THE NAVAL ARCHITECT

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Published by:
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8-9 Northumberland Street
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E-mail production production@rina.org.uk
E-mail subscriptions subscriptions@rina.org.uk

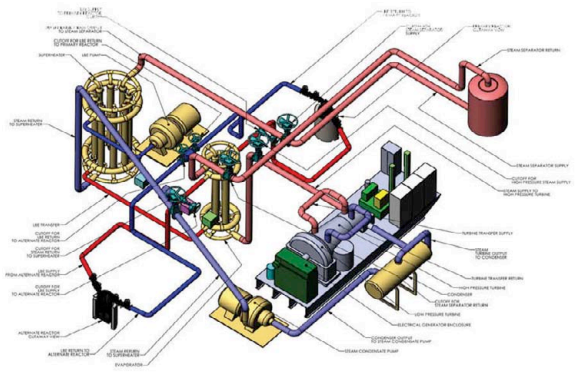
Printed in Wales by Stephens & George Magazines.

A 2014 subscription to *The Naval Architect* costs:

	12 Months	24 Months	36 Months
Inland	£167	£290	£419
Europe	£175	£306	£436
Overseas	£187	£327	£470

Average Net Circulation 10,933
1 January to December 2013
ISSN 0306 0209

Taking a closer look nuclear propulsion 26



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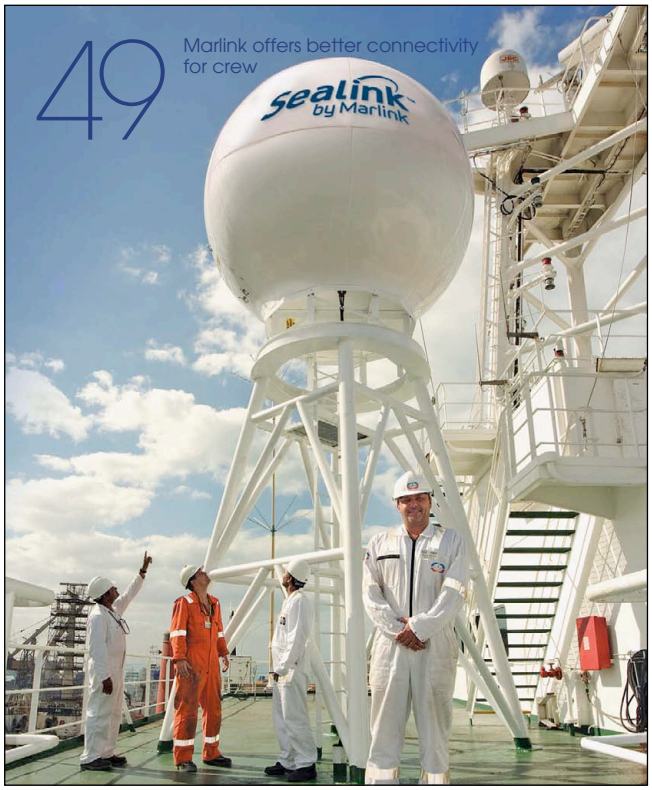

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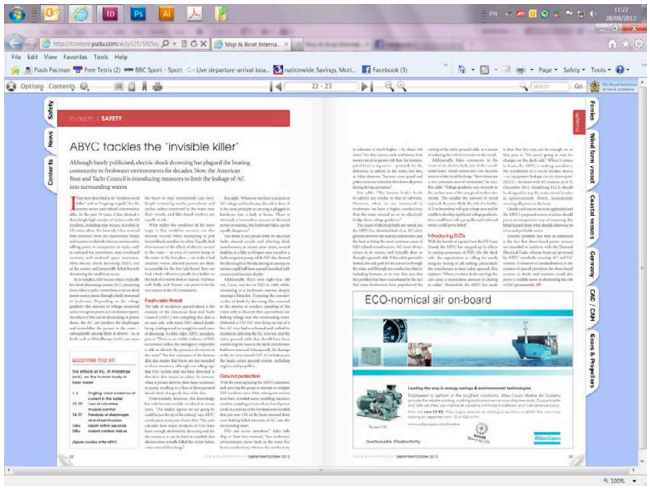

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Pushing the nuclear buttons

The 38MW reactor of *Otto Hahn* was taken critical in 1968 and the vessel completed 1.2 million km as a nuclear powered vessel before the reactor of the ore/passenger carrier was decommissioned in 1979

Ever since Eisenhower commissioned *Savannah* there has been debate over the commercial viability of nuclear powered ships. Since *Savannah*, Germany has commissioned the bulk carrier *Otto Hahn* and the Russians have operated the nuclear icebreaker Sevmorput in the 1960s and later Japan launched its own nuclear freight vessel, Mutsu.

Savannah was explicitly developed as a non-profit making vessel, a "peace ship" that would showcase the peaceful uses of nuclear energy, according to Eisenhower. Given Japan's place in history as the only nation to be victims of a nuclear attack it is certainly poignant that Japan was the last country to attempt to develop a nuclear fleet.

Interestingly, Mutsu's career was beset with political complications following a minor radiation leak that caused outrage with fishermen blocking the return of the vessel to port for more than 50 days before a deal was reached where the vessel was allowed back into Ominato, its home port, on the basis that the government would find the vessel a new home port.

Mutsu was decommissioned in 1992 after completing a total of 82,000km. In total the project's costs had exceeded US$1.2 billion. But, perhaps the most significant outcome from Mutsu was the depth of the antipathy created by the very idea of a nuclear powered ship.

In this month's issue Spyros Hirdaris and his co-authors layout a plan for a nuclear powered Suezmax tanker. Hirdaris, who works for Lloyd's Register, outlines the design of the vessel in some detail. Lloyd's Register have, in this very journal (page 40 *The Naval Architect* January 2011) argued that shipping needs "an outpacing technology". That is a technology that will reduce the levels of emissions from shipping even as the growth in shipping demand increases.

In effect LR's argument is that as the cost of bunkers increases and the regulations around NOx, SOx, particulates and carbon emissions becomes more stringent the use of nuclear power as an alternative "outpacing" technology becomes increasingly attractive.

In his paper Hirdaris touches on the possible social issues that could arise from the development of a nuclear powered vessel. However, the piece is a technical paper and as such its remit is to look at the technology rather than the politics or social implications of nuclear power.

Atomic energy does arouse such strong opinions, however, that it means the technical and social issues become fused, the flip side of a nuclear coin. The Hirdaris paper has immediately fallen victim to this truism.

"As noted the nuclear powered vessels in service today are implicitly insured by National Governments. Commercial ships need to be insured by the market and this needs to include piracy. To be a serious proposition it will be necessary to compare the full cost of designing, building, owning, operating & disposing of nuclear powered ships with the other options available to reduce emissions from commercial shipping," wrote one commentator.

Commentary has not been limited to social and economic discussions. Technological issues remain to be overcome as another commentator points out. "In general, the biggest problem in operating LBE reactor is "Polomium-210 (Po-210)". Bismuth-209 (Bi-209) in LBE coolant undergoes neutron capture (Bi-210) and subsequent beta decay and finally becomes Po-210 which is highly radioactive and dangerous material emitting alpha radiation."

A third area for discussion was also raised: "The analysis of design options and application of the ALARP principles is to be applauded, however my impression is that the regulator would take the view that the design proposed is not yet as safe as it is reasonably practicable to be, for example, a single longitudinal bulkhead separating the propulsion elements should be increased with significant separation; whilst it is good to see independent propulsors they are vulnerable to a single collision in this region."

Technological hurdles remain the carrot to the engineering donkey and can be surmounted given time. Political and social hurdles can likewise be overcome. More difficult for lay people to surmount is the psychological impact that nuclear power has and this impact should not be underestimated.

It is clear that nuclear power has the ability to solve some of the problems caused by emissions from ships, the fear is that those harmful emissions could be replaced by something far worse in the event of an accident or through decommissioning of reactors on an industrial scale.

Or as another commentator put it: "The sector is busy identifying all of the current and emerging options and putting together all the elements to allow the various players in the shipping sector to make the right investment decisions. These will change looking further ahead as the cost of emissions becomes increasingly expensive or restrictive by regulation. Somewhere down that road nuclear propulsion will become economically attractive but only by an objective comparison will the sector know when and under what circumstances. This paper makes a start down that road and I would now like to see the other parts of the jigsaw put in place and the comparisons made." *NA*

Regulations

EP calls for NOx and CO_2 monitoring

According to the EU shipping is a "growing source" of greenhouse gas (GHG) emissions and the EU wants to engender a global approach to tackling GHGs and thereby climate change.

As a consequence the European Parliament's Environment Committee overwhelmingly voted to strengthen elements of the European Commission's proposed monitoring, reporting and verification (MRV) that it says will help decrease emissions from shipping.

The EU believes there should be a three step process that will aid the maritime industry in cutting its emissions by 40-50% of 2005 levels as required initially by MRV of CO_2 emissions so that a clear picture of the emissions from shipping. Then targets will need to be set for reducing emissions and the third element will be the introduction of market based measures (MBM) to limit carbon emissions.

"The MRV system is expected to cut CO_2 emissions from the journeys covered by up to 2% compared with a 'business as usual' situation, according to the Commission's impact assessment. The system would also reduce net costs to owners by up to €1.2 billion (US$1.6 billion) per year in 2030.

"In addition it will provide useful insights into the performance of individual ships, their associated operational costs and potential resale value. This will benefit shipowners, who will be better equipped to take decisions on major investments and to obtain the corresponding finance."

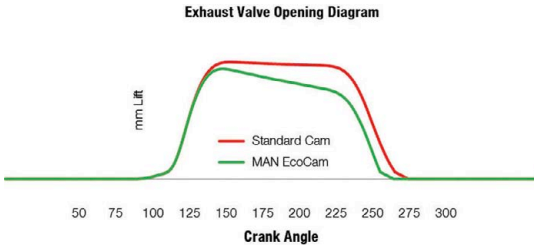
Engines

MAN retrofit offers fuel savings

Danish engine designer MAN has introduced the MAN EcoCam as a retrofit solution for the low-load optimisation of its low-speed, mechanical engines with single turbochargers.

EcoCam works by adjusting the exhaust valve timing at load levels of between 10-60% reducing emissions by 2 - 5g/kW with almost no scheduling interruptions to make the EcoCam adjustments and installation, said the company.

Christian Ludwig, head of retrofit & upgrade – MAN Diesel & Turbo, said: "Slow-steaming is now an established industry standard across all segments, including the tanker and bulker markets, and MAN Diesel & Turbo continuously seeks to further refine its technology and improve efficiency."



Comparison of camshaft opening angles

MAN says it will roll out EcoCam starting with the smaller bore engines, the MAN S50MC-C engines before extending the programme to medium and larger bore engines.

"The MAN EcoCam introduces a flexible cam profile, called a virtual cam. The profile is controlled hydraulically by adjusting the amount of actuator oil in the hydraulic pushrod.

Low-load tuning has an impact on torsional vibration and NOx. When a low-load tuning method is installed on an engine, the torsional vibrations' impact and the NOx levels have to be taken into account to ensure that the vibrations' impact is not harming the engine and that the NOx level is in compliance with IMO regulations," said MAN.

According to MAN the payback time for the system can be as little as one and a half years.

Monitoring

NIRIS drills down into fuel structure

An infrared sensor that can detect the molecular structure of bunker fuel allowing ship operators to optimise the fuel is said to offer considerable fuel savings according to CMR Group.

The Near Infrared Intelligent Sensor (NIRIS) uses hydrocarbon profiling to determine the molecular structure of fuel, whether it is mineral diesel or bio-diesel, which allows operators to make real-time adjustments to optimise the fuel use when used in unison with and engine control unit.

The company said: "This technology is relevant to the marine sector due to the increased use of bio-fuels in the form of bio-diesels and the quantities of biodiesel being blended into conventional diesel fuels."

The sensor uses an infrared spectrometer that performs continuous in-line analysis to measure more than 12 parameters "including the Cetane index, density, percentage of biodiesel and HCP," said the company, adding that: "The sensor provides simple, easy-to-understand information that engineers can use for assessing the quality of the diesel fuel powering engine systems such as: standard, premium or bad."

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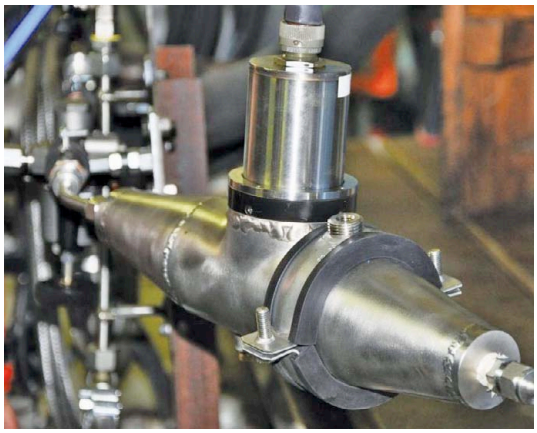

The NIRIS sensor can detect the molecular structure of a fuel which can determine how operators use the fuel, ultimately saving on fuel consumption

CMR says that the sensor package is small, about the size of a juice bottle and can be easily fitted to an engine block and to other engine control devices. NIRIS, says the company, can save owners up to 5% in fuel consumption as part of a vessel's fuel management system.

"The unit can be quickly and easily retro-fitted anywhere between the low pressure and high pressure fuel pumps and interface with other instrumentation through CANopen or SAE J1939 protocols."

Newbuilding

MES delivers *Ton Hil II*

Mitsui Engineering & Shipbuilding Co., Ltd. (MES) delivered the 56,000dwt bulk carrier *Ton Hil II* from its Chiba Works on 14 February 2014 to Ton Hil Shipping SA of the Marshall Islands.

The handymax bulk carrier has a large cargo hold capacity of more than 70,000m^3 and is the 163rd ship in this series.

TECHNICAL PARTICULARS

Ton Hill II

Length overall	189.99m
Breadth (moulded)	32.25m
Depth (moulded)	18.10m
Gross Tonnage	31,756gt
Deadweight	56,047dwt
Main Engine	MITSUI-MAN B&W Diesel Engine 6S50MC-C8.2 x1set
Maximum Continuous Output	8,000kw x 119.9rpm
Service Speed abt.	14.5knots
Complement	25 persons
Date of Delivery	14 February, 2014

The vessel is designed in accordance with the International Association of Classification Societies Common Structural Rules and, as a result, its structural safety and operational flexibility are said to be improved, says the yard.

According to the yard the vessel has a good fuel oil consumption level and offers good propulsive performance while the length and draught of the vessel was designed with accessibility to the world's major ports in mind.

In addition the vessel has five cargo holds and four cargo handling cranes and is designed to offer flexibility with the tank top designed with extra strength in order to load a variety of cargoes.

Long loads such as pipes can also be handled as well as heavy cargoes, such as hot coil in the specially strengthened holds.

Both the main engine, a MITSUI-MAN B&W Diesel Engine 6S50MC-C, and auxiliary engines comply with MARPOL NOx restrictions for exhaust gas, while ballast water can be changed during navigation for protection of marine environment.

Green Technology

Japanese test scrubbers

ClassNK and its partners, Kawasaki Kisen Kaisha, Ltd. (K-Line), Mitsubishi Heavy Industries (MHI), Mitsubishi Kakoki Kaisha, Ltd, (MKK), and Japan Marine United Corporation (JMU) have announced that they will participate in a new joint development project to install and verify the effectiveness of new Sulphur Oxide (SOx) scrubber technology onboard a Pure Car Carrier (PCC).

This new joint research project is being implemented as part of K-Line's new Drive Green Project, which aims to protect the environment and reduce CO_2 emissions through the use of new maritime technology. As part of the Drive Green Project, K-Line will install a variety of new green technologies, including a new Hybrid SOx Scrubber System developed by MHI and MKK, on a 7,500 unit PCC being built at JMU for delivery in 2016. The vessel will be the flagship of a series of eight new PCCs currently on order by K-line.

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BWMC debate enters critical stage

Ballast water management systems will be one of the major topics for debate when the IMO's Marine Environment Protection Committee meets in March, with calls for a re-think of rules relating to them, Sandra Speares.

Trade associations including the International Chamber of Shipping, Intertanko, Intercargo, BIMCO and the World Shipping Council have made a submission to MEPC saying that guidelines for approval of ballast water treatment systems (G8) will need to be amended as a matter of urgency in order to ensure the success of the Ballast Water Management Convention, which is not yet in force.

"There is a continuing lack of confidence that ballast water management systems type approved under the current G8 Guidelines for the testing of ballast water management systems will operate consistently in accordance with the Ballast Water Management (BWM) Convention's ballast water discharge standard (regulation D-2)," the submission suggests.

Since filing the submission the ICS board has said that it will continue its stance of not "actively encouraging" administrations that have yet to sign up to the convention to do so.

ICS Chairman, Masamichi Morooka explained that: "In principle ICS fully supports the eventual entry into force of the Convention and wants to make it work as soon as possible in order provide protection against invasive species. But, the industry still has very serious concerns with respect to the lack of robustness of the current IMO type-approval standards for the very expensive new treatment equipment that will be required, as well as about the criteria to be used for sampling ballast water during Port State Control inspections.

"Governments need to understand that the industry cannot support the immediate entry into force of a regime that will require billions of dollars of investment without any confidence that the new treatment equipment will actually work, or that it will comply with the standards that governments have set for killing unwanted marine micro-organisms."

The ICS believes it would be "unfortunate if the Convention comes into force 'by accident' as result of further ratifications by governments before these outstanding problems have been properly addressed".

Industry associations have long believed that the type approval process for ballast water treatment systems is flawed and in many cases it has been a question of putting the cart before the horse by approving systems without the certainty that these would meet the required standards.

According to the submission: "When the Convention was adopted there was a general understanding by the shipping industry that if a ballast water management system, type approved by an administration to approved guidelines, was purchased and operated correctly, compliance issues would not arise. The subsequent concerns that have come to light with the reliable efficacy performance of some treatment systems already approved under the G8 guidance has unfortunately removed confidence in the type approval process on the part of both authorities and shipowners, resulting in the demand for rigorous port state sampling and analysis".

