

# MARITIME IMPACT

ISSUE 01-17

THE MAGAZINE  
FOR CUSTOMERS AND  
BUSINESS PARTNERS

SMARTER OPERATIONS

## THE DIGITAL JOURNEY

**HEAVY LIFTER**

Giant semi-submersible sets new record in transport capacity

**CYBERSECURITY**

A health check for on-board control networks

**PANAMA CANAL**

The expanded waterway's impact on the shipping industry

  
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**Knut Ørbeck-Nilssen**  
CEO of DNV GL - Maritime

At Nor-Shipping, Norway steps up to showcase every aspect of the maritime value chain. And at DNV GL, we are proud to be associated with this event as the main sponsor.

Every Nor-Shipping challenges us to engage with the transformative trends within our industry, to see where the opportunities might be, and to work to identify and mitigate the risks of today and tomorrow. This year, the digital transformation of the shipping industry is the central theme, whether it is in the Big Data Forum, the Disruptive exhibition or the opening conference.

In this issue of Maritime Impact, we examine many aspects of this key topic. In our Digital Journey, we look ahead to see how both our services and the industry can benefit from increasing digitalization. We can improve safety by helping the crew on board with advanced navigation software and smart control systems that track a vessel's course and raise an early warning, if they detect a potential collision. We can deliver better services by using intelligent software agents to help customers find the optimal time and place to book a survey and with electronic certificates that ensure that documentation never gets lost, is always up to date and is accessible from any device - anywhere in the world. And we can improve performance, by unlocking siloed data through our Veracity platform, enabling partners to transform secure, quality-assured data into valuable insights.

At the same time, our industry is under increasing societal and regulatory pressure to reduce the environmental impact of vessels. With several new regulations soon to be in force, we examine operational and technology solutions to meet compliance requirements simply and efficiently. You can read more about the first ballast water treatment systems to obtain U.S. Coast Guard approval and the first steps on the road to complying with the new EU MRV regulation. Alongside these we have several articles that feature innovative vessels and solutions, like the PERFECT II project, which shows how owners can cut ship emissions, while at the same time enjoying competitive economic performance.

At DNV GL, we engage with these issues to help our customers, stakeholders, and the industry itself navigate these waters. And if you are attending Nor-Shipping this year, come and visit us at our booth and join the conversation.



**Knut Ørbeck-Nilssen**



# VISION OF THE FUTURE

Inspired by a new environmental awareness and advanced technology, shipping is reinventing itself. DNV GL is helping customers realize their vision, with vessels that push the boundaries of design, while minimizing their environmental impact.





As impressive below deck as she is above, *Vision of The Fjords* is possibly one of the most advanced sightseeing vessels ever built. The drive is a parallel hybrid, with a conventional MAN engine and two electric motors that can each power the ship separately or together. On top of that the two electric motors can be charged by the on-board diesel engine, or in just 20 minutes directly with on-

shore power. *Vision of The Fjords* is owned by The Fjords AS and was built at the Brødrene Aa shipyard in Norway. And while the exterior of this DNV GL-classed vessel is designed to remind passengers of the winding roads up the Norwegian mountains, beneath the water the catamaran hulls are shaped to minimize her wake, reducing shoreline erosion in the protected fjords where she operates.



Photo: Flåm as/sverrehjornevik.com

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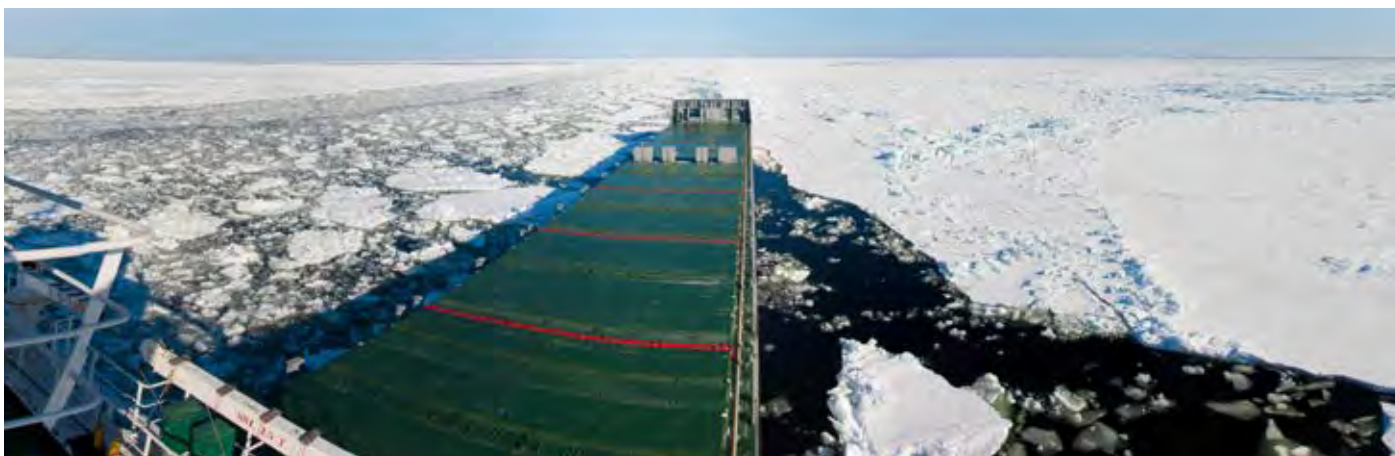
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## IN BRIEF

The offshore supply ship *Stril Polar* is optimized for operation in cold climates.



### First Norwegian vessel to comply with IMO Polar Code

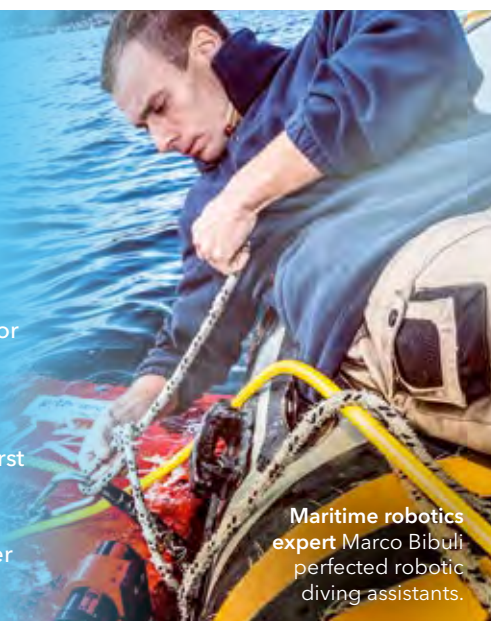
After a successful approval process and survey, DNV GL and the Norwegian Maritime Authority have issued the first polar ship certificate to the Norwegian platform supply vessel *Stril Polar*.

The *Stril Polar*, owned by Simon Møkster Shipping AS, is built for operation in cold climates and only

minor adjustments were needed to achieve compliance with the Polar Code. The process of achieving compliance required DNV GL to undertake a risk assessment of the planned operational profile as well as a detailed review of the vessel's equipment to ensure that the requirements of the code were met.

### DNV GL COMPIT Award 2017 for smart underwater robotics

Marco Bibuli is the winner of the DNV GL COMPIT Award 2017. The Italian maritime robotics expert, working at the Italian research centre CNR-ISSIA in Genoa, was honoured for his work on collaborative, smart robots - Cognitive Autonomous Diving Buddies (CADDY). Through a combination of machine vision, machine learning and cybernetics (control engineering), Bibuli developed the project through to the first field testing stages. The prototypes give a glance at a future where robots become ubiquitous helpers in underwater inspection, cleaning, rescue operations, tank surveys and other tasks, supporting divers for increased safety and efficiency.



Maritime robotics expert Marco Bibuli perfected robotic diving assistants.



## DNV GL receives DAKkS accreditation as EU MRV verifier

In April, DNV GL gained accreditation from the German accreditation body DAKkS to verify compliance with the EU Monitoring, Reporting and Verification (EU MRV) regulation.

The regulation, part of the EU's commitment to reduce greenhouse gas emissions, requires operators to monitor and report on CO<sub>2</sub> emissions based on ship fuel consumption. It applies to all merchant ships of 5,000 GT or above calling at EU (and EFTA) ports. "The choice of DAKkS as our accreditation body represents a conscious decision to go with a truly European accreditation body which understands the needs of the market and the regulatory context," says Nils Wegener, MRV Manager at DNV GL. "With DAKkS we also provide



**Accreditation granted:** Oliver Darley, Vice President, Head of Ship Systems, Materials & Components (left), and Nils Wegener, MRV Manager (both DNV GL).

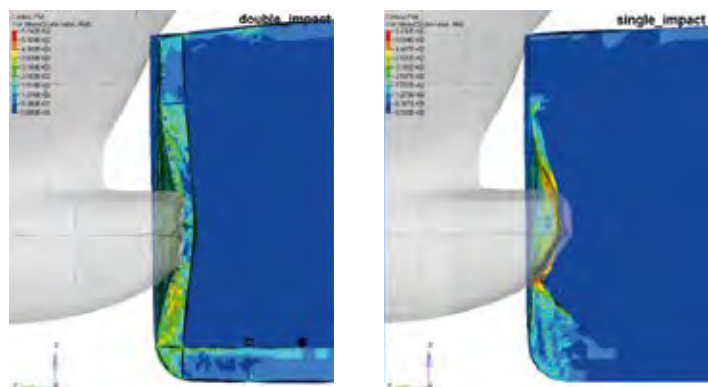
our customers with a long-term, sustainable solution for their verification requirements that is deeply connected to the European regime."

## The world's first double side hull LPG carrier

At the Gastech 2017 conference in Tokyo, DNV GL presented Hyundai Mipo Dockyard (HMD) with an approval in principle (AiP) certificate for a new double side hull LPG carrier design - LPG SAFE (Structural Advances for the Environment).

The result of a development project conducted by HMD working closely together with DNV GL, the AiP certificate confirms that the new design complies with the new DNV GL rules for the classification of ships. The innovative LPG SAFE design is the first 38k LPG carrier design to provide the safety benefit of a double side hull, while offering the same cargo carrying capacity and the same construction cost as a conventional design.

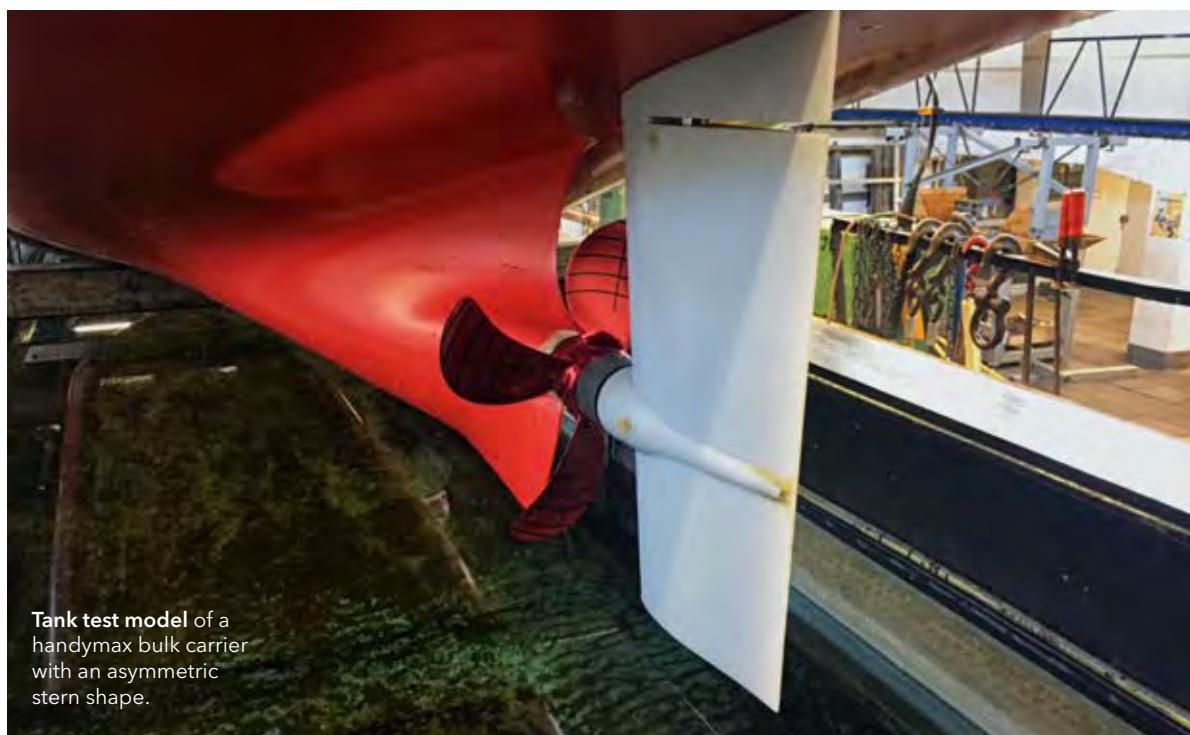
LPG carriers are designed to carry liquefied gases such as propane and butane in bulk. The ships are normally equipped with Type A independent



**The double side hull design** enhances safety and protects the cargo in the event of hull damage.

cargo tanks arranged inside the hold, supported on insulation-bearing blocks, which typically consist of wooden chocks installed on the inner bottom structure. The double side hull design of LPG SAFE offers a significant increase in protection for these tanks, especially in the event of a collision.

## IN BRIEF



**Tank test model** of a handymax bulk carrier with an asymmetric stern shape.

## A twist in the tail: DNV GL adds asymmetric stern to ECO Lines hull optimization service

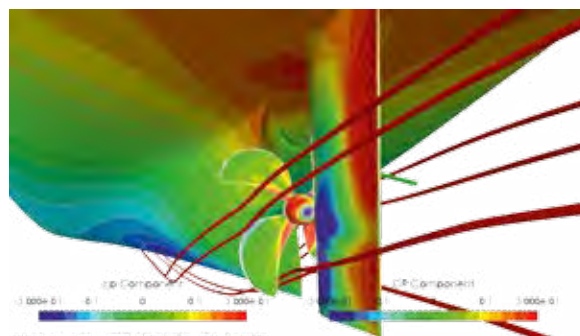
The idea of the asymmetric stern emerged in the 1960s, but due to the difficulty of manually developing the optimal shape, this design failed to make a large impact at the time.

DNV GL has revisited the idea and, using high-fidelity computational fluid dynamics (CFD) in combination with parametric formal optimization, can now offer shipowners the option of incorporating an asymmetric stern into their vessel designs.

"We are now able to model an aft shape that acts as a propulsion-improving device, without the vibration and fatigue strength concerns that come with fins and nozzles," says Dr Karsten Hochkirch, Head of Department, Fluid Engineering at DNV GL – Maritime. "Using our in-house formal parametric optimization procedure, we can assess hundreds of options until we find a design that strikes an optimal balance between pre-swirl and resistance while meeting the customer's design requirements."

