had embarked on a buying spree acquiring several local specialists such as Scandinavian Electric Holdings, ODIM and Smartmotor in 2008, 2010 and 2013 respectively. In addition it had also taken over German engine builder MTU in 2011. During 2013, before the price of crude began its dramatic decline, Rolls Royce had made a reported $8bn play to acquire Wärtsilä. In January 2014, the talks between the two were ended just weeks after Rolls-Royce lowered its profits guidance for the year.

The next few years were not so kind to Rolls-Royce Marine, with the decline in offshore impacting severely on orders and revenue. Several rounds of job cuts resulting in more than 2,000 redundancies did nothing to quell investor disquiet and there were several attempts by speculators to force the company to reduce its involvement in marine or to divest entirely.

New CEO Warren East was drafted in in mid-2015 to restructure the group and turn its fortunes around. The January announcement was the latest shake up to Rolls-Royce's structure and implied that the future of the Commercial Marine sector might lie outside of Rolls-Royce with a review of the business to take place this year.

This sparked ideas that the whole of the marine division including engines would be up for sale although the announcement was quite clear this was not the case. Rolls-Royce later clarified this by confirming that the engine and propulsion business would remain with the group inside its new Power Systems division.

What the announcement was clear about was the extent of the effect of the offshore slowdown. Since 2015, the Marine division has divested non-core businesses and reduced the number of sites from 27 to 15 – an overall reduction in footprint of 40% – and cut employee numbers by 30% to 4,200.

Specific mention was made of the company's leading position in ship intelligence and automation, concluding with the statement: "It is only right that we consider whether its (the Commercial Marine division) future may be better served under new ownership."

With the power section's future firmly within Rolls-Royce, the only activities up for review would appear to be specialist offshore equipment production, ship design – although some capability will need to be retained for serving the defence sector – and ship intelligence and automation projects.

From a shipping industry viewpoint, the latter has been the centre of the company's activity since former Wärtsilä director of Concept Design, Oskar Levander joined Rolls-Royce in 2012 as VP Innovation. It has certainly given the company some positive publicity to offset the poor financial performance with demonstrations of remote operation of real vessels and the opening of a state-of-the-art research facility in Turku, Finland just a week after the announcement of the restructuring in January.

Interest in automation and unmanned ships has attracted some governmental support in a number of European countries and in China and Japan. Aside from Rolls-Royce the major players would appear to be Wärtsilä, Kongsberg, ABB and perhaps Siemens. It might be thought that autonomous ships would be of great interest to Rolls-Royce's defence customers and that retention of this aspect would therefore be desirable for that reason alone.

If Rolls-Royce decides to retain its interest in autonomous ship projects, then the only possible divestment looks to be diesel injection specialist L'Orange and the offshore machinery operations. The sale of L'Orange – acquired in 2014 when Roll-Royce took full control of the MTU/Tognum operation is reportedly under discussion and expected to raise around $950M.

That would leave the offshore machinery, mostly specialist winches and cranes. This is a competitive field with several other players active and presumably also suffering from poor sales. Whether any of the rivals would be a potential purchaser is debatable, however.

Of course there is always the possibility that a revival in offshore could persuade the company to drop the idea of any divestment and no doubt things will become clearer as the year progresses. *NA*

Coatings

AkzoNobel to develop UV-LED fouling solution

Dutch coatings manufacturer AkzoNobel has announced its intention to work with Royal Philips in creating a pioneering and "economically-viable" fouling prevention coating that utilises ultraviolet light-emitting diodes.

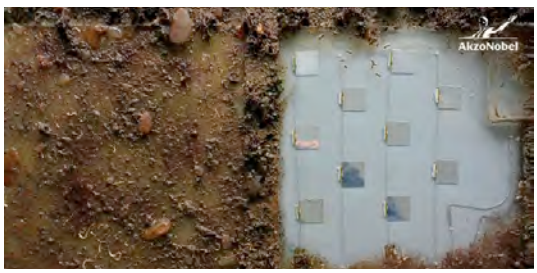
Well known for introducing the maritime industry's first biocide-free coating in 1996 – Intersleek – AkzoNobel says that it remains committed to developing environmentally friendly solutions, of which UV-LED technology is the latest. Oscar Wezenbeek, AkzoNobel marine and protective coatings director, stated: "In our Sustainable Fouling Control initiative, we actively explore and develop alternatives to biocidal-based solutions. This development is a great proof point of our continuous focus on delivering eco-friendly solutions to our customers."

UV light-emitting diodes will be integrated in a "functional film" within the coating, preventing biofouling by sterilization, a technique that AkzoNobel claim will deliver total prevention of biofouling accumulation. The product will initially be developed for use on ships, yachts and offshore, but "could possibly be extended to include other surfaces challenged by biofouling issues."

Commenting on the joint project, Klaas Kruithof, chief technology officer at AkzoNobel, said: "In our quest to not only protect and colour, but also functionalise surfaces, we actively look for complementary technologies and partners to innovate with. In this case, the combined capabilities and technology of Royal Philips and AkzoNobel will enable us to accelerate the realisation of this transformative innovation, which we intend to initially market ourselves and consider licensing out to third parties for large-scale adoption."

AkzoNobel has not yet announced a timeline for the development and release of the coating, suggesting the project is still in an early phase.

www.akzonobel.com



A mock-up of the proposed LED fouling prevention coating in action

Performance monitoring

Eniram launch SkyLight 3.0 and partner with Concirrus

Wärtsilä-owned Finnish software engineering company Eniram has launched the latest update to its Skylight service, Skylight 3.0, also confirming a new partnership with Quest developer Concirrus.

First launched in 2016, Skylight is a subscription-based fleet performance monitoring tool that collects fuel usage, speed and performance data in real time, sending them to Eniram to combine with meteorological reports in order to model speed and fuel efficiency. The data is then fed back to ship owners, operators and fleet managers via the cloud, allowing them to optimise the operation of their vessels and save on fuel costs.

New features in Skylight 3.0 include the introduction of mobile device updates about speed over ground and water, ETA, and charter party compliance, plus virtual propeller RPM sensing. The most significant part of the update, however, is Eniram's new partnership with Concirrus, developers of the marine insurance underwriters' application Quest. The data collected by Skylight 3.0 will be integrated with Quest, which allows marine insurers to manage their risks on a real-time basis by providing insight into the operational performance of their client's vessels/fleet(s). Because the data collected by Skylight will now be available to both insurers and clients, it will "provide a transparent and shared view of risk, with tailored insurance that allows customers to pay only for what they need".

Andrew Yeoman, CEO of Concirrus, commented: "The future of marine insurance has now arrived with the Eniram and Concirrus partnership […] For fleet operators, the Eniram technology facilitates safe, efficient operations and has the added benefit of lowering risk. Insurers can now offer innovative, connected policies that reflect the needs of their customers and reward safe operations. For insurers, this means that the market now has a new segment of lower risk, responsible operators who can be incentivized with innovative insurance products."

www.eniram.fi

Ballast water management

ISO to work on ballast water standards with industry experts

The International Organization for Standardization (ISO) has announced that it is working on two new chapters for ISO 11711: Ships and marine technology – Piping and machinery – Ballast water sampling and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analysis. In order to develop the new standards, the ISO has consulted a number of governmental organisations and businesses, including France's Aqua-tools, Denmark's DESMI and the US Navy.

Published in 2013, 11711-1 advises on the materials, design and installation of sampling equipment used to sample treated ballast water from vessel discharge pipes. However, the standard does not provide guidance on how take samples, or analyse the ballast water for compliance. In order to rectify this, 11711-2 and 11711-3 are being developed. Together with 11711-1, they will "provide shipboard personnel as well as port and flag state officials with a standard for verifying whether the BWMS is working as intended."

The companies and organisations that will participate in the creation of the new standards must first demonstrate their status as an expert in their field to their national standards organisation and then subscribe to the committee, in this case ISO/TC 8. At this point, they can choose to either be an active contributor or simply an observer. Aqua-tools, for instance, will work with Association Française de Normalisation, and has chosen to be an active contributor to the new standards, building on its experience at the IMO BW Working Group. In January, the company supported the French Maritime Administation at the IMO Subcommittee on Pollution Prevention and Reponse (PPR5), advising on ballast water analysis methods.

www.iso.org

Servicing

Wärtsilä and CSSC to service WinGD engines

Swiss two-stroke engine manufacturer Winterhur Gas & Diesel (WinGD) have announced the signing of an agreement with CSSC Marine Service Co. Ltd and Wärtsilä Services that renders them authorised global service providers.

Valid from the beginning of 2018, the agreement will allow the companies to deliver spare parts, provide service engineers, recondition components, train crew, and upgrade solutions, amongst other services, for WinGD two-stroke engine brands, which include Sulzer, Wärtsilä and WinGD.

The rights of manufacturers to service their own engines have not been affected. WinGD has further confirmed that its own warranty and customer support will continue alongside Wärtsilä and CMS undertaking scheduled or preventative maintenance and carrying out long term service agreements.

Commenting on the agreement, WinGD director of operations DR Rudolf Holtbecker said: "It was important to us that Wärtsilä Services remained a key partner. Having been the sole global service provider for many years, they have an extensive global footprint with a full-service solutions portfolio in the lifecycle support for two-stroke engines. CSSC Marine Service, a new company in the two-stroke engines service market, provides additional customer choice and the opportunity to diversify the offered services meeting a larger variety of customer needs."

Service agreements offer ship operators greater flexibility in engine maintenance decisions

www.wingd.com

Fleet management

LR endorse Hanseaticsoft cloud software

Lloyd's Register has announced that it is to work with Hamburg-based Hanseaticsoft, whom the classification society invested in last April, to promote the company's Cloud Fleet Manager software to LR clients.

Citing the problem faced within shipping process management of incomplete, inconsistent or unavailable information, LR suggests that simple processes often take much more time than they need to as information must first be gathered, with much difficulty. What is required is a tool that enables crews, shipping company employees and agencies to work in an interconnected and efficient fashion by facilitating data exchange and management.

As such, LR is promoting Hanseaticsoft's Cloud Fleet Manager, an application-based software platform in the cloud which centralises data and makes it available to all parties who require it, quickly, consistently, and easily. Examples given of applications in CFM include Inspections & Audits, Schedule & Agents, Purchase, and Crewing.

Hanseaticsoft's MD, Alexander Buchmann, was quoted in the announcement as saying: "The cloud is being embraced by some of the world's leading shipping companies… Having up-to-date and reliable information available in real time supports better decision making, helps companies reduce costs, increases the return on investment and drives economies of scale from a single ship to the fleet."

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Economic operation analysis of Chinese shipbuilding industry in 2017

The China Association of the National Shipbuilding Industry's (CANSI) report suggests continued improvement but raises concerns for the future

In 2017, China's shipbuilding industry achieved good results in three major shipbuilding indicators: continuous improvement of products and industrial structure, integration of industry and finance, and the improvement of shipbuilding industry quality and international status. However, due to the profound adjustment of the international shipbuilding market, deep-rooted problems such as the difficulties in financing, delivery and profitability persist and the situation facing the shipbuilding industry remains severe.

Qingdao Beihai Shipbuilding Heavy Industry Co BSIC) – one of the shipyards of China Shipbuilding Industry Corporation (CSIC) located in Qingdao

Fundamental situation

It was a case of two up and one down in the three main national shipbuilding indicators. In 2017, the national shipbuilding completion volume was 42.68 million deadweight tons, a year-on-year increase of 20.9%, and the new ship orders were 33.73 million deadweight tons, an annual increase of 60.1%, whereas at the end of December, the shipbuilding order book was 87.23 million deadweight tons, down 12.4% compared to the same time of the previous year.

Moreover, there was continued growth in ship exports. In 2017, China completed 39.44 million deadweight tons for export ships, up 17.9% over the same period of the previous year. New orders for export ships were 28.13 million deadweight tons, up 72.9% year-on-year. At the end of December, the order book for export ships was 78.68 million deadweight tons, down 14.7% annually. Export vessels accounted for 92.4%, 83.4% and 90.2% of the national completed shipbuilding orders, new orders and the order book, respectively.

