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## 7 Editorial comment

MEPC set for historic meeting

## 8-16 News

- 8-10 News
- 12 News analysis
- 14-16 Equipment news

## 18-24 In-depth

- 18-20 **Opinion** | COP21 has changed the climate of the environmental debate
- 22-23 **HOLISHIP diary** | HOLISHIP: from birth to berth
- 24 **Profile** | Palfinger rejection sparks TTS renewal

## 38 Diary



7 MEPC70 set to make shipping history

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## 26-34 Features

### Feature 1 Ecoships

26-29 Ship design pushes green agenda

### Feature 2 Chemical & product tankers

30-31 The art of design

### Feature 3 Japan

32-33 Imabari's new star burns bright

### Feature 4 Russia & Eastern Europe

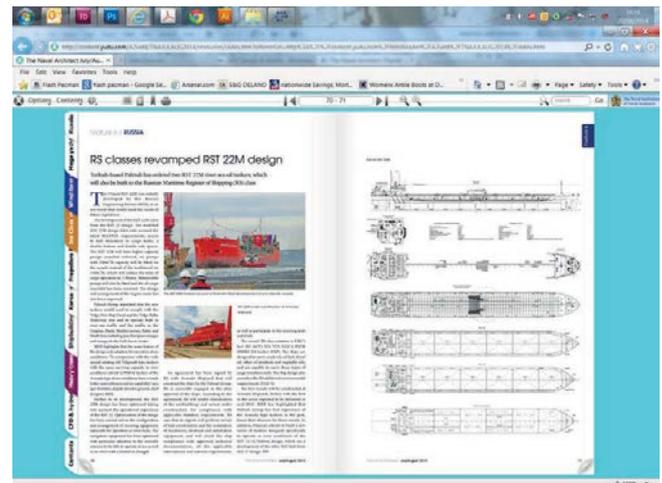
34 Return of the Russian cruiseship



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## MEPC set for historic meeting

IMO is set for one of the most important Marine Environment Protection Committee meetings in its history

The forthcoming Marine Environment Protection Committee 70 (MEPC 70) is likely to be one of the most important meetings in the history of the IMO, as it considers core rules which will govern ship operators on environmental issues.

Key to the debate will be the current cornerstone of the IMO's environmental policy – the Energy Efficiency Design Index (EEDI), particularly where the rules apply to ro-ro and ro-pax ships. There will also be discussions on whether the IMO should move to phase two of the EEDI implementation plan now that some 1,900 ships meet the rules.

Greenhouse gas (GHG) emissions will dominate the MEPC's debate, which follows other far reaching discussions on how best to curb GHG emissions from ships. As a result of these discussions the MEPC is expected to establish a working group at MEPC 70 that will determine how the industry can best tackle the issues around GHGs.

In addition, the MEPC is expected to consider whether to adopt the mandatory MARPOL Annex VI requirements for ships to record and report their fuel consumption, which were approved at the last session.

Proposals to require operators of ships of over 5,000gt to collect consumption data for each type of fuel they use, "as well as other, additional, specified data" will also be discussed.

According to the IMO: "The aggregated data will be reported to the flag state after the end of each calendar year and the flag state, having determined that the data has been reported in accordance with the requirements, will issue a Statement of Compliance to the ship. Flag states will

be required to subsequently transfer this data to an IMO Ship Fuel Consumption Database. IMO would be required to produce an annual report to the MEPC, summarising the data collected. Data would be anonymised so individual ship data would not be recognised."

In another important decision regarding the Global Sulphur cap and its implementation, MEPC69 agreed, in principle, to decide on the implementation date for the global 0.5% m/m sulphur cap for fuel oil, based on the outcome of a review. IMO said that a Steering Committee of 13 Member States, one intergovernmental organisation and six international non-governmental organisations has overseen the review. MEPC 70 is expected to decide to implement the sulphur cap from 2020, rather than delay implementation until 2025.

Staying with emissions the meeting will also consider proposals to designate the Baltic and North Sea areas as Emission Control Areas for NOx emissions. As all the coastal states have co-sponsored the proposal, it is expected to be passed and that the ECA will be enforced from 1 January 2021.

The IMO said: "Designation as a NOx ECA would require marine diesel engines to comply with the Tier III NOx emission limit when installed on ships constructed on or after 1 January 2021 and operating in the North Sea and the Baltic Sea."

Another major element of the IMO's environmental policy has been the controversial and long-awaited Ballast Water Management Convention (BWMC). The entry into force of this regulation on the 8 September next year, some 13 years after its

approval at IMO, is expected to precipitate a rush to fit ballast water treatment systems.

However, MEPC 70 must now review the guidelines for the approval of ballast water management systems, "taking into account the outcome of work carried out in a correspondence group and an intersessional working group which will meet during the week preceding MEPC 70."

Additionally, MEPC 70 must consider the agreed roadmap for the implementation of the BWMC and these "include the development of guidance on contingency measures and will also continue discussions on exemptions and exceptions to the BWM Convention, including proposals on the concept of 'same risk area'".

Ballast water management systems that use active substances will be considered for Basic and Final Approval, following consideration of the report of the 33rd meeting of the Joint Group of Experts on the Scientific Aspects of Marine Environment Protection (GESAMP) Ballast Water Working Group.

In other business, MEPC 70 will consider the approval of the unified interpretations of the draft NOx Technical Code 2008, which relates to selective catalytic reduction systems that meet the NOx standards.

Finally, MEPC 70 will consider whether to create a Particularly Sensitive Sea Area (PSSA) at the Jomard Entrance, part of the Louisiade Archipelago at the south eastern extent of Milne Bay Province, Papua New Guinea.

"The proposal includes established routing systems (four two-way routes and a precautionary area) which were adopted in 2014 and entered into force on 1 June 2015," says the IMO. *NA*

Class

## Sudden passing of KR CEO and chairman

Dr BS Park, the chairman and CEO of the Korean Register (KR) since December 2014 has died suddenly after a short illness. He was 63 years old.

A popular figure with staff Dr Park was seen as a modernising chairman whose forward thinking was transforming the class society into a forward looking organisation that proactively sought and embraced change.

“A quiet sea will not make a great captain,” he told *The Naval Architect* in June last year. Approaching the challenges of a turbulent market in the same fashion, he relished the battle, but still displayed the model behaviour and leadership required.

In the announcement of his passing, KR said: “he will be remembered both as a moderniser and as someone who cared deeply for the people he worked with.” In the less than two years of his tenure he had become a well-respected industry figure, particularly by his own staff.



The Korean Register's Dr BS Park passed away last month

“Dr Park had graduated from Korea Maritime and Ocean University in 1976 and joined Pan Ocean Shipping where he worked in a number of capacities until 2001. In that year he was appointed CEO of Welson Korea Insurance Brokers before becoming COO of Korea P&I Club in 2006,” said a KR statement. “Dr Park was 63 and leaves a wife and two grown up children.”

For more on Dr Park please see *The Naval Architect* June 2015, “A model not a critic”, page 28. And the October 2015 issue; “Beyond compliance: the world according to Park” (pages 44-46).

Newbuildings

## Danes order two ro-ros

Danish ro-pax operator DFDS has signed a contract with China's CSC Jinling Shipyard for two large ro-ro vessels.



Designer Knud E. Hansen claims that DFDS's two newbuildings will be amongst the most environmentally friendly vessels in the world

The 235m vessels will have a beam of 33m and a speed of 21kn with a capacity of 450 trailers in 6,700lane metres in the cargo hold.

The ferry company has worked with naval architects Knud E. Hansen and CSC Jinling Shipyard over a period of four months to refine and optimise the vessel concept. According to Knud E. Hansen: “The result of these efforts is a new generation of ro-ro vessels that will be among the largest in the world and will raise the bar for what is considered environmentally friendly.”

The company went on to say that the “Energy Efficiency Design Index (EEDI) is a big challenge for ro-ro vessels and there has been a strong focus on structural solutions and optimised hydrodynamic capabilities. During the contractual design, a preliminary model test has been performed in order to validate the vessel's speed/power performance.”

The future task for Knud E. Hansen is to further develop the design into a Basic Design.

Newbuildings

## Dutch yard set to move into cruise

Netherlands based Damen Shipyards has collaborated with Expedition Voyage Consultants and naval architects Knud E. Hansen to develop an expedition cruiseship capable of operating in the Polar regions.

The 115-passenger vessel will be 134.4m in length, have a 22m beam and a 5m design draught with a maximum speed of 18kn. The vessel will also have a Polar Class 6, which allows the vessel to operate in the summer and autumn in medium first-year ice that may include old ice inclusions. The vessel will be capable of 30-day autonomous cruises and will comply with the SOLAS Safe Return To Port regulations.

Damen says: “Because the capabilities of an expedition ship directly impact the quality of experience its passengers have, Damen concentrated not just on the

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Damen's Expedition Cruise Vessel will have a number of viewing platforms including a crow's nest and platforms that can be deployed over the side of the ship

onboard comforts but also the onboard logistics. This was furthered with the significant practical input from Expedition Voyage Consultants. "Passengers will be able to see that this vessel was not only designed for the expedition industry, but also by the expedition industry."

In designing this vessel the three collaborators wanted to "connect its passengers to the pristine environments in which the vessel will sail." The vessel will have a number of viewing platforms, including a 'crow's nest' that will offer panoramic views, while other platforms will extend over the side of the vessel.

"With approximately 1,100m<sup>2</sup> of public space and 2,500m<sup>2</sup> of outside deck, there will be sufficient space for 115 passengers," said the company, which is also set to develop a larger version of the vessel that will accommodate more than 200 passengers.

In addition, the company says it "selected a diesel-mechanical hybrid configuration. More specifically, this will encompass IMO Tier III compliant (EPA tier 4 equivalent) medium speed engines. A PTI-PTO [power take-in – power take-out] variable frequency drive will also be included, enabling efficient load distribution on the engines."

The vessel has also been designed to be 'battery ready', so that it can be equipped with an energy storage system that would be capable of a number of functions, including peak-shaving, provision of supplementary power for manoeuvring or silent sailing operations and auxiliary generator UPS.

"This hybrid propulsion technology is the most fuel efficient option available," says Damen product director Henk Grunstra referring to the vessel's 16kn service speed and 18kn maximum speed. "In combination with the hull design and the effective use of electricity onboard, we are expecting to reach fuel consumption and CO<sub>2</sub> reductions of at least 20%."

#### Performance monitoring

## Eniram's blue sky thinking

Performance monitoring will be a key element in the fight against the dissemination of greenhouse gas (GHG), and

Finnish company Eniram has developed its SkyLight system to help owners meet the coming demands.

Earlier this year another Finnish company, Wärtsilä, acquired Eniram and the company has now developed its system which it says will "help operators to effectively manage their business".

Eniram says that its brief was to deliver reliable performance monitoring "without expensive and complex installations onboard".

The company went on to say: "Our answer is SkyLight, an innovative, next generation fleet performance monitoring tool, which offers a vastly improved and more accurate solution compared to manual performance reporting."

SkyLight is a simple solution that combines the rudimentary technology applied to noon reports with the twenty-first century technology of a transponder that sends information via satellite, every five minutes, to Eniram's specialist data centre. The company will then use the information from the noon reports and "enrich" this with meteorological information, the sea state and currents to model the vessel's speed and fuel consumption.

"Results are sent to you [the ship operator] in an easily understandable PDF format or can be viewed on a web interface."

SkyLight allows operators to cost-effectively monitor their fleet and to compare the performance of each vessel. The software keeps records of each ship's performance, which allows prompt reporting, planning and cost optimisation.

SkyLight is a subscription-based service and the equipment, which includes a transponder, cloud software and satellite link are included in the service package that is available at very low rates, according to Eniram.

