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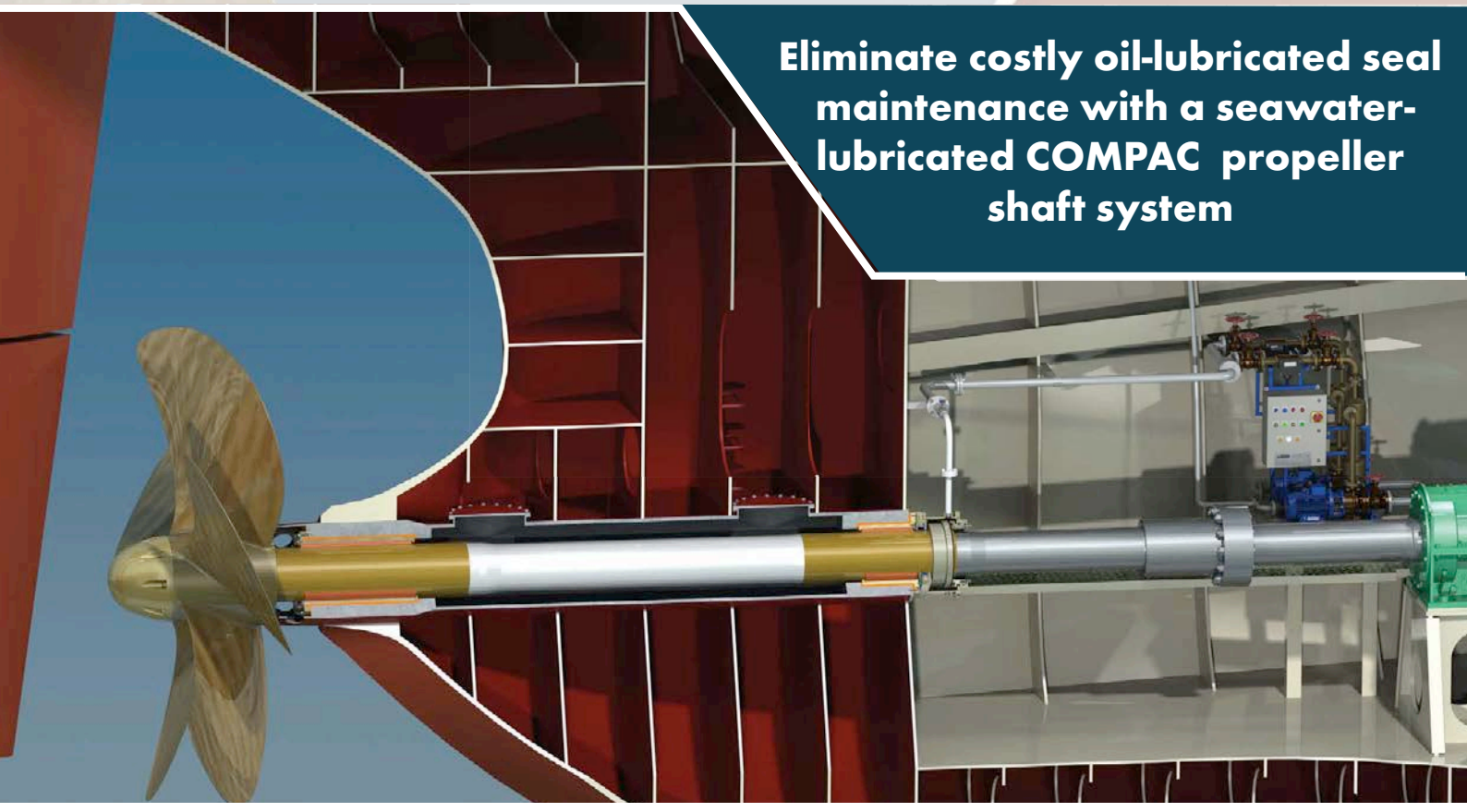

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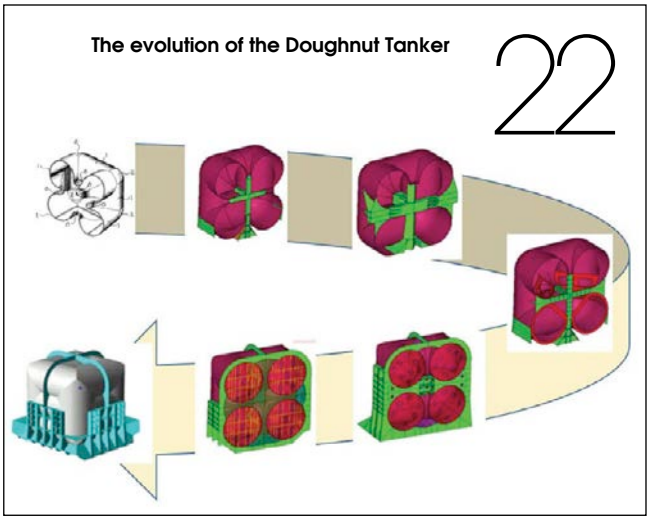

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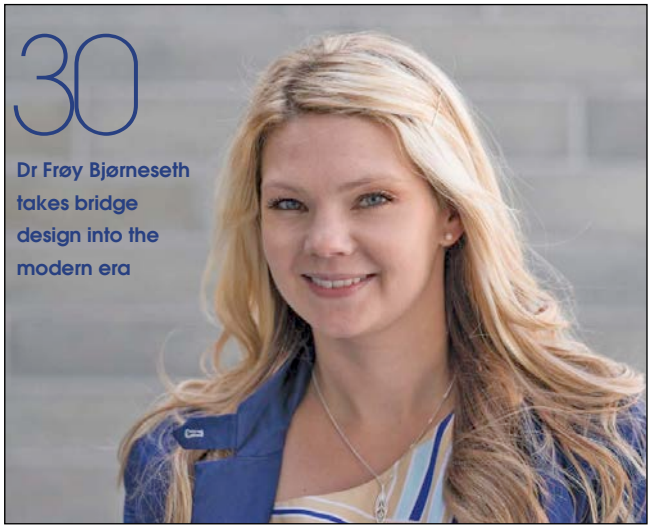

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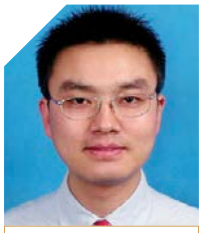

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Rules revisited

Never-ending debates ask questions of the way rules are made

Green shipping regulation is strongly featured in this issue of *The Naval Architect* with MAN Diesel & Turbo's focus on Tier III regulations in the Engine Technology feature and the Shipboard Water Treatment feature's look at the regulations governing the discharge of waste water. Both regulations came into force on 1 January this year, and these and other regulations are shaping the future composition of the maritime industry and the design of vessels that will come to operate within the rules.

However, the implementation of some of this regulation has been less than ideal at times, resulting in much reflection at IMO and, in some instances, the intensification of criticisms of regulations as it became clear that the rules have not met the required standards.

This has not been the case for many of the green regulations passed by IMO.In this month's issue, both In Depth features have focused on environmental aspects of shipping. In the case of China Shipping News, the writer has emphasised the need for the Chinese shipbuilding industry to make great strides in order to catch up with their competitors, mainly in Japan and South Korea but also to a lesser extent in Europe, in the implementation of NOx and SOx regulations. Green shipping is an accepted element of the industry today and the regulations have been implemented with few complaints.

However, in the second In Depth story, the issues surrounding the Energy Efficiency Design Index (EEDI) indicate that its application to ro-ro and ro-pax vessels has not been without heated debate.

The discussion about how EEDI could be applied to ro-ro ships reached its peak in 2013, and it was thought to have been settled. However, the issue has resurfaced and will be discussed further at MEPC in April.

Debate over the application of the EEDI formula reached its apparent denouement at the IMO's MEPC (65) (Marine Environment Protection Committee) when Denmark, Japan and Norway proposed the use of a cubic capacity correction factor while Sweden and Germany proposed the use of the Froude number to calculate an EEDI number.

The Swedish and German proposal was accepted at MEPC in May 2013, and many industry observers, including such bodies as Interferry, supported the proposal. However, at the time, representatives from Denmark were particularly adamant that the German/Swedish proposition was unworkable.

Three years on and MEPC is set to debate the issue again following difficulties in making the preferred Swedish/German proposal into a workable solution for ro-ro vessels of all types, including ro-ro, ro-pax and car carriers.

A number of industry figures and some major academic institutions are now addressing the problem of correction factors for EEDI calculations that appear to make EEDI targets so punitive that ro-ro ship operators are in danger of becoming less competitive than road transport operators or even to cargo moving by air. There now appears to be common agreement that the formula in its original form is unworkable.

The need to revisit such a significant regulation raises the question of whether it was evaluated with sufficient rigour. A parallel can be drawn here with the development of another IMO regulation governing the treatment of ballast water. The original Ballast Water Management Convention was adopted at IMO in February 2004, more than 12 years ago. However, the rule has yet to come into force as owners have complained it is unworkable.

The issue is further complicated by the introduction by the US of ballast water rules that are more stringent than those proposed by the IMO.

The failure of the rules to be implemented after so many years is a consequence, in part, of owners' lack of confidence in the technology that would clean the ballast water and the technology that would test measure the extent of live organisms following the cleansing process.

The difficulties which industry is experiencing and reporting with these two ecological regulatory issues also begs the question as to whether they are the result of a failure of the system which created them. Confidence in IMO's role as rule maker would surely be improved by a review of the system and the processes which created them. Perhaps this should be a priority for secretary general, Kitack Lim. *NA*

Personnel

Tor Svensen leaves DNV GL

Group executive vice president at DNV GL, Tor E. Svensen, will retire from the Norwegian/German class society on 1 August, it has been announced.

Knut Ørbeck-Nilssen who succeeded Svensen as chief executive officer of DNV GL's Maritime business will move up to the Group EVP role, exactly one year to the day after both he and Svensen took their new positions.

After 23 years at the class society Svensen told *The Naval Architect* that he wants to pursue some of his own personal interests, but that he will remain in the maritime industry. "You have heard me talk many times about safety," he said, "now I will get involved in the new thinking around safety barrier management at Strathclyde University."

DNV GL's Tor Svensen is set to join the University of Strathclyde following his retirement from the class society in August this year

Svensen's role at Strathclyde will be part-time, spending 30-40% of his working time within academia, having "come full circle, I started in academia and now I will go back to academia," he said.

He added that Strathclyde is one of the leading maritime universities in the UK with more than 100 PhD students on their books and the university offers him the opportunity to work with the renowned Professor Dracos Vassalos.

Svensen said he will also pursue other personal interests following his retirement, including advisory roles or lecturing, but he has not yet confirmed the details of this work.

Cybersecurity

New approach for LR in cyberspace

UK-based class society Lloyd's Register (LR) says the old prescriptive approach to risk management is no longer applicable to cybersecurity and that with the inter-connectivity of digital technology requires a holistic approach to security.

In technical guidance issued to LR's clients the company emphasises a non-prescriptive, risk-based approach. "A 'total systems' approach is required taking into account all systems onboard and – critically – on shore, how they are designed and installed, how they connect, and how they will be managed," says LR.

Luis Benito, LR's Marine Marketing Director, commented: "ICT is revolutionising shipping, ushering in a new era – an era of the cyber-enabled ship. Today, leading manufacturers and ship operators want or have the potential to innovate using the latest ICT systems, going beyond traditional engineering to create ships with enhanced monitoring, communication and connection capabilities – ships that can be accessed by remote onshore services, anytime and anywhere for safety and performance benefits.

Assurance of safety and security will require owners and operators to reflect on six areas, says the class society; systems, human-systems, software, network and communications, data assurance, and cybersecurity.

Satellite technology

Fleet Xpress flies in Arctic

The hybrid Ka and L-band satellite service Fleet Xpress has successfully completed a trial in Antarctica following the installation of the system on the 1992 built cruiseship *Ocean Nova*.

Inmarsat and Global Marine Networks along with Network Innovations said that following the successful trial the group had received the first commercial order for the system from Nova Cruising Ltd.

Using Inmarsat's Global Xpress satellite network the Fleet Xpress system delivered "the world's first globally available high-speed broadband service from a single network operator," claimed Inmarsat.

Dr Luis Soltero, chief technology officer of Global Marine Networks said: "Fleet Xpress delivered on its promise of high-speed seamless mobile broadband service in one of the world's most difficult areas for most satellite systems. Antarctica requires low-horizon satellite views

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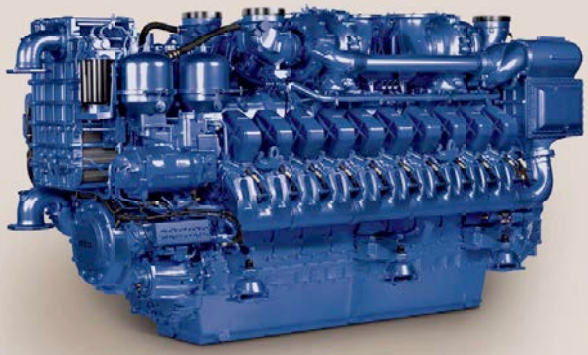

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through heavy cloud cover and precipitation. Fleet Xpress successfully overcame these conditions."