From January to November in 2017, China's total ship exports amounted to US$21.07 billion, an increase of 4.4% over the same period of the previous year. Among the exported ships, bulk carriers, oil tankers and container ships still dominated, with a total amount of US$12.88 billion, accounting for 61.7% of total export ships. These ships were exported to 181 countries and regions, but still mainly to Asia. China exported US$11.07 billion worth of ships to Asia, accounting for 52.5% of the total export ships. Ship export to Europe was US$4.12 billion, accounting for 19.6% of the total while ship export to Oceania amounted to US$2.79, accounting for 13.2% of the total.

But the shipbuilding sector did report declined returns. From January to November in 2017, the total revenue from their core businesses of the 1,407 national scale shipbuilding enterprises was 590.04 billion yuan, down 8.2% from the same period of the previous year. The further breakdown of the revenue was as follows: the shipbuilding industry 279.19 billion yuan, down 5.9%; ship supporting industry 84.53 billion yuan, down 6.1%; ship repairing industry 20.69 billion yuan, down 26.2% and offshore engineering equipment manufacturing industry 41.69 billion yuan, down 12%, all compared to the same period of the previous year.

These shipbuilding industrial enterprises achieved a total profit of 14.18 billion yuan, down 15.9% from the same period of the previous year. The further breakdown of the profit was as follows: the shipbuilding industry 7.5 billion yuan, down 35.4%; ship supporting industry 4.53 billion yuan, down 10.3%; ship repairing industry 0.69 billion yuan, an increase of 38% and offshore engineering equipment manufacturing industry 0.77 billion yuan, turning loss to profit, all compared to the same period of the previous year.

Economic characteristics

In 2017, the global shipping market bottomed out and the new ship market stayed active. Chinese shipbuilding companies seized the favourable opportunity from market recovery and actively expanded the market. China's international market share ranked first in the world in terms of all three main shipbuilding indicators, i.e. the annual shipbuilding completion volume, orders for new ships and the size of the order books which were 41.9%, 45.5% and 44.6% of the global market, respectively. The industrial concentration in Chinese shipbuilding industry has also been further enhanced and, in 2017, the top 10 shipbuilding companies in China accounted for 58.3% of the shipbuilding completion volume in the country, an increase of 1.4 percentage points over 2016. The new orders received also showed a noticeable trend in favour of the dominant enterprises and the new orders gained by top 10 companies accounted for 73.4% of the national total. The Chinese mainstay shipbuilding companies have clear advantages and their core competitiveness has continued to strengthen; five enterprises entered the top 10 globally in terms of completion volume and 4 companies entered the world top 10 in terms of new orders.

The key Chinese shipbuilding enterprises have continued to increase investment in scientific and technological innovation and product structure was continuously improved. A series of high-tech and high value-added ships were successfully developed and a number of high-end ships and offshore engineering equipment delivered, including the world first smart ship of 38,800tons, the most advanced 6,000ton subsea rock installation vessel, an 84,000m^3 capacity very large gas carrier and diving support vessels. These companies have received new orders for high-tech ships and offshore engineering projects including the world's largest dual fuel container ship of 22,000TEU, a 174,000m^3 LNG carrier, an LNG floating storage and regasification unit (LNG-FSRU) of 174,000m^3, and 300,000tons floating production storage and offloading (FPSO) vessels. The ratio of the compensated tonnage and DWT reached 0.34 for the new order ships.

Chinese shipbuilding enterprises followed the demands of the market closely and continued to strive for the brand development of the leading products. For example, Nantong COSCO KHI Ship Engineering Co. Ltd. (NACKS) has undertaken upgrades on ship types such as large container ships and clean energy ships and developed its own brand featuring good performance, high quality and advanced technology. In 2017, seven projects in the shipbuilding industry won the National Science and Technology Award and four newbuilds were selected as individual champions in the second national manufacturing product championship: a capesize bulk carrier from Shanghai Waigaoqiao Shipbuilding Co (SWS), a dual fuel liquefied ethylene gas carrier from Jiangnan Shipyard (Group) Co (Jiangnan shipyard), a medium range product tanker from Guangzhou Shipyard International Company Limited (GSI) and an engineering vessel from CSSC Huangpu Wenchong Shipbuilding Company Limited (CSSC Huangpu Wenchong).

Market segmentation

In 2017, in response to the current lack of market demand for new ships of the three main ship types in recent years, China's key shipbuilding companies proactively pursued market development via meticulous market segmentation and promoted market exploration with remarkable achievements in special vessel types, river and ocean-going intermodal transport ships, small and medium-sized boats and offshore fishing vessels. The world's first liquid ethane gas carrier with independent tri-lobe C type tanks was successfully delivered and China also saw the launches of the world's first 25,000-ton LNG high-pressure dual fuel bulk carrier, Asia's largest self-propelled cutter suction dredger, *Tian Kun Hao* and China's first electric powered self-unloading cargo ship.

China's offshore equipment manufacturers took the initiative to cultivate new growth areas and actively embarked on the development of markets not directly related to oil and gas such as marine mineral resources, marine biological resources and ocean space resources. The companies have delivered the world first deep-sea semisubmersible automated offshore fish farm, *Ocean Farm 1*, multi-functional ocean farm jackups and the manned submersible *Shenhai Yongshi* (meaning 'deep-sea warrior') in succession. The ultra-deep-water twin tower semisubmersible drilling rig, *Bluewhale I*, assisted China in making its successful initial natural gas hydrate (combustible ice) find in the ocean and the world's first deep-sea mining vessel project is making steady progress. Other new areas under active development include an offshore wind power farm, offshore gas power generation vessels, floating power generation and seawater desalination rigs, offshore waste power generation ships, integrated marine entertainment platforms and offshore hotels.

Lean management

In 2017, the global shipping and shipbuilding markets remained sluggish. Facing such tough problems in gaining orders, vessel delivery and remaining profitable in the face of a changing market and customer needs, Chinese shipbuilding enterprises made great effort in transforming product strategy, technological innovation and their management approach, through lean management, cost control, intelligent manufacturing, risk prevention and other measures to reduce costs.

The construction efficiency of companies under the China Shipbuilding Industry Corporation (CSIC) continued to improve. For example, the first 72,000ton product tanker built by Dalian Shipbuilding Industry Co was launched 17 days ahead of schedule and the construction cycle time of the very large crude carrier (VLCC) in dry dock was continuously reduced. Huangpu Wenchong meanwhile continued to increase efficiency and reduce costs through rigorous implementation of budget managements, cost specific management, positive efforts in procurement management and other measures to 'restrain outgoings', reducing costs in excess of RMB300 million. Through a roof solar panel project, JINHAI Heavy Industry saved 10% of the yearly electricity cost and by introducing ship repairing robots, Zhoushan IMC-Yongyue Shipyard and Engineering Co raised the average working efficiency by three times.

In-depth integration of production and finance

China's ship financial leasing business continues to develop rapidly and has gradually become the main customer for newbuildings. According to incomplete statistics, in 2017, Chinese-funded financial leasing companies such as ICBC Leasing, MINSHENG Financial Leasing, China Development Bank Leasing and Bank of Communications Financial Leasing have ordered in total more than 300 ships of 10,000tons or greater from Chinese shipyards.

2017 also saw international maritime regulations become increasingly stringent, especially with regard to emission requirements. In order to meet the new requirements for environmentally friendly products, China's shipbuilding supporting enterprises increased R&D of core technologies and strengthened product development and market expansion. Among highlights were completion and delivery of the world's first micro-pilot ignited dual-fuel engine, the first domestic low-speed marine diesel engine with self-developed high pressure selective catalytic reduction (SCR) system and the world's largest marine propeller. There was also the independently researched and developed electric marine winch with active heave compensation, the CS21 marine medium-speed diesel engine, full speed anti-rolling fin, R6 level mooring chain and the GCS1000 gearbox. Meanwhile, the SunRui BalClor Ballast Water Management System (BWMS) developed by SunRui Marine Environment Engineering Co. became the first Asian BWMS to achieve type approval from the United States Coast Guard. *NA*

Aye, Aye, A.I. – Digital Trends in the Maritime Industries

The 17th Conference on Computer and IT Applications in the Maritime Industries (COMPIT) will be held 14–16 May 2018 in Pavone, Italy. Organiser Volker Bertram of Stellenbosch University, Department of Mechanical and Mechatronic Engineering, offers a unique preview for *The Naval Architect*

Over the past two decades, COMPIT has established itself as a key conference in information technology (IT) for the maritime industries, bringing together software developers and users. The 2018 edition is signalling a shift from classical CAD towards Big Data and artificial intelligence. The conference lasts three full days, and each day has four sessions:

- Day 1: 'Let me challenge your design paradigms', 'Game Changers in Design', 'Smart Simulations', and 'Digital Twins, Really?'
- Day 2: 'Boldly Exploring Design Spaces', 'Smart Yards', 'Big Data & Machine Learning', and 'A Different Game thanks to VR & Co'
- Day 3: 'Achtung, Baby!', 'Smart Navigation', 'Unmanned Ship on the Horizon', and 'Get Real on Artificial Intelligence'

While the initial structure of the conference moving from concept design to operation is still vaguely visible, the distinction between the different phases of the life-cycle has become increasingly blurred. 3D design models are re-used in operation, and operational (big) data is piped back into design. The key message seems to be that processes, people and 'things' get increasingly connected.

This year, the main trends seen in COMPIT are:

- **Appgrades**: Many papers show evolutionary progress. The applications cover traditional tasks, now performed better thanks to new technologies: using apps from the web instead of installed software, smartphones instead of 3D scanning, or Virtual Reality instead of 2D displays for training and instruction.
- **Digital Twins**: From early design to ships in service, product life-cycle management is model-based. The Digital Twin grows and evolves as the real ship does. However, reality in implementations falls soberingly short of the grand vision.
- **AI**: Assorted new developments use the power of Big Data and artificial intelligence (machine learning). AI is embraced as a useful tool, nothing more, nothing less.

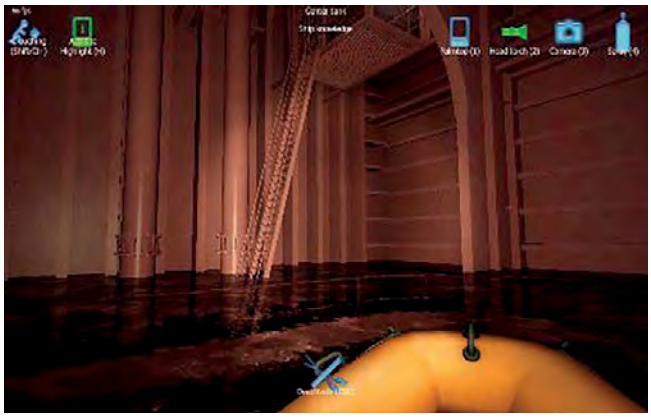
Digital Twins are seen as a game changer – but different people seem to understand different things of what the term means (DNV GL)

Appify me

A relatively new (and somewhat nebulous) term, Appification is the act of turning software that used to be installed on your computer into an App – software that is in the cloud and can be run from your smartphone. Actually, that is quite a smart idea and these Apps are now making their way to the marine world. Appify what can be Appified seems to be the motto this year. Palluch et al. (Friendship Systems and ISA Propulsion) describe a web-based App (webApp) for geometric modelling and design of propellers. The App builds on a well-established design environment CAESES offering selected functionalities via a standard web-browser. Building on CAESES' parametric modelling techniques, a propeller is generated with just a handful of inputs. Its geometry can be downloaded in standard format descriptions, e.g. for CFD simulations or 3D printing.

There are persistent rumours that smartphones are actually sometimes used for phoning other people. But surely, they are busy most of the time with these Apps or other engineering wizardry. Did you know that smartphones can replace 3D scans? This little gem is presented by Fischer et al. (Fraunhofer and Rostock University), who describe new ways of capturing the as-built state of ships. Instead of expensive laser scanners, mobile devices like smartphones are used to create point clouds and ultimately 3D models. During assembly, the 3D model of the ship as-built is then available with precious little time delay. Son et al. (Korean Register) use the smartphone to visualize finite-element models and results. Jacquenot & Maisonneuve (Sirehna) go one step further and use Virtual Reality to visualise CFD results.