The transponder itself can be attached to a ship's rail quickly and easily by crew and the sealed unit will need no further maintenance by crew, says the company. **NA**

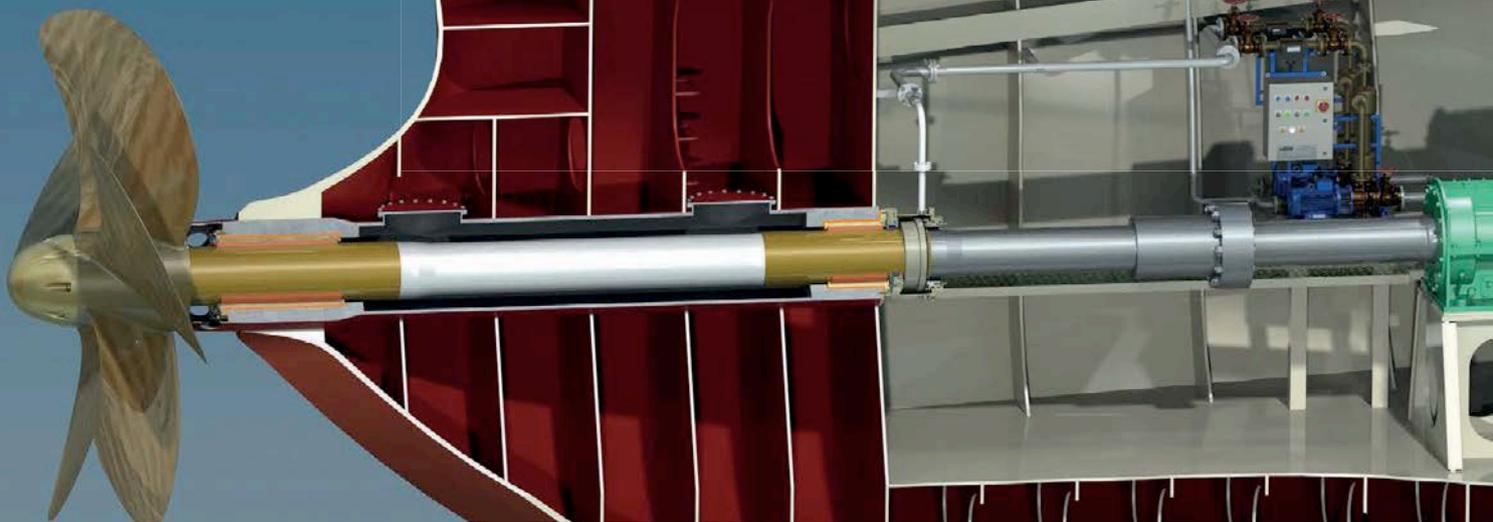
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# LSFO key to introducing sulphur cap

**T**his month's Marine Environment Protection Committee (MEPC) meeting is set to decide the implementation date for the global sulphur cap and if either the 2020 or 2025 proposed dates get the green light; somebody is going to be left dissatisfied, writes *Sandra Speares*.

If 2020 is chosen, refiners will have to ensure the necessary supplies of the right quality fuel are available, but whatever the outcome, the strategy going forward will continue to be a matter of some debate, in spite of the many years of debate already held at IMO on the issue.

The International Chamber of Shipping has said that it views the start date as being more of a political issue while in the run-up to MEPC 70, trade association BIMCO was expressing its concern over whether the necessary preparation has been made to meet the target.

BIMCO suggested the official IMO study assessing the relevant availability of fuel oil failed to address terms of reference in areas including whether fuel oil available at the implementation date was safe to use and store on ships – BIMCO suggests it would not be. Whether a perceived sulphur removal capacity shortage in refineries will be resolved in time for 2020 is also a concern as is what will actually happen on the day before the switch - December 31, 2019.

BIMCO suggests that if the MEPC decides for 2020 based on current information, "it would suggest that fuel availability at implementation is not an important concern – nor are the wider global consequences of a fuel shortage." BIMCO raised serious concerns about the conclusions of the official IMO study on this matter prior to MEPC. "We would remain extremely concerned if the implementation date was set for 2020 without addressing the issue of fuel availability and its wider implications."

The Oil Companies International Marine Forum (OCIMF) meanwhile supports the improvement in the environmental performance of tankers, but says: "The provision of LSFO (low sulphur fuel oil) is a commercial matter on which OCIMF does not have a position."

Environmental lobby groups are unlikely to come quietly if the decision goes against the 2020 implementation date and the official EU response will also be a matter for consideration. Environmentalists say 2020 implementation "would prevent 200,000 premature deaths globally", according to a study, and any delay in the implementation of the sulphur cap for ship fuel, "would be unacceptable and unjustifiable". John Maggs, senior policy advisor at Seas At Risk added: "The world has waited far too long for ships to ditch dirty fuels."

Other topics on the agenda at MEPC include the recent ratification of the ballast water convention and the development of a timeline to reduce the shipping industry's greenhouse gas emissions.

While the industry has been accused of dragging its feet on the ballast water convention implementation, a recent survey from Maritime Strategies International suggests that its ratification in September could be a "dry bulk blessing in disguise".

The argument goes that the sheer cost of installing a ballast water treatment system – estimated at US\$0.5m to US\$2m per bulker – coupled with the expense of a special survey, will push dry bulk players into scrapping tonnage with a resulting boost in the fortunes of the market overall.

As many in the shipping sector have been raising concerns about the lack of ballast water treatment systems that are known to meet US Coast Guard requirements, the results of Optimarin's application for approval are awaited with interest. DNV GL submitted all final documentation for USCG type approval of the Optimarin Ballast System in late September.

At that time, John Mauger, Commanding Officer of the Coast Guard's Marine Safety Center (MSC), said: "The receipt of the first application for a Coast Guard type-approved ballast water management system represents an important milestone for the future of protecting our nation's waterways from the spread of invasive species."

The company says Optimarin has currently received orders for around 500 of its market proven systems, which utilise a combination of filtration and powerful 35kW UV lamps to treat ballast water without the need for chemicals.

Tore Andersen, CEO of Optimarin commented: "At the time of submitting the application the MSC [Maritime Safety Center] publicly stated that its goal was to review and reply to submittals within 30 days. With that in mind we are expecting to hear from them imminently with regard to final approval."

"The importance of USCG approval cannot be overstated, both for ourselves and shipowners. For us it provides a key point of difference, illustrating that our proven technology delivers complete compliance and peace of mind, while for owners with global fleets and a need for flexibility, the ability to operate in US waters is a must. In that respect, having a compliant system is a ticket to trade." *NA*



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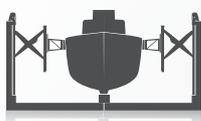
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## Smart Ships

## Cargotec joins autonomous ship ecosystem

The world's first autonomous ship ecosystem is to be created for the Baltic Sea by 2025 in an initiative involving Rolls-Royce, Ericsson, Meyer Turku, Wärtsilä, Tieto and Cargotec, amongst others.

Cargotec, a specialist in cargo and load handling solutions, aims to develop cargo operations for fully autonomous or remotely operated vessels as part of the project, building on the progress its Kalmar business area has achieved with regard to more automatic and autonomous container terminals.

Jouni Lehtinen, director, R&D, cargo stowage & securing systems, says: "Recently this has led to a situation where nearly all operations in container terminals (from unloading/loading the container from truck/train to operation of STS cranes) can be made autonomous or remotely operated...[and] autonomous maritime operations are a natural continuum in this development."

The company believes that future productivity developments will come from advancements in connectivity, digitalisation, and new business models, and is participating in the autonomous ships initiative while it increases its own focus on software, services and digital business.

Three key areas will be researched and developed for the initiative. The first will look at automating the remaining manual stages in the loading and unloading of vessels. "MacGregor's target is to introduce radical changes e.g. for container vessel cargo stowage and securing (lashing of containers), and for the loading and unloading of bulk carriers," says Lehtinen.

The second concerns cargo awareness during sailing, as with the exception of reefer containers, most cargo vessels do not have solutions for monitoring the condition of cargo during sailing, says Lehtinen. "MacGregor's goal is to provide new digital solutions to this emerging need - and not just fulfil the existing requirements but radically increase the safety of vessels." The first solutions for containers and bulk vessels are already in the piloting stage.

The final area concerns the performance and utilisation rate of the vessels, making sure that the autonomous vessels carry cargo in the most efficient way.

"MacGregor's continuous target is to maximise ship owners' earnings by getting more cargo onboard," says Lehtinen, before adding: "In the future, Cargotec's target will be to shape the industry by combining better cargo awareness and innovative vessel stowage planning software with new collaboration platforms."

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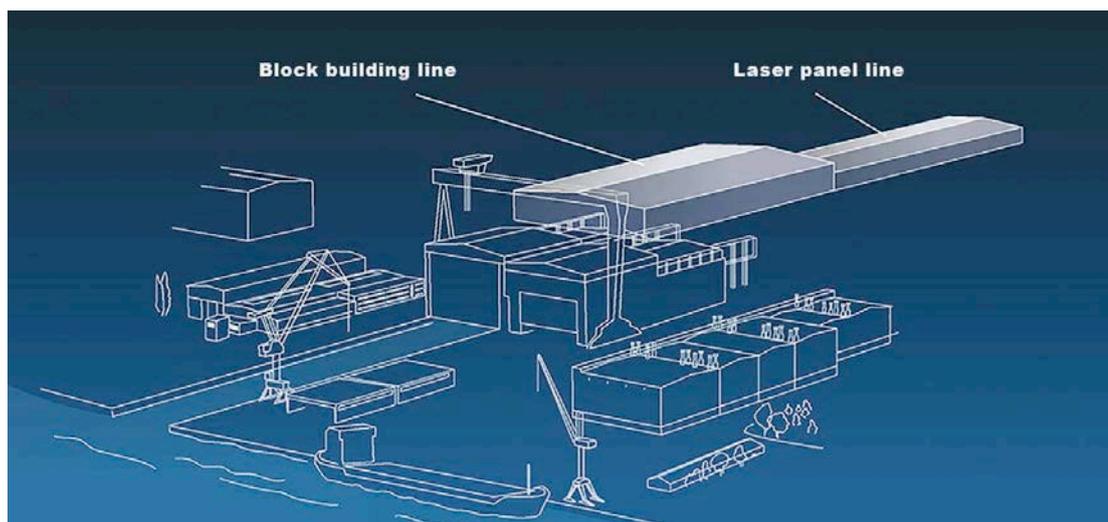
## Shipbuilding technology

## Yard upgrades for cruiseship builds

The shipyard group MV Werften will invest approximately €75 million (US\$83.7 million) in Rostock shipyard, one of the group's three shipyards, to enable it to tackle cruise shipbuilding projects with substantial amounts of thin steel plate construction.

The funding will be used to purchase a new thin-plate laser panel line from welding and automation production specialist Pemamek, which offers welding processes such as the robotised welding of T-beams to deck panels, as well as everything from material handling to milling. The fund will also be used to finance the construction of a new hall for the yard and a new block building line.

MV Werften's new infrastructure will drive its production of cruiseships



Jarmo Laakso, managing director, MV Werften, says: "With the investment in our Rostock yard and especially in this new and most efficient welding method, we will increase our steel prefabrication capacity and thus improve our productivity." The laser-hybrid welding method reduces distortion and straightening work, allowing production to run at higher speeds but with less energy and heat input, adds MV Werften.

The laser-hybrid welding station is scheduled to be installed in the new hall in September 2017 and commissioned in February 2018.

[www.mv-werften.com](http://www.mv-werften.com)

#### Classification & regulation

## Support for hybrid welding

Japan-based classification society, ClassNK, has released updates to its guidelines on laser-arc hybrid welding in an effort to support the growing popularity of the production technique with improved weld evaluation methods.

The updated guidelines include toughness evaluation methods and set out criteria to be fulfilled in the event of fracture pass deviations (FPD).

These deviations can occur during Charpy impact tests on the weld joints of laser-arc hybrid welding, according to ClassNK, when the fracture pass deviates from the hard and narrow weld metal part to the base metal. Such deviations make it difficult to accurately

evaluate a weld's toughness as there is an increase in apparent absorbed energy, says ClassNK.

[www.classnk.com](http://www.classnk.com)

#### Power & propulsion

## First LNG ro-pax for the Med

LaNaval shipyard has contracted Wärtsilä to design, supply and install the LNG power and propulsion solution for a new 232m-long ro-ro passenger ferry to be operated in the Mediterranean Sea by Spanish owner Baleària.

The vessel will enter service in 2019 and has capacity for 331 vehicles and 1,700 passengers, of which 70% can be accommodated in cabins.

Wärtsilä says: "In comparison to standard marine diesel fuel, Wärtsilä's LNG solution reduces CO<sub>2</sub> emissions by 25%, nitrogen oxide (NO<sub>x</sub>) emissions by 85%, while sulphur and particulate matter are virtually entirely eliminated."

