# THE NAVAL ARCHITECT

A publication of The Royal Institution of Naval Architects | www.rina.org.uk/tna



Greenships / CAD/CAM / Ice class / South Asia / Shipboard water treatment / **January 2017**

CADMATIC

SOFTWARE SOLUTIONS

# Marine Design Software

*INCREASE QUALITY in*
***Design & Production***

*OPTIMIZE RESOURCES with*
***Distributed Engineering***

*ENHANCE UNDERSTANDING with*
***Project Communication***

*CONTROL PROJECTS with*
***Information Management***

*Feel Empowered*

www.cadmatic.com

**Editor** Nick Savvides
**Assistant Editor** Robert Grisbrook
**Design/Production Manager** Sandy Defraine
**Group Sales Director** John Payten
**Assistant Advertising Manager** Valder Gates
**Advertisement Production Manager** Stephen Bell
**Subscriptions & Publications Manager** Jim-Ray Semanhyia
**Publisher** Mark J Staunton-Lambert

Published by:
The Royal Institution of Naval Architects
Editorial & Advertisement Office:
8-9 Northumberland Street
London, WC2N 5DA, UK
Telephone: +44 (0) 20 7235 4622
Telefax: +44 (0) 20 7245 6959
**E-mail editorial** editorial@rina.org.uk
**E-mail advertising** advertising@rina.org.uk
**E-mail production** production@rina.org.uk
**E-mail subscriptions** subscriptions@rina.org.uk

Printed in Wales by Stephens & George Magazines.

The Institution is not, as a body, responsible for opinions expressed in *The Naval Architect* unless it is expressly stated that these are the Council's views.



A 2017 subscription to *The Naval Architect* costs:

**NAVAL ARCHITECT (10 issues per year)**

| 12 months | Print only† | Digital Only* | Print + Digital |
|---|---|---|---|
| UK | £185 | £185 | £235 |
| Rest of Europe | £193 | £185 | £244 |
| Rest of World | £207 | £185 | £258 |

†Incudes p+p
*Inclusive of VAT

The Naval Architect Group (English & Chinese Editions)
Average Net Circulation 16,685 (total)
1 January to 31 December 2015
ISSN 0306 0209

7 **Editorial comment**
Regulation in the modern age

8-14 **News**
8-10 News
12-13 News analysis
14 Equipment news

16-19 **In-depth**
16-19 **Standards** | Raising the hull monitoring standard

46 **Diary**


10 ***FF8000* is the first commercial vessel to be designed to feature modern rotor sails, a C-Job optimised hull and alternative fuels**

## 20-42 Features


**Feature 1 Greenships**

20-22 Selektope hits the water

24-25 The roads to (energy) freedom

**Feature 2 CAD/CAM**

26-30 The Internet of Ships: a new design for Smart Ships

**Feature 3 Ice class**

32-36 Computer simulation targets Arctic hazards

37-38 Planet ice and the dual-functional *Attenborough*

**Feature 4 South Asia**

40-41 VLCC project moves ahead

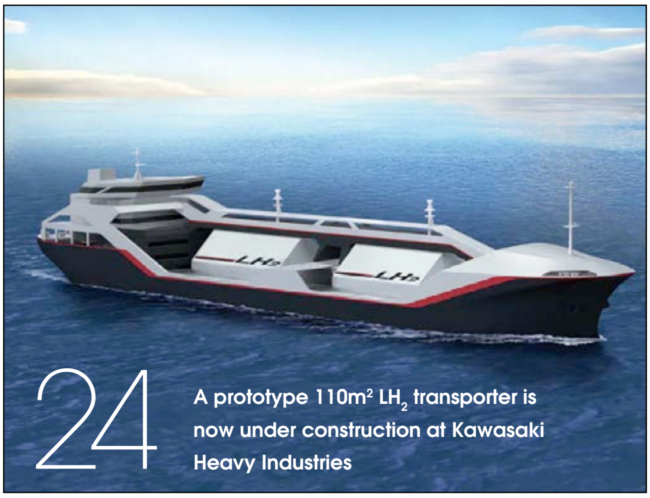
**Feature 5 Shipboard water treatment**

42 Clearing the FOGs


26 CAD systems will have to adapt to make the most of IoT, says SENER

37 Naval architects from Rolls-Royce discuss the unique challenges they faced while designing RSS *Sir David Attenborough*

20 Results are in for the first year trial of Selektope, a new biocide treatment

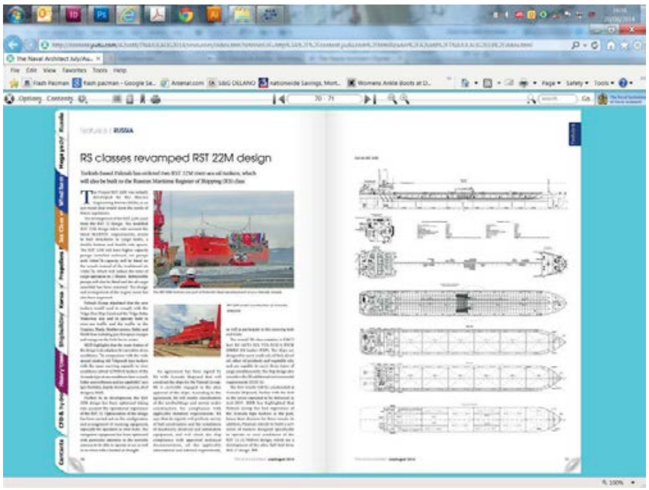


24 A prototype 110m² $LH_2$ transporter is now under construction at Kawasaki Heavy Industries

### Digital Editions

*The Naval Architect* is published in print and digital editions. The current and archived digital editions (from January 2004) may be read on PC, iPad or other touchpad.

Visit http: www//rina.org.uk/Naval-architect-digital.html to read the digital editions, or download the free RINA Publications App.



# Regulation in the modern age

Time waits for no industry

Ship design is moving on at a pace with further developments in smart shipping design and new regulations shaping the environment in which new vessels will operate.

Both the Marine Environment Protection Committee (MEPC) and the Marine Safety Committee (MSC) at the IMO have introduced new rules and regulations that will benefit the climate, reducing harmful emissions, and will change the way ships are designed and ultimately the design of vessels.

Accompanying these new regulations are new technologies, in particular the Internet of Things, that are expected to take hold first in coastal vessels, before being used more broadly in deep sea vessels.

*The Naval Architect* will shortly publish an Internet of Things supplement, which itself will complement the Smart Ships conference that will be staged in London this month on 24-25 January.

Vessel design will be informed by the major changes that will be brought about through the introduction of new technology. With those major changes come major challenges and the most significant challenge facing the industry in the electronic era remains security.

Hackers have shown themselves to be very adept at forcing their way into the systems of unsuspecting businesses. Yahoo recently reported more than a billion names and addresses of its users were stolen. Banks have also fallen foul of the hackers' trade in recent times and even the Pentagon is not safe.

Shipping has been slow to take up the latest technological innovations and to some extent this slow uptake has protected the industry from the E-criminals. However, the benefits to the bottom line that these developments will bring, allied with the changes in regulations, mean that the electronic era will inevitably come in the shipping industry as it is being developed in other sectors.

"Vessel design will be informed by the major changes that will be brought about through the introduction of new technology. With those major changes come major challenges and the most significant challenge facing the industry in the electronic era remains security"

In addition, the complex web of regulation, with special areas for dumping waste, such as the Baltic, NOx and SOx emission control areas and the ballast water convention, with its more stringent rules in US waters than in other regions of the globe, mean that technology will be used to make certain that shipowners do not fall foul of regulations.

Already there are internet linked units that can monitor a vessel's position and tell crew exactly which regulations apply in the region within which the ship is operating. It is not beyond the wit of mischievous hackers to break into these machines and cause owners problems that could cost them substantial amounts of money as a consequence.

In other news, after some seven and a half years at *The Naval Architect* I will be stepping down as editor. It has been a pleasure and a privilege to cover technical and regulatory developments in this period and to work with so many interesting and dynamic members of the maritime fraternity.

I feel proud to have served the members in a time of great flux in the industry and hope that the issues that we have followed during my tenure at the magazine have been useful to the readers.

Thank you for your attention and I wish my successor all the very best in meeting the needs of members and readers alike. *NA*

LNG

# Bright future for LNG?

The long oil price depression has seen the contraction of many markets that are dependent on the oil price in the past 24 months. Bunkering with liquefied natural gas (LNG) has been one of those areas affected by the drop in the conventional fuel for the maritime industry, and with the cost of oil low the benefits of LNG are also diminished.

In a survey conducted through Oil & Gas IQ's bunkering network the outlook for the future of the fuel has been seen as encouraging. Some 87% of respondents thought that the use of LNG as a fuel in shipping would become widespread in shortsea shipping, while a further 64% said its use would also spread to deepsea vessels.

Some 42% said that regulation was the most important factor when faced with the decision to adopt LNG as a fuel with a further 25% citing profits as key to that decision. However, in a contradictory fashion only 4% said that regulation would "accelerate growth in the sector".

Europe is seen as the most likely region that will drive the adoption of LNG as a fuel and around 56% of respondents saw the lack of infrastructure as the main stumbling block to that adoption.

Ferries

# Electrifying ferries set for Denmark

Finland based ABB has begun a project at the Öresund Dry Docks to convert two HH Ferries vessels to electric power using 4.16MW battery packs.

*Tycho Brahe* and its sister vessel *Aurora* will be fitted with containers that have the battery packs installed within. The first vessel to undergo the refitting, *Tycho Brahe*, will have the battery pack container lifted onboard in February with the drydocking taking place in April. *Aurora* will undergo its conversion work in October.

The 111m ships will then operate an emission free ferry service on the route between Helsingor in Denmark and Helsingborg in Sweden.

"Our conversion of the *Tycho Brahe* and *Aurora* ferries to battery operation is an essential part of our environmental strategy to reduce emissions and reduce the environmental footprint of our operations on Öresund. We are proud of the initiative, which is the largest single project investment in the company's history. When the two ferries will sail on pure electric power before the end of 2017 it will be to the benefit of our many passengers and the local environment," said Henrik Rørbæk, CEO of HH Ferries AB.

ABB will deliver batteries, an energy storage control system and Onboard DC Grid technology to the modernised ferries. At both ends of the route ABB will also supply the first automated shore-side charging stations using an industrial robot to optimise the connection time and maximise the charging period.

*Tycho Brahe* is set to be converted to electric power next spring

The SEK300 million (US$32.8 million) investment is co-financed with SEK120 million (US$13.13 million) by INEA, the EU's executive agency for innovation and network.

Regulation

# MSC approves GBS implementation timetable

The IMO's Maritime Safety Committee (MSC) has agreed a revised timetable for the introduction of Goal Based Standards (GBS) for bulk carriers and crude oil tankers.

After a short debate that provided direction to the working group, the committee decided that due to time constraints the working group was only able to agree a portion of the proposed work. Some amendments were agreed with further amendments that will be discussed again at MSC 98.

According to a statement from the MSC, discussions were completed and current non-conformities will be assessed and dealt with in 2017 at MSC 98. Rule changes, if any, will be processed by the Secretariat for audit in 2018. The revised GBS Verification Guidelines are scheduled to be completed and adopted at MSC 100 in November 2018.

Before the commencement of MSC 97 the secretary-general Kitack Lim told delegates: "I would like to highlight some key issues amongst the various agenda items of MSC 97. As regards the implementation of the goal-based standards for new ship construction of bulk carriers and oil tankers, it is fundamental to emphasise that your Committee's unanimous confirmation that the information provided by the submitters [the 12 IACS members that are recognised organisations] demonstrated that their rules conform to the GBS

standards. The completion of this initial verification process now provides a genuine link between the classification and statutory processes and this is a significant development in the IMO rule making process which is the culmination of huge efforts by all stakeholders of the Organisation over a period of more than a decade."

Lim went on to say that after this significant achievement, the Committee must now focus on developing amendments to the GBS Verification Guidelines based on the experience gained during the initial verification audits. He said that MSC must not forget that "the Secretariat is arranging the verification audit for the rectification of non-conformities stemming from the initial verification audit for submission and consideration at MSC 98."

Shipyards

## Blohm+Voss sale gets green light

Germany's Fair Trade Commission has approved the acquisition of the Hamburg shipyard Blohm+Voss by the Bremen-based family owned group Luerssen Maritime Beteiligungen GmbH & Co. KG.

Luerssen Maritime is primarily a yacht builder to the super rich, but with the acquisition of the historic Blohm+Voss shipyard the company will expand its business into the repair and refit of yachts, naval and commercial ships as well as developing the company's new build activities within their corporation.

Peter Luerssen, managing partner of Luerssen Maritime says: "With the acquisition of Blohm+Voss we are taking over a shipyard with a strategically advantageous location and versatile production facilities. We want to use these facilities to complement our existing refit and repair activities and also to offer our customers an ever better service. In addition, we would like to utilise the competence and experience of the shipyard and its employees for the new build of complex naval ships and continue their production at the Hamburg site. The construction of yachts at the Hamburg yard will depend on the overall market situation and it is difficult to judge at this time."

Newbuildings

## Flettner Freighter takes wing

Dutch naval architect C-Job has designed an 8,000dwt general cargo ship with wind-assisted power for the family-owned firm Switijnk.

The 131m vessel has a specially designed hull and four Flettner Rotors that "form a sustainable concept by which energy costs and greenhouse gas emissions are reduced," says the designer.

The company added: "This form of 'Hybrid Wind Assisted Shipping' consists of vertical rotating cylinders that convert crosswinds into forward thrust by means of the 'Magnus effect'.

"It is the first time in which the combination of modern Rotor Sails, a C-Job optimised hull and alternative fuels has been applied to the commercial shipping market. The design can therefore be classified as very sustainable. Switijnk is currently focusing its attention on finding partners to develop and finance this innovative ship. The company currently has two other ships in service."

Director Stefan Switijnk says: "Sustainable development is part of our future-proof philosophy as a family business."

Apart from the rotor sails, the owner is also considering the main engine fuel options, including bio-fuels and LNG. *NA*


The 131m *FF8000* dry cargo vessel will use wind-assisted power to reduce its emissions

# MEPC sets shipping agenda

Owners and operators are going to have to step up to the plate over the coming year as shipping firms prepare for the introduction of the Ballast Water Convention in the autumn and the advent of the global low sulphur cap in 2020. Lifeboat safety was also back on the agenda at the Maritime Safety Committee meeting in November, *writes Sandra Speares.*

With the Ballast Water Convention set to enter into force in September 2017, owners and operators are on the critical path to installing systems that comply with its requirements. One particular area of concern has been whether any system installed, and they do not come cheap, will meet US requirements.

There was a coup for Norwegian ballast water treatment specialist Optimarin in December 2016 when it became the first system supplier to gain full USCG type approval meaning it is, so far, the only company to have produced a system which is compliant both as far as the US and the IMO are concerned.

The Optimarin Ballast System uses a combination of filtration and powerful 35kW UV lamps to treat ballast water without the need for chemicals. DNV GL tested the system to USCG standards for fresh, brackish and marine water at the NIVA test facility in Norway. The USCG is now considering further ballast water systems seeking approval.

The issue of life saving appliances (LSA) has been on the IMO agenda for a number of years and was recently discussed at a workshop organised by the Cruise Lines Industry Association in Miami.

The International Chamber of Shipping (ICS) formed the Industry Lifeboat Group (ILG) some years back to provide a better focus for users of LSA, particularly because it was felt that owners were being "outmanoeuvred" at the IMO by manufacturers present under the aegis of various country states. At the same time when regulations for the new SOLAS lifeboat release hooks were being drafted, the ICS felt that the manufacturers were dragging their feet in making improvements.

"Time will tell whether the new hooks have fully achieved their aim," says John Murray ICS marine director. "The ILG has had some success, most recently at MSC 97 when it was agreed that our submissions MSC 97/19/4 & MSC 97/INF.3 would be forwarded to SSE 4 for inclusion in their work and to specifically consider our proposal to amend the definition of 'simulated launching' of free-fall lifeboats."

The Cruise Lines Industry Association (CLIA) has now formed a work group on survival craft safety that is looking specifically at issues on cruiseships, although obviously the wider link to other ships' LSA remains. The new workgroup should be able to complement the work of ILG and can be welcomed, says ICS.

Following considerable debate, the decision was taken at the last Marine Environment Protection Committee to implement the global sulphur cap of 0.5% in 2020. World Fuel Services described the decision as one that would "turn the whole bunker industry upside down".

"IMO has not set specific sanctions and/or fines for not complying with the new regulations: instead these will be determined by the individual States. We can be sure that the consequences to non-compliance will not be trivial," WFS says.

In the meantime, concern was expressed at IMO's Maritime Safety Committee (MSC) that the decision by MEPC on low sulphur fuel implementation had not been formally sent to MSC for the safety implications to be considered, which created some tension between the two committees.

> "Pursuing regional measures such as an EU ETS or climate fund will seriously endanger international progress"

More concerns were expressed about the possibilities of unilateral action by the EU on the issue of greenhouse gas emissions from ships with the European Community Shipowners' Associations (ECSA) facilitating recent discussions in the European Parliament.

The focus of the discussion was the roadmap that IMO agreed at the end of October 2016. This roadmap foresees the adoption of an initial strategy in 2018 to meet the targets of the Paris Climate Agreement, which has just entered into force. The initial strategy will be validated by actual emission figures gathered through the IMO's data collection system as of 2019, leading to a final agreement on targets and measures including an implementation plan in 2023. The 2018 and 2023 deadlines are fully consistent with the process agreed in Paris, according to ECSA.