Which brings us to Virtual Reality (VR); what we see are increasingly realistic computer generated images with user interaction. While still a far cry from the grand vision of the Holodeck, the technology is advocated for training and instruction. VR training applications are akin to video games – you need to create a sufficiently



If development time and cost can be lowered, VR training applications may become more common

large virtual world to make it interesting, with sufficient level of detail and behavioural realism and with sufficient interactivity and training elements for the player/learner to keep them playing/learning. And that comes at a hefty price. Did you know that high-end video games cost double-digit millions to produce? Even if your expectations are not quite that ambitious, production costs are still often prohibitively high for our industry. This explains why there are so few maritime VR training applications on offer, as found by Bertram & Plowman (DNV GL) in their survey. Friedewald & Meluzov (TU Hamburg) might offer a silver lining on the horizon with their work on bringing development time and cost down, in their case for Augmented Reality based instruction modules as intended for ship services and maintenance.

Digital Twinning

The Digital Twin is a 3D geometry model (= CAD), plus product information (= PDM), plus simulation models (strength, vibration, hydrodynamics, etc.) which are updated to track the changes of this behaviour over the lifetime of the ship. The vision is to have a computer model with the look and feel of the real deal. As with Virtual Reality, the vision is much grander than the reality of current implementations.

Morais et al. (SSI) point out that the "Digital Twin journey" is a rocky one: "While the benefits of a Digital Twin are real, achieving the desired outcome is more challenging than generally thought. Many obstacles, some cultural, some process related, and some technological, commonly appear when trying to create a Digital Twin." The challenges are manifold. Having a 3D model with some CFD or FEA simulation models attached as now in standard design practice is not enough. These models need to be calibrated and updated as the ship ages, e.g. increased resistance due to fouling in the CFD model or adjusting changing steel plate thickness due to corrosion in the FEA model. Erikstad (SAP Fedem) sees in-service measurements and design simulations not as alternatives, but rather as complementary technologies that need to be combined for Digital Twins. In other words, the Digital Twin needs two parents: Big Data from operation and advanced (and easily updated) simulation models.

Niepert & Grau (Prostep) show how a Digital Twin could be used in practice to accelerate design and production, describing model-based class approval and site inspection. Historically, these processes required numerous drawings, transferred between classification society and shipyard. Much time is saved if 3D models are enhanced by functionalities such as digital signatures, annotations that convert directly into data-management systems, search functions, or digital highlighting. With 3D PDF you can create fully customizable 3D documents that serve this purpose. And like 2D PDF documents, the software to read these documents is widely available and free of charge.

Van Os (Siemens) points out that the Digital Twin requires many stakeholders to cooperate if the vision is to come true. The original builder is the shipyard, but the owner will adopt and shape the Digital Twin through life. Suppliers contribute to and benefit from the Digital Twin; they should adapt their approval and inspection processes to serve the Digital Twin. And some of them do already. Moser & Astrup (DNV GL) elucidate how the class verification process could be approached based on the exchange of a Digital Twin. The aim is to establish a fully digital workflow providing a seamless and transparent digital design data exchange between stakeholders during the ship newbuilding basic design stage. They present a digital data exchange schema (DEX) developed for this purpose.

AI is just a tool

One of the often used and rarely understood buzzwords in recent times is artificial intelligence (AI). The time is ripe for demystifying it, as done by Bertram (DNV GL). The take-home message is that there is no need to fear that humankind will be eliminated by a robot revolution. AI is "just an engineering tool", but it is a powerful one and we would be stupid not to embrace the power of Big Data and machine learning.

Perez (Sener) outlines his vision for Big Data and AI based detailed design for ships, where full-scale performance data are piped back into design rules which supplement simulation-based first-principle design. As Perez admits, "some of these improvements may seem unrealistic in the short term, but reality often exceeds expectations". And each journey starts with first steps towards the vision on the horizon. Woo et al. (Korea Maritime & Ocean University et al.) have collected production data from several Korean shipyards and harvested this wealth of data to improve the standard information system for the time factor of process lead time. Xie et al. (DNV GL) look at automatic crack detection on images from drone-based inspections of ships, using machine learning for the pattern recognition.

Artificial meets natural intelligence at COMPIT 2018

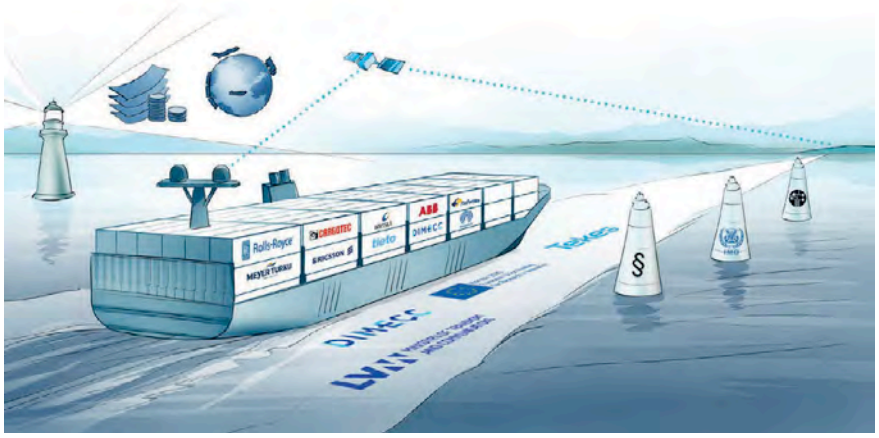
The character of COMPIT is changing, reflecting the general changes in our industry. Not only do we need to learn Digital Newspeak, we need to prepare for a new world of working. Not a revolution, but a fast transition. And movers and shakers seem set to gather at COMPIT this year. The conference promises yet again to be a highlight in this year's calendar for anyone interested in how the digital revolution is transforming our maritime industries. *NA*

Autonomous shipping ecosystem by 2025 in sight for One Sea

Despite being ahead of schedule, regulation, resistance and lack of common standards remain challenges for the Finnish initiative

Digitalisation of the shipping industry and the development of an autonomous shipping ecosystem is a wide ranging task and in addition to purely technical and regulatory matters, it requires a great deal of psychology as well, says Päivi Haikkola, head of One Sea in Finland.

One Sea, an ecosystem of companies under the management of DIMECC – Digital, Internet, Materials & Engineering Co-Creation – seeks Nordic and global partners to join the research collaboration and aims to create a new industrial standard for marine traffic and to lead the way towards an active commercial autonomous shipping ecosystem by 2025.



The One Sea ecosystem brings together nearly 80 project partners, including Wärtsilä, Rolls-Royce and ABB

"The digitalisation of marine traffic will create new opportunities for the whole marine industry and pave the way for new business ventures and models, spanning commercial and passenger traffic to raw material freight and cargo handling," One Sea states on its website.

The key area of focus in the work of the network has changed over time, Haikkola tells *The Naval Architect*. "We are ahead of schedule in that many companies that are part of the network have rolled out new products. The key challenges at the moment are in the area of regulation, such as the IMO and other international regulators. We need to develop regulation that works and this has been harder work than we had anticipated," she says.

Another major focus area in the work arises from the fact that the network comprises many companies and it is necessary to find IT solutions that have adequate communality so that they will work together. "Companies that are fierce competitors are working together on a pre-competition level," Haikkola said, adding that the aim is to develop common standards on which future systems would work.

Shipping as an industry is often seen as conservative, having a mindset that resists change. Haikkola suggests that many structures in shipping are old and dated, and experience from other sectors has shown that digitalisation can break them down. "This seen both as a source of fear and opportunity in shipping," Haikkola says, adding that the industry does employ many people that are forward thinking.

Perhaps inevitably, there remains skepticism among those who work at sea. "Recently, I delivered a presentation to a group of seafarers, some of whom were retired and one of whom said that in his view, nothing could replace the human eye on the bridge," Haikkola says. But when she then told the audience that by combining sensors it would be possible to produce a view of the situation around the ship that would exceed what is possible to the human eye, they agreed.

At another meeting with seafarers, a master mariner with many years experience at sea recalled an occasion when he had to turn his vessel in a location that had strong currents and bad visibility. He put the vessel on autopilot and admitted that he would not have been able to perform the manoeuvre himself.

"We want to take careful steps forward and take into account their consequences," Haikkola continues. While it is possible to leave engine rooms unmanned for a period of time, current regulations stipulate that two persons must be on the bridge at all times and performing other tasks during the watch is not permitted. "If we think of a vessel that is crossing the Pacific Ocean, you may not see any other vessel for weeks. You need to ask what this will do to the motivation of the officers at work," Haikkola said.

Consequently, a significant step forward could come in the form of permitting the bridge to be left unmanned in certain situations, with technology monitoring the areas around the vessel and raising an alarm should anything beyond permitted parameters emerge. Its advocates argue that the main purpose of developing automation is to improve safety at sea.

DIMECC is also in charge of a test area for autonomous vehicles on the west coast of Finland that is open to all parties with an interest to develop such systems. Called Jaakonmeri, in honour of the late colleague Jaakko Talvitie, the area is about 11 miles long and about three miles wide. It also offers possibilities for testing these systems in ice conditions, with DIMECC providing data links to the area with its co-operation partners. One Sea has stated that the first tests are due to take place this spring. *NA*

Economy and manoeuvrability prompt Viking Line's Azipod choice

The Finnish company has decided to fit its latest newbuilding with ABB's versatile propulsion system, report Kari Reinikainen and Alan Lam

The 13-deck, 63,000gt, 2,800-passenger capacity Viking Line ferry is currently under construction at Xiamen shipyard, China. While electric, azimuthing propulsors have been used on cruise ships since the late 1990s, the Viking Line newbuilding is one of very few such installations on ferries.

The yet-unnamed vessel, due for delivery in 2020, is the third newbuilding of the Mariehamn-based company since 2000. The first, the 35,778gt *Viking XPRS* was delivered in 2008 and fitted with a traditional medium-speed diesel power plant that drives two controllable pitch propellers via gearboxes and shafts. The four diesels deliver a total of 40,000kW to give the ship a cruising speed of 25knots, which was deemed necessary to reduce the crossing time between the Finnish and Estonian capitals to around two and a half hours.

Viking Grace, much larger at 57,565gt, entered service on the Turku-Mariehamn-Stockholm service in 2013. The ship has four dual fuel Wärtsilä main engines that deliver 30,400kW and drive two propellers via electric motors. In practice, the ship has used LNG, making it the first large ferry to use this type of fuel.

Ulf Hagström, SVP Marine Operations and Newbuildings at Viking Line, told *The Naval Architect* that with the new ship, the company wants to take efficiency to the next level. To be used on the same Turku-Mariehamn-Stockholm service as *Viking Grace*, the ship will only spend about three hours in port each day. The superior manoeuvrability that Azipods offer means that time can be saved in docking and undocking. This translates to a lower speed requirement at sea and savings in installed power requirement and fuel consumption.

ABB will supply the twin Azipod XO 2100-type units, with a combined power of 6,000kW. The ship will have a very large wind surface area, and the powerful thrusters are intended to ensure good handling of the ship while manoeuvring in port. The new ship will also be fitted with three bow thrusters from Wärtsilä with electrical motors.

Concept illustration for Viking Line's as-yet-unnamed ferry, currently under construction in China

The 218m length of the new ship, five metres more than that of *Viking Grace*, also requires good manoeuverbility as the vessel will operate in the archipelagos of Turku, the Åland Islands and Stockholm, with only some two hours of open sea on each crossing of about 10 hours.

Hagström notes that officers that are used to working on ships that are fitted with Azipods generally prefer these vessels over conventionally driven ones due to their superior handling qualities. "However, it takes a little bit of time to get used to Azipods. Rudder steering is very course-stable, but when you steer with the propellers, you frequently need to adjust the course of the vessel," he adds.