In a recent project a 3,000 TEU container ship design was tuned to achieve minimum power consumption. Starting from a well-optimized symmetric

baseline design, the asymmetric stern enabled a propulsion power reduction of more than three per cent, a result that was confirmed in tank testing. In another project, the ECO Lines team was asked to identify propulsion efficiencies in a 38,000 dwt tanker. The CFD optimization generated a design promising a 3.5 per cent decrease in propulsion power compared to the symmetrical design.



**Advanced CFD** and optimization methods enable engineers to improve propulsion efficiency by precision-designing an asymmetric stern for new vessels.



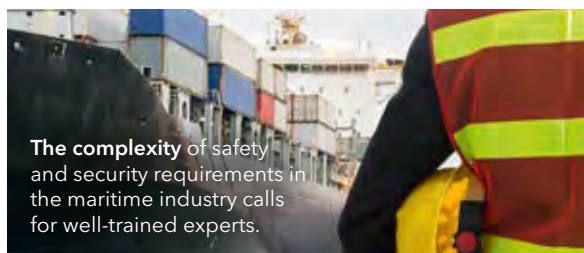
## New postgraduate diploma launched

The World Maritime University (WMU) and the DNV GL Maritime Academy have launched a new postgraduate diploma in Maritime Safety and Security (MSS).

The programme is designed to help people involved in shipping operations and the associated

regulatory framework develop the profound understanding of all aspects of safety and security they need in today's complex maritime industry.

The programme examines the contemporary maritime transport system and the fundamentals of shipping operations, the environmental aspects and the related liabilities of shipping safety, explains the IMO's approach towards the "human element", and elaborates on the main legal conventions and codes, including the Maritime Labour Convention 2006.



The complexity of safety and security requirements in the maritime industry calls for well-trained experts.



Register here:  
[maritime-safetyandsecurity-diploma.com/register](http://maritime-safetyandsecurity-diploma.com/register)

## JIP to develop LNG-fuelled Capesize concept

DNV GL and BHP Billiton, Mitsui O.S.K. Lines, Rio Tinto, SDARI and Woodside signed a new joint industry project (JIP) agreement in Singapore recently.

The Green Corridor JIP is a financial and technical feasibility study of an LNG-fuelled Capesize bulk carrier concept intended to operate from Australia. It will look at a wide range of factors, including capital costs, operational costs and price sensitivities in terms of LNG and low-sulphur marine fuel oils, comparing the outcome with both a conventionally

fuelled vessel and an LNG retrofit. In addition, it will perform a high-level bunker supply chain assessment to identify key issues affecting the vessel design and business case.

The project partners will also develop a concept design for an efficient LNG-fuelled Capesize vessel. The ship will be optimized for operations from and to Australia, and will be developed to a technical stage so that it may achieve approval in principle (AiP) in compliance with the new DNV GL rules.



**Signing ceremony** for the Green Corridor joint industry project (f. l.): Chen Gang, Technical Manager at SDARI; Toshiaki Tanaka, Executive Officer, Deputy Director General, Dry Bulk Business Unit at Mitsui O.S.K. Lines; Steen Lund, Regional Manager South East Asia, India and Pacific, DNV GL - Maritime; Mike Utsler, Chief Operating Officer at Woodside Energy; Abdes Karimi, Freight Operations Manager at BHP Billiton; and David O'Brien, Freight Manager at Rio Tinto Marine.

Photos: DNV GL, WMU

# DNV GL'S DIGITAL JOURNEY

From electronic certificates, machine learning tools and drone surveys to the launch of a new industry data platform, DNV GL is embracing digitalization to enhance class services and improve communication with customers.

Shipping has undergone a remarkable transformation over the past few decades. Advances in technology, new materials and new insights into the design, construction and operation of vessels mean that they are more complex, more efficient and larger than ever before. While the use of ship-to-shore data and greater digitalization is improving operations and performance, reducing maintenance and operational costs, as well as enhancing safety. DNV GL has been at the heart of this transformation for more than 150 years.

"For us, digitalization is not an end in itself, we see it as another means to fulfil our main purpose:

ensuring safe operations at sea and protecting life, property and the environment," says Knut Ørbeck-Nilssen, CEO of DNV GL - Maritime. "The role of class in ensuring the integrity of the vessel and safety of the crew will continue, but the way surveys are conducted may change significantly. Furthermore, digitalization enables us to become more efficient and improve our level of service," he adds.

## Single access point to all digital services


When our customers interact with classification, they want this to be as simple and efficient as possible. To help, we launched My DNV GL. This is a single >



A digital twin can be used to run simulations throughout the lifetime of a vessel.

Photos: DNV GL, Hasenpusch, zinkevych - Fotolia





**Digitalization** is enhancing our understanding of maritime operations, improving efficiency and helping to reduce costs.



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“For us at DNV GL, digitalization is not an end in itself, we see it as another means to fulfil our main purpose: ensuring safe operations at sea and protecting life, property and the environment.”

**Knut Ørbeck-Nilssen**, CEO of DNV GL - Maritime

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Complex ship systems have become more vulnerable to cyberattacks. Using a digital twin, DNV GL experts can check how networks on board would respond to security breaches.

“To make our DATE service even better, we have introduced a tool that uses machine learning to automatically match our customers with the right expert for their question.”

**Knut Ørbeck-Nilssen,**  
CEO of DNV GL - Maritime

> access point for all of our digital services, with many applications designed to support our customers in areas such as port state control inspections (see info box - PSC Planner), cybersecurity preparedness and regulatory compliance. To provide worldwide access to class documentation, DNV GL customers will soon be able to use electronic certificates. This means their documentation never gets lost, is always up to date and is accessible from any device (see info box - Electronic Certificates).

“And with the introduction of our new simple survey booking tool towards the end of the year, we will also start using intelligent software agents to help customers find the best time and place to book a survey,” adds Ørbeck-Nilssen (see info box - Simple Survey Booking). When customers have questions or

run into a problem, they can get in touch with one of DNV GL’s technical experts through the DATE service. “This service has been a great success and now, to make it even better, we have introduced a tool that uses machine learning to automatically match our customers with the right expert for their question,” says Ørbeck-Nilssen. The tool has already analysed more than 200,000 requests and is continuing to learn (see info box - Machine Learning). “Soon, we expect it will be able to answer simple questions on its own,” he adds.

#### Modern survey methods

One of the most important ways we work to keep shipping safe is by conducting annual surveys on all of the vessels in our class. So far this has meant

#### ELECTRONIC CERTIFICATES

Starting in September 2017, DNV GL will introduce electronic certificates for the class and statutory regimes. Accessible from anywhere in the world, electronic certificates bring many advantages to both DNV GL and its customers. By eliminating paper handling, they reduce the administrative burden on all

stakeholders. A validation solution ensures that electronic certificates are just as safe as paper. In addition, electronic certificates are easy and convenient to share. Compiling them in My DNV GL provides a comprehensive overview of key ship data that cannot get lost and is just a few clicks away. For DNV GL,

electronic certificates help make processes more efficient, and they provide experts with easy access to certificates when they need to check up on something, be it during a survey or at a customer meeting. Electronic certificates will be rolled out gradually and will be implemented with a vessel’s next annual survey.





**SMART SURVEY BOOKING**

The Smart Survey Booking tool will be launched towards the end of the year. It simplifies survey booking, fitting inspections into the customers' schedule while saving time and costs. This is how it works:

- Customers are notified about the best time to order surveys and audits and notified shortly before the due date of the next survey.
- The tool proposes the scope of the survey and states how long a survey of this scope would take.
- A list of approved service suppliers in each port is provided,



**The tool** generates a list of approved inspectors in various ports.

- and helps operators to find out whether an in-water survey can be performed in a specific port.
- The tool offers up-front cost estimates including travel and overtime charges for survey combina-

tions during any given port stays based on ETA (estimated time of arrival) and ETD (estimated time of departure).

- Based on automatically calculated cost estimates and the possible scope of the inspection in each port, customers can compare and benchmark various port-stay options.
- Once the date is set, the tool attaches relevant survey preparation notes to the booking confirmation to help the operator prepare for the inspection.

a surveyor needs to crawl and climb to reach every remote corner inside a ship. But new technologies are changing even how DNV GL does this. Already, surveyors have used camera-equipped drones to visually inspect large cargo holds and tanks. Using a drone opens up a lot of new possibilities. "In the future, drones could eventually be piloted remotely or even autonomously, meaning the surveyors could work from their desk thousands of miles away from the ship and inspect the vessel in virtual reality (VR)," says Ørbeck-Nilssen.

For our customers, the successful delivery and regular inspections of a vessel as well as interactions with class are just one part of a bigger puzzle. The other big questions are: How does the design perform in daily operations? Is the engine achiev-

ing optimal fuel consumption? And are the safety systems reliable at sea?

**Turning data into business intelligence**

Today, advanced sensor technology and powerful satellite connections have opened up a new range of possibilities for understanding more about vessels and their operation. Everything on board, from the engines, the propeller and the safety systems to the containers themselves can be fitted with smart sensors to monitor performance and catch irregularities early on. This information can then be fed into the DNV GL performance management platform ECO Insight, which can check the quality of the data before analysing it. "This lets operators benchmark their vessels against the world fleet, turning their

**PSC PLANNER**

Launched in April 2017, the Port State Control (PSC) Planner is one of the most recent additions to the My DNV GL customer portal. Designed to help shipowners, managers and operators increase operational efficiency, the PSC Planner gives an overview of vessel or fleetwide PSC performance, which can then be benchmarked against the IACS-classed world fleet. The tool also assists the crew

on board by highlighting specific areas to focus on when preparing for the next inspection.



**Find out more at**  
[www.dnvgl.com/maritime/mydnvgl-service-overview/psc-planner.html](http://www.dnvgl.com/maritime/mydnvgl-service-overview/psc-planner.html)

**Being well prepared** for the next PSC inspection helps crews and operators avoid costly surprises.







Advanced technology is helping to modernize communication with class and is changing the way DNV GL conducts surveys.

> data into valuable business intelligence,” says Ørbeck-Nilssen.

DNV GL can also take this data and combine it with information from inspections and a 3D model of the ship to build a “digital twin” – a digital copy of a real object, modelled to exactly represent its properties. DNV GL experts can use the digital twin to find the best design, see how the networks on board respond to cyberattacks, test measures to improve performance and identify when vital equipment needs maintenance or replacement – throughout the lifetime of the vessel. Ultimately, digital systems could end up controlling ships entirely – without

the need for a human crew. An autonomous ship would use advanced navigation software and smart control systems to follow a course, avoid obstacles and safely deliver its cargo. Of course, if the industry is going to rely on these systems, they need to be as reliable and secure as possible. With software-in-the-loop testing and a digital twin, DNV GL can check and correct weaknesses in the system.

#### The broader view

These new digital solutions are not confined to the world of shipping. “It doesn’t matter where you look in DNV GL, our customers are using data analytics to improve safety, gain efficiencies, reduce environmental impacts and evolve new business models,” says Remi Eriksen, Group President & CEO at DNV GL. “On drill ships, we’ve seen how sensor data and advanced data analytics are helping our customers save millions of dollars in downtime. In the renewables industry, power cybernetics is helping to integrate variable wind and solar power safely into the grid, while machine learning helps oil and gas pipelines become safer by drawing insights from previously unconnected data sets,” he explains.

#### A new industry data platform

All of these advances need many different project partners working together with accurate, reliable and secure data from multiple sources. And as decision-making and business models become more data-driven, trustworthy data becomes even more valuable. “Without trust in this data, truly cooperative projects

#### MACHINE LEARNING

DNV GL has introduced a new machine learning tool to the Direct Access to Technical Experts service (DATE). When customers have a query, this service connects them to one of more than 400 technical experts located at five support hubs worldwide. DATE was used more than 20,000 times in 2016, with over 97 per cent of requests being completed within the customer’s deadline. Matching every request with the right expert as quickly as pos-

sible is essential. DNV GL’s new machine learning tool searches for key words in a customer enquiry to create a profile for each request. Then it sends the request to an appropriate expert. After a piloting phase the machine learning tool went live for all DATE requests at the beginning of May 2017. It has viewed about 200,000 requests already and is learning continually. In the future, it could even answer simple questions on its own.



A machine learning tool accelerates request processing in the DATE service.





**DNV GL surveyors** perform a final check on one of the custom-built DNV GL drones, before using it to inspect a cargo tank.

cannot deliver the progress we hope for. At DNV GL, we have always been trusted with data, trusted to give an independent expert view and trusted to connect different industry players. That is why we have created a place for industry experts and data to come together securely: our new, multi-sided industry data platform called Veracity,” says Remi Eriksen.

Veracity is a meeting ground for co-innovation and co-creation between multiple industry stakeholders, playing a key role by assuring data quality, data security and access. It is an open platform for qualifying, unlocking and improving data from sensors and other sources. Customers stay in control

in this secure environment, and can trust domain experts, algorithms and analytics to combine and transform their data into real value. And Veracity could be a key component of a class-concept built around sensor-based data: securing and assuring data for use in the condition assessment of the hull and critical components.

“The digital transformation cannot be realized with one solution or one service. It is a journey,” says Knut Ørbeck-Nilssen. “By working together with us, customers can capitalize on these new opportunities – to make the world safer, smarter and greener.” ■

## VERACITY

The Veracity industry data platform is designed to help companies improve data quality and manage the ownership, security, sharing and use of data. One area where the maritime industry could benefit from the Veracity data platform in the future could be allowing DNV GL's maritime customers to document compliance of main on-board machinery and systems through predictive analytics, removing the need for calendar-based inspections. In one of DNV GL's first pilot projects a drilling operator embarked on a project to explore predictive analy-

tics with a components vendor and an analytics services company. Working with DNV GL to see if this approach could gain class approval, an analysis of the data revealed severe quality issues that none of the partners were previously aware of. Once the data was quality-assured, machine learning algorithms could be applied to the data with success. A key learning from the project was that it demonstrated the need for continuous data management and quality assurance to reap the benefits of a data-driven approach.

**Veracity** could use predictive analytics to document compliance of main on-board machinery and systems.



# TREAT HER RIGHT

With the ratification of the Ballast Water Management Convention, shipowners are pressed to decide which treatment systems to choose. For manufacturers keen to be selected, attaining type approval by the U.S. Coast Guard can be a deciding factor. DNV GL provides comprehensive support.

After many years of discussions, the date is set. The IMO's Ballast Water Management Convention will enter into force on 8 September 2017. For operators with vessels that discharge ballast water in international waters, this means that they must have a treatment system installed on their vessels within five years. The specific deadline depends on the next renewal survey of a vessel's International Oil Pollution Prevention (IOPP) certificate.

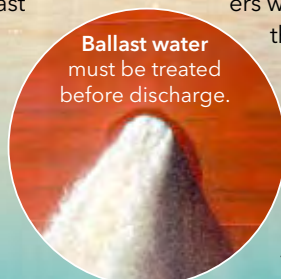
For many operators trying to decide which type of system to install, one of the most important questions is: Does the system meet the U.S. Coast Guard (USCG) requirements? In late 2016, the manufacturers Alfa Laval, Optimarin and OceanSaver became the first to be awarded U.S. Coast Guard type approval certificates for their ballast water treatment systems. "We are proud to have worked with all three of these successful applicants from the very beginning," says Martin Olofsson, Senior Principal Engineer, Environmental Protection DNV GL - Maritime Approval of Ship Systems and Components.