"We invite European policy makers and all stakeholders to join industry in seizing the momentum and showing leadership to make the IMO roadmap work," commented Patrick Verhoeven, ECSA Secretary General at the time. "On the other hand, pursuing regional measures such as an EU ETS or climate fund will seriously endanger international progress, in addition to having negative effects on trade and jobs. The EU should also build trust by aligning its MRV Regulation on the monitoring, reporting and verification of $CO_2$ emissions to the global data collection system agreed in IMO."

Another topic on the MSC agenda was Goal Based Standards (GBS). John Murray, ICS marine director, explains that "Following completion of the IMO GBS initial verification audits for the IACS Common Structural Rules for Bulk Carriers and Oil Tankers, as reported at MSC 96, it is anticipated that proposals by the classification societies relating to rectification of non-conformities that were identified during the audits will be submitted to IMO during December 2016."

IMO and the International Association of Classification Societies (IACS) have recently signed a memorandum of understanding to cooperate more fully in three areas including cyber safety, the ongoing maintenance of the verification process of IACS members' rules with goal based standards, and the redesign of the Marine Casualty Investigation module of the IMO Global Integrated Shipping Information System.

According to IACS, the inclusion of the GBS focus area is based on the recognition of the highest priority that IACS and IMO is giving to the successful delivery of this new work area notably verifying the compliance of class structural rules with goals and requirements that have been set by the IMO.

IACS has also made cyber security one of its key focus areas in recent times, with the establishment of a dedicated IACS Panel and chairmanship of a cross-industry working group. The aim of this work is to review, develop or refine standards, operating procedures and best practices as may be appropriate in producing practical and achievable solutions.

Meanwhile, the inclusion of the MCI module focus area "further enhances the support that IACS is already providing to the IMO Secretariat on the redesign of the MCI GISIS module. IACS shares the IMO Secretary-General's view of the importance of analysing statistics related to maritime casualties and incidents in order that the IMO can deal proactively with safety issues building on a firm evidence base."

Marine evacuation systems were also on the agenda at the recent MSC meeting with the committee noting the information provided by the UK (MSC 97/21/6) regarding failed deployments of marine evacuation systems (MES) during six-yearly rotational tests. Member States and international organisations witnessing MES deployments were invited to share their experience with the UK.

The ICS also highlighted discussions on the ventilation in totally enclosed lifeboats. A proposal by the Bahamian delegation confirmed that the occupants of a totally enclosed lifeboat risk overheating and also that poor air supply inside such a boat often leads to raised $CO_2$ levels.

"ICS and others questioned the application and capacity of powered ventilation systems particularly when applied to lifeboats carried on tankers that are required to have a supply of engine and breathing air to facilitate escape under conditions of fire or gas release," John Murray said. *NA*

Ballast water treatment

## Race for compliance won

Ballast water specialist, Optimarin, has won the race for a USCG-approved ballast water treatment system.

The Norwegian company's Optimarin Ballast System (OBS) complies with the most stringent testing standards set by the USCG for vessels operating in US waters. OBS is consequently the first system to be compliant with IMO and USCG regulations and can be used in waters worldwide.

So far, the USCG standard has been a stumbling block on the path to worldwide ballast water treatment adoption. Various treatment units have been awarded USCG certification as Alternate Management Systems (AMS); however, this was only a temporary measure, and full USCG-approval opens the way for shipowners looking to invest in a fully-compliant system.

Tore Anderson, Optimarin CEO, says: "USCG has the world's most stringent testing standards, meaning that once a system has approval it is assured of total global compliance, now and into the future."

OBS combines filtration and 35kW UV lamps to treat ballast water without chemicals.

**www.optimarin.com**

Ship safety

## Polar Code demonstrator complete

Norway-based lifeboat builder, Norsafe, has completed full-scale tests during a search and rescue expedition to address issues with the use of lifesaving equipment in polar regions.

The testing aimed to demonstrate compliance with the risk and goal-based Polar Code – which takes effect on 1 January 2017 – assessing and analysing potential risks in polar environments and how to mitigate them.

Tests included how to avoid heat loss in -30°C and performance checks on sprinklers, and were carried out with other stakeholders participating. These included: Norwegian Coast Guard, Norwegian Maritime Authorities, Norwegian Petroleum Safety Authorities, ENI, DNV GL and five universities.

Norsafe says its participation in the expedition in April 2016 has resulted in an order of life saving appliances for the Natural Environment Research Council's new polar research vessel, *Sir David Attenborough* (see pages 37-38).

**www.norsafe.com**

Instruments

## Metal only thickness gauge launched

Coltraco Ultrasonics has launched a new portable gauge for measuring metal only corrosion that promises accuracy to ±0.1mm.

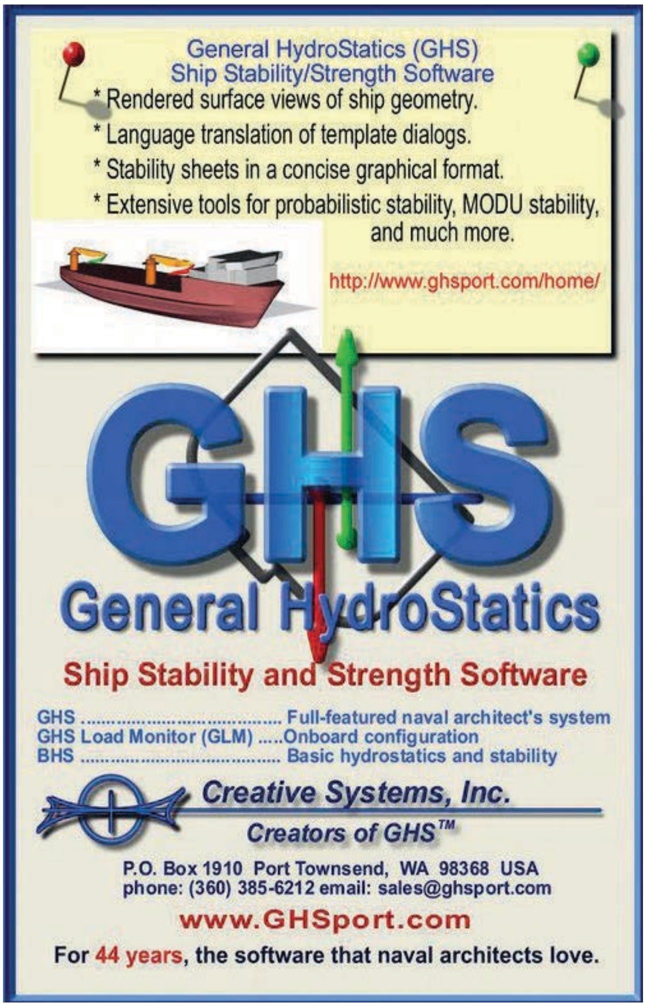
Portagauge 4 can be used to gauge the thickness of steel, aluminium, brass, grey cast iron, cast iron, copper, and zinc, and has the capability to ignore surface coatings that may be applied to sections of a vessel when taking readings.

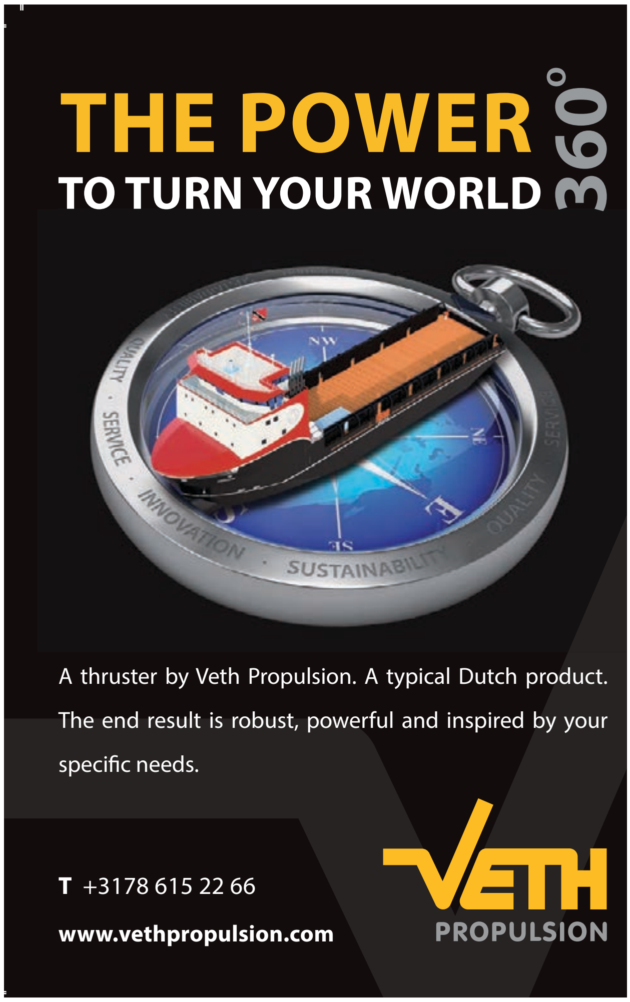
The company says the new gauge requires no zeroing in and can be easily calibrated, and adds that a variety of sensor options and underwater variants can be offered to fulfil a variety of uses and requirements.

A spokesperson says: "At Coltraco we have found that there are crucial safety issues within the Marine and Shipping industries which are severely undervalued. Coltraco's outlook, initiatives and products aim to use cutting edge scientific technology to tackle these issues to ensure a genuine improvement in marine safety across the world."

**www.coltraco.co.uk**

Norsafe have taken part in a search and rescue exercise in anticipation of the adoption of the Polar Code on 1 January 2017


General HydroStatics (GHS)
Ship Stability/Strength Software
* Rendered surface views of ship geometry.
* Language translation of template dialogs.
* Stability sheets in a concise graphical format.
* Extensive tools for probabilistic stability, MODU stability, and much more.
http://www.ghsport.com/home/
GHS
General HydroStatics
Ship Stability and Strength Software
GHS ........................................ Full-featured naval architect's system
GHS Load Monitor (GLM) .....Onboard configuration
BHS ........................................ Basic hydrostatics and stability
Creative Systems, Inc.
Creators of GHS™
P.O. Box 1910 Port Townsend, WA 98368 USA
phone: (360) 385-6212 email: sales@ghsport.com
www.GHSport.com
For 44 years, the software that naval architects love.


THE POWER
TO TURN YOUR WORLD 360°
QUALITY · SERVICE · INNOVATION · SUSTAINABILITY · QUALITY · SERVICE
A thruster by Veth Propulsion. A typical Dutch product.
The end result is robust, powerful and inspired by your specific needs.
T +3178 615 22 66
www.vethpropulsion.com
VETH
PROPULSION


EUROPORT
TURKEY
5 - 8 April 2017
Istanbul, Tuzla
JOIN THE LEADING
MARITIME EXHIBITION
Over the past 10 years, the Europort brand has grown to be the leading maritime exhibition in Turkey.
From 2017 onwards Europort Turkey has chosen for a new location, right in the beating heart of Istanbul's shipbuilding industry: Tuzla.
Join Europort Turkey 2017 and meet over 200 exhibitors in the number 1 shipbuilding region of Turkey!
More information:
www.europortturkey.com
T +31 10 29 33 250
Organised by
ROTTERDAM AHOY
VIA FUARCILIK A.Ş.

# Raising the hull monitoring standard

ISO 19030 points the way to reducing world energy fleet costs and greenhouse gas emissions. Practical methods for measuring changes in ship-specific hull and propeller performance are included in the standard developed to enable the shipping industry to operate with enhanced environmental performance

Hull performance monitoring solutions offer significant fuel and emission saving potential, a fact that is prompting growing interest from the maritime industry – especially in light of the forthcoming ISO 19030 standard. However, hull performance monitoring is difficult due to several rapidly changing factors that influence fuel consumption including draft, trim, ship speed, and wind. Also, while the different monitoring systems all have a similar approach, the available approaches are difficult to measure.

The standard, which prescribes practical methods for measuring changes in ship-specific hull and propeller performance, has now been approved by the ISO Draft International Standard (DIS) ballot, with 93% of country representatives voting in its favour. This resounding approval rate paves the wave for final publication, with ISO 19030 expected to be publicly available at the end of Q3 this year.

Geir Axel Oftedahl, Jotun's Business Development Director – Hull Performance Solutions, managed the project on behalf of the International Organization of Standardization (ISO) and is clear about its importance.

"Poor hull and propeller performance is estimated to account for around 10% of the world fleet's energy costs (US$20 billion)," he notes. "There are very effective solutions for improving performance but, until now, no globally recognised and standardised way for measuring this and providing a return on investment for shipowners. ISO 19030 satisfies that demand, prescribing measurement methodology and defining performance indicators for hull and propeller maintenance, repair and retrofit activities.

"We believe this will provide much needed transparency for both buyers and sellers of fuel saving technologies and solutions, and in doing so, enable the industry to operate with genuinely enhanced efficiency and environmental performance."

Oftedahl has, since 2013, managed a project involving 53 experts in an ISO working group convened by Svend Søyland of Nordic Energy Research in a bid to develop a standard that is comprehensive, accurate and workable worldwide.

Oftedahl and Søyland are keen to emphasise that performance monitoring is entering a mature phase and that the new voluntary standard represents a "good starting point to offering a level playing field and the adoption of industry-wide best practices and transparency."

Here is an outline of the initial motivation, purpose and implementation of the standard (extract from their paper entitled ISO 19030- the motivation, scope and development) followed by Oftedahl's views on advances in measurements of hull performance and the implications for buyers and sellers of performance enhancing technologies and solutions.

## Why is ISO 19030 needed?

Today hull and propeller performance is a ship efficiency killer. According to the Clean Shipping Coalition in MEPC 63-4-8, poor hull and propeller performance accounts for around 1/10 of world fleet energy costs and greenhouse gas (GHG) emissions. This points to a considerable improvement potential; 1/10 of world fleet energy costs and GHG emissions translates into billions of dollars in extra costs per year and around a 0.3% increase in man-made GHG emissions. The culprits are a combination of biofouling and mechanical damage.

Most vessels leave the newbuild yard or subsequent drydocking with their hull and propeller in a fairly good condition. Then on account of a combination of biofouling and mechanical damage, hull and propeller performance begins to deteriorate.

There are technologies and solutions on the market that can protect the hull and maintain good performance over the full duration of the docking interval - why then is hull and propeller performance still so poor?

Figure 1: Hull and propeller performance

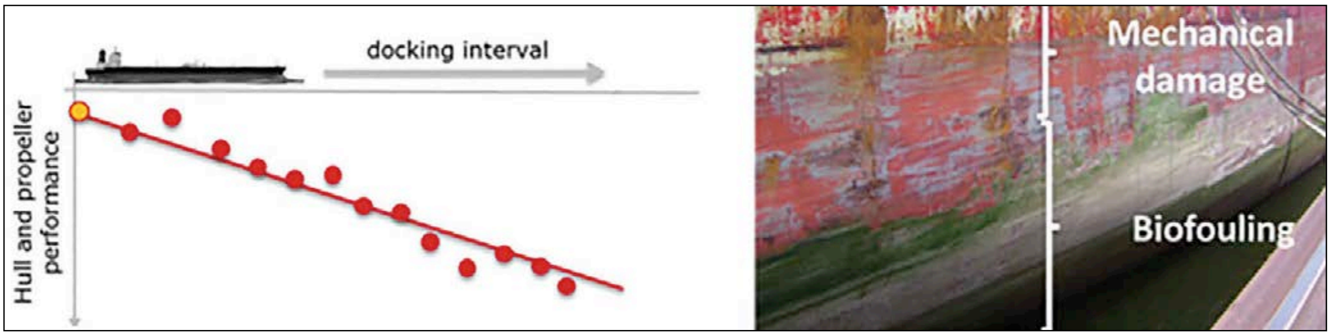
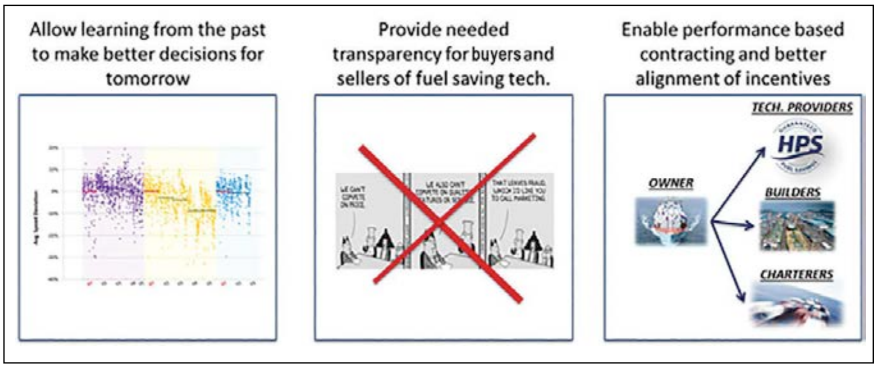


Figure 2: Why ISO 19030 is needed




In the past the problem has been a lack of measurability. If one cannot measure it, one cannot manage it. Now a multitude of measurement methods are being introduced in the market; some quite good, some really bad, most of them proprietary (black box) and many using their own yardsticks. However, it is becoming challenging even for the most resourceful to determine which of these methods can be relied upon and which cannot. Moreover, the measurement methods have different and incompatible yard sticks resulting in the measurement output serving to confuse rather than inform.