The submission also suggests that the recent introduction of ballast water regulations in the US had added a further layer of confusion regarding the testing process. It states that some IMO type approved systems will not meet more rigorous US testing requirements.

Proposed amendments to the G8 guidelines outlined in the submission include performing test using fresh, brackish and marine waters to ensure that the system will continue to work correctly in waters of all salinities. Testing should also consider the effect of temperature in cold and tropical waters on operational effectiveness and environmental acceptability. The trade associations point to one BWMS, which was withdrawn from the market due to residual toxicity in cold water, which was not detected during the type approval testing conducted with temperate water.

Other proposals include using standard test organisms that challenge the treatment process.

"It is a serious concern that some test facilities may select organisms with either a high natural mortality or low resistance to disturbance for convenience due to the test site location". Suspended solids in test water should provide a more realistic challenge than at present, the submission says.

Type approval testing should not allow discounting test runs in the full-scale testing that do not meet the D-2 standard, nor should the results of test runs be "averaged", it submits. Testing should realistically represent the flow rates the system is approved for. In addition the continued effectiveness during low ballast water flow rates should be verified as a BWMS will be required to operate effectively at both full flow and reduced flow such as when topping up ballast tanks and fine adjusting the ballast condition en route. *NA*

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Accommodation & interiors

Bolideck decks out

Dutch flooring and decking specialist Bolidt has secured a new contract to supply and install Bolideck Future Teak for the deck onboard a Fast Yacht Support Vessel under construction at Damen Shipyards Group company Amels, of Vlissingen.

The durable, lightweight synthetic decking system will be fitted on the Sea Axe 6711 Fast Yacht Support Vessel (FYSV), a 67m length vessel due for delivery in early 2014.

The new vessel is able to accommodate 21 personnel and has been designed for relief crews needed for superyacht operations. Offering ample space for water toys such as tenders, jet skis and sailing dinghies, the vessel also features a separate certified helipad with 5,000kg take-off weight for commercial use.

The contract follows a run of orders for Bolideck Future Teak onboard the comparable FYSVs Umbra, Oberon and Garcon.

www.bolidt.com

Communication

Beacon of safety

Telemar UK Ltd, in partnership with MarineMTS, launched its Individual Position Indicating Rescue Beacon (iPIRB), which can locate and identify marine casualties fast so that every effort can be concentrated on rescue and lifesaving.

The company said that when help has been summoned to the rough location of an incident, iPIRB identifies the precise location of casualties within a search area, either on board a craft or, crucially, in the water. Even unconscious casualties can be located, as the beacon is automatically activated on impact with the water. If an incident results in multiple casualties, each can be located with a very high level of accuracy – reducing time in the water, and thereby increasing the chances of survival.

The company says the main features of the iPIRB are that it is a robust and compact, pocket-sized AIS-SART and in combination with Loc8 and MicroPlot software provides a unique, reliable way of locating and tracking marine disaster casualties.

www.telmar.co.uk

Ballast water treatment

Panasia seeks US approval

Korea-based Panasia is working its way to get US Coast Guard type approval. The company has said that in accordance with ballast water treatment system (BWTS) Rule represented by USCG (United States Coast Guard) only the vessels that are equipped with BWTS approved by USCG are allowed to call at the port in USA.

In consideration of the fact that it takes approximately at least two-and-a-half years or three years to acquire USCG type approval for BWTS, with a five-year grace period from the ratification of USCG's BWDS (Ballast Water Discharge Standard) has been given to the vessels by the application of Alternate Management System (AMS).

Panasia's BWTS GloEn-Patrol obtained AMS approval as of 29 April 2013. In addition to this, Panasia has already obtained ABS, BV, LR, RINA, RS, CR type approvals, The Netherlands flag approval, DNV ATEX approval, G8(nation flag approval) and G9(Active substances). Besides, more approvals including DNV and JG (Japanese Government) are presently being processed.

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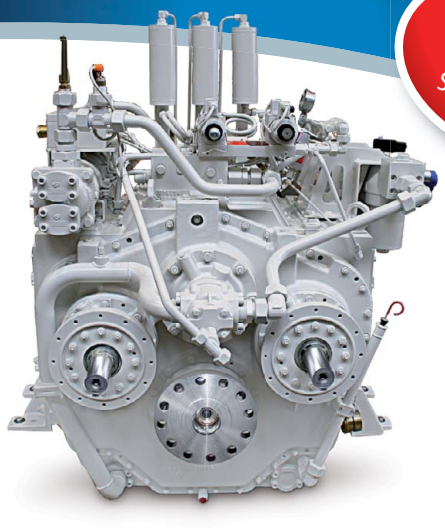

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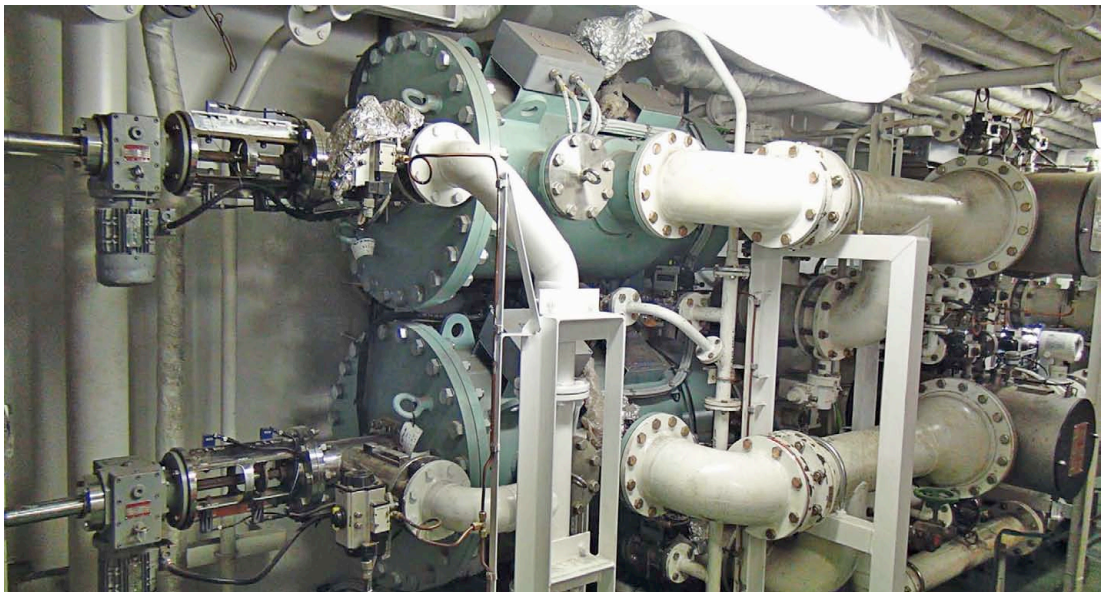

Panasia sets its sights on USCG type approval

GloEn-Patrol, Panasia's BWTS, is a combined treatment system taking advantage of Filtration and UV irradiation.

www.gloen-patrol.com/english.html

Navigation & communication

Martek launches iECDIS

Martek has spent two years developing its iECDIS system, and learning from other ECDIS industry failings, and has developed what it classes as its most rugged, reliable and at the same time the fastest ECDIS available today.

The network-connected iECDIS features heavy-duty military specification hardware and software that is used by the US military. The system has fan-less operation with no moving parts, making it maintenance free and extending the life. It has a 32GB solid state drive (SSD) with an integrated GSM modem option. The company states that it is also the fastest ECDIS on the market with 8GB RAM and has a compressed system electronic navigation charts (SENC) format.

www.martek-marine.com

Environment

EnSolve launches SOx Scrubber

EnSolve Biosystems has announced that it has developed a new product called EnScrub which treats particulates and petroleum hydrocarbons from the effluent of shipboard sulphur oxides (SOx) scrubber systems. This patent-pending technology, partially funded by a Phase II National Science Foundation (NSF) grant, combines biological and physical processes to remove and destroy petroleum hydrocarbons from the aqueous effluent of SOx scrubbers.

In late 2012, EnSolve conducted efficacy testing of a prototype EnScrub System on effluent obtained from a SOx scrubber system at the Port of Long Beach, California. The analytical results indicated that the EnScrub system was successful in reducing more than 99% of the petroleum hydrocarbons from the SOx scrubber water effluent, the company noted. Subsequent testing in 2013 confirmed the results of the 2012 Port of Long Beach field trial.

EnScrub models are available for closed-loop, open-loop or hybrid applications.

www.ensolve.com

Classification

RINA certifies Aggreko marine generators

International classification society RINA has certified the power generators which Aggreko provides for temporary marine use. The certification provides shipowners with the assurance that the generators meet all applicable SOLAS rules for temporary use onboard a ship.

Pino Spadafora, area manager, RINA Services, says: "This certification delivers peace of mind for shipowners and ship operators that SOLAS rules are fully checked and complied with by the equipment providers. The RINA approval certificate on an Aggreko generator ensures compliance with onboard safety requirements."

Maarten Martens, business development manager, Aggreko Continental Europe, said: "This is a major step in the way we help our shipping customers meet SOLAS rules. This process will ensure faster and simpler delivery of containerised diesel power generators for planned or emergency projects."

RINA certification of the generators and associated safety systems will make it simpler for shipowners and ship operators to comply with safety procedures when using a generator onboard for a short or medium period, says the classification society.

www. aggreko.com

Ancillary equipment

DSME opts for Bestobell

Bestobell Marine, part of the President Engineering Group Ltd (PEGL), has secured a major new order for its cryogenic globe, check and FLIV valves with South Korean shipbuilding company DSME, as part of a multi-million dollar deal.

Actuated globe valve with Emerson actuator in production

The order includes five ship sets of valves that will be fitted on the 173,000 LNG carriers being constructed for Teekay LNG Partners LP of Canada, with the vessel due for delivery during the first half of 2016.

The new vessels will be constructed with M-type, electronically controlled, gas injection (MEGI) twin engines. This is the first time any LNG Carrier will have been fitted with this innovative type of engine that has significant environmental benefits, the company said.

This latest contract follows Bestobell securing an agreement in 2013 to supply Globe and Check valves to DSME for one of the world's first Floating, Storage & Re-gasification Units (FSRU) in a deal worth US$500,000.

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Ballast water treatment

Saver class cleans up with CleanBallast

Pursuing the aim of top-efficiency ship operation and improved operational performances,

Seaspan is to equip its Saver class vessels with RWO's ballast water treatment system CleanBallast. The delivery of the first plant to China's Jiangsu New Yangzi shipyard is set for March 2013 where installation will take place.

RWO launched a modified version of its CleanBallast technology last year, which is based on the proven technology but using considerably less footprint, the company says. The treatment principle is based on two cleaning steps, consisting of the removal of sediments and bigger particles by self-cleaning deep-filtration disc filters followed by a disinfection step using RWO's patented EctoSys technology eliminating the remaining bacteria and organisms.

www.rwo.de

RWO gets more orders for its CleanBallast

3D modelling raises CSR-H standard

In a presentation to the International Conference on Computer Applications in Shipbuilding, NAPA Group product manager Tapio Hulkkonen, ClassNK and DNV GL, outline a practical method for improving structural design efficiency in preparation for CSR-H, by using a 3D product model for all design activities

The introduction of the new harmonised Common Structural Rules (CSR-H) for bulk carriers and oil tankers presents new challenges for vessel structural design. Upon the new rule's application in 2016, designers must have completed significant software upgrades, or face delays to the structural analysis process.

In July 2016 when CSR-H is rolled out to tankers over 150m and bulk carriers over 90m, the process of achieving vessel compliance will become altogether more complex. Aimed at enhancing structural safety and reliability, CSR-H introduces more in-depth analyses, new rule checks and a common standard applicable to both ship types. Although 3D product models already support compliance against the current common structural rules (CSR-BC for bulk carriers and CSR-OT for oil tankers), the geometry required to meet CSR-H is more demanding.

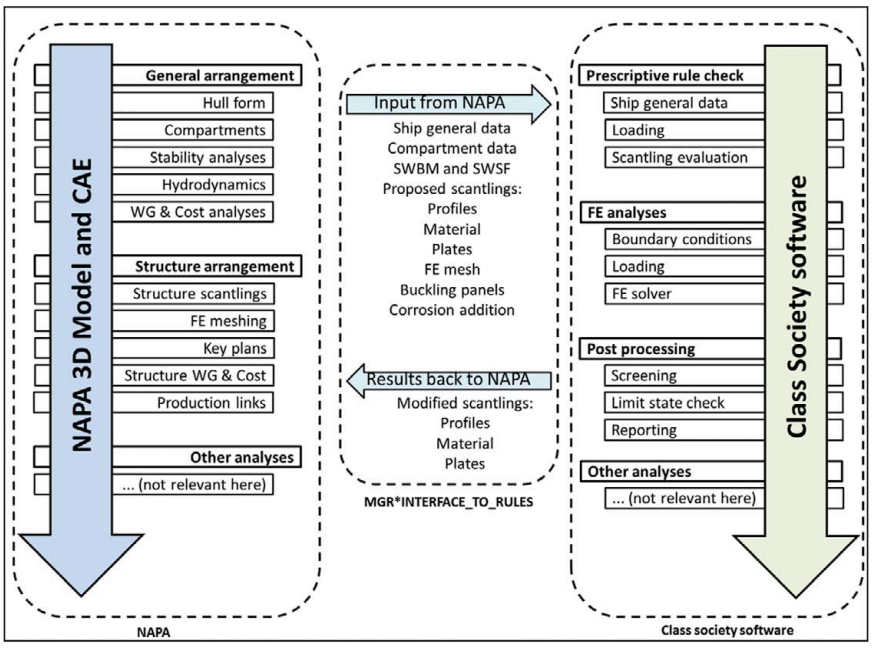


Figure 1: Design process with NAPA and Class software

For direct strength analyses of cargo holds, the requirement is to create a three-cargo hold finite element (FE) model for each cargo hold, where the mid-hold is the target for analyses. CSR-H also requires an extension to the FE analyses from parallel midship to the aft and fore ship. And, in addition to the mesh geometry for global and fatigue analysis, the 3D model will be utilised in combining compartment information to structural geometry and producing further the required information for corrosion and loading for strength analysis.

In addition to implementing software upgrades to fulfil these extended requirements, ship designers also have to contend with the International Association of Class Societies (IACS) members' policy to develop their own independent rule check software. This means achieving seamless integration of rule checking and product model software is a key priority, if efficiency in structural design analysis is to be retained when CSR-H is introduced. Such is the challenge of this integration, that it has prompted a first-time collaboration between NAPA, Class NK and DNV GL. While all three have already established software in the maritime market, this is the first time the organisations have collaborated to harmonise their products: NAPA Steel, ClassNK PrimeShip-HULL and DNV GL POSEIDON.

Ship design processing

NAPA has been continually developing its 3D vessel model with the aim of creating fluency in the ship design process. The software currently offers functionalities such as state-of-the art tools for naval architecture calculations, FE meshing for global and fine mesh areas, and interfaces to common class rule check software that relay results back to the product model.

To develop the product model for CSR-H, NAPA is sharing tasks with PrimeShip-HULL and POSEIDON in order to utilise the knowledge and strengths of each software package, as illustrated in Figure 1.

A 3D product model can be utilised when the initial scantling check is being submitted. Cross-section geometry and initial scantlings as well as compartment information of an existing 3D model can be imported to a class rule check software, where results that fulfil CSR-H requirements are imported back to the 3D product model in NAPA. The fact that the scantling evaluation is based on one 3D product model and results are read back saves times and reduces the possibility of human errors. This is a clear improvement

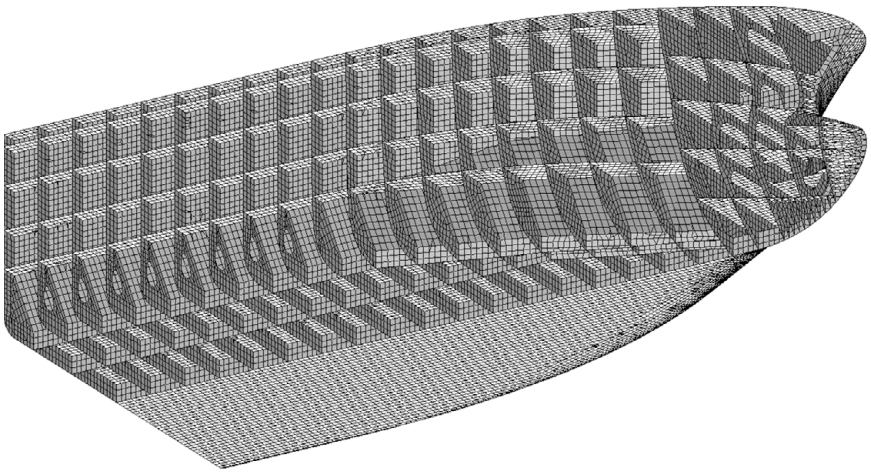


Figure 2: NAPA Cargo hold FE model.

on the traditional process, where 2D sections are modelled in the rule software and information exchange is manual.

Scope and status of the interface

PrimeShip-HULL has two parts related to the development of the CSR-H product model. Firstly it will provide prescriptive rule checks through an interface from NAPA designed to transfer the complete NAPA Steel model to PrimeShip-HULL. Currently under development as part of the ClassNK Joint R&D for Industry Program, the interface is based on a 3D xml format specified by ClassNK that covers the transfer of information related to longitudinal strength as well as compartment data. An additional part 'xml for ship 3D' covers structural geometry and proposed scantlings.

The second part of the interface is supporting buckling and yielding panel information from NAPA in xlsx format. PrimeShip-HULL has the capability to directly generate this information; however, the use of panels automatically generated by NAPA will enhance the process. The third part of the interface covers the NAPA FE meshing in bdf format, with the development work extending above cross section rule check and 3D FE analyses to include prescriptive rules of longitudinal structures. FE meshing features are also available both in NAPA and PrimeShip-HULL as beta versions for testing.