"Fleet Xpress is set to redefine maritime communications and will transform the way vessels are managed and optimised throughout the globe," added Ronald Spithout, president of Inmarsat Maritime.

Shipyards

JES Holdings sells out

Chinese shipyard owner JES Holdings International (JES) announced last month that it "has entered into a sale and purchase agreement" with Hong Kong Victo International Limited which will acquire the shipbuilding assets of JES, including Jiangsu Eastern Heavy Industry Co., Ltd (JEHI) and Jiangsu New Eastern Marine Engineering Equipment Co., Ltd (JNEME) and 49% of the registered capital of Jiangsu Nereus Shipyard Co., Ltd (JNS).

Hong Kong Victo will pay a consideration of US$500,000 for JES which includes its known debts, which stand at RMB1.956 billion (US$ 300 million), while the company's assets stood at RMB1.531 billion (US$234.705 million) as of the last accounts on 31 December 2014.

JEHI was registered in the PRC on 22 August 2006 and is a wholly-owned subsidiary of the Company, and as at the date of this Announcement has a registered capital of US$79.8 million. JEHI was engaged in the business of shipbuilding. As previously announced, JEHI ceased operations following the filing of the application for restructuring. The sale comes after

JNEME was registered in the PRC on 26 June 2008and is a wholly-owned subsidiary of JES and as of 3 February 2016 has a registered capital of US$90 million JNEME is a dormant company. JNEME is the legal and beneficial owner of the entire registered capital of Jingjiang Eastern Heavy Steel Structure Co., Ltd (JEHSS), registered in the PRC on 21 August 2009. JEHSS is a dormant company.

JEHSS is the legal and beneficial owner of the entire registered capital of JYJJP Eastern Shipyard Supplies Co., Ltd (JES Supplies), registered in the PRC on 6 October 2008, and 51% of the registered capital of JNS.

ES International Holdings Limited's (JES) core business is in shipbuilding. Its shipyard is located in Shiwei Port, Jingjiang City, Jiangsu Province, PRC and covers a coastline of approximately 1.8km long on gross land area of about 804,000m^2.

Annual capacity is about two million deadweight tonnes. Its key products include bulk carriers, oil tankers, containerships and ocean engineering vessels. In the end of 2013, it started work on two platform support vessels, cementing its entry into the offshore segment.

Newbuilding

MAN powers Indonesian training ship

The 110m *Kri Bima Suci*, currently under construction at the Freire Shipyard in Vigo, Spain, will be powered by an MAN 6L21/31 engine, which will be available when only an unfavourable wind is blowing in the vessel's 3350m^2 sail.

Kri Bima Suci will offer training to up to 200 cadets onboard the vessel. The MAN 6L21/31 engine has a power rating of 1,320kW and can run on MDO, MGO or HFO.

The Tier II compliant engine is designed for low noise, easy maintenance, says MAN. "For easy installation and maximum operational safety, the auxiliary systems are integrated and self-supported with the engine. The engine's advanced front-end box, which carries the turbocharger and charge air cooler, also incorporates engine driven cooling water pumps, lube oil pump, lube oil cooler, double full-flow depth lube oil filter and thermostatic valves," the company added. *NA*

The MAN 6L21/31 engine (below) will be fitted to the 110m *Kri Bima Suci* sail training vessel

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Call for transparency on CSR software

With the recent amendments to the common structural rules for bulk carriers and tankers, classification societies have been introducing new software to assist in the design process, *writes Sandra Speares*.

According to David Tongue, secretary general of INTERCARGO "The first concern is that there is a strong need for transparency in the software that class uses for determining CSR (or Goal Based Standards (GBS)) compliance- there is a requirement for more than just inputs and outputs through a 'black box' as has been commonly the case. Detailed assumptions need to be declared for confidence. The 'trust me I'm a doctor' approach is no longer acceptable.

"Secondly there is a need to ensure that the software used is 'futureproof'. We are now experiencing instances where programmes used by class to determine compliance cannot be run on the later software platforms, with the original platforms now obsolete and redundant. We need to provide that when the CSR (GBS) compliance software needs to be run for verification purposes in the later life of a CSR vessel, this will be a regulatory requirement and the software must remain usable and available."

Challenges for ship designers and yards resulting from the new rules include the increase in overall vessel design time, according to ClassNK. To alleviate the burden of these new rules on ship designers and cut down the required man hours, ClassNK initially released PrimeShip-HULL(HCSR), a multi-functional vessel design support tool aiming to make it easier for designers to carry out rule calculations and optimise their designs.

The latest version, PrimeShip-HULL(HCSR) Ver. 3.0.0 is now being marketed. "The prescriptive calculation software includes enhanced data linkage with popular commercial CAD systems, which further streamlines the design process. In particular, data linkage with the widely used 3D ship design system NAPA Steel has been updated to include all structural members in the fore and the aft of bulk carriers and oil tankers. This makes it possible to exchange an entire ship model from NAPA Steel so that ship designers will be able to benefit from even further reduced modelling time," the class society said.

Meanwhile ABS and Lloyd's Register have formed a joint venture company called Common Structural Rules Software which has released its own new software tools for meeting the requirements of the CSR.

Version 2.5 of the CSR Prescriptive Analysis and the new CSR Finite Element (FE) Analysis software allow assessment of whole vessel structures, including new bulk carrier and oil tanker designs. Both class societies will use these new tools to evaluate new designs to the CSR.

"This software constitutes a new industry standard," says ABS chairman, president and CEO Christopher Wiernicki. "In our collaboration as two of the world's leading class societies, we continue to achieve our primary objective to enable the advancement of the maritime industry through reliable and dependable software applications."

The CSR Prescriptive Analysis software requires only that the user input the appropriate data. All of the outputs are clear, straightforward and easy to read, the new joint venture says. A summary report provides required and offered scantlings with graphic representation of any deficiencies. An intermediate report summarises dominant criteria for each structure, and a detailed report provides data for every parameter value. In conjunction with CSR Finite Element (FE) Analysis, this complete tool makes verifying compliance with CSR possible with minimal effort.

According to LR Marine director Tom Boardley: "Following the development of the CSR in 2005, LR and ABS quickly realised that only common software would support the industry desire for common scantlings, and our CSR Software tools had become widely used. With the introduction of the new CSR, we have developed a completely new generation of CSR software that will enable shipbuilders and shipowners to easily and consistently address the requirements of the new IACS Rules."

Following his appointment as IACS chairman last year Wiernicki stressed that common structural rules for tankers and bulk carriers were very comprehensive. Unified requirements are by definition technical ones, some of which were prescriptive and some functional in nature and he said there was enough "bandwidth" in that to address the vast pace in technology which will require a different mind-set going forward.

Although there has been a good deal of discussion over the introduction of common structural rules for containerships, he said that as a result of continued technology advancement, in order to assess the safety of a containership requires some "very sophisticated advance analysis solutions to begin to understand how large containerships behave in a seaway".

Containerships are still going through a period of adjustment and safety concerns have been addressed through unified requirements rather than CSR, with focus on issues like longitudinal strength. Unified requirements are minimum, technical, functional, prescriptive requirements, he said, whereas CSR for tankers and bulkers are "integrated, comprehensive sets of technical requirements". *NA*

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Intellectual Property Rights (IPR) are an increasingly important part of a company's value. As developed countries move to knowledge based economies, protection of IPR becomes both more difficult and more important for designer, particularly in a more competetive market. In a global marketplace, international protection of IPR is complex and generally not well understood in sectors of the maritime industry.

The one-day Seminar on IPR and the Naval Architect will provide designers, and others involved in the marine industry, with an understanding of IPR law and the extent to which it protects inventions and designs. The seminar will consist of a number of sessions in which presentations on various aspects of IPR will be given by experts and practictioners, followed by discussion.

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Engines

ECAs bring low sulphur fuel challenge

Vessels using ultra low sulphur fuels in order to comply with ECAs may be affected by the formation of paraffin wax in engines and fuel tanks, according to Wilhelmsen Ships Service (WSS).

In cold temperatures the formation of wax in engines and fuel tanks increases. Sachin Gupta, business manager of oil solutions at WSS explains: "Distillate fuel contains paraffins, or wax particles, and colder climates pull these together to create large structures. These structures, basically waxy sludge masses, accumulate in fuel tanks and block fuel filters, damaging them and causing an increasing number of loss of power (LOP) incidents."

WSS says there has been confusion in negotiating this problem because of its complexity. "A key issue is that fuels with only slight differences of the same grade can react very differently at cold temperatures – with some flowing freely, while others have catastrophic effects on fuel filters," says Jonas Ostlund, a marine fuels expert for WSS. "It's therefore vital to have a clear picture of both the temperatures vessels will be operating in and the characteristics, quality and specifications of the fuel you intend to use."

In order to manage this sticky eventuality, Ostlund prescribes that crew members know pre-determined Cloud Point (CP) and Cold Filter Plugging Point (CFPP) figures for the distillate in use, as well as for owners and operators to buy distillates designed for slightly colder waters than the vessels will be sailing in.

Distillate fuel treatments, or cold flow additives, can also be used to prevent the formation of distillate waxes by postponing the formation of wax crystals. "They can help keep vessels safe when temperatures approach the limits of what a fuel can tolerate," says Gupta.

www.wilhelmsen.com/shipsservice

Auxiliary equipment

LNG PowerPac cuts port emissions

An LNG onshore power solution, LNG PowerPac, from Becker Marine Systems has received a grant notification from the German Ministry of Transport and Digital Infrastructure for a concept that provides alternative and greener means of supplying energy to ships at port.

"During layovers at port the power for containerships is currently being supplied by onboard auxiliary diesel engines using fuel oil (Marine Gas Oil, MGO). By doing so, ships account for the majority of harmful emissions at ports," says Henning Kuhlmann, managing director of Becker Marine Systems. "With LNG PowerPacs we are creating a modern, environmentally-friendly, safe and economical option for supplying power based on LNG to containerships during layovers at port."

Becker Marine Systems' LNG PowerPac cuts emissions in port

Each LNG PowerPac can provide 1.5MW from its gas-powered generator and 20-foot LNG ISO tank that lasts up to 30 hours. The system can work in tandem with additional units if supplemental power is needed.

The LNG PowerPac has been designed to fit within the space of two 40-foot containers and can be loaded onboard using standardised equipment, such as gantry cranes, ship-to-shore cranes or van carriers.

www.becker-marine-systems.com

Scrubbers

TUI cruiseships scrub up

Valmet, a global developer and supplier of process technologies, will supply two new cruise vessels with exhaust gas scrubber systems (EGCS).

TUI Cruises' *Mein Schiff 7* and *Mein Schiff 8*, which are currently under construction at Meyer Turku, Finland, will be the latest of the cruise line's vessels to adopt Valmet's cleaning system.

Valmet's system washes exhaust gas with seawater in open loop mode and with recirculated water and alkali in closed loop mode. The wash water is then cleaned with Valmet's water treatment system.

The scrubber system orders include integrated hybrid scrubber systems for both engine rooms and all auxiliary systems with automation. They are scheduled for delivery in the fourth quarter of 2016 and the first quarter of 2017.

www.valmet.com

BWTS

Producing for a boom

FilterSafe, a manufacturer of high volume ballast water filtration equipment, is doubling its manufacturing capacity in anticipation of the ratification of the Ballast Water Management Convention (BWMC) and a subsequent boom in Ballast Water Treatment Systems (BWTS).

The company plans to raise its annual production from 750 ballast filtration systems to 1,500 in order to meet the demand of the shipbuilding industries in China and South Korea. It also plans to employ 20% more staff for its production facilities this year in addition to a previous 25% rise in manpower in 2015 and to double the size of its manufacturing plant in Israel from 2,000m^2 to 4,000m^2.

www.filtersafe.net

CAD/CAM

Tooling up

HydroComp, Inc. delivers new functions in its PropCad Premium design software, both reducing the manipulation of propeller designs within a 3D CAD tool and facilitating the reconstruction of existing designs with its Scan Converter feature.

The new Patterns Corrections tool allows users to directly specify machine stock and shrinkage to create machining models, casting patterns, and mould geometries. It can be used to expand and thicken propeller designs to create machining models and casing patterns.