## More systems close to approval

In the first quarter of 2017, DNV GL submitted two further applications to the U.S. Coast Guard, for manufacturers Sunrui and Ecochlor. "Currently, we have also completed land-based testing cycles for four further manufacturers. Successfully passing land-based testing is a good indication that the systems could also meet the U.S. Coast Guard's requirements, once they have undergone shipboard testing," says Olofsson. "Land-based testing really challenges the efficacy of these systems. In 15 test cycles, they expose the systems to 1,000 times more large organisms and ten times more medium-sized organisms than shipboard testing." If all goes to plan, another four systems could be approved in the first half of 2018.

The USCG officially appointed DNV GL as an Independent Laboratory (IL) to perform type approval testing of ballast water treatment systems (BWTS) in 2013. "DNV GL and its associated sub-laboratories DHI Denmark, NIVA (Norway), Golden Bear Facility (USA) and DHI Singapore have been deep into the details of USCG testing for three years and have gained substantial experience in what is practical and possible to achieve in compliance with the regulation," says Olofsson. There are now five "Independent Laboratory" accreditations for BWTS. Out of 45 BWTS manufacturers who have signed a letter of intent for having their systems approved by the USCG, DNV GL is currently handling 25, making it the largest independent provider of laboratory services by far.

The choice of the best-suited treatment system for a particular vessel depends on a number of factors: What ship type is it? Does the vessel operate in fresh or brackish water? Does it primarily sail in cold or temperate waters? Will the system have to work in high-turbidity conditions, meaning water that contains a lot of clay, algae or silt? All these questions are very important for making the right choice. The five treatment systems which already hold or are soon expected to hold a USCG type approval certificate include UV systems, electrolytic systems and chemical injection systems. Read on to see how these types of systems work, which operational profiles they can handle and their advantages and drawbacks (see next page). ■ AJO/HH



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## SELECTED BWT SYSTEMS AT A GLANCE

### UV SYSTEMS

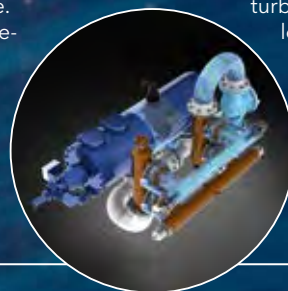
■ **How it works:** With a market share of 50 per cent, UV systems are the most popular option at present. They use a two-step process of filtration and ultraviolet (UV) irradiation to sterilize organisms and stop their reproduction.

■ **Suitable for:** UV systems are suitable for any vessel in theory, but primarily for those which do not take in too much ballast water and have flow rates of up to around 1,000 cubic metres per hour. This includes ro-ro vessels, container ships, offshore supply vessels and ferries.

■ **Advantages/Challenges:** UV systems are easy to install and retrofit, and have few safety concerns from a class point of view. They also operate independently, no matter what the water salinity and temperature are.

However, they are dependent on the water transmittance (UV-T) and work less well in turbid water. The U.S. Coast Guard's interpretation that

any organisms released into US waters should be dead before leaving the vessel, rather than just made infertile, means that a type-approved filter+UV system becomes more sensitive to water turbidity and may require longer holding times to ensure mortality.



**Optimarin** received USCG type approval for its filter/UV system in 2016.

### ELECTROLYTIC SYSTEMS

■ **How it works:** Electrolytic treatment systems have a market share of around 35 per cent and therefore come second in the treatment systems' ranking. Many of these systems also use a filter as a pretreatment. By passing an electric current through a small side-stream of seawater, they use the salt and the water molecules in a chemical reaction to generate sodium hypochlorite, a disinfectant, which is then reinjected into the ballast water to kill all organisms.

■ **Suitable for:** Electrolytic treatment systems are more suited for larger vessels such as tankers and bulk carriers, which have large ballast water volumes and high flow rates in the range of up to 8,000 cubic metres per hour.

■ **Advantages/Challenges:** As well as being able to handle large capacities, electrolysis-based systems are very efficient and the treatment of the water is done on the intake only (possible neutralization on discharge). This means they provide on-board disinfection, and some sys-

tems even provide in-tank circulation treatment during the voyage, when treatment in the port is not feasible. One of the disadvantages is that the electrolytic reaction generates small amounts of hydrogen gas, a factor which needs to be accounted for in safety considerations. In addition, electrolytic systems are sensitive to low salinity and low temperatures, so salt or a heating system must be added where necessary. Finally, they are more complex to install, control and maintain compared to UV filter systems.

### CHEMICAL INJECTION SYSTEMS

■ **How it works:** These systems are often used in combination with filtration. A chemical solution is injected into the ballast water to ensure disinfection. The disinfectant may be liquid or granular and will sometimes require neutralization prior to discharge overboard. Some of the active substances which are commonly used

include sodium hypochlorite, peracetic acid and chlorine dioxide.

■ **Suitable for:** Chemical injection systems are deemed appropriate for most ballast flow capacities ranging up to 16,000

cubic metres per hour and are mostly used to treat ballast water on vessels with larger capacities and flow rates, such as tankers and bulkers. The technology also makes it suitable for infrequent usage and is also good for disinfecting tanks that have been used without treating the ballast water during ballasting and deballasting in local waters.

■ **Advantages/Challenges:** Chemical injection systems generally have low power requirements, because their only energy consumption comes from distributing the chemicals into the ballast water. With the dosing pump as their main component these

systems require less space on board, making them easier to install than other technologies. However, the chemicals which are used, such as Peraclean or Purate, are trademarked, and supply might be limited to specific ports. In addition, the chemicals must be stored on board in closed containers and may be hazardous. The use of chemicals requires implementation of strict safety provisions and crew training. Having to stock up the supply of chemicals regularly also generates additional operational costs compared to UV or electrolysis systems, which have electricity as their main cost item.

Photos: Dudarev Mikhail - Fotolia, Erni - Shutterstock, Hasenpusch, Optimarin



**Invasive species** threaten marine ecosystems around the world.

# UNMANNED SHIPS ON THE HORIZON

With a new testbed and several research projects underway, autonomous shipping is one step closer to becoming a reality. And DNV GL is working on developing the necessary rules.

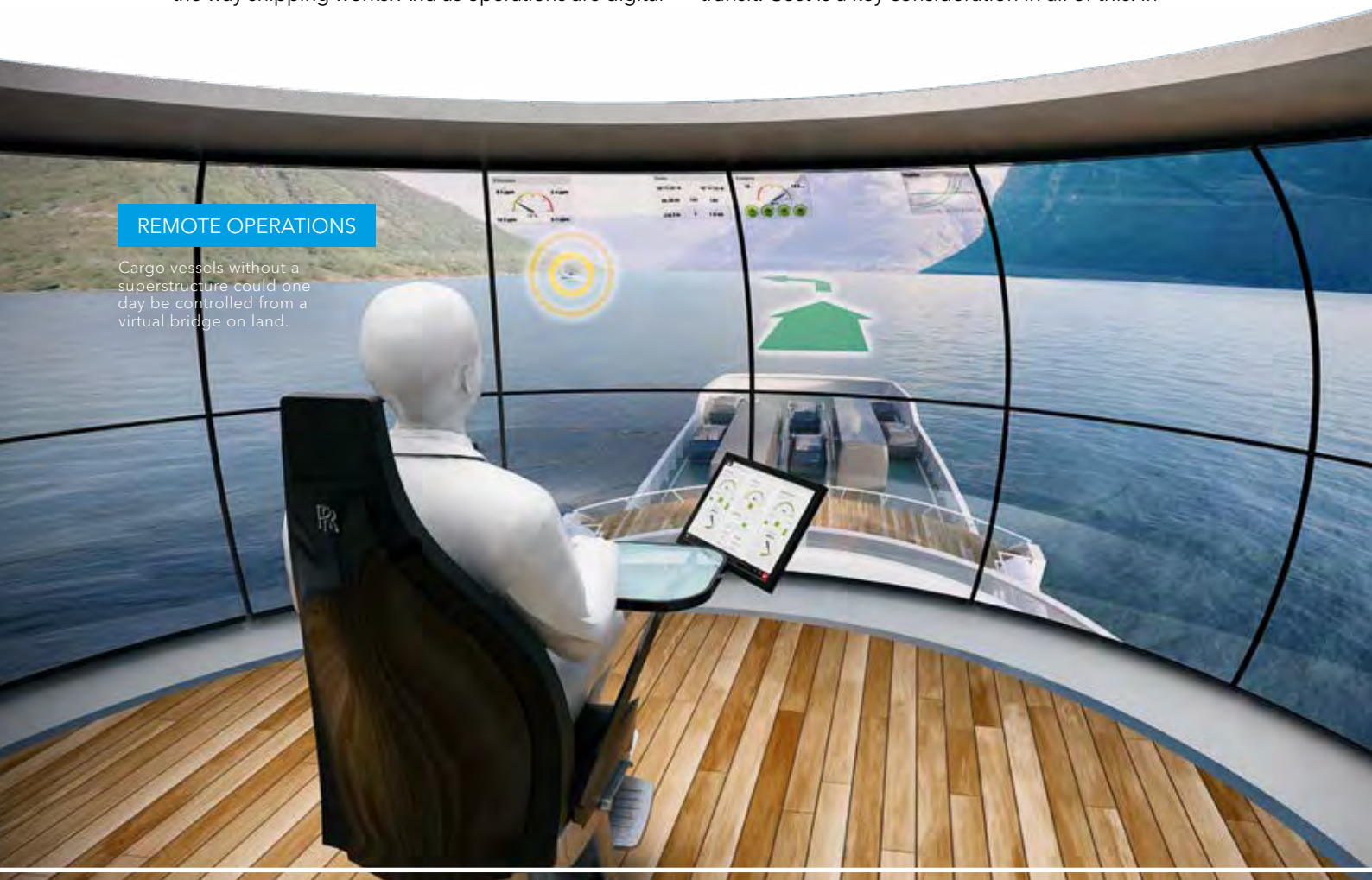
The little craft bearing the DNV GL logo gingerly braves the waves, as it skippers across the Trondheim Fjord under the watchful eyes of Kjetil Muggerud and Henrik Alfheim from the Norwegian University of Science and Technology (NTNU) in Trondheim. Both students are investigating how advanced control systems and navigation software could control an unmanned vessel, using a 1:20 model of DNV GL's concept vessel ReVolt: "Advances in sensor technology, data analytics and bandwidth to shore are fundamentally changing the way shipping works. And as operations are digital-

ized, they become more automated," says Dr Pierre C. Sames, Director of Group Technology & Research at DNV GL.

Governments around the world are looking into unmanned shipping as a way to move more cargo to sea in order to contain the spiralling costs of road maintenance caused by heavy lorry traffic, not to mention air pollution. Norway has taken the lead in exploring innovative ways of tackling this issue and bridging its many fjords and sea passages to ease transit. Cost is a key consideration in all of this. In

## REMOTE OPERATIONS

Cargo vessels without a superstructure could one day be controlled from a virtual bridge on land.







### SCIENTIFIC REVOLT

The DNV GL experimental scale model is used by NTNU researchers for trials.



would also become more economical, as eliminating the superstructure would save weight and create more cargo space. Furthermore, unmanned ships may be used in hazardous operations, e.g. firefighting, or as stand-by rescue vessels for offshore structures.

2016 government agencies and industry bodies established the Norwegian Forum for Autonomous Ships (NFAS) to promote the concept of unmanned shipping. In support of these efforts, the Norwegian government has turned the Trondheim Fjord into a test bed for autonomous ship trials. Other nations, most notably Finland and Singapore, are pursuing similar goals.

DNV GL is in the midst of this development, following its mission to make sure the technologies enabling autonomous ships will perform to the benefit of humans, their assets and the environment.

### The human factor

"If we look at recent advances in driverless car technology, the thought of trying something similar with ships does not appear too far-fetched. After all, water has at least one great advantage: there is less traffic than on roads and reaction times are usually longer," says Sames.

The DNV GL experts identified three main factors that could positively influence the uptake of autonomous shipping: "Automation reduces the potential for human error. In addition, water transport can be cheaper and more energy efficient than moving goods on land."

With a battery propulsion system, as seen on DNV GL's ReVolt model, an autonomous ship would also be lower in maintenance than conventional ships. Additionally, an unmanned cargo vessel

### Small craft with great ambitions

DNV GL has initiated or is taking part in various projects revolving around ship automation and autonomous control. The ReVolt project is one example; once all aspects of the autonomous control technology are mature, such a design could possibly be built and deployed as a 100 TEU feeder vessel on fixed routes in coastal waters.

Another project with DNV GL involvement, the Advanced Autonomous Waterborne Applications Initiative (AAWA), led by Rolls-Royce, is investigating a wide array of aspects relevant to commercial unmanned shipping – from technical development to safety, legal and economic aspects as well as societal acceptance. "At DNV GL, we are doing



### FJORD1 DOUBLE-ENDED FERRIES

In the race to put the first autonomous ship on the water, Rolls-Royce is getting the autonomous navigation and propulsion systems ready for the Fjord1 ferry project, developed by Multi Maritime.



### AAWA ROLLS-ROYCE

The AAWA project investigates a broad range of criteria relevant to autonomous shipping, including safety, economic and social aspects.



> a lot of work to understand the potential risks that come with autonomous ship systems in order to set new standards for them," explains Sames. "We are already working on developing requirements to be able to test and classify unmanned vessels in the future," he adds.

The Autosea project of NTNU, supported by DNV GL, Kongsberg and Maritime Robotics, seeks to understand the performance of novel sensor systems and the error potential of autonomous control technology, especially collision avoidance. The NTNU scientists are also working on an autonomous craft for Trondheim harbour. The idea is to provide an on-demand ferry service to passengers and bicycles across a channel at the push of a button. Featuring electric propulsion, an induction-charged battery, GPS navigation and an anti-collision system, the craft will carry up to twelve persons. It is intended to function as a cost-saving alternative to building a bridge. A pilot study is planned for this year, and the ferry is expected to start operating in 2018/2019.

Meanwhile two commercial projects are nearing completion: Rolls-Royce is supplying automatic crossing systems for two DNV GL-classed double-ended, battery-powered ferries the Norwegian op-

erator Fjord1 plans to commission in 2018. Both vessels will navigate autonomously under the captain's supervision, and he has the option to take control at any time. The first ferry will still require human-controlled berthing, while the second one will be able to perform this task automatically as well.

The unmanned offshore vessel *Hrönn*, under construction at Fjellstrand shipyard for a Norwegian and UK consortium led by Automated Ships and Kongsberg, will also be delivered in 2018. The light-duty, fully automated utility ship will be deployed in a shuttle service for offshore installations but could be used for many other purposes, ranging from research to fish farming operations.

Furthermore, a plan to build the first unmanned and fully-electric container feeder ship was recently unveiled by Kongsberg and the Norwegian fertilizer specialist Yara. After her delivery, *Yara Birkeland* will initially operate as a manned vessel and start traveling between the Norwegian ports of Brevik and Larvik autonomously in 2020.