The interface to POSEIDON is designed to transfer a user-defined longitudinal range of the vessel model, such as the complete cargo hold area or the global ship model. The transferred geometry of the hull structure is transferred cross-section wise at automatically selected positions by NAPA to build a three-dimensional construction in the POSEIDON software. Longitudinal plates and transverse web plates, both with stiffeners, are transferred as they are defined in NAPA Steel into a readable form so that the user can perform small modifications or structural optimisations inside the imported model with greater ease. Rule check calculations at any cross section inside the transferred block boundaries, automatic buckling field detection and the assessment of a global FE analysis are also possible through the POSEIDON model.

Although the interface is still under development, the current version can already be used in vessel production, when dimensioning the longitudinal members of a complete cargo hold.

Cargo hold FE models

Under the new requirements of CSR-H, cargo hull models with a prismatic shape will no longer be sufficient. Instead, a real 3D geometry of nearly the entire ship hull needs to be defined in the software to create a FE mesh for analysis, promoting a significant increase in modelling work.

NAPA has created a FE meshing tool that creates the FE mesh according to the CSR-H rules automatically based on the 3D product model. The FE mesh is available for the whole ship or for a user-defined model extent.

Idealisation of structures An intelligent idealisation of structures plays an important role in FE mesh creation, when the mesh is based on an as-built 3D geometry of the hull. If the mesh is created without idealisation and purely on top of the as-built 3D geometry, it often results in unnecessary elements at several locations in the mesh, yielding a poor and unrealistic global analysis. An accurate 3D geometry is needed in the product model for several purposes, for example, weight estimation, drawings and production design. It is also needed in fatigue assessment.

In the NAPA product model, the idealisation is separated from the real geometric definition. The product model has the accurate geometry, and FE mesh is idealised in a separate automatic process guided by the user. A typical idealisation of a structure includes connected stiffeners extended to the connection point, and unconnected stiffeners moved to the closest connection point, if the distance is smaller than 20% of the longitudinal mesh size. Brackets, seams and plates are omitted from the coarse mesh model while cut outs and corner notches are removed from the global FE model. CSR-H also includes the introduction of full-quad-mesh at all free boundaries for better stress estimation during the FE assessment and a face plate for the primary supporting member that can be included with rod or beam elements. The bracket toe is also cut for cargo hold models, as illustrated in figure 3.

Primary supporting members The end of primary supporting members (PSM) needs to be idealised to avoid unnecessary poorly shaped elements at bracket toes. Without the idealisation of the geometry, the case yields such mesh where there is a triangular element at the web end. If the FE mesh combines the nodes in the inner bottom, then the last element in the web is a triangle, and the rod element (from the face plate) is connected to the inner bottom. This type of a configuration is too stiff compared to the actual structure, where the bracket toe is soft and the faceplate has a tapered end shape.

This type of geometry can be automatically idealised in NAPA so that the web geometry is cut vertically at the location

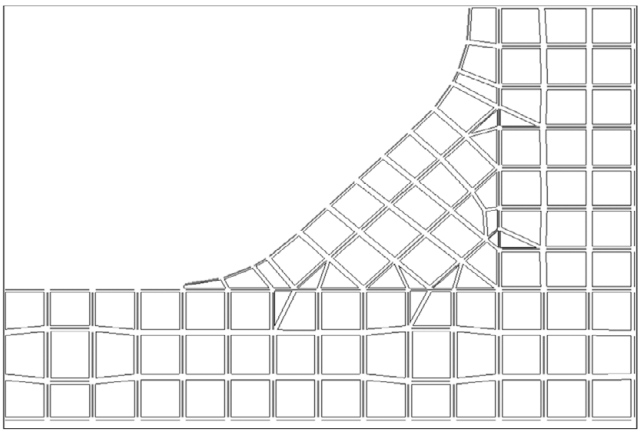


Figure 3: Shell elements plotted with 5% shrink.

of the longitudinal stiffener. In addition, the rod element, representing the faceplate, is not connected to the inner bottom.

Local refinements Structural integrity is very sensitive for fatigue failure for certain types of ship structures, for example, a hopper knuckle in a ship with a double side and a connection of transverse web and inner bottom. At fatigue critical areas, such as a web frame, a fine mesh analysis must be carried out if the area exceeds the structural screening criteria.

NAPA has implemented an effective way of creating fine mesh areas including the transition area between fine mesh and coarse mesh. The level of detail can be adjusted inside the fine mesh and the transition area.

For the fine mesh analysis, it is necessary to include all structural details, such as face plates, a stiffener web and a flange as well as the possible cut-outs. The mesh should be created with shell elements for accurate stress estimation within the structure, unlike in a coarse mesh model, where many of the details can be ignored and stiffeners could be included as beam elements. The user input required is the location of the fine mesh areas, the level of detail, and the mesh size. Based on that information the fine mesh model is created automatically in NAPA.

Corrosion Margin According to CSR-H, the FE assessment must be conducted with the corrosion margin taken into account. At the same time, when the structures are designed with 3D software, the as-built thickness is applied to the 3D model to calculate the lightweight correctly, produce drawings and get accurate production information.

Therefore, automatic corrosion reduction is essential, when large FE models are created in order to minimise the possibility of human errors, if the corrosion reduction is submitted manually and to save man-hours during the FE modelling process.

CSR-H corrosion additions are based on the location of the element and on the compartments on each side of the element. For beam elements, the corrosion addition is computed based on the compartment where the stiffener lies, since a stiffener can lie only inside one compartment.

NAPA handles the corrosion reduction automatically based on the information included in the NAPA product model. The key issue in handling corrosion is to have the information about compartment content and geometry. NAPA Steel combines the information from a compartment model and FE meshing producing the CSR-H required corrosion values. Both POSEIDON and PrimeShip-HULL support the corrosion addition definition, and therefore, in the developed process, there is also the option to use corrosion addition directly from class software

Conclusion

When the new harmonised CSR-H rules were unanimously adopted at the 68th IACS Council meeting in December 2013, the IACS council described the achievement as 'historic' and the result of 'many years hard work by technical specialists from all member societies and intensive and continuing consultation with industry and authorities at every stage'. While working to secure adoption of the rule was a major undertaking, many challenges still remain for ship designers in integrating required information for CSR-H with class rule check software and product models used in ship design. To avoid increasing the time spent on structural analysis, software designers should update their programmes to meet the new rule's superior geometry and harmonisation demands. NAPA's unique collaboration with ClassNK and DNV GL offers a practical method addressing achieving this, which can be built on in the lead up to 2016. *NA*

Aiming for two highs

Step up research & development, advance into high-tech, value-added product arenas, boost maritime equipment expertise, optimise production chain, aid shipbuilders to upgrade to ensure industry's sustainability says Shen Nan Song, Vice Mayor of Jingjiang, Jiangsu Province in an interview with Chang Ying

Ships are what made Jingjiang City famous and affluent. Thriving for years on shipbuilding, the city has long become the force behind the development of the industry in central Jiangsu.

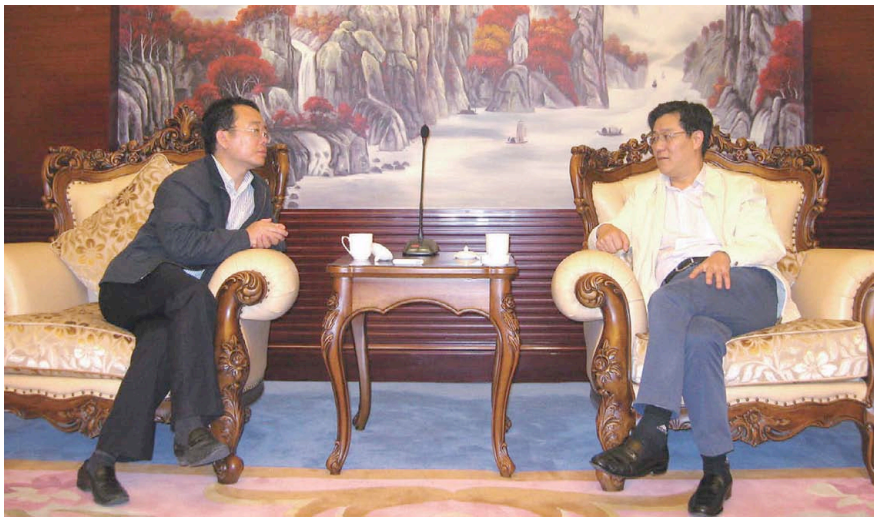
The number of vessels completed by its shipbuilders last year accounted for 10% of the entire country's vessel output and 30% of the provincial total. These figures clearly indicate that the industry has been vital to the development of the city.

Currently, with the shipping and shipbuilding markets still in a slump, more risks and uncertainty are anticipated for shipbuilding enterprises. The city's Vice Mayor Shen Nan Song shared his thoughts on that at a meeting earlier with the CEO of China Ship News Li Zhong. He said the city will step up research and development efforts and push forward into the high-tech and high-value-added product arenas, work hard to further its maritime equipment expertise and optimise shipbuilding industrial chains, as well as make sure its shipbuilders are able to weather the "winter chills" and transform and upgrade, in order to ultimately achieve sustainable development.

When the market was more buoyant the city chose to follow a development path different from that taken by most major shipbuilding hubs. It did ride the favourable tide to grow, however, at the same time, its shipbuilders also annually increased investment in their maritime equipment expertise, having in place industrial chains for major supportive operations for turning out diesel engines, furnaces, generators, anchor chains and cables for ships.

To date, apart from producing to the specifications of shipowners and classification societies, they are capable of delivering proprietary equipment.

Shen says: "In 2009 and 2010, not feeling any imminent impacts from the economic downturn, Yangzijiang Shipbuilding and New Century Shipbuilding ranked first and second in economic output among shipbuilders, making the city the largest and strongest industrial base for private shipbuilders." However, by 2011, at the drag of the low tide, shipbuilding enterprises saw the selling price and profit margins of their products plummet and many were troubled by capital problems.



Vice Mayor of Jingjiang, Shen Nan Song (on the right), exchanges views with the CEO of China Ship News, Li Zhong

"In this respect, with its backbone shipbuilders had the foresight to cap and control risks, Jingjiang aced the test. Yangzijiang Shipbuilding and New Century Shipbuilding, for example, not only secured full returns from investment, but also boasted robust liquidity with about RMB10 billion (US$1.65 billion) cash-in-hand."

Furthermore, in recent years, the city's shipbuilders have advanced in research and development as well as localising maritime equipment related capabilities, giving them stronger competitiveness and bargaining power in landing orders. They are providing the local shipbuilding workforce with a solid footing.

In the first three quarters of last year, the city's shipbuilders had begun to see the fruits of their efforts to adjust their business structure, and transform and upgrade operations. They have managed to "breakthrough" from typically taking orders for bulk carriers and oil tankers to higher-end vessels such as super container carriers and chemical tankers.

Between January and September, Jingjiang's shipbuilders obtained orders for 52 vessels with a total capacity of 3.762 million DWT, a 591.7% leap year on year, claiming provincial first with a 33% share and accounting for 9.9% of the national total.

Yangzijiang Shipbuilding alone saw a 382.8% climb in orders, whereas New Century Shipbuilding landed orders for 25 vessels with a total capacity of 2.37 million DWT in the last three months letters of intent for vessels totalling 5.02 million DWT have also been signed. The city's shipbuilders have orders to last them until 2016.

According to Shen, while focusing on putting out recognised products, shipbuilders

Miao Wei Qun, (Deputy General Manager) of Yangzijiang Shipbuilding, explains production situations to Li Zhong.

in Jingjiang have been actively looking into high value-added operations and areas including environmentally-friendly ship models, super container carriers and maritime engineering equipment. Yangzijiang Shipbuilding managed a 10,000TEU container carrier, which is a new record among the private shipbuilders in China and it has also started work on its first jack-up platform marking its foray into the maritime engineering equipment field.

New Century Shipbuilding put out products that included a 320,000dwt VLCC and new environmentally-friendly vessels with intellectual property rights protected showing how it has transformed and excelled.

Known for its expertise in the production and sale of anchor chains, Asian Star Anchor Chain Co., Ltd developed and launched to market the R5 mooring chain series for maritime platforms and also pursued R&D of higher-end mooring chain products. Such efforts will eventually boost its say in the industry.

"All these exertions and achievements have contributed to the healthy growth of the city's shipbuilding industry," explains Shen.

Shipbuilding, being a pillar industry of Jingjiang, is held close to the city's heart. With strong confidence in the industry, Shen says Jingjiang, which is blessed with a superior coastline and port, makes the best home for shipbuilders.

"As an open port, vessels coming and going need simply to go through relevant custom procedures there and then. Furthermore, construction work has begun for the 12.5m draught waterway down the Yangtze from Nanjing, which when completed, will allow 100,000dwt vessels to sail down the Yangtze from Shanghai to Nanjing, and in turn logistics and shipbuilding operations on the shores along the course will flourish."

He says the city's shipbuilding industry stands out in competitiveness because its players are quick to transform. Heeding the new market situations, Jingjiang will harness its advantages further and support its backbone shipbuilders. To make sure local shipbuilding enterprises are well-equipped to fence off market risks, it will encourage them to better their knowhow and improve where it is needed, explore new businesses, new vessel models and markets, step up development of advanced technologies and high value-added products, as well as optimise their industrial chain and maritime equipment expertise.

"We also look forward to clearing constraints rooted in the system so that private enterprises will have a fair and competitive environment and be able to reach out and work with well-known overseas peers. That will help maximise the overall influence of the city's shipbuilding industry."

Shipbuilders in Jingjiang, he added, will continue to "venture out and usher in" and work shoulder-to-shoulder, for one plus one can be a lot greater than two, pooling energy that can fuel development of the country's shipbuilding industry and help it realise the vision of becoming a global shipbuilding giant. *NA*

Li Zhong visits the production floor of Asian Star Anchor Chain Co. Ltd.

Taking the nuclear option

A surge in greenhouse gas emissions from shipping is inevitable as demand for ships increases over the coming years. IMO targets to reduce net emissions by 2050, cannot be met even with more efficient ships, but Lloyd's Register's Spyros Hirdaris looks at modern nuclear power for a Suezmax tanker as a cleaner alternative energy source

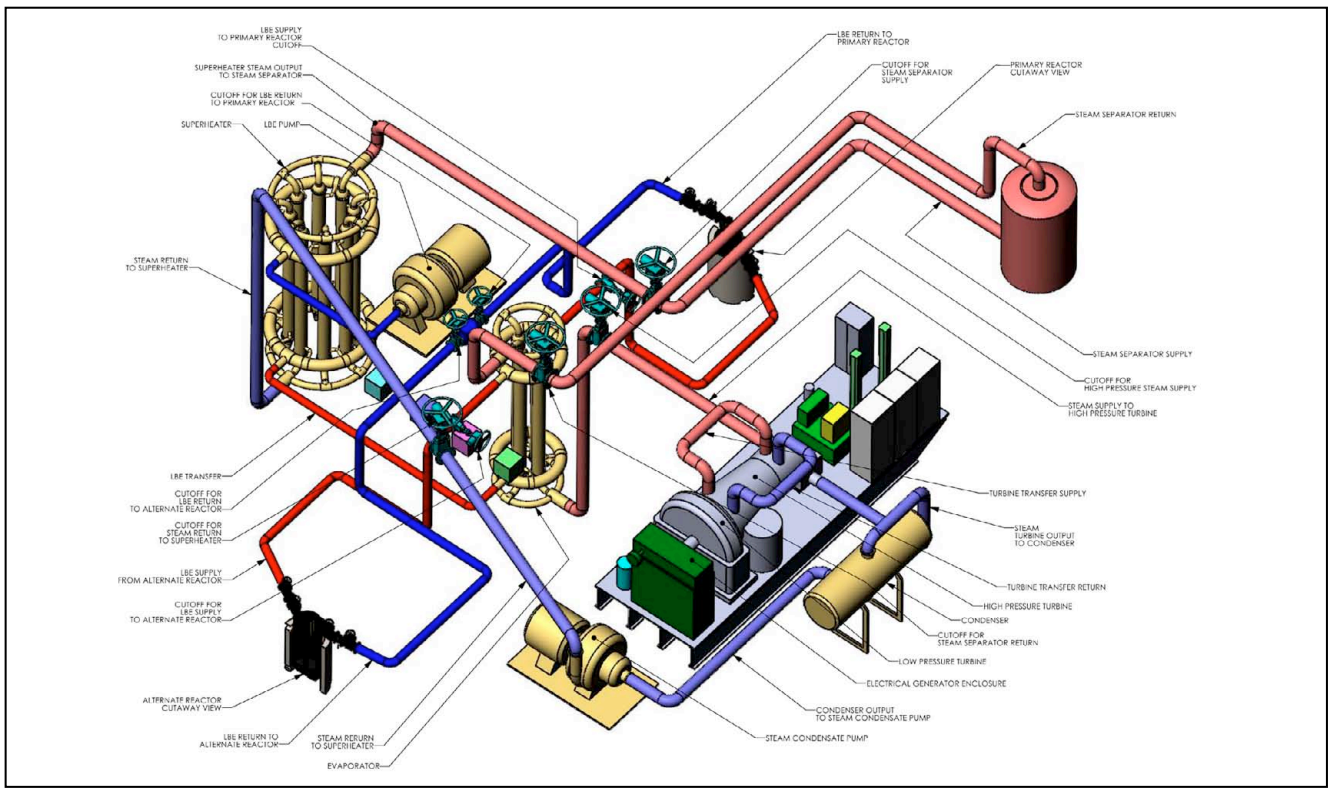
Treating shipping within the context of global environmental concerns has gained significant momentum over the last 10 years, particularly in relation to the generation of green house gases (GHG) and other contributions to air and water pollution.