Scope of supply includes four 8-cylinder 50DF dual fuel main engines, four 9-cylinder 20DF dual fuel auxiliary engines, as well as an LNGPac fuel storage and management system. It will also feature two twin/single out gearboxes, two controllable pitch propellers, a bridge control system, and two

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

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

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Tel: +44 (0)20 7235 4622 Ext: 331  
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[www.rina.org.uk/Historic\\_Ships\\_2016](http://www.rina.org.uk/Historic_Ships_2016)

transverse thrusters. Delivery of the equipment is scheduled for mid-2017.

[www.wartsila.com](http://www.wartsila.com)

#### Power & propulsion

## Battery breakthrough

Saft is breaking into the luxury yacht market with a lithium-ion (Li-ion) battery system for a 100m+ vessel under construction by Italian builder Benetti.

Project Zoza, the working name for the yacht under construction, will feature a propulsion system from ABB with six main engines, as well as two battery systems from Saft that provide a power plant capacity of 3MW in total.

Each battery will deliver 600v using the company's Li-ion Super-Iron Phosphate (SLFP) electrochemistry, which has received certification from Bureau Veritas and Lloyd's Register, and will be arranged in a customised mechanical structure, created by Saft, that will be integrated into the hull.

Benefits to the shipowner include silent propulsion, peak shaving and zero emission operation in harbour, and make Project Zoza one of the first yachts to feature such capability, according to Saft.

Looking forward, Annie Sennet, executive VP, Saft, says: "The high level of mechanical customisation required will position Saft for other ambitious projects in the luxury yacht market."

[www.saftbatteries.com](http://www.saftbatteries.com)

#### Power & propulsion

## Engines sourced for LNG cruiseships

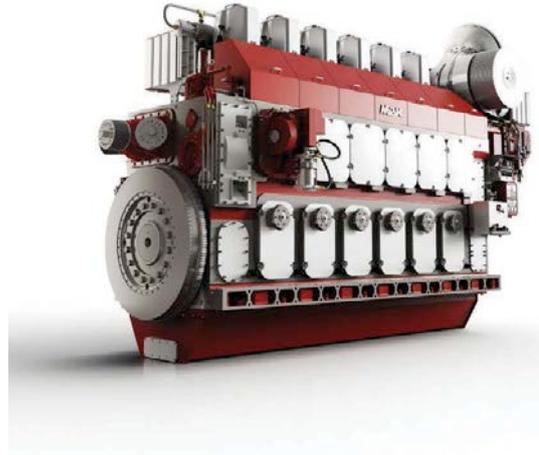
Caterpillar Marine will supply dual fuel engines for a new generation of LNG-powered cruiseships under construction at Meyer Werft, Germany, and Meyer Turku, Finland.

The order features Caterpillar's MaK 16 M 46 DF dual fuel engines and a complete LNG supply and handling system for four new cruiseships.

According to Caterpillar, the MaK 16 M 46 DF engine has been successfully operated at loads of less than 20%, which allows the LNG main engine to be used from the very beginning of a voyage and for diesel engine specific emissions to be avoided.

The company now offers a complete range of LNG propulsion solutions, from shore-side bunkering and onboard storage to the dual fuel engines mentioned above.

"From a single source, we provide the complete system for ship operators who wish to capitalise on the benefits of LNG as a marine fuel," says Ulf Hannemann, Caterpillar Marine cruise and ferry segment manager.



Caterpillar Marine's MaK 16 M 46 DF dual fuel engine

Hannemann adds: "it is in the cruise sector that we see the greatest opportunities...clean fuel for cruise vessels is essential for both operational and business strategy terms."

[www.cat.com/marine](http://www.cat.com/marine)

#### Automation systems

## Automatic crossing system rolled out

Rolls-Royce will supply automatic crossing systems for two electric ferries operated by Norwegian ferry company Fjord 1.

The systems, which Rolls-Royce describes as the first of their kind, automatically control the vessel's acceleration, deceleration, speed, and track in order to manage operations safely and in the most energy-efficient way possible.

The Captain is charged with supervising the system in this set up, and can intervene if necessary. Rolls-Royce says: "If the Captain is not, for some reason, able to take manual control, the system stops the vessel at a safe distance from the quayside and keeps it safely positioned automatically until further action can be taken."

This first project will limit automatic operation of the vessel so that the Captain must manoeuvre the ferry manually for the final few metres to the dock, but Rolls-Royce plans to add an automatic berthing capability to future iterations of the product.

The two double-ended ferries, *Anda* and *Lote*, will use the system as they travel along E39, a 1,330km-long navigation route that connects the west coast of Norway.

[www.rolls-royce.com](http://www.rolls-royce.com)



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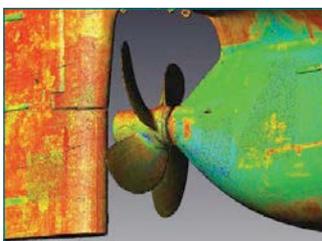
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23-24 November 2016, London, UK



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Shipping is one of the most efficient means of transportation for bulk commodities. However, as part of the global effort to reduce greenhouse gases (GHG) the industry must design and operate lower emissions-higher energy efficient ships. IMO introduced mandatory standards on the energy efficiency (EEDI) of the majority of new built vessels and further regulations are expected to be developed for ship types not already covered. The Energy Efficiency Design Index and the Ship Energy Efficiency Management Plan (SEEMP) has been adopted for existing ships in an attempt to monitor (Energy Efficiency Operational Indicators -EEOI) and improve their efficiency.



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# COP21 has changed the climate of the environmental debate

COP21 represented a major change in direction for environmental regulation. Climate change is now recognised as a real issue and actions are needed to limit the level of climate gases in the atmosphere. Former DNV GL Group executive vice president Tor Svensen reports

**T**he Financial crisis more or less coincided with the uninspiring Copenhagen Climate Conference in 2009, resulting in Governments having other things to focus on than climate change.

In shipping, the broad CO<sub>2</sub> debate also more or less vanished after 2009 for the reasons outlined above and almost all focus on air emissions since then has been about energy efficiency, NO<sub>x</sub> and SO<sub>x</sub>.

In the aftermath of COP21 and with the Paris agreement entering into force within a few weeks, I believe we can expect that CO<sub>2</sub> will come firmly back on the agenda for shipping.

## What was the real outcome of COP21?

First and foremost, COP21 became a real call for action. Nearly all participants have accepted that CO<sub>2</sub> emissions need to be reduced and it is necessary to take action in order to limit the extent of global warming. The ambition is 1.5°C.

The biggest change since the disappointing Copenhagen Conference in 2009 is that the fronts between developed and developing countries have faded. The earlier talks between the US and China and the fact that these two countries have decided to start committing to climate change actions was important.

The Paris agreement is a legal agreement, but without commitments on targets and reductions. This will come in 2020. Until that time most of the participants have made voluntary pledges.

The old principle of “Common but differentiated responsibilities” was significantly weakened during COP21 and this has removed an important political barrier for further progress in the IMO. But, “differentiation” as a principle is still retained and we shall expect to see a special mechanism to



Following the Paris COP21 meeting shipping must map out its own route to reducing greenhouse gases argues Tor Svensen, who recently retired from DNV GL

cater for developing countries. This poses some real challenges for global industries like shipping and aviation.

The Paris agreement focuses on transparent and robust reporting of emissions and this will also apply to shipping and future IMO work. MRV represents the first step in such a system of measurement and reporting.

The Paris agreement also includes an obligation for developed countries to establish a Green Climate Fund, initially of US\$100 billion. Shipping and aviation are likely to be seen as sources of funding, and this may become one driver for the establishment of market based mechanisms within these two sectors.

The Paris Agreement expects all sectors to contribute, including shipping and aviation.

As a result, it will become very important for shipping, through the IMO, to establish long term targets and trajectories and to communicate this properly.

To sum it all up, shipping got what it wanted (or at least what most of the stakeholders in shipping wanted), to keep the IMO as the regulator, but this also carries responsibilities for actually doing something over the next four years up to 2020.

## Options for Shipping

CO<sub>2</sub> is from 2016 firmly back on the agenda and IMO has the mandate (which it actually always had). The shipping Industry and stakeholders will need to take a much more proactive role on CO<sub>2</sub> reductions than has been the case for the past six or seven years.

The downside of not being proactive will be that others take over and regulations will

come from outside IMO. This means a messy patchwork of regional regulations.

The shipping industry needs to fight hard for four main principles related to future regulations on CO<sub>2</sub>:

- Flag Neutral. This means leaving “Common but differentiated Responsibilities” behind and a move forward on a flag-neutral basis. If not, we might as well close down the debate in IMO on this issue
- Global Regulations through IMO
- Focus on the ship (as an entity) and not fleet/flag/country or region. However, we must expect that the shipping industry will have to describe a trajectory and targets for the industry as a whole and monitor and report against these targets
- Technically “sound” regulations

Despite the current slowdown in the world economy, the expected longer term growth in shipping makes absolute emissions reductions very challenging. At best, we can stabilise emissions at current levels. This is supported by the IMO’s third greenhouse gas (GHG) study as well as many other studies, including those performed by DNV GL in 2010 and 2013.

Carbon offsets is therefore a likely and realistic option in order to achieve substantial reductions in CO<sub>2</sub> emissions towards 2050 and real reductions will have to take place in other sectors. The solution to push the burden of real reductions over to other sectors, irrespective of the practical and economic rationale, and even if shipping is paying for it, will require significant efforts in both communication and negotiation.

#### Can we learn from other industries?

Aviation probably has the most similarities with shipping. Both carry out transportation internationally, across borders and are subject to national as well as international regulations. Both have also in practice been exempt from climate negotiations, so far. International aviation and shipping emits about the same level of CO<sub>2</sub> per annum. Shipping emitted 796 million tonnes in 2012 and aviation emitted 724 million tonnes in 2014. This represents just over 2% of global emissions each.

The efficiency improvements seen in aviation over the last years are driven by technological developments (airframes and

engines), which again have been spurred by high fuel prices and airline requirements to ever-improving efficiencies due to profitability problems.

Aviation states that CO<sub>2</sub> reductions will be achieved through technical and operational means as well as infrastructure improvements and offsets. Two weeks ago, the ICAO Council agreed to start a voluntary piloting of a carbon reduction and offsetting mechanism that will be developed over the next 10 years.

Medium term, they would like to stabilise net aviation CO<sub>2</sub> emissions at 2020 levels through carbon neutral growth. This will involve new technology, infrastructure and offsets. Long term, aviation has set an aspirational goal to reduce net emissions to 50% of what they were in 2005 by 2050. Here, new technology, biofuels and offsets will be the main pillars to achieve this.

In short, Aviation has stated an intention that they will improve fuel efficiency through new technology and an offsetting mechanism, but has made no binding commitments. In this respect, shipping has progressed further, having mandated technical improvements through the EEDI as a first step.

#### Why do I keep referring to aviation?

Because shipping is being compared with aviation and COP21 confirmed this yet again. Shipping will not be able to continue self-regulation through IMO on these issues without delivering commitments that are similar to aviation.

At the same time, shipping needs to develop its own pathway and measures, and to communicate these bearing in mind that as an industry we will continue to be compared with aviation.

#### A possible blueprint for shipping

While observing the challenges that both aviation and shipping have in reducing emissions and at the same time serving global transportation needs and remaining competitive, there is a rationale to treat these sectors differently. There is in fact a strong argument that for certain parts of the transportation sector, hydrocarbon or carbon-based fuels represent the most efficient way of carrying your fuel with you at the same time as delivering the required

range and efficiency. If we also consider hydrocarbons as a transition towards more environmentally friendly types of biofuels, then we can justify a system of carbon offsets for a certain period of time, say 30-50 years.

A future scenario for CO<sub>2</sub> reductions in shipping will thus have to consist of three elements:

- Technical means
- Operational means
- Offsets

Shipping will need to establish a trajectory of emissions. This can be fairly concrete in the 15-20 years horizon and more “aspirational” towards 2050. The ICS proposal to start with sector intended contributions (INDCs) is a good way forward, at least for the longer term targets.