### The challenges

Overall, autonomous shipping opens up great opportunities for the European shipbuilding and



HRÖNN

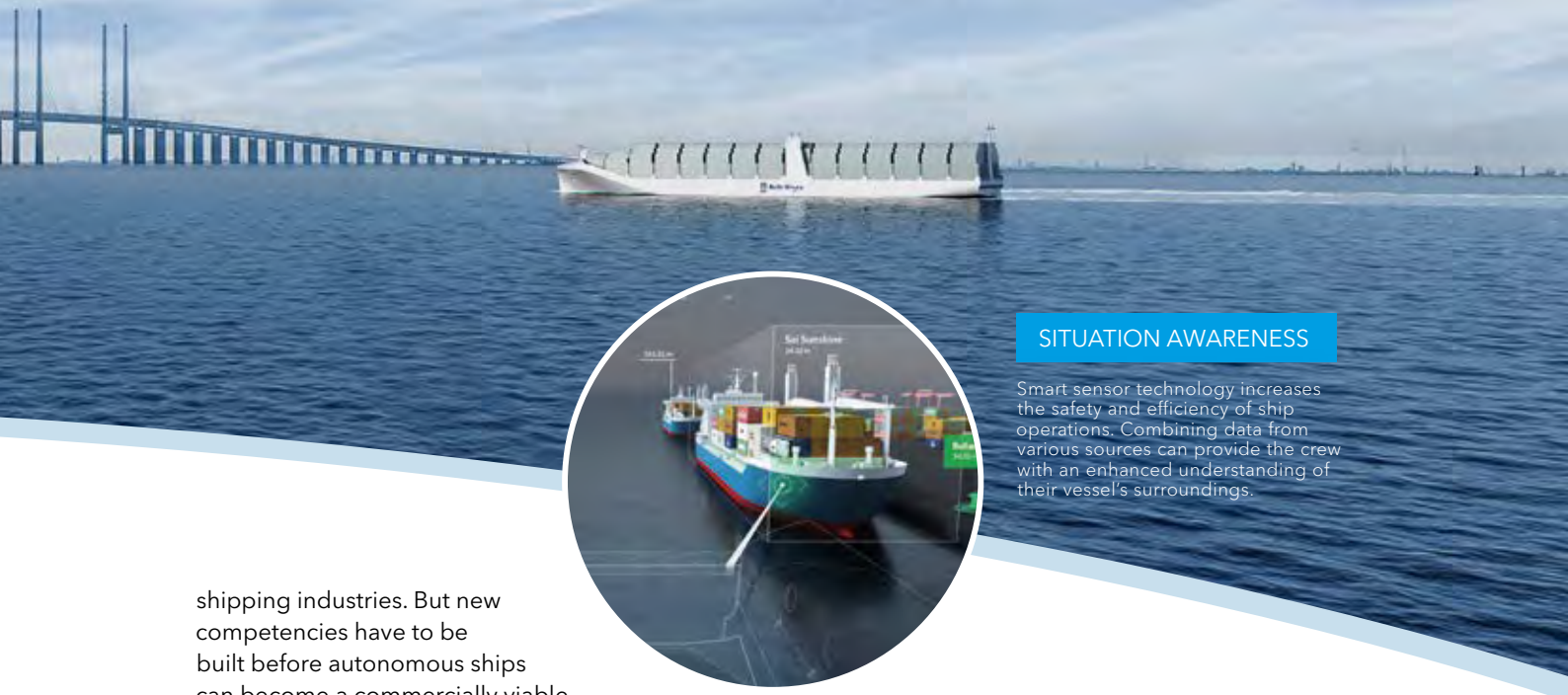
An unmanned multi-purpose utility vessel, *Hrönn* will start operating in 2018 servicing offshore sites.



**Dr Pierre C. Sames,**  
Director of Group Technology & Research at DNV GL

"The most likely scenario is that autonomous shipping will be an additional option for future ship operation."





### SITUATION AWARENESS

Smart sensor technology increases the safety and efficiency of ship operations. Combining data from various sources can provide the crew with an enhanced understanding of their vessel's surroundings.

shipping industries. But new competencies have to be built before autonomous ships can become a commercially viable reality. Key research must be done to improve sensor technology, the acquisition of high-resolution ranging data and instrumentation accuracy. Software plays a very important role in this scenario by enabling situational awareness, a prerequisite for automated decision management. While existing know-how from the aerospace and automobile industries can be leveraged, specific expertise in ship autonomy has yet to be built up, states Sames. The research activities at NTNU, sponsored by DNV GL and industry stakeholders, are instrumental in creating a new generation of highly skilled ship autonomy experts.

Another concern is the operational availability of on-board machinery. No immediate repairs are possible on an unmanned craft so reliability of all mechanical and electronic components is of utmost importance. "In addition, having battery-powered unmanned vessels would eliminate movable parts from the power generation system and make them easier to maintain," says Sames.

Segments that could see the first autonomous vessels in operation, include ferries or offshore supply vessels operating in coastal areas or smaller cargo vessels operating in short-sea-shipping.

However, the expert cautions that, as yet, there is no legal framework that governs the use of unmanned ships. DNV GL is developing a set of rules, but to avoid potential conflicts with international law autonomous ships will not be able to operate in international waters until the IMO develops appropriate regulations, which will take time. For the deep-sea segments, autonomous shipping

is not an option today, says Sames. "These vessels travel distances that go beyond the range of battery propulsion, and they require well-trained crews on board who can respond quickly to any technical issue," says Sames. "If an unmanned vessel had a technical issue in the Atlantic, it would take days to reach it and fix the problem. This would not be safe or economical," he adds.

### Additional crew support

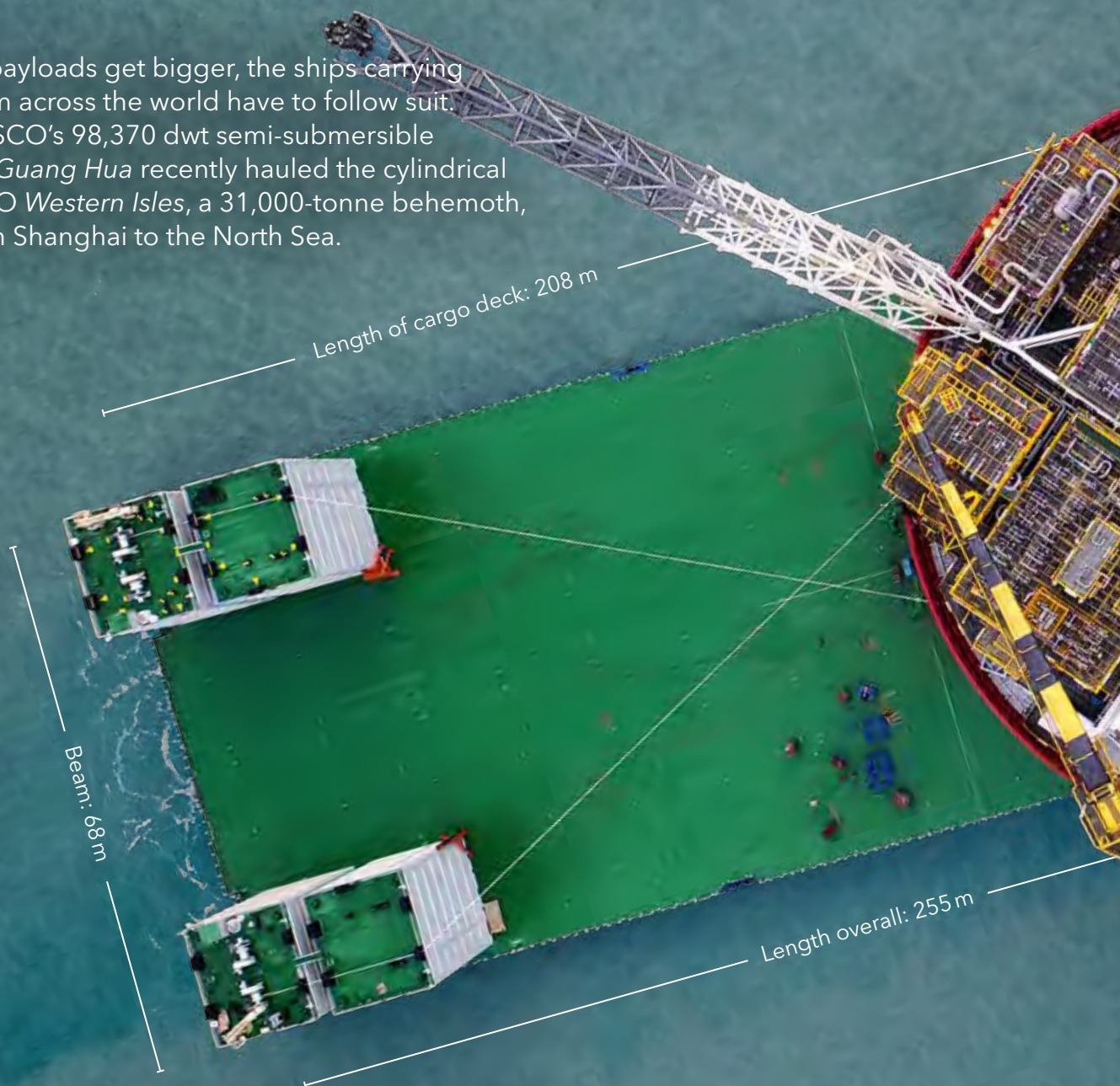
However, advances in automation can benefit all industry segments in some way, even without fully autonomous control. In the future, some ship traffic could be controlled remotely from land-based virtual bridges – with one ship master overseeing several vessels at the same time. "But the most likely scenario is that the technology which enables autonomous ship operations will simply be an additional option for operation – meaning they could be used for specific purposes without fully replacing traditional, manned operations," Sames suggests. "So for example, autonomous navigation and control systems could support the crew in steering a vessel, increasing safety and optimizing operational efficiency." ■AK

### DNV GL Expert

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# MADE IN CHINA: THE HEAVY LIFTER

As payloads get bigger, the ships carrying them across the world have to follow suit. COSCO's 98,370 dwt semi-submersible *Xin Guang Hua* recently hauled the cylindrical FPSO *Western Isles*, a 31,000-tonne behemoth, from Shanghai to the North Sea.







With her ultra-long open, reinforced deck, *Xin Guang Hua* provides a main deck area the size of two standard football pitches.

Engine power  
**2x10,500**  
kW

Service speed  
**14.5**  
knots

Loaded draught  
**10.5**  
metres

Submerged draught  
**30.5**  
metres

Deadweight  
**98,370**  
tonnes



*"Xin Guang Hua symbolizes a firm step towards our strategic goals of being the world's most competitive specialized carrier company and the leading provider of project logistics services."*

**Han Guomin**, General Manager of COSCO Shipping Specialized Carriers

Since her delivery into service in December 2016, *Xin Guang Hua* has been setting records. She is the largest semi-submersible in China and the second largest in the world. The *Western Isles* was the largest single piece of cargo by weight and the largest cylindrical object by volume ever carried by a COSCO semi-submersible.

*Xin Guang Hua* is owned by COSCO Shipping Specialized Carriers, while the *Western Isles* FPSO was manufactured by COSCO Shipping Heavy Industries Company. Both companies belong to the newly-merged China COSCO Shipping Group. Their collaboration in the transport of the *Western Isles* FPSO to the UK included everything from ensuring loading preparedness to the pre-voyage meeting and on-site loading, and was another example of Chinese companies adding "service by China" to the "made in China" label.

"*Xin Guang Hua* will significantly improve the service capabilities of our company's semi-submersible fleet for transporting large-scale international maritime projects and promote the progress of modularization and upsizing in the manufacturing industry. The vessel symbolizes a firm step towards our strategic goals of being the world's most competitive specialized carrier company and the leading provider of project logistics services," says Mr Han Guomin, General Manager of COSCO Shipping Specialized Carriers.

*Xin Guang Hua* is the eighth semi-submersible heavy-lift vessel operated by the company. Designed by Vuyk Engineering Rotterdam, with detail design by MARIC, and built by GSI (Guangzhou Shipyard International), *Xin Guang Hua* is classed by DNV GL and CCS. In addition, she has been awarded the class notations 1A1 Semi-submersible heavy transport vessel and BIS DK (+) DPS(2) E0 ICE (1B) Recyclable RP.

"This is an impressive vessel, she has a very robust structural design and is equipped with redundant propulsion power, making her optimized for sea transportation of heavyweight and oversized cargoes," says Chi Shaoguang, DNV GL's Guangzhou Station Manager.

#### New flagship

The vessel features an ultra-long open and strengthened deck measuring 208 metres in length and 68 metres in breadth, providing a main deck area of over 14,000 m<sup>2</sup>, equal to two standard football pitches. To ensure the cargo deck loading capability, the deck plates are made of 60 mm grade E steel plates, which in combination with a supported and strengthened internal structure, results in a loading capacity of 25 tonnes/m<sup>2</sup> uniform load, and the load of up to 125 tonnes/m<sup>2</sup> on transverse web frames arranged at every second frame. The hull has been reinforced, and propulsion power meets the require-

Bow and stern thrusters  
**4 x 2,650**  
kW

Hull depth  
**14.5**  
metres

Within six hours the vessel submerges to a depth of 30.5 metres with 16 metres of water above the main deck.

**COSCO SHIPPING**





60 millimetres steel deck plates and a reinforced load-bearing structure enable a loading capacity of 25 tonnes per square metre.



Overall load  
on main deck  
**25**  
tonnes/m<sup>2</sup>

ments for Baltic Sea 1B ice class (0.8 m of floating ice), which means the ship is capable of sailing safely in moderate ice conditions at 10.25 metres loaded draft.

Equipped with two electric propulsion systems plus two sets of side thrusters fore and aft that meet DP2 dynamic positioning system requirements, *Xin Guang Hua* is the largest semi-submersible heavy-lift vessel with a DP2 dynamic positioning system in the world. Electric power on board is supplied by six 4,750 kW diesel main generators. The vessel has redundant propulsion and steering systems with double propellers. This means that in the event of loss of main propulsion, she can sail on with no less than 50 per cent of design power and sufficient steering capacity.

*Xin Guang Hua* has 117 ballast tanks with one valve to sea in each. When submerging, the on board control system will open the valves of the corresponding tanks without additional power. Within six hours she can submerge to a depth of 30.5 metres, where the waterline reaches 16 metres above the main deck. When *Xin Guang Hua* has reached her required depth, four heavy-duty air compressors are available

to lift the vessel back up. By virtue of her sheer size, this gigantic ship is capable of handling ultra-large indivisible objects such as offshore units, large steel structures, floating docks and feeder vessels which are unsuitable for ocean navigation. *Xin Guang Hua* is also able to handle salvage and rescue operations.