This standard is intended for all stakeholders that are striving to apply a rigorous, yet practical way of measuring the changes in hull and propeller performance. It could be shipowners and operators, companies offering performance monitoring, shipbuilders and companies offering hull and propeller maintenance and coatings. ISO 19030 will make it easier for decision makers to learn from the past and thereby make better informed decisions for tomorrow. It will also provide much needed transparency for buyers and sellers of technologies and services intended to improve hull and propeller performance. Finally, it will make it easier for the same buyers and sellers to enter into performance-based contracts and thereby better align incentives.

## What ISO 19030 covers

ISO 19030 outlines general principles of, and defines both a default as well as alternative methods for, measurement of changes in hull and propeller performance. The standard defines sensor requirements, measurement procedures, including various filters and corrections, as well as how to calculate a set a set of four performance indicators for hull and propeller related maintenance, repair and retrofit activities.

One of the performance indicators is "In-service performance". In-service performance refers to the average change in hull and propeller performance over the dry-docking interval. Performance over the first year following the docking is compared with performance over whatever remains of the docking interval – typically two to four years. This performance indicator is useful for determining the effectiveness of the underwater hull and propeller solution – for example the hull coating system used.

The three additional performance indicators are "Drydocking performance", "Maintenance trigger" and "Maintenance effect".

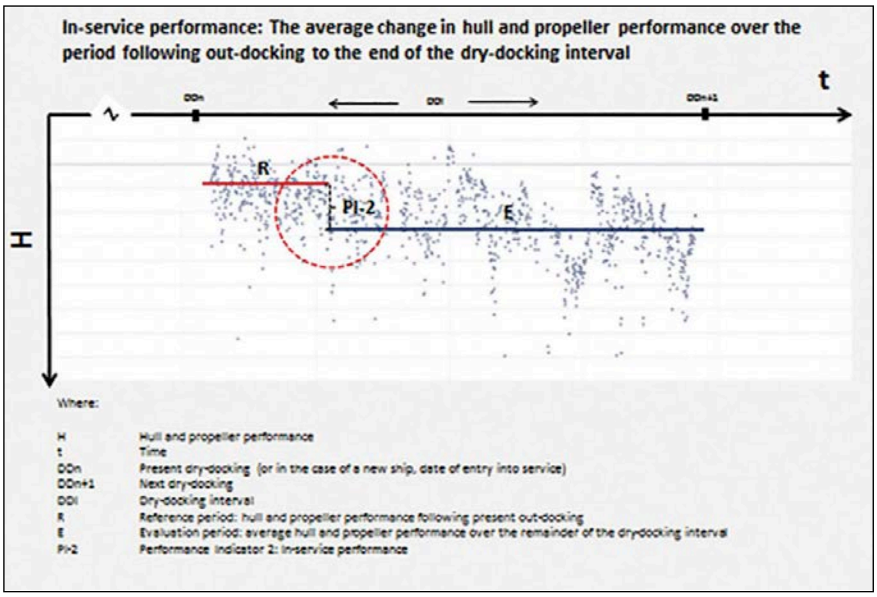
- Drydocking performance: Hull and propeller following the present out-docking is compared with the average performance from previous out-dockings. This provides useful information on the effectiveness of the docking.
- Maintenance trigger: Hull and propeller performance at the start of the drydocking interval is compared with a moving average at a point in time. Useful for determining when hull and propeller maintenance is needed – including propeller polishing or hull cleaning.
- Maintenance effect: Hull and propeller performance in the period preceding the maintenance event is compared with performance after. This provides useful information for determining the effectiveness of the event.

ISO 19030 is fairly all-encompassing. It covers what sensors are required, how these are to be maintained, step-by-step procedures for filtering and correcting the data, and finally how the individual performance calculators are to be calculated.

The standard is organised into three parts:

- ISO 19030-1 outlines general principles for how to measure changes in hull and propeller performance and defines the four performance indicators for hull and propeller maintenance, repair and retrofit activities.
- ISO 19030-2 defines the default method for measuring changes in hull and

Figure 3: Performance indicators in ISO 19030 – In-service performance



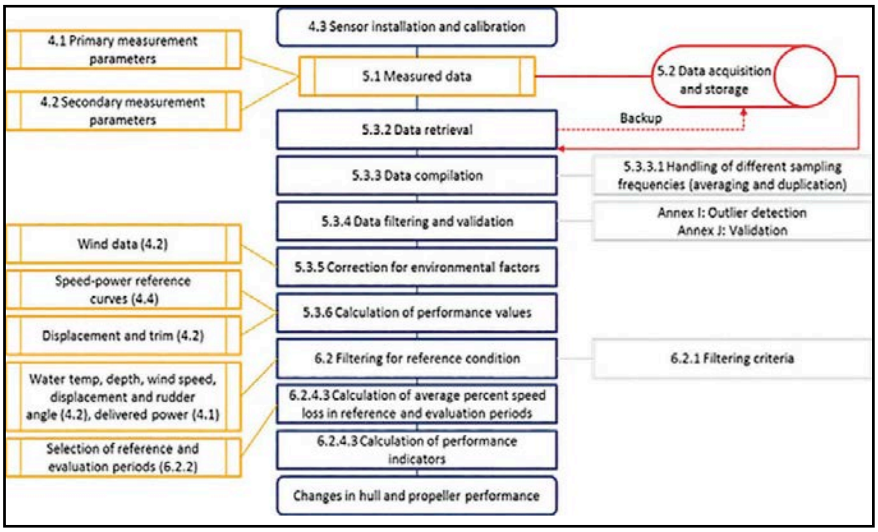



Figure 4: ISO 19030 scope

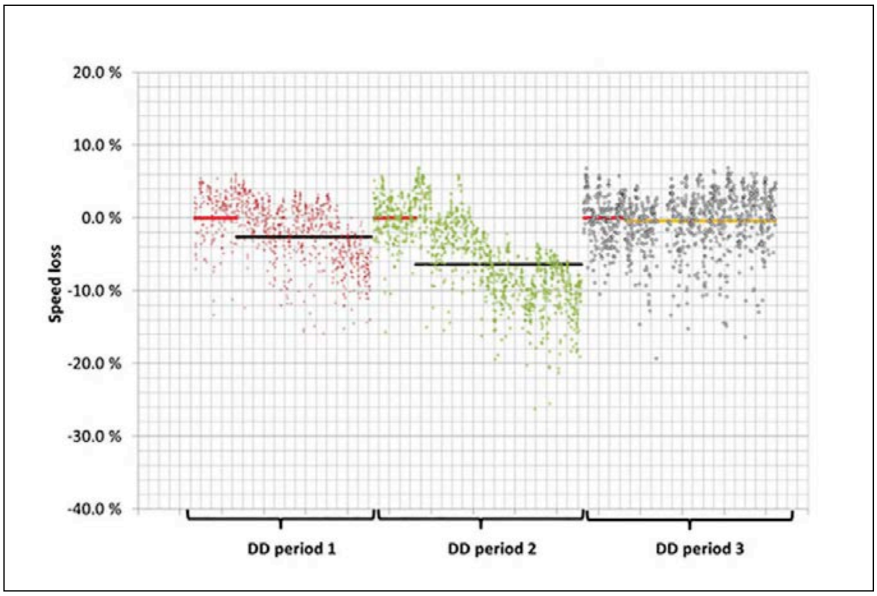



Figure 5: Change in hull performance on same vessel in same trade over three full drydocking intervals with different hull coating solutions

propeller performance. It also provides guidance on the expected accuracy of each performance indicator.

- ISO 19030-3 outlines alternatives to the default method. Some will result in lower overall accuracy but increase applicability of the standard. Others may result in same or higher overall accuracy but include elements which are not fully validated in commercial shipping.

## How ISO 19030 has been developed

The process towards developing ISO19030 started when the Environmental NGO Bellona Foundation and Jotun A/S had informal discussions on how to improve energy efficiency within the maritime sector. Bellona looked for a robust and verifiable way to reduce $CO_2$ emissions, whereas Jotun saw the need for a more transparent approach to verify a myriad of performance claims on hull and propeller maintenance.

A series of workshops held in accordance with Chatham House Rules involved a steadily increasing number of stakeholders and paved the way for a common understanding among performance monitoring companies, measurement manufacturers, ship maintenance system providers, classification societies, shipbuilders and shipowners and their associations. Bellona Foundation and Jotun subsequently held a side-event at IMO-MEPC meetings and presented the embryo for a reliable and transparent hull and performance standard at several maritime conferences.

Work on the ISO-Standard was initiated in June 2013 when Working Group 7 under SC2 TC8 (Sub Committee 2 Technical Committee 8) was formed. Svend Søyland from Nordic Energy Research serves as the convener of the working group and Geir Axel Oftedahl from Jotun has the role as project manager. A series of Working Group meetings have been held worldwide.

More than 50 experts and observers representing shipowners, shipping associations, newbuild yards, coatings manufacturers, performance monitoring companies, academic institutions, class societies and NGOS participated in the ISO working group that reached consensus on the ISO 19030 standard. Additional industry stakeholders have been consulted and involved as a part of this extensive process.

The drafting process uncovered a need to address both the most rigorous methods available and the most commonly used approaches used. This led to the division into three parts. A Committee Draft of part 1 and 2 (CD) was submitted in March 2015. A Ballot among P-members was concluded in May 2015 with sound support. The target date for submitting a Draft International Standard (DIS) of all three parts was December 2015. An ISO-Ballot was concluded in March 2016 and the standard is now publicly available. The Working Group (WG7) will remain operational in order to prepare future revisions and refining the standard.

## Implications for buyers and sellers

Turning to advances in measurements of hull performance and the implications for buyers and sellers of performance enhancing technologies and solutions. Oftedahl reiterates the point made earlier that over the past several years a wide range of new and innovative technologies and solutions have been introduced in the market "with the promise of substantial improvements in hull performance and thereby improved ship efficiency. Still, potential buyers have largely found themselves unable to accurately and reliably determine their individual contributions. The resulting ambiguity has slowed down investments in technologies and solutions that actually deliver. At the same time, it has resulted in needless spending on many that never will."

However, Oftedahl also points out that "current advances in sensor technologies, onboard ICT infrastructure as well as analysis methods, are making it increasingly possible to isolate and measure the energy efficiency contributions from individual technologies and solutions. When published, ISO 19030 will make it easier to rely upon and compare the output from such measurements."

Oftedahl further emphasises that advances in measurements of hull performance "should make it possible for buyers and sellers to make better and quicker decisions that better align stakeholder interests."

## Better decisions

"As an example for decision makers," says Oftehdahl, "reliable and comparable measurement output will make it easier to learn from the past and thereby make better decisions for tomorrow".

Consider the real-life example in Figure 5. The figure shows actual hull and propeller performance over three separate five-year drydocking intervals on the same vessel in the same trade, but with different hull coating solutions.

In the middle drydocking interval, the development in hull performance is very similar to what was found to be market average in MEPC 63-4-8. In this interval there is a 6.4% speed loss or a 19% increase in power needed to maintain the same speed - on average over the four years following the benchmark period. Note that the ship needs 38% more power at the end of the period to maintain the same speed.

In the first of the three drydocking intervals, the development in hull performance is somewhat better. In this interval there is a 2.7% speed loss or an 8% increase in power needed on average over the four years following the benchmark period.

In the last of the three drydocking intervals, the development in hull performance is indicative of what is possible with today's hull antifouling technologies: virtually no performance loss over the full period.

The difference between market average and best performance is around 18% in the power required to maintain the same speed over the past four years of the drydocking interval. On the 54,000dwt bulk carrier in question, at a bunker price of US$350 per tonne, this difference would translate into a US$1.8 million difference in fuel cost and a 16,000tonne difference in $CO_2$ emissions.

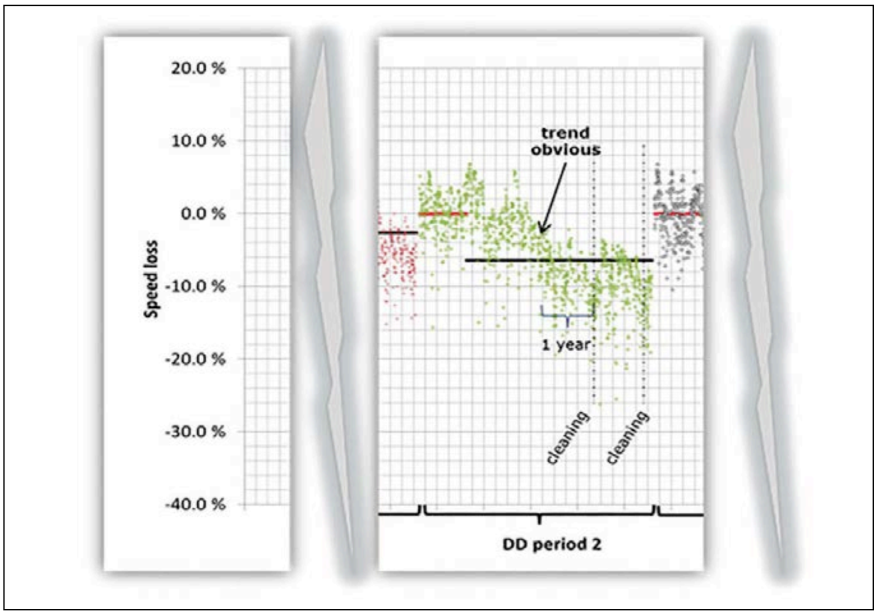



Figure 6: The potential for quicker decisions on unplanned maintenance and repair

## Quicker decisions

Oftedahl further argues the point that "for decision makers, reliable and comparable measurement output will, when delivered in a timely fashion, also allow for quicker decisions on unplanned maintenance and repair of the underwater hull. Such a capability can prove very valuable."

Consider again the middle interval from the real life example provided above. After about 3.5 years into the drydocking interval, the underwater hull on the vessel was cleaned. This resulted in an immediate improvement in speed of around 6% or conversely an 18% reduction in the power needed to maintain speed. Note that the hull was cleaned for a second time around 4.5 years into the drydocking interval.

On this vessel, at the time, performance data was collected and stored but changes in hull performance were not monitored continuously. As can be seen from the data, if changes in hull performance had been continuously monitored it would have been possible to identify a negative trend at a much earlier stage. Two and a half years into the drydocking interval, this negative trend would have been impossible to miss.

Regular cleaning of the underwater hull from about 2.5 years and onwards would not have eliminated the problem but would have served to improve hull performance over the remainder of the drydocking interval considerably. A reasonable estimate is that the vessel, given cleaning every six months or so (for a total of five cleanings), would have been able to end up with an average over the period speed loss of around 4% rather than 6.4% (based on two cleanings).

On the 54,000dwt bulk carrier in question, and at a bunker price of US$350 per tonne, this difference would translate into a US$0.7 million difference in fuel cost and a 6,000 tonne difference in $CO_2$ emissions. The direct cost of the three additional underwater hull cleanings would typically be around US$0.1 million – leaving a US$0.6 million net gain.

## Measurable impact

"In summary, advances in measurements will make it possible for buyers and sellers of technologies and solutions that promise improvements in hull performance to make better and quicker decisions. It will also make it easier for both to better align interests with 3rd parties," says Oftedahl, concluding: "the advances in measurements as reflected in the new ISO 19030 standard should therefore contribute to the realisation of the great improvement potential within hull and propeller performance and as such have a measurable impact on world fleet energy cost and GHG emissions." *NA*

# Selektope hits the water

A biocide produced by a Swedish tech company that prevents marine organisms from attaching themselves to vessel hulls has completed a year of trials on *Calypso*, a 46,067dwt chemical and products carrier owned by Laurin Maritime. In an exclusive report *The Naval Architect* can reveal the results of the trials

Climate change is already having a tangible effect, according to some South Korean yards, who say that warming sea temperatures are leading to an increase in fouling problems.

In the warm waters around South Korea the problem is becoming particularly acute with newly launched vessels remaining stationary for some three or four months during the fitting out process, becoming so badly fouled that they perform badly during sea trials.

This problem has forced the South Korean yards to find a solution to hard fouling, which can damage newly applied coatings and can in some instances change the hydrodynamics of the vessel's hull to the extent that it interferes with the flow of water into the propeller, reducing its efficiency.

A remedy has come in the form of Selektope, a biocide developed by a pharmaceutical company that has been adapted for use in the marine industry (see *The Naval Architect* September 2016 pages 22-26). The biocide works by exciting the marine organisms that come into the proximity of the coating, making it impossible for them to settle on the hull.