Notwithstanding the potential of renewable or alternative energy solutions onboard ocean going ships, the nuclear engineering option could also be considered as an alternative with minimal detrimental emissions. Recent research from UK based Lloyd's Register Group Ltd. and BMT Nigel Gee ship designers in association with Gen4Energy small modular reactor (SMR) technology producers from the US and Enterprises Shipping and Trading SA of Greece explores the feasibility of developing a commercially viable concept for an oil tanker with a conventional hull form, but with alternative arrangements for accommodating a 70MW SMR propulsion plant.

International agreements on the need to combat climate change, the fluctuating, but generally rising, costs of marine fuels which account for a large proportion of the running costs of a ship backed up by technological advances have led many in the industry to question whether the present methods of ship propulsion are sustainable.

Amongst the number of propulsion options currently being researched by the maritime industry modern nuclear technology could perhaps offer a useful alternative in terms of efficiency and reduced CO_2 emissions (RAEng, 2013). Over the years the limited application of nuclear technology in the ocean going merchant marine sector has been influenced by fears over the inevitably strong social and environmental impact of a potential disaster.

Figure 1: Gen4Energy SMR Power Generation core Module (The module is connected to the primary loop. The liquid metal coolant is pumped through the reactor module to heat exchangers that heat the secondary liquid metal circuit. Additional primary system components include the cover gas system and the oxygen control system. The steam generator contains a feed pump, an evaporator and a super-heater.)



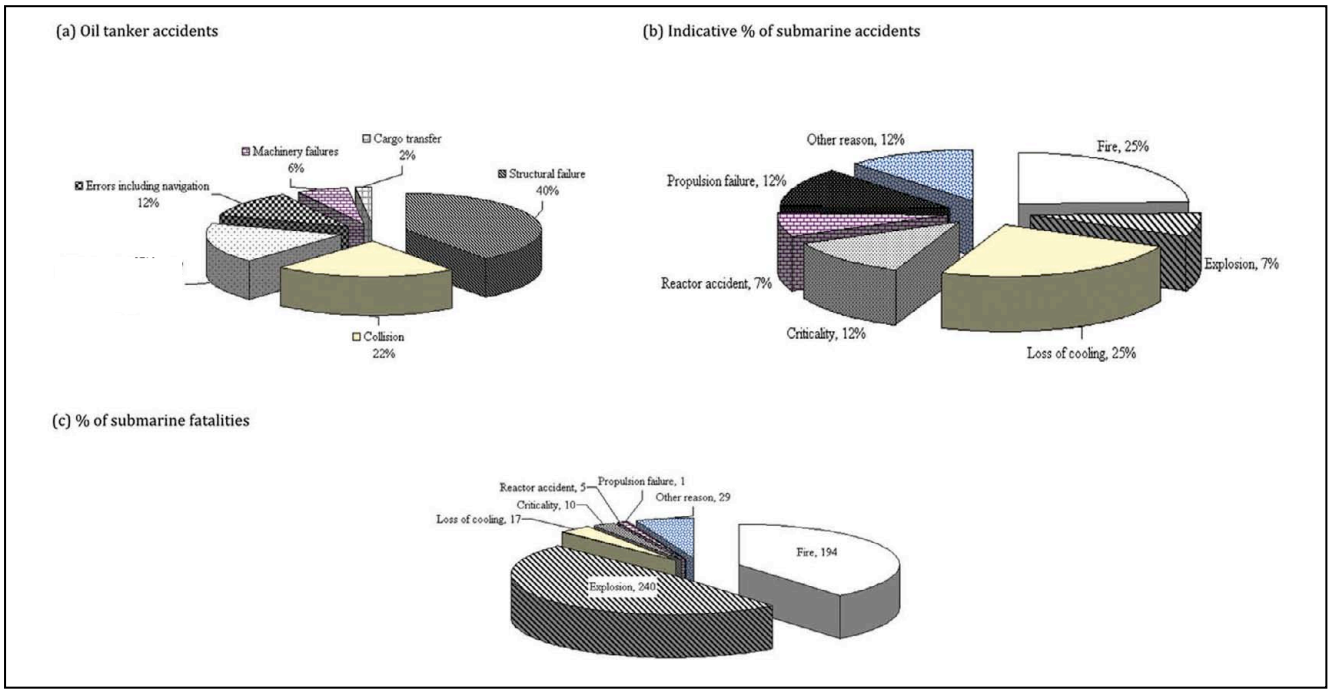


Figure 2: Key commercial tanker and naval nuclear submarine accidents (NB: 'Propulsion failure' may involve the reactor system although in most cases this seems not to be the case; 'Other reasons' involve collisions and suspected operator error).

Political and regulatory issues, business risks, lack of understanding of the influence of modern nuclear technology on maritime applications also hindered the development and expansion of a nuclear fleet of ocean going vessels. Many of these issues remain as possible stumbling blocks, but more recently, the influence of the global decarbonisation agenda, the advances in nuclear technology and the potential modernisation of the regulatory framework offer an opportunity to explore the potential benefits of applying modern nuclear propulsion solutions to the merchant marine sector; with the proviso however that *risks are well realised and understood.*

Engineering	Description	Characteristics	Benefits
General Reactor features	Fast Neutron Spectrum	• Power 70MW$_{thermal}$;25MW$_{electrical}$ • Weight < 50 tonnes • Diameter = 1.5 m ; Height =4 m • Use of full energy potential • Better dynamic performance • Few changes in system with lifetime	• Long core lifetime without refuelling (approx. 10 years) • Small impact of fission products on reactivity • Little isotropic transmutation • Reduced radioactive waste trough transmutation
Core Coolant	Liquid metal LBE (Pb-Bi)	• Lower melting temperature and minimum expansion at melting in comparison to Pb • Lower risk of leaks and subsequent chemical reaction with water or air in comparison to Na	• Compact core design that can produce a 500^{0}C high coolant temperature • Good system efficiency
Nuclear Fuel	Uranium Nitride (UN) stainless clad	• ^{235}U enrichment of 19.75% • UN pellets contained in tubes made of HT-9 (ASME 12Cr1MoVW) stainless steel	• Good thermal conductivity • High core life • Low fission gas release and fuel swelling • Resistance to irradiation damage over extended time • Factory fuelling
Reactor core	• Uranium Nitride (UN) open lattice • Improved active and passive safety features	• Reactivity control rod system composed of 6 inner and 12 outer B_4C shutdown rods • Reserve shutdown system consisting of a cavity into which a single B_4C rod may be inserted. • Heat is transferred from the core via circulation of coolants.	• Light design; easy scaling and transportation • 10 year Long life without refuelling • Enhanced system reliability to operational blackouts and shutdown conditions • Improved Safety by active and passive shutdown • Independent means to remove decay heat under all plant shutdown conditions

Table 1: Key Gen4Energy SMR technology features

The nuclear option

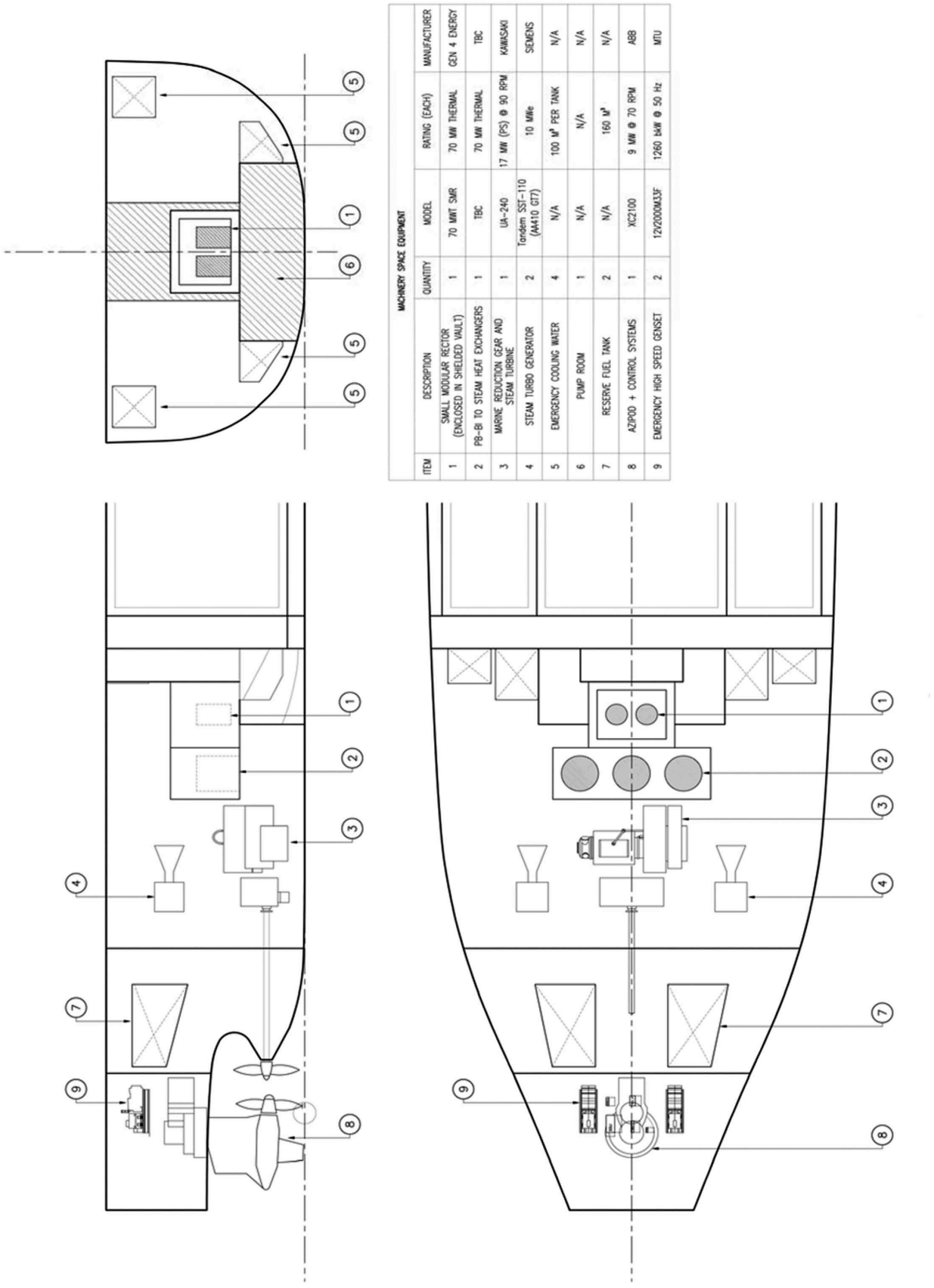
According to the IMO international shipping contributes between 2.7% and 3.3% of the global CO_2 emissions annually. This number, on its own, places the industry, in absolute terms, as the sixth largest producer of GHG. It is estimated that without action these emissions could grow significantly until 2050. Nuclear marine propulsion has advantages against renewable (e.g. wind and solar) and alternatives (e.g. LNG resources) in terms of reduced CO_2 emissions. For example, lifecycle CO_2 emissions from fossil fuels are far higher than their corresponding nuclear indirect emissions. Also, in contrast to hydrocarbon driven combustion, nuclear fission entails no chemical reactions.

Yet, it is important to realise that the overall nuclear fuel cycle has some potentially hazardous emissions associated with the released energy of fission and the energy of neutrons. Also GHG and other contaminants may be released into the atmosphere during plant construction, uranium mining or milling, reactor fuel manufacture and transportation, auxiliary power generation and plant decommissioning. These are risks that would significantly influence operational costs as well as human centred decisions throughout the lifecycle of a nuclear maritime asset and should not be underestimated.

The SMR option

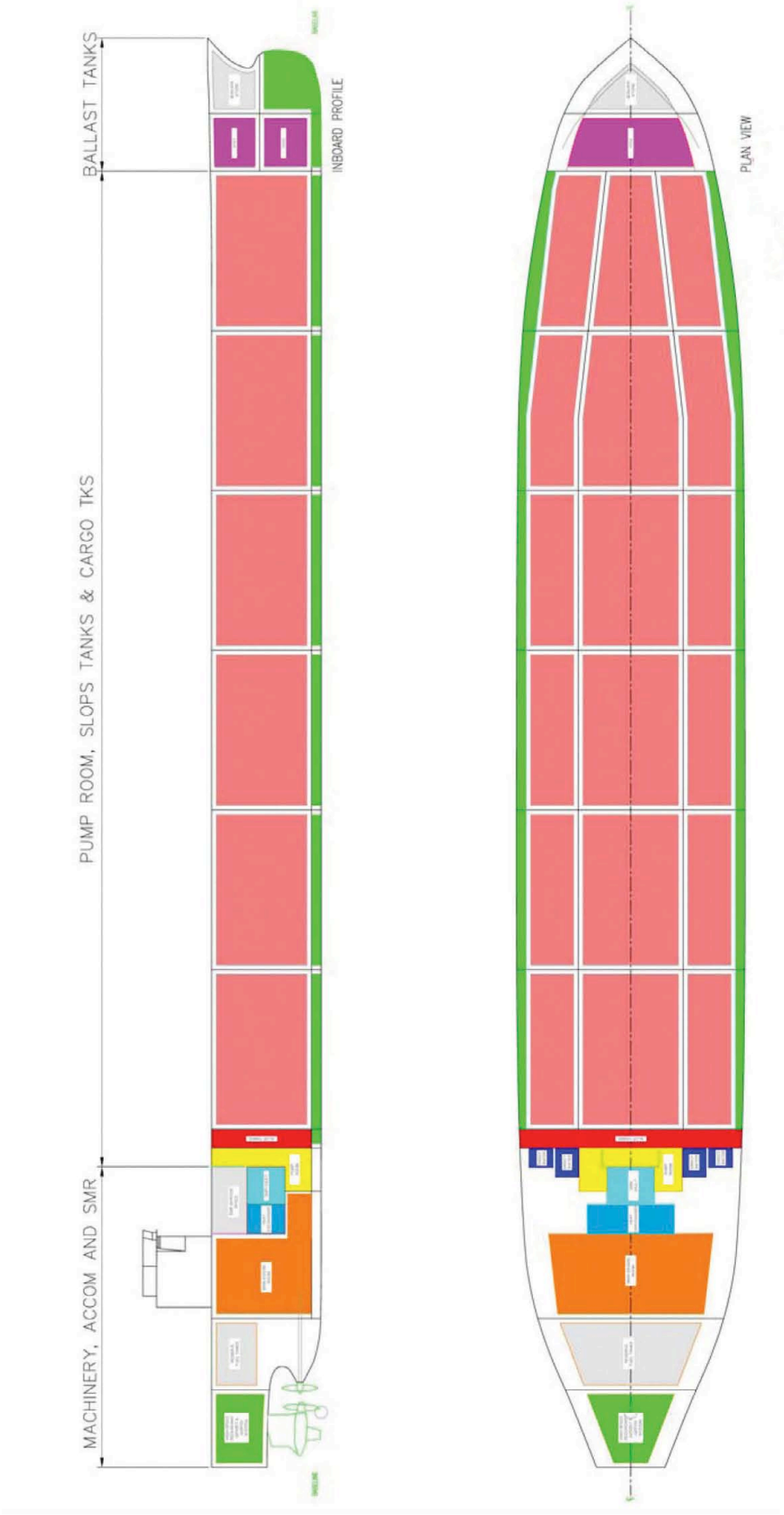
SMRs with an equivalent electrical power of less than 300MW are today a reality. Whereas application of the technology for maritime applications is yet to be engineered and proved

Figure 4: SMR concept vessel Machinery Arrangement



MACHINERY SPACE EQUIPMENT					
ITEM	DESCRIPTION	QUANTITY	MODEL	RATING (EACH)	MANUFACTURER
1	SMALL MODULAR RECTOR (ENCLOSED IN SHIELDED VAULT)	1	70 MWT SMR	70 MW THERMAL	GEN 4 ENERGY
2	PB-BI TO STEAM HEAT EXCHANGERS	1	TBC	70 MW THERMAL	TBC
3	MARINE REDUCTION GEAR AND STEAM TURBINE	1	UA-240	17 MW (PS) @ 90 RPM	KAWASAKI
4	STEAM TURBO GENERATOR	2	Tandem SST-110 (A410 GT7)	10 MWe	SIEMENS
5	EMERGENCY COOLING WATER PUMP ROOM	4	N/A	100 M³ PER TANK	N/A
6		1	N/A	N/A	N/A
7	RESERVE FUEL TANK	2	N/A	160 M³	N/A
8	AZIPOD + CONTROL SYSTEMS	1	XC2100	9 MW @ 70 RPM	ABB
9	EMERGENCY HIGH SPEED GENSET	2	12V2000M53F	1260 bkW @ 50 Hz	MTU

Figure 3: SMR concept vessel General Arrangement.



Option	SMR Location	Qualitative vulnerability realisations		
		Collision Damage	Cargo Tanks & Fire/Explosion	Motions & vibrations
A	Aft end – Under Funnel	High	Low	Medium
B	Aft of Cargo Tanks	Low	Medium	Medium
C	Amidships	Medium	High	Low
D	Forward of Cargo Tanks	High	Medium	High

Table 2: SMR location options

Item	Steam Drive		Electric Drive		Comments
	1. Twin Screw	2. Single Screw	3. Twin Screw	4. Single Screw	
Technology					Marine steam turbine reduction gears are commercially available but may need to be updated for SMR steam conditions.
Efficiency					Single screw would lead to low powering requirements. Steam drive & reverse reduction gear would allow for better underway efficiencies.
Redundancy					Arrangements can be configured to comply with safe return to port and have redundant power.
GA Impact					Twin screw installations may prove more challenging. Electric installations are likely to require greater machinery space volumes than direct steam drive installations.

Key to colour

Better / No Issue

Neutral / Some Issue

Poorer / More Issues

Table 3. SMR power train options

Table 3: SMR power train options

some SMRs approved by the International Atomic Energy Agency are used by land based industries (IAEA, 2012).

In principle, SMR technology offers simpler, standardised and a safer modular design by being factory built, cheaper and easier to manufacture. From a nuclear engineering perspective the technology marks a more radical departure from current designs including reactors cooled by lead, sodium, molten salt, supercritical water and helium. These advanced reactors use various nuclear fuel types including oxide, nitride, carbide and metal, and can be based on uranium, plutonium, and thorium.