#### A new era for COSCO after 50 years

One day before the delivery of *Xin Guang Hua*, COSCO Shipping was renamed COSCO Shipping Specialized Carriers, forming the largest specialized carrier company in the world. DNV GL has enjoyed a productive and cooperative relationship with the company for many years. This relationship was further enhanced when DNV GL and COSCO signed a new framework agreement at the beginning of 2017 to deepen their partnership in fields such as newbuilding, ship operation, loading technology, and engineering technology services. This is another step forward for both companies in their efforts to respond to the demands of global specialized transport by delivering well-designed solutions. ■ CZ



Photos: COSCO

#### DNV GL Expert

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# HEALTH CHECK FOR CONTROL NETWORKS

As the complexity of on-board control systems and networks increases, so naturally does the potential for operational disruption. DNV GL and owner CMM are developing a concept for testing the integrity of these often safety-critical systems.

In the summer of 2016, DNV GL teamed up with Innovative Greek owner Consolidated Marine Management (CMM) for a test on the health of a control and communication network on board seagoing vessels. The pilot project, conducted on one of CMM's state-of-the-art chemical tankers, investigated exactly what it takes to undertake a successful test of a vessel's communication and control systems in order to strengthen their overall robustness and resilience.

Any state-of-the-art vessel carries a multitude of IT and OT (operational technology) devices that are not only interconnected and communicate with each other but, more often than not, are also in near-constant contact with the world beyond the ship, for example the internet, vendor offices and company headquarters.

## Tracking down network issues

To give an example, on a cruise vessel the IT systems encompass all the hotel, entertainment and guest systems and servers, convenience features, wireless networks, television, telephony and all the supporting infrastructure, while the OT - or marine - domain covers the integrated bridge, navigational equipment, HVAC, power and engine management systems, to name but a few.

"On-board communication networks have become the 'nervous system' of vessels' integrated machinery," says Dr Mate J. Csorba, Principal Specialist, Marine Cybernetics Advisory, DNV GL - Maritime. "A growing share of disruptions and downtime in offshore operations can now be traced back to problems with networked equipment. Currently these are usually tackled by ad hoc troubleshooting, which makes the testing and verification of these increasingly complex and often safety-critical systems ever more important."

The purpose of a network health test is to evaluate the performance and integrity of a communication system at a given point of time, (i.e. snapshotting), but most importantly to detect any failures present, including but not limited to capacity problems, failing communication devices and misconfigurations that

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"Having a comprehensive overview of the 'health' of the network on board will allow owners to schedule preventive measures at convenient times."

**Dr Mate J. Csorba**, Principal Specialist  
Marine Cybernetics Advisory at DNV GL - Maritime

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Safeguarding against IT malfunction on board is of critical importance.

can lead to off-hire. Control system communications on board vessels are very often made up of the same building blocks as land-based industrial control systems. However, some of the operational requirements are specific to the maritime environment and these need to be taken into account.

In the event that any issues are revealed, specific mitigating actions help to increase the overall robustness and resilience of the communication and control systems on board the vessel. If such an action is not possible, this is still very beneficial as those responsible for the system become fully aware of the real condition of the systems.

### Comprehensive health assessment

The overall aim, therefore, is to obtain the capability to examine if there are any intermittent errors, and predict future failures such as any emerging network degradation, existing capacity or configuration problems, or other threats to the availability and integrity of the control system network being tested.

"We believe that with advanced technology-based assessments, our customers can reap significant savings. Having a comprehensive overview of the 'health' of the network on board will allow owners to schedule preventive measures at convenient times, enable better maintenance planning and perhaps even result in an extended lifespan of ageing assets," says Csorba.

The pilot project on board CMM's vessel consisted of 46 tests covering Ethernet-based networks

(control systems and auxiliary systems), CAN-bus connectivity (sensors and the alarm system) and a selection of DNV GL class rules addressing on-board communication networks. In practice this translated into a focus on the alarm monitoring system, the ballast water treatment system, the main engine shaft power and performance monitoring system, the main engine control and monitoring system, and auxiliary networks.

The testing was conducted mainly from the engine control room, the cargo control room and the bridge. Active stress tests were used to verify whether the communication network is robust enough under specific failure scenarios, while passive measurements were employed to find indications of any potential problems and deviations from a system's installation documentation.

### Important first step

"CMM's vessel is new with modern IT equipment both in software and hardware, built in 2015, and it proved to be in very good condition," comments Nikolaos Kakalis, DNV GL Manager for R&D and Advisory Services South East Europe and Middle East. "The results did not indicate any discrepancies, and as such were considered as an initial snapshot of the health of the vessel's communication systems. This 'healthy' snapshot can be used to quickly identify any changes or deviations and to aid troubleshooting if any issues are encountered with individual systems in the future," says Kakalis.

"This was an important first step, and we are very grateful for CMM's excellent cooperation in this test," says Csorba. "Looking ahead in developing such concepts further, it is possible that we will be able to move to more extensive data collection by automated on-board sensors, which report on system health between port stay and enable remote access procedures which could allow us to do system tests from shore in more or less real time."

"For us at DNV GL, Greece is our third home market, after Germany and Norway," says Nikolaos Kakalis. "And we are glad to introduce and co-develop advanced technology-based services with the Greek shipping community that will help our customers manage their risks in practice." ■ SIAD

### DNV GL Expert

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# FITTING IN

Opening a direct passage between the Atlantic and Pacific Oceans, the Panama Canal was a game changer for maritime trade 103 years ago. One year after the completion of its expansion project, the canal is now open to 80 per cent of the world fleet tonnage.



Wind conditions can be challenging for ships entering the Agua Clara locks.

26 June 2016, Panama – *COSCO Shipping Panama* slowly glided along the 427- by 55-metre chamber, and while two tugboats carefully manoeuvred the vessel into the new locks, onlookers held their breath. The container ship was the first vessel to travel through the expanded Panama Canal. Today, roughly twelve months later, more than 1,000 Neo-Panamax have undertaken the same journey.

This expansion project has opened up a new shipping lane for larger, Neo-Panamax vessels. The construction of two new sets of locks on the Pacific and the Atlantic sides of the canal was by far the most important component of the expansion. Increasing the size of vessels able to pass through, from a maximum length of 294 metres and a beam of 32.2 metres, to 366 metres and 49 metres, means that today 80 per cent of the world's fleet, based on GT, can transit the Panama Canal.

Initially, traffic at the new locks was slow. This is because the procedure for guiding ships through, has changed significantly. "Instead of pulling vessels through with locomotives mounted on each side of a lock, vessels are navigated through using tugboats – with one connected to each end of the ship. This

process is a lot more complex than the locomotive system," explains Marcus Ihms, Ship Type Expert Container Ships at DNV GL – Maritime. "But over the course of the first year, the speed at which larger vessels are processed has increased significantly. Since June 2016, the number of Neo-Panamax vessels passing through the new locks per day has climbed from one vessel in the beginning to an average of four ships per day in early 2017," says Jeffrey van der Gugten, Market Analyst at DNV GL – Maritime. In May, the Canal Authority noted that this number had increased to an average of 5.9 vessels per day.

## LPG carriers affected the most

So far, container ships and LPG carriers have been the segments that have made the most of the new locks, logging 479 and 287 transits respectively (as per March 2017).

And even though they made fewer transits than container vessels, Neo-Panamax LPG carriers have felt the impact of the new waterway the most. In May 2016, Neo-Panamax LPG carriers exclusively travelled from North America to Asia via the Cape of Good Hope in Africa. Today, this trade has been completely



rerouted, with 100 per cent of Neo-Panamax LPG carriers transiting through the Panama Canal.

### Preparing for transit

Operators interested in rerouting their services need to take several factors into consideration before booking a slot for an existing Post-Panamax ship. One of the biggest adjustments concerns the mooring equipment. All chocks and bollards, which are used for the towing operation, need to withstand a safe working load of 90 tonnes, since the tugboats manoeuvre the vessel with greater force than the locomotives would. In some cases, the Canal Authority has required owners to change the existing mooring arrangement due to the new handling procedures.

In addition, the ship's bridge needs to be equipped with five specific conning positions to be used by pilots during transit, and from which certain equipment and indicators have to be accessible and visible. The visibility requirements during the passage are generally stricter than those defined in SOLAS V/22. On laden vessels the view of the water surface from the conning positions may not be obscured by more than  $1 \times$  length overall (LOA) forward of the bow. For vessels in ballast, this figure is limited to  $1.5 \times$  LOA. And finally, pilots need to be provided with platforms and shelters to protect them from sun and rain.

These retrofit measures can be carried out while a vessel is afloat and do not require dry docking. "Their main purpose is to ensure that the mooring equipment can handle the forces of the tugboats and that the vessel doesn't suffer structural damage while passing through the new locks. But we have seen that, even if ships comply with these requirements, passing through the new locks can still be demanding," says Ihms.

### Making it through

One of the general challenges in the Panama Canal is that the vessels have to operate in constant side wind due to the general wind direction in this region. "In the old locks this was not such a problem, because the vessel was fixed in the middle by the locomotive - but in the new locks, especially on the Atlantic side of the canal, vessels and their tugs can easily go adrift and slam into the edges of the funnel-shaped entrance at Agua Clara," says Marcus Ihms, adding that several operators had reported such incidents here. The damage varied from smaller dents to significant gashes in the hull. To avoid this becoming a regular issue, Ihms recommends the installation of protective rubber fenders along the entrance of the Agua Clara locks.

But overall, he sees the expansion project as a success: "The new locks can help vessels travelling



**The old system:** At the Miraflores locks, vessels are guided through using a locomotive.



Work on the expansion project officially began in 2007.

between the East Coast of North America and Asia cut up to more than 5,000 nautical miles (a minimum of ten days) from their journey. And once we see everyone become a little more familiar with the new operational procedures, I think we will see transits become smoother and more efficient." ■ **AJO**

### DNV GL Expert

Marcus Ihms, Ship Type Expert Container Vessels, MPV & General Cargo Ships  
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### DNV GL SUPPORT

DNV GL provides advisory services for customers interested in retrofitting mooring equipment on existing vessels and ensuring that newbuilds fulfil the requirements set by the Panama Canal Authority. In addition, DNV GL verifies the strength of any additional mooring equipment. For more details about the retrofit and documentation requirements, please visit: [www.dnvgl.com/news/new-requirements-for-panama-canal-transit-58190](http://www.dnvgl.com/news/new-requirements-for-panama-canal-transit-58190)

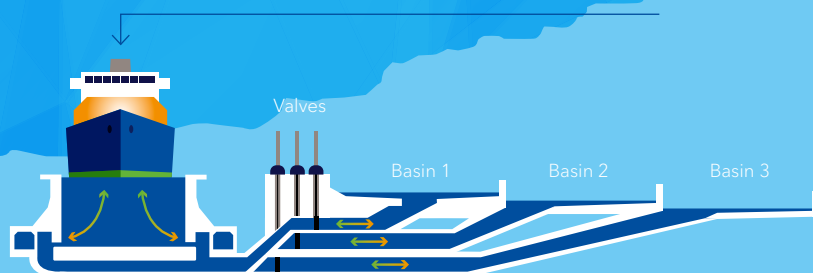


# ENGINEERING MARVEL

Boasting larger locks and a deeper waterway, the new Panama Canal opened in June 2016 after nine years of construction work. More than 30,000 people helped realize the mega-project, whose total cost added up to 5.25 billion US dollars.

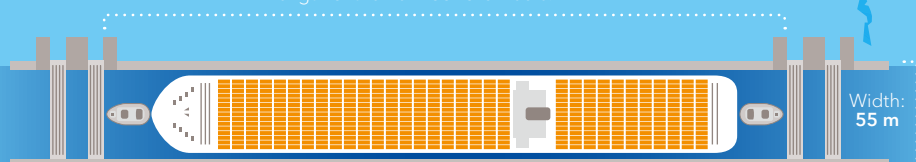
**100%**  
of Neo-Panamax  
LPG carriers

Today, all Neo-Panamax LPG carriers travelling from North America to Asia now transit through the Panama Canal.



The water-saving basins reduce water consumption by 7 per cent compared to the old lock system. 60 per cent of the water required for each transit is reused.

Length of the new lock chambers: **427 m**



Length overall of Neo-Panamax container ship: **max. 366 m**

Width:

**55 m**

Distance Pacific Ocean – Atlantic Ocean  
**approximately 82 km**

Atlantic Ocean

Gatún Lake

Atlantic Ocean

Colón

Gatún locks

Agua Clara locks

Gatún Lake

Gatún locks

Agua Clara locks

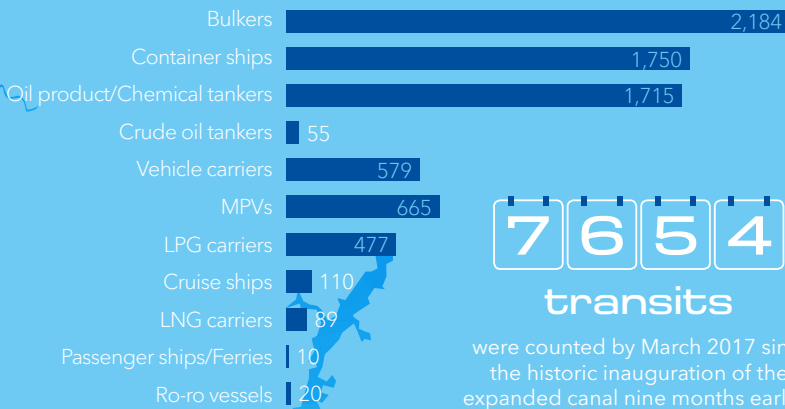
Gatún Lake

Southbound ships travelling from the Atlantic to the Pacific Ocean are lifted to 26 metres above sea level by the three successive stages of the Agua Clara and Gatún locks.

Altitude difference between  
Gatún Lake and sea level **26 m**



### NUMBER OF VESSELS PASSING THROUGH THE CANAL LOCKS old and new locks combined, period: 06/2016 - 25/03/2017



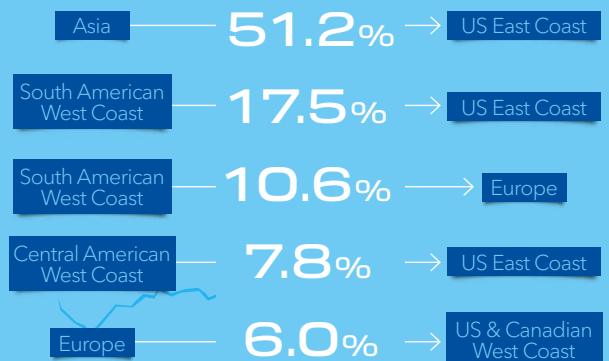
**7 6 5 4**  
**transits**

were counted by March 2017 since the historic inauguration of the expanded canal nine months earlier.



Before exiting into the Pacific Ocean, ships are lowered by 9.5 metres down to sea level, using the new, three-stage Cocoli locks which run in parallel with the old Pedro Miguel and Miraflores locks.