The tool's ability to directly apply corrections to the propeller parameters is a major advantage, according to HydroComp, as it allows the calculation and visualisation of sections, blade parameters, and radial distributions. Following the specification of corrections and the display of the derived geometry, 3D models, 2D drawings and offset reports can be generated for the new geometries.

HydroComp also reveals that its ScanConverter function, now part of PropCad Premium, is being used to convert 3D inspection data into PropCad designs, 2D drawings, and reports. The tool can process extracted propeller parameters, such as pitch, skew and thickness using 3D data points collected from a physical propeller.

"Once the design is in PropCad, additional documentation such as 2D drawings, pitch inspection reports, and 3D offsets can be easily generated for customers, clients, and record keeping," says the company.

www.hydrocompinc.com

BWTS

Stocking up for BWMC

Sinopacific Shipbuilding Group announces that Optimarin will supply BWTSs for nine of its Anchor Handling Tug Supply (AHTS) vessels operating in the Arabian Gulf.

Tore Andersen, CEO, Optimarin, explains that the system's modularity makes it easy to install on vessels, such as AHTSs, where space is at a premium. "These vessels are state of the art and designed to excel in the region's shallow waters, high temperatures, salinities and humidity. This will ensure optimal quality, reliable operations, and Sinopacific wanted a BWT system to match."

The vessels will be operated by ESNAAD, a subsidiary of the ABHU Dhabi National Oil Company (ADNOC), and are scheduled for delivery to the company before the end of 2017.

Andersen adds: "With the upcoming full USCG approval of our system, expected in autumn this year, and our vast experience of both newbuild and retrofit installations, we think we're perfectly placed to offer shipowners and yards the best in BWT. That means complete system performance, compliance and peace of mind for the future."

www.optimarin.com

Seals & bearings

A rubber alternative to welding

Roxtec, a manufacturer of cable and pipe transit systems, is aiming to supply the marine and offshore oil and gas sectors with a rubber safety seal that guards against fire, gas and water ingress.

The Roxtec Single Pipe Metal (SPM) product

The Single Pipe Metal (SPM) product is designed to seal any kind of metal pipe in steel decks or bulkheads with its highly elastic EPDM (ethylene propylene diene monomer) rubber, offering an alternative to welding.

Roxtec UK's managing director, Graham O'Hare says: "A crucial point is that it provides an alternative to the costly and laborious welding process often used to seal metal pipes. This process requires a re-paint after weld. In addition, current practices involve pipes being hit with hammers which can lead to damage. Our seal is easy to open up and re-seal for maintenance."

O'Hare describes the product as "a lightweight, single-sided solution which is quick and easy to install," adding that "the seal is made out of durable and malleable rubber, while the fittings are made out of acid-proof stainless steel."

The seal comes with an A-60 fire rating, is watertight to 1 bar, gas tight to 0.67 bar, and comes in a range of sizes for pipes of 12mm-222mm.

www.roxtec.com

Bridge & communications

New digs for Alphatron Marine

Alphatron Marine, a supplier of integrated bridge solutions, announces the opening of an office in Madrid to service the needs of its domestic customers in Spain and Portugal.

The new office, Alphatron Marine Iberia, will provide storage, service, and maintenance facilities for bridge equipment for all types of vessels within its 850m^2 premises. It will also feature a technical area that is specifically for new projects, as well as a showroom to display the company's latest technologies.

The office's main priority will be to promote JRC and Alphratron Marine products following the merger of JRC and Alphatron Marine in the beginning of 2014.

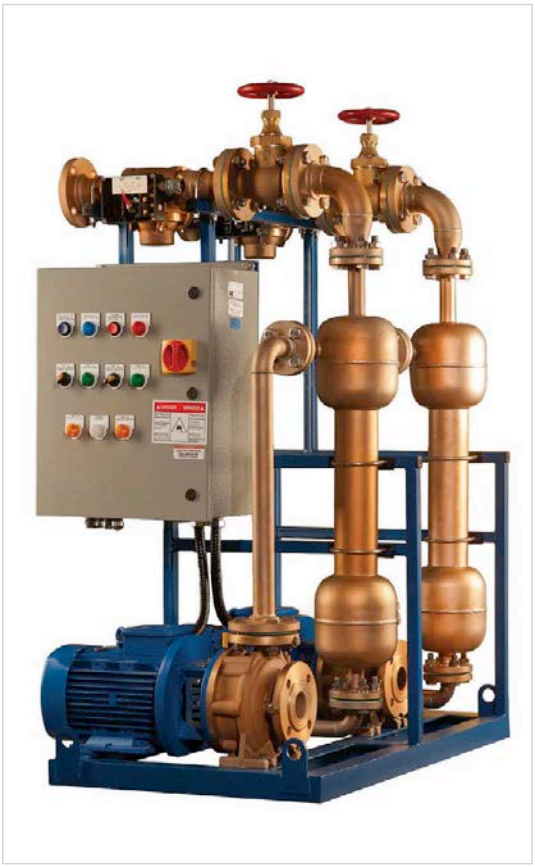
Alberto Olmos, general manager of Alphatron Marine Iberia, says: "We foresee many chances for improving the JRC and Alphatron Marine presence in our area. One of our most important goals is to develop a completely new structure tailored to the specific needs of Spanish and Portuguese customers."

www.alphatronmarine.com

Seals & bearings

Keeping it clean

Thordon Bearings' Water Quality Package (WQP) has provided Atlantska Plovidba's *Revelin* with a clean and consistent supply of seawater to the bearings while operating in filthy river water.



Thordon's Water Quality Package allows shaft bearings to be lubricated when the sea chest is drawing in filthy river water

Scott Groves, business development manager, Thordon Bearings, says the vessel needed to function during ocean-going operations and in river entrances where the seawater is highly abrasive, and so by constantly running Thordon's WQP the propeller shaft bearings were able to be lubricated while the sea chest was drawing in filthy river water.

Atlantska Plovidba's vice-president, ship management, Marin Matana, explains: "Our vessels trade globally, including in the USA. With the Vessel General Permit (VGP) in effect, we felt that the seawater-lubricated system was the perfect solution. It meets the U.S. VGP requirements and is the right choice for the environment."

Revelin is the second in a series of two environmentally sustainable handy-size bulk carriers delivered by Qingshan Shipyard, China. Both vessels of the series (*Revelin* and *Dubrava*) were built to the Green Dolphin 38 design unveiled by the Shanghai Merchant Ship Design & Research Institute (SDARI) in 2012 and feature Thordon Bearings' seawater-lubricated COMPAC propeller shaft bearing system.

Arrested development

The impacts of current EEDI calculations for ro-ro cargo and ro-ro passenger vessels are once again under scrutiny

The formulation of a correct method for calculating EEDI for ro-ro cargo and ro-ro passenger vessels was a rocky, and at times, controversial undertaking. It ultimately ended with the adoption of a method in April 2014, but recent research and industry experiences are reopening the debate and adding weight to old concerns.

Ro-ro cargo and ro-ro passenger vessels were always difficult to include in IMO's EEDI because of, in simplified terms, the huge diversity of technical and ship design characteristics of these ships and the varied nature of their operations. This diversity meant that every vessel would exhibit substantial variations in technical characteristics and mission profiles, and a wide EEDI scatter would therefore be seen when the data was grouped.

As a result, correction factors were sought to establish the required EEDI reference line for these vessel types. It is especially these correction factors (the so-called $f_{jRo\text{-}Ro}$ factor and the f_{jRoPax} factor) that are once again under scrutiny, as according to research by Aimilia Alisafaki and professor Apostolos Papanikolaou of the National Technical University of Athens, and Hans Otto Holmegaard Kristensen, Head of Maritime DTU at the Technical University of Denmark, an alternative method that uses different exponents for calculating the fj factors of EEDI for these ro-ro vessels is more suitable.

The new exponents in this method (Table 1 and Table 2) make it easier for shipowners to fulfil the EEDI requirements, which, at present, create infeasible goals and could potentially close ferry routes if vessels are unable to operate at the speed and efficiency required of them to function commercially and within regulations. In addition to the calculated EEDI values for the sample ships being lower, the statistical variance of the statistical sample is also reduced - an outcome that should be desirable for IMO.

Speaking of his own calculations in a paper entitled "Influence on attained EEDI for ro-ro ships using a revised formula for the fj correction factor," Kristensen says: "Using the revised power exponents proposed by Alisafaki and Papanikolaou decreases the attained EEDI for ro-pax ships by 15 – 27%, while the attained EEDI for ro-ro cargo ships is reduced by 12-19%, depending on the ship size, which means that it will be easier to fulfil the EEDI demands by using the revised exponents in the fj correction formula."

It is important to note that a lowering of EEDI targets is not aimed at prolonging higher pollution levels in the ferry sector or to rein in the setting of ambitious emission reduction targets; it is instead intended to prevent ferry route closures and the redirection of cargo traffic through the more polluting automotive and aeronautical industries, and Kristensen emphasises that he is diagnosing a problem, not suggesting a definitive solution.

An example of the results found in Kristensen's study can be seen in Figure 1 where the requirements for future EEDI targets of the current method are also plotted. The figure shows the obtained EEDI at different design speeds from 12 to 22knots using the present EEDI calculation procedure. The normal design speed for the ro-pax ship carrying 1500 passengers is approximately 21.3knots. Lowering the design speed lowers the EEDI until around 13knots where the EEDI increases due to the wrong definition of the f_{jRoPax} factor. Using the revised f_{jRoPax} factor proposed by Alisafaki and Papanikolau results in a more logical EEDI curve that shows EEDI is decreasing with decreasing design speed.

Such results call for further discussion of the current method of calculation for ro-ro cargo and ro-ro passenger vessels, and coverage of the EEDI debate will continue in *The Naval Architect*'s April issue. NA

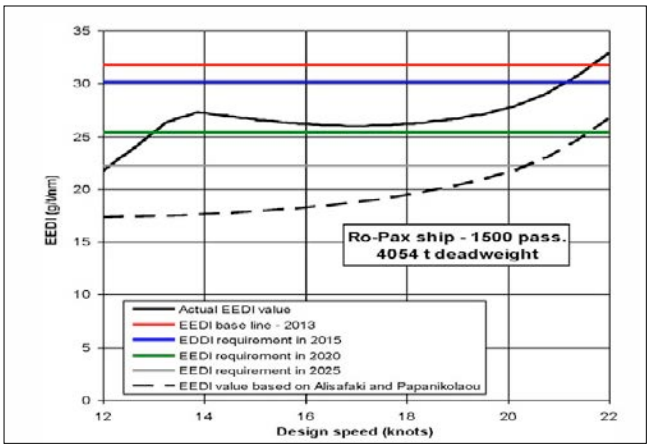


Figure 1: Changing EEDI requirements for an example 1,500 passenger ro-pax ship from Kristensen's study

Table 1: Exponent values for ro-ro cargo ships

Exponent values	Acc. to IMO	This study, non linear approach	This study, linear approach
α	2.00	2.80	2.00
β	0.50	1.89	2.00
γ	0.75	1.26	1.50
δ	1.00	-1.84	-1.00
ε	0.503	0.93	0.503

Table 2: Exponent values for ro-ro passenger ships

Exponent values	Acc. to IMO	This study, non linear approach	This study, linear approach
α	2.50	2.79	2.00
β	0.75	1.97	2.00
γ	0.75	1.40	1.50
δ	1.00	-2.07	-1.00
ε	0.567	0.93	0.567

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ALISAFAKI, A.G. and A.D. PAPANIKOLAOU, On the Energy Efficiency Design Index of Ro-Ro passenger and Ro-Ro cargo ships, IMechE 2015 *Journal of Engineering for the Maritime Environment*, October 2015.

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SHIP ECONOMY & TRADE

Outlook on China's green future

Weng Zhenping, director at China Ship Scientific Research Center talks about the development of shipping technology, writes Wang Sun

The director from China Ship Scientific Research Center, Weng Zhenping, illustrates how cutting-edge green shipbuilding technology will be integrated with conventional shipping equipment, and how it should dynamically combine functional and performative demands with that of energy saving and environmental protection.

In the whole life cycle of a vessel, including ship-design, manufacturing, operating and scrapping, the industry must conserve energy and resources, reduce or eliminate environmental pollution, guarantee the safety and health of manufacturing staff and users with new technology. This concept is universally accepted in the industry, exemplified by the various newly promoted international conventions, standards, and norms, all of which have higher demands for design, manufacturing, energy consumption and performance. Many western countries already have strict requirements on the exhaust standards of vessels moored in a harbour.

The above environment pushes different ship research institutes and shipbuilding enterprises dedicated to R&D, to produce new technology, new vessels and new energy sources that are in accordance with the 'green ship' concept.

Weng Zhenping says that within this decade the shipping industry in China has gained great impetus for development and formed the competence for R&D, design, production and support systems.