Fast Neutron Reactor (FNR) designs such as the Gen4Energy SMR use liquid metals as coolants and allow for fast neutrons of higher energy to create fission. In particular, the Gen4Energy SMR system comprises of a primary loop using Lithium Bismouth Eutectic (LBE) as coolant and a secondary system that operates as steam Rankine cycle (see Figure 1, Table 1).

There is also an intermediate LBE loop, preventing contamination of the steam circuit or steam in the primary low pressure Pb-Bi circuit. The reactor module has been sized to be transportable (1.5m radius and 4m in height) and is shielded in a containment system that could, for example, provide protection in case of a hull girder catastrophic collapse or unforeseen external threats (e.g. terrorist attack).

The biggest difference of an SMR in comparison to a modern Light Water Reactor (LWR) is that it operates at near atmospheric pressure. So, there is no pressure to be released in a postulated accident. Also, the use of LBE implies a very high vaporisation temperature of 1,700^{0}C so it cannot flash to vapour like water. The rather simple architecture of engineering systems implies that the risks that may arise from engineering complexity could be minimal. Yet, the system's detailed engineering concepts and application of maritime assets remains to be developed and proved.

Rules and regulations

Advances in nuclear technology raise questions on the current status and evolution of land based and maritime rules and regulations. Nuclear technology and regulation has evolved since the introduction of the IMO code of safety for nuclear merchant ships (IMO, 1981). However, most of the maritime safety principles are pertinent today.

There are also a number of areas where ship safety assessment requirements have changed due to the advances in technology and detailed methods underpinning regulatory requirements. For example, the segmentation of nuclear regulations, the lack of harmonisation between maritime and nuclear regulatory frameworks, the application of Goal Based requirements by updated IMO instruments (e.g. SOLAS, 2009) raise the stakes of ship design innovation and its balance against safety and environmental efficiency.

As a first step towards bridging some of the challenges ahead, the consortium worked along the lines of Lloyd's Register's goal based Guidance Notes for the design of nuclear propelled vessels (Lloyd's Register, 2011). On the assumption that prescriptive requirements may not be thorough enough for integrating a nuclear plant into a ship these guidance notes attempt to satisfy land based nuclear regulators and give sufficient confidence to class a vessel.

Design goals are underpinned by design principles and corresponding detailed design requirements. The latter provide an illustration of either the only way or one way in which the required design performance can be achieved. The goals identified relate to engineering and safety systems, the ship structure and radiological protection.

The overall rationale of the Rule making process assumes that in contrast to the current marine industry practise where the designer/builder typically demonstrates compliance with regulatory requirements, in the future nuclear regulators will wish to ensure that it is the operator of the nuclear plant that demonstrates safety in operation, in addition to the safety through design and construction.

Risk-based ship design

The reference vessel studied was a 159,000dwt conventional hull form CSR Suezmax tanker, with a typical operational life of 25 years. This is not the only asset where the application of SMR technology may be worthwhile to explore, but this case study helped to set issues against a realistic technical background.

The concept ship design process lead to the development of a design that promises an

Item	Key issues	Considerations
1	Accessibility to high radiation areas	Practical control of 3rd party accessibility
2	Space for a 2nd SMR	SMR positioning
		SMR cooling, access, containment
		Operational requirements
		Regulations; Vessel could be considered to be carrying spent radioactive waste
		Methods for reactor removal
3	Operation of emergency cooling systems	Capacity/design of the reactor passive cooling systems accounting for cooling duration
		Consider grounding conditions where the vessel could tilt
4	Protection of the reactor from accidental loading	Design SMR cooling system to prevent meltdown in the event of ship sinking
		Define operational guidelines on grounding to maintain reactor integrity
		Define fire fighting system requirements and boundary cooling for SMR compartments in case of onboard fires/explosions
		Design for back-up power source setup and positioning to account for reactor shut down due to loss of propulsion
5	Reactor protection against terrorist attacks	Physical protection of the reactor against impact from missiles
		Considerations under Section 4 a,b,c,d apply
6	Reactor/propulsion system emergency stop	Define transient operating conditions for the reactor, steam system, turbine and heat removal

Table 4: Summary of key HAZID considerations

ALARP (As Low As Reasonably Practicable) potential of environmental damage or loss of life due to nuclear radiation or oil spills. Top level equipment failures considered: (a) minimisation of the potential of radiation leakage due to human or environmental factors; (b) elimination of small, medium or large amount of oil spills as a result of accidental failures; (c) zero fatality and injury rate for tanker operations.

On the basis of openly available data describing the risk profile of tankers and nuclear propelled vessels it was concluded that placing the SMR aft the cargo tanks, below the foreward end of the accommodation may be subject to low or medium risk levels (see Figures 2, 3 and Tables 2, 3). This part of the assessment also revealed that a well designed nuclear mechanical option would take up less space, weigh less and provide better propulsive efficiencies in comparison to electrical propulsion. It was, therefore, decided to consider in greater detail risks associated with twin and single screw nuclear mechanical propulsion train arrangements in a Hazard Identification Study (HAZID).

HAZID scenarios and recommendations considered that the SMR module may be affected by combined failures of turbines, propulsion systems and redundant power sources (see Table 4). A key driver in terms of design for propulsion has been the need for the vessel to be able to "*return to a safe haven*" in the event of a casualty due to accidental loads (e.g. collision, flooding, etc.).

In this respect the consortium decided that the propulsive redundancy must be achieved assuming the worst case MARPOL Annex I damage scenario (MARPOL, 2013). This requirement is in excess of the Lloyd's Register Propulsion and Steering Machinery Redundancy requirements with separate machinery spaces enhancement (PSMR*), which does cover separation of machinery, but considers the loss of one compartment only. The HAZID process concluded that a suitably configured single screw configuration (with redundancy) could be treated as similarly reliable to a twin screw installation. As a single screw installation would result in a better hydrodynamic hull form this formed the basis of further studies.

The concept design for a single screw mechanical power train system would

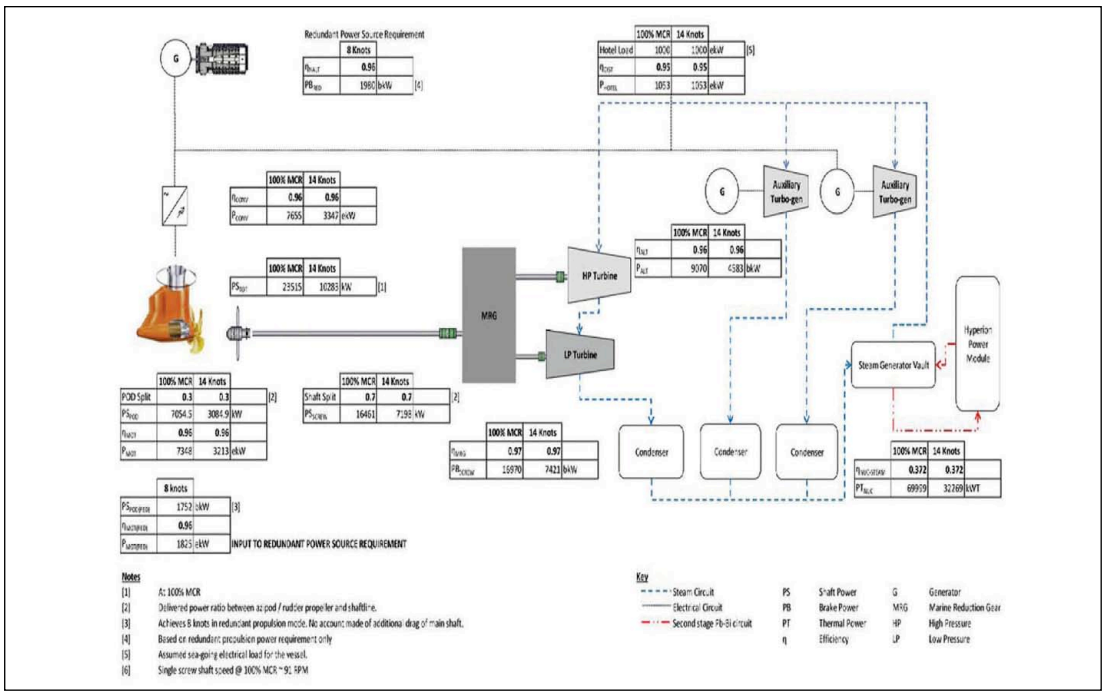


Figure 5: SMR concept vessel direct drive steam turbine and Azipod/ rudder propeller (Demonstration of efficiencies at 100% MCR and 14knots)

require maintaining propulsive capability with two flooded compartments and raising power spread across three ship subdivisions. Single screw redundancy could be achieved in one of two ways:

(a) A Contra Rotating Propeller (CRP) installation, with a main screw shaft and an Azipod providing propulsion and steerage;

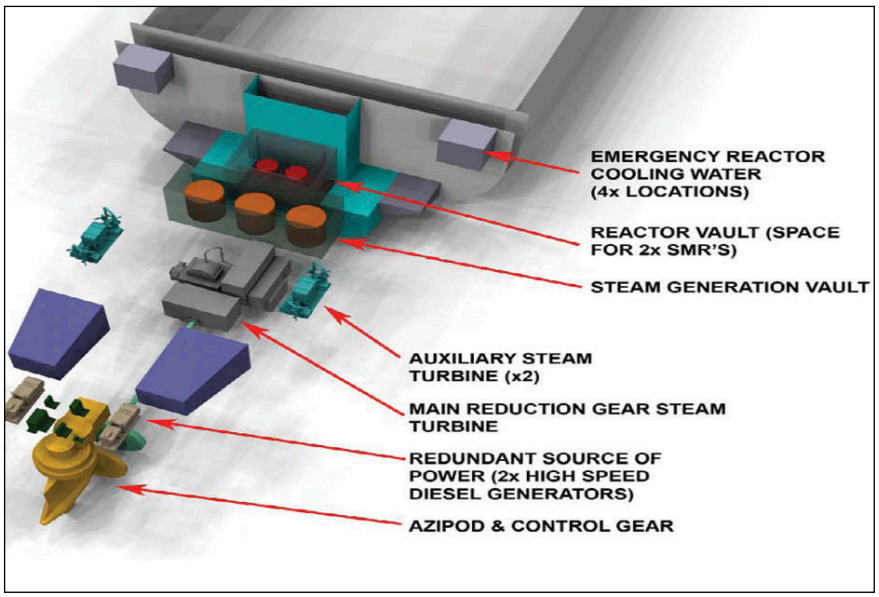
(b) A Single screw shaft installation with a shaft motor two compartments away from the main steam turbine reduction gear.

In order to separate the shaft motor from the main steam turbine reduction gear the vessel would have to grow by an uneconomical 40-50m. On the other hand a single screw propulsion solution with a CRP configuration is preferable since the propulsion could be placed safely in way of two subdivisions and away from the main power generation source without leading to any increase to the vessel draft.

This solution would require a 30m increase of the overall vessel's length once the design is adjusted to the reference ship hydrostatic trim whilst maintaining the same cargo carrying capacity. More specifically a 20m length extension aft of the cargo zone would help to accommodate for the new propulsion system and redundancy after damage (see Figure 3).

Current Azipod designs in the power range required for this ship are of electric drive configuration. Hence, the choice eventually led to a combined steam and electric system with the added advantage that the redundant source of power generation (a low cost high speed diesel engine) could easily be located remotely from the main machinery space. A fringe benefit of this configuration was the propulsive efficiency improvement associated with a CRP installation (see Figure 6).

Figure 7: Three - dimensional view of machinery arrangement for SMR Tanker



Reactor Performance Estimates (Table 1)	Reactor Life	10	EFPY	
	Reactor Power (@100%)	70000	kW_T	
	Full Life Energy Delivery	2.21×10^{16}	J	Assuming 70 MW_T for 10 full years
SMR Suezmax Tanker	Average shaft power	9746	kW (Ps)	Per year in Ballasted and Cargo condition
	Reactor loading	30738	kW_T	
	Annual availability	95	%	Or 347 days per annum
	Annual energy consumption	9.22×10^{14}	J	
	Reactor life	24	Years	

Table 5: SMR life prediction based on modified hull form and 14knots transit speed

The final hull form and power demand is estimated to be almost sufficient to match the current 25 year design life of a Suezmax Tanker (see Table 5). This raises the possibility that one SMR could be used for the entire life of the vessel and would only be removed on de-commissioning of the vessel.

Looking ahead

The risk assessment process and engineering solutions developed in this study are feasible. However, considering that the current style of regulation within the maritime industry is prescriptive and the operational framework of national nuclear administrations is highly segmented, readdressing the needs of the technology, regulators and organisations involved within the context of harmonised performance based standards will be necessary.

Design and operation of modern nuclear ships might lead to a new era of operation for assurance organisations. Classification societies would be responsible for facilitating the assurance for the successful integration of reactor modules in the ship within the context of risk based Life Cycle Assessment. They would also have to ensure that hazards from and to the ship reactor are managed.

On the other hand, land based nuclear regulators would have to be involved in classifying and assuring the reactor as well as facilitating an open dialogue with manufacturers and nuclear engineers. Considering that this approach is also consistent with the regulation adopted by most land-based nuclear industries today it may be conceivable that the marine industry could base any future regulatory approach on instruments similar to the Irradiated Nuclear Fuel code (INF, 1974). The Lloyd's Register Guidance Notes for marine nuclear propulsion could support these efforts as they introduce the concept of a design authority, which represents

the organisations involved in design, construction and operation of the ship. Harmonisation of nuclear and marine regulations and introduction of new licensing procedures for SMR technologies would be equally important.

Future technology initiatives may focus on researching or developing the knowledge required for assurance. From a maritime perspective further development of a formal systems engineering approach within the context of Life Cycle Analysis may be necessary. Modernisation of the nuclear specific maritime regulations may also require the development of a database and methodology of marine accident investigation for risk based design according to the IMO FSA guidelines. Further development of naval architecture or marine engineering concepts using holistic multi-criteria objectives applicable to alternative arrangements and operational scenarios, techno-economics, direct analysis design procedures for the assessment of extreme and accidental loads would be essential for risk mitigation and design approval.

Understanding of the effects of SMR implementation on human factors (e.g. manning and training) and ship ergonomics will also be important. A number of safeguards were identified by the team to mitigate the likelihood and/or consequences of human hazards that may affect the reactor or vessel. Broad technical and institutional challenges involve the broader deployment, testing and validation of technological innovations in components, systems and engineering (especially testing and the fabrication of fuel), fear of first-of-kind reactor designs, economy-of-scale, perceived risk factors for nuclear power plants, and regulatory and licensing issues.

Other issues to be addressed are the cost of reactor decommissioning, spent nuclear fuel and supply chain management. For example, the necessity to provide an effective emergency response capability supported by external agencies is anticipated to put additional requirements on competence development for all stakeholders. Ship specific competence development and assurance for shore and ship personnel is almost certainly required for the reliable operation of nuclear powered vessels. This may require a new model for resourcing that is significantly different to that traditionally employed in the maritime industry in order to deliver continuity of expertise.

This article attempts to shed some light to obvious issues based on output from ground breaking research published by the RINA International Journal of Maritime Engineering (Hirdaris et al., 2014). *NA*

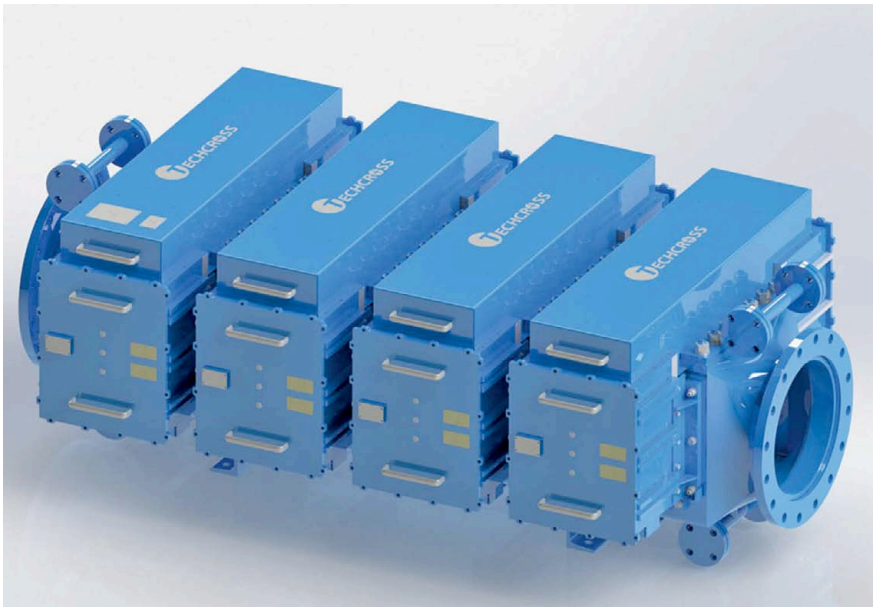
Techcross' learning curve

Korean ballast water treatment (BWT) manufacturer Techcross has reported that it is making further developments to its system after its Electro Cleen BWT suffered two accidents onboard vessels

Techcross has reported that there were two unfortunate incidents involving its Electro Cleen system (ECS) in 2013. Both incidents, one on a containership the other on a bulk carrier, resulted in the main electro chamber unit (ECU) breaking apart at the weakest welding points due to an excess pressure caused by water vapour and gases that were emitted from the continuous supply of power with the isolation valves inadvertently shut.

It is important to note that both incidents occurred during manual or emergency manual modes. Techcross notes that this may have occurred due to a lack of training and/or operator's unintentional mis-operation. In automatic mode, there are sensors, alarms and shut-down functions in place to prevent such occurrences. In manual and emergency manual mode, all these sensors, alarms and shut-down functions are overridden.

This was a design failure which Techcross has acknowledged and says it has now fully rectified with upgrades and modifications to both software and hardware. Techcross has dispatched engineers to attend to vessels all over the world to complete the upgrades. In addition, Techcross has closely cooperated with classification societies after the incidents to conduct various risk assessments.