### MAIN TRADE ROUTES

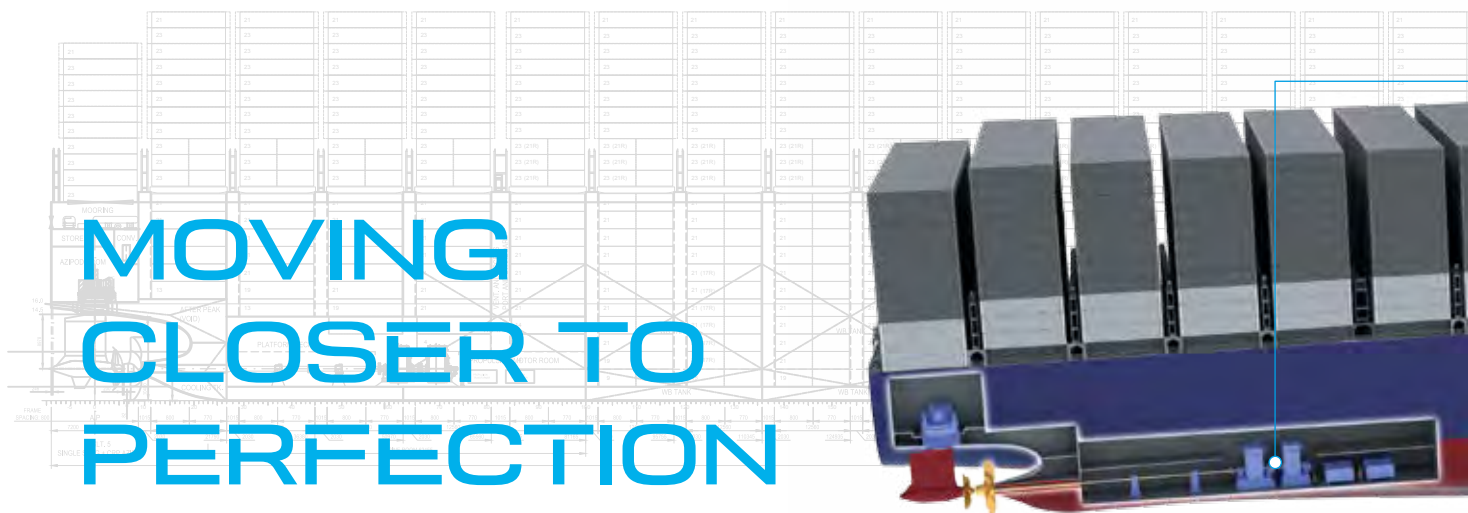


## 1,000th Neo-Panamax vessel

On Sunday, 19 March 2017 the container ship **MSC Anzu** made the historic 1,000th transit through the expanded canal, heading northbound from the Atlantic to the Pacific Ocean. Built in 2015, the Panama-flagged and DNV GL-classed vessel measures 299.98 metres in length and 48.23 metres in breadth and carries up to 9,008 TEU.

Daily average of Neo-Panamax transits

**5.9**  
**vessels**



In phase II of the PERFECt project, DNV GL and several industry partners refined the technical details and explored the commercial viability of an ultra-large container vessel propelled by a combined gas and steam turbine system.

When the PERFECt II project was launched in September 2016, it was able to build upon extensive research done in the first PERFECt study of 2015, which had demonstrated the technical and economic feasibility of a 20,000 TEU ultra-large container vessel (ULCS) powered by a combined gas and steam (COGES) turbine system.

"Phase II brought a new set of expert capabilities to this project, enabling the partners to develop a mature concept design. The resulting PERFECt ship offers owners a comprehensive technical overview to support a purchasing decision," explains Dr.-Ing. Gerd Würsig, Business Director Alternative Fuels at DNV GL - Maritime.

#### Compelling benefits

COGES technology is currently the most efficient and economical method of converting fuel into electricity. Large, land-based COGES power plants running on

natural gas achieve net efficiencies of more than 60 per cent. "As LNG moves into focus as a clean-burning ship fuel that meets current and future emission limits, the COGES power generation technology offers an intriguing perspective for ship propulsion," Gerd Würsig points out.

The propulsion concept offers several attractive benefits. Apart from the small environmental footprint of LNG (liquefied natural gas), an on-board COGES plant does not require a conventional engine room. Instead, the power generation and propulsion systems can be placed in separate sections of the ship because they only require an electrical interconnection. This makes it possible to replace the huge two-stroke engine with high-power-density electrical motors in the aft of the ship, and means that the funnels are shifted to the wheelhouse. This frees up space for additional container slots. At the same time, the absence of an engine room entails major structural design changes from conventional ships.

"Gas turbine-driven power production utilizing a very clean fuel in combination with electric propulsion results in simpler and much more robust ship machinery," Würsig explains. "Implementing this approach can be expected to lead to new maintenance strategies resembling those applied in the airline industry, potentially allowing operators to reduce the ship's engine crew and save further costs."

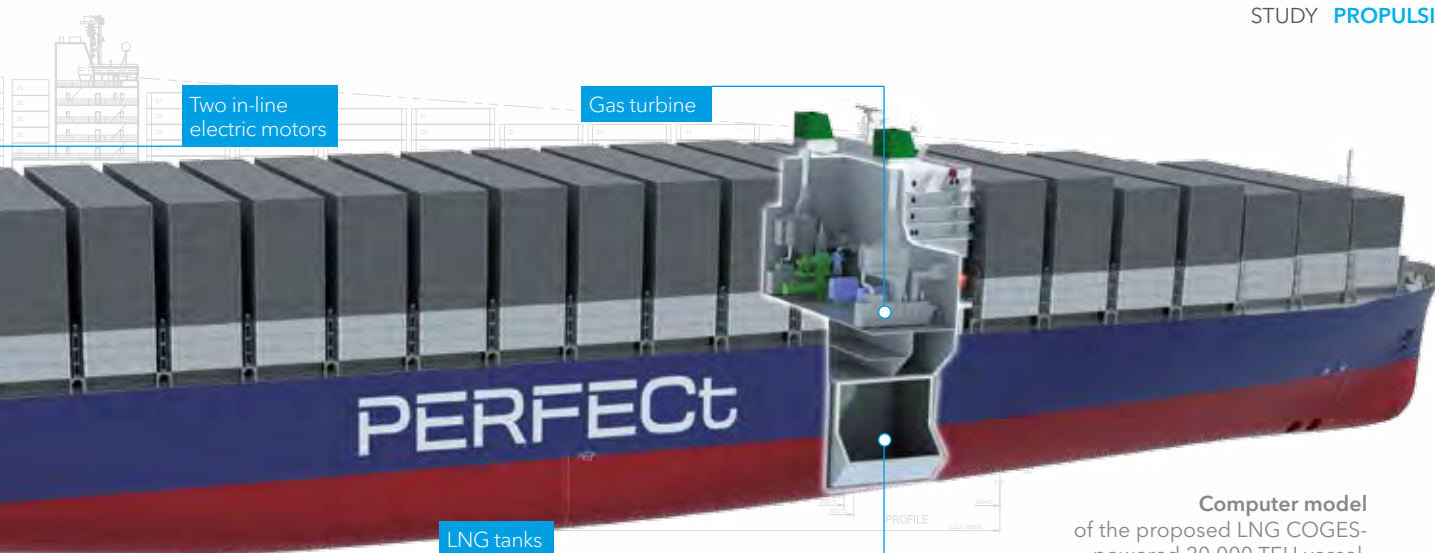
#### PROJECT IN BRIEF

The PERFECt II, or "Piston Engine Room Free Efficient Container Ship" project, was launched in September 2016 with a group of six partners: Gaztransport & Technigaz (GTT), a specialist in the design of containment systems with cryogenic membranes for liquefied gases; CMA CGM and its subsidiary, the ship management company CMA Ships; ABB, which contributes power optimization expertise; Solar Turbines, a Caterpillar company specializing in the manufacture of industrial gas turbines; Odense Maritime Technology (OMT), a ship design and consultancy company with broad experience in the design of cost-effective and fuel-efficient vessels; DNV GL as the project coordinator and the expert for simulation and numerical optimization of energetical systems.

#### Fine-tuned by experts

Drawing on the technical expertise of its expanded circle of partners, the PERFECt II project succeeded in further optimizing the process technology of the COGES power plant. Measures included minimizing the size of the steam turbine, reducing power capacities and using a two-stage pressure steam turbine and steam generator as well as innovative measures for increasing part-load efficiency, thus increasing the net





Computer model of the proposed LNG COGES-powered 20,000 TEU vessel.

efficiency of the ship. The propulsion system consists of a conventional propeller driven by two in-line electric motors as well as an ABB Azipod thruster in the place of a conventional rudder. This configuration further reduces the in-board space requirement. Contrary to historic attempts at using MGO-fuelled steam turbine technology on ships, this innovative, LNG-based concept design is highly efficient and a competitive alternative to standard dual-fuel and conventional HFO ships using LNG, says Würsig.

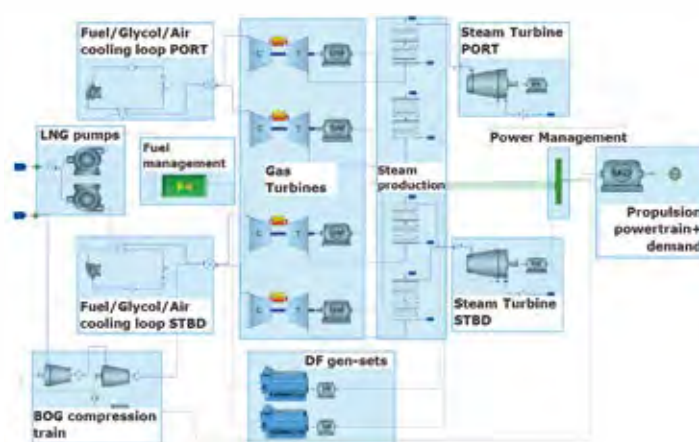
#### A ready-to-order design concept

Completed by the project partners in 2017, the PERFECT vessel concept is a truly collaborative achievement. The overall ship design, including the measures for the optimization of water resistance and the reduction of propulsion power, was prepared by shipbuilder OMT. ABB designed the electrical infrastructure, the propeller system, the power electronics and the generators. The turbine systems as well as the steam ducting were provided by Solar Turbines, a Caterpillar company. The ship management expert CMA CGM/CMA Ships had drawn up the operational specifications and the requirement profile. GTT developed the tank system and LNG process installations. DNV GL performed system simulations, specified the safety systems and provided the project leadership.

"This state-of-the-art ULCS meets the most stringent standards," says Gerd Würsig. "It is efficient, flexible, and eco-friendly. Its cargo capacity is considerably larger than that of the conventionally powered 20,000 TEU reference vessel. And nearly the entire space that would normally be occupied by the engine room and funnel structure is available for additional cargo. We have every reason to be pleased with the results of this joint project." ■ AK

#### DNV GL Expert

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Piping and instrumentation diagram of the model (209 components, 4,048 non-linear equations).



Project partners GTT, CMA CGM (and its subsidiary CMA Ships) and DNV GL signed a cooperation agreement with new project participants ABB, the Caterpillar company Solar Turbines, and OMT for phase two of the highly successful PERFECT project. From left to right: Rune Lysebo, Senior Vice President Sales at ABB, Ennodio Ramos, Vice President, Power Generation and Strategic Growth at Solar Turbines Inc., Knut Ørbeck-Nilssen, CEO of DNV GL - Maritime, Ludovic Gérard, Executive Vice President CMA Ships, Thomas Eefsen, Business Development Director for Container Ships at OMT, Philippe Berterottière, Chairman and CEO of GTT.

# THE FLOATING PIPELINE

German shipowner Reederei Hartmann is a major player in the global gas carrier market. Recently, the company unveiled two new series of ships, developed with support from DNV GL.

Leer is a picturesque town in Lower Saxony, two hours south of Hamburg. But with a seafaring academy that boasts 160 years of history and the headquarters of one of Germany's most prominent shipping groups, Leer is also one of the country's major hubs for maritime expertise. Today, the Hartmann Group, founded by Alfred Hartmann, is a heavyweight in the international tanker business. But this company emerged from very humble beginnings.

Alfred Hartmann was a shipmaster by trade and had a vision to build his own shipping company. Starting off with one coaster vessel just over 30 years ago, Hartmann has managed to grow his fleet from one to about 150 vessels and his company to a business with 5,000 employees on land and at sea. In 2008 Hartmann placed the leadership of his company into the hands of his son Niels, but continues as Chairman of the Supervisory Board of the holding that owns the shipping company and President of the German Shipowners Association VDR.

## Accumulated know-how

"Our founder's three guiding principles – ensuring access to cargo, extensive crew training and diversification – continue to apply to our work today. And I think they have been the key to our success," says Michael Ippich, Managing Director Operations of Hartmann Shipping Services. "For example, we recruit and train our crews ourselves. With crewing agencies in Poland and the Philippines and state-of-the-art training centres located in both Leer and Manila, we can make sure that our officers and crews are well trained across all disciplines," he adds.

To diversify its fleet, the Hartmann Group not only operates gas and product tankers, but also container vessels, bulk carriers and coasters. "Since

an economic downturn never really affects all ship types equally, diversification helps us strike a balance," says Ippich.

Diversification can be realized on a regional basis as well: roughly half the fleet – mainly gas tankers, container ships and coasters – are managed from Leer, while the rest – product tankers, cement tankers and handysize bulkers – are operated from Cyprus. "We have created Centers of Excellence in both places to pool our know-how for the benefit of our customers," Ippich points out. For example, operating gas tankers takes specialized expertise: "You can't just go ahead and open a gas tanker company one day – the oil majors won't trust you so easily." Safety is the top priority, which is why the market considers 20 years as the right age for a gas tanker

## ECO STAR 36 K

- Length: 188.30 metres
- Beam: 29.00 metres
- Draught: 9.50 metres
- Cargo volume: approx. 36,000 m<sup>3</sup>
- Engine: MAN B&W 7G50ME-GIE
- Power output: 12,040 kW
- Speed: 16.5 knots
- Reach: 10,000 nm
- Class: DNV GL
- Investment volume each: approx. 80 million USD
- Delivery: November 2016 (*GasChem Beluga*); July 2017 (*GasChem Orca*)





to retire, even if the ship is still in good condition. The average age of the Hartmann gas carrier fleet is currently around 12 years.

#### Fascinating project

For a long time the shipping company was hesitant to launch newbuilding projects: "We only build ships when we know we have a long-term charter agreement," says Ippich. A while ago a new opportunity arose when the Saudi Arabian company Sabic indicated it wanted to ship ethane from Houston, Texas, to Teesport in northern England on a regular basis: ethane, available in large quantities in the US market, is used as a raw material for PVC and polyester production.

"Sabic essentially wanted to establish a floating pipeline, so to speak," says Ippich. This was to become one of the most fascinating projects of the segment, leading to the development of the ECO STAR 36k class, a new generation of gas carriers, which recently celebrated their debut in the Hartmann Group's fleet.

The DNV GL-classed vessel, *GasChem Beluga* has been sailing between Houston and Teesport for several months now. Built by the Sinopacific Offshore and Engineering shipyard in China, this vessel was the largest LEG carrier with Type-C tanks



"After such a positive development process, we are confident that it will set a new standard for this segment."