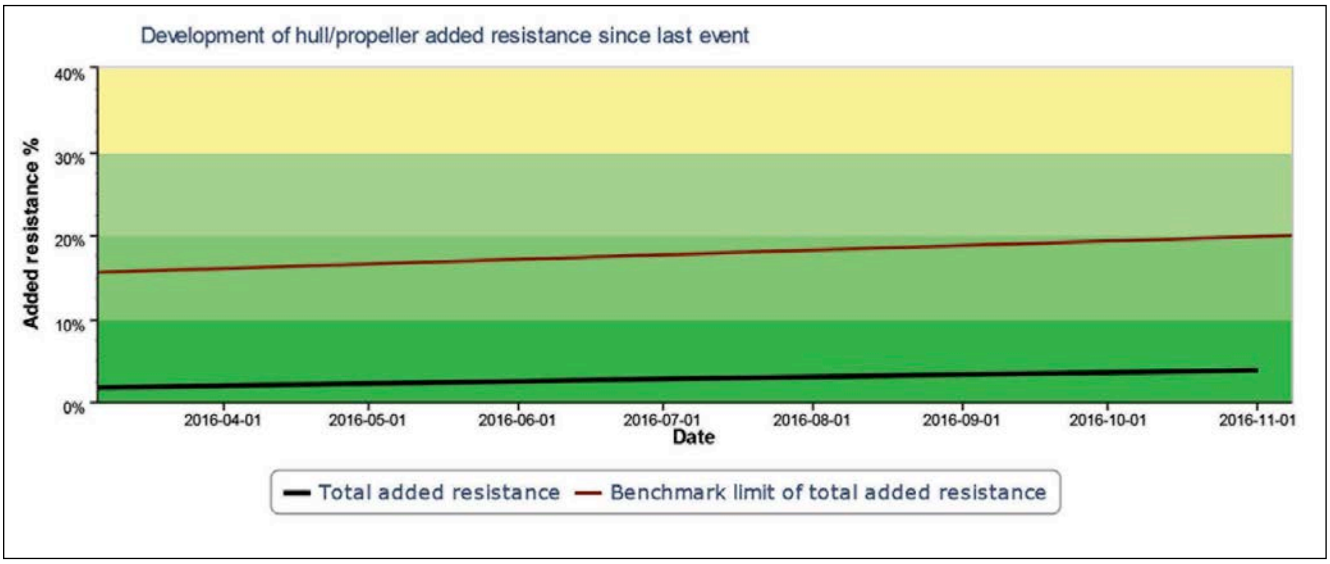
Selektope CEO Philip Chaabane says the biocide has no lasting effects on organisms

Philip Chaabane, CEO of biocide company I-Tech AB, which produces Selektope, is quick to point out that any effect on the organism is temporary and the organism will simply swim away from the vessel. This, apparently simple solution, works very effectively according to the latest results from hydrodynamic analysis of performance data carried out by independent party Propulsion Dynamics over the last year.

Applied to the 2010 built chemical and product tanker *Calypso*, which operates in a number of regions including East and South Asia, the Americas and Australia, the operating results, as measured by the fuel oil consumption and power output, give an encouraging view of the effectiveness of the coating additive.

After 12 months, the vessel was measured to have increased its resistance to fouling by a total of 3% compared with a benchmark new

The CASPER graph shows the added resistance is the increase in hull and propeller resistance relative to new building at design draft and design speed. The benchmark limit is an upper limit of the normal development of added resistance. Hull or propeller cleanings should be considered when the total added resistance exceeds the benchmark limit. After each drydocking the benchmark limit is adjusted to the new level



The long term effects of Selektope must also be tested says Stefan Sedersten, I-Tech chairman

vessel that would see an increase in resistance of 5-10 %. Calypso showed that the increase in resistance came mainly from the propeller, 3%, with the remaining resistance being measured on the hull.

"So far so good," says the Laurin Maritime technical director Bertil Andersson, who added: "this is the first year of a 60 month system on a fully blasted hull, so we will have to see how it [Selektope] compares with other high quality coating systems in two or three years' time."

Andersson says that Selektope offers protection mainly against barnacles, but as the Laurin ships often operate in the "red zones", where the water temperature can be high, it is important that the company selects a coating that can cope with this type of climate, particularly if a ship is at anchorage for three to four weeks.

"The CASPER Reports [produced by Propulsion Dynamics] are important because they give much more detailed information, on propeller resistance and hull resistance, you can see it immediately," explains Andersson.

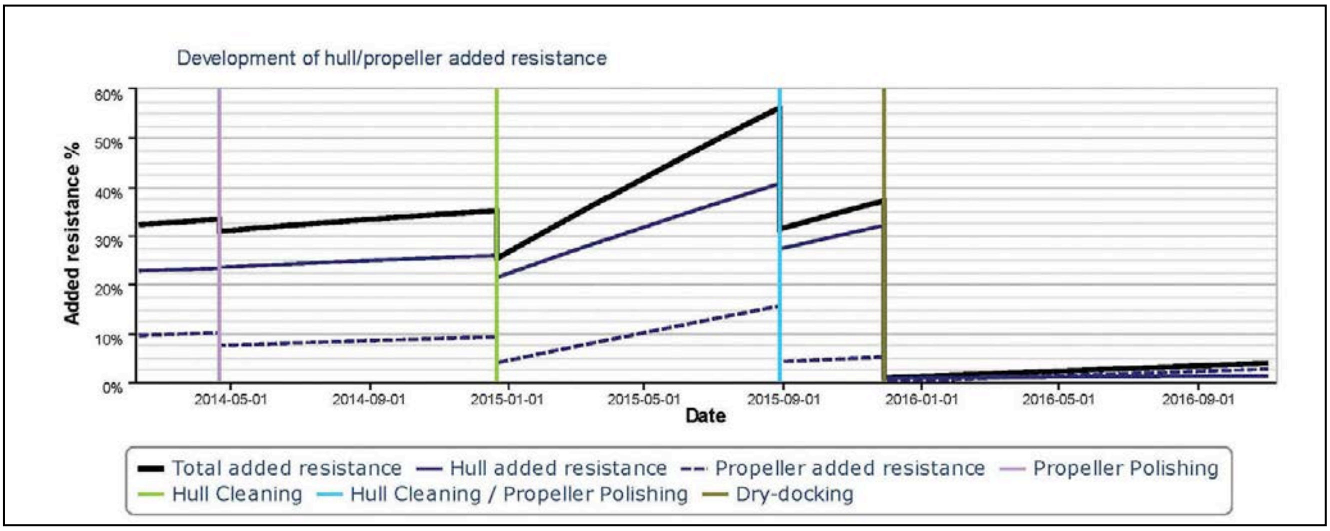
"The benchmark is made up of a large number of different vessels with different coatings related to the size of the database within Propulsion Dynamics. We believe it is not possible to compare equal ships to equal ships, but one ship can be compared to a large average of a variety of similar vessels."

I-Tech chairman Stefan Sedersten, however, adds a note of caution: "Although there are very convincing long-term performance results from patches, more time is required to confirm the promising results from *Calypso* [and] there would need to be further trials of Selektope for longer periods so that the long-term effects of the biocide can be measured."

If Chaabane is correct and climate change has already warmed the oceans by 1-2°C then the requirement for a more effective fouling control will certainly increase. And while these test results, produced over a year's operation on a single ship, do not by themselves show that Selektope is the solution, they do show that the additive is a contender to help combat some of the effects of climate change, as well as a means to reduce ship emissions through the maintenance of cleaner, more efficient hulls and propellers. *NA*


*Calypso* having its new coating applied on its first drydocking

A CASPER graph for *Calypso*



CASPER comparison of speed and FOC to sea trial performance for *Calypso*

**Vessel Performance**

| | |
|---|---|
| Total added resistance | 4 % |
| Hull added resistance | 1 % |
| Propeller added resistance | 3 % |
| Benchmark limit of total added resistance | 20 % |
| Development rate of total added resistance (approximately, normally between 0.5% and 1.5%) | 0.3 % / month |
| Development rate of hull added resistance (approximately) | 0.0 % / month |
| Development rate of propeller added resistance (approximately) | 0.2 % / month |
| Reduction of added resistance due to last event | 37 to 1 % |

**Registered ship events**

| | |
|---|---|
| Ship built | 2010-10-19 |
| Date for latest dry-docking | 2015-11-28 |
| Date for latest hull cleaning | 2015-11-28 |
| Date for latest propeller polish | 2015-11-28 |
| Number of observations since latest event | 432 |
| Number of observations since latest report | 39 |

## Comparison on speed and fuel consumption

| Defined service condition | | Loaded | Ballast |
|---|---|---|---|
| Draft aft | m | 11.10 | 7.63 |
| Draft fore | m | 10.86 | 6.34 |
| Mean draft | m | 10.98 | 6.99 |
| Trim | m | 0.24 | 1.29 |
| Displacement | t | 50,798 | 30,965 |
| Shaft generator power | kW | 0 | 0 |
| Fuel calorific value | kJ/kg | 40,700 | 40,700 |
| **Fuel consumption** | | | |
| Incl. weather allowance and possible shaft generator | | | |
| Speed for calculations | knots | 13.0 | 13.0 |
| Fuel consumption trial trip | t/24h | 20.7 | 18.9 |
| Fuel consumption, after last event | t/24h | 21.1 | 19.2 |
| Current fuel consumption | t/24h | 21.6 | 19.6 |
| Excessive fuel consumption compared to trials | t/24h | 0.9 | 0.7 |
| Excessive fuel consumption since last drydock | t/24h | 0.8 | 0.6 |
| Reduction of fuel due to last event | t/24h | -0.0 | -0.0 |
| **Speed** | | | |
| Incl. weather allowance and possible shaft generator | | | |
| Engine load for calculations (MCR) | % | 70 | 70 |
| Speed trial trip | knots | 13.8 | 14.2 |
| Speed, end of actual period | knots | 13.6 | 14.1 |
| Speed reduction | knots | 0.2 | 0.1 |
| Speed reduction | % | 1.4 | 0.7 |
| **Fuel/CO2 index** | | | |
| Design index, Fuel | g/tons displacement/ nautical mile | 1.24 | 1.86 |
| Maintenance index, Fuel | | 0.05 | 0.07 |
| Total index, Fuel | | 1.30 | 1.93 |
| Design index, CO2 | g/tons displacement/ nautical mile | 3.88 | 5.80 |
| Maintenance index, CO2 | | 0.17 | 0.21 |
| Total index, CO2 | | 4.04 | 6.01 |
| **Potential fuel savings** | | | |
| Speed for calculations | knots | 13.0 | 13.0 |
| Excessive fuel consumption since latest hull event due to hull resistance | t/24h | 0.0 | 0.0 |
| Excessive fuel consumption since latest propeller event due to propeller resistance | t/24h | 0.6 | 0.4 |

# The roads to (energy) freedom

Solving the greenhouse gas conundrum is the ultimate existential challenge, threatening humanity across the globe if we fail to deal with emissions causing increases in average global temperatures. This challenge is motivating Japan's development, with its Australian partners, of a carbon-free shipping future

Many observers have dismissed hydrogen as a green fuel due to the expense of producing the gas, but Kawasaki Heavy Industries (KHI) believes that it has a solution that will allow it to meet all of Japan's power needs for more than 200 hundred years.

Often the production process considered has been electrolysis, but KHI is considering the benefits of hydrogen produced in Australia from gasified brown coal. The extracted and liquefied hydrogen would then be transported to Japan in purpose built tankers to provide a carbon-free fuel for the foreseeable future. According to the company it is building the infrastructure, including a prototype $LH_2$ tanker, which will allow the company to meet its goal of developing the gas supply chain which it calls the Hydrogen Road.

The $LH_2$ prototype liquefied hydrogen tanker is to be built at KHI's Kobe shipyard and the front end engineering design of the prototype vessel is now complete. The ship with two prototype 1,250m$^3$ liquefied hydrogen tanks has a length of 110m, which was elongated to ensure the design would allow the ship to safely transit from Australia's southern province of Victoria to Japan with the liquefied hydrogen cargo onboard.

Yukichi Takaoka, a hydrogen ship development officer at KHI, told *The Naval Architect* that the extra space adjacent to the cargo holds will be used to conduct tests for when the full sized ship is built some years in the future.

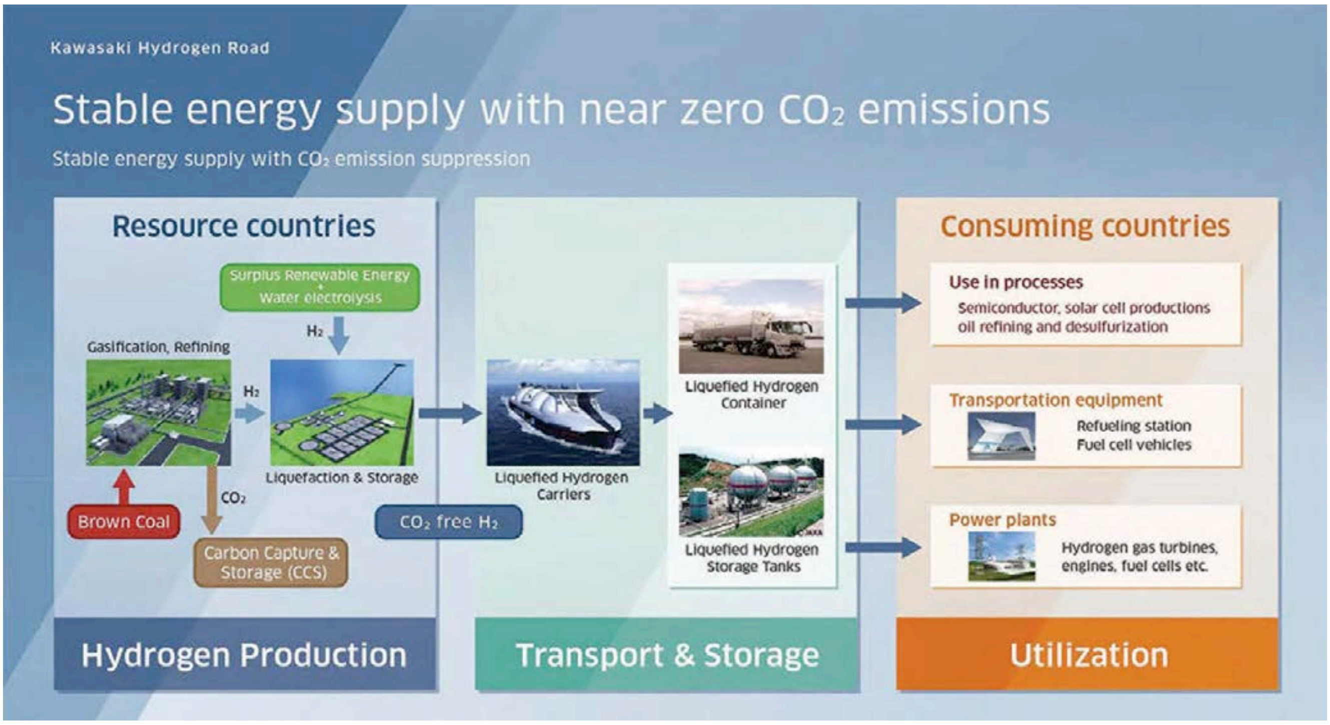
The concept of the Hydrogen Road will see the production of hydrogen in Australia from brown coal, which will then be liquefied and stored in tanks at -253°C before it is transported by the newly developed $LH_2$ tanker to a terminal in Japan for use in the production of power.

"Hydrogen has two advantages, it is clean and it is powerful," says Seiichi Sugawa, a hydrogen project development officer. "The fuel has a high power density in terms of weight and a high calorific value in terms of weight," he added. Further pointing out that hydrogen is used as a rocket fuel, which shows the possibilities for its development as a power source, both for producing electric power from a power station and as fuel in cars or ships in the shape of a fuel cell, currently under development in a number of countries, including Japan.

According to Sugawa, a massive amount of hydrogen can be imported to Japan if the cost simulation that searched for the optimum energy combination remained in the CIF price range of ¥25-45/m$^3$. This, he continues, is a competitive price compared with other energies and is cost combined with energy output and the condition of the hydrogen. "If we consider the lowest cost case (¥25), hydrogen will provide 40% of all of Japan's energy needs, and in the highest cost case (¥45) it will be 20% of Japan's needs by 2050," explains Sugawa.

KHI says it will establish a test run for the technology necessary to develop, store,

The prototype 110m $LH_2$ transporter is now under construction at the KHI shipyard in Kobe




The Hydrogen Road as envisaged by Kawasaki Heavy Industries

transport and deliver liquefied hydrogen from Australia to Japan.

Gasification of brown coal mined in the Australian state of Victoria will split the fuel into its component parts, carbon, which will be captured and stored securely underground, and hydrogen, which will be liquefied and stored at -253°C in tanks specially designed by KHI, before being transferred to an $LH_2$ tanker and transported to Japan, for example Kobe in the case of the pilot chain, where it will be stored on land and distributed to outlets.

The prototype Hydrogen Road has been under discussion since 2009 and, with much of the technology already tried and tested, the company is confident that it will be able to develop the complete logistical chain for the fuel within four years with a view to providing the first commercial power station with fuel by 2025.

The technology for the storage tanks already exists, for example. KHI has more than 20 years of experience in handling hydrogen rocket fuel, storing it in double skinned stainless steel tanks that have a vacuum between each of the walls to provide insulation for the cryogenically stored liquefied gas.

This same technology will be adapted for use on the $LH_2$ tanker; however, unlike LNG tankers, the pilot tanker will use conventional diesel electric power for propulsion. Much of the technology that will be used in the construction of the $LH_2$ tanker prototype has already been tried and tested either in Japan's space programme or on the LNG tankers that the company itself builds, including double walled piping, valves and loading systems.