Techcross learns from its mistakes with two incidents involving its Electro Cleen system

Further to this, Ah-Mi Mun, sales & marketing, Techcross says: "The ECS has been upgraded with multiple layers of safety for shutdown safely and to prevent the operation of ECS if necessary even in manual or emergency manual mode."

Techcross believes that this comparatively new technology will see more incidents occur as the use of BWT systems becomes more widespread.

"As the ballast water management system industry has very little operation experiences, many more accidents are possible with these new equipment onboard vessels. Ballast water management system manufacturers have to accept that their products may have the possibility of an accident, and to look to prevent unfortunate accidents with the efforts to improve upon safety and crew training including the importance of conducting risk assessments with Class," says Mun.


Techcross has dispatched engineers to complete upgrades

Techcross has accepted the incidents with their system as a good learning experience to improve upon safety. Techcross says that it hopes that by openly sharing with all about important operational experiences whether positive or negative, the entire industry will benefit from the development of not only more effective equipment, but ones that are safer and easier to operate. *NA*

TECHNICAL PARTICULARS

Techcross Electro Cleen

Techcross has made many upgrades to its Electro-Cleen system since the incidents onboard the two vessels. Those upgrades have been;

Software upgrades:

- Real time monitoring of input voltage & stop signals
- Safety check on ballasting operation
- Controller & viewer PC
- Deletion of manual mode

Hardware upgrades:

- Ballast signal check module
- Selection switch for controller or viewer function
- Shut type MCCB in PDE
- Pressure switch & gauge

Cathelco awaits approval

After five years of research and development, Cathelco are close to gaining IMO Type Approval for their ballast water treatment system which is based on a combination of filtration and UV technology

Cathelco initially started out in pipework anti-fouling and impressed current cathodic protection (ICCP) hull corrosion protection systems. Now the company is diversifying in to the ballast water treatment market, which the company says they have intentionally waited until now to do.

"We have entered the market later than some manufacturers, but we knew this would enable us to incorporate the latest technical developments and also take into account the ever more stringent IMO testing and approval standards", said Peter Smith, sales director.

Bringing the BWT system to the point where it can be sold has involved a concerted effort by technical teams based in Chesterfield and Kiel, Germany where a dedicated R&D facility was set up headed by Dr Matthias Voigt. This was followed by land based testing at the NIOZ facility in The Netherlands and shipboard testing on ro-ro vessel *Eddystone*.

During this time, the long awaited ratification of the IMO treaty has still not occurred, although this may not be far away. It now only requires the signature of one major flag state with more the 4.7% of the global fleet to reach the target of 35% of world tonnage.

Across the Atlantic, things are moving more quickly with the introduction of the US Coastguard regulation requiring vessels with ballast capacities between 1,500m^3 and 5,000m^3 to be installed with a BWT system at the time of their first drydocking after January 2014. New vessels, built after December 2013, must also comply with the regulation when arriving in the US.

Bearing this in mind, the next step for Cathelco is to submit their BWT system for approval under the US Coast Guard Alternative Management System (AMS), enabling it to be used on ships entering American ports. One of the requirements is that the system must operate at all levels of salinity in fresh, brackish and salt water.

"Our system was designed to exceed the IMO regulations in as much as we included fresh water testing within the programme at the NIOZ facility. Relatively few systems are approved for both sea water and fresh water operation and we are hoping to be amongst the first companies in the market to gain AMS approval for fresh water", Smith commented.

Cathelco says that one of its system's main features is that it can operate in all types of water

The Cathelco system has undergone onboard testing on *Eddystone*

From a design perspective, ballast water management is continuing to produce more challenges in terms of the regulations that apply.

"The legislation is still evolving on a global scale and there is no published long term commitment to the current standards. Although the main parameters are in place, the authorities are continuing to make minor amendments, one of the most recent being the way in which BWT data is logged", said Robert Field, Cathelco's technical manager in Chesterfield.

It is essential that BWT systems can automatically adjust to different qualities of sea water, compensating where necessary for high levels of sediment. Unlike some systems which simply measure the turbidity (amount of suspended sediment), the Cathelco system uses a UVT sensor to measure UV light transmittance – the amount of UV radiation actually passing through the sea water, the company says.

As Cathelco move from the design stage into production, they are aware of the challenges in terms of matching output with demand.

"Following ratification, there will be a rapid expansion of the market followed by considerable down-sizing after the peak has passed. New companies who are solely reliant on manufacturing BWT systems will find this a challenge in the long term", said Robert Field. *NA*

Hyde Marine goes for gold

The tidal wave of fitting ballast water treatment systems is expected to hit once the IMO's Ballast Water Management (BWM) Convention is ratified. Hyde Marine, Inc., in preparation of this event has launched its Hyde GUARDIAN Gold Ballast Water Treatment System (BWTS)

From the lessons learned in the retrofit market, Hyde Marine saw the need for a new, purpose designed BWTS that was optimised for retrofit installations. This insight led to the development of the Hyde GUARDIAN Gold BWTS.

The latest IMO Type Approved Hyde GUARDIAN Gold BWTS aims to offer shipowners the smallest footprint on the market and addresses shipowners' concerns over the limited space available in many retrofit vessels, the company claims. The system will still incorporate medium pressure Ultraviolet (UV) disinfection to destroy smaller organisms, but will also now remove sediment and larger organisms with screen filters dedicated to ballast water management.

Hyde Marine prepares for the rush with the launch of its latest BWTS

Commenting on the product improvements Chris Todd, Hyde Marine sales director, says: "The Hyde GUARDIAN Gold BWTS is the ideal system for retrofit installations. It is the smallest BWTS on the market, and has minimal impact on the ship's normal operations. The filters allow for very compact installation setups. On average, Hyde GUARDIAN Gold system installations consume 40% of the space of traditional Hyde GUARDIAN system installations."

In 2013, Hyde Marine made a significant investment to test every filter available in the ballast water market. In recent years, many filter manufacturers have recognised that the ballast water market is unique, and now filters are available that have been purpose designed for use in ballast water applications. Hyde Marine performed tests at many test facilities around the world in an effort to find the most rigorous way to test ballast water filter performance.

Mark Riggio, Hyde Marine product manager, explains: "The microorganisms found in salt water tend to have stiff bodies and rigid cell walls, making them relatively easy for filters to remove. Fresh water microorganisms on the other hand, tend to be soft and flexible in shape. They are very difficult for filters to remove from water, and they also tend to clump together, making the captured organisms difficult to remove from clogged filters."

Hyde Marine chose to test filters in a fresh water lake, which contained many thousands of times the organism concentration required for land based treatment system tests. In addition to measuring every engineering parameter (i.e. flow rates, pressures, energy consumption, etc.), a full biological study of zooplankton and phytoplankton was performed from sample ports before and after each filter test. The additional biological testing is necessary as the filter is only one part of the Hyde GUARDIAN Gold treatment process. It is also the only way to truly measure a ballast water filter's actual performance, the company says. As a result of the filter testing, Hyde Marine was able to add several additional filters to their Lloyds Hyde GUARDIAN Type Approval. The additional filters are part of the new Hyde GUARDIAN Gold product.

During ballasting, the Hyde GUARDIAN Gold system delivers constant flow to the ballast tanks, even while the filter is in its automatic cleaning mode. The filters have 45% less pressure drop than the traditional Hyde GUARDIAN filters, which allows existing ballast pumps to still run at their nominal points along their pump curves. Available flow rates range from 60m^3/hr to 6,000m^3/hr.

In addition to the new filters, the Hyde GUARDIAN Gold product includes multiple enhancements to the controls of the BWTS. Most noticeable is the new color touch screen operator interface. Treatment is carried out by using automatic sequence commands such as "Ballast", "Deballast", and "Internal Transfer", which can be activated with a single touch. Every critical operating parameter is visible from one "System Overview" screen. A full maintenance mode is also available, allowing the operator to temporarily take control of each individual component. The intuitive graphical interface will reduce the time required for crew training and familiarisation with the BWTS.

The BWTS also features a more capable Programmable Logic Controller (PLC), which allows for monitoring and control of more process variables. It also features upgraded data logging capabilities to meet future regulations. Additional sensors have been added to ensure safe and simple operation of the treatment system. A level detector ensures that the UV reactor is completely filled with water before it can be energised, and a moisture detector checks for leaks or condensation inside the UV reactor's cover panels.

The Hyde GUARDIAN Gold BWTS is designed so that it is easy to interface with the existing ship's automation system for remote and seamless operation. An external USB port has been added for automatic data log downloads to USB flash drives by regulatory inspectors or the ship's crew. Additionally, the entire control system is designed to make operation of the treatment system as simple, intuitive, and safe as possible for the end operator. *NA*

Teamtec cleans up

Teamtec has developed its latest solution for dealing with waste in an eco-friendly way as Ole Kristian Bulien, head of sales team – incinerators, Teamtec explains

Incineration of waste is an IMO/MARPOL accepted way of dealing with a possible source of contamination of the seas.

The test standard has specific demands for the maximum emissions of soot and CO, as well as other restraints, but these two variables are also indicators of complete combustion, if found in small amounts.

The demand for effective ways to cope with the onboard waste streams is today very visible. Several class societies have realised the significance of this, and have made the incinerator a compulsory set of equipment onboard newbuilds.

Port authorities have raised the focus on inspecting where the waste streams go, several waste fractions. The cost of landing waste is only going one way, upwards.

For three decades, Teamtec has been focusing developments in waste incineration, with particular emphasis on eliminating the oily residue onboard ships by cleaner combustion at a very high rate and temperature. The temperature is also the key; the higher the temperature, the higher the efficiency. Some use massive amounts of fuel for support burners, while Teamtec has developed a concept that use's a fraction of this, utilising the heat value of the sludge itself. The incineration of sludge is balanced at a temperature allowing combustion of up to 50% water content in the sludge. This is obtained by proper sludge preparation in a single/dual tank system, depending on the situation.

All vessels have excess heat energy generated from the engines. The massive amounts of heat generated (465 – 1,500kW) in the incinerator have historically been ventilated without being utilised. Teamtec has been developing the option of injecting, often contaminated, (bilge) water. This adds a new waste step to the incineration process, which would have to be classified as sludge or be cleaned in an oily water separator to a level below the 15ppm limit with related costs. On many vessels, this option can be quite attractive.

The principle is quite simple, but the science lies in the combustion control. Once a certain temperature is reached, the programmable logic controller (PLC) allows a controlled injection of water in the chamber. At this point, no diesel fuelled burners are operated, only the sludge burner. Thus cheap energy is generated for a positive use.

However, if water is injected at too low a temperature, the incineration rate will decline, and before long it has to be shut down. Teamtec has identified the temperature level, where sustained combustion can continue, balancing the water injection at a high level. The water will still cool the chamber, but the PLC compensates by injecting more atomised sludge.

This means the sludge capacity of the incinerator is increased; at the same time as 1 to 2m^3 of troublesome water is eliminated per day.

The footprint of the incinerator does not change when water injection is introduced, but a water service tank is added. This tank may also be preheated for higher injection capacity.

System requirements:

- Necessary amounts of sludge must be available
- The combination of sludge/water injection with solid waste burning is limited, so please inquire
- The quality of sludge to allow full throttle water injection is max 40% water content, compared to 50% without water injection
- There must be room for a water service tank in the vicinity of the incinerator
- Other than that: The incineration plant is very similar to the ones already delivered.

The incineration plant is customised in close dialogue with the client each case, for optimum performance.

When the equipment was made available to the market, it created some head-scratching, since the class societies and IMO had never thought of this possibility, but this has been resolved, and the share of incinerators with water injection is on the increase. *NA*

GEA increases capacity

GEA has developed its latest ballast water treatment system (BWTS) based on its previous Ballast Master V 500, but with a larger capacity

Concern's around treatment for vessels with larger ballast water capacities is one of the issues that shipowners have been following. The latest system from GEA, which is expected to be launched this year, will cater for this market with a higher throughput capacity.

The main difference with the latest system compared to the previous version is that it will take up less space, reduce the number of single components and also reduce production cost, claims Sven Jadzinski, Head of Sales, GEA Westfalia Separator Group GmbH .

"The design is based on the existing and type approved BallastMaster ultraV 250m^3/h. We up-scaled it and enlarged the UV chambers in particular," says Jadzinski.

"The development of the BallastMaster ultraV 500 will have a capacity of 500m^3 per hour," says Jadzinski. "The necessary tests for up-scaling the installation were successful and the documents for obtaining IMO type approval have been submitted." *NA*

Testing, testing

Alfa Laval has opened its new testing facility in Aalborg that it hopes will fast track its future product developments

Located at the site of the former Aalborg shipyard the Alfa Laval Test & Training Centre will be the largest and most advanced test facility in the marine industry, the company has claimed.

The centre is comprised of a 250m^2 testing area, built around a 2MW MAN 9 cylinder 4-stroke medium speed engine, along with commercial and prototype equipment from Alfa Laval's marine product portfolio. Connected to the test system are a dedicated control room and a training complex and seawater supply via an 800m pipeline.

"The main reason we have developed this test centre is to speed up development of products and get more accurate tests for approval," says Lars Skytte Jorgensen, vice president product centre boilers, Alfa Laval Marine & Diesel. "Also the facility allows us to test at sea conditions and to create a more smooth process of testing."

Exhaust gas cleaning technology was the initial reason for building the facility and apart from the further development of the PureSOx system the centre will also be working with NOx reduction.

Further research will also be conducted for ballast water treatment system filters. Jorgensen says that Alfa Laval is looking into many types of filters that are on the market along with the ability to test them with sea water. "We are looking at different filters before putting them into systems, which we are testing with sea water being supplied from Limfjord, which is as close to sea testing as possible," he says.

The main feature of the test centre is its access to sea water and with this Alfa Laval aims to reassure its customers of the testing efficiency brought by this additional test facility. "The added advantage of this test centre for product development is speed. We should be capable of launching more products and go through the approval process quicker," highlights Jorgensen.

Jorgensen says that the test centre has only just started operating its test and developmental research, initially the centre has been running verification tests on existing products and hopes to expand it research based on these results. *NA*

ABS passes stern test

Stern tube failures can be dangerous to crew and is costly to owners. Monitoring the stern tube can save lives and prevent vessel failures. ABS has developed the Digital Shaft Alignment Monitor to help owners and crew avoid the perils of stern tube failures, reports Mark Vassell

ABS has partnered with industry to develop the Digital Shaft Alignment Monitor (D-SAM) system which significantly enhances the operators' ability to detect and correct a prominent source of marine casualties, and helps to improve the efficiency and safety of the merchant fleet.

D-SAM, the result of several years of research and development, utilises a series of proximity sensors and custom-built software to monitor the clearance between the surfaces of the stern tube bearing and the propulsion shaft.

The system is being offered just as larger vessel sizes, increased engine power and energy efficiency demands are putting renewed stress on propulsion components, particularly the aft stern tube bearing, which is being exposed to heavier propeller loads at very low shaft revolutions.

"These new conditions require not only an improvement in the approach to alignment designs and installation, they also need a better way to verify that alignment while operations are on-going," said Todd Grove ABS's Chief Technology Officer. "Other than temperature probes, which may detect a problem too late to prevent damage to, or a failure of, the stern tube bearing, I am not aware of another system that allows owners and operators to monitor events inside the stern tube between the propulsion shaft and the stern-tube bearing."

A damaged or failed stern tube bearing incapacitates a vessel; at a minimum, it causes substantial downtime. A failure could, depending on the location and sea conditions, endanger the crew, the vessel and the local environment.

The primary source of problems for the stern tube bearing is improper interaction with the propulsion shaft. Excessive localised loading on the bearing from the shaft can lead to a critical reduction in the thickness of the film from the lubricating fluid, resulting in metal-to-metal contact, overheating and, likely, damage or failure.

ABS' D-SAM aims to help crew monitor stern tubes more closely

However, the interaction between the shaft and the stern tube bearing is a complicated matter which continually changes during operations, depending upon the initial shaft alignment, the loading conditions, draft, hull deflection, rudder angle and speed, among other factors.

This relationship becomes even more complicated with ultra large and/or twin screw vessels, and any designs that seek to optimise energy efficiency by reducing steel weight, resulting in increased flexibility of the hull structure.

Because twin screw designs are increasingly the desired option for the propulsion of large LNG vessels and container carriers, the D-SAM system was first trialled on a Triple 'E' class containership. It has been active within that ship for several months and is currently being installed in a new Atlantic-max LNG carrier.

On a twin-screw ship, the load from the propeller on the stern tube bearing is significantly higher than with single screw propulsion systems, and the problems in designing and ensuring shaft alignment are significantly more pronounced.

The problems are even more complex with shaft alignment verification.

The industry has been able to effectively evaluate the condition of the alignment on all the bearings except the aft stern tube bearing, the most critical component.

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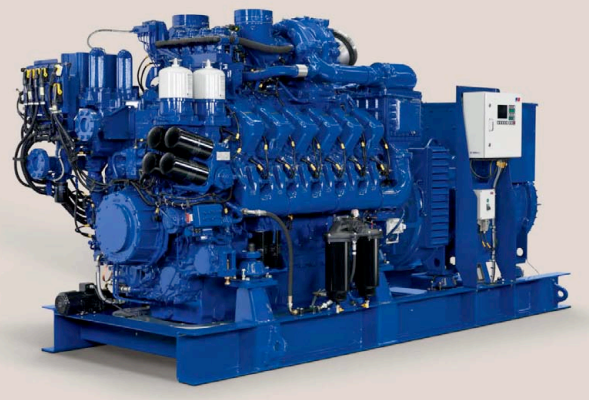


Power. Passion. Partnership.

Traditionally, the condition of the stern-tube bearing has been validated solely by monitoring its temperature with sensors imbedded below the surface of the bearing and an alarm which sounds whenever temperatures exceed established thresholds.

However, the warning is often too late to save the bearing.