Marcus Högblom, head of passenger and dry cargo ship segment at ABB, confidently predicts Azipods are likely to be the propulsion solution of choice on future ferries.

The two largest and fastest RoPax ferries in Japan were the first vessels in the world to be equipped with Azipods. Launched in 2004, the ferries have brought huge benefits to their owners, Shin Nihonkai Ferry, including a 20% reduction in fuel consumption compared to the previous vessels. The ferries are faster than their predecessors and can carry 15% more cargo by volume.

"The ferry sector was quiet for quite some time. There was quite a bit of newbuilding activity in the 1990s, but then it turned very quiet, until about the time *Viking Grace* was built," Högblom tells *The Naval Architect*. Many ferry companies are using ageing vessels – the ship Viking Line's newbuilding will replace dates back to 1989 – so there is a need for more efficient and environmentally friendly ships.

In the Viking Line project, a simulation was carried out showing *Viking Grace* operating with Azipod propulsion, using a simulator at the Customer Experience Center at ABB. The results delivered by the digital simulation confirmed that the use of Azipods would deliver superior manoeuverbility and reduce fuel consumption and thereby operating expenses, Högblom explains.

Moving on to the larger picture, Högblom says that as all new marine propulsion technologies that are either in development or studied involve electricity, be they batteries or fuel cells etc, and ferry companies are becoming increasingly interested in preparing their vessels for possible later adaptation to new ways of powering them. *NA*

SUSTIS brings sustainability back to basics

The rise of ethical consumers is driving a shipbuilding network's project

Sustainability in shipping is generally considered to cover the operations of vessels and their ultimate recycling when they are withdrawn from service, but a project in Finland expands the coverage of sustainability to shipbuilding.

Called Sustainability and Transparency in Shipbuilding Networks – SUSTIS for short – the project team maintains that ship owners themselves need to widen the concept of sustainability to reflect a change in the way they are thinking. Shipyards act as system integrators and together with their supplier networks, which are extensive in the case of Finland where the industry focuses on passenger ships and other specialist tonnage, will have to cover a large part of the value chain when it comes to transparency and sustainability.

The project, which brings together the University of Turku and a number of companies, focuses on the collecting, combining and utilisation of sustainability information of materials and manufacturing processes for creating sustainability based value in shipbuilding. It has two goals. Firstly, to expand the use of sustainability to the whole life-cycle starting from raw materials and working conditions at all stages and secondly, to generate new business through opening the sustainability data.

The reasons are very much commercially driven, says Kaapo Seppala, SUSTIS project manager: "A change is taking place on the consumer side. A new generation is emerging (in the cruise market) and in their decision making, sustainability plays an important role. This is a major change in values: the product in itself is no longer enough, and not even operational aspects of sustainability. These people want to know exactly what this ship is about from a sustainability point of view," Seppala tells *The Naval Architect*.

By taking a proactive stance in the matter, SUSTIS team members expect to develop their business so that the information regarding the sustainability of the entire value chain in the shipbuilding process will be available to the public. They also intend to anticipate future regulation and to exceed the minimum requirements regarding sustainability, rather than to wait for new regulation to take effect and adjust to them at the last minute, which often is the case in industries.

Discerning passengers increasingly want assurances a vessel is sustainably built

The logic is that by adopting a best practice stance in sustainability and transparency, the project participants and the Finnish ship building industry can gain an advantage over its competitors, bearing in mind the ongoing change in how cruise passengers view sustainability. "In passenger shipbuilding, this matters much more than in the case of cargo vessels, because consumers themselves are the customers of cruise lines," Seppala says.

The project was launched in February 2016 and it is due to run for three years. Its first phase, which was linked with a parallel project by Meyer Turku, the cruise ship builder, focused on identifying relevant sustainability indicators, their transfer and utilisation. The main result of the Phase I was validation of sustainability's business value in the shipbuilding network, particularly for the cruise business.

Phase II widens the scope to exploring more methods and solutions for data transfer. Utilisation of the transferred sustainability data is covered by creating and testing various pilot applications. "Phase II promotes dialogue around the utilisation of sustainability arguments and data for increased economic resilience of the shipbuilding network," the research team said in a statement. For making sustainability issues transparent and widely utilisable, a pilot platform for sustainability data will be created. Phase II also includes quantification of the data with sustainability modeling, as well as exploring the new business possibilities provided by the open sustainability data.

The supply chains in cruise ship building are often long and although information is available about various aspects of the network, finding a way to present a large part of this from a sustainability point of view poses a key question in the work, Seppala points out. "Pressure is mounting against shipyards to show what exactly is needed to build a cruise liner from a sustainability point of view," Seppala continues. Identifying areas of sustainability that are critical from a business point of view and finding ways companies in the project team can utilise them to benefit their business are key targets of the work.

"Sustainability will be a way how European shipbuilders can retain their leadership (in cruise ship building), when you understand the principles of these systems and their importance," he concludes. Industry and supporting partners of the project are: DNV GL Business Assurance Finland Oy, Evac Oy, Lautex Oy, Meriteollisuus ry, Meyer Turku Oy, NIT Naval Interior Team Oy, Paattimaakarit Oy, Piikkio Works Oy, Sininen Polku Oy, and SSAB Europe Oy. ***NA***

Automation and integration drive Norwegian Control Systems' Fjord1 project

Automation and integration look set to take up the increasingly challenging task of achieving further efficiency improvements. Norwegian Control Systems' project for Fjord1 provides a convincing test case

Traditionally, vessel efficiency improvements have been enabled through engineering – designers and manufacturers have sought to consistently improve componentry, either by releasing new models or designing retrofittable parts for existing equipment, to enhance vessel performance by bringing each element up to an optimum standard.

This approach still continues today, and is arguably one of the key responsibilities for naval architects and engineers, given that efficient equipment means sustainable operation. However, the ongoing pursuit of efficiency and the ever-increasing pace of development have created a situation in which some manufacturers claim that they are close to reaching peak efficiency using engineering alone. In January's *The Naval Architect*, for instance, engine giant MAN Diesel & Turbo commented: "With the constraints given by engine design itself […] the efficiency of a modern two-stroke main engine and a modern four-stroke auxiliary engine is in fact close to the maximum theoretical efficiency." Although MAN acknowledged that "further improvements can be made," they predicted this to be in the region of 1-2%. While this margin is of course still valuable, such predictions will lead many designers, owners and operators to question how they will meet ever-tighter regulation – and save on fuel costs – when they cannot rely on a regular programme of equipment upgrades.

With the rapid development of digital technology for maritime applications, however, integration and automation have come to the fore as tools that can secure continuing efficiency improvements. The former generally refers to the assimilation of the various components and systems aboard the vessel into the bridge, creating a centralised platform where whole vessel operation and performance can be monitored. The latter involves digitising the control of these components and systems, promoting ease-of-use. The two concepts tend to work in hand in the form of an 'integrated automation system' (IAS) – a scalable hardware and software package which brings a large degree of control of the vessel into the bridge by collecting performance data and providing it to crew to aid with their decision making and equipment adjustment using the control stations. With real-time data on vessel operation, crew can make operational changes on a situational basis – reflecting meteorological conditions, for instance – thus achieving efficiency improvements flexibly and effectively.

The concept design for a Fjord1 Havyard Design 936 ferry, which will feature NCS' IAS, ship performance monitoring and power management systems

Norwegian innovation

Ålesund-based Norwegian Control Systems, formerly known as Havyard Power & Systems, has been involved with integrated automation systems for almost a decade, putting their offering on the market back in 2008. Known for designing and supplying electrical and control systems to a range of vessels, including ferries and those involved in offshore and fishing, they have since branched out into a range of integrated and automated solutions, tied in to their modular, scalable "concept bridge" turnkey solution.

Recent projects include the provision of automation and bridge solutions, as well as propulsion and power machinery, to the world's biggest wellboat, *Ronja Storm*, for Sølvtrans. Havyard Group, which owns Norwegian Control Systems, was the sole supplier on this project, pulling in a number of its brands to provide design and engineering services, outfitting, and fish handling equipment, complementing the work of NCS.

Another significant project – for Norway's largest ferry operator, Fjord 1 – involves the duo of Norwegian Control Systems and sister company Norwegian Electric Systems. Announced in January, the companies are set to deliver IAS and concept bridges for five brand new Havyard Design 936 electric-hybrid ferries, complementing work they are already contracted for on four other Fjord 1 vessels (three Multi Maritime Design MM 62 FD EL designs and one Fjellstrand Zerocat120).

The total value of the contract is reportedly NOK21 million, with the first delivery scheduled for later this year. The ferries will operate between Hareid-

Sulesund and Magerholm-Sykkylven, routes which are close to NCS's Ålesund base.

IAS features

The GMR100 software platform that underlies NCS's IAS system was developed by Høglund Marine Automation, and works across the various products that make up the system.

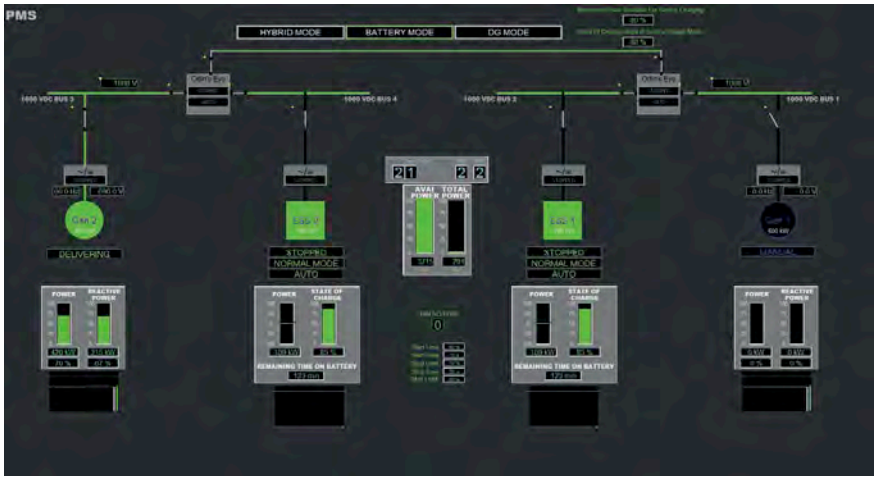
The most basic aspect of the IAS is the alarm and monitoring system, which allows crew to keep track of equipment operation parameters and alerts them to any malfunctions or abnormal behaviour. This can be tied into NCS's Emergency Shutdown System (ESD), which shuts down equipment such as diesel generators, ventilation fans, HVAC units and oil pumps in the event of an emergency such as fire or an escape of toxic gas. Whilst the ESD uses the same operator stations as the IAS, all controller functions are independent.

The IAS alarm and monitoring system also includes a "playback" function. If there is a partial or total switchboard blackout, all vessels alarms sound, making it difficult to determine the cause of the incident. However, "playback" will allow crew to scroll back in time and view the control stations' digital displays as the issue occurred, helping them to identify the culprit, for instance critical temperature, high voltage or a power surge.

Beyond the alarm and monitoring system, the IAS on the ferries will incorporate tank sounding functionality, in which tank pressure transmitters connected to the IAS's IO cards will handle level indication and volume calculations. Automating this process saves crew having to manually sound the ferries' tanks. The IAS will also allow for the control of pumps, valves and the HVAC system from workstations on the bridge, further promoting ease of operation for the ferries' crew.

SPM

The technology integrated within the IAS that is most concerned with energy efficiency is the Ship Performance Monitor (SPM), designed to support the implementation of the Ship Energy Efficiency Management Plan (SEEMP). SPM will monitor the power consumption of all the major consumers on board the ferries with its power management system (PMS), measuring fuel flow to the diesel engines with flowometers or from the engine's control system directly, plus the electric power (kW) used, as in the case of the hybrid vessels. The data collected will then be reported to crew and uploaded to the cloud for shore-based fleet managers, who will be able to determine inefficiencies, the operating profile of the vessels, and overall fuel usage, with an eye to reducing consumption and therefore emissions. As ferries, the vessels will likely perform a repetitive route, and will thus benefit from the optimising capability of the SPM.