"Our production size and comprehensive competence have continuously expanded, with conspicuous advantages in the research and development sector. We are now the most powerful shipbuilding country in the world with the competence of building most of the current vessel types while maintaining high production efficiency. But in terms of green shipping, China is still lagging behind Japan and South Korea. On the one hand, Japan and South Korea are outperforming us in terms of the average energy consumption, material consumption and pollution emissions; on the other hand, we rely on our overseas partners' design support for the high-tech and high value-added vessels. Furthermore, we have not yet totally localised the current equipment while the new generation of green equipment has come to the stage, which challenges us greatly."

One of the first Chinese-built LNG ships, *Dapeng Moon*, was delivered from Hudong-Zhonghua shipyard

For the above problems, Weng Zhenping offers his insight by putting emphasis on green technology. "Our scientific research efforts should be concentrated on green vessel types, green power, and green supporting technology, and our manufacturing competence should be correspondingly developed. Green shipping can be nurtured out of the existing shipping industry cluster so that we can finish the transformation from size and tonnage advantage to a technology-and-profit-driven pattern, thus finishing our transition from big manufacturer to competent manufacturer."

In his joint study with Wu Yousheng, a member of the China Academy of Engineering, Weng Zhenping says that in the first instance to integrate green shipping systems through the optimisation of key technology in terms of vessel types, power, supporting equipment, manufacture, operation, maintenance and scrapping, we can reduce emissions of NOx and SOx by 90%, and CO_2 by 30%. In the energy conservation and emission reduction of new concept vessels, by developing optimised vessel types, utilisation of non-polluting and light-weight materials, and the recycling of resources, there can be a realisation of the goal to operate zero emission ships.

In addition to developing vessels with high-performance, improved Energy Efficiency Design Index (EEDI) and Energy Efficiency Operating Index

(EEOI) statistics for the three main types of vessels, researchers should systematically study the EEDI baseline assessment method, pre-verification technology, experimental technology, and focus on comprehensive optimisation technology to meet the performance design requirement of EEDI.

The reduction of water resistance and effective propulsion technology must also be studied in order to develop a series of green vessel types. This would help to develop smart energy-conservation, voyage planning technology and navigation aids.

Furthermore, building new technological systems based on tests from operating green vessels might not include current classification standards and the new goal should be to focus on hull energy-saving, consumption-reduction and safety. Similarly, the following aspects should be highlighted: precise onboard tests, compound material application technology, technology for optimised material to reduce weight, technology for structural loading analysis and technology for structural safety and reliability.

Priority needs to be given to voyage energy-conservation, pollution-prevention and safety. The following problems also demand our attention and solution: shipping risk assessment technology, risk control technology, onboard safety alarms, accident and disaster prevention and control, smart salvation preparation and operational technology.

Studying the technology on the energy-saving and environmentally friendly equipment the prospective field includes: low and middle speed diesel power technology for a new vessel; smart diesel electric fuel injection and electronic technology; fuel cell and LNG vessel power technology; civil vessel nuclear power for propulsion design technology; offshore deep water floating wind power array technology; tidal power, current power generation and temperature difference power generation technology.

Studying technology in supporting equipment that features energy conservation and environmental protection includes new high performance and energy-conservation generating sets; low consumption and low noise vane pump and volumetric pumps; low noise and high performance fans; residual heat utilisation technology for main engines and marine equipment; new energy saving and clean cabinet equipment technology; effective blast water disposal system technology; tributyltin (TBT)-free anti-pollution and resistance-reducing paint and coating technology; and vessel garbage and waste water disposal technology.

The development of green vessel operations on domestic rivers and lakes for direct transportation that will meet these standards will also be a requirement argues Weng Zhenping. "Based on our country's waterway transportation development features, we should develop the following areas: a standard shipping series for 21st century green waterways; a standard shipping series for inland waterway direct transportation; high speed ferries for the Taiwan Strait; a Taiwan Strait special wind and current environmental database; a vessel design capable of producing an excellent performance in a harsh environment; and technology that supports a high-speed water transportation network."

Finally it is necessary, says Weng Zhenping, to develop a green offshore and coastal fishing vessel series. It includes: a standard shipping series for a 21st century green coastal fishing vessel; LNG–powered offshore fishing and fish-resource-discovery series; a marine fishing fleet guarantee; a supply freezer processing vessel; and fishing equipment such as fishing tools and fishing nets.

Weng Zhenping points out that to develop and to implement the noise goal of green vessels has challenged shipping, shifting the focus from macro phenomenon and response to micro aspects. Correspondingly, its research content has shifted from potential flow, unidimensional flow, constant and linearity problems, to viscous flow, multiple-phase flow, inconstant and non-linearity problems.

The focus has changed from a single function in an ideal environment to the comprehensive optimisation of different subjects within a genuine environment. In terms of green shipping and structural safety, Chinese shipyards should pay particular attention to such problems as structural optimisation by reducing weight and increasing loading; structural bearing ceiling capacity; wave-induced vibration and slamming vibration; accident damage prevention and control; and ice area vessel and ocean structure loading and safety. *NA*

Innovation fills the Doughnut Tanker

Designers of the Cubic Doughnut Tank System say the innovative design will be cheaper than existing tankers to build and will be comparable with the membrane tankers as far as space utilisation is concerned

The Cubic Doughnut Tank System (CDTS) was originally developed in 1973 and a patent was awarded in 1976. The main design principle behind the initial design concept was the construction of a near prismatic shape using 12 substantially identical cylinders that were interconnected to each other so that it would have the structural efficiency of a spherical tank and the volumetric efficiency of a membrane tank.

Unfortunately, this was the time when the US broke off diplomatic relations with Algeria cancelling all contracts to import LNG. Six new LNG Carriers were immediately laid up and interest in LNG containment technology in the USA waned until recently.

In 2005, Altair Engineering, Inc. was providing advanced structural engineering analysis tools to the University of Michigan and applied it to the CDTS as a case study. This in turn developed into an interest to develop this Type 'B' tank concept further resulting in the awarding of multiple improvement patents to Altair's Product Design team in 2013, 2014 & 2015, and Approval-in-Principle (AIP) by ABS in March 2015. Since 2005, the development has been continuous, as shown in Figure 1, with the design efforts focused on the use of CDTS for both the marine transport (LNG Carriers) and Floating LNG Processing and Storage Platforms (FLNG).

Alcoa joined this effort in 2012 providing material recommendations as well as manufacturability assessments, and Dongsung Finetec in 2014, providing insulation solutions. The details of the CDTS have been presented at the Offshore Technology Conference in 2009 and 2010 as well as LNG Conferences in London in 2009 and ICCAS 2009. Since the original concept was patented:

- The average LNG ship size has increased, increasing the need for sloshing mitigation
- Altair has identified and solved functional and structural problems with the original concept and patented the improved design
- The economics of transport costs have made efficiency an even more significant economic opportunity

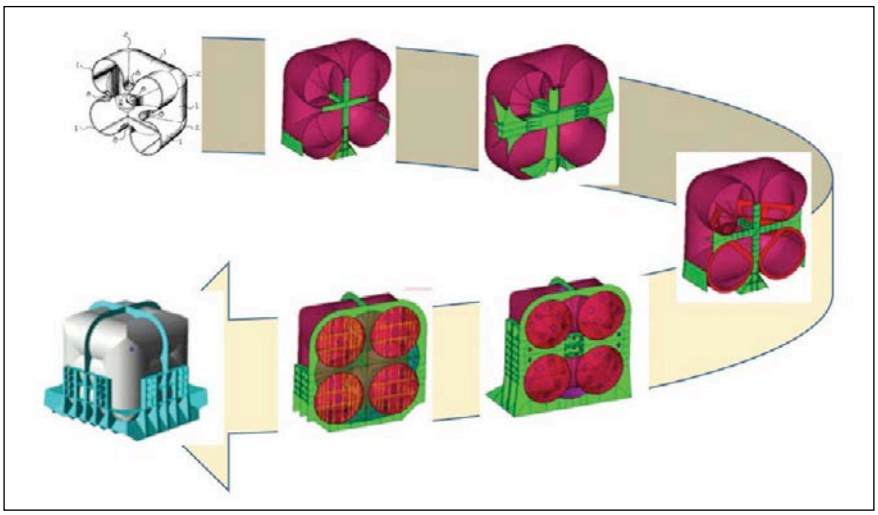


Figure 1: The different stages of development for the CDTS

The marine transport of LNG is a mature technology that is almost 50 years old. In the early years of LNG Carrier designs, a number of containment systems were developed and the most successful were the Moss Rosenberg Spherical Tank and the Gas Transport Membrane Lining System.

The CDTS has much better volumetric efficiency (0.85) than the Spherical Tank (0.52) and is close to the membrane system (0.88). This high hold space volumetric efficiency coupled with the CDTS being of an independent tank construction and self-standing allows for higher utilisation of available space above and below the main deck resulting in a significantly smaller ship length for the same cargo capacity. Recent development of the extended Spherical Tanks has improved the Volumetric Efficiency to 0.56.

The major benefit of the CDTS is that for the same LBP it offers 35% more capacity than Spherical and 24% more than a Membrane and IHI SPB ship, or a reduction in ship or platform length for equivalent Cargo Capacity; 12% compared to Spherical and 6% compared to Membrane ships.

The use of the CDTS results in the following additional advantages:

- Significant reduction in Gross Tonnage
- Significant reduction in the overall construction schedule compared to the membrane tank system
- Eliminates the restriction on partial filling of tanks for sloshing, allowing multiple discharge locations
- Reduced estimated cost of LNG carrier by 10% compared to Spherical and 5% Membrane
- Provides ease of construction and ease of installation in the ship
- Offers superior structural efficiency
- Less installed power and thus fuel savings in service
- Utilises a simple support system
- Better protection from side collision damage – 4m versus 2.5m for Membrane Ships and 3.25m for Spherical Tank Ships
- Better protection from bottom damage – 4m versus 2.75m for Membrane Ships
- Excellent Boil off Gas performance
- Internal Connectivity provides Natural Conductive Cool-Down Pathways – low

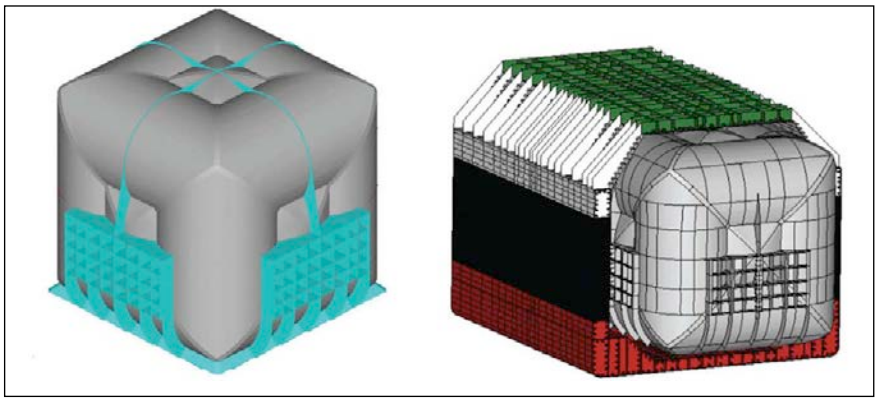


Figure 2: Isometric views of the CDTS and its installation in a ship

pre-loading spray down time with low spray-in mass flow-rate

Furthermore, the CDTS can be constructed using typical shipyard rolling and forming equipment. While the CDTS offers benefits just from the tank design, construction and installation in the ship, it also offers unique benefits in the design of the ship including a significant reduction in length, providing a significant reduction in the longitudinal bending moment, which results in construction benefits in reduced steel weight and less work content for the same capacity ship compared with any other system.

A comparison of tank outlines are shown in Figure 3 for the spherical, spherical extended, membrane, SPB and CDTS tanks of equal volume. Table 1 shows the capacity benefit of the CDTS over the other containment systems for the same Length Overall (LOA) of 300m and within the new Panama Canal beam restriction of 49m. The spherical extended tank would enable the LNG Capacity to increase to 180,000m^3 within the 300m LOA and 49m beam restrictions. Note that the pure spherical tank LNG Carrier would have a beam of 52m and that the largest total spherical LNG Carrier capacity for the new Panama Canal would be 155,000m^3 compared with the CDTS LNG Capacity of 210,000m^3.

Altair ProductDesign provided the structural design expertise and technology that was used to complete the development of the CDTS design, and enabled the Approval-In-Principle (AIP) from ABS.

Altair's HyperWorks Suite of software was used to ideate design solutions, and subsequently to analyse and optimise the CDTS tank. Altair's HyperWorks suite is a computer-aided engineering (CAE) simulation software platform that allows businesses to create superior, market-leading products efficiently and cost effectively. The HyperWorks platform offers modelling, visualisation as well as ideation, analysis and optimisation solutions.