To resolve the problem, D-SAM was designed to continuously monitor both temperature and the clearance between the shaft and the bearing. It has a number of proximity probes imbedded inside the stern-tube bearing, which measure the distance between the shaft and the bearing at several locations, providing direct insight into the clearance between their surfaces.

When clearance information is combined with the temperature readings, remedial action can be taken when the shaft comes into close proximity to the bearing, causing the temperature to rise. This level of monitoring, enabled by customised software, can give the operator a real-time observation of the shaft position inside the bearing.

> "A damaged or failed stern tube bearing incapacitates a vessel; at a minimum, it causes substantial downtime"

In addition to its monitoring function, the D-SAM system can be arranged to provide an alarm when a combination of reduced clearances and rapid temperature changes occur within the stern tube bearing, allowing the crew to take remedial action.

It is also possible to integrate D-SAM into the overall ship-monitoring system. This software-related option, needs to be customised to each individual ship, according to information gained during its sea trials.

Moreover, the monitoring data obtained from the Triple 'E' containership trial were applied to calibrate the supporting Fluid Structural Interaction and Computational Fluid Dynamics software developed by ABS. The software is used to investigate the shaft-bearing inter-action, in particular to assist in the validation and optimisation of future aft stern tube bearing designs.

The D-SAM system is provided to industry by ABS as a service. An optional classification notation is under development for vessels and units that incorporate the D-SAM system, as it is expected to provide an enhanced level of safety and operating efficiency for operators. *NA*

ABB's Tier III solution

Pure gas and dual fuel (DF) engines are widely discussed alternatives for marine propulsion, because they comply with IMO Tier III NOx emission limits without additional exhaust gas after-treatment. Claudio Christen and Daniel Brand, ABB Turbo Systems, Switzerland, explain how its Power2 turbocharging solution will aid ships to meet Tier III

Today's commercially available marine DF engines have a bmep in the range of 20 to 22bar. They feature a single stage turbocharging system combined with moderate Miller cycle and fixed valve timing. The compression ratio is rather low in order to prevent engine knock in the gas mode. Often the bore size is somewhat enlarged to match the output of their diesel counterparts. Commonly, DF engines are operated at constant engine speed; however, engines for fixed pitch propeller (FPP) operation have also been announced lately.

The performance of today's established marine engine designs is limited mainly by the phenomenon of knocking combustion. In the case of pure gas engines, this limitation sets the achievable efficiency and power density. Additionally, in the case of DF engines, operation in diesel mode also suffers from lower efficiency.

The power of port injected gas engines is controlled by the gas admission valve in the inlet ports, while the air excess ratio is adjusted by a corresponding control device. For established DF engines, an Exhaust Waste Gate (EWG) is used for the above purpose.

For the development of future DF and gas engines the following four points are expected to be of major importance:

1. Improvement of efficiency in both gas and diesel mode
2. Extended power density
3. Improvement of load step response or engine acceleration without decrease of steady state engine efficiency
4. Enabling direct drive propulsion by mitigating the tendency to knocking combustion

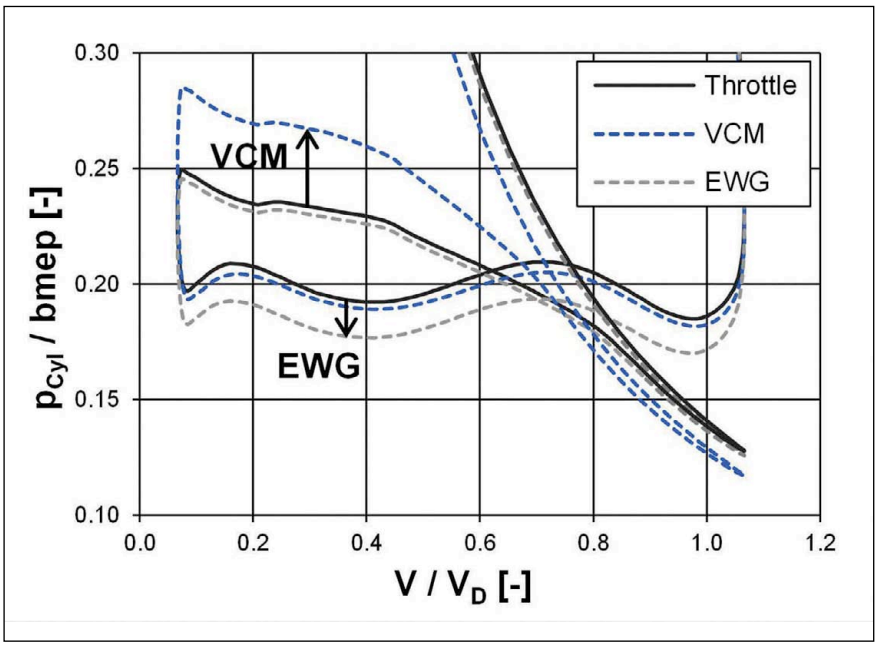


Figure 1: Gas exchange with VCM, EWG or throttle valve

Improving efficiency

Control of unwanted knocking combustion is a key factor to increase power density and efficiency of engines operating according to the Otto cycle.

By increasing the Miller effect with a corresponding early intake valve closure in-cylinder cycle temperatures can be lowered allowing for increasing of compression ratio (supporting high engine efficiency) and/or power density. This again requires higher charge air pressure which can be provided by two-stage turbocharging. The very high two-stage turbocharging efficiency strongly improves the gas exchange work.

Improving load response

Air excess ratio control based on variable valve control allows for highly improved load response even at an increased level of engine efficiency, [4], [5]. The gas exchange losses are substantially reduced and the lowered process temperature due to the increased Miller effect substantially increases the closed cycle efficiency.

Improving power density

Engine operation at reduced engine speeds and increased torque is a demanding task due to knock and control margin issues. Again, this challenge can be met by applying strong Miller timing and variable valve timing.

Simulation-based optimisation

Starting point of the simulation-based study is an engine model of a single stage turbocharged DF engine with moderate Miller cycle. The camshaft has a fixed timing for DEP operation. For FPP operation a switchable inlet valve closure timing is assumed. The engine features a standard main diesel injection system, a CR system for pilot fuel injection and a port injection system for gas admission.

Gas Mode Limits	Diesel Mode Limits
Max. knocking integral value	Max. turbine inlet temperature
Max. pilot spray ignition delay	Max. ignition delay
Air excess ratio constant	Min. air excess ratio
Max. cylinder pressure	Max. cylinder pressure

Table 1: Limiting conditions

This simulation model has been extended and modified with the following features:

- increased compression ratio e
- strong Miller effect to avoid engine knock
- variable inlet valve train for optimal inlet closure setting and engine control
- two-stage turbocharging system to deliver high boost pressure and turbocharging efficiency

For the simulation-based optimisation the proven ABB in-house simulation tool Sisy has been used. For key model assumptions refer to [1] and [2].

Optimisation calculations have been carried out at full engine load for several values of bmep considering both gas and diesel mode engine operation in order to arrive at optimum engine design parameters. For the full load optimisation a two-stage turbocharging system with constant turbocharger component efficiencies has been assumed.

The compression ratio, the IVC timing and combustion phasing of diesel and gas modes have been adjusted to achieve maximum engine efficiency. However, the feasible range of design parameters is restricted (see Table 1).

The results in Figure 2 show that the engine performance benefits considerably from an increase in the compression ratio. The plot shows the increase of thermal engine efficiency for several values of bmep as a function of the compression ratio. According to the plot an efficiency increase of more than +2% points is possible compared with today's established engine technology.

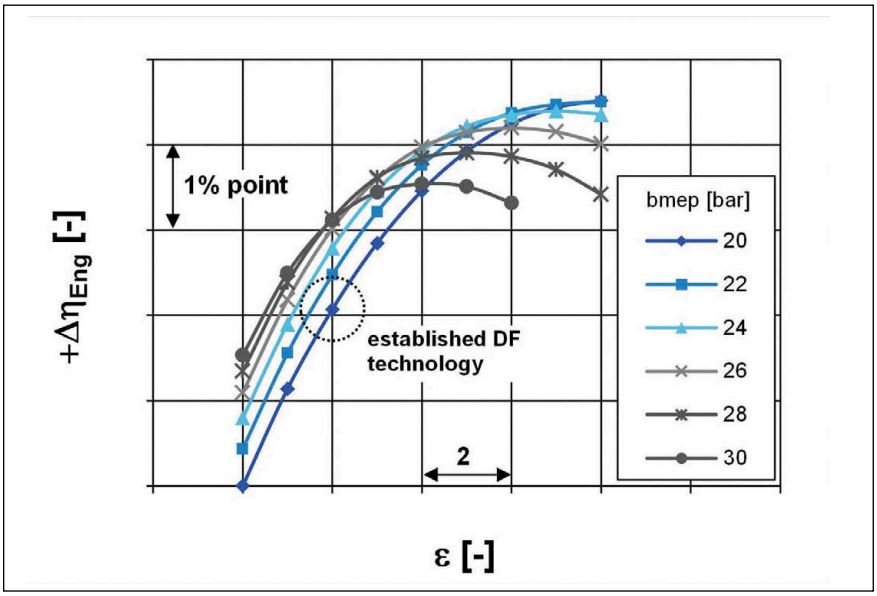


Figure 2: Average of diesel and gas mode engine efficiency gains

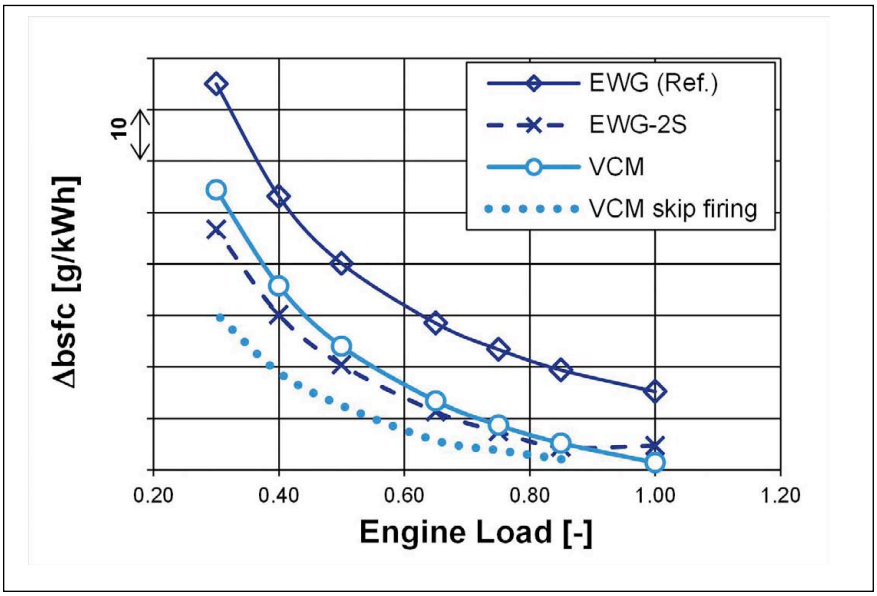
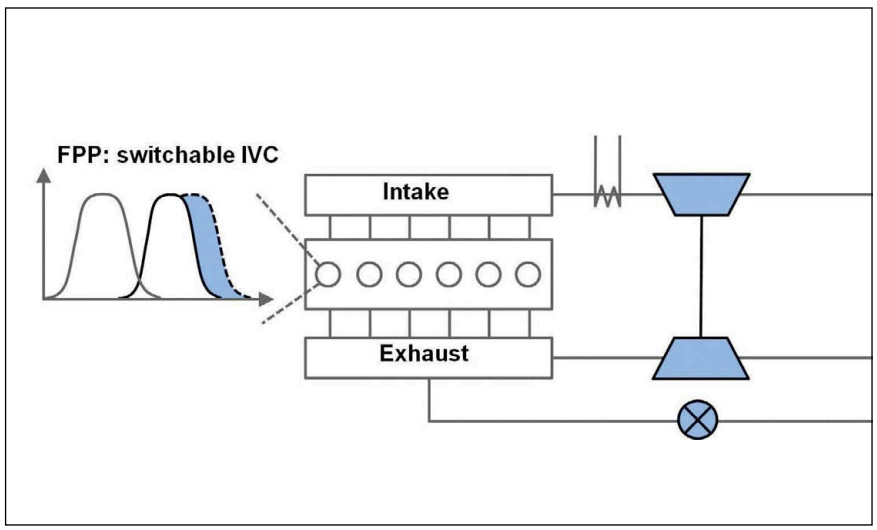


Figure 3: DEP gas mode fuel saving



Two-Stage Turbocharging with Exhaust Waste Gate Control (EWG-2s)

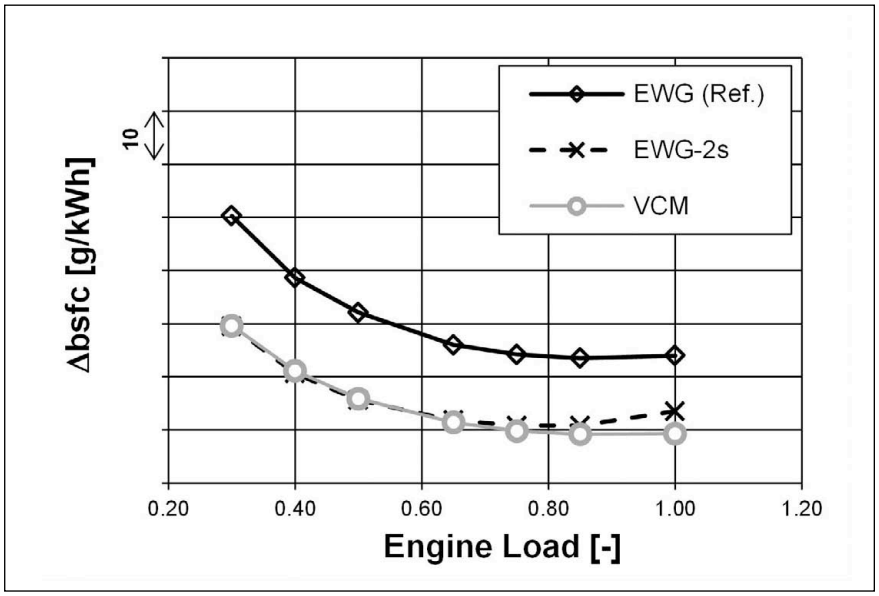


Figure 4 : DEP diesel mode fuel saving

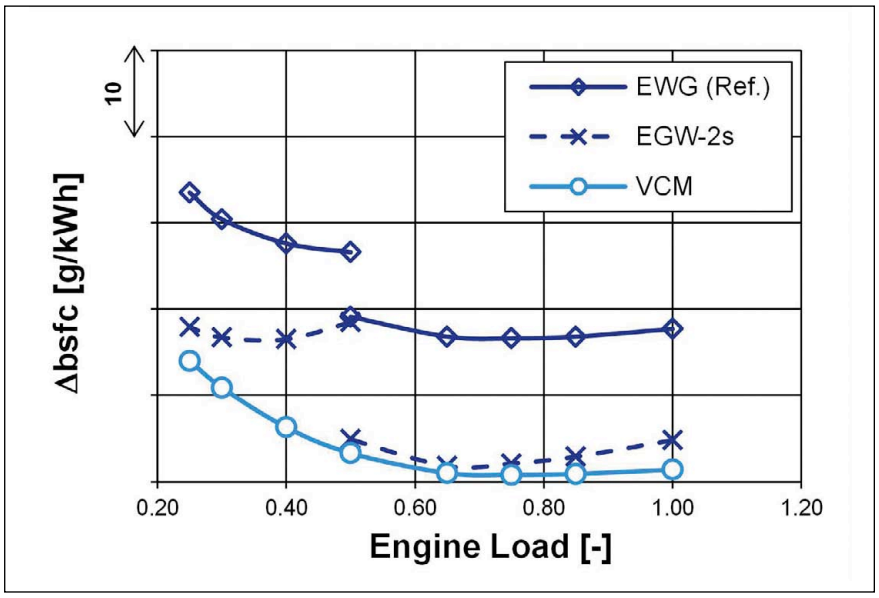


Figure 5: FPP gas mode fuel saving

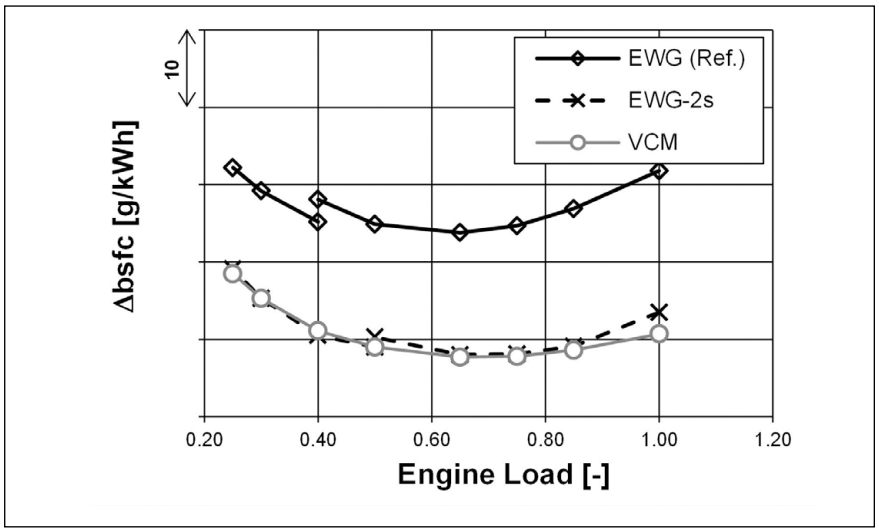
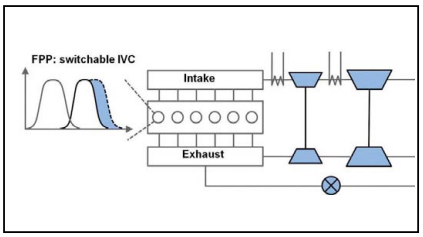
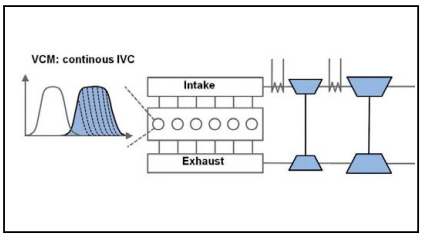


Figure 6: FPP diesel mode fuel saving



Two-Stage Turbocharging with Variable Inlet Valve Control (VCM – Valve Control Management)



The Two-stage turbocharged engine above has been fitted with a fully variable system for inlet valve closure (e.g. VCM) to replace the exhaust waste gate control.