A robust and global MRV system is a prerequisite for establishing and monitoring progress against targets. A robust and global MRV system is also the best way of removing the regional MRV system being introduced by EU. Final adoption of the IMO Global MRV system at MEPC70 is therefore of paramount importance. Thereafter we can hope that common sense will prevail and the two systems can be adjusted so as to enable the formulation of one single global MRV system.

The basic principles of an offset system as well as actual carbon pricing needs to be compatible with other industries. Possible funding mechanisms for the Green Climate Fund (US\$100 billion) have to either apply to all industries/countries where offsets are used or be funded through energy consumption taxes or similar, but certainly not be targeted at one or two specific industries.

A possible blueprint for shipping may then look like this: Follow EEDI targets for new ships until 2025. This will in principle give a reduction of 30% for all new ships; introduce and make operational a global MRV system by 2018 or 2019; set a target of minimum carbon-neutral growth from 2023 based upon no purchase of offsets (i.e. achieved through technical and operational means); set an ambition to achieve a 50% reduction in CO<sub>2</sub> emissions by 2050 compared with the baseline from IMO’s third GHG study in 2013. This can first be an aspirational target or sector INDCs as proposed by ICS, but is to be translated into committed targets by 2023; the gap between carbon-neutral growth and

a long term 50% reduction in total industry sector emissions is to be covered by a global offset mechanism through IMO. The simplest solution to start with here is an offset system based upon a levy as proposed by ICS and this can be changed later if the targets set out in the long-term trajectory are not met.

**Obstacles and challenges**

Getting traction in the IMO on a defining trajectory for shipping and the various means and mechanisms that should be deployed to follow this trajectory is one challenge. COP21 has significantly weakened one of the obstacles to real progress at the IMO, “Common but Differentiated Responsibilities”. Removal of this obstacle has been one of the pre-requisites for the IMO to move forward.

The EU MRV system will be rolled out and the IMO need to move quickly to establish a global system that is equivalent. The best way of removing regional regulations is to get in place a robust international regime. Nevertheless, we may expect a period of dual reporting systems (EU and IMO) before the EU decides to sunset its regulation.

An absolute reduction in CO<sub>2</sub> emissions in the shipping sector without an offset mechanism is going to be very difficult to achieve in the medium term. The introduction of a market based mechanism may leave the door open for a political decision to use shipping and aviation as major contributors to the planned Green Climate Fund. This represents a real threat to shipping as an industry.

The simplest of offset mechanisms is a levy system. A levy system will allow some of the funding raised to be retained within the industry for further technology development. However, a levy carries the challenge of proving that real offsetting is taking place. It is therefore likely that a significant portion of the revenue from a levy will have to be spent on carbon reduction initiatives in other sectors.

Communication to external stakeholders as a united industry has to date been a big challenge. The shipping industry needs to learn from others (like aviation) and communicate better both its achievements and intentions on emissions.

**In conclusion**

COP21 has put CO<sub>2</sub> emission reductions firmly back on the agenda for shipping and IMO needs to move quickly to establish a global MRV system. However, it is important to remember that a Global MRV system is only the starting point. Shipping will, through the IMO, have to establish long term targets and trajectories for meeting climate change targets and commit to these.

Carbon-neutral growth looks possible if all technical and operational means are deployed. Absolute CO<sub>2</sub> emissions reduction will be difficult to achieve, and a long term 50% reduction in absolute terms looks unlikely, even with a lot of new technology. Therefore an offsetting system will be required and we should plan for this as part of the long term solution.

Let us therefore hope that the IMO can run with this ball and score a successful outcome at MEPC70. Taking the initiative and delivering a long term plan in accordance with the spirit of the Paris Agreement is the only way for shipping to remain in charge of its own destiny. **NA**

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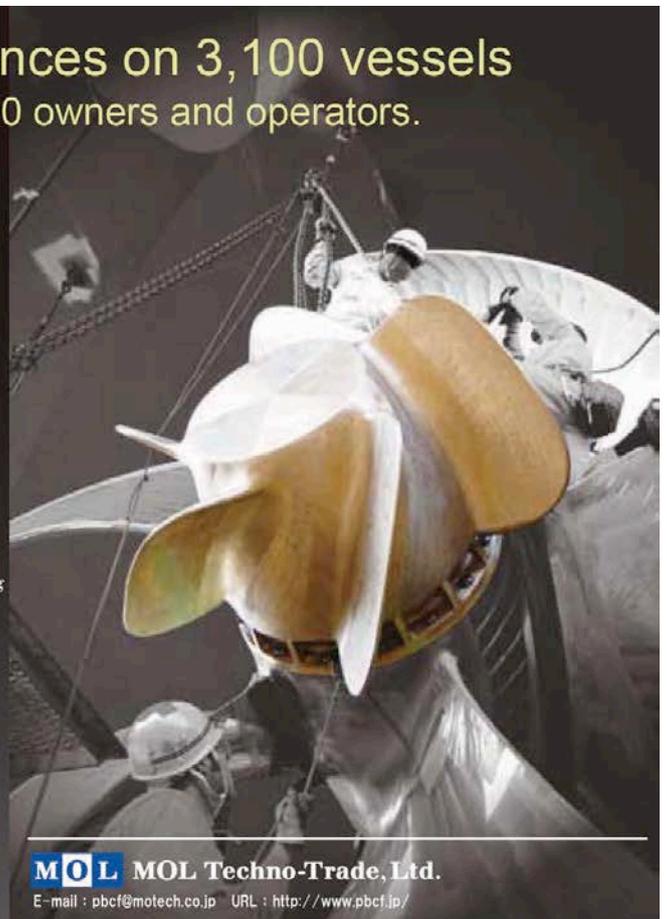
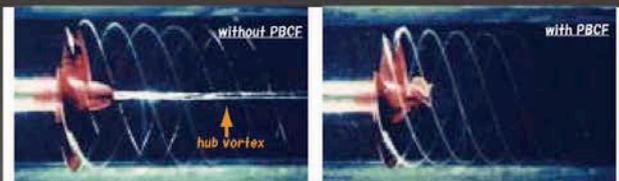
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## RINA-QinetiQ Maritime Innovation Award

Innovation is key to success in all sectors of the maritime industry and such innovation will stem from the development of research carried out by engineers and scientists in universities and industry, pushing forward the boundaries of design, construction and operation of marine vessels and structures

**The Maritime Innovation Award** seeks to encourage such innovation by recognising outstanding scientific or technological research in the areas of hydrodynamics, propulsion, structures and material which has the potential to make a significant improvement in the design, construction and operation of marine vessels and structures

The Award is made annually to either an individual or an organisation, in any country. Nominations for the Award may be made by any member of the global maritime community, and are judged by a panel of members of the Institution and QinetiQ. The award will be announced at the Institution's Annual Dinner.

Nominations are now invited for the 2016 Maritime Innovation Award. Individuals may not nominate themselves, although employees may nominate their company or organisation.



**QinetiQ**

**Nominations** may be up to 750 words and should describe the research and its potential contribution to improving the design, construction and operation of maritime vessels and structures.

**Nominations** may be forwarded online at [www.rina.org.uk/maritimeinnovationaward](http://www.rina.org.uk/maritimeinnovationaward)

or by email to: [maritimeinnovationaward@rina.org.uk](mailto:maritimeinnovationaward@rina.org.uk)

**Nominations** should arrive at RINA Headquarters by 31st December 2016.

Queries about the award should be forwarded to the Chief Executive at [hq@rina.org.uk](mailto:hq@rina.org.uk)

# HOLISHIP: from birth to berth



HOLISHIP's 'kick-off' meeting in Athens last month included 75 representatives from 40 industry and academic companies and institutions

**C**lose to 75 representatives of 40 European maritime industry and research institutes<sup>1</sup> gathered on September 29 and 30, 2016 in Athens for the kick-off meeting of project HOLISHIP (HOListic optimisation of SHIP design and operation for life cycle). Funded with an €11.3 million (US\$12.45 million) grant by the Horizon 2020 Transport Research Programme of the European Union, HOLISHIP will develop the next generation of ship design systems for the needs of the European maritime industry by adopting a holistic, life-cycle approach to ship design and operation capable of meeting tomorrow's challenges.

In the coming years this new column will regularly report on the project's achievements and allow readers to follow HOLISHIP's evolution and dissemination of results.

The design of ships and of maritime assets is in general a complex endeavour requiring the successful coordination of many disciplines, of both a technical and non-technical nature, and of individual experts to arrive at valuable design solutions; this includes the complex and multi-disciplinary nature of a ship's operation.

A systemic approach to ship design and operation considers the ship as a complex system integrating a variety of subsystems and their components, e.g. subsystems for energy/power generation and ship propulsion, for cargo storage and handling, accommodation of crew/passengers and ship navigation.

Inherently coupled with ship design and operation and related decision making is optimisation, namely the selection of the best solution out of many feasible ones on the basis of a criterion, or rather a set of criteria.

Ship design should inherently address the whole ship's life cycle; accordingly, it is traditionally split into various stages consisting of the concept/preliminary design, the contractual and detailed design, the ship construction/

*“The whole is more than the sum of the parts” (Aristotle Metaphysics)*

fabrication process, the ship operation over its economic life and finally ship's scrapping/recycling.

In practice today and depending on the degree of integration of modern ICT into the ship design process (which greatly varies between yards and design offices), only parts of the above ship's life cycle are integrated on a common data and software platform. Thus, decision making is based, to a great extent (if at all), on the synthesis of best solutions of individual part problems. It is evident, however, that the optimal ship will be the outcome of a holistic optimisation of the entire, above defined ship system, its subsystems and components over

its whole life cycle, where “the whole is more than the sum of the parts” (Aristotle Metaphysics).

We note, of course, that even the simplest subsystem/component of the above defined optimisation problem is complex enough to be often modelled in a simplified (reduced) way in practice. Inherent to the optimisation of ship design and operation are also the conflicting requirements resulting from design and operational constraints and optimisation criteria (merit or objective functions), reflecting conflicting interests of various stake holders in the maritime transport chain, the stability/instability of market conditions and the associated transport demand and supply, the variability of the operational conditions over ship's life cycle, the cost of raw materials (shipbuilding steel) and energy, the type and cost of fuels, and the change of regulatory requirements with respect to ship's safety and the ecology of the marine environment.

The HOLISHIP approach brings together all relevant main disciplines of maritime product design and operation under the umbrella of advanced parametric modelling tools and integrated software platforms. This enables parametric, multi-objective optimisation of the product ship or of marine assets in general.

Market analysis and operational data, hull form and structural design, adaptation of prime movers, propulsors and main outfitting, economic, efficiency and environmental considerations form

the mission requirements and enable the formulation of a rational foresight analysis for the viability of the product model over its life cycle. For achieving its goals, HOLISHIP is integrating techno-economical databases, calculation and optimisation algorithms, modern GUI and information exchange systems, allowing the exploration of the design space to a much larger extent than in today's practice.

This leads to new insights and promising new design alternatives. Even more, depending on the degree of fidelity of the employed/integrated geometry models and the software tools, it inherently offers the option of generating virtual prototypes/digital mock-ups of the product.

Within HOLISHIP, virtual prototyping is understood as digital mock-ups of varying complexity, namely for concept development, design

exploration and optimisation, design prototyping and optimisation at the stage of contract design, modelling and optimisation of ship operation, including refined modelling of main systems and components, dynamic modelling and assessment of the ship-prime mover/propulsor-environment interaction ('Virtual Vessel Demonstrator' VVD).

Two well established design software platforms will be used in HOLISHIP for the integration of software tools, the processing of work flow and the generation of the Digital Mock-Ups (DMA), namely CAESSES, which is being supported by Friendship

Systems and CPACS supported by DLR (Deutsches Zentrum für Luft und Raumfahrt). Both software platforms will be presented in a forthcoming issue of *The Naval Architect*. **NA**

<sup>1</sup> HSVA (coordinator), ALS Marine, AVEVA, BALANCE, Bureau Veritas, Cetena, CMT, CNR, Damen, Danaos, DCNS, DLR, DNVGL, Elomatic, Epsilon, FhG-AGP, Fincantieri, Friendship Systems, HSB, IRT SystemX, ISL, Lloyds Register, MARIN, Marintek, Meyer Werft, Navantia, NTUA-SDL, RR-AS, RR-PE, Sirehna, SMILE FEM, Starbulk, TNO, TRITEC, Uljanik, Univ. Genoa, Univ. Liege, Univ. Strathclyde, van der Velde, IRT-Systemx



HOLISHIP is being funded by the European Commission within the HORIZON 2020 Transport Programme.