In the meantime, "Kobe City will provide a suitable area for a hydrogen Terminal, and it is now designing the terminal which will be built by 2020," explained Seiichi, adding: "At this moment this $CO_2$ free chain is achievable, and the pilot chain will prove it is possible." *NA*

Technical details of the $LH_2$ carrier

## Pilot Ship - Outline

| | |
|---|---|
| **Ship Principal Particulars** | |
| Dimensions: | $L_{pp}$ 108.00 m x B 19.00 m x D 10.60 m |
| Gross Tonnage: | abt. 8,000 tons |
| Propulsion system: | Diesel - electric |
| Max. Continuous Output: | 2,650 kW @ 217 rpm |
| Speed: | abt. 13.0 knots (including 50 % sea margin) |
| Person On Board: | 25 persons |
| Endurance: | abt. 10,000 Nautical miles |
| Flag State / Class : | Japan / Class NK |
| **Cargo Containment System** | |
| Total Capacity: | 2,500 $m^3$ (No.1 & No.2 Tank: 1,250 $m^3$ each) |
| Tank Type: | IMO Independent Cylindrical Tank Type C |
| Max. Design Pressure: | 0.4 MPaG |
| Min. Design Temperature: | -253 degree C (20 K) |
| Tank Material: | Austenitic Stainless Steel (SUS304L) |
| Insulation System: | Vacuum Insulation + Panel Insulation |
| Press. Control System: | Pressure Accumulation |

# The Internet of Ships: a new design for Smart Ships

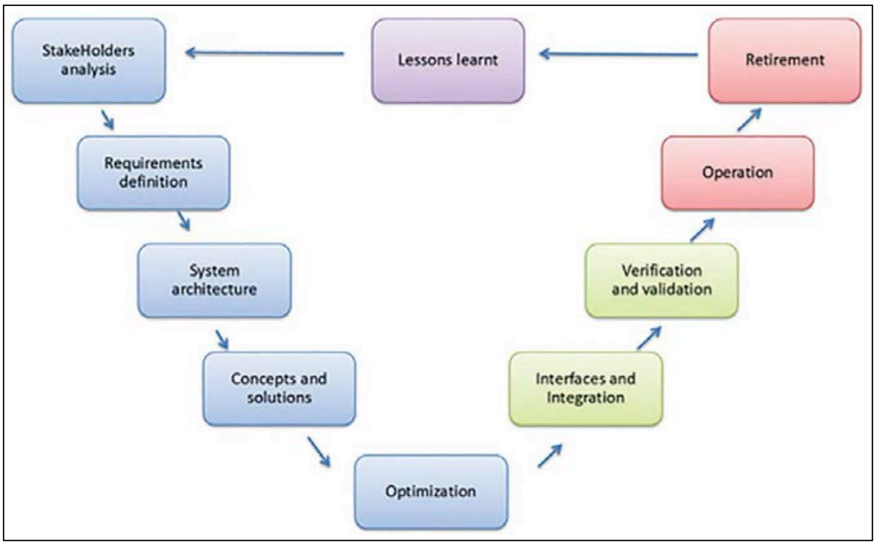
Developments in the Internet of Things can help to deliver smart vessels that improve operation, usability and profitability for shipowners, users and workers, explains Jesús A. Muñoz & Rodrigo Perez, SENER Ingeniería y Sistemas S.A., Spain

If the marine industry wants to adapt to new technologies it must start with the design process and prepare vessels for the inclusion of new technologies throughout their development.

Shipbuilding has two well-defined and separate periods: the design phase and the operational life. These periods can be sustained through working methodologies. Of particular note is systems engineering. Systems engineering appears to solve problems that need to be addressed in sectors with high added value, such as products for defense or aerospace engineering, which require strong design and construction processes from the very early stages to reduce costs, ensure planning and keep schedules within budget. Systems engineering requires the use of more specific technologies in order to be applied effectively.

CAD systems are traditionally used for the design and construction stage, and, in more recent times, PLM solutions have emerged providing valuable tools for product management. However, these tools require an enormous amount of information that must be provided during the ship design and construction project stages. It is therefore necessary to find a way to join these two technologies, CAD and PLM, so that all the value mutually contributed in a project is not lost. In this way, the PLM system must always be used as the unique source for the reference of data, while the CAD system must feed the PLM with its data – data that the PLM incorporates into its core.

This said, it is only one side of the problem, and there are different technological trends emerging as the engines of great change. Among them, the Internet of Things (IoT) stands out because of its direct impact on the world we see and touch.




A new design process is needed to prepare vessels for the inclusion of new technologies throughout their development

## IoT challenges

Ships are small pieces of humanity at sea; they are like medium sized cities, medium industries, leisure places or whatever anyone imagines. All the necessities that a society can have shall be necessities on the ship. If the society progresses in some knowledge or technological area, sooner or later, the vessels will have to address that progress. It is obvious that IoT can provide many advantages for ships. However, specific risks have to be taken into account when anyone thinks of deploying the IoT for ships.

We can recognise several areas where IoT presents problems that need a common solution: security, standardisation and business orientation.

Security represents the most significant problem to be solved before bringing IoT to ships. Recent Distributed Denial of Service (DDoS) attacks by thousands of malicious software infected devices connected to the Internet, with more than 100,000 Mirai IoT botnet nodes bringing down services on Twitter, Paypal, and Spotify last October, ask questions of the reality of more connected ships: what could happen if a ship is waiting on responses from the internet in the middle of a storm, especially when thousands of people are onboard? Will safety be compromised? At present there are no guaranteed solutions, but several issues such as the identification of devices, protection against attack, control of updates, and redundancy will have to be considered.

The rapid growth of IoT has led to an uncontrolled growth of devices connected to the Internet through the separate system platforms of manufacturers. Each device manufacturer has built their own IoT solution by connecting their hardware to their cloud server to answer their requests. As the industry evolves, the need for a standard model to perform common IoT backend tasks is becoming more relevant.

The success of IoT will not go hand in hand with the early adopters, but with the companies, and this will only be possible if the initiatives have a clear component oriented in the business, that is to say to add a value. It is necessary to identify which of the initiatives provide a clear value to the business, but also to take into account that this value can be in various terms and not all directly economic. In the field of ships, there are many possibilities. The clearest ones have to do with the optimisation of energy costs, fuel consumption, choice of routes, safety at sea, but also in the work itself inside the ship or the security onboard.

How can the naval sector adapt itself to these changes, taking into account that it is a very conservative sector and in which changes take time to penetrate? The answer lies in putting the focus on its processes and accepting the value propositions that appear both in the product scope, as in the design and construction. This adaptation must take into account the entire value chain.

## The contribution of a CAD System to the IoT

CAD tools are at the beginning of the product life cycle, but they also have a strong relationship with the production cycle, providing the information needed for construction in all aspects. Those CADs with a compact and homogeneous database can extend their contribution to both the lifecycle management tools and the IoT connectivity management application of the ship's elements.

CAD applications will need to have certain characteristics to make all of this possible. A CAD system like SENER's FORAN, for example, will need to evolve into a global solution that not only provides a CAD system, but also provides applications that manage the connection of devices and objects in the CAD model to IoT. In our view, the CAD system will not only be the heart of the design, but also the vehicle of communication between the products, their manufacturers and their operation. However, what characteristics turn a CAD system into a global design solution? To answer this, it is necessary to identify future technological trends, and amongst them connectivity stands as both the most obvious and most important, requiring a variety of approaches:

- Connectivity of design systems
- Connectivity of design and construction systems
- Connectivity of ship systems to each other and to the world of IoT.

## Connectivity of design systems

The design of a ship needs a diverse range of design applications. It seeks to optimise the product from different points of view, which requires design systems that, to a greater or lesser extent, need to be connected. They must be able to talk to one another, exchange data, models or forms, and necessitate data communication agreements through either APIs or common interfaces.

> "A CAD system like SENER's FORAN will need to evolve into a global solution that not only provides a CAD system, but also provides applications that manage the connection of devices and objects in the CAD model to IoT"

CAD exchange formats have extended their scope. The connection of CAD systems with product lifecycle management systems (PLM) has been indispensable in bringing value to the product itself. The PLM will not only be part of the design and construction stage, but will also extend to the operation of the ship. The PLM stands as the controller of the product where all valid information is kept. The different objects and equipment of the ship should not be autonomous entities that decide by themselves; they should instead be supervised by a system that takes into account the product as a whole.

Due to a vessel's innate high value, as well as the value of its cargo, it cannot be left on the edge of technological autonomy considering the number of unpredictable circumstances a ship faces (sea conditions, piracy, etc.). It must have a higher controller and this responsibility must fall to personnel.

## Connectivity of design and construction systems

Along the production process the communication between the shipyard and design office is constant and both must have updated information about the product and its building phase, opening up opportunities for interesting and increasingly viable new technologies that connect the two parties.

IoT can provide many advantages for ships, opening up new levels of insight

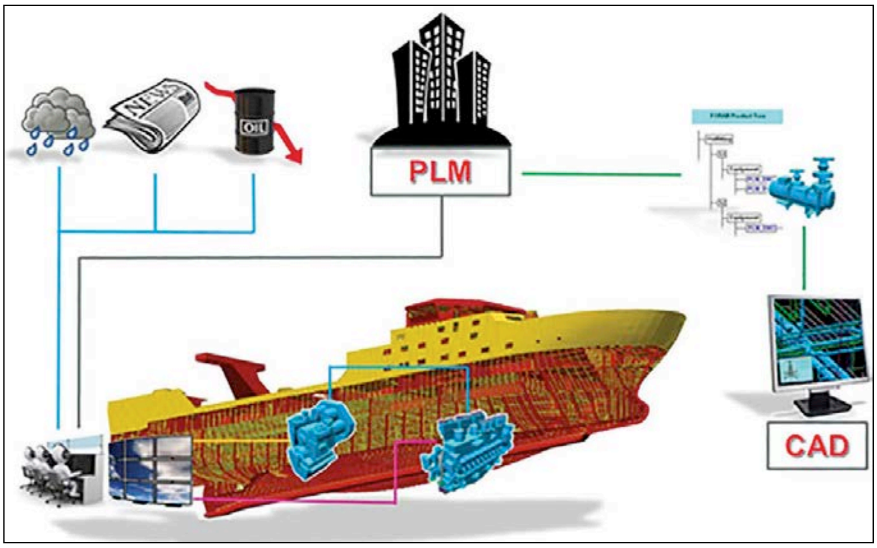

creating seaworthy software
www.autoship.com
Stability & Strength Assessment
Cargo Management & Load Planning
Ship Design & Production
World-Wide Service & Support
Why go anywhere else?
autoship.com


NASDIS
NAVAL ARCHITECTURE•SHIP DESIGN•INFORMATION STRUCTURE
Engineering. Solutions to your expectations.
Visit us online at www.nasdis.ro
NASDIS is a flexible, multidiscipline design structure, capable to cover the full design flow stages - functional, basic, class and detail design including production information and "as built" documentation, active both in shipbuilding/marine engineering and offshore engineering.
NASDIS also provides IT technical assistance for integrated ship design, CAD systems management, installation, configuration, customization and software development.
ROMANIA
NASDIS Consulting SRL
Rosiori 16 Bl G4
Ap 8
800055 Galati
Contact:
office@nasdis.ro
COSMOS
NASTRAN
VERISTAR
ENGINEERING
IDEAS
TRIBON
PDMS
AVEVA MARINE
NUPAS/CADMATIC
BENTLEY PLANTSPACE
AUTOCAD
SOLUTIONS
FREEDOM
CUSTOMIZED SOFTWARE
TOOLS AND SOLUTIONS

One development would make each of the assembly plans available for consultation from the workshop. The assemblies would have indelibly printed Quick Response (QR) codes that uniquely identify each of the elements, but can also incorporate identification or access to the assembly drawings. Video sequences would show how this assembly must be built, and mobile devices would read the QR code giving access to the mounting video.

CAD systems that have virtual reality solutions can perform these assembly sequences, record them and store them as part of the assembly information as made with the drawings. Workers may consult simultaneously or alternatively with this information, which circulates in the local network of the shipyard. However, it is necessary to ensure that the information has the appropriate level of confidentiality, providing security certificates for devices so that only those who have the appropriate level of security can access the corresponding information. This is one of the most important factors in military projects, but also applies to preserving a shipyard's commercial knowledge.

The different parts to be mounted can incorporate their QR codes with the information described above, but can also incorporate Radio Frequency Identification (RFID) or other location devices. These well-placed and secured devices will allow them to be located in the assembly line, which will in turn allow the controllers to know their finishing condition and therefore the progress of the construction. Obviously, these devices must have different characteristics compared with the simple RFID tags of the products existing in the stores. They must be sufficient, robust and have enough scope so that they can be detected in the workshop area of the assembly line. This information serves not only to know the progress of the construction, but also to support the management of materials and necessary purchases.



It is necessary to merge CAD and PLM technologies to leverage the data/value each system creates to the max

## Ship systems connectivity and the world of IoT

Finally, there is the connectivity of devices using IoT. We understand that objects of a ship may have interesting applications when connected with the world of IoT, but such connectivity must be controlled and governed from within the vessel system as a whole and with human supervision. Such control will be simpler if the management applications of such a global solution have the necessary information and are capable of centralising connectivity.

For each of the elements that must participate in this ecosystem, the design system can define the information that should be shared, i.e. which sensors must be equipped in those connectable elements. The application will manage and centralise the information from connected elements and will be in charge of managing direct or indirect connectivity with the rest of the world.

The solution proposed by FORAN is the incorporation of a set of server applications that allow the linking of all the different levels of work around a unique and powerful relational database. Within the work levels are access to client applications, which allow 3D models to be created in the database or provide access to the server, including applications of design, visualisation and control, but also client applications for connected objects. These client applications will be designed to meet particular functions, and may transmit operational information, diagnosis, results, etc. This information is then handled by the server application that determines any action to take and then executes it. Diagnostic information can be transmitted to request maintenance actions or manage the results to take action on other elements or simply to provide information on the state of the devices and objects to the control systems or computers onboard.

## A new concept: the Internet of Ships

Future Smart Ships must utilise IoT. However, the connecting of smart devices within a Smart Ship must ultimately be human-controlled, limiting the level of autonomy onboard. The control should start from the design tools because they control the shipbuilding process from the early stages of the design up to final production. The design tools, product lifecycle management and devices must be interconnected and will provide the platform for the Smart Ships connected to IoT. The information shared in the scope of the IoT must be managed by personnel along the whole lifecycle of the ship, starting from the beginning of the initial design, and this need requires the CAD tools to be prepared with specific characteristics to handle that information. This new ecosystem, incorporating emerging technological trends that have been adapted to the specific environment of shipbuilding, will be the Internet of Ships. *NA*

## Authors

Jesús A. Muñoz, FORAN system product manager, SENER.
Rodrigo Perez, naval shipbuilding area manager, SENER.

# Computer simulation targets Arctic hazards

## Discrete element simulation of a ship breaking through ice ridges can yield important benefits for ships accessing Polar Regions, writes Aleksei Alekseev, a graduate of the EMSHIP Masters Course in Advanced Ship Design

Increasing economic and industrial activity in Polar Regions requires new engineering solutions to deal with arctic hazards. Sea ice ridges are one of the most difficult obstacles encountered in ice-covered seas. When two ice sheets come into contact, they break and small pieces of ice accumulate along a line, creating large floating structures embedded in the ice sheet. With an underwater depth sometimes exceeding 30m, ice ridges represent considerable obstacles to ship navigation, but also to floating structures and vessels under dynamic positioning operations.

Nowadays the main tool for the prediction of performance and interaction of ships and structures in ice is model scale experiments. Such tests are carried out in specially built ice tanks. However, numerical methods and numerical simulations for ice-related problems are receiving greater interest as they can help ship designers to assess the performance of vessels and offshore structures at the early design stage, offering cost benefits.

The Arctic Technology Department team of HSVA has been developing new software for simulating vessel navigation through ice ridges. This software is based on the Discrete Element Method (DEM), which is already used in metallurgy, mineral processing, rock engineering and other industries. The primary motivation for developing the DEM software is to create a numerical model for interaction between ice pieces themselves, and then to simulate the interaction of these ice pieces with ship hulls or structures at a later date.

One of the main advantages of the proposed software is better representation of the realistic geometry of ice pieces. While most studies of discrete elements use disks in two dimensions or spheres in three dimensions (driven mostly by computational complexity), it is obvious that realistic ice particles are polyhedral rather than roundish and must be modelled with flat surfaces and sharp edges limited by vertices. In the present simulation, only those particles of ridge keel are simulated by discrete elements, as they contribute to most of the total resistance on a structure breaking through an ice ridge. When simulating such interactions with a ship or structure, an added ice resistance is introduced to consider the effects of level ice breaking. The comparison of a numerical model with a model-scale ice ridge from the HSVA ice tank is presented in Figure 1. As can be seen, the overall representation of the underwater keel part is in good correspondence with reality.