This example of a control station display shows the kW power being used, in real time, by the ferry's batteries, helping crew to optimise the vessel's power consumption

Auto-X

To further build upon the repetitive routing typical of ferries, three of the vessels NCS are working with – Multi Maritime designs – will be installed with NCS's pioneering Auto-X Fjord-crossing system, which will be tested in May. Although not strictly part of the IAS, Auto-X can be integrated with the system, and operated from the same bridge control stations. The software will control the vessels' propeller speed and power, setting a track with defined acceleration and retardation curves that will offer the most economical route, which is calculated to coincide with a set arrival time. Crossing speed is adjusted throughout the journey to ensure that energy consumption is as low as possible.

Auto-X represents NCS's first step towards autonomous vessels, an area in which they hope to conduct further research and create new technologies, reflected in their membership of the Norwegian Forum for Autonomous Vessels (NFAS).

Integrated, automated and efficient

The suite of integrated NCS solutions to be fitted out on board Fjord1's ferries exemplifies the priorities of modern operators – efficiency, ease-of-use, and optimisation. In contrast to equipment overhauls, which can be costly, time-consuming, and aren't guaranteed to offer optimal performance in all conditions, technologies such as the IAS allow for ad-hoc performance monitoring and adjustment, a much more flexible approach to efficiency improvements that works day-to-day rather than year-to-year. Moreover, the modularity and scalability of NCS's technologies aboard the ferries will allow for easy integration of new software and features; NCS have touted LNG bunkering functionality, for instance, as a possible future addition to the IAS. With many other similar projects occurring across the shipping industry, it is clear that integration and automation have joined engineering as the pathways to a lower-emission, lower-cost future. *NA*

Record-breaking dual-fuel power

French carrier CMA CGM's 22,000TEU generation will use LNG fuel on Asia/Europe round-voyages, putting down a new marker for the industry

Dual-fuel, two-stroke propulsion engine technology has received a prestigious and large-scale endorsement through the nomination of X-DF machinery developed by Winterthur Gas & Diesel (WinGD) for CMA CGM containership newbuilds of record-breaking capacity.

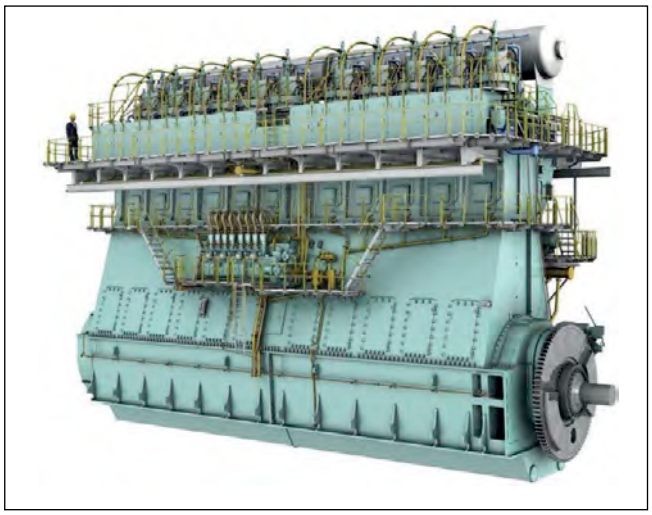
The shipbuilding programme entails nine 22,000TEU vessels, all of which are scheduled to be delivered in 2020 for the Asia/North Europe trade. The orders have been split between two members of the China State Shipbuilding Corporation (CSSC), whereby five will be constructed by Hudong-Zhonghua, and four by Shanghai Waigaoqiao Shipbuilding. In each case, the primary power installation will be a WinGD licensee-produced 12-cylinder X92DF engine.

Swiss-headquartered WinGD has itself been a 100% subsidiary of CSSC since June 2016, following the Chinese group's purchase of Wärtsilä's remaining 30% shareholding.

CMA CGM plans to use the LNG fuel capability of the new ships' plant to the maximum, while still reliant on an element of oil for the engine's pilot ignition system. Each ship's LNG fuel storage capacity will allow for a full round-voyage on LNG before refuelling, representing a substantially higher LNG bunker volume than on any other vessel to date.

By opting for LNG dual-fuel propulsion, operation in gas mode will virtually eliminate sulphur emissions, ensuring compliance with IMO's 2020 global 0.5% sulphur cap, and will yield a 20% improvement in the ships' Energy Efficiency Design Index (EEDI) relative to a diesel-fuelled installation. X-DF types meet IMO Tier III NOx criteria when running on gas, obviating the need for selective catalytic reduction (SCR) or exhaust gas recirculation (EGR).

But the move to embrace LNG in such fashion has to be seen not only in the light of unfolding legislative requirements but also in the context of CMA CGM's own corporate goals. It demonstrates a belief in environmental responsibility, while also creating greater resilience to cope with what many believe will be ever more exacting controls on the shipping industry in years to come.



WinGD's 11-cylinder X92 two-stroke engine. Each of CMA CGM's 22,000TEU generation will have a dual-fuel version in 12-cylinder configuration

The fact that it chose to announce the deal for LNG-fuelled mainliner tonnage on the occasion of the UN Climate Change Conference (COP23) gathering in Bonn last November is not without significance. CMA CGM's track record is such that, between 2005 and 2015, the group reduced CO_2 emissions per container transported per kilometre by 50%, and is now embarked on a plan to achieve a further 30% cut by 2025.

With direct drive to the propeller, the 920mm-bore, 12X92DF 'cathedral' engines specified for the 22,000TEU generation will be rated for a maximum 63,840kW output at 80rpm, making them the most powerful gas and dual-fuel engines ordered to date.

The X-DF series employs the lean-burn, Otto-cycle combustion process, with low-pressure gas admission and micro-pilot ignition, as is the standard technology on medium-speed DF engines. WinGD claims that the low-pressure solution saves costs because it uses less expensive, more energy-efficient gaseous fuel compression equipment compared with low-speed DF engines employing high pressure gas injection. Liquid fuel for pilot ignition will be marine gas oil, and should account for no more than 1% of total heat release.

Each vessel will embody an LNG fuel tank of 18,600m^3 capacity, arranged underdeck beneath the ship's forward superstructure, with the fuel to be fed to the engine room aft. The Mark III membrane system designed by GTT, the market leader in LNG carrier cargo containment, will be used for the tanks, to be fabricated under licence by Hudong-Zhonghua for all nine newbuilds. Although the nature and integration of the bunker tanks is space-efficient, CMA CGM's decision to incorporate the biggest LNG bunker tanks to date has meant some penalisation of cargo capacity that would otherwise be attainable within the hull envelope.

In support of the LNG-fuelled endurance factor being built into the nascent class of ships, CMA CGM has signed a long-term, fuel supply agreement with French energy group Total. Under the pact, unprecedented in the volumes involved for a shipping application, Total Marine Fuels Global Solutions will provide LNG bunkers totalling around 300,000 tonnes per annum over 10 years, starting in 2020.

Bureau Veritas will class the vessels, which were designed under the aegis of CMA Ships Solutions. Hydrodynamics, engine and fuel specifications, tank size and other areas were all investigated and modelled before the contract was awarded to CSSC. *NA*

Further advance in engine control

Wärtsilä's electronic wastegate promises improvements in valve performance

Subtle, pragmatic changes in componentry make an understated contribution to technological progression in engine design and operability. Where the individual technical improvement or advance lends itself to retrofit applications in existing plant, as well as forming part of the integrated matrix of elements that yield performance gains for new models of machinery, the potential value of the development to both vendors and users is considerably enhanced.

Such is the case with Wärtsilä's electronic wastegate, a performance-improving valve package intended for use not only on new medium-speed engine platforms but also for retrofit projects to update engines in the current portfolio. The wastegate valve allows the charge air pressure to be adjusted according to engine speed and load. It gives a faster valve reaction time, optimising engine running at all times and improving engine stability, and also enables more comprehensive operating data to be obtained digitally, allowing for better diagnostics.

The electronic wastegate, activated by high-speed electric motor, is a standard feature on the latest addition to the company's medium-speed range, the Wärtsilä 31, which actually offers a common design platform for distinct diesel, dual-fuel, and pure gas versions. The wastegate is also standard across the Wärtsilä 46DF series, as well as in the company's spark-ignited 20V34SG and 18V50SG gas engines used in landside power generation applications.

Although originally conceived for new engines, the potential benefits as a retrofit on older engines soon became apparent for the company's Services division. As a consequence, the wastegate valve package is also being rolled-out for the upgrade of older models, starting with spark-ignited 34SG series gas engines. The updated electronic wastegate valve and actuator fit in the existing engine layout, allowing ease and rapidity of installation. The exhaust wastegate valve is used to regulate the volume of exhaust gas passing through the turbocharger turbine, thereby controlling and modulating turbocharger speed and charge air pressure.

It is designed to work in seamlessly with the Wärtsilä Operation Interface System (WOIS), for valve diagnostics. The built-in diagnostics yield more comprehensive wastegate operating data, such as the actual valve position compared to its set position. *NA*

Damaged auxiliaries: human error a key factor

A new report by The Swedish Club indicates a pressing need for a better standard of work by crews on auxiliary machinery

Mutual marine insurance company The Swedish Club has found that over half of all auxiliary engine damage occurs almost immediately after maintenance work has been carried out. It also determined that containerships have a much higher claims frequency as regards auxiliaries than other vessel types.

The report was conducted in response to members' concerns about the incidence of auxiliary machinery damage, with the aim of investigating and analysing claims, highlighting predominant factors, and providing advice to obviate problems so as to reduce the frequency and severity of damage.

The Swedish Club has always had a proactive policy directed at raising awareness of claims trends and giving hands-on advice on how to mitigate casualties. The latest findings, from a review covering 2010-2016, showed that auxiliary engine claims accounted for 13% of the total machinery claim costs and 16% of the volume, with an average claim cost of US$345,000. The study only included damage in excess of the average US$105,000 deductible.

The records show that 55% of the casualties took place within only 10% of the time between overhauls (TBO), corresponding to the first 1,000 hours or so after overhaul, but with damage occurring in most cases only a few hours after start-up. Shortcomings in the standard of work in connection with regular overhaul is the common factor for these occurrences. In particular, the assembly of connecting rods (conrods), bearings and pistons leads to severe and costly accidents.

The significantly higher claims frequency in the containership sector of the fleet entered with The Swedish Club reflects the larger number of auxiliaries in such vessels, and their typically higher output, leading to higher repair costs compared with other tonnage.

"Auxiliary engines run at high revolutions and have a common lubrication system for both cylinder and crankcase lubrication," observes Peter Stalberg, The Swedish Club's technical adviser. "They are not under the same strict regime from the classification society as the main engine, and maintenance is often carried out by the vessel crew."

Damage incidence to auxiliary machinery soon after maintenance is a worrying trend

"We see incorrect maintenance and wrongful repair in all too many cases, and poor lubrication management is also a major contributing factor to auxiliary engine breakdowns. With an average repair cost of more than US$345,000, we cannot emphasise enough the principle that prevention is better than the cure," says Mr Stalberg.

Of the cases analysed, the Club identified four major areas associated with damage causation. The largest single category was that of conrod bolts, due mainly to improper procedures and wrong assembly by crew, followed by contamination of lubricating oil with water or soot, incorrect maintenance and deficient procedures, and engine overspeed. Only in a small number of instances, evidently, were latent defects identified as the cause of damage.