Since both the Diesel and the Otto process are limited by the maximum cylinder pressure and knocking combustion respectively, an increase in compression ratio needs to go hand in hand with an increase in Miller effect, thus increased charge air pressure.

Case Study

Based on the optimisation results shown above, three case studies have been elaborated in more detail.

Established technology with Exhaust Waste Gate Control (EWG). This is the reference case and represents the currently commercially available state of technology.

In contrast to the reference case above (EWG), the inlet valve closure has been considerably advanced (advanced Miller timing) to allow for an increase in compression ratio and power density. As the power density in gas mode becomes similar to the one of modern diesel engines, bore size is reduced to the dimension usually used for diesel-only engines of the same platform. The 1-stage turbocharging system of the reference case has been replaced by a two-stage turbocharging system to provide enough boost pressure and efficiency.

Simulation Case:	TC system	bmep	bore	e	IV control
EWG *	single stage	Ref	Ref	Ref	EWG
EWG-2s *	two-stage	+30%	-6%	+4	EWG HP+LP
VCM **	two-stage	+30%	-6%	+4	VCM

The Two-stage turbocharged engine above has been fitted with a fully variable system for inlet valve closure (e.g. VCM) to replace the exhaust waste gate control.

Figure 4 shows the reduction of fuel consumption as a function of engine load achieved in the cases EWG-2s and VCM compared to the reference case EWG in gas mode. In the case of diesel mode refer to Figure 3.

As expected from the optimisation results, the potential gain of engine efficiency is very high. In both operating modes a reduction of fuel consumption in the range of 10 to 15g/kWh is predicted by simulation at full engine load. While in diesel mode the VCM case shows better performance towards full load, in gas mode the EWG-2s displays a more pronounced potential at engine part load, which can be explained as follows:

The required cylinder throttling towards part load by further advancing of the IVC event (VCM case) leads to a very high reduction of the in-cylinder temperature level. As a result, the ignition of the pilot diesel spray is impeded. The retarded combustion thus leads to the depicted difference in fuel consumptions between the VCM and EWG-2s cases. Among other valve control strategies, the issue of excessive Miller timing for DEP part load operation could be mitigated by the application of skip firing.

Results for FPP engine operation

Figure 5 and Figure 6 show the specific fuel saving at FPP engine operation. It is evident that the simulations predict a substantial reduction of fuel consumption in the whole engine load range; in gas mode with a special asset with VCM.

Conclusion

Based on an extensive simulation study, efficiency and power density of pure gas and DF engines can be substantially improved, closing the gap towards today's diesel engines. Increased power density would provide for reducing the enlarged bore diameter of today's gas and DF engines to the level of diesel engines of the same frame size.

Required technology building blocks:

- Highly efficient two-stage turbocharging in order to provide a suitable boost pressure
- Variable IVC timing for air/fuel ratio control and switching between fuels optimised diesel and gas operation mode
- Pilot fuel injection system capable of flexible SOI setting
- Optimised but fixed compression ratio e
- Mechanical structure for a gas engine with bmep = 26bar and cylinder firing pressure up to 220bar

Engine control with an exhaust waste gate solution shows improvements comparable to those achieved with VCM. However, solutions with VCM have several advantages:

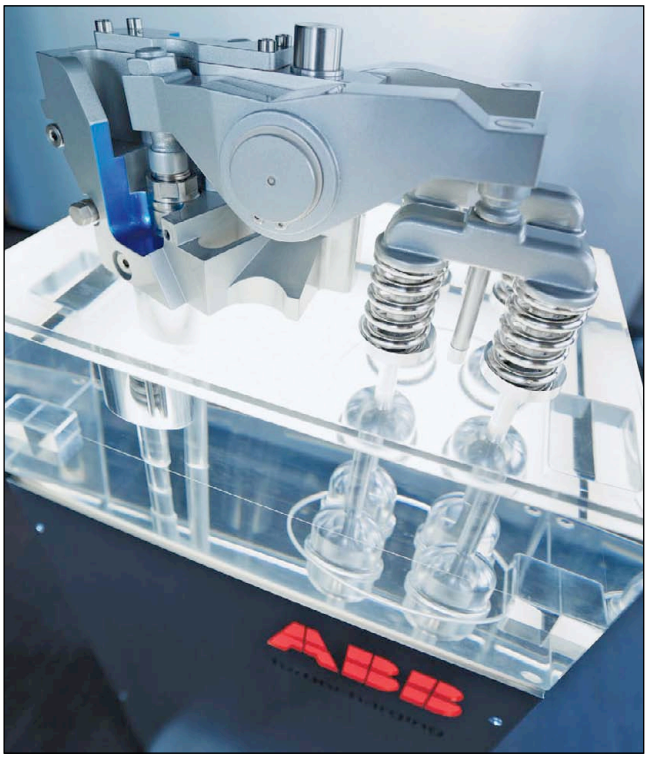
- Increased transient response
- Higher margin with regard to knock limit
- Facilitated engine start
- Fuel efficient control of air excess ratio without control device being exposed to hot exhaust gases (HFO operation).

As the proposed concepts go hand in hand with a simultaneous development of engine and combustion technology, the following points need special consideration during future R&D work:

- Homogeneous mixture cylinder charging
- UHC Emission
- Diesel Pilot Spray Ignition
- Lubrication Oil Ignition
- Combustion Chamber Design

Today, pure gas and DF engines already comply with the NOx and SOx limits in ECAs. Therefore, they represent an interesting alternative to diesel engines equipped with EGR or exhaust gas after-treatment as IMO Tier III abatement technologies.

With Power2 and VCM, ABB offers key technologies for the implementation of the concept outlined in this article. Power2 has been successfully introduced to the market and a second generation is under development in order to meet the future needs of ABB customers. *NA*



The VCM system varies valve timing and lift by interposing a high pressure oil chamber into the engine valve train.

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Streamlining ENC management

A new solution called FlatFee by Jeppesen, a Boeing Company, promises to help mariners accurately predict charting costs and to streamline the process of purchasing official electronic navigational charts (ENCs)

Most traditional systems for ordering ENCs currently in the market have proven to be problematic for some with the ordering of chart management software, which has to be selected and installed onboard the vessel and the any additional training and familiarisation for the software. The next step is to do a general route planning test to find out which charts are needed and to order them. After receiving the licenses for the selected charts follows the time consuming process of installing the ENCs before finally being able to access the ENCs and start detailed voyage planning. The worst case scenario is if some of the required charts are not ordered, the last part of the process will have to be run all over again.

The underlying complexity of ENC management and the frequent frustrations and challenges experienced by shore-side staff and mariners has inspired Jeppesen managing director John Psychas to come up with a solution in the shape of Jeppesen FlatFee. "We decided to simplify the entire ENC process, from ordering, licensing and installing to updating, administering and budgeting to create a service that would take care of this for shipowners and at a fixed price." Jeppesen's FlatFee service was launched in October with the promise to revolutionise ENC management says the company.

The service ensures that the electronic chart display and information system (ECDIS) always has updated ENC chart data onboard for both planning and navigation. This will help mariners improve safety and ENC handling, while simplifying Port State Controls and ensuring predictable charting costs by predicting the exact annual chart costs for all departments from operations and chartering to finance and administration.

Safer and simplified ENC handling

Norwegian shipping company Rederiet Stenersen was one of the first to use Jeppesen FlatFee on their vessels. Their experience so far has been positive, says Stian Haugland, marine and training superintendent and company security officer at Rederiet Stenersen. "It has been well accepted by our sailors, because now they can just sail instead of dealing with ENC management." The ability for sailors to focus on their core functions also has a tangible effect on the vessel's navigational safety.

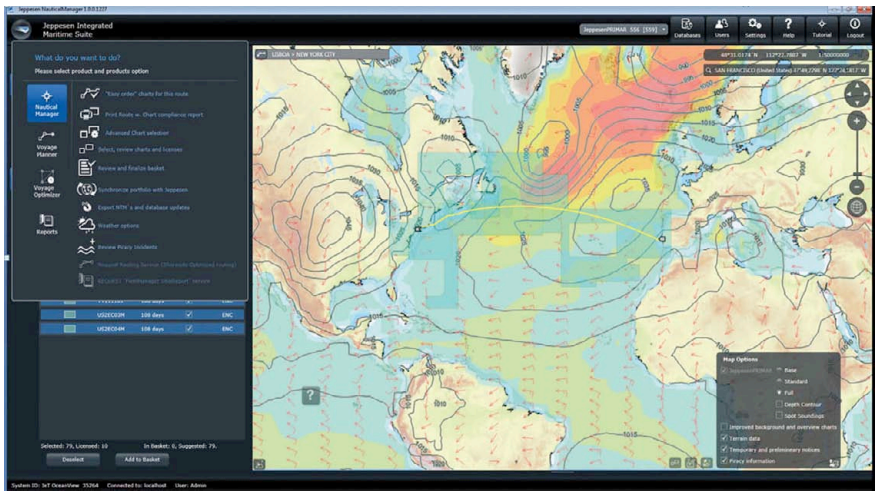
The main advantage for Haugland is the ease of use and flexibility the service offers: "With traditional direct licensing, you only have a small corridor of charts available when you are ordering charts. In case you then suddenly have to deviate from the planned route, you have to order new charts again. This is why FlatFee is currently the best available option in the market."

Transparent and predictable cost

Another advantage lies in the way FlatFee simplifies budgeting through a fixed fee on a company level, Haugland points out. According to Psychas, cost predictability has been high on his client's wish list. For most ENC solutions today, invoices arrive from all vessels as they are licensed. This makes tracking the actual chart cost and predicting an annual budget pretty complex. "While there are specialised pieces of software in the market to deal with that problem, the training and handling of said software also requires time and money." Companies calculate an average of time they currently are spending for handling ENC, add that to their chart cost and see that FlatFee not only save them concerns, but also money for the total ENC handling, says Psychas.

Underlining that ECDIS is already recognised as a step forward for improving safety at sea, Psychas says: "FlatFee is the runway for implementing ECDIS and transitioning into paperless navigation. Mariners can focus on their primary goal, safe navigation from A to B, and forget ENC logistics and budget headaches. They just install an annual license, keep the charts updated online and sail." *NA*

Jeppesen aims to bring down the cost of charting for shipowners



New Technology to Support BYOD

Giving crew better connectivity for them to use in their own time has been a key feature for developing further communication advances. Reinhold Lueppen, director solutions, Airbus Defence and Space explains further

In the Crew Communications 2012 Research Whitepaper, published by major satellite telecommunications solutions provider Airbus Defence & Space (then Astrium Services) and consultants Stark Moore Macmillan, officers and crew expressed a desire for more personal access to connectivity. Essentially, they want to use what in business on land is called Bring Your Own Device (BYOD).

The difference at sea is that users don't want to use their own devices for work, but they do want to use them on the company network, in order to communicate with friends and family, and access the internet for leisure. Providing this capability on board, whether free or paid, is an attractive crew welfare solution.

Based on this growing requirement, Airbus Defence and Space has developed a new BYOD solution that will be sold by its Service Provider partners. The goal is to make it much easier for owners and operators to enable crew to use their own devices on board if using Pharostar VSAT services, FleetBroadband or Iridium OpenPort. Included in the solution is preconfigured network equipment, technical support and remote maintenance and free hardware replacement (excl. shipment). It's sold as a value added services and is dependent on the XChange communication management platform.

XChange is designed to take the complexity out of using personal devices on board. A new version released in December 2013 introduced more BYOD functionality. Crew members now benefit from a single account with automatically remembered login for data and telephony services on their own devices. Regardless of service all data and voice costs are charged to the single account. XChange now features new voice and data apps that are designed to make phone calls and data usage from a personal device as easy as it is on land.

Sealink VSAT from Marlink is already providing sufficient bandwidth for increased crew access

For voice calling, the user simply starts the XChange Voice App and accesses contacts directly. They click on the name of the person they want to call and prior to the call they will get a recorded message telling them the cost per minute to their destination. For using the internet, email or social media data use, the user simply clicks on the XChange data app icon where they can instantly check their credit and ability to access the network, before going online. Whilst simplifying the process for crew, this approach also relieves IT staff of some of the load, as more of the process is dealt with on the user's device.

In addition to meeting seafarer requirements for using their own devices on board, XChange also features an interface designed to secure privacy for personal and operational communication at sea. In order to ensure security whilst allowing access to crew and passenger devices, XChange has enhanced network control via white/black listing of network clients for Internet access and a clear separation of crew/passenger and corporate networks, giving greater control to the captain and IT staff of who can access the network and when. This is especially important for operators who want to ensure crews can only access the vessel's network from certain areas on board or for instance, only when on duty. *NA*

Furuno gets Japanese approval

Furuno NavSkills CAT (Computer Aided Training) distant learning system has been approved by ClassNK as fulfilling the requirements for ECDIS type specific familiarisation training specified by the ISM code subsections of 6.3 and 6.5.

The Furuno NavSkills CAT brings a new level to Computer Based Training for trainees with the inclusion of an instructor on demand (IOD) feature, which will allow the trainee to get access to an instructor via voice over internet protocol (VoIP) at any time during a training session. The CAT software also uses replicas of Furuno's ECDIS control panels used in its FEA-2807/FEA-2107 and FMD-3200/FMD-3300 models alongside this feature.

ClassNK has evaluated the workstation and training software application, which are provided as part of the Computer Aided Training concept, as well as the training system support provided by Furuno and has verified that the training system meets the standards for contents and method for equipment familiarisation training.

"ClassNK started the Maritime Education & Training Registration service for ECDIS training prior to the phase-in ECDIS mandatory carriage, which commenced in 2012, and we certified the class-room training conducted by Furuno in 2011," states Koichi Fujiwara, executive vice president, ClassNK, "the certification of Maritime Simulator Systems Registration we issued for NavSkills CAT this time is our affirmation that the distant learning scheme by means of Computer Aided Training can deliver high quality training programme and support, comparable to the class room training".

In addition, ClassNK has approved Japan Maritime Science (JMS), a subsidiary of the Japanese shipping company Nippon Yusen Kabushiki Kaisha (NYK LINE), as a training facility that provides ECDIS type specific familiarisation training fulfilling the training requirements by using the NavSkills CAT system. By combining the two certifications on both the training system and training facility, ClassNK says that the training based on Furuno NavSkills CAT by the training provider will be in full compliance with the requirements for ECDIS familiarisation. *NA*

The Royal Institution of Naval Architects

Marine Heavy Transport & Lift IV

29-30 October 2014, London, UK

Call for Papers

The marine heavy transport and lift sector has enjoyed a buoyant and growing market due to the boom in offshore renewables and large project cargo work. The rapidly growing Wind Farm sector in particular has increased the number of offshore project requiring transportation, installation or removal of a wide range of structures and modules. The project cargo transport market has been growing, particularly power generation and refineries work in US, South America, Africa, India, Pakistan and China.

As the structures and cargo become bigger and heavier and destinations seemingly more difficult to access the market is looking for more and better equipped vessels. There are also increasing safety and greater environmental concerns for all aspects of marine operations. The new generation of heavy lift vessels designs are responding to the demand for higher lifting capacity and larger outreach. There are also an increasing number of new designs concepts aimed at servicing this increasing demand in the marine heavy transport and lift industry.

This conference, the Fourth in the series from RINA, aims to bring together naval architects, operators, project engineers, warranty surveyors and designers to examine the various design and operational issues associated with this industry. Papers are invited on all related topics including the following:

- Current design and operational experience
- Float over and float off; offshore discharge
- Station keeping
- Propulsion system redundant
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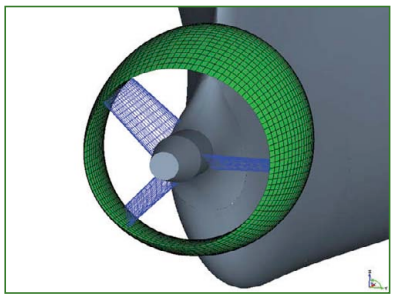
Influence of EEDI on Ship Design

24-25 September 2014, London, UK



Call for Papers

The reduction of CO_2 emissions has been a key target in the Marine Industry since the IMO's Marine Environment Protection Committee published its findings in 2009. From which a number of measures resulting in technical and operational reductions were made mandatory in 2011. Foremost amongst these measures; nearly all new builds have to conform to the limits of the Energy Efficiency Design Index (EEDI).

The EEDI will enter into force in a number of phases that increases the restriction on CO_2 emissions. The current phase has led designers and operators to retrofit existing technologies and make operational changes that make slight gains in hull and engine efficiency. However as later phases introduce tougher restrictions, more fundamental changes in ships design will be needed in order for a vessel to comply. The EEDI will become an ever more important design parameter.

To further investigate the impact of the EEDI on ship design, RINA invites papers from naval architects, class societies, regulators, operators, and researchers on all related topics, including:

- Hull efficiency
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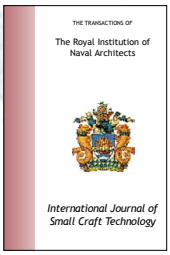

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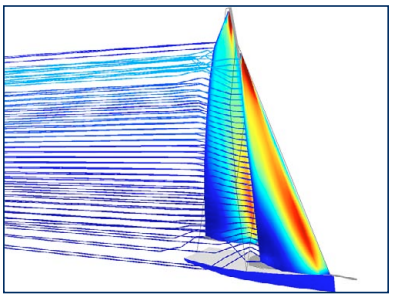

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