## RINA - Lloyd's Register Maritime Safety Award

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

The Maritime Safety Award is presented annually to an individual, company or organisation that in the opinion of the Institution and Lloyd's Register, is judged to have made an outstanding contribution to the improvement of maritime safety or the protection of the maritime environment. Such contribution may have been made by a specific activity or over a period of time. Individuals may not nominate themselves. Nominations are now invited for the 2016 Maritime Safety Award.

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

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



The closing date for nominations is **31st December 2016**.

The Award will be announced at the Institution's 2017 Annual Dinner.

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

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Queries about the Award should be forwarded to the Chief Executive at: [hq@rina.org.uk](mailto:hq@rina.org.uk)

# Palfinger rejection sparks TTS renewal

Failure of the takeover bid by Palfinger of TTS Group in Norway has meant the company must now move on. In an exclusive interview with *The Naval Architect* new TTS Group CEO Toril Eidesvik describes the company's latest moves in a challenging market

Senior managers at TTS Group were “surprised” by the failure of the takeover bid by Palfinger earlier this year after the company had completed “almost the entire process” before pulling out of the US\$72 million deal.

The TTS board has now decided that it is full-speed ahead to develop the company and that there will be no further sales processes, according to CEO Toril Eidesvik who took over the company in April this year.

The collapse of the deal that would have seen the Norwegian ship equipment business, TTS Group, become part of the expanding Austrian empire of Palfinger, initiated a process to put pressure on integrating businesses the group had bought over the years.

With 24 subsidiaries, the result of acquisition such as Germany's well known crane designer and builder Neuenfelder Maschinenfabrik (NMF) and ownership in Chinese companies like TTS Hua Hai Ships Equipment, the Norwegian company now presides over a disparate group of companies that renders the running of the organisation somewhat inefficient.

Since replacing Björn Andersson, the 70-year old out-going CEO, Toril Eidesvik has made it her goal to streamline the whole TTS Group operation. “The history of TTS is growth through acquisition and that means there is still much integration work that needs to be done,” says Eidesvik. “We need to make sure we do things right at once and at every step rather than doing things several times.”

There is a belief at TTS that much of the cost-cutting, and job cutting, has already been achieved and so the company can now maintain the capacity that is there already. However, “We need to look at the whole structure and build an organisation that is more flexible in the future by streamlining divisions so that they're less vulnerable to fluctuations in the market,” explained Eidesvik.



TTS Group CEO Toril Eidesvik believes teamwork and planning will push the company forward following the failed takeover bid by Palfinger

Seen as an on-going process the restructuring of TTS will force the group to focus on measures that will ensure the plan is implemented. In the long term the aim is to continue developing a ship-type focus and a variety of products and to switch to “life cycle thinking”.

“Our strategy is to streamline and expand our product portfolio by looking at what products are related to the things we produce today. We will work with owners to develop these products that we identified collaboratively.”

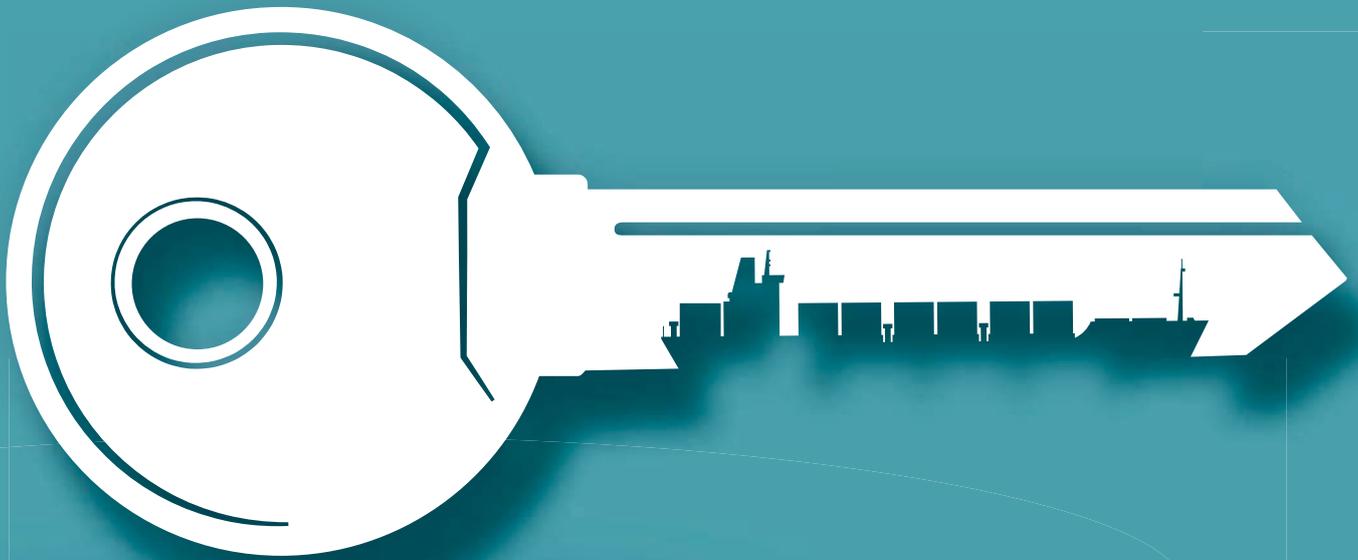
In general, one of the positive sides of a downturn is that it releases creativity which can offer new products or new solutions for the market. “Repricing in shipping means that all people and companies must optimise their operations; this is also a benefit of the downturn,” explains Eidesvik.

In all, Eidesvik insists the company is in a strong position with “very good development” within the joint venture companies and an increased market share in hatch covers. But she emphasises the need for the company to re-focus, re-group and restructure.

According to Eidesvik TTS has state of the art products, good relations with its clients, excellent technicians and a significant footprint and with this base the company is in a strong position to push on, but she says, “we must focus on the results and benefits from all the good work that we put in”.

“My message to employees is to focus on the future and work together – that's a cliché, but it's true – we need to cooperate to make us stronger, we must achieve this and to achieve it we must live it.” **NA**

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# Ship design pushes green agenda

Japan-based NGO Peace Boat is working to design and build a cruiseship that demonstrates a cleaner future for the cruise industry, and may, in turn, persuade the wider maritime industry to take up emissions targets in a meaningful way

The ratification of the Paris climate change agreement (COP21) by China and the US on 3 September will aid efforts to reach the agreement's target of a global temperature rise of less than 2°C, but other stakeholders, such as the shipping industry, must find a way to do more than their current share of sustainable work.

The aeronautical industry recently signed a landmark agreement on "a new global market-based measure (GMBM) to offset CO<sub>2</sub> emissions from international flights and a comprehensive roadmap for the sustainable future of international aviation" at the 39th Assembly of the International Civil Aviation Organization (ICAO) on 6 October. However, there is as yet no agreement between IMO member states on CO<sub>2</sub> reduction targets despite new calls from the world's national shipowner associations for the development of a GHG reduction timeline for shipping.

Instead, it is falling to initiatives such as Peace Boat's Ecoship project, to push the green agenda forward and demonstrate what eco-centric designs can achieve if realised.

The Ecoship project was first discussed in 2014 as a response to the global cruise boom – particularly that seen in the Asian cruise market – involving the design and construction of an environmentally-friendly



*Ecoship* raises the bar for the sustainable design and operation of cruise vessels, and sends a message to the wider industry: the green epoch must come

cruiseship that far outstrips the green credentials of the current best-in-class.

Its founding purpose was and is to challenge the cruise industry's model in the wake of this rapid expansion of demand, demonstrating a 'clean' model by which the industry can move forward more sustainably. This new model utilises a host of green technologies to significantly reduce emissions and waste beyond current capabilities in a design that synthesises the technologies and moves the matter of sustainability to the heart of the way a cruiseship is designed and operated. 30 engineers, scientists and thinkers from fields such as shipbuilding to renewable energy, biophilia and waste management, developed the design of *Ecoship*.

Director of the Ecoship Project, Andrés Molina, stresses that "it is not a simple matter of advanced technology but, specially, a different and real environmentally friendly approach that is, in turn, an important part of the commercial presentation of the owner."

The project is now at the stage of taking bids for construction of the vessel and is having design consultation carried out by DNV GL, a partner that recently signed a Memorandum of Understanding with Peace Boat at SMM in September, following original design work from Spanish firm Oliver Design. The contract for the build of the vessel is due to enter into force in 2017, with delivery scheduled for 2020.

## Project goals

The main environmental goals include a 40% reduction of CO<sub>2</sub> compared with Peace Boat's current ship, *Ocean Dream*; zero SO<sub>x</sub> and NO<sub>x</sub> emissions; a 20% reduction in fuel consumption for propulsion (compared with cruiseships of a similar size); a 50% reduction in fuel consumption for the hotel (compared with cruiseships of a similar size); and use of LNG as a main fuel source for propulsion, while also using biodiesel, solar, and wind as much as possible to further reduce emissions.

### TECHNICAL PARTICULARS

#### *Ecoship*

Length, oa.....	224m
Breadth.....	31m
Scantling draught.....	8m
Gross tonnage.....	55,000gt
Speed (cruising).....	17knots
Speed (maximum).....	21knots
Passenger capacity.....	2,000 (1,500+500)
Number of Guest Cabins.....	776

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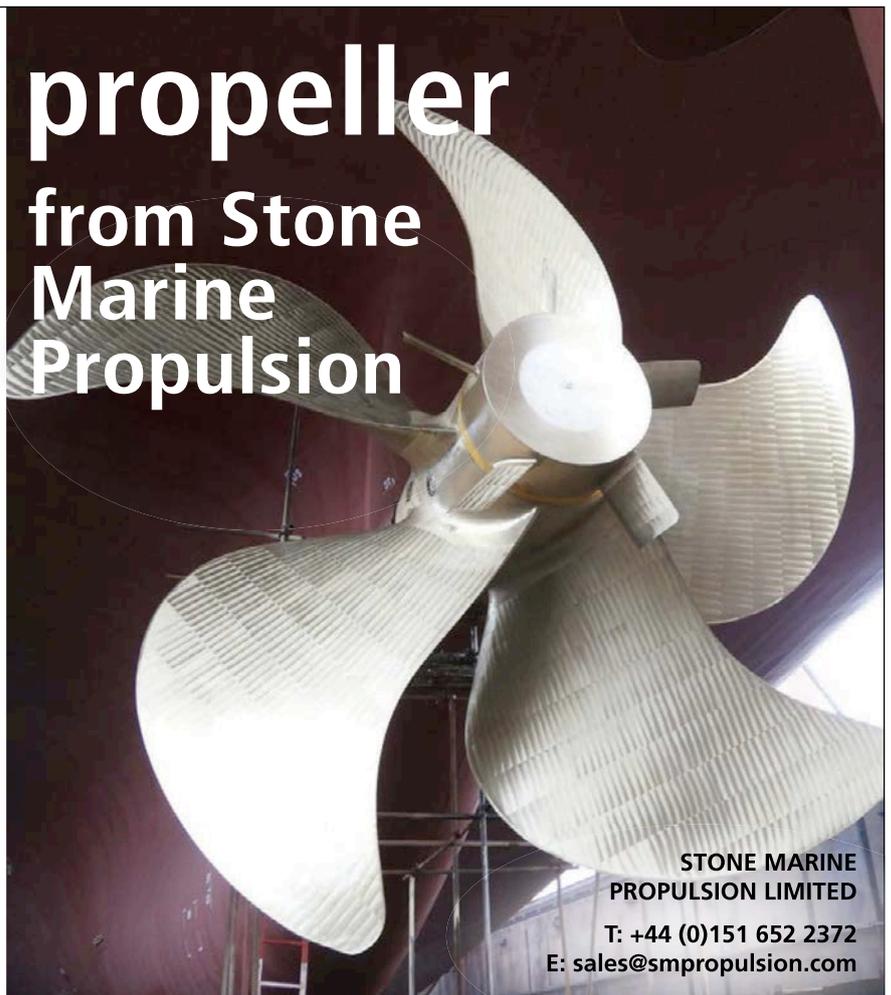
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Molina explains: “Compared with a ship built at the same time as the *Ecoship*, we might say that an approximate CO<sub>2</sub> reduction of 20% will be seen, considering the sails, PV panels, special hull and other fuel saving measures as well as its operational efficiency approach.”