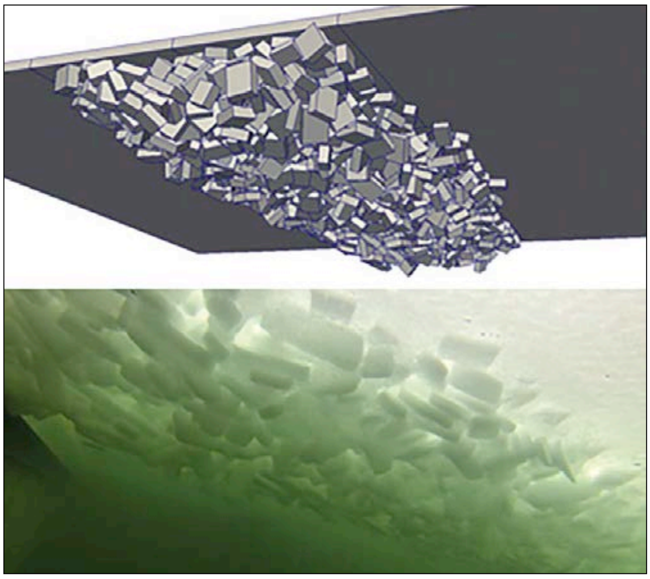


Figure 1: Comparison of a numerical model with a model-scale ice ridge from the HSVA ice tank

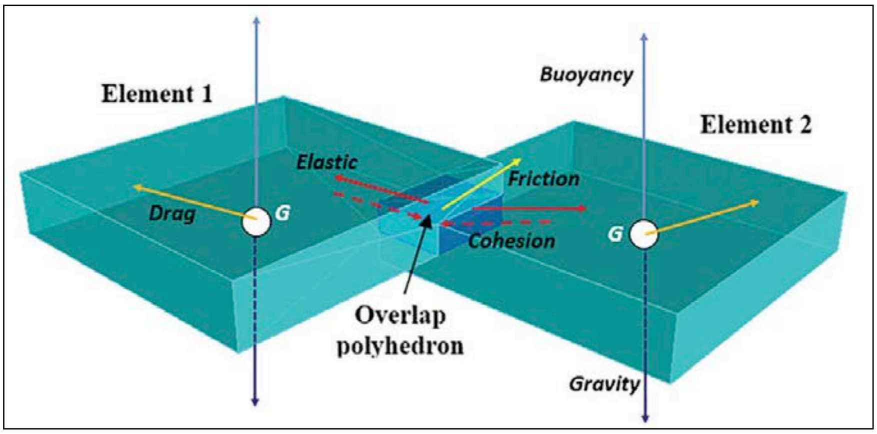
The representation of ice floes in 3D space is made with a fixed Cartesian frame. Their motion is divided into a translational displacement of the centres of mass, described by Newton's second law, and a rotational motion around these centres that is represented via quaternion rotation. The latter is an efficient and numerically stable method for rotational degrees of freedom, and is also used in computer game engine development.

All the ice pieces are driven by different kinds of forces acting upon them. For example, consider two discrete elements in contact with each other (Figure 2). The resulting external force is the sum of the gravitational force, buoyancy force, hydrodynamic forces, and contact forces, accounting for the total number of contacts per element. Each contact force itself can be divided into a normal component, which is the sum of a repulsive force, a dissipative force, and a cohesive force, and a tangential component, the sum of a tangential friction force, and a damping friction force.

The elastic force is a repulsive force, which is adapted from elasticity models by Hook and Hertz. The assumption for this model is an elastic deformation of the particles during collision. The magnitude of this force is proportional to the hypothetical deformation of both elements, here presented as proportional to the volume of the overlap polyhedron between these two contacting elements.

Full overlap geometry including its volume, centre of volume and contact

Figure 2: Two discrete elements in contact with each other




area for each pair of colliding particles is calculated. This is computationally different, more complex and more CPU consuming than methods using only the penetration depth to compute the contact force. Some other approaches even do not need penetration information by just adding a repulsive force to two close enough elements, depending on their velocities and added mass matrices. The method implemented in this software has the advantage to generate smooth changes in overlap volumes and contact forces, allowing formation of stable heaps of elements and providing good numerical stability.

In the present version of the simulation software, the hydrodynamic forces are simply modelled by general analytical formula, in which this force is proportional to the density of fluid, square of velocity and some shape-dependent force coefficient. Frictional forces are introduced in the form of a Cundall-Strack friction model. Cohesive force is introduced in order to model the bonding between discrete elements.

All the aforementioned forces are computed when elements are colliding. Beforehand, a contact detection algorithm checks if there is a possible overlap between two elements. The simplest algorithm would calculate for each element if it overlaps with every other element in the domain, resulting in highly time consuming calculations for simulations, considering that we have a large number of elements. Some effort has been put into the development of a multi-phase fast contact algorithm. A broad phase algorithm is first used in order to detect collisions that may happen, based on the comparison of axis aligned bounding boxes of the ice pieces. This technique offers a fast and simple approach to create a list of elements potentially in contact. Based on this list of potential contacts, a narrow phase algorithm is then used for actual collision detection.

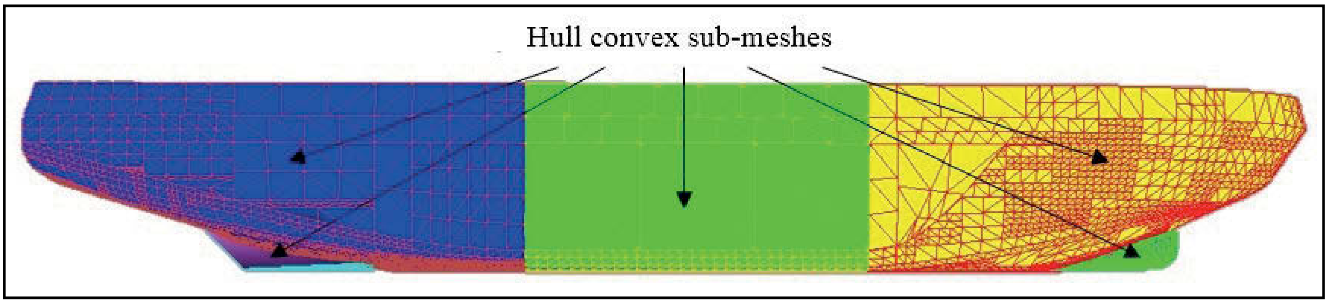
Gear's predictor-corrector algorithm is employed to integrate equations of elements' motions. Its advantages are stability and efficiency, as it requires neither a matrix inversion nor the solution of a non-linear system of equations. In the first predictor step, time is incremented and position and orientation of elements are estimated, assuming there are no changes in forces and torques acting on them. Using these predicted coordinates, the overlap calculation is performed and forces and torques on all elements are calculated accordingly. A corrector step is then applied by solving the equations of translational and rotational motion with correction coefficients.

## Ship hull as a special discrete element

In order to be compatible with the adopted data structures of discrete elements the ship hull geometry must also be represented as a polyhedron with triangulated faces. The hull surface can be created and meshed with any CAD system supporting a conventional *.OBJ* file format. This format contains information on mesh vertices and their interconnections. During data import the programme reads the *.OBJ* file, calculates the number of vertices and faces, computes topological information from these input data, computes entries of face equations, and stores information in the DEM data structures.

Most icebreaking ships and arctic offshore structures are highly non-convex bodies. This non-convexity is especially high in the bow part (forward skeg, reamers, etc.) and the stern part (appendages and propulsion system). However, convex meshes are required in the simulation due to the fact overlap computation algorithms can only deal with convex bodies (Figure 3). Calculation of overlap volume, required for determining the elastic interaction between ice pieces or between ice and the ship's hull, works only with convex volumes. In this regard, special considerations are taken for non-convex ship hulls, and this approach treats non-convex bodies as a composite of convex meshes rigidly connected between each other.

Figure 3: Convex meshes are required in the simulation



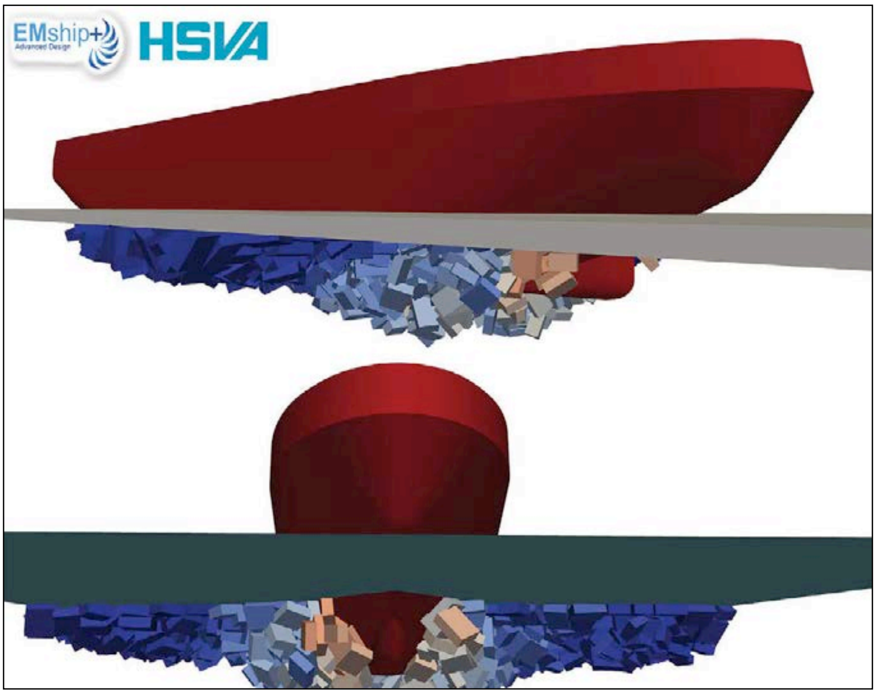



Figure 4: Simulation results

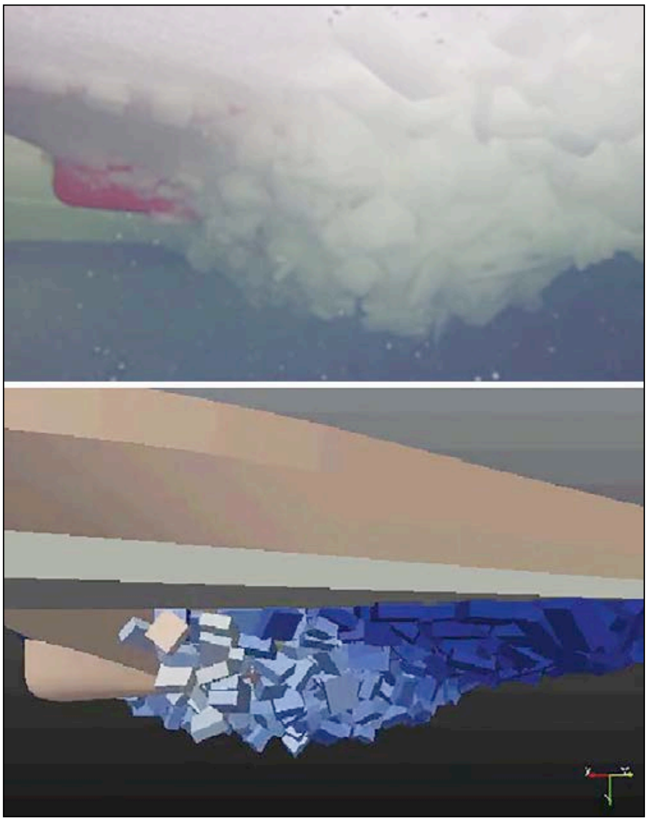


Figure 5: Comparison of the model test and simulation

During simulation of a ship breaking through an ice ridge the full dynamic behaviour of the ship is expected when interacting with the ridge. When the ship penetrates the ridge the bow part can rise up because of the buoyancy of the ice elements in the ridge keel. This pitch angle is quite often observable during model tests. In order to simulate these motions properly information is required about the second order inertia tensor of the ship, which is estimated using statistical-empirical formulae.

Due to the change in ship draught, pitch and roll angle during interaction with the ridge, displacement, the position of the vessel's buoyancy centre and restoring forces have to be updated at each time step. In order to minimise calculation time during the time-integration loop, it has been decided to pre-calculate these properties outside the time loop for various combinations of draughts, pitch and roll angles. The actual "in-time" values are then interpolated between these pre-calculated values.

## Visualisation, calibration and validation of the code

For comparison with one of the HSVA model test results, a simulation has also been performed at model scale. Visualisation of the simulation results are presented in Figure 4 and the simulation exhibited very satisfactory results when compared to the model test (Figure 5). On impact with the ridge, ice pieces are displaced downwards and relatively little dragged under the hull bottom.

Simulation results can also be compared quantitatively to model test results. The graph in Figure 6 gives the time series of ship velocity for the model test and three simulation runs with different parameter sets. For all three simulation runs, velocity drops rapidly after encountering the ridge, as observed during the model test. Afterwards, velocity increases again after the bow has passed the ridge keel, but with a lower rate as in the model test and after a longer period with low velocity. This first brief validation of the numerical tool proves that numerical simulation of ship breaking through an ice ridge can be done with DEM as it provides a realistic picture of the interaction and behaviour of the ship and ice pieces during ridge breaking. However, in order to get a more accurate numerical tool, further calibration of the created forces model is needed. Such calibration will include analysis of multiple test cases and detailed study of the influence of all the aforementioned parameters.

## Conclusions

Present work has demonstrated that the idea of introducing DEM modelling as a simulation tool for ice ridge breaking is a successful approach. As long as one deals with the ice/structure interaction processes that do not involve ice breaking, DEM simulations can provide sound results. This concept along with the described software can be expanded for modelling ship navigation in various fragmented ice formations such as brash ice and broken ice fields. Moreover, possible consideration of other physical effects and coupling with such tools as Finite Element Analysis and Computational Fluid Dynamics could provide powerful numerical solutions. Such tools could cover a wide range of simulation scenarios (initial speed, load cases, etc.) in various ice conditions to the benefit of Arctic research and development. *NA*

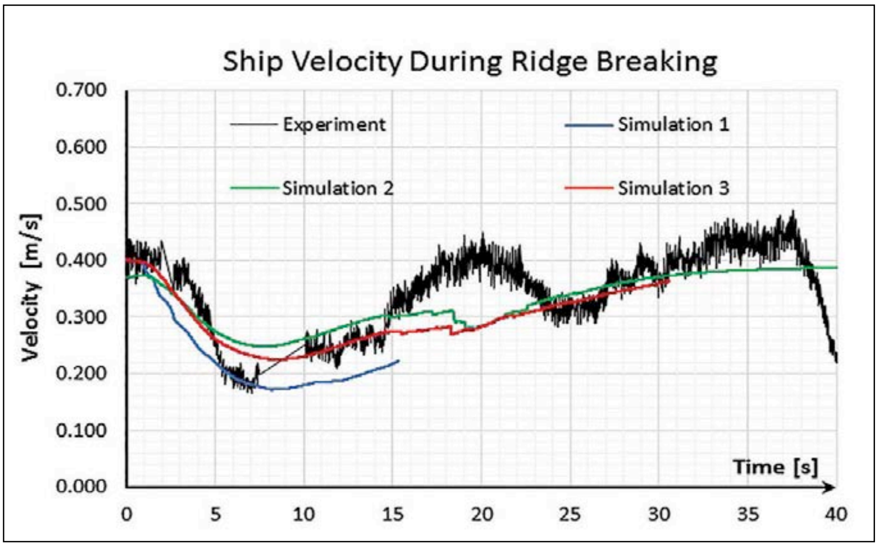



Figure 6: Time series of ship velocity for the model test and three simulation runs with different parameter sets

## Acknowledgments

This work was partly developed in the frame of the European Masters Course in "Integrated Advanced Ship Design" named "EMSHIP" for "European Education in Advanced Ship Design", Ref.: 159652-1-2009-1-BE-ERA MUNDUS-EMMC.

Alekseev received one of DNV GL's Young Professional Awards for a paper based on the presented subject matter during a ceremony at Posidonia last June.

# Planet ice and the dual-functional *Attenborough*

**Naval architects Erik Leenders and Martijn de Jongh describe the ins and outs of the Natural Environment Research Council's (NERC) new research vessel, RSS *Sir David Attenborough*, in an exclusive interview with *The Naval Architect***

Designing *Sir David Attenborough* posed an unusual challenge, according to Erik Leenders, designer, ship design & systems, Rolls-Royce. Unlike preceding ice-going vessels Rolls-Royce has worked on, it is required to fulfil the duties of a research vessel and a cargo ship, and so demanded a new combination of design features to cater to the contrasting disciplines.

In this sense, continues Leenders, many of the innovations featured on the vessel have been seen elsewhere, but never in the twin skeg, ice class, underwater noise managed combination that *Attenborough* demonstrates.

A more comprehensive list of its requirements includes the DNV Silent-R notation; minimum bubble sweep down; icebreaking; a shallow draught of 7m; a multi-discipline working deck (cargo/science operations); a large aviation fuel tank capacity (660m$^3$); SPS compliance; and helicopter landing capabilities.

Figure 1: Flexibility is key for the hybrid duties of RSS *Sir David Attenborough*, which require icebreaking, cargo storage and research capabilities

Much of the need for flexibility comes from NERC's plan to combine the capabilities of its current polar exploration fleet, RSS *Ernest Shackleton* and *RSS James Clark Ross*, in a single ship, and Leenders and fellow Rolls-Royce designer Martijn de Jongh stress that flexibility in the vessel's arrangement was a crucial design node as each scientific cruise the vessel sails on will be different and will require different arrangements of onboard space.