Non-adherence to procedures, lack of training and experience are seen as major factors in the problem of incorrect assembly of vital engine parts such as conrods, bearings and pistons. "A connecting rod assembly is a critical and highly stressed joint and must be re-assembled exactly in accordance with manufacturer's instructions and with proper tools," asserts the Club. *NA*

How to avoid auxiliary engine damage

Advice from The Swedish Club:

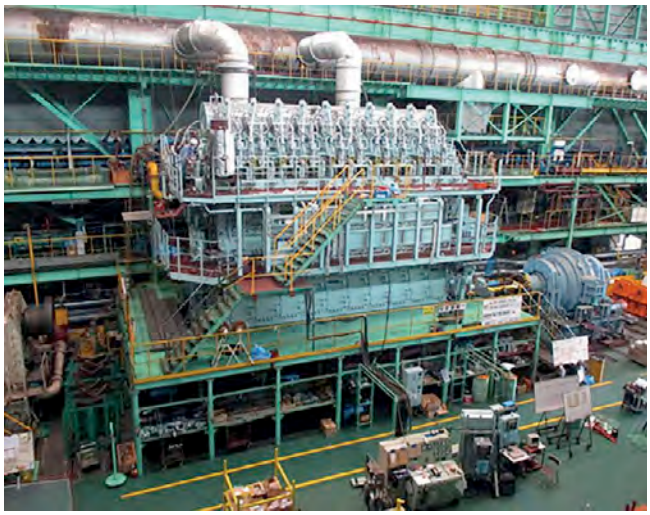
- **Ensure you have the necessary knowledge and experience before commencing any overhaul work.**
- **If you have not received training on the specific engine model, consider engaging an expert from the manufacturer.**
- **Always strictly follow manufacturer's instructions.**
- **During overhaul, check and double check that stud bolts for connecting rods and bearing keeps are tightened 100% in accordance with manufacturer's instructions.**
- **Ensure that required tools are available and calibrated as necessary.**
- **Regularly monitor the quality of your lubrication oil and take prompt action when irregularities are detected.**

Japanese designer shows new dynamism

A raft of new additions to the product range and a concerted drive on the Chinese market show the business intent of new entity J-ENG

As the sole competitor to the MAN Diesel & Turbo and Winterthur Gas & Diesel (WinGD) brands in the large two-stroke engine sector, Japan Engine Corporation (J-ENG) is pursuing a multi-faceted product development strategy that belies its proportionally minor stake in the market as a whole.

Its extensive range of UE low-speed machinery inherited from Mitsubishi Heavy Industries (MHI) has an especially important following among Japanese shipowning and shipbuilding clients, and J-ENG's receptivity to the evolving requirements of those communities remains undiminished as the company looks to bolster business on the wider stage.



New 10-cylinder model of the UEC50LSE-Eco-B1 type under shop tests by J-ENG

The higher profile achieved on the Chinese market since J-ENG came into being on 1 April 2017 is indicative of that strategic endeavour, while the uptake of the first examples of newly refined 450mm- and 500mm-bore two-stroke designs for newbuild projects at Japanese yards reinforces its domestic standing.

Based in Akashi City, J-ENG was created from the two-stroke engine business spun-off from MHI and integrated into the former Kobe Diesel, a longstanding licensee of the UE marque.

Technical support is nonetheless forthcoming from the restructured MHI organisation, as J-ENG grows and adapts the UE range and the associated equipment portfolio. A case in point is the current work on new versions of 500mm- and 350mm-bore UE engines designed specifically for operation on marine gas oil (MGO). The initial target is market release of a six-cylinder model, the 6UEC50LSH-Eco-C2-MGO type, in March 2019, to be followed before the end of that year by a five-cylinder configuration.

Incorporating two-stage turbocharging, and also exhaust gas recirculation (EGR) and water injection to restrict NOx emissions, the engines will be suited to handymax and supramax bulkers and other tonnage such as product tankers that figure so prominently in the Japanese shipbuilding industry's output.

Meanwhile, the first example of the 10UEC50LSE-Eco-B1 diesel model was delivered by J-ENG at the end of November for installation in a 7,000dwt ro-ro freight vessel under construction at MHI's Shimonoseki yard on the Kanmon Strait, and destined for coastwise operation with Fujitrans Corporation.

The nomination of two-stroke propulsion machinery is significant, given the particular space constraints imposed by ro-ro vessel design, coupled with the comparatively high power needed for coastal and shortsea service. The combination of multiple (10) cylinders and a median bore size in the new UE reference reflects these parameters. The UEC50LSE-Eco-B1 series had hitherto only been available in configurations of up to nine cylinders.

The ro-ro sector has also yielded an opening order for the 6UEC45LSE-C1 model, chosen for a newbuild contracted at Kanda Shipbuilding. Relative to the immediately preceding 450mm-bore type (UEC45LSE-B2), the new UEC45LSE-C1 offers a higher output, at a maximum rating of 1,440kW per cylinder.

As a consequence of increased efforts in China, J-ENG reported that, by the end of 2017, over 30 UE engines had been ordered and manufactured by Japanese and Chinese licensees for the Chinese market. A feedership newbuild project in China, moreover, has provided the first order for J-ENG's proprietary, low-pressure selective catalytic reduction (SCR) system, which ensures IMO Tier III NOx compliance.

A new licence agreement was signed with Qingdao-based China Shipbuilding Industry Corporation Diesel Engine Co (CSE), which was established on 28 April last year through the amalgamation of the low-speed engine activities of Yichang Marine Diesel, Qingdaohaixi Marine Diesel, and Dalian Marine Diesel. Through CSE and another Chinese licensee, Zhejiang Yangpu Heavy Machinery Co, orders were secured for engines of the 6UEC33LSII and 6UEC33LSE-C2 types to be installed in newbuild asphalt tankers and feeder containerships. Furthermore, Japanese licensee Akasaka Diesels is increasing export sales of UE propulsion machinery to China.

Moreover, J-ENG is party to a joint research project along with the NYK Group and affiliated company MTI, aimed at harnessing opportunities presented by digitalisation to improve the technical management, reliability and efficiency of ships' machinery. *NA*

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Market leaders in pact for LPG engines

The drive is on to bring LPG-fuelled, low-speed propulsion engines to the market, fired by new enviro rules, writes David Tinsley

As market leaders in their respective fields, MAN Diesel & Turbo and Hyundai Heavy Industries (HHI) plan to work together to introduce dual-fuel, two-stroke propulsion machinery designed to run on liquefied petroleum gas (LPG).

The rationale for the recently signed memorandum of understanding (MoU) regarding engine development and production lies in the ability of an LPG-based powering solution to meet the impending worldwide limit on sulphur oxide (SOx) emissions, coupled with perceived benefits as to fuel availability and system costs.

In its capacity as designer and licensor, MAN has a commanding share of the global market for two-stroke plant, while HHI's position as the most prolific shipbuilder is complemented by a 35% stake in worldwide marine engine production through its Engine & Machinery Division (HHI-EMD).

MAN began work on a liquefied gas injection (LGI) dual-fuel ME-LGI engine several years ago, with an eye especially to the use of what it viewed as "more sustainable fuels" such as methanol and LPG. The new pact with South Korea's pre-eminent industrial force will build on existing knowledge, for the further development and manufacture of the envisaged ME-LGIP series.

The Naval Architect was advised that the initial target is a seven-cylinder S60ME-C9.5-LGIP model and/or a six-cylinder G60ME-C9.5-LGIP, for delivery towards the end of 2019 or by early 2020. Through the agreement, MAN signals its support for HHI's preparations to produce and test the engine.

By pairing with HHI-EMD to realise the ME-LGIP series, MAN can marry its technological and operational know-how with the South Korean group's expertise and scale in engine production and newbuild installation. The extent of Hyundai's overall offering, which gives added weight to its market pull in shipbuilding, has been continually strengthened beyond the role of licensee by a growing home-grown product range, including HiMSEN-brand four-stroke diesels and dual-fuel engines.

Declaration of intent: signing the memorandum of understanding with Hyundai to bring an LPG dual-fuel version of MAN's ME-series engine into being

Due to ever more stringent emission limits, LPG carrier operators had looked to MAN to develop an LPG-fuelled engine that could provide the requisite propulsion power in the most viable, convenient and economical manner using just a fraction of the LPG cargo already onboard. Subsequently, according to MAN Diesel & Turbo's Bjarne Foldager, vice president for sales and promotion in the company's two-stroke business, "other shipping segments have also begun investigating this option, a general tendency that is growing."

As with LNG, LPG fuel offers a reduction of some 90-95% in SOx emissions relative to a Tier II engine running on heavy fuel oil (HFO). Its future as a viable fuel for marine transportation looks promising, in MAN's view, as it will not require as large an investment in bunkering facilities and other infrastructure in contrast to other gaseous fuels. A substantial demand is accordingly expected for LGIP engines, in the first instance, from the very large gas carrier (VLGC) and coastal vessel sectors.

While there is a pressing requirement for environmentally benign systems to meet the roll-out of tougher, mandatory emission standards, cost acceptability is a fundamental issue. MAN points out that it expects an ME-LGIP installation for a merchant vessel "to be extremely competitive price-wise, compared to other, dual-fuel burning engine types."

South Korea's maritime industry is already set to make a commitment to LPG fuel in a newbuild application, albeit not through recourse to reciprocating engine plant but to GE's combined gas turbine-electric and steam (COGES) technology.

A contract for the envisaged recipient, a ro-pax ferry, is anticipated within the first quarter of 2018. The vessel will be operated by Youngsung Global, with suitability for both Korean coastal service and shortsea routes to China or Japan.

One of the outcomes of the initiative is the plan to create an LPG bunkering hub at a Korean port, as announced in January this year by the Korea LPG Association. While the first target in terms of users would be the contemplated Youngsung ferry, the facility and its potential bunker tanker feeder operations would cater to all marine LPG users.

Japanese LPG importer, shipper and distributor Astomos Energy, which controls the largest Japanese fleet of LPG carriers, could be an early exponent of LPG dual-fuel machinery. In addition to studying the adoption of such prime movers in its own ships, it is examining the potential for other vessel types.

Over the course of 2017, Astomos signed agreements with energy companies in Norway, Australia and Kuwait to conduct joint studies into the use of LPG as marine fuel. *NA*

Tanker damage stability: historical problems

Keith Hutchinson, of Babcock Energy and Marine Technology, and Andrew Scott, of the Maritime and Coastguard Agency, discuss the historical issues surrounding the demonstration of a tanker's compliance with the damage stability regulations if a specific loading condition deviates significantly from those shown in the approved Trim and Stability Book

Some of the regulations relating to tanker damage stability state that if a proposed loading condition differs significantly from an equivalent condition in the Trim and Stability book on board then it must be approved by the authorities for compliance with the damage stability regulations before a tanker sails. Complications arise through having to calculate fluid loss from a damaged compartment which may be filled to any level and carry liquids with a wide potential range of density. When this is allied to an extensive variety of loading patterns and multi-compartment damages, demonstration of compliance, other than by use of an on-board 'direct calculation' computer, can be difficult even though the regulations permit the simplifying assumption that all the fluid in the damaged compartment is instantaneously lost and replaced by sea-water up to the outside damaged equilibrium waterline.

In practice, for various reasons, advance approval of all the potential damage cases for 'non-standard' loading conditions is seldom sought and hence it was widely acknowledged that there was an urgent need to develop guidelines for the verification of damage stability requirements for tankers that regularly sail in conditions of loading that are significantly different from those in approved documentation. Such guidelines have recently been adopted at the International Maritime Organization. This article discusses these historic problems, the solutions and the outstanding issues, which will be further discussed in June's *The Naval Architect*.