The intention is to deploy a diesel-electric system with two pods producing 10MW each and six dual fuel four stroke hybrid LNG/MGO engines that each produce 4.59MW. In addition, ten sails are to be fitted to the vessel in order to take advantage of Peace Boat’s long spells at sea while sailing around-the-world. This should reduce the propulsion power needed by around 10% in good wind conditions, says Molina. However, at this stage, the design of the sails is not firm and a range of options, from Flettner rotors to the foldable sails shown in the rendering of *Ecoship*, are being considered.

Andreas Ullrich, senior principal engineer international rules, DNV GL, and consultant to the project, explains that architects and the shipyard will need to discuss the best way of realising any sail design, taking issues of stability, and the impact of too much wind into account when making decisions. To this end, DNV GL’s current role in the project is to support Peace Boat in realising *Ecoship*’s complex design. This includes evaluating technical solutions and discussing the project with yards as well as suppliers. It will then act as class society during the construction of the vessel.

Wind power will also be used to generate electricity for the vessel. Approximately 150kW is anticipated to be produced in favourable conditions from wind generators positioned on *Ecoship*’s top deck. This alternative energy source will be contributed to by 10 wind generators, while 6,000m<sup>2</sup> of photovoltaic (PV) panels (also positioned on the top deck and on cabin balcony fenders) will reduce the vessel’s hotel fuel consumption by about 750kW. Cabin balcony fenders will be fitted with PV panels to power cabin lighting, with batteries installed to store and retrieve energy overnight.

Energy storage and recycling are at the heart of the *Ecoship* project, and as such, a variety of storage solutions are being analysed for the vessel. These include

### Peace Boat and its mission

**Peace Boat is a Japan-based non-profit NGO that has operated for over 30 years providing education and advocacy during around-the-world cruises. It has Special Consultative Status with the Economic and Social Council of the United Nations and was nominated for the Nobel Peace Prize in 2008. It currently sets sail three times a year for voyages of 80-100 days, carrying approximately 1,000 passengers on each voyage.**

**The *Ecoship* project will build on Peace Boat’s core aims, creating a ship that is more environmentally sustainable than the current-best-in-practice, offering a 40% CO<sub>2</sub> reduction compared with the current Peace Boat ship. *Ecoship* will provide educational voyages for 6,000 people every year and will act as a “floating sustainability laboratory contributing to research on the ocean, climate and green marine technology.”**

suggestion of operating an energy balance system that would allow wasted thermal energy created at sea at service speed to be used while the vessel is alongside.

Peace Boat says the goal of the storage systems is “to store enough energy to stay alongside with either the engines stopped or running on H<sub>2</sub> for six hours.” In this way, “Even a slight increase of the power of engines at sea should be better for the port ambient conditions than having engines running when alongside.”

Molina explains that 1,500kW (at 200°C) of wasted thermal energy, about 20% of the total, is available per day at sea at service speed to be stored and used when alongside. That is equal to 1,290,000 Kcal/h. Three days at sea has the potential to produce 17,200,000 Kcal if the efficiency of storage and extraction is improved, which means 3.5 hours of energy demand can be catered to while in port. In order to reach the goal of six hours of energy for the ship in port without engines, 500tonnes of frozen water and an additional 300kW from the ship’s engines while sailing for three days is necessary, as well as approximately 150tonnes of lithium batteries.

“Energy storage is one of the biggest challenges and H<sub>2</sub> is a big temptation since it could be produced onboard using wasted heat, stored at 600 bars and burnt when the ship is alongside,” says Molina. “Theoretically, the new IGF covers LNG and other low flash point fuels, but H<sub>2</sub> requires separated development...if we cannot get it for delivery, we will get it and install it afterwards.”

hydrogen electrolytic plants, hot tanks for additional storage, frozen tanks to store ‘cool’, and electric batteries. There is also the

Figure 1

**ADDITIONAL SAVINGS DUE TO OPERATIONAL OPTIMIZATION (POWER MANAGEMENT), SAILS, VARIABLE SPEED IN ENGINES, AND VARIABLE SPEED IN HVAC AND PUMPS**

Speed	Propulsion savings by HULL OPTIMIZATION at service speed	Propulsion savings by SAILS	Propulsion savings by BUBBLES	Corrected Power	Service +15%	Power at engines with cos φ 0,9	T/H	T/Day
14,50	0,00%	5,00%	5,00%	4.739,46	5.450,38	5.723,26	0,93	22,25
15,00	0,00%	4,50%	5,00%	5.306,60	6.102,59	6.408,13	1,04	24,91
15,50	0,00%	4,00%	5,00%	5.931,18	6.820,86	7.162,36	1,16	27,84
16,00	0,00%	3,50%	5,00%	6.616,59	7.609,08	7.990,05	1,29	31,06
16,50	1,00%	3,00%	5,00%	7.286,23	8.379,17	8.798,69	1,43	34,21
17,00	3,00%	2,50%	5,00%	7.918,39	9.106,14	9.562,06	1,55	37,17
17,50	1,00%	2,00%	5,00%	8.975,13	10.321,40	10.838,16	1,76	42,13
18,00	0,00%	1,50%	4,98%	10.038,70	11.544,50	12.122,50	1,96	47,13
18,50	0,00%	1,00%	4,95%	11.084,98	12.747,73	13.385,97	2,17	52,04
19,00	0,00%	0,50%	4,92%	12.214,37	14.046,52	14.749,79	2,39	57,34
19,50	0,00%	0,00%	4,89%	13.430,71	15.445,32	16.218,62	2,63	63,05
20,00	0,00%	0,00%	4,86%	14.660,88	16.860,02	17.704,15	2,87	68,83
20,50	0,00%	0,00%	4,83%	15.972,19	18.368,02	19.287,65	3,12	74,98
21,00	0,00%	0,00%	4,80%	17.367,35	19.972,46	20.972,42	3,40	81,53

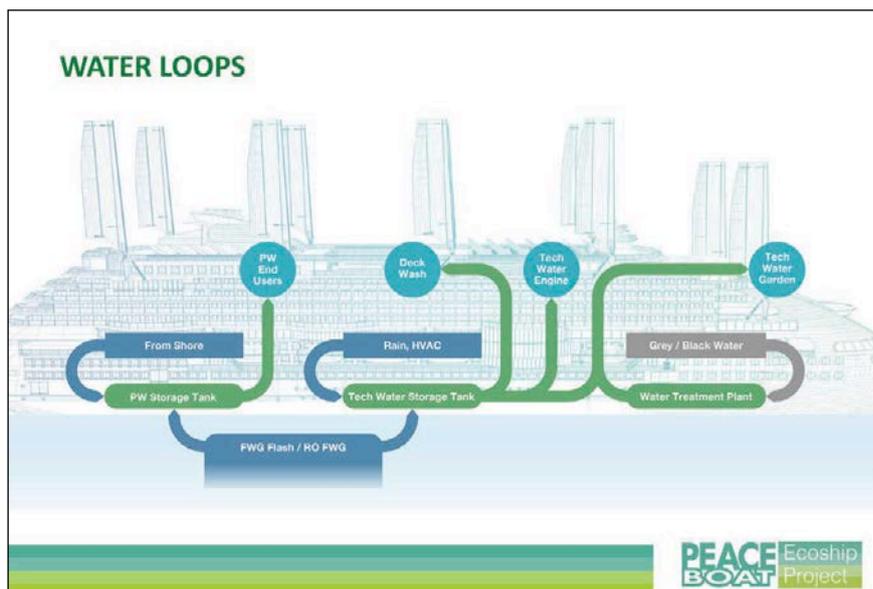


Figure 2

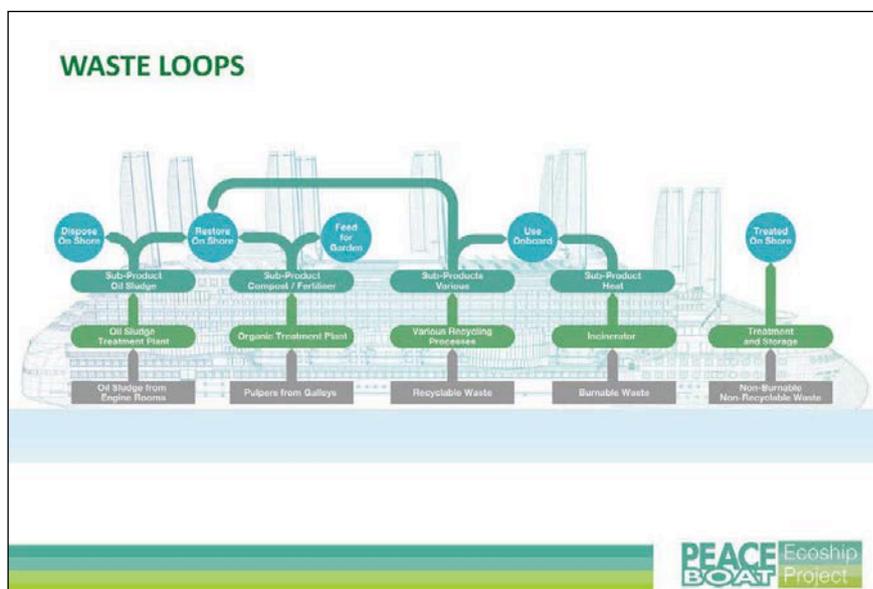


Figure 3

Heat from onboard cooling systems will be used to produce water that can be used for domestic applications, and, as a mark of the Ecoship project's ambition, there is a target to reuse 80% of the energy normally lost in air and water.

Further recycling of resources can be seen in the water loops and waste loops portrayed in Figure 2 and Figure 3, as well as in the vessel's innovative HVAC air loop system. This loop utilises onboard gardens as cooling towers. "Basically, desiccant units will dry and pre-cool the incoming air. That air is water sprayed and, so, cooled down to pre-cool the chiller water

in the cooling towers (gardens with water evaporation). Then, the chiller water will go to the main chiller units. We may gain 3-4°C in the chiller water. The desiccant units are re-generated with wasted heat," Molina explains.

### PMESC

A complex power management and energy saving control system (PMESC) is needed to combine the array of technological solutions to be deployed on Ecoship in an efficient holistic model. "This is, in fact, one of the most crucial items for which the technology is not yet developed enough," says Molina.

"For the time being we have only succeeded in the integration of the different distributed power management systems, but we did not get the proper upper level system to manage the power systems from a pure combined optimisation mode."

The system will need to retrieve and analyse data from regular onboard power management systems such as propulsion and hotel loads, from external conditions (solar radiation, wind, waves, external temperature etc.), and internal ambient conditions like wasted energy re-use, wasted water re-use and energy storage levels. Peace Boat states it must be capable of optimising energy use and wasted energy recycling. However, self-consistent energy systems might be monitored and controlled by subsystems that work to alert the main PMESC if they do not require interaction with other systems.

"Nobody before realised the combination of wind, solar and 'regular propulsion' management including CO<sub>2</sub> control and waste energy re-use," says Molina. "The system would work as our own brain, where the unconscious (upper level management system) proposes actions and the conscious (Master) select and executes throughout the distributed energy management systems...plus the 'learning' adaptive function that is passing on the unconscious those functions that are becoming repetitive or that have been proven to be measurable through a mathematic algorithm. That requires research that only a few commercial makers are willing to do, so we are approaching universities. In any case, the ship might be delivered without the latest technology in place, but prepared to get it as soon as it is available."

A route optimisation system will also be needed to balance the various propulsive technologies and power generation systems to make the most of wind and sea conditions.

### Continuing development

It must be noted that *Ecoship's* arrangement has been designed with flexibility in mind and so technological solutions, such as fuel cells, may be adopted and the GA changed to allow for this possibility and others in the coming months. NA

# The art of design

Designing modern tankers has greater challenges than ever before, according to Schulte Marine Concept, as naval architects must look at the whole project. Design in this sense is an art as much as a science

Designing ships, according to Schulte Marine Concept (SMC) - the project-focused business within Bernhard Schulte Shipmanagement, is an art. "Not everyone can be a singer, not everyone can bend it like Beckham and not everyone can be a ship designer, it is something you feel, it is something you must have in your genes," says Krzysztof Kozdron, managing director at SMC.