**Michael Ippich**, Managing Director Operations of Hartmann Shipping Services

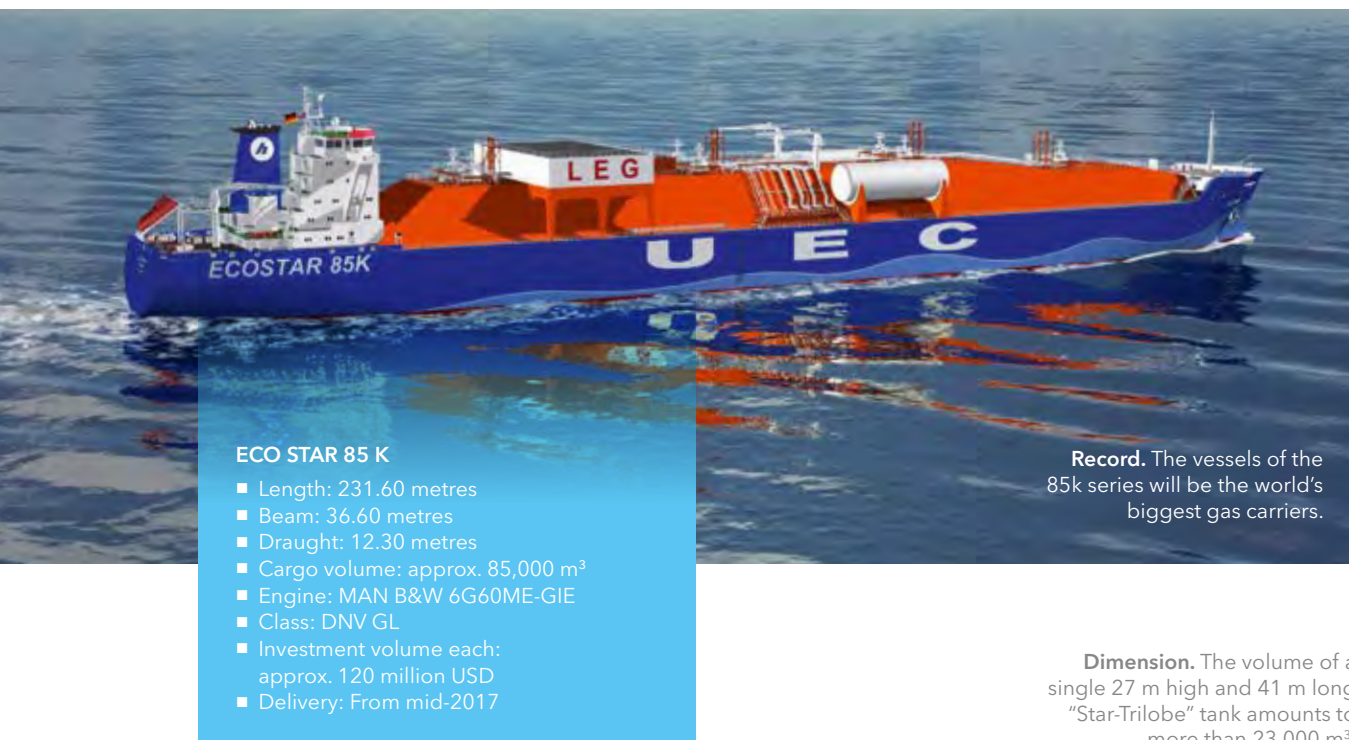
when it came into operation. The ship sails under a long-term charter for SABIC Petrochemicals B.V.

Developing the vessel design was a complex project that took several years and brought together Hartmann, DNV GL, the Hamburg Shipmodel Basin (HSVA) and the Oldenburg-based engineering company HB Hunte. "We had very specific requirements, so it was a challenge to ensure that the final vessel concept had the exact ship weight and draught we needed," says Ulrich Adami, Technical Director and Fleet Manager at Hartmann Reederei. "The collaboration with our partners was excellent and their input was instrumental for the success of this project," he adds.

>

**Success.** The *GasChem Beluga* operates between Houston, USA, and Teesport in the UK.





> A key requirement was to boost the cargo volume significantly compared to conventional gas carriers without lengthening the vessel, in order to remain within the size limits of certain terminals. The result is an innovative tank design called "Star-Trilobe", which essentially consists of three horizontal cylinders joined in a cloverleaf configuration. These steel tanks, each weighing in at roughly 7,500 tonnes when filled, are placed on a special wooden bed inside the ship's hull. They are flexible enough to withstand the pressure caused by temperature differences.

#### Class on board

"The biggest challenge was the structural integrity versus weight equation," says Adami. Tanks of this size capable of handling minus 104 degrees centigrade, the temperature of liquefied ethane, had never been built before. The Trilobe tanks improve utilization of the available space inside the ship's hull by about 25 per cent compared to conventional bilobe tanks, while offering a much better volume-to-weight ratio.

Adami felt very strongly about having the DNV GL experts on board right from the start: "This was a joint brainstorming process, and getting the class perspective on the different options from the start was essential to determining the feasibility of the tank design."

Making sure the vessel achieved significant efficiency gains and was equipped to operate under the challenging conditions in the northern Atlantic were

also at the top of the wish list. "These ships travel from America to Europe fully laden and return empty. This meant we needed to ensure stability without needing excessive amounts of ballast water. In the winter, the vessel may face waves of up to 12 metres in the northern Atlantic. The solution for the new 36k carriers was a special hull design including a Svelte bow and a bridge located near the bow to optimize weight distribution," says Matthias Malinowski, Ship Type Expert Gas Carriers at DNV GL.

To boost efficiency the designers developed a smart combination of propulsion components: the ships are fitted with an innovative MAN B&W engine, the world's first quadruple-fuel engine (capable of burning heavy fuel oil, marine gas oil, LNG and ethane). "The first voyages have shown the fuel switchover process to be quick and painless," says Adami.

A special feature of this engine is its high-pressure injection system which avoids methane slip almost entirely. For additional efficiency gains the engineers added an MAN Kappel adjustable, high-performance propeller with an HB Hunte Twist-Flow rudder behind it. "To a layman these look as if they were bent out of shape," the expert remarks. "However, the result of the project, which has been confirmed by model tests at HSVA, is by far the most efficient gas carrier the world has seen. While we refrained from painting the ship green, it is in fact a totally 'green' ship," says Adami.





In terms of financing the two 36k vessels, the Hartmann Group chose an innovative approach: owned by Norwegian investment company Ocean Yield, a member of Aker ASA Holding, the vessels are operated by Sabic as the end customer under the technical and commercial management of the Hartmann Group as the charterer, who also handles crewing.

### Strong partners

The sister vessel of *GasChem Beluga*, *GasChem Orca*, is due to be delivered this summer. And soon, the Hartmann Group will set a new record for the world's biggest gas carriers, with a series of 85k vessels. The first ship in this series is currently under construction at Dalian Shipbuilding Industry Off-shore in China. When it hits the water, it will be able to carry nearly two-and-a-half times the amount of cargo as *GasChem Beluga*. Equipped with Star-Tri-lobe tanks and highly efficient multifuel engines, the 85k VLECs follow in the footsteps of the 36k series. This time the owner is Luxembourg-based Jaccar Holdings, and the ships will be chartered out to the Chinese energy company Oriental Energy. They will commute between the USA and Southeast Asia.

It was not until 2012 that the market began demanding VLECs carrying more than 25,000 cubic metres. Until then, the common assumption was that Type-C tanks larger than 40,000 m<sup>3</sup> were not feasible, and that future ethane carriers capable of transport-

ing in excess of 80,000 m<sup>3</sup> would use either prismatic Type-B tanks or several membrane systems. But a comparative study by DNV GL of typical 83k VLGC hull scantlings, which would also apply to 85k very large ethane carriers (VLECs), concluded otherwise.

"We also performed fatigue and crack propagation analyses and supported the designers in specific areas such as the twin saddle, swash bulkhead and triple Y-joint design tasks, enabling significant improvements to the 36k Trilobe design," explains Matthias Malinowski from DNV GL. The fatigue strength and fracture mechanics verification performed by DNV GL was extended from a 20-year to a 30-year tank lifetime.

"We feel honoured to be part of this project as a classification society. It is not only sheer size but also the technical innovations that make these vessels a real breakthrough for the industry," says Torsten Schramm, President Maritime of DNV GL.

According to Michael Ippich, Hartmann's Managing Director Operations, the market is watching very closely to see how this new vessel class performs. "But after such a positive development process, we are confident that it will set a new standard for this segment." ■ HSG

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# ON THE STARTING LINE FOR MRV COMPLIANCE

The transport industries are coming under increasing scrutiny as governments and regulators look to reduce the amount of greenhouse gas (GHG) being emitted into the atmosphere. The European Union's Monitoring, Reporting and Verification (EU MRV) regulation is designed to bring the maritime industry into the EU's 2009 climate and energy package by establishing a CO<sub>2</sub> emissions baseline for shipping and providing useful information on vessel performance and operational costs.

The EU MRV regulation entered into force on 1 July 2015 with the new requirement for the monitoring, reporting and verification (MRV) of carbon dioxide emissions from maritime transport.

The reported CO<sub>2</sub> emissions, together with additional data (e.g. cargo, energy efficiency parameters), are to be verified by independent verifiers and sent to a central database managed by the European Maritime Safety Agency (EMSA). Additionally, further guidelines are necessary that will amend the MRV framework, and this work will continue in the ESSF (European Sustainable Shipping Forum) MRV subgroups until summer 2017.

## ★ WHO IS AFFECTED

The regulation requires shipowners and operators to annually monitor, report and verify CO<sub>2</sub> emissions for vessels larger than 5,000 gross tonnage (GT) calling at any EU and EFTA (Norway and Iceland) port. Data collection will be on a per voyage basis and begins on 1 January 2018. A "voyage" is defined as any movement of a ship that originates from, or terminates in, a port of call and that serves the purpose of transporting passengers or cargo for commercial purposes.

## ★ CHECK SYSTEM

When considering their MRV compliance, owners and operators should assess their reporting system and decide whether it will allow them to fulfil the

MRV requirements. Can the system capture, extract and aggregate the required data? Is it capable of differentiating between EU and non-EU ports, different fuels and emissions at berth, as well as including additional details such as anchoring time? And does it produce data of sufficient quality, an important factor when data will be publicly available.

DNV GL introduced the MRV Readiness Check app to offer a first assessment on EU MRV readiness. The app is available free of charge on My DNV GL. With a condensed checklist, it gives a clear picture of a user's current preparedness and provides a to-do list to plan the next steps.

## ★ PROVIDE AND VERIFY PLAN

The first concrete action required for shipowners and operators in complying with the EU MRV regulation is to prepare a monitoring plan for each of their ships that fall under the scope of the regulation. The monitoring plan is subject to verification by an independent verifier and should therefore be submitted by 31 August 2017 at the latest.

For companies operating several vessels, however, Article 2 of the implementing regulation (EU) 2016/1927 offers the option to split the monitoring plan into a company-specific section and a vessel-specific section, provided the respective company descriptions are applicable to all vessels of the fleet and all requirements are covered. These monitoring plans (as well as the emission reports) are subject



to verification by an independent verifier, such as DNV GL.

To achieve compliance with the first phase of the regulation, DNV GL has launched an MRV monitoring plan app. This is available through the My DNV GL portal free of charge. The app guides users through each step of generating a monitoring plan and ensures that the plan has a compliant format, significantly reducing the time and cost of preparing a plan.

### ★ START REPORTING

The first reporting period commences at the start of 2018. The monitoring and reporting shall cover CO<sub>2</sub> emissions from the combustion of all fuels at sea and at berth, which must be separately reported. In addition, the data must include the transport work and energy efficiency of the vessel (see box "Detailed reporting").

### ★ SUBMIT VERIFIED REPORT

The first reporting period covers 1 January 2018 to 31 December 2018 and by 30 April 2019 companies are required to prepare and submit an emissions report, including any verification activities performed by an independent verifier. These reported and verified emissions, as well as related data on energy efficiency, will be made publicly available by the European Commission on 30 June 2019.

DNV GL has followed the development of the MRV regime since its infancy, and has put considerable resources into developing its competence and processes for the new regime.

At the same time, DNV GL has invested heavily in putting in place a set of digital solutions that will make compliance as simple and transparent as possible for customers. ■ SIAD

#### DNV GL Expert

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#### DETAILED REPORTING ON A PER VOYAGE BASIS

- Port of departure and port of arrival, including the date and hour of departure and arrival
- Amount and emissions factor for each type of fuel consumed in total CO<sub>2</sub> emitted
- Distance travelled
- Time spent at sea
- Cargo carried
- Transport work, which is defined as: distance travelled x cargo carried

#### MONITORING ON AN ANNUAL BASIS

- Amount and emissions factor for each type of fuel consumed in total
- Total aggregated CO<sub>2</sub> emitted within the scope of this regulation
- Aggregated CO<sub>2</sub> emissions from all voyages between ports under a member state's jurisdiction
- Aggregated CO<sub>2</sub> emissions from all voyages which departed from ports under a member state's jurisdiction
- Aggregated CO<sub>2</sub> emissions from all voyages to ports under a member state's jurisdiction
- CO<sub>2</sub> emissions which occurred within ports under a member state's jurisdiction at berth
- Total distance travelled
- Total time spent at sea
- Total transport work
- Average energy efficiency

#### NAVIGATOR INSIGHT

Navigator Insight is DNV GL's solution for ship-to-shore reporting. It comes with an on-board reporting tool for manual input covering all the required parameters as per the

MRV regulation, but can be extended to cover all aspects of daily ship operations. Navigator Insight enhances data quality even before it is sent ashore.



Please refer to [www.dnvgl.com/mrv](http://www.dnvgl.com/mrv) for a comprehensive overview of all topics regarding the EU MRV regulation.





# ZERO EMISSIONS

Fuel cells, advanced battery packs and the world's biggest hybrid ferry - zero-emission technologies are becoming an emerging force in the maritime world.

The international shipping industry is facing an increasingly tight regulatory environment, especially when it comes to emissions to air. And with the recent decision to implement the global sulphur cap in 2020 and to add the North and Baltic Seas to the list of nitrogen oxide (NO<sub>x</sub>) emission control areas, the pressure is on. For zero-emission solutions such as fuel cells, battery and hybrid technology, these developments have been a real boost.

Color Line's decision to order *Color Hybrid* is the latest milestone for the adoption of battery hybrid solutions in shipping. With a length of 160 metres, it will have the capacity to carry 2,000 passengers and around 500 vehicles - making *Color Hybrid* the

world's biggest hybrid ferry. After its delivery from the Norwegian Ulstein Verft in 2019, the vessel will operate between Norway and Sweden.

## A promising technology

As a plug-in hybrid, *Color Hybrid*'s batteries will be recharged either with a power cable with green electricity from shore or by the ship's on-board generators. Its bank of four-to five MWh batteries will deliver sufficient power to enable fully electric operation for 30 minutes and enough to sail, silently and with zero CO<sub>2</sub>, NO<sub>x</sub> and SO<sub>x</sub> emissions.