Although the constituent parts of the CDTS comprise of simple shapes, the overall geometry is structurally complex

Figure 3: A comparison of outlines for the five containment systems for equal volume

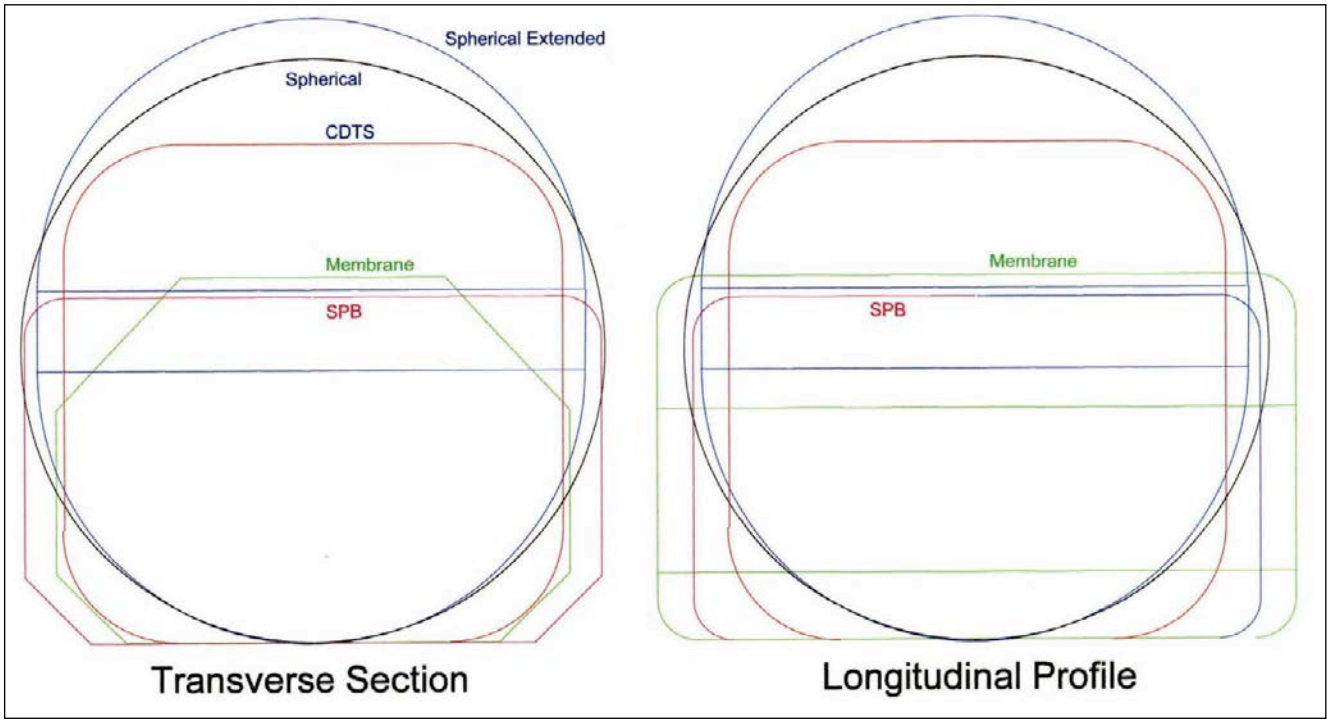


Table 1: Design comparisons for restricted length and draft for the four containment systems

Particulars	Spherical	Membrane	IHI SPB	CDTS
LBP (m)	285	285	285	285
Beam (m)	49	47	49.5	49
Depth (m)	25.9	27.4	32	28
Draft (m)	12	12	12	12
Displacement (t)	123,090	126,758	135,468	148,881
Lightship (t)	36,774	34,610	41,590	44,895
Deadweight (t)	86,316	92,148	93,878	103,996
Deadweight Coefficient	0.701	0.727	0.693	0.699
Cargo Capacity (m^3)	155,000	170,000	170,000	210,000
Relative capacity to membrane	86	100	100	124
Relative capacity to spherical	100	116	119	135
Relative capacity to SPB	86	100	100	128
SHP (kW)	30,418	30,771	34.206	32,896
SHP/Capacity	0.196	0.181	0.201	0.157

with significant design improvement opportunities. Starting from 2005, the HyperWorks suite of advanced structural design, analysis and optimisation tools were used to improve the design to meet the structural objectives which could not otherwise be attained by the proposed original design. An earlier paper RAMOO, 2009 describes the finite element analysis and optimisation of the CDTS as applied for LNG applications. The design tools (software) used included:

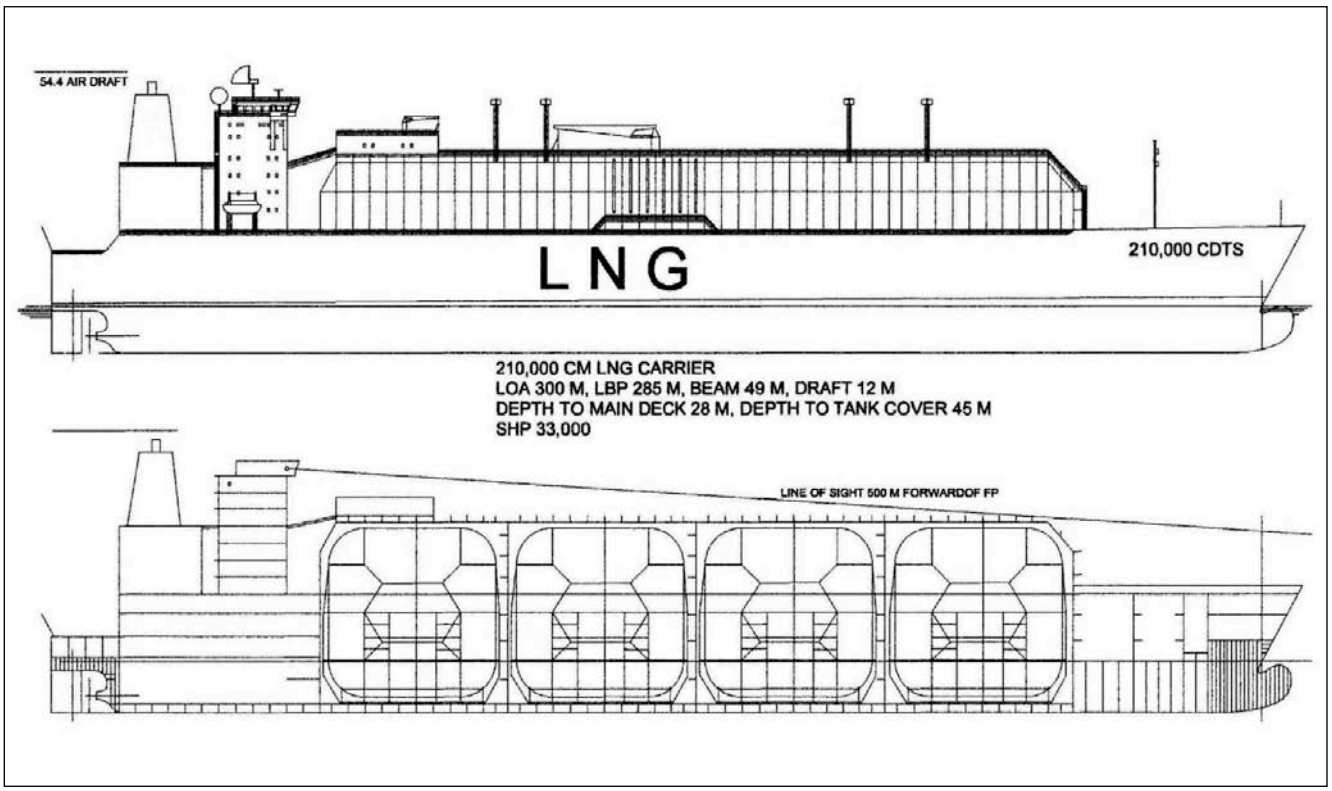
- Optimisation Techniques: Topology Optimisation, Free-Size Optimisation, Size/Gage Optimisation
- RADIOSS Non Linear Transient Dynamic Analyses for ALE & SPH analyses to predict sloshing loads
- AcuSolve CFD Analyses for Fluid & Heat Transfer analyses
- HyperStudy (MDO) was used to develop the thermal management strategy such as position, locations, and volume of LNG spray-in.

Altair and its partners are currently actively marketing the CDTS to shipowners and working with shipyards and tank fabricators to investigate fabrication and integration solutions. *NA*

Authors

Thomas Lamb (Emeritus Research Scientist and Adjunct Professor, Univ. of Michigan, Ann Arbor), is the original inventor of the CDTS. Regu Ramoo (VP of Engineering at Altair ProductDesign), is the CDTS program manager.

Figure 4: CDTS 210,000m^3 concept design for 300m LOA and 49m beam restriction



New wave connectivity

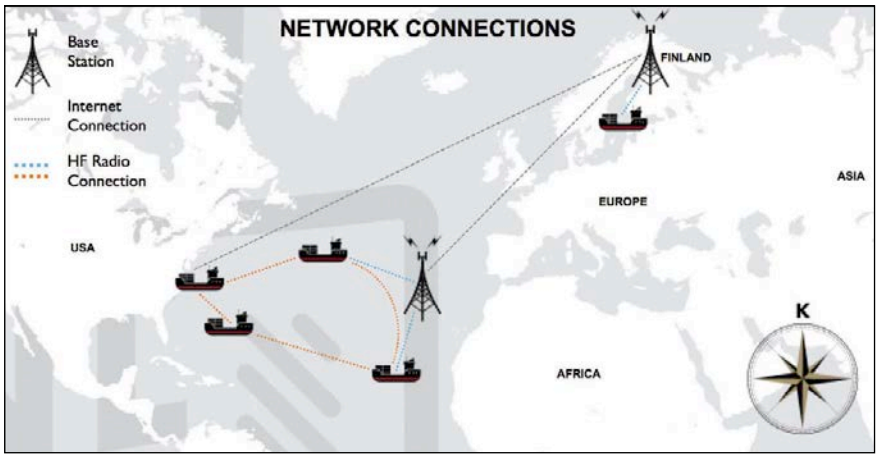
A Finnish start-up company is redefining maritime communications with a military-grade encrypted digital radio network that promises satellite-like services and constant connectivity across the globe

We live in an age of communication that is constantly increasing our use of communication technologies; however, up until recently, at sea communication and data transfer have been snagged by the limits of satellite connectivity and the service it provides for those communicating between vessels and the shore.

A new Cognitive Networked High Frequency (CNHF) radio system from Finnish start-up KNL Networks is set to change this, according to its developers, disrupting the way information is passed to and from vessels with a secure and "100% reliable" system that partners and reduces satellite communication. The innovative design, which is believed to be "the only known alternative to satellite communication", is intended to be used for email communications, Internet of Things (IoT) data, instant messaging, sensor data, and file updates, as well as secure and mission-critical communications, and offers greatly improved coverage, including in polar regions and across a link distance of up to 10,000km.

This kind of range is facilitated by the CNHF radio's dual-technology, which combines the latest cognitive and software radio technologies with a traditional high frequency (HF) terrestrial radio. The combination uses short wave radio transmissions to transmit data over large distances, and KNL have innovatively utilised the HF spectrum as a gateway to the IP-network (Internet-Protocol-network). The CNHF system operates completely digitally and has been designed with built-in cellular, WiFi and LAN-connections for providing IP-connectivity to other networks.

One of the radio's key features is how it relays information through different users of the MESH-radio network.



An illustration of the network in action

KNL Networks explains that: "The CNHF radio acts as a terminal or a base station, depending on the status and location of the user. When a user is lacking cellular or LAN connection, the radio operates as [a] terminal providing services to the user. While connected to the Internet or IP-network, the radio switches to base station mode for offering communication to other users as well, still maintaining [a] terminal role for the end user." This means that "a dedicated link is always established for the end user, so the data rate is not divided between users as it is in Satcom. This enables an exceptional quality of service [for] most applications except very high quality video streaming."

At present, Satcom has limitations. These can include non-existent coverage in polar areas (a problem that will grow in significance if Arctic shipping is realised); coverage that is limited to satellite orbits; a shared downlink capacity that may be severely affected by weather and shadowing; and a service that comes at considerable expense.

KNL Networks state that their service will take effect in two phases. The first phase will allow email, IP/file transfer, chat messages and built-in location tracking, while phase two, following growth in the number of users and therefore the spread and capacity of the MESH-radio network, will enable new applications like Voice over Internet Protocol (VoIP) and internet browsing. Toni Linden, CEO of KNL Networks, emphasises that all of these services can be transmitted at the same time other than online video streaming due to the dedicated end to end link the system provides, and adds that the reason online video streaming cannot be handled at this juncture is because of the system's low bandwidth, which allows data rates of 700-153,000 bit/s. This being said, the system can be optimised to work for the needs of users and the type of data they are trying to transfer.