Non-standard loading conditions complicate the process of ensuring compliance

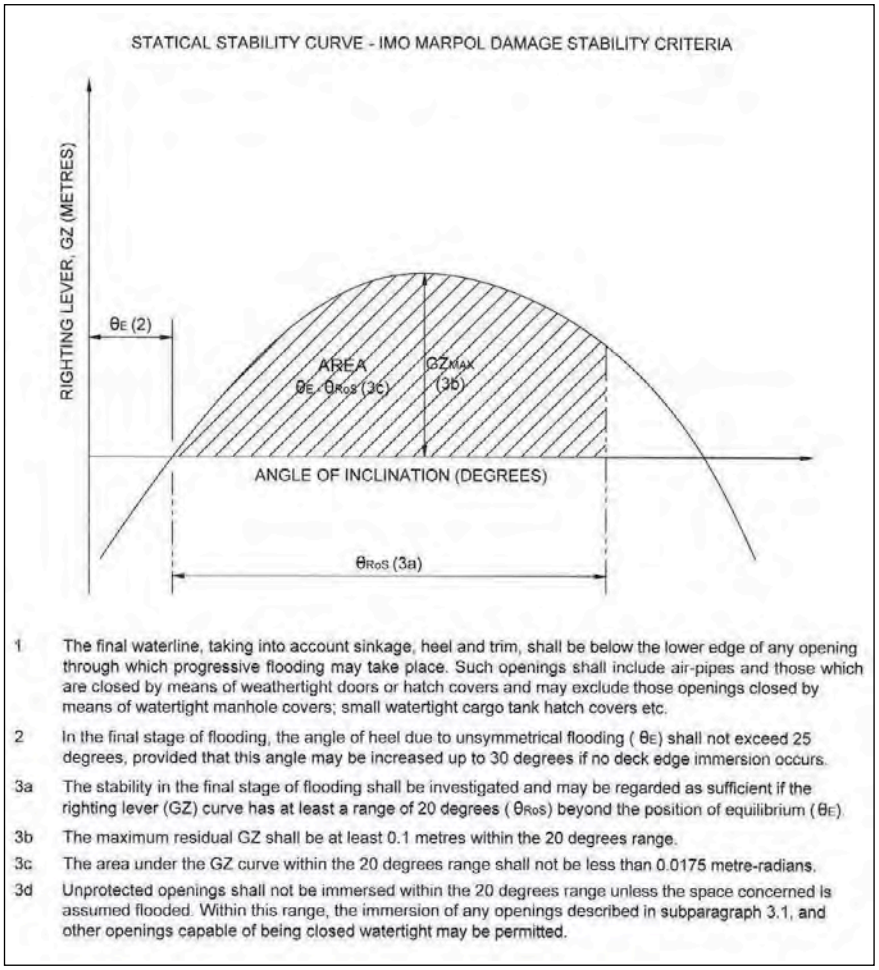
Current damage stability regulations

The current version of the International Maritime Organization [1] (IMO) Safety of Life at Sea (SOLAS) covers damage stability for passenger ships of all sizes and dry cargo ships with length greater than or equal to 80 metres with keels laid on or after 1st January 2009. Certain cargo ship types and specifically tankers are excluded from complying with the probabilistic damage stability regulations in Part B-1 if they comply with the deterministic damage stability requirements included in the following instruments instead:

- Tankers (except combination carriers with Type B freeboards) under Regulation 28 of Annex 1 to The International Convention for the Prevention of Pollution from Ships (MARPOL) 73/78;
- Chemical carriers under Chapter 2 of the 2007 International Bulk Chemical (IBC) Code;
- Liquefied gas carriers under Chapter 2 of the 2016 International Gas Carrier (IGC) Code.

Tankers of more than 150 metres 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).

Floating production storage and offloading vessels (FPSOs) and floating storage and offloading vessels (FSOs) etc. are not explicitly covered by MARPOL etc. and ultimately the applicable regulations are the responsibility of the flag or coastal



IMO MARPOL Damage Stability Criteria

State. However, it is typical to apply MARPOL damage stability criteria and, in some cases, the damage requirements of Chapter 3 of the 2009 Mobile Offshore Drilling Unit (MODU) Code (see Figure 5 of [2]), either in isolation or in addition to MARPOL, to such vessels.

The references for the above damage stability regulations and their updating etc. can be found in [2].

2005 ship-owners survey

In 2005 concerns began to arise that some tankers were being loaded only in accordance with the intact stability requirements and that compliance with the damage stability regulations was only being partially considered or, in some cases, overlooked altogether. The specific issues were: (a) low or zero margins on stability in the worst cases of damage; (b) damage cases omitted particularly those of lesser extent; (c) insufficient consideration given to the effects of empty or partially filled tanks; (d) deck tanks either not accounted for or given insufficient consideration; and (e) approvals based upon unrealistic conditions of loading with respect to cargo distribution. One survey showed that of 11 Liquid Petroleum Gas (LPG) carriers and chemical tankers, with existing stability approvals considered for endorsement at this time, seven (63%) were found to be incorrectly based and omitted critical elements to the verification.

In a more detailed survey covering 76 oil, product and chemical tankers and gas carriers it was found that: 59 (77%) loaded 'non-standard' conditions to those in the approved Trim and Stability Book, including Longitudinal Strength; 43 (56%) regularly operated with slack or empty tanks; 69 (90%) were fitted with Loading Instruments, however 30 (39%) could only assess intact stability and 16 (21%) could only assess 'non-standard' loading conditions using an intact stability Loading Instrument.

Additionally, from Port State Control (PSC) inspections, it was observed that tankers were regularly loaded in 'non-standard' conditions from those in the approved Trim and Stability Book. It was also found that tanker's loading conditions were commonly being appraised using a longitudinal strength computer with only intact stability assessment, and that Masters were utilising loading conditions clearly marked 'not valid for damage'.

The conclusions from various surveys and inspections undertaken during this period were that insufficient pre-departure checks to ensure compliance with statutory damage stability requirements were being made and that existing stability approvals for some tankers may not be sufficient to ensure that minimum statutory requirements are being met; it was also concluded that there was a compelling need for further action to ensure existing international instruments are being complied with.

The results of this work were informally presented to SLF 51 (Stability, Load Lines and Fishing Vessel Safety Sub-Committee) in 2009.

2009 data gathering exercise

As a result of various 'flag-in' issues and the 2005 survey and PSC inspections, during 2009 one IMO member state conducted a confidential survey of Masters and Officers of tankers to gather information on the facilities available to them to reliably check the stability (intact and damaged) of a ship, and that ships were loaded in accordance with the approved damage stability information / regulations.

For this questionnaires and checklists were used, as detailed in [2], to gather information regarding the application of damage stability to tankers in support of on-going work at IMO aimed at: (a) ensuring existing IMO instruments were enforced in a consistent manner; (b) minimising risks to tankers and the seafarers who operate them; (c) minimising risks to the environment from loss of marine pollutants; and (d) ensuring non-compliant tankers are identified and brought into compliance.

The survey of 73 tankers was completed by the end of September 2009 with a mixture of oil, chemical, chemical / products tankers and gas carriers. It was found that, 47 (64%) were either fitted with satisfactory means of routinely verifying that the damage stability requirements were met on departure, or that there was no requirement for such verification due to use of standard loading conditions. It was also established that, when inspected, 23 (31%) were loaded to a condition significantly different from an approved loading condition and had no information available to verify compliance with damage stability or that the information available was not routinely used – hence, these tankers were considered non-compliant.

The data from this together with reanalysed data from the 2005 Owners Survey was presented to SLF 52 in January 2010 [2] showing that 35% of ships were non-compliant.

2010 Paris MoU CIC

In 2010, the Paris Memorandum of Understanding (MoU) on PSC undertook a three-month Concentrated Inspection Campaign (CIC) on Tanker Damage Stability, between 1st September 2010 and 30th November 2010, to verify correct damage stability on oil tankers, chemical tankers and gas carriers, as discussed in [2].

During the CIC, the Paris MoU Maritime Authorities conducted a total of 1,065 inspections - 419 oil tankers, 538 chemical tankers and 108 gas carriers. A total of 94 (8.8%) inspections resulted in deficiencies directly related to the CIC leading to 4 (2 oil tankers and 2 chemical tankers) being detained for not complying with damage stability requirements. Significantly, for a total of 173 ships (16.2%) comprising 77 oil tankers, 84 chemical tankers and 12 gas carriers, the Master could not demonstrate that they were normally loaded in accordance with the approved Trim and Stability Book.

Detailed analysis of the results of the campaign were reviewed by the 44th meeting of the Paris MoU PSC Committee in May 2011, and a report subsequently submitted to IMO.

2010 Black Sea MoU CIC

The Black Sea MoU undertook their CIC in conjunction with routine PSC inspections. To harmonise with the Paris MoU, the same questionnaire and checklist was utilised over the same period.

The CIC conducted 229 inspections on board 227 tankers, which equated to 95% of all tankers entering ports of Black Sea MoU during the period. Deficiencies were found on about 41% of the inspected tankers but none led to detention. It was found that 97% of the inspected tankers had an approved Trim and Stability Book on-board and that for 96% of the time it was written in the language understandable by the Master. For 89% of inspected tankers the Master could demonstrate normal loading of the ship with the Trim and Stability Book.

Detailed analysis of the results of the campaign were considered by the Black Sea MoU PSC Committee in March 2011 and, as with those from the Paris MoU, were submitted to IMO.

Issues with tankers

The fundamental difficulties in demonstrating that tankers comply with damage stability arise from having to address, often simultaneously, (a) fluid loss from a damaged tank; (b) an extensive variety of loading patterns, with empty, part-filled or full tanks sometimes combined with a range of cargo densities; and (c) multi-compartment side / bottom / raking damages.

Damage scenarios

Potential multi-compartment side, bottom and raking damage cases required in the regulations are, as discussed and illustrated in Figures 6 to 19 of [2], very complex and numerous in nature, possibly totalling many hundreds of cases. Hence, the identification of the dominant case(s) from amongst the typically large operational draught range of all tankers (which are often 'pure' or 'semi' deadweight carriers) is obviously complex and time consuming, and therefore difficult to establish and present in an accessible form.

Fluid loss and cargo density

As alluded to above, a major problem with tanker damage stability lies with the complexity of dealing with fluid loss, so-called fluid deadweight 'drop-out' from damaged tanks which may be filled to any level and carrying liquids with a wide potential range of density. For example, ships, such as some products and chemical tankers, are designed to carry a range of cargoes, with densities ranging from 0.7 to 2.1 tonnes.metres^{-3}, in any given loading condition.

For example, if the density of the liquid in a damaged tank, initially assumed to be full, exceeds that of seawater then the ship could list away from the damaged side in certain circumstances. Conversely, if the density 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. Thus, accounting for full or partially filled ballast tanks and different extents of damage, as discussed above, it can be appreciated that establishing damage stability compliance involves many permutations and hence is complex and time consuming. This is illustrated graphically in Figures 20 to 26 of [2].

Loading patterns

When different loading patterns are allied to an extensive variety of damage cases the demonstration of compliance with the damage stability criteria becomes difficult.

For some ships, such as crude oil tankers as illustrated in Figures 27 to 32 of [2], the loading pattern, cargo density and tank filling levels are often predictable. Hence, damage stability performance can be verified with some confidence against pre-approved loading conditions detailed at build in the Trim and Stability Book, with the detailed assessment given in the Damage Stability Book (DSB).

However, as soon as a loading condition deviates 'significantly' from the fixed approved loading conditions, which is quite common for parcel tankers, products carriers, chemical tankers and liquefied gas carriers (often designed to carry a range of cargoes with various densities), FSOs and FPSOs, then, strictly speaking, a new damage stability verification calculation is needed which should be approved by the certifying authority before the ship sails / prior to loading offshore. Examples of such 'non-standard' loading are given in Figures 36 to 42 of [2].

Hence, when such different 'non-standard' loading patterns, consisting

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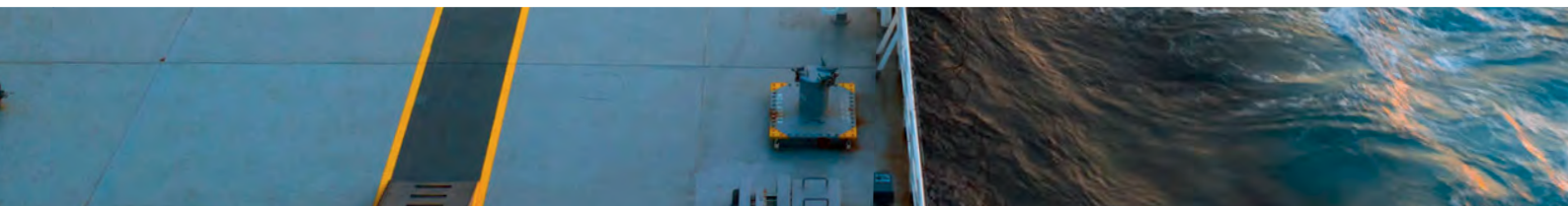


of combinations of various tank filling depths, possibly with different cargo densities, are allied to an extensive variety of damages it is obvious that demonstrating damage compliance is all but impossible other than by use of a Loading Instrument. This is due to the complexity and subsequent volume of information required to adequately convey the post-damage performance of the ship to the Master.