Kozdron says that for many, designing a tanker sounds like nothing new, we have seen so many tanker designs on drawing boards, under construction in the yards and in service; after all the history of tankers dates back to the 19th century, when the marine transport of oil products was first commercialised.

However, all the material, equipment, engineering, science, including advanced computing methods and technology developments we have witnessed over close to 200 years has brought us to an era of highly performing, highly capable ship design offices and shipbuilding yards in the 21st century.

"In this case we must ask, is designing tankers such a straight forward task in the modern era?" says Kozdron; "Or maybe we should look at tanker design as a purely financial investment, or as a commercially driven marine transportation project; or maybe as an inspiring technical challenge focusing on technical perfection, or maybe as a bit of an engineering art?"

There are no simple answers to these multidimensional, often contradictory questions and most probably we should consciously blend all of the tanker project drivers in order to arrive at a vessel design that will please financiers, cargo owners, shipowners, shipmanagers, regulatory and statutory bodies, and non-governmental organisations amongst others.

Kozdron refers to a specific project for a product tanker that is currently being developed which he says had a clearly defined cargo list from the outset of the project and that meant that the design development



The art of ship design is "something you feel", says SMC MD Krzysztof Kozdron

could immediately "jump to the purely technical and operational side of the design", which simplified and optimised the design process for the project.

SMC in this instance could move directly to looking at more specific design decision areas, like the segregations and performance of the cargo system, including the arrangement of the cargo manifolds, the speed, and the propulsion power and electrical power generation for the vessel.

## Cargo list

No matter what the original drivers are for a project, the vessel must perform its functional duties of safe and efficient carriage of cargo. But which cargoes should the vessel be designed to carry? "This is the million dollar question," says Kozdron.

The cargo list is one of the key parameters driving the commercial attractiveness of the vessel, as even with a product such as the vessel in question here, which has a long term contract, there may be a need to either sell the vessel on the second-hand market or move it to another trade, and in both these scenarios flexibility will be key.

In this sense the longer the cargo list the better. But this is not necessarily always the case. The length of the cargo list comes at a price and it is worth asking whether a vessel really needs to be capable of carrying a wide range of cargoes.

Cargo lists will define the cargo tank lining system to efficiently protect cargo and to protect the cargo hold structure.

Cargo lists will also predefine, to a certain extent, the size and type of the tanker along the lines of the 60-year old Average Freight Rate Assessment industry standard; however "nothing here is carved in stone, the global markets are changing, existing trading routes and directions change, new ones will open," says Kozdron.

Loading and discharging times are of the same consequential magnitude as cargo lists and the vessels' operational speed and corresponding fuel consumption. In most of the cases the decision is based on the industry standard, where the vessel is simply benchmarked against the existing fleet. "Not a bad solution one may contend, though only if the intention is to deliver and to operate a vessel that is offering performance not inferior to most of the current competitors," argues Kozdron.

This approach [benchmarking against the existing fleet] appears as a decision-making shortcut. "A deep understanding of what we want to carry and what the expectations of cargo owners and terminals are will provide a solid foundation for the decision-making process, resulting in a vessel which has a far higher performance and which is fit for purpose".

## Trading patterns

Once it becomes more evident what cargo will be carried, the designer will then be naturally led to the next question, that of trading patterns, which will be next in line to assist engineers with

design development and hydrodynamic and propulsion plant optimisation. “World-wide trading is the simplest (read the easiest) answer, but not necessarily the one that will help safeguard development of the right design,” says Kozdron.

“Do we really plan to operate each tanker continuously on the North Atlantic route to request fatigue life based on 25 years of North Atlantic wave data? It comes at price, in general for public opinion such fatigue performance looks attractive, when considering the second-hand value of the vessel it is also attractive, but it is really worth looking at alternative, equally or even more efficient and more economical ways of safeguarding the durability and reliability of the hull structure, taking into account the vessel’s trading pattern and its operational and maintenance requirements and abilities.”

For the Bernhard Schulte product tanker, Kozdron says the company has spent considerable time reviewing hull hydrodynamic optimisation processes, using a “pre-defined operational profile”. This includes the hull form optimised for propulsion power efficiency, mitigated propeller born cavitation and “propeller induced excitations” achieved through advanced CFD modelling, towing tank and cavitation tank testing with design propeller and design rudder, amongst others.

Understanding trading routes and the definition of a tanker’s intended or at least prevailing operational profile, matrix of speed/draught/trim, will help in providing invaluable input into the hull hydrodynamic optimisation process.

Interestingly, the definition of the hull form for a given operational profile does not end the optimisation process, as a vessel’s prime mover must also be selected according to the propulsion power demand.

With the engine selection we open the door leading to new areas and challenges of a vessel’s design. The engine is selected not only from the criteria of deliverable mechanical power, but also taking into account specific fuel consumption (non-linear curve, to make our life more interesting) directly linked with engine de-rating scrutiny that is driven by selection of load tuning methods directly related to the heat balance of our vessel; for example the lower mechanical power of a highly performing prime mover gives less heat that can be utilised elsewhere, triggering

additional fuel consumption through the auxiliary boilers.

Last, but not least, for propulsion and electric power generation plant design, compliance with NOx emissions Tier III arises adding to the complexity of the decision making process, with immature technology and with considerable CAPEX and OPEX for available solutions: selective catalytic reduction, exhaust gas recirculation or maybe natural gas used as a fuel.

Here things get multidimensional; applying academic feedback theory; we could easily describe the above design development as a self-deregulating feedback process with optimisation gaps widening and narrowing inputs.

In addressing a vessel’s propeller design, where another optimisation process kicks in, to find the best compromise (somehow optimisation and compromise appear to be interchangeable words in shipping language, with engineers usually referring to optimisation, while the commercial sphere elects to use compromise) between maximum propulsion efficiency and draught limits, cavitation challenges and low draught venting risk, not to disregard potential and unwelcome propeller borne vibrations.

In addition, Kozdron asks: “Do we really need to be compatible with such a long list of terminals or maybe we can miss out some terminals with very specific requirements like, length of parallel body, making our vessel incompatible, and consequently restricting commercial operations.

“A ship-to-shore compatibility study, critically important and driven by commercial expectations, is expected to be an inherent part of the diligent design process.”

### Regulatory framework

The list of class notations is getting longer, says Kozdron, and shipowners are free to choose from a very generous source of classification notations addressing hull (over 40 items of choice), machinery (over 50 items), machinery special (over 20 items), refrigerated systems (over 10 items), environmental protection (over 5 items), and descriptive notes (over 40 items).

It is a challenge to fully understand all the potential benefits and consequences for operational expenditure (OPEX) and

capital expenditure (CAPEX) and combine this with the technical or commercial nature of the design, and even more difficult to rationally select notations.

The appointment of a classification society appears to be an easy step for the owners, predominantly based on non-technical criteria, like intentional diversification of fleet classification and scale leveraging cost optimisation (though one may provocatively think, that in reality, taking into account the technical prospective and consequences of choosing a class society and the corresponding classification notations and descriptive notes, all leading societies offer very similar merchandise though under a different label, with a different wrapping).

Class is just the beginning of the legislative journey, however, which increases the complexity of the design process from the start. In addition there is a list of over 30 rules and over 40 industry guidelines and recommendations that are either compulsory or voluntary that must be considered for an average tanker design.

“We have superficially scratched the surface of the tanker design challenge, attempting to draw the outermost design boundaries through addressing some of the key, tanker specific, moving goalposts. We intentionally skip the long list of equally interesting and influencing inputs, like the currently trendy energy saving devices to choose from; the philosophy behind the electric load balance; the degree of a vessel’s automation.”

In this article we have outlined a high-level approach and philosophy for tanker design and development that avoids the decision making processes, from either party involved in this process, based on market benchmarking and a shift towards decisions based on systematic commercial, technical and operational analyses generating a vessel fit for its intended purpose, explains Kozdron.

“So, getting back to initial question: is the tanker design financial investment, or commercially driven marine transportation project or an inspiring technical challenge or an engineering art? Well, without any doubt, in our modern world it is a loose mass of often-conflicting financial, commercial, technical and operational expectations masterminded into tanker design by engineering art.” **NA**

# Imabari's new star burns bright

Efficiency is key to the development of new vessels and Imabari's latest design, the *NEW I-STAR* 63,000dwt bulk carrier, combines greater environmental friendliness with an increased cargo capacity when it is compared to its predecessor *IS I-STAR*

New measures to improve vessel efficiency such as the Energy Efficiency Design Index (EEDI) introduced by the IMO some three years ago are having some effect on the design of

ships as naval architects seek to achieve the EEDI rules for new designs.

One such ship is the *NEW I-STAR* 63,000dwt bulk carrier which was completed at Imabari's shipyards at Shin Kasado Dockyard Co., Ltd. (Yamaguchi Pref.) and the Iwagi Zosen Co., Ltd. (Ehime Pref.) yard in April this year.

*NEW I-STAR* is the successor to the successful 61,000dwt type *IS I-STAR* that achieved a construction record of 120 vessels up to now. The latest version of the vessel has a greater deadweight with an extra 2,000dwt and a deepened fully loaded draught in comparison to its *IS I-STAR* predecessor.

A 10% improved propulsion performance has been achieved through the use of energy saving devices such as cylindrical ducts located in front of the propeller and a specially designed fin fitted on the front edge of the rudder.

In addition, the vessel is suited for a wide variety of cargoes including lengthy cargo

and hot coils, although because it has five hatches and holds the handymax type is mainly intended for coal, iron-ore and grain cargoes.

Four deck cranes are equipped on each of the cross decks and make cargo handling possible even in ports where no shore cargo handling equipment is available. All cargo holds are fitted with wide opening hatches of the same dimensions (breadth), which contribute to cargo handling efficiency.

Pipes on deck are installed within the hatch coaming stay in order to minimise damage during cargo handling.

A fuel oil shifter is employed in consideration of reducing grain cargo damage due to bunker oil tank heating.

*NEW I-STAR* was originally developed in 2013 and the yard hopes that the vessel will build on the reputation that its predecessor has gained from local and overseas operators and shippers as an efficient, reliable and flexible vessel, even in today's tough market. **NA**