Cybersecurity

Increasing digitalisation is tremendously beneficial, but it raises the issue of cybersecurity and the question of how the maritime industry will cope. With this debate afoot, Linden believes that Satcom is too vulnerable to jamming for vessels to rely on its security in the future, and that the CNHF radio offers one answer.

According to Linden, its system is substantially harder to jam or tamper

with than satellite communications because it sees other users of the system and interference in the same way: external entities to the end to end link. Linden claims: "Not even a governmental organisation [is] ready to block it at the moment." But admittedly adds that anything is possible in a cyberattack with enough time and resources. Part of the system's robustness comes from its ability to detect jamming or indifference and automatically change data parameters to continue transmitting. It also rapidly synchronises at random points of the radio spectrum without repeating these points, increasing the difficulty for would-be jammers.

The company says: "Adding security on operations is a value itself. With the CNHF system there's finally an alternative communication system to operate in parallel with easy to jam Satcom." KNL Networks is currently involved in talks with larger organisations and companies interested in Smart Ships for which its system's redundancy would be attractive.

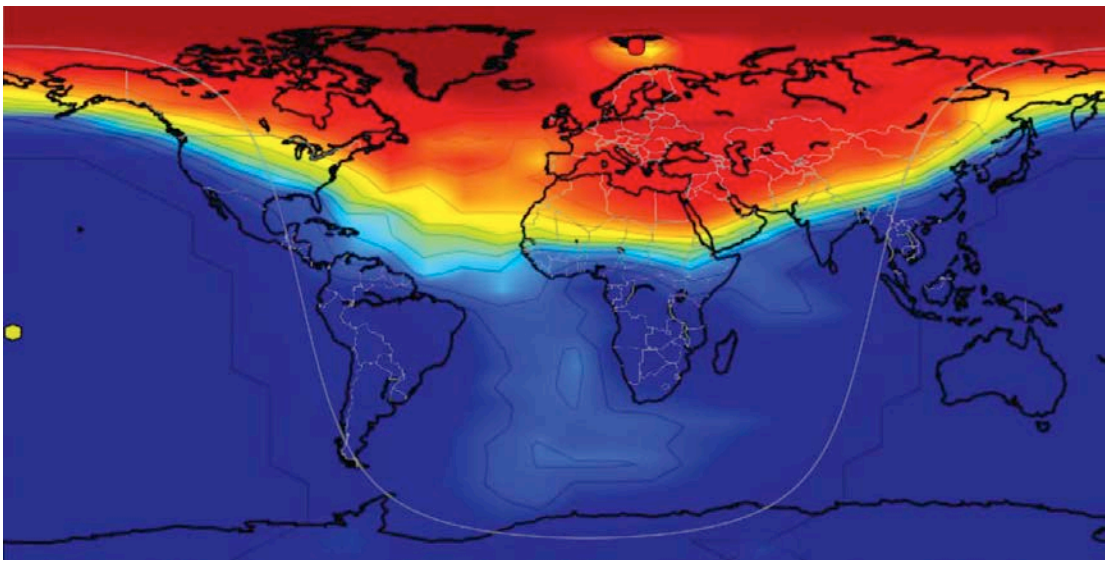
KNL Networks' Cognitive Networked HF-radio provides a complete infrastructure independent, MESH-radio network

Development

The company was formed in 2011 after spinning off from the University of Oulu. Its system design was so "out there" that they needed a prototype, which, following its success in testing, was commercialised and is currently being scaled-up to be launched later this year. Linden says that the company realised during the R&D stage that services and a network were needed, so they expanded from their development of the cognitive radio technology.

Linden stresses that the service is already in operation for selected customers and that the company currently has the capability to add hundreds of new ships to the network. The new service may be particularly attractive for ship owners wishing to improve communications with their ships, as this could lower their insurance costs. However, KNL Networks are also in the process of approaching equipment companies; the constant real-time passing of monitory data could be a revelation, proffering valuable information, for example, in the case of preventive maintenance strategies. Linden also suggests that the service could be offered by equipment providers themselves, stating that leftover bandwidth from the transmission of equipment performance information could be offered to the vessel for ship communications.

The company's promise, "Keeping you online. Always", is appreciative of the maritime industry's heading and its need for the constant flow of information. This paradigm shift will require innovative technologies like the CNHF-radio to facilitate the future, and, with the keeping of this promise, the CNHF-radio has the potential to solve present connectivity problems and facilitate what is to come for the maritime industry: Big Data, smart shipping and Smart Ships. *NA*



The red area represents coverage from a transmitter in Svalbard

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The devil is in the detail

Recent research has taken an analytical and inclusive approach to bridge design that looks to systems users for design features that deliver during vessel operation

CASCADe, a three-year, EU-funded project to develop new bridge designs came to a close at the end of January having successfully created new ways of sharing and displaying information on a ship's bridge, such as adaptive bridge displays and a novel 'Shared Display' touch screen for better cooperation on the bridge. Its core aim was to improve vessel efficiency and develop systems that would lower the number of accidents at sea by utilising the experience of seafarers to synergise human operation and electronic actuation; however, this cooperative and ergonomically-minded bridge project is not the first of its kind.

Dr Frøy Bjørneseth, a principal engineer for Human Factors and Control Centres at Rolls-Royce

Rolls-Royce used a similar design process in the development of its Unified Bridge concept, explains Dr Frøy Bjørneseth, a principal engineer for Human Factors and Control Centres for the company that grew the concept from a PhD project that ended in 2010. The company wished to go beyond the simple production of equipment, instead aiming to collaborate on an ergonomic bridge environment that would benefit operators and operations alike through design, fundamentally improving the work environment and experience to improve ship safety. This Unified Bridge project is still developing, adds Bjørneseth, with ongoing data capture from the system's first installation onboard PSV *Stril Luna* in 2014, as well as with the implementation of the system on different vessel types and sizes – of which the next is soon to be delivered.

The project was conducted with four design criteria in mind. The first, simplicity, dictated that the consoles developed should be cleaner and more easily understood, reducing the mental strain for crew members. This idea fed into the second criteria, safety, as by reducing the regular cognitive load on individuals using bridge consoles, brain energy levels would be saved for safety-critical operations when crew member awareness is most needed. Proximity, the third criteria, is part of this core drive to increase safety, optimising the distance and location of particular bridge instruments so that the system was easier to use. The final criteria, to increase performance, would be facilitated by the previous criteria, and lead to more efficient operations by a happier crew.

Bjørneseth stresses that what may seem like luxury problems, such as the minutiae of lever designs and positioning on a console, are important and that an accumulation of these smaller problems can lead to more substantial problems and possibly an incident at sea. For example, lighting needs to be carefully managed from day 'til dusk to prevent glare as well as to maintain night vision during night operations, she explains, adding that the traditional manual operation of light levels detracts from the operation of the bridge, reducing functionality and efficiency. By automating and defining light settings for particular times of day, especially maintaining night vision for more difficult nocturnal operations with low level light, the crew's physical and psychological burden can be eased, improving safety and efficiency. Similarly, research found that a vessel's alert system was raising stress levels for crew members, so Bjørneseth and her team standardised the mute button in response, simplifying the interface so that all bridge alerts were contained in one display. Standardisation of the consoles was very important in the design of the Unified Bridge, says Bjørneseth, as the intention was to define the Rolls-Royce brand, but, more importantly, to make operators feel familiar with the system when moving between vessels with the same bridge system, improving safety and efficiency.

Pinpointing these issues and affecting positive change requires time and immersion in the operational environment, according to Bjørneseth: "We don't want to rely on industrial designers only – we want to prove what is right for operators."

Armed with this mentality the researchers went to sea, implementing a fly-on-the-wall approach in an observational study of bridge operations aboard different vessel types. Part of this involved the deployment of sight tracking technology that could follow and plot where operators have to look – the underpinning idea was that eye tracking and strain could be reduced with the information gathered. The study also involved interviewing the crew about events and how responses and communications were made in these cases. Following these findings, port interviews,

function/task analysis and simulations were carried out, mapping issues and testing design optimisations. Ten participants were typically used for each hour-long simulation study, says Bjørneseth.

Results and data continue to be received from the first functioning iteration of the Unified Bridge concept on *Stril Luna*, but its captain, Lars Aure, has said: "Controls are easy and logical to handle and information presented on the screens is clear," adding that "the Unified Bridge takes the working environment seriously, and helps to give better working conditions onboard and safer operations."

Ongoing developments

The Unified Bridge system has been delivered to two megayachts used for leisure purposes that are also capable of undertaking luxury expedition support. These vessels have been fitted with forward facing Unified Bridge consoles holding two workstations, one for navigation and one for monitoring and support. The bridge consoles have four large 26" displays in close proximity to the operators and some smaller 10" touch displays for smaller applications. Rolls-Royce has delivered an ACON automation system, Rolls-Royce dynamic positioning system and the propulsion system including levers for DP and manoeuvring control, all with the new Unified Bridge design.

In addition, the Rolls-Royce ACON Bridge Control (ABC) system has been delivered. This system allows operators to control the windscreen wipers, lanterns, search lights, CCTV, bridge ceiling lights and decklights from a software application on one of the 10" touchscreens. There is also a single interface for alert, easing the captain's workload and increasing comfort.

An overhead console supplements the floor mounted consoles, and is situated in the ceiling in front of the operators. This holds larger 26" monitors to give a good placement to display the vessel's CCTV cameras feeds, conning display and DP system monitoring. "The bridge concept provides the captain and his bridge crew with a state of the art user experience both during navigation and other activities and fits the vessel's operational profile perfectly," says Rolls-Royce.

Another Unified Bridge has been installed on a 128m long subsea Inspection Maintenance and Repair (IMR) and construction vessel. The vessel is equipped with a Unified Bridge on all bridge workstations (forward, aft and bridge wings).

The aft workstations are where the operations on the aft deck are monitored and controlled, and where it is important that the operator has a good working environment to support them through their watch. An overhead console gives the operator full overview of information which is mainly for monitoring purposes. The vessel features two separate aft workstations equipped with Rolls-Royce dynamic positioning systems, Rolls-Royce UniCon (unified propulsion control), the Rolls-Royce ACON automation system, and the ABC system for controlling auxiliary equipment.

The forward workstations, of which there are also two, have divided duties; one is for navigational purposes and the other is for watch keeping and support with access to manoeuvring control and the DP system. To aid accessibility, the Integrated Navigation System (INS) equipment is within easy reach for the operator and the display unit configuration is as described above (both forward and aft) with large 24"/26" monitors mounted in the consoles within easy reach. Monitors utilised for radar/ECDIS purposes must be 26" to adhere to the regulations.

The wing stations are smaller stations with a smaller overhead console and a smaller Unified Bridge console adapted to wing operations (docking, operations from the flank of the vessel). UniCon and ABC systems are available in addition to a sensor display. This is a collection of different sensors gathered in one display to save space and to move space demanding equipment to a secondary location, optimising the operator experience.

For this vessel an additional feature called Unified Monitoring was included in the ABC system. This feature enables operators to bring up any application on any display unit (depending on classification), easing communication across the bridge.

Following further research into ergonomic requirements the latest consoles are height adjustable and can be adjusted to the height of any operator while complying with standards NORSOK S-002, ISO 11064 and NAUT-AW, NAUT-OSV. The consoles can be combined with the typical Unified Bridge consoles for forward/aft bridge and also utilised to form an office landscape on the bridge for large vessels (e.g. cruise vessels) where this might be a requirement.

Rolls-Royce continues to develop its system in a rolling programme of research that may potentially lead to new console development and a focus on bridge office space. The company is currently analysing the suitability of its Unified Bridge concept for MPVs, large construction vessels, drill ships, anchor handling vessels, PSVs, as well as passenger vessels. *NA*

Onboard *Stril Luna:* the first installation of the Unified Bridge console

MAN outlines Tier III solutions

MAN Diesel & Turbo offers an emissions guide for Marpol Annex VI regulations which have been enforced since the beginning of this year

The international NOx emission limits on marine diesel engines as determined by MARPOL Annex VI are shown in Figure 1. Ships constructed after 1 January 2016 must not exceed Tier III limits when sailing inside NOx ECA, except in cases where the area is designated later than the construction date of the ship. When sailing outside NOx ECA, the Tier II limits must be met.