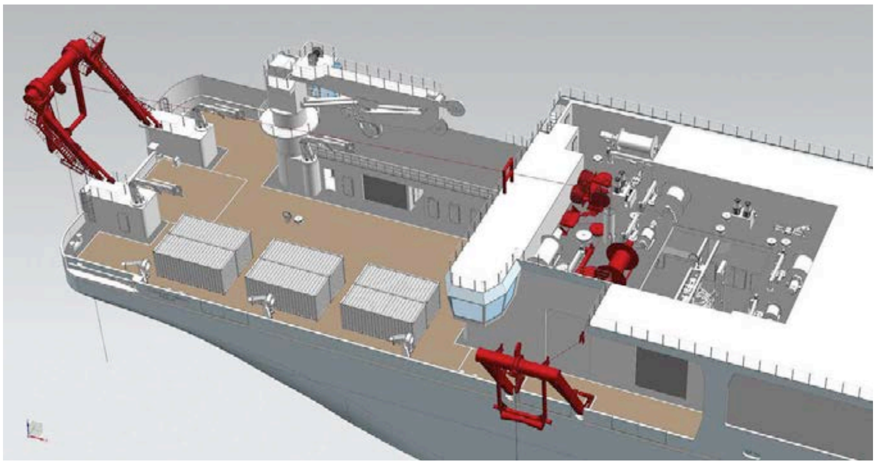
Leenders explains that the design/logistics puzzle of the vessel was partially solved with adaptable spaces, such as laboratories and hangars that can be rearranged and a helideck that can be re-appropriated for scientific work. But, he continues, it was also by carefully zoning the main deck. This zoning was particularly important (and difficult to achieve) for safely balancing spaces for science operations and the carrying of cargo. Additional gas zones had to be taken into account as *Attenborough* has the unique charge of transporting aviation fuel to Antarctic bases; a requirement Rolls-Royce has not previously come across in an ice class research vessel.

Other technical specifications include cargo containers to be transported in the hold and on deck (pictured in Figure 1), a skidding system in the hold, scientific containers in the vessel's scientific hangar and helicopter hangar, as well as the equipment and capability to carry out over side and moonpool operations. These operations were particularly complex to manage as the respective winches for the stern, side a-frames and moonpool needed to be arranged in one room near the stern of the vessel so that their wires could be routed effectively. This arrangement can be seen in Figure 2, which illustrates the compact design and routing challenges faced. Leenders and De Jongh say that a close dialogue between the owner and designer was needed to meet the vessel's winch requirements, which include eight scientific winches, and add that *Attenborough* is fit to carry out over side and moonpool operations to depths of 9,000m, utilising a moonpool door in the bottom of the ship and a dedicated Conductivity, Temperature and Depth (CTD) handler.

Rolls-Royce's experience with complex offshore designs and the recent build of Norway's new polar research vessel, *FF Kronprins Haakon*, aided in the development

## TECHNICAL PARTICULARS
***Sir David Attenborough***

| | |
|---|---|
| Length overall: | 128.9m |
| Length between pp: | 121m |
| Breadth moulded: | 24m |
| Depth main deck: | 11m |
| Design draught: | 7m |
| Shipbuilder: | Cammell Laird |
| Class notation: | LRS, ✠100A1, ✠LMC, Polar Research Vessel, UMS, DP (AA), NAV1, IBS, Ice Class PC5 (Hull and rudder – PC4), CAC1, LFPL, ECO (BWT, GW, OW, P, NOx$_3$, SOx, IHM, R), Helicopter Landing Area, Winterisation D(-35) H(-35)IWS, LI, PSMR*, DNV: Silent-R & Silent-S |
| Icebreaking (1m ice with 20cm snow cover, 500kPa flexural strength): | 3knots |
| Working deck area: | 650m$^2$ |
| Fuel oil capacity: | 2,200m$^3$ |
| Fresh water capacity: | 400m$^3$ |
| Accommodation: | 90 persons (28 crew, 60 scientists, 2 spare) |



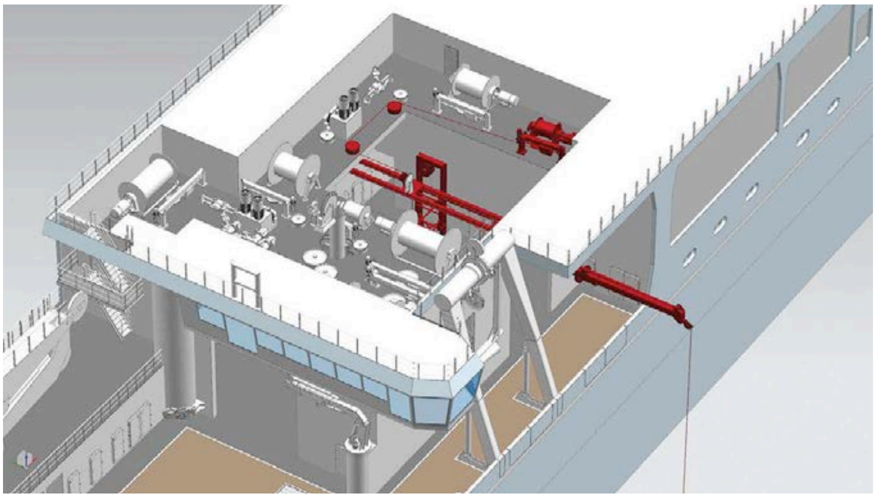


Figure 2: *Attenborough*'s winch room has been carefully and compactly arranged to allow for extensive stern, over side and moonpool operations

of the vessel, but, as mentioned above, new challenges had to be overcome and new trade-offs made to meet NERC's requirements. "No vessel is the same… there are new requirements and you have to approach them from a new angle," says De Jongh, adding that "[You can] build upon the challenges before, [but] challenges can be quite different, even conflicting."

This conflict was felt in the requirement to combine the best characteristics for icebreaking, carrying out research tasks, transporting cargo and seakeeping.

Icebreakers, especially those of a relatively large size like the 128m-long *Attenborough*, create bubbles that are swept under the hull. These bubbles are usually harmless for such a vessel, but *Attenborough*'s research function means that they would interfere with research equipment such as sonars and (multi-beam) echo sounders. As a result, the design team spent a great deal of time refining the lines for the bow, compromising on icebreaking lines and bubble streams to achieve the best all-round performance. Testing at the Hamburg Ship Model Basin (HSVA) was consequently extensive to check the correct compromises had been made. It required that normal ship performance tests for an icebreaker, icebreaking tests, as well as normal performance tests for a research vessel and targeted tests to analyse research capabilities were carried out on *Attenborough*'s design.

Initial CFD calculations were made to measure hull resistance, before moving on to bubble sweep down/flow behaviour analysis. This simulated the drawing down of air bubbles at the upper water layers and gave *Attenborough*'s designers an insight into where bubbles would travel. With these results they were able to adjust the vessel's hull lines and direct bubbles away from *Attenborough*'s sensor arrays.

The designers worked closely with DNV GL throughout the project in order to fulfil the requirements of the class society's Silent-R & Silent-S notations. The vessel can consequently travel at a speed of 11knots without creating significant levels of noise and vibration that may be harmful to marine organisms or interfere with the research vessel's sensor arrays. This allows the vessel to carry out research quietly and at a faster pace than previous research vessels through the use of silent (and more efficient) five-bladed controllable pitch propellers (CPP) and resiliently mounted equipment. Importantly, this ability does not cost *Attenborough* its icebreaking credentials, as while the propellers' polar class was downgraded from Polar Class 4 (PC4) in order to reduce noise and vibration through a reduction in their size, the 4.5m diameter CPPs can still handle Polar Class 5 (PC5) level operation – described as "year-round operation in medium first-year ice which may include old ice inclusions" by IACS.

The design team also had to balance seakeeping qualities with good icebreaking characteristics, as an efficient icebreaking bow is not usually optimal for seakeeping, says Leenders. This challenge extended to meeting the vessel's dwt requirements and draught restrictions, as the owner additionally stipulated that the vessel would need a 7m draught in order to access a number of shallow harbours. This, considering the size of the icebreaking vessel at 128m in length, is a relatively small draught, and meant that *Attenborough* could not be of a slender design.

Finally, airflow was also an important consideration. One of the vessel's research duties will include taking air samples and meteorological measurements, and so necessitates that the air collected is as clean as possible. This has impacted the vessel's arrangement, with the mast positioned at the bow to take air samples. Similarly, the position of the exhausts had to be considered in relation to air intakes and science measuring points, and helicopter operations also had to be allowed for.

*Sir David Attenborough* is currently under construction by Cammell Laird, Birkenhead, UK, and is being built according to Lloyd's Register Class and Maritime Coastguard Agency (MCA) requirements. It is due to be delivered and operational for Arctic and Antarctic duties in 2019. *NA*

# VLCC project moves ahead

## Hanjin's Philippines-based yard has moved into new VLCC territory with delivery of a Korean design

After more than 10 years of shipbuilding in Subic Bay, the Philippines, Hanjin Heavy Industries Corporation Philippines (HHIC Phil) delivers its first very large crude carrier (VLCC) based on a design from Hanjin's primary operation in South Korea.

The 300,000dwt ocean-going crude oil tanker, *Gener8 Hector*, is the first of a series of vessels and features an optimised hull form, as well as a Mewis duct and rudder bulb for more efficient operation and a more competitive rate of fuel oil consumption.

A MAN 7G80ME-C9.2 main engine powers the vessel, producing a SMCR of 26,450kW at 66rpm and a service speed of 14.8knots at NCR with 15% sea margin on a 20.5m draught. The engine can run on HFO or MGO, as can the vessel's three sets of diesel-driven alternators, which produce 1,263kW at 900rpm, and *Gener8 Hector*'s single fixed pitch propeller, which has a diameter of 10.7m, runs at 72rpm.

The vessel design includes a double bottom and double-hull structure of cargo tanks consisting of five pairs of centre and side (P&S) cargo tanks, two slop tanks, and five pairs of water ballast tanks that surround the side and bottom of the cargo tanks. This double-hull structure, as required by the IMO's fuel oil protection requirement for vessels delivered on or after 1 August 2010, protects the vessel's fuel oil tanks.

The hull structures are also designed in accordance with the International Association of Classification Societies (IACS) common structural rules (CSR) based on a 25-year lifetime in the North Atlantic wave environment. Approximately 50% of construction was undertaken with high-tensile steel, while no aluminium was used in the hull/superstructure, according to the yard.

*Gener8 Hector*'s design includes a liquid cargo capacity of 344,826.44m$^3$ and bunker capacities of 5,567.54m$^3$ for heavy oil and 1,041.35m$^3$ for marine gas oil. It has 100% segregated ballast and a water ballast capacity of 91,478.28m$^3$, while Samsung Heavy Industries provided the vessel's 6,000m$^3$/hr (elec. type) water ballast treatment system.

Hanjin's Subic Shipyard delivers the vessel to its owner, Navig8 Tankers, the third largest owner of VLCCs worldwide following its merger with General Maritime Corporation in 2015, according to the company. *NA*

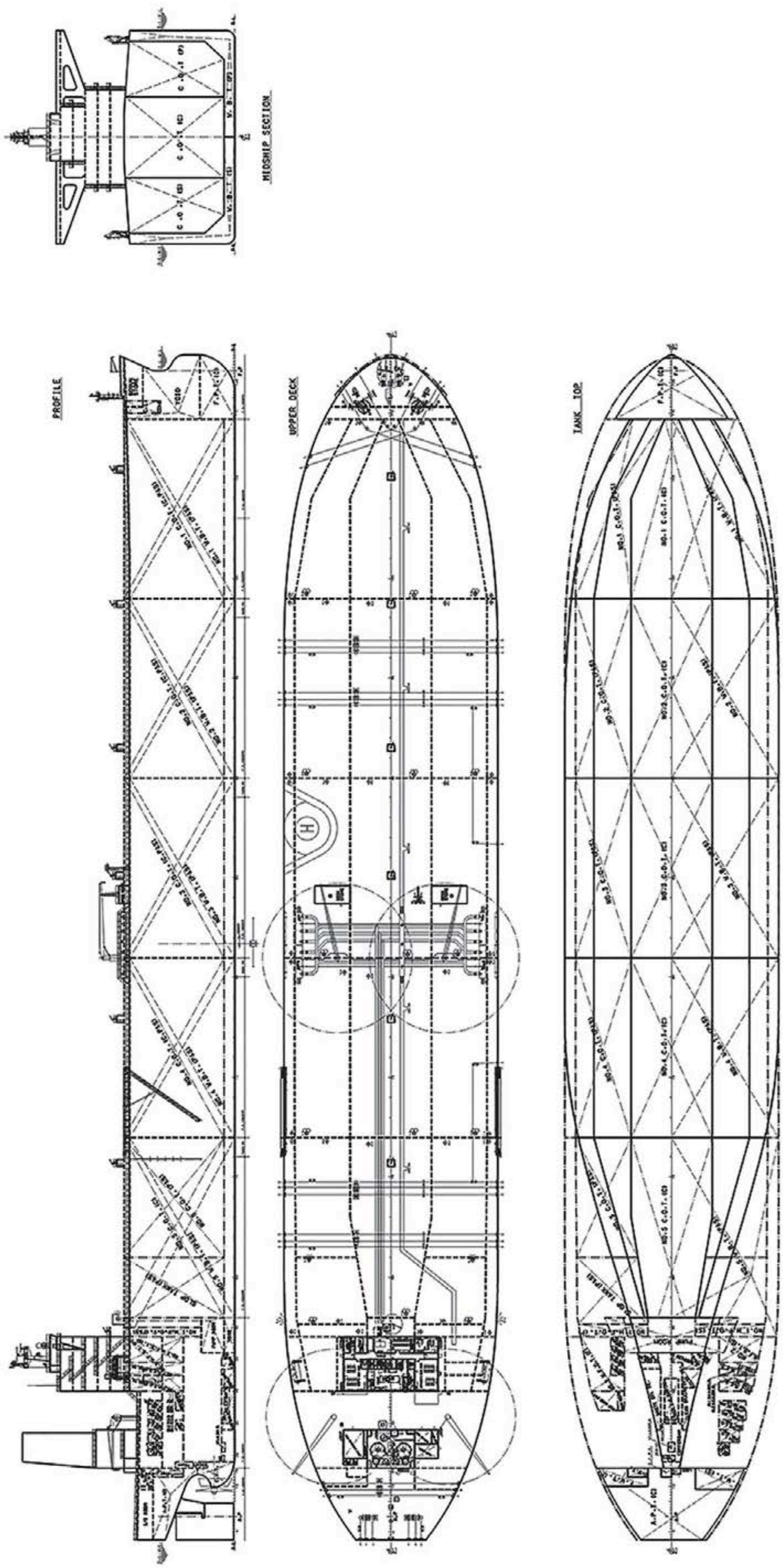
### TECHNICAL PARTICULARS

***Gener8 Hector***

Length oa: 333m.................Length bp: 321.9m
Breadth moulded: ....................................... 60m
Depth moulded
to main deck: ........................................ 29.5m
Width of double skin
Side: 3m ........................................Bottom: 3m
Draught
Scantling: ....................................21.6m (mld.)
Design: .........................................20.5m (mld.)
Gross: .......................................... 156,517tonnes
Displacement: .........................343,838.9tonnes
Lightweight: ..........................abt. 45,400tonnes
Deadweight
Design: .................................278,731.5tonnes
Scantling: .............................298,438.9tonnes
Speed, service (65 % SMCR output): ........ abt. 14.8knots
Classification society and notations:........ DNV: +1A1, "Tanker for Oil ESP", E0, CSR, SPM, BIS, VCS-2, BWM-T, COAT-PSPC(B;C), TMON, CLEAN, RECYCLABLE
Main engine
Design: ...........................................MAN B&W
Model: ..................................... 7G80ME-C9.2
Manufacturer: ................................ HYUNDAI HEAVY INDUSTRIES CO, LTD.
Number: .................................................... 1 set
Type of fuel: .............................. HFO or MGO
Output of each engine: ............... 17,200kw x 57.2rpm (65% SMCR)
Daily fuel consumption
Main engine only: ............. 67.58tonnes/day
Auxiliaries (G/E): ......................5.7tonnes/day
Auxiliaries (Boiler): ................70.9tonnes/day
Cargo cranes/cargo gear
Number: ................................................2 sets
Make: ...............................................ORIENTAL
Type: ........Electro-hydraulic Driven, Cylinder Luffing type Jib Crane
Performance: ..........................SWL 20tonnes

*Gener8 Hector* was designed in Korea by Hanjin Heavy Industries but built by its Philippines-based yard

**GA plan for the very large crude carrier *Gener8 Hector***



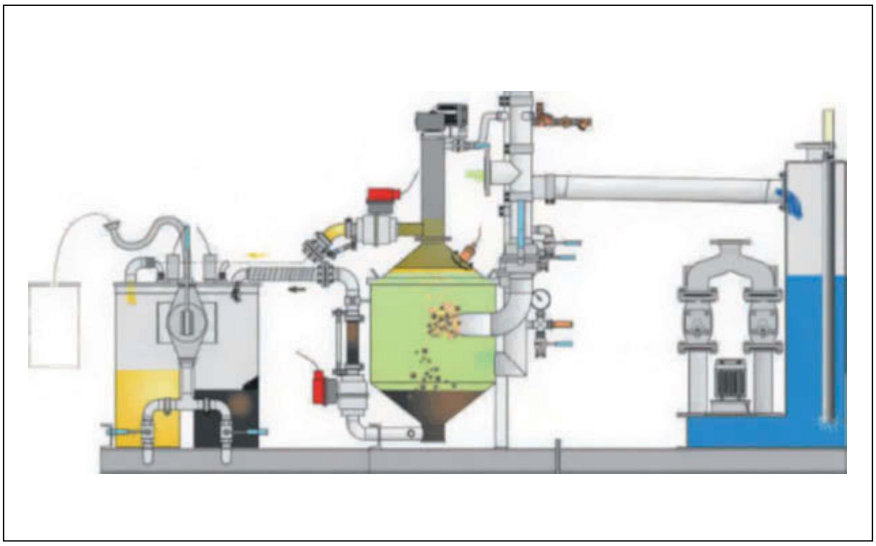
# Clearing the FOGs

New rules governing effluents from new vessels were introduced in January last year and those limitations will be extended to existing ships next January, but there are no standards for the separation of grease from galley water, even though oils must be separated before discharge

Advances in membrane-based wastewater treatment systems for galley water should render any discharges free of waste solids (sludge), fats, oils and greases (FOGs) before the water enters the treatment process, otherwise blockages can occur.