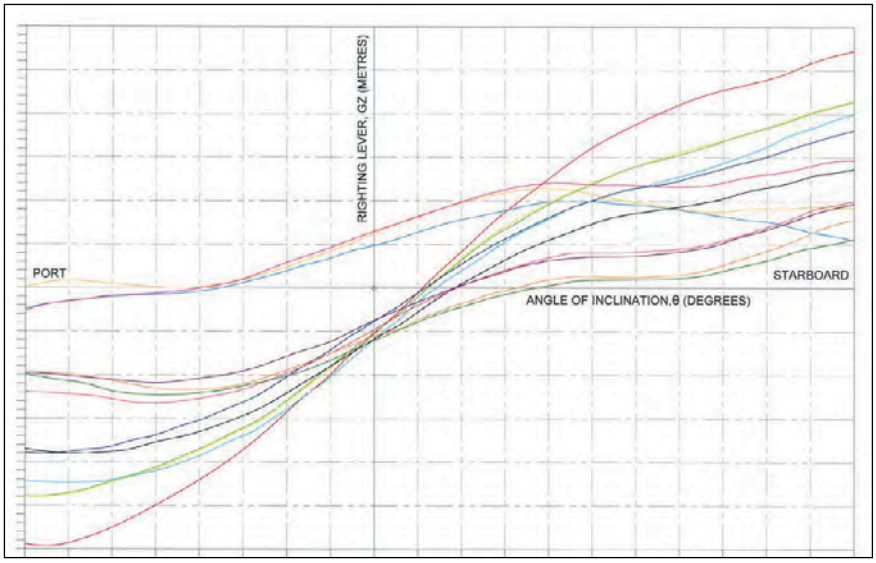
However, Combined Critical KGf (CCKG) information, explained below, can be provided but, as discussed, it is not 'simple' or quick to use by the crew.

Variation in damage stability performance

It has been shown that, within the seafaring community, there was a significant lack of awareness of the complexity of damage stability calculations together with their variation due to loading – demonstrated by Figure 3. This is surely an issue that must be addressed through ongoing education (continuing professional development, CPD) of naval architects and, most importantly, seafarers. Additionally, such insight needs to be incorporated in to the education of all new naval architects and deck cadets / officers.

Presentation and establishing compliance

As stated above, it is possible, but exceptional in tanker Trim and Stability Books, to demonstrate damage compliance of 'non-standard' loading conditions, against an extensive variety of damage cases using CCKG information. This is 'simplified stability information' namely 'loading condition specific' or 'generic' combined (intact and damaged) critical limiting maximum Fluid Vertical Centre of Gravity (KGf) or minimum Fluid Transverse Metacentric Height (GMTf) curves, as illustrated in Figures 33 to 35 of [2], and tables. Such information is common in the Trim and Stability Books of SOLAS ships (both using the deterministic and probabilistic approach to damage) as the stability analyses typically assume a 'bare boat' basis where there is no fluid deadweight 'drop-out' as there is relatively little available for loss.



Righting Lever (GZ) Curves for one Damage Case but various Loading Conditions

However, to fully cover the wide range of possible loading condition scenarios and evolutions and accurately assess the damage performance of tankers, fluid deadweight 'drop-out' must be considered. Such CCKG information is not easy to produce and present concisely and yet this is of the utmost importance from the aspect of effective and correct use by the Master or crew to ensure the operational safety of tankers, their crews and the environment. The production of such CCKG information is difficult for the naval architect which is perhaps why most tanker shipbuilders do not provide it for the use of the Master and, if it is provided, application on-board is neither 'simple' or quick. Figures 44 to 48 in the sub-Section on 'Presentation of Damage Stability Performance' in [2] give a more detailed explanation of the construction and use of CCKG information.

The alternative, if preferred, option is through 'direct' verification of the condition using an on-board or shore-based loading computer, but the interpretation of information produced is also a potential issue. Additionally, if the on-board Loading Instrument is in error or fails then if CCKG information is not available to the Master within the Trim and Stability Book (which is the primary source of stability information for any ship rather than the Loading Instrument) then the ship cannot proceed to sea or load accordingly if at sea. As stated above, it is uncommon for shipbuilders, consultants etc. to present CCKG information in tanker Trim and Stability Books to allow the Master to demonstrate compliance with damage stability. It is more common for FPSOs, especially conversions, where the stability analysis and associated Statutory documentation is produced by consultants such as Babcock Energy and Marine Technology. It was not unusual for tankers to be provided with critical KG information covering compliance with the intact stability criteria only and it was clearly found, during the above-mentioned surveys, that some loading officers believed that compliance with the intact stability criteria alone was sufficient.

From a purely professional perspective, it is perhaps surprising that naval architects involved with the design, conversion or provision of operational support for such 'liquid tank deadweight ships' in some cases seemed to overlook the fact that the damage stability critical KG curves usually dominate over those derived from intact stability, especially at deeper draughts. The authors found this rather alarming given that, a decade or so ago, both owners / operators and regulators within the tanker industry were advised of a considerable lack of awareness amongst all parties of the complexity of damage stability calculations including the inherent susceptibility of a tanker's

damage stability performance to varying cargo types, tank filling depths, cargo densities etc. It is imperative that the Master is furnished with this understanding in a clear, unambiguous and accessible manner together with any associated restrictions such as 'liquid loading limits' etc.

The earlier provision of such misleading information and its approval by the authorities is being addressed following recent revisions to MARPOL and related tanker Codes which, from 2016, require the use of on-board or shore-based computers to supplement the approved Trim and Stability Book for all new tankers, with a phase-in period of five years until 2021 for existing tankers (with only limited exceptions). For ships other than tankers, IMO is making it clear in the forthcoming amendments to SOLAS that CCKG data must combine both the intact and damage stability criteria in one consolidated curve or set of curves.

Possible solutions

In the second instalment of this series of articles, to be published in the Regulations and Classification feature of the June 2018 edition of *The Naval Architect*, the authors shall explore the solutions proposed and adopted to demonstrating a tanker's compliance with the damage stability regulations including the provision of Guidelines by the IMO. *NA*

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.

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Bollfilter launches innovative filtering concept

German company says its aquaBoll automatic water filtering system represents a new standard in optimised functionality and adaptability

With the Ballast Water Management Convention's entry into force with effect last September, ballast water management systems (BWMS) are now becoming an accepted and necessary inclusion in any vessels' equipment profile. Irrespective of whether they have adopted a UV or electrochlorination-based system, the vast majority of these BWMS will also have a filtration component, namely the automatic seawater filter.

But there are numerous other applications for seawater filtration onboard a modern vessel depending on the ship type. For large cruise ships, on which fresh water consumption is typically around 1,500,000 liters per day, they are essential for the provision of fresh water for the various kitchens and the passengers' and crews' sanitation needs, not to mention recreational facilities such as water slides and swimming pools.

Moreover, technological advances and regulatory changes are also helping to extend and redefine the role of filtration systems. With exhaust gas cleaning systems, or scrubbers, the sulphur dioxide content of exhaust gases is neutralised by spraying it with seawater – filtered for the presence of any organic or inorganic particles – through a system of nozzles. Likewise, wastewater needs to be filtered prior to discharge.

Other applications include filtration protection for seawater vapourisers in regasification units onboard FRSU's and the filtration equipment for FPSO's used in the water injection process for Sulphate Reduction Packages.

The aquaBoll comes with multi-part housing and is available with a variety of housing materials and coatings

Automatic filters

In the past it has been common for the RO (reverse osmosis) units used for freshwater production to be protected with sand filter-based systems. However, the weight and requirements for such installations are much larger than that of mechanical automatic filters and in the drive for greater efficiency there is a growing trend towards space and weight saving solutions.

> "We recognise there is increased ecological awareness within the maritime sector"

Automatic filters have some additional advantages, says Frank Zichel, Head of Water Filtration for Boll & Kirch (Bollfilter): "Besides automatic backwash filters you will find manual simplex or duplex filters. The major difference between these two types of filtration units is the manual cleaning process required for manual filters.

"Automatic backwash filters do not require manual cleaning, as the backwash process is generated automatically, triggered by Delta-P [differential pressure] and time settings in the system control."

Demand for greener and more efficient solutions is also influencing shipowner choices, Zichel adds: "We recognise there is increased ecological awareness within the maritime sector, which you can see from the new ballast water and emission regulations, as well as regional requirements.

"This means innovative water treatment solutions are required. Automatic water filters are an integral component in water treatment systems."

Unique concept

Motivated in part by these drivers Boll & Kirch recently launched a new filter, the aquaBoll, which the company describes as a new concept in fully automatic water filtration that increases overall plant efficiency through optimised functionality.

Zichel says that the aquaBoll automatic filter provides a lot of features which make it unique. In particular, the platform allows for the use of three different types of filter element technology within the same housing: filter candle, sieve cylinder and fine sieve cylinder.

He explains: "This comprises Micro Particle Filtration (from 10-80µm), Macro Particle Filtration (100-1000µm) and Coarse Particle Filtration (1-5mm). Each of those different ranges of filtration grades has its own element & backwash facility technology, which is in particular designed for cater for the various requirements of the different applications it can be installed in."

For the first generation of AquaBoll, launched in November 2017, the filters were casted, with a maximum flange connection of DN500. Bollfilter is planning to complete its portfolio with a second generation, expected in the summer of 2019, which will include fabricated filter units with a flange connection up to DN1000.

Uniquely, he emphasises, the system is customisable and the filter sizes, pressure rating and materials of construction can be adjusted depending on the filter's particular application and the required level of filtration and degree of contamination. Zichel is confident the company can deliver customised filter units in some of the shortest lead times available on the market while remaining competitive.

The aquaBoll can be customised to different filtration options according to the customer's needs

He adds that the system has all the necessary endorsements from marine surveyors: "AquaBoll was presented to all major marine classification authorities and subject to their inspection processes. As a result we can provide type approvals from all classes for this filter type."

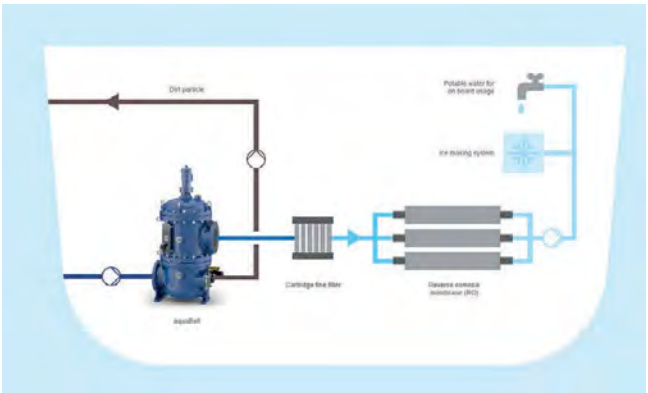
Choosing the right filter

Application engineering is critical in the selection of the right filter unit. This includes the selection of type of filter, appropriate filter sizing and selection of suitable grade of filtration based on the quality of the medium being filtered. In the course of this application engineering the operating conditions, various processes and design parameters, as well as the place of the installation must be considered.

Development of the aquaBoll concept also led Bollfilter to optimise its own internal processes, a philosophy it describes as 'Standardisation without compromise'. Restructuring of its sales department in 2016 led to the development of implementation of application-specific know-how for different scenarios in which the filters can be used.

Zichel says: "This allows a professional consultation with the customer, including application engineering. It is very important to verify all relevant process, design and installation parametres, which may have a negative impact on the filter, in order to receive the best performance out of your filter system installation."

"The installation of automatic water filters especially in large vessels does provide challenges to the functionality and performance of the filter unit, due to piping arrangements, piping elevations and drafts. So for these applications in particular, shipowners, original equipment manufacturers and shipyards benefit from a professional consultation service." *NA*



It's common for sand-based filtration systems to be used in freshwater production, but Bollfilter says that aquaBoll can offer high flow rates with a smaller footprint

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