MAN Diesel & Turbo offers two alternative methods to meet the Tier III NOx requirement on two-stroke engines. The first method, exhaust gas recirculation (EGR), is an internal engine process to prevent the formation of NOx by controlling the combustion process. The second method, selective catalytic reduction (SCR), is an after-treatment method using a catalyst and an additive to reduce the NOx generated in the combustion process. Figure 2 shows the layout of an EGR and SCR configured engine.

The present EGR and SCR solutions are designed for low sulphur fuels of 0.1% or less, due to the SOx requirements in the emission control areas. In case a Tier III solution for high sulphur fuel is needed, a more complex solution including a SOx scrubber is also available.

A Tier III engine has two emission cycle operating modes: Tier II for operation outside NOx Emission Control Areas and Tier III for operation inside NOx Emission Areas.

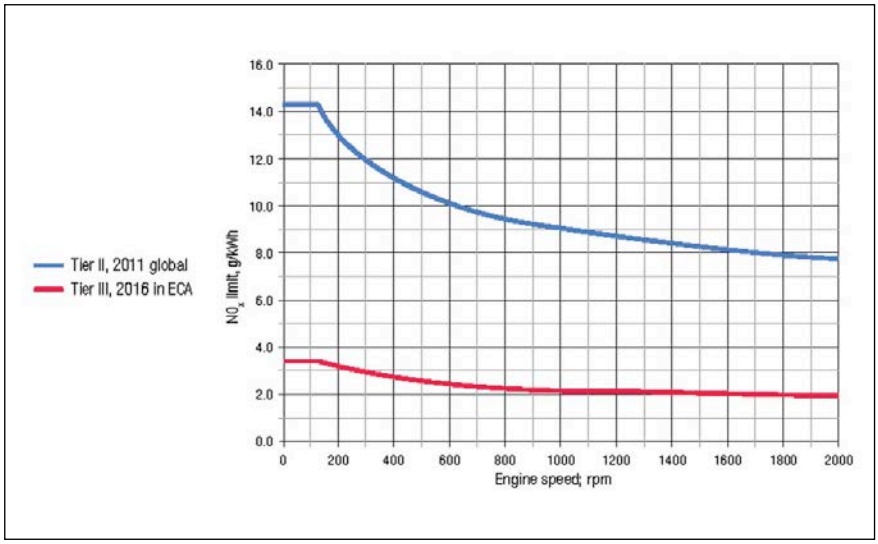

Figure 1: NOx emission limits according to MARPOL Annex VI

Figure 2: Two-way approach for Tier III engines – EGR on the left and SCR solutions

The EGR principle

Exhaust gas recirculation is a method to significantly reduce the formation of NOx in marine diesel engines. By using this method, the Tier III requirements in NOx ECA can be met.

In the EGR system, after a cooling and cleaning process, part of the exhaust gas is recirculated to the scavenge air receiver. In this way, part of the oxygen in the scavenge air is replaced by CO_2 from the combustion process. This replacement decreases the O_2 content and increases the heat capacity of the scavenge air, thus reducing the temperature peak of the combustion and the formation of NOx. The NOx reduction is almost linear to the ratio of recirculated exhaust gas.

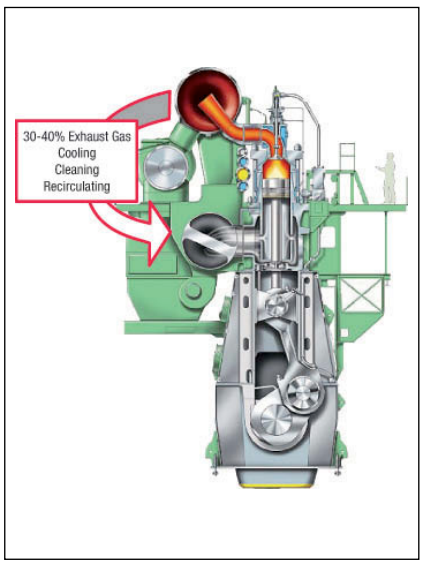

Figure 3: The principal of how EGR systems work

Two different matching methods are used for the EGR systems:

- EGR with bypass, configured with only one turbocharger and used for engines of bore 70 or less
- EGR with Turbo Charger cut-out matching, configured with two or more turbochargers and used for engines of bore 80 or greater.

SCR – Selective Catalytic Reduction

The SCR solutions here assume low-sulphur fuels (≤ 0.1%) for Tier III running modes. SCR is an exhaust gas treatment method by which the NOx generated in a marine diesel engine can be reduced to a level in compliance with the NOx Tier III requirements.

The NOx reduction is obtained by a catalytic process in an SCR reactor installed in the exhaust gas line after the combustion process. In the SCR reactor, the NOx is reduced catalytically to nitrogen and water by adding ammonia

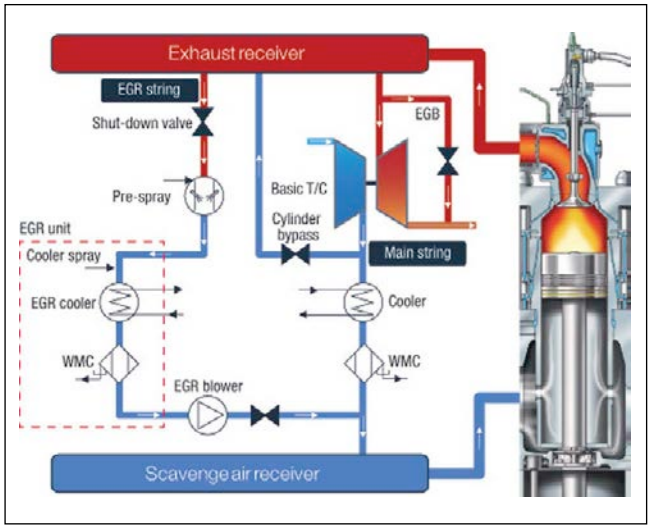

Figure 4: EGR process diagram. Bypass matching

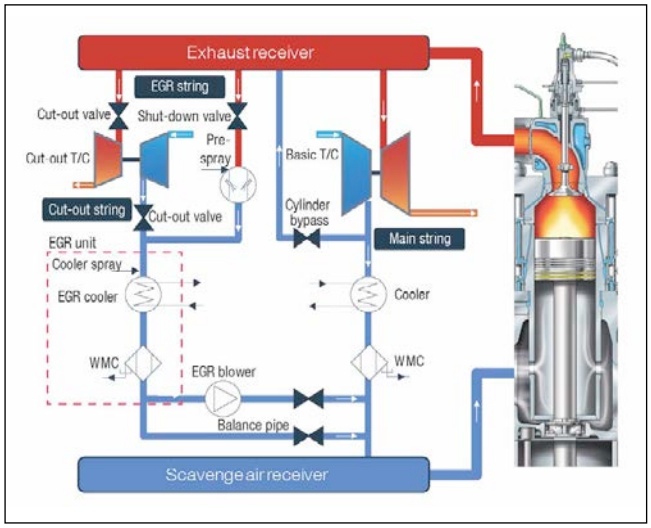

Figure 5: EGR process diagram. TC cut-out matching

as a reducing agent. The catalyst in the reactor consists of blocks with a large number of channels, providing a large surface area in which the catalytic process takes place.

SCR system

An essential parameter of the SCR process is the inlet gas temperature. A lower temperature limit is dictated by the sulphur content in the fuel and the subsequent formation of sulphuric acid in the gas. At low temperatures, the sulphuric acid is neutralised by ammonia. This forms a sticky product, ABS (ammonium bisulphate, (NH_4)HSO_4), which may accumulate in the SCR elements. However, this reaction can be suppressed by keeping a high temperature of the exhaust gas. When the sulphur content in the fuel is equal or less than 0.1%, a temperature of approximately 310°C would be sufficient. At low exhaust gas pressures, the required minimum temperature will be lower.

The minimum temperatures required to avoid the formation of ammonia bisulphate are found in Figure 6, which shows the relation between the fuel sulphur content and the exhaust gas pressure. Figure 6 shows a high pressure curve (4.0bar) and a low pressure curve (1.5bar), which is the approximate pressure at high engine load and at low engine load respectively.

On the other hand, the temperature must not be too high as this will result in an increased SO_3 formation in the catalyst. SO_3 subsequently reacts with water creating sulphuric acid, which appears as an undesired white aerosol plume. Another undesired reaction which also limits the upper temperature for SCR operation is the oxidation of NH_3 as the exhaust gas temperature approaches 500°C, ie. more NH_3 is needed. Additionally, the catalyst material starts to sinter at temperatures above 500-550°C.

In other words, to ensure a robust SCR operation it is crucial to maintain exhaust gas temperatures within a certain temperature window. The low sulphur SCR systems can be chosen as high-pressure or low-pressure installations.

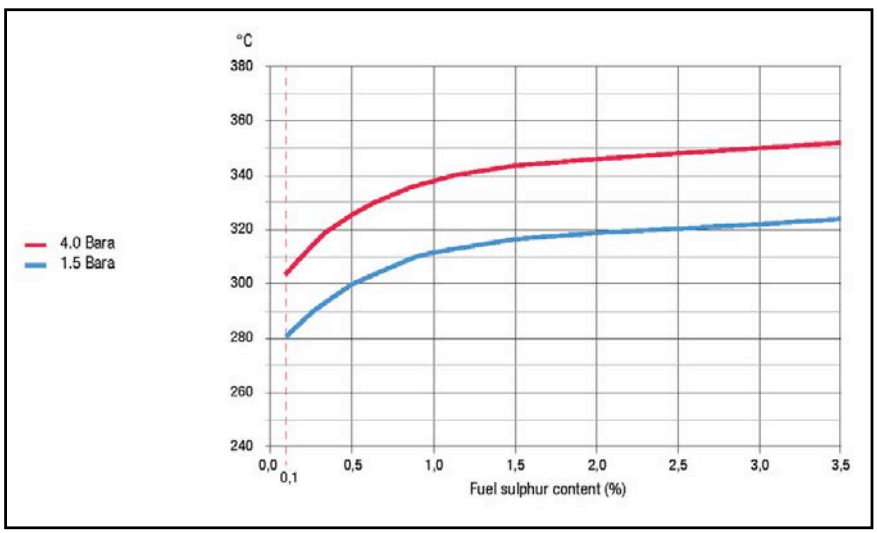

Figure 6: Required temperatures for SCR related to sulphur content and exhaust gas pressure

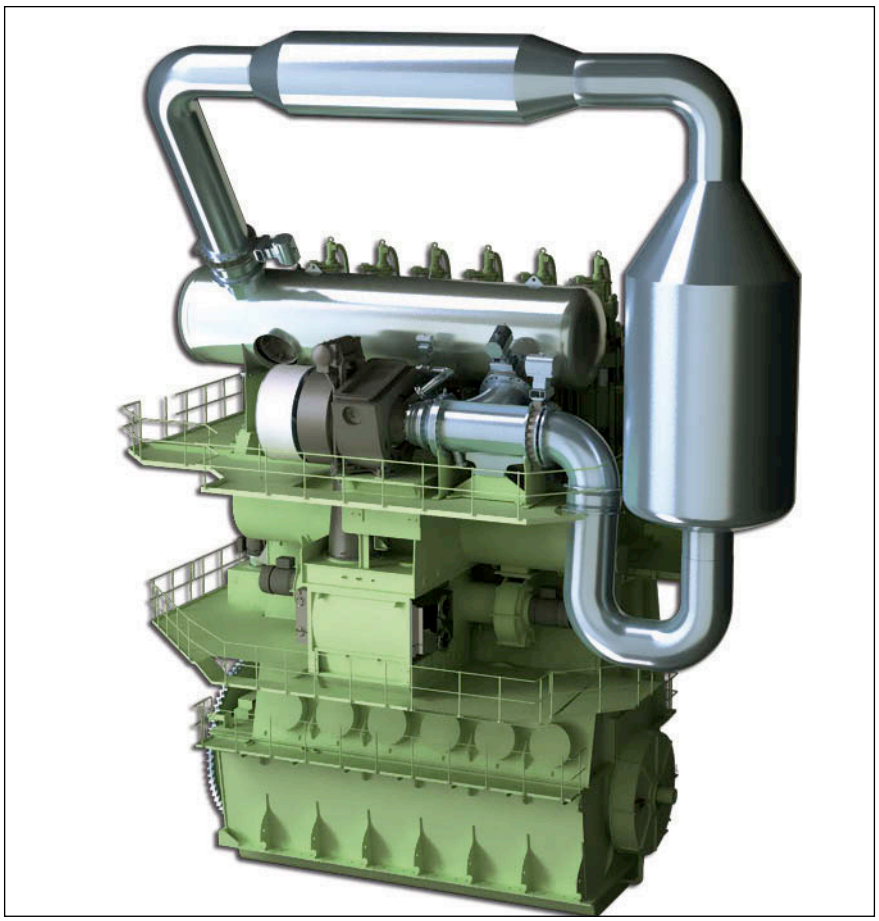

Figure 7: Layout of a high-pressure SCR system, as supplied by Hitachi Zosen

The implementation of MARPOL Annex VI (14.8) from 1 January 2015 for operation on fuels containing less than 0.1% sulphur in ECAs has forced many owners and operators to make their own investigations into economic feasibility of alternative fuels to HFO.