"However, while this wastewater must be treated according to requirements laid down in IMO MEPC 227(64), which does not allow the discharge of any oils, there are currently no IMO standards for the separation of grease from galley water," says wastewater treatment specialist ACO Marine.

The Marine Environment Protection Committee (MEPC) at the IMO adopted resolution MEPC 227 (64) in 2012 and this new rule was introduced in January of last year. The new rules change the discharge requirements and test protocols adopted by Resolution MEPC 159 (55), with the specific aim of reducing nitrogen and phosphorous from the treated water, preventing the acceleration of nitrification of the seas.



To meet the requirements of onboard operation, grease separators should be totally enclosed to avoid any possibility of odours into the compartment and fully flooded to remove any free surface effect caused by the movement of the vessel

New passenger ships when operating in a MARPOL Annex IV special area and intending to discharge treated waste water into the sea on or after 1 January 2016 must use equipment that purifies the effluent to the new standards. By January of next year all existing vessels operating in a MARPOL Annex IV special area and intending to discharge treated sewage effluent into the sea must also meet these new standards.

Currently the only MARPOL Annex IV special area designated is the Baltic Sea, but other regions will be specified in the future, extending the reach of the designated areas substantially.

The rules require that an approved sewage treatment plant must meet the technical specifications in Section 4 and the test protocols set out in revised guidelines. However, section 4.2 on nitrogen and phosphorous removal applies to passenger ships operating within a special area intending to discharge treated sewage effluent into the sea. It also notes that, for ships operating an approved sewage treatment plant, MARPOL Annex IV enforces that the effluent must not produce "visible floating solids or cause discolouration of the surrounding water".

"Dilution is not a solution to pollution; it is not treating it, it is reshaping it"

In addition, an approved sewage treatment plant "should not rely solely on dilution of wastewater".

ACO Marine MD, Mark Beavis, has a different view: "Lots of technologies use dilution, but dilution is not a solution to pollution; it is not treating it, it is reshaping it; we can treat it and remove the pollutants," he has said, referring to the development of the company's new patented "ACO Bio Sword" technology, which is at the heart of ACO Marine's next generation Clarimar MF and Maripur NF wastewater treatment units.

However, Aco Marine also believe that of all the wastewater generated onboard ships (toilets, sanitary, laundry and galley), galley water is the most difficult to treat effectively and it is often the one most overlooked. Fats, oils and greases are the single biggest contributing factor to wastewater treatment system failure, regardless of the treatment technology used. Early provision in the ship design for the correct grease separation technology will ensure reliable operation, and lowest risk, to the wastewater treatment system as a whole and ensure a vessel's legislative compliance. *NA*

## ADVERTISERS' INDEX

If you would like to receive further information on the advertisers' featured within *The Naval Architect* please contact **John Payten, Group Sales Director,** jpayten@rina.org.uk


| Client | page | Client | page | Client | page |
|---|---|---|---|---|---|
| Alfa Laval | FC | Euromaritime | 6 | Seatrade Communications | 4 |
| Ahoy | 15 | Faststream Recruitment Ltd | 43 | Seawork Exhibition | IBC |
| Autoship Systems Corporation | 29 | Jotun Coatings | BC | ShipConstructor Software Inc. | 27 |
| Cadmatic Oy | IFC | Kawasaki Heavy Industries | 11 | Steerprop Oy | 13 |
| Creative Systems | 15 | NASDIS | 29 | Veth Propulsion BV | 15 |
| Dellner Brakes AB | 36 | Palfinger Marine GmbH | 9 | Wolfson Unit | 31 |

# RINA publications

## Books

***Please note all prices include postage & packaging***

**LAMENTABLE INTELLIGENCE FROM THE ADMIRALTY**
**By Chris Thomas**
HMS Vanguard sank in thick fog in Dublin Bay in September 1875 rammed by her sister ship. No lives were lost (except perhaps that of the Captain's dog) but this one event provides valuable insight into naval history of the late nineteenth century. Chris Thomas examines what happened, setting it in the context of naval life, the social and economic situation of officers and ratings. He describes the furore caused by the unjust verdict of the Court Martial, vividly illustrating the joys and trials of the seagoing life in the Victorian era, and the tragic effect on the life of Captain Richard Dawkins and his family.
**Price: UK £9.00 EUR £10.00 OVS £12.00**
**AMAZON PRICE: £12.74**

**SHIPS AND SHIPBUILDERS: PIONEERS OF SHIP DESIGN AND CONSTRUCTION**
**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 1983 America's Cup, the story is brought right up to date.
**Price UK £12.50 EUR £16 OVS £18**
**AMAZON PRICE: £21.25**

**THE ROYAL INSTITUTION OF NAVAL ARCHITECTS 1860-2010**
Published to commemorate the 150th anniversary of the founding of the Institution, The Royal Institution of Naval Architects 1860-2010 provides a history of the Institution as reflected in the development of the naval architecture profession and the maritime industry over that time. In the book, members give their personal views on the development of their sector of the maritime industry and how it will develop in the future.
**Price UK £5.50 EUR £6 OVS £7**
**NOT ON AMAZON**

## International Journal of Maritime Engineering (IJME)

**2017**

***Members Part Ref: IJME17 Set Ref: ST17***

| Part A1 | Part A2 | Part A3 | Part A4 | Set |
|---|---|---|---|---|
| £18 | £18 | £18 | £18 | £49 |

***Non-Members Part Ref:IJME17 Set Ref: ST117***

| Part A1 | Part A2 | Part A3 | Part A4 | Set |
|---|---|---|---|---|
| £25 | £25 | £25 | £25 | £82 |


IJME - is published in March, June, September & December. The IJME provides a forum for the reporting and discussion of technical and scientific issues associated with the design, construction and operation of marine vessels & offshore structures

## International Journal of Small Craft Technology (IJSCT)

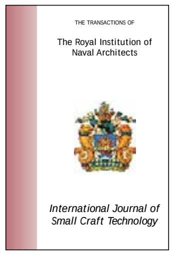
**2017**

***Members Part Ref: IJSCT17 Set Ref: SS17***

| Part B1 | Part B2 | Set |
|---|---|---|
| £18 | £18 | £31 |

***Non-Members Part Ref: IJSCT17 Set Ref: SS117***

| Part B1 | Part B2 | Set |
|---|---|---|
| £25 | £25 | £45 |




IJSCT - is published in June & December. The IJSCT provides a forum for the specialist reporting & discussion on technical & scientific issues associated with research & development of recreational & commercial small craft.

**Each month RINA offers up to 70% discount on the normal price of its publications.**
**Please visit the website at www.rina.org.uk/bookshop-bargains**
**to see this months specials.**

## Journals

**THE NAVAL ARCHITECT**
*quarterly publication* **OFFSHORE MARINE TECHNOLOGY**
*bi-monthly publication* **WARSHIP TECHNOLOGY**

Published 10 times a year

- Providing up-to-date technical information on commercial ship design, construction and equipment.
- Regular reports on centres of shipbuilding activity worldwide.
- Comprehensive, technical descriptions of the latest newbuildings.
- News, views, rules & regulations, technology, CAD/CAM, innovations.

**2017 SUBSCRIPTION**

| 12 months | Print only† | Digital Only* | Print + Digital |
|---|---|---|---|
| UK | £185 | £185 | £235 |
| Rest of Europe | £193 | £185 | £244 |
| Rest of World | £207 | £185 | £258 |

†Incudes p+p
*Inclusive of VAT

**SHIP & BOAT INTERNATIONAL**

Published 6 times a year

- In depth coverage of small craft/small ship design, building & technology.
- Specialist sections include: fast ferries, tugs, salvage & offshore, patrol & paramilitary craft, coastal & inland waterway vessels, pilot boats, propulsion and transmissions.
- Advances in construction materials, electronics, marine equipment.
- Contract news and the latest market developments.

**2017 SUBSCRIPTION**

| 12 months | Print only† | Digital Only* | Print + Digital |
|---|---|---|---|
| UK | £136 | £136 | £166 |
| Rest of Europe | £144 | £136 | £175 |
| Rest of World | £164 | £136 | £195 |

†Incudes p+p
*Inclusive of VAT

**SHIPREPAIR & CONVERSION TECHNOLOGY**

Published Quarterly

- In depth coverage of all aspects of shiprepair and conversion work and comprehensive technical descriptions of major conversion projects.
- Regular regional surveys on the major shiprepair centres.
- Developments in shipboard and shipyard equipment technology.
- Contract news, appointments, industry views, new regulations.

**2017 SUBSCRIPTION**

| 12 months | Print only† | Digital Only* | Print + Digital |
|---|---|---|---|
| UK | £63 | £63 | £83 |
| Rest of Europe | £69 | £63 | £89 |
| Rest of World | £77 | £63 | £98 |

†Incudes p+p
*Inclusive of VAT

# RINA publications

## Conference Papers

**If the CD ROM format is required please add CD after the reference number.**

| | | *Non-Members* | *Members* |
|---|---|---|---|
| **2016** | **Historic Ships** HIST16 | £135 | £115 |
| | **Energy Efficient Ships** EES16 | £135 | £115 |
| | **Design & Construction of LNG Ships** LNG16 | £135 | £115 |
| | **Human Factors** Ref: HF16 | £135 | £115 |
| | **Education & Professional Development of Engineers in The Maritime Industry** Ref: EDU16 | £135 | £115 |
| | **Warship 2016** Ref: WS16 | £135 | £115 |
| | **Design & Operation of Ferries & Ro-Pax vessels** Ref: FRV16 | £135 | £115 |
| | **Innovations in Small Craft Technology** Ref: ISCT16 | £135 | £115 |
| | **Wind Support Vessels** Ref: WSV16 | £135 | £115 |
| | **Smart Ships** Ref: ST16 | £135 | £115 |
| | **Maritime Project Management** Ref: MPM16 | £135 | £115 |
| **2015** | **Education & Professional Development of Engineers in the Maritime Industry 2015** Ref: EDU15 | £135 | £115 |
| | **ICSOT India** Ref: ICSOTINDIA15 | £135 | £115 |
| | **ICSOT Indonesia** Ref: ICSOTIN15 | £135 | £115 |
| | **Energy Efficient Ship** Ref: EEF15 | £135 | £115 |
| | **Pacific 2015** Ref: PACIFIC15 | £39 | £34 |
| | **ICCAS 2015** Ref: ICCAS15 | £180 | £150 |
| | **ICSOT Korea** Ref: ICSOTKOR15 | £135 | £115 |
| | **Marine Design** Ref: MD15 | £135 | £115 |
| | **Warship 2015: Surface Vessels** Ref: WS15 | £135 | £115 |
| | **Mega and Super Yachts** Ref: MSY15 | £135 | £115 |
| | **Ice Class Vessels** Ref: ICE15 | £135 | £115 |
| | **Damaged Ship III** Ref: DS15 | £130 | £110 |
| | **Structural Load and Fatigue on Floating Structures** Ref: SLF15 | £40 | £35 |
| | **Design & Operation of Wind Farm Support Vessels** Ref: WFV15 | £130 | £110 |
| **2014** | **Experimental & Computational Marine Hydrodynamics** Ref: CEMH14 **PDF Only** | £91 | £80 |
| | **Historic Ships** Ref: HIST14 | £130 | £110 |

***For further information on previous editions please contact the Publications department on:***
***Tel: +44 (0) 20 7235 4622, Email: publications@rina.org.uk or Website: http://www.rina.org.uk***

**Payment Details:** Payments must be made in pounds sterling to **RINA** by sterling cheque drawn on a UK bank, International Money Order or Credit Card, we accept Visa, Mastercard, or AMEX.

I enclose a cheque for ______________________ payable to RINA.

Please charge my Credit Card No: ______________________

Expiry date: __/__/__ Security code: _____ Signature: ______________________

Print name: ______________________

Name: ______________________

Address: ______________________

Country: ______________________ Postcode: ______________________

Tel: ______________Fax:______________Email:______________

Please allow 30 days for dispatch and delivery. Post to:

**The Publications Department, RINA, 8-9 Northumberland Street, London WC2N 5DA, UK.**

**Tel: +44 (0)20 7235 4622** or **Fax: +44 (0)20 7259 5912.**

## ORDER FORM

*Please send me the following:*

**REF NA JANUARY 17**

| REFERENCE | QUANTITY | PRICE |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | **TOTAL:** | |

For a publications catalogue please call the Publications Department on +44 (0)20 7235 4622 e-mail: publications@rina.org.uk or visit our website at http://www.rina.org.uk

**January 24-25, 2017**
**Smart Ship Technology**,
international conference,
London, UK
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

**January 31 – Feb 2, 2017**
**Euromaritime**,
international exhibition, Paris
www.euromaritime.fr/73/2017-innovation

**February 22-23, 2017**
**Influence of EEDI on Ship Design & Operation**, international conference,
London, UK
www.rina.org.uk/ShipDesign_EEDI

**February 22-24, 2017**
**AOG: Fixed and Floating Offshore Structures**, international conference,
Perth, Australia
www.rina.org.uk/AOG_2017

**March 13-16, 2017**
**Seatrade Cruise Global**, international exhibition, Fort Lauderdale,
Florida, USA
www.seatradecruiseglobal.com

**March 29-30, 2017**
**Design & Construction of Wind Farm Support Vessels**,
international conference,
London, UK
www.rina.org.uk/WFSV_2017

**March 29-31, 2017**
**INMEX Vietnam**, international exhibition, Ho Chi Minh City, Vietnam
www.maritimeshows.com/vietnam

**April 4-5, 2017**
**Design & Operation of Containerships**,
international conference, London, UK
www.rina.org.uk/Container_Ships

**April 4-7, 2017**
**Gastech**, international conference and exhibition, Chiba, Tokyo
www.gastechevent.com

**April 25-27, 2017**
**Sea Asia**, international conference and exhibition, Singapore
www.sea-asia.com

**April 27, 2017**
**RINA Annual Dinner**, London, UK
www.rina.org.uk/Annual_Dinner_2017

**May 3-5, 2017**
**Contract Management for Ship Construction**, Repair & Design Course,
London, UK
www.rina.org.uk/Contract_Management_May_2017

**May 10-11, 2017**
**Design & Construction of Super & Mega Yachts**, international conference,
Genoa, Italy
www.rina.org.uk/superyachts2017

**May 16 - 18, 2017**
**IMDEX Asia**, international maritime defence exhibition and conference,
Singapore
www.imdexasia.com

**May 17-19, 2017**
**Torsional Vibration Symposium, Salzburg Congress**, Salzburg, Austria
www.torsional-vibration-symposium.com

**May 25-27, 2017**
**Bari-Ship 2017: Imabari Maritime Fair**,
international exhibition,
Imabari City, Japan
www.bariship.com

**May 30 – June 1, 2017**
**Undersea Defence Technology (UDT) 2017**, international exhibition & conference, Bremen, Germany
www.udt-global.com

**May 30 – June 2, 2017**
**Nor-Shipping 2017**, international exhibition & conference, Oslo, Norway
www.messe.no/en/nor-shipping

**June 6-8, 2017**
**Electric & Hybrid Marine World Expo 2017**, Amsterdam, The Netherlands
www.electricandhybridmarineworldexpo.com

**June 6-9, 2017**
**Basic Dry Dock Training Course**,
London, UK
www.rina.org.uk/Contract_Management_May_2017

**June 13-15, 2017**
**Seawork International**, international exhibition, Southampton, UK
www.seawork.com

**June 14-15, 2017**
**Warship 2017: Naval Submarines & Unmanned Underwater Vehicles**,
international conference, Bath, UK
www.rina.org.uk/Warship2017

**June 28 – July 2, 2017**
**International Maritime Defence Show (IMDS-2017)**,
international exhibition,
St. Petersburg, Russia
www.navalshow.ru

**September 6-8, 2017**
**Seatrade Europe**,
international exhibition,
Hamburg, Germany
www.seatrade-europe.com

**September 11-13, 2017**
**BALTEXPO 2017**, international exhibition and conferences,
Gdańsk, Poland
www.baltexpo.ztw.pl/en

**September 12-15, 2017**
**DSEI**, international exhibition, ExCel,
London
www.dsei.co.uk

**September 19-22, 2017**
**NEVA 2017**, international exhibition,
St. Petersburg, Russia
www.transtec-neva.com/home/neva

**September 25-27, 2017**
**Seatrade Offshore Marine & Workboats Middle East**,
international exhibition,
Abu Dhabi National Exhibition Centre,
Abu Dhabi,
United Arab Emirates
www.seatrademaritimeevents.com/somwme

**September 26-28, 2017**
**International Conference on Computer Applications in Shipbuilding (ICCAS 2017)**,
Singapore
www.rina.org.uk/ICCAS_2017