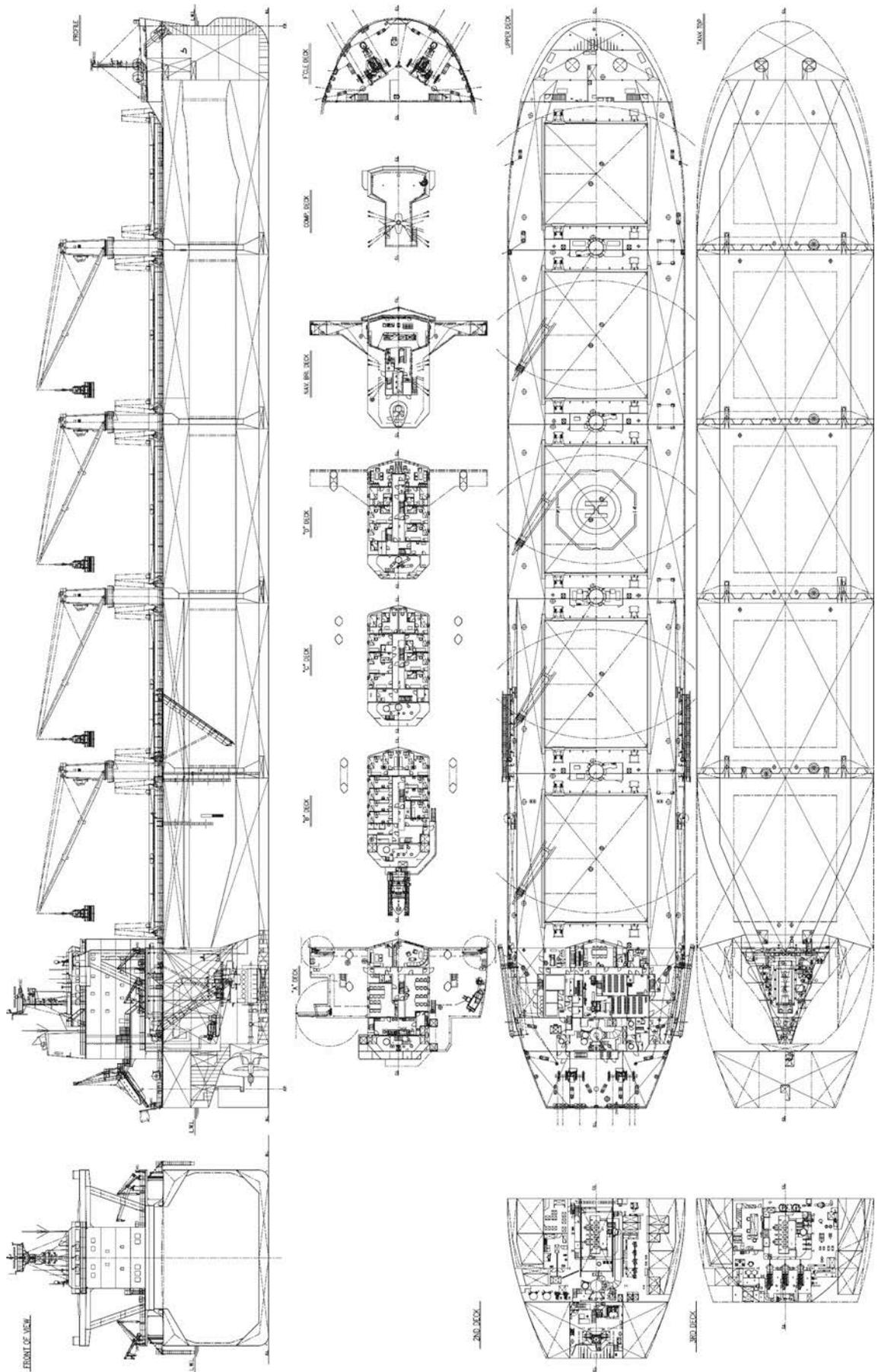
## TECHNICAL PARTICULARS

### *NEW I-STAR*

Registry.....	PANAMA
Classification.....	NK
Length oa.....	199.90m
Breadth.....	32.24m
Depth.....	19.15m
Scantling Draught.....	13.40m
Deadweight.....	63,000tonnes
Gross.....	36,000tonnes
Speed.....	14.5 knots
Hold Capacity.....	80,000
Main engine Type.....	MAN B&W 6S50ME-B9.3
Output.....	7,560kW

*NEW I-STAR*, a 63,000dwt ship, replaces the original 61,000dwt *IS I-STAR*





# Return of the Russian cruiseship

United Shipbuilding Corporation is rejuvenating Russia's cruise shipbuilding industry with a sizeable river-sea vessel and the promise of more to come

The Russian cruise shipbuilding industry has lain dormant for over 60 years, but the sleeping giant now wakes as United Shipbuilding Corporation (USC), Russia's largest shipbuilding group, begins Project PV300, an initiative to build much needed replacement vessels for the nation's outdated passenger fleet.

Dmitry Zakharov, USC, explains that burgeoning interest in cruiseship holidays and the resultant rise in demand of new cruise vessels from shipowners looking to exploit the sector's booming popularity is driving USC to revive Russia's cruise shipbuilding.

"For USC, the revival of the river and sea passenger fleet is one of its priorities," he says. "The first Project PV300 vessel has been laid down [and] its construction has to spur the further development of inland river cruises on a new level."

The first vessel of the project *PV300VD* is currently under construction at Lotos Shipyard, Astrakhan, following its keel-laying in August, and is scheduled to be delivered to its owner, Moscow River Shipping Company, for 2019.

Russian naval architecture firm Marine Engineering Bureau was responsible for the design of the 141m vessel, which has a 16.82m beam and a draught of 5.5m, tailoring its characteristics to meet the specific navigational demands and limitations of the Volga River.

Zakharov says: "This is practically the first river-sea passenger vessel of this size in the world. It was built in accordance with the concept of maximum travel sizes [for] use of [the] European part of inland Russia's waterways."

*PV300VD* will operate a number of routes, including Moscow - St. Petersburg with Ladoga and Onega lakes crossings; Moscow - Astrakhan; and Moscow - Rostov-on-Don with the passage of the Volga-Don canal.

The design brief also stipulated that the vessel should be able to operate in the Black Sea, Baltic Sea and Caspian Sea



*PV300VD* will be the first cruise vessel to be built in Russia for over 60 years and marks the start of a revitalisation of such building projects for United Shipbuilding Corporation

in order to extend its annual operational window. At present, older Russian cruise vessels can only operate between May and October, and in exceptional circumstances between April and November, according to Zakharov, but *PV300VD*'s sea-going characteristics will change this, opening up new commercial opportunities.

"Caspian Sea cruises can only be operated by vessels like *PV300VD*," continues Zakharov. "Because on the one hand it can go through inland waterways and on the other hand it complies with all national and international sea regulations."

He added: "According to calculations, which were the basis for concluding a contract, the project is expected to show profit"

Perfecting the project management of such a build should pay dividends for USC as it prioritises cruise shipbuilding as part of its long-term strategy. To this end, the shipbuilder is already preparing to conclude a second vessel contract for a different customer, and is considering a number of cruise passenger vessels for construction, including a larger, 180m-long cruise vessel (*PV500VD*) with a capacity of 550 persons, and a Golden Ring paddle-driven vessel project.

Zakharov continues: "As to the required financial instruments, USC sees the preferential leasing programme, which is already in use by the Corporation, the most important of these. The programme has been in effect with support of the Ministry of Industry and Trade since 2009 and proved to be effective. According to USC's estimates, the total funds to implement the programme for constructing Russian-built sea and river vessels in 2016-2030 will exceed 102.2 billion roubles (US\$1.6 billion), including: 33 billion roubles (US\$528.7 million) of state budget funds; 69.2 billion roubles (US\$1.1 billion) of extra-budgetary funds.

"The total amount of financing for the leasing projects during 15 years may reach 102.2 billion roubles (US\$1.6 billion), due to the multiplier effect. One can predict that this approach will result in the construction of more than 146 vessels. In addition, it will generate up to 8 billion roubles of tax revenues over 15 years of the programme." **NA**

TECHNICAL PARTICULARS	
<i>PV300VD</i>	
Length, oa.....	141m
Breadth, oa.....	16.82m
Depth.....	5.5m
Deckhouse tiers.....	4
Passenger capacity.....	310
Crew.....	90
Passenger lifts.....	2 x 6pers.
Cargo lifts.....	4
Class.....	Russian River Register Class. ✱ M-SP 3.5 (Ice 30) A
Main diesel-generators.....	4 x 1,140kW
Rudder propellers.....	3 x 1,000kW
Emergency diesel-generator.....	1 x 214kW
Speed.....	22.5km/h

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By Chris Thomas

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By Fred Walker FRINA

Ships and Shipbuilders describes the lives and work of more than 120 great engineers, scientists, shipwrights and naval architects who shaped ship design and shipbuilding world wide. Told chronologically, such well-known names as Anthony Deane, Peter the Great, James Watt, and Isambard Kingdom Brunel share space with lesser known characters like the luckless Frederic Sauvage, a pioneer of screw propulsion who, unable to interest the French navy in his tests in the early 1830s, was bankrupted and landed in debtor's prison. With the inclusion of such names as Ben Lexcen, the Australian yacht designer who developed the controversial winged keel for the

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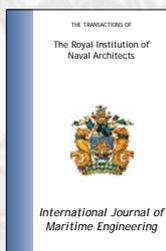
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[www.metstrade.com](http://www.metstrade.com)

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[www.rina.org.uk/EES\\_2016](http://www.rina.org.uk/EES_2016)

**November 24-25, 2016**

**Computational & Experimental**

**Marine Hydrodynamics,** international

conference, Chennai, India

[www.rina.org.uk/Computational\\_](http://www.rina.org.uk/Computational_)

[Experimental\\_Marine\\_](http://www.rina.org.uk/Computational_)

[Hydrodynamics2016](http://www.rina.org.uk/Computational_)

**November 25, 2016**

**Workshop on ship scale hydrodynamic**

**computer simulation (Lloyd's Register),**

Global Technology Centre, Southampton

[www.lr.org/en/events/ship-scale-](http://www.lr.org/en/events/ship-scale-)

[hydrodynamics-numerical-methods-](http://www.lr.org/en/events/ship-scale-)

[workshop](http://www.lr.org/en/events/ship-scale-)

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Shanghai, China

[www.seaworkasia.com](http://www.seaworkasia.com)

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[www.rina.org.uk/Historic\\_Ships\\_2016](http://www.rina.org.uk/Historic_Ships_2016)

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World Trade Center, Guangzhou, China

[www.maritimeshows.com/china](http://www.maritimeshows.com/china)

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**10th International Conference on**

**Marine Technology**

**(MARTEC 2016),**

BUET, Dhaka, Bangladesh

[www.icmartec.com](http://www.icmartec.com)

**January 24-25, 2017**

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international conference,

London, UK

[www.rina.org.uk/Smart\\_Ships2017](http://www.rina.org.uk/Smart_Ships2017)

**January 24-25, 2017**

**International Conference on Maritime**

**Energy Management (MARENER 2017),**

World Maritime University, Malmö, Sweden

[conferences.wmu.se/marener2017](http://conferences.wmu.se/marener2017)

**January 31 – Feb 2, 2017**

**Euromaritime,** international exhibition,

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[www.euromaritime.fr/73/2017-](http://www.euromaritime.fr/73/2017-)

[innovation](http://www.euromaritime.fr/73/2017-)

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[www.rina.org.uk/ShipDesign\\_EEDI](http://www.rina.org.uk/ShipDesign_EEDI)

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**Structures,** international conference,

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[www.rina.org.uk/AOG\\_2017](http://www.rina.org.uk/AOG_2017)

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**Seatrade Cruise Global,** international

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[www.seatrade-cruise-global.com](http://www.seatrade-cruise-global.com)

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**Design & Construction of Wind**

**Farm Support Vessels,** international

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[www.rina.org.uk/WFSV\\_2017](http://www.rina.org.uk/WFSV_2017)

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**INMEX Vietnam,** international exhibition,

Ho Chi Minh City, Vietnam

[www.maritimeshows.com/vietnam](http://www.maritimeshows.com/vietnam)

**April 4-7, 2017**

**Gastech,** international conference and

exhibition, Chiba, Tokyo

[www.gastechevent.com](http://www.gastechevent.com)

**April 25-27, 2017**

**Sea Asia,** international conference and

exhibition, Singapore

[www.sea-asia.com](http://www.sea-asia.com)

**April 27, 2017**

**RINA Annual Dinner,** London, UK

[www.rina.org.uk/Annual\\_Dinner\\_2017](http://www.rina.org.uk/Annual_Dinner_2017)

**May 10-11, 2017**

**Design & Construction of Super**

**& Mega Yachts,**

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[www.rina.org.uk/superyachts2017](http://www.rina.org.uk/superyachts2017)

**May 16-18, 2017**

**IMDEX Asia,** international maritime

defence exhibition and conference,

Singapore

[www.imdexasia.com](http://www.imdexasia.com)

**May 17-19, 2017**

**Torsional Vibration Symposium,**

Salzburg Congress, Salzburg, Austria

[www.torsional-vibration-symposium.com](http://www.torsional-vibration-symposium.com)

**May 25-27, 2017**

**Bari-Ship 2017: Imabari Maritime Fair,**

international exhibition, Imabari City, Japan

[www.bariship.com](http://www.bariship.com)

**May 30 – June 1, 2017**

**Undersea Defence Technology (UDT)**

**2017,** international exhibition & conference,

Bremen, Germany

[www.udt-global.com](http://www.udt-global.com)

**May 30 – June 2, 2017**

**Nor-Shipping 2017,** international

exhibition & conference, Oslo, Norway

<https://messe.no/en/nor-shipping>

**June 6-8, 2017**

**Electric & Hybrid Marine World Expo**

**2017,** Amsterdam, The Netherlands

[www.electricandhybridmarineworldexpo.com](http://www.electricandhybridmarineworldexpo.com)

**June 13-15, 2017**

**Seawork International,** international

exhibition, Southampton, UK

[www.seawork.com](http://www.seawork.com)

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international conference, Bath, UK

[www.rina.org.uk/Warship2017](http://www.rina.org.uk/Warship2017)

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**(IMDS-2017),** international exhibition,

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[www.navalshow.ru](http://www.navalshow.ru)

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