Natural gas is of particular interest, which has been reduced somewhat in cost due to increased global production and has become increasingly available in the form of LNG, mainly due to political and financial initiatives for increased funding of the construction of LNG bunker stations within ECAs.

However, the investment required for bunkering of LNG onboard and consequent use for propulsion can be prohibitively expensive, and as the volatile fuel prices dictate, any business case can be broken down. Therefore, a compromise is emerging in the marine industry whereby a vessel can be considered "gas ready" without requiring full investment in LNG bunkering or gas operation. This allows the owner or operator the opportunity to upgrade the vessel to operate on gas by implementing all the relevant requirements for gas operation at the design stage.

Applications – ship types

With the exception of LNG tankers, the fundamental reasons for selecting gas operation are essentially the same whether the vessel is gas-ready or a fully prepared gas vessel. The key factor for differentiating between the two lies in the availability of the LNG bunker. If the LNG bunker station on the vessel's route is expected to come on-stream just five years after the vessel enters service, it is likely to be more economically feasible to have the vessel "gas ready" rather than have the investment cost installed onboard and lying idle in the meantime.

The ME-GI engine

MAN Diesel & Turbo's ME-GI engine is capable of operating on conventional fuel oil or gas fuel, depending on the operator's fuel preference. This provides an unprecedented degree of flexibility for the operator, accommodating the economic advantages of choice of fuel type, environmental benefits of gas fuel operation and accessibility of fuel oil.

The ME-GI engine has similar, if not improved, performance in gas operation compared to fuel-oil operation. The fundamental design of the engine is unchanged when compared to ME engines, meaning that the application potential for the ME-GI engine applies to the entire ME engine programme.

Furthermore, as the GI concept is already class approved, all MAN B&W ME-engines can be considered "gas ready", as the GI is simply an add-on to the existing engine. In order to convert an ME engine to an ME-GI engine, both the mechanical and electrical components for gas operation need to be installed and the software enabled. The conversion of the engine itself can be performed by MAN Diesel & Turbo's PrimeServ organisation during a docking period.

Ship design

The majority of the aspects required for a "gas-ready" vessel are related to all the auxiliary equipment required for gas operation. This starts at the LNG bunker station and follows the whole process to the gas inlet on the main engine. Furthermore, at the 95th MSC (Maritime Safety Committee), IMO has formally adopted the international code of safety for ships using gases or other low flashpoint fuels (IGF code). A careful study of these requirements is necessary.

Classification societies

Depending on the class of the vessel, the specific rules must be examined. There is typically a conceptual design approval, and then a detailed design approval where the vessel is granted a state of gas readiness of equivalent status denoting compliance of design and construction with their own design guidelines for gas fuelled vessels. Additionally, there are various notations, which indicate that there may already be gas equipment approved and installed on the vessel prior to entering service.

Classification societies will typically require arrangement drawings indicating all the hazardous areas on the vessel. As a guideline for ME-GI type engines, Figure 8 shows a typical installation and designation of hazardous areas.

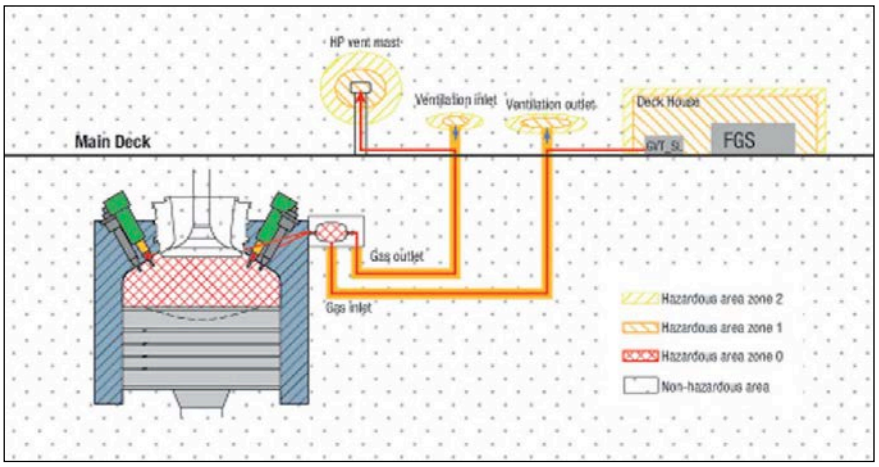

Figure 8: Hazardous area designation scheme

LNG bunkering and tanks

Typically, the location and arrangement of the bunker station will need to be included in the ship design. Furthermore, it may be required to specify in detail all the piping and equipment used in the bunker station. When designing the bunker station, one of the key factors is the filling capacity requirement.

This needs to be matched with both the bunker barge or terminal and the amount of time the vessel has to bunker. Moreover, it is important to consider the allowable LNG tank pressures onboard the vessel, and how this will affect the LNG bunkering process. It is certainly recommended to have an LNG bunkering procedure in place at this stage, so it is already factored in at the design stage.

As the most expensive item in the LNG package, it is expected during construction that the vessel is made ready for tank installation at a later stage. The LNG tank will have the biggest influence on the vessel design and will require some relatively detailed investigation as to the size, arrangement and location of the tank/s at this early stage. This is perhaps the most difficult factor to estimate for the "gas-ready" vessel, as it is unlikely that the route of the vessel in five-10 years' time is known.

Fuel Gas Supply system

The second most costly item is the FGS system; therefore, it is expected that this will also be installed at a later stage. The typical layout of the FGS system will be similar regardless of supplier, as the delivery conditions are already specified by MAN Diesel & Turbo.

Inert gas system

Some vessels may already have an inert gas system installed, in which case it is recommended to incorporate the additional volume required from the ME-GI, the gas piping and the FGS into the inert gas system at the time of newbuilding.

It is strongly recommended to consider routing of all gas piping from LNG bunker stations to LNG tanks, from LNG tanks to FGS, and from FGS to main engine, and if relevant, gensets. Further material and safety requirements should also be considered in the PID.

Gas Valve Train

The gas valve train (GVT) is MAN Diesel & Turbo's designation for the high-pressure gas valve unit, familiar to low-pressure gas systems. MAN Diesel & Turbo has worked closely with sub-suppliers to develop a novel solution, which is both compact, easy to maintain and flexible with regard to the vessel design requirements. *NA*

Figure 9: An assembled gas valve train

Winning the faecological battle

New regulations that came into force in January governing the release of treated effluent from vessels has raised the requirements from merely diluting black and grey water to actively reducing the pollutants. A slew of options are available to owners for the treatment of effluent that will help operators comply with the new rules

Some confusion over the implementation of the regulation MEPC 227(64), which governs the release of treated waste water from ships and was adopted on 5 October 2012, has arisen with the IMO clarifying the situation as following flawed interpretations from a number of sources.

According to the IMO the resolution MEPC 227(64) did come into force on 1 January 2016 and all its requirements will be enforced from this date except the elements concerning the concentrations of phosphorous and nitrogen, MEPC (69), which takes place in April, will consider the entry into force dates and an announcement on that issue should be expected following that meeting.

ACO Marine MD Mark Beavis says: "Lots of technologies use dilution, but dilution is not a solution to pollution; it is not treating it, it is reshaping it; we can treat it and remove the pollutants"

Essentially MEPC 227(64) will apply to sewage treatment plants installed on or after 1 January 2016 on ships, other than passenger ships, in all areas and passenger ships outside MARPOL Annex IV special areas. Currently the only 'special area' designated is the Baltic Sea, though there is an expectation that new areas will be stipulated in the near future.

The requirements of these Guidelines, including those in section 4.2, will apply to sewage treatment plants installed on new passenger ships when operating in a MARPOL Annex IV special area and intending to discharge treated sewage effluent into the sea on or after 1 January 2016 and on existing passenger ships when operating in a MARPOL Annex IV special area and intending to discharge treated sewage effluent into the sea on or after 1 January 2018.

Sewage treatment plants installed prior to 1 January 2016 and on or after 1 January 2010, on ships other than passenger ships operating in MARPOL Annex IV special areas and intending to discharge treated sewage effluent into the sea, should comply with the earlier resolution MEPC.159 (55). Sewage treatment plants installed prior to 1 January 2010 on ships other than passenger ships operating in MARPOL Annex IV special areas and intending to discharge treated sewage effluent into the sea, should comply with resolution MEPC.2 (VI).

In order to meet the required standards vessel owners and operators will need to use an approved waste water treatment plant to process grey water, that is water from showers and galleys and black water which comes from toilets and may contain faecal matter.

However, the IMO stipulates that: "an approved sewage treatment plant should not rely solely on the dilution of wastewater."

Treatment of effluent should meet the standards required by the IMO, that is, "The geometric mean of the thermotolerant coliform count of the samples of effluent taken during the test period should not exceed 100 thermotolerant coliforms/100ml as determined by membrane filter, multiple tube fermentation or an equivalent analytical procedure."

In addition, the Total Suspended Solids (TSS) content of the samples of effluent taken during the test period should not exceed 35 Qi/Qe mg/l, where Qi is influent and Qe is effluent.

Meanwhile the IMO stipulates that the method of testing should be through filtration of a representative sample through a 0.45µm filter, followed by drying at 105°C and weighing. An alternative would be the centrifuging of a representative sample (for at least five minutes with mean acceleration of 2,800-3,200g), drying at a minimum of 105°C and weighing or any other internationally accepted equivalent test standard.

The IMO advises that: "Administrations should ensure the sewage treatment plant is designed to reduce both soluble and insoluble organic substances to meet the requirement that the geometric mean of a five-day biochemical oxygen demand

without nitrification (BOD5 without nitrification) of the samples of effluent taken during the test period does not exceed 25 Qi/Qe mg/l and the chemical oxygen demand (COD) does not exceed 125 Qi/Qe mg/l.

"The test method standard should be ISO 5815 1:2003 for BOD5 without nitrification and ISO 15705:2002 for COD, or other internationally accepted equivalent test standards."

According to ACO Marine MD Mark Beavis, which along with a number of other manufacturers, including, RWO, Scanship, Wärtsilä Hamworthy and Selmar's Blue Sea technology among others, is in a position to offer an approved waste water treatment system: "Currently the Baltic Sea is the only IMO designated Special Area, but other areas are applying for special area status and so there would potentially be a wider impact on passenger ship operations. Owners and yards really do need to start specifying plant now if they are to comply with the new rules in time."

The IMO says for the purpose of regulation 9.2.1 of MARPOL Annex IV, a sewage treatment plant installed on a passenger ship that intends to discharge sewage effluent in special areas should additionally meet the nitrogen and phosphorus removal standard when tested for its Certificate of Type.

The geometric mean of the total nitrogen and phosphorus content of the samples of effluent taken during the test period should not exceed:

- Total nitrogen: 20 Qi/Qe mg/l or at least a 70% reduction
- Total phosphorus: 1.0 Qi/Qe mg/l or at least an 80% reduction.

The method of testing should meet either the ISO 29441:2010 standard for nitrogen and the ISO 6878:2004 standard for phosphorus or other internationally accepted equivalent test standards.

According to Lloyd's Register MEPC 67 reviewed the nitrogen and phosphorus removal standards in the 2012 Guidelines on the implementation of effluent standards and performance tests for sewage treatment plants and the conclusion was that, "While there was concern about [the] availability of treatment systems meeting the MEPC.227(64) requirements, the majority view reflected a high degree of confidence that such treatment systems will be available. Subsequently, MEPC 67 decided not to revise (lower) the nitrogen and phosphorus removal standard given in paragraph 4.2.1 of the resolution." *NA*

Testing formula:

The overall percentage reduction over the entire test period n is:

$$PR = \sqrt[n]{PR_1 \cdot PR_2 \cdots PR_n} \cdot 100$$

where PR_n is the daily removal value:

$$PR_n = \frac{\left(\frac{(Q_i)_n \cdot \sqrt[s]{(C_i)_1 \cdot (C_i)_2 \cdots (C_i)_s}}{1000}\right)_n - \left(\frac{(Q_e)_n \cdot \sqrt[s]{(C_e)_1 \cdot (C_e)_2 \cdots (C_e)_s}}{1000}\right)_n}{\left(\frac{(Q_i)_n \cdot \sqrt[s]{(C_i)_1 \cdot (C_i)_2 \cdots (C_i)_s}}{1000}\right)_n},$$

where: n represents the test day number; and s represents the sample number collected on test day n

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