"To date, hybrid battery solutions have been mostly confined to smaller car ferries, offshore





#### ABOUT COLOR HYBRID

- To be built at Ulstein Verft
- Steel cutting: July 2017
- Delivery: May 2019
- Number of passengers: 2,000
- Number of crew: 100
- Number of cars: 500
- Length: 160 metres
- Beam: 27.1 metres
- Design draught: 6.0 metres

supply vessels and tug boats, where they can handle spikes in power demand, and on shorter ferry routes," says Narve Mjøs, Director Battery Services & Projects at DNV GL - Maritime. However, innovative research conducted to develop batteries for the automobile industry means that today batteries boast enhanced power density, and the cost of lithium-ion batteries has been lowered by up to 80 per cent over the past four years, making battery and hybrid technology a more attractive option for larger ship segments as well.

Last autumn Hurtigruten signed a contract with the Norwegian Kleven yard for two 140-metre-long hybrid cruise ships. DNV GL is the classification partner for both projects. The first of the Hurtigruten vessels will feature a battery-powered auxiliary engine for "peak shaving", where the battery dynamically responds to cover spikes in demand - this

measure alone is predicted to cut fuel consumption by 20 per cent. The second vessel will have batteries capable of sustaining fully electric operation for 15 minutes, possibly more. If it proves successful, this more ambitious implementation will later be retrofitted to the first ship. "I am confident we will see battery and hybrid technology being implemented on large transoceanic cruise vessels as well. For example, operators could use battery power to eliminate emissions during port sailing and port operations and ensure noise- and vibration-free operations when sailing through spectacular tourist sites such as fjords. Battery power could also power tender boats and eliminate any vibrations and diesel smoke," says Mjøs.

#### A new generation of fuel cells

Another zero-emission technology which has gained traction is fuel cells. In Germany, leading



> German shipbuilders, shipowners, suppliers and DNV GL have joined forces in the fuel cell project e4ships. Launched in 2009 with support from the German government, e4ships aims to develop technical solutions for the implementation of fuel cells in marine applications and feeds into the development of international regulations on fuel cells.

#### Successful pilots

Fuel cells are quiet, efficient and cause no noticeable vibration. To make this technology safe to use and commercially viable, the e4ships consortium has developed fuel cells capable of running on low-sulphur diesel or methanol, and has tested them in several pilot projects.

In the Pa-X-ell project, DNV GL and the German cruise yard Meyer Werft are working together to trial high-temperature PEM fuel cells, powered by methanol, on board passenger ships. ThyssenKrupp Marine

“The pilot projects have successfully completed initial readiness tests for maritime deployment and have been installed on board ships for prototype trials.”

Lars Langfeldt, Senior Project Engineer  
at DNV GL – Maritime

is heading another project called SchIBZ, which focuses on the development of a scalable, integrated hybrid fuel cell system for ocean-going ships, with a rated power output of 50 to 500 kilowatts. This hybrid system has an electrical efficiency

#### ROALD AMUNDSEN AND FRIDTJOF NANSEN

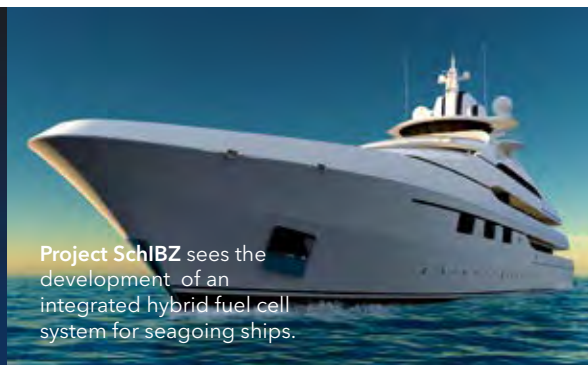
The first of Hurtigruten's new Explorer-class vessels

- Also suited to Norwegian coastal routes
- Rolls-Royce design together with Espen Øino and Hurtigruten
- To be built at Kleven Verft
- Passenger capacity: 530
- Cabins: 265
- Crew: 151
- Dimensions: length 140 metres, beam 23.6 metres, height 29 metres
- Draught: 5.3 metres
- New hybrid technology
- 20 per cent reduction in fuel consumption and CO<sub>2</sub> emissions
- Enabling fully electric propulsion for the first time on a cruise ship, up to 30 min.
- Classed by DNV GL





**Project Pa-X-ell** is putting high-temperature PEM fuel cells to the test on passenger vessels.



**Project SchIBZ** sees the development of an integrated hybrid fuel cell system for seagoing ships.

of approximately 50 per cent. Finally, the Rivercell project is dedicated to the design and development of a fuel cell hybrid system for inland vessels. "The pilot projects have successfully completed initial readiness tests for maritime deployment and

have been installed on board ships for prototype trials," says Lars Langfeldt, Senior Project Engineer at DNV GL - Maritime, who works on the e4ships project. "All of them use fuels that are readily available in large quantities around the world," he adds. While Rivercell and Pa-X-ell use methanol as an energy source, the fuel cell system tested in the SchIBZ is powered by low-sulphur diesel.

### The second phase

Currently, the e4ships project partners are focusing on the next development steps and prototype tests as well as the design of decentralized on-board networks comprising several fuel cells. Project phase II is scheduled to continue until 2021 - the ultimate goal is to present production-ready technologies.

New insights, generated by e4ships and its pilot projects, have already made an impact on the shipping world. "The results of the first phase have made an important contribution to the IMO's International Code of Safety for Ship Using Gases or Other Low-flashpoint Fuels (IGF Code), which entered into force in January 2017. The code is an important prerequisite for fuel cell technology to reach market maturity, and we are very proud to be part of that," says Dr.-Ing. Gerd Würsig, Business Director Alternative Fuels at DNV GL - Maritime, who heads the classification society's involvement in the e4ships project. "e4ships is a milestone achievement for the use of alternative energy conversion technologies and fuels in shipping. We are very pleased with the way it is progressing, and we look forward to continuing our work with all the project partners to make this a success" ■ SJ



**The hybrid-powered expedition ships** are due to be delivered in 2018 and 2019.

Photos: DNV GL, e4ships, Rolls-Royce

### DNV GL Experts

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Transporting goods from Asia to Europe normally takes around 20 to 25 days, if you travel from China to the UK. Most vessels leaving from the Far East travel through the Suez Canal to reach the European continent. For a long time this was their only option, but the global rise in temperatures has created an alternative: the North-East Passage. Instead of heading south, ships can now travel to Europe on the Northern Sea Route, which takes them along the coast of northern Russia into the Arctic Ocean and the Barents Sea.

#### Arctic 2030

This route is currently open for about four and a half months per year and can cut travel time by up to twelve days, reducing a ship's fuel costs and, with it, its overall environmental footprint. But does this theory live up to the industry's expectations in practice? What efficiency gains can be realized? What are the risks involved? And what logistical challenges could operators face when their vessels navigate the Northern Sea Route?

To investigate this, DNV GL has teamed up with experts from across the northern hemisphere in the Arctic 2030 project, bringing together the Centre for High North Logistics, the University of Busan, South

## NAVIGATING THE NORTH

While low oil prices have cooled interest in the Northern Sea Route, a deeper understanding of the risks and opportunities will make it easier for operators to head north when the time is right. An international study is taking a closer look at the North-East Passage.

Climate change has opened up the North-East Passage for commercial shipping.





Korea, FSUE Atomflot, the Russian government-owned operator of the nuclear icebreaker fleet based in Murmansk, the Norwegian University of Science & Technology, the Norwegian Shipowners Association, and DNV GL. The goal of Arctic 2030 is to perform a comprehensive analysis of current commercial transport and logistics operations along the Northern Sea Route.

The study covers aspects such as potential efficiency gains, the cargo base, costs, infrastructure needs as well as security and safety. "It aims to gather the data, performance indicators and scenarios needed to assess the feasibility and reliability of using this route in the future," says Morten Mejl  nder-Larsen, Discipline Leader Arctic Operation & Technology at DNV GL - Maritime.

#### Safe Arctic operations

A remote and inhospitable environment combined with limited infrastructure makes safety an absolute priority in Arctic operations. "In many respects the dangers in the Arctic differ

little from those in other sea regions: collision with a vessel or installation, fire and explosion hazards, structural failure, grounding, an accidental oil spill. But the consequences of any individual incident could be much more serious," explains Mejl  nder-Larsen.

Adding regional hazards such as ice, topside icing, low temperatures, darkness and fog, this changes the risk equation. Many of these factors were considered in the development of the IMO Polar Code, a set of internationally agreed minimum standards for ice operation, which has been in force since January of this year.

#### Vessel-specific considerations

Most of the ship traffic takes place over the summer months and a vessel's risk profile varies according >



**19 vessels**

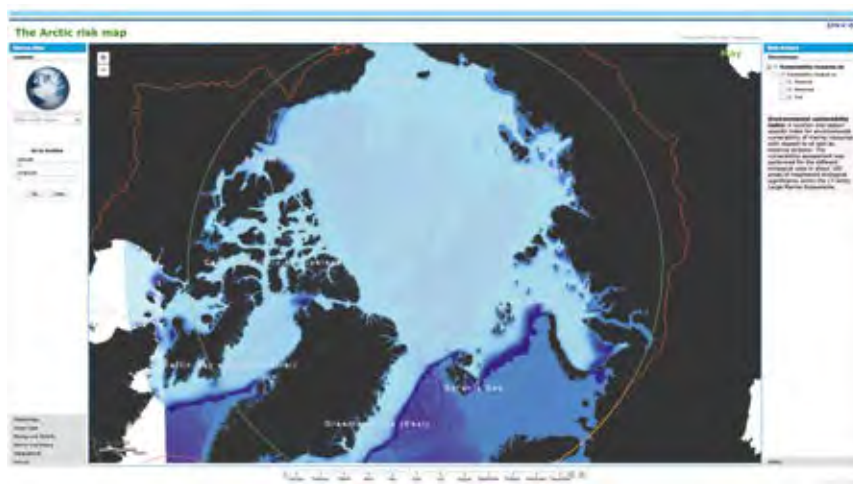
transited the Northern Sea Route in 2016, averaging

**14.3 days**

of transit time

The duration of a trip from eastern Asian ports to northern Europe can be reduced by up to twelve days.





The interactive Arctic risk map on the DNV GL website provides a dynamic overview of the ice cover, meteorology and ecology of the Arctic region as well as search and rescue information, oil and gas activities and shipping statistics.

> to its type and mission. "Offshore support vessels tend to work in groups. If one gets into trouble, another can come to its aid, but on the flip side there is a heightened danger of collision or contact. Cargo ships in transit will be heavily dependent on icebreaker assistance. For expedition vessels and large cruise ships it is essential to provide additional passenger training to make sure everyone on board is aware of the risks particular to this environment," says Mejlænder-Larsen. The elevated risk for passen-

ger vessels and tankers is reflected in the Polar Code's additional training requirements for officers on watch on board these two vessel types.

When assessing the feasibility of Arctic operations, the availability and cost of emergency response services during each leg of the voyage is one of the main considerations for all vessel types. "Operators need to be aware that some ports along the route are not open or equipped to handle international traffic," Mejlænder-Larsen explains. "Furthermore, the costs

#### PREPARING TO CROSS THE NORTH-EAST PASSAGE

- **Certification:** Operators should check whether their vessel has the necessary ice class certification. The requirements will vary, depending on the time of year and the conditions predicted by the Northern Sea Route Association.
- **Communications:** Vessels need to ensure that their vessels have com-

munication equipment adapted to the planned sailing route. GMDSS Sea Area A3 is acceptable for operations up to 70°N/S. GMDSS Sea Area A4 is required for operations above 70°N/S. Ships travelling through these polar regions must carry a DSC-equipped HF radiotelephone/

telex. Non-GMDSS systems, such as Iridium, can be effective for voice and data communication in polar waters.

- **Operation:** Vessels travelling through the North-East Passage are required to have a Russian ice pilot on board during this part of their voyage.



of a response are hard to predict and not always transparent.”

Since the Arctic is an environmentally sensitive region, it is also necessary to draw up effective plans and prepare resources for efficient clean-up in the event of an oil spill. This comes on top of making sure the vessel is fit for Arctic operation and its crew has the relevant skills and experience.

### Ready for the challenge

“Our investigations found that infrastructure in the region is slowly improving, but future development will depend on the attractiveness of the area to potential investors. Recent activities have mostly been driven by the oil and gas industry, particularly the Yamal LNG project,” says Mejlænder-Larsen.

Low oil prices and a drop in commodity prices have reduced the appeal of the route to international shippers. In 2015 the number of transits went down to 18 from a high of 71 in 2013, with tankers being the most common ship type to use this route.

“However, with the Polar Code rules for ice class vessel designs in place, as well as a growing body of experience and deeper understanding of the risk involved, it may only take a turn in the markets or a rebound in oil prices for that interest to be rekindled,” says Mejlænder-Larsen. “If and when that happens, we at DNV GL will make sure our customers are well prepared for the challenge.” ■ KT

### DNV GL Expert

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Operation & Technology

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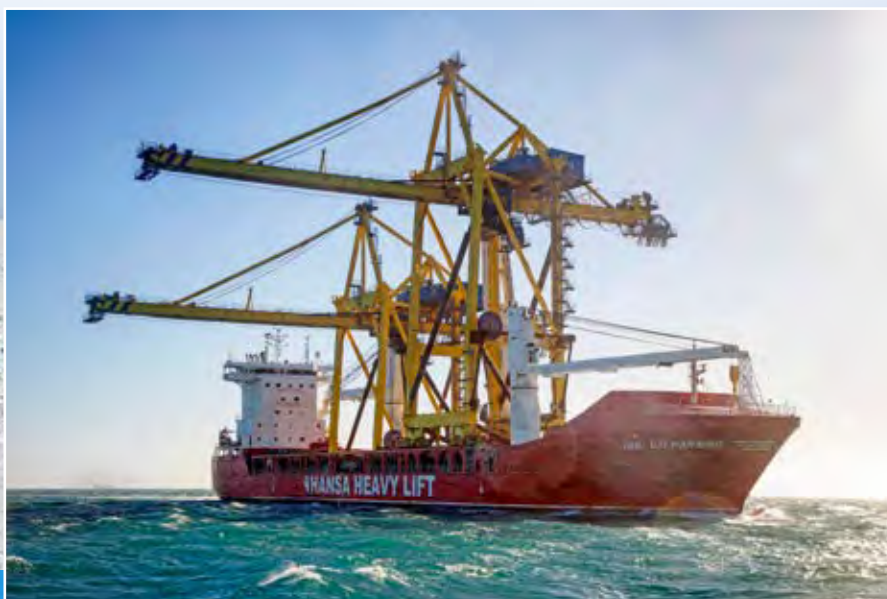
The Arctic 2030 report will be available for download at [www.chnl.no](http://www.chnl.no) from June 2017.



For more insight about the IMO Polar Code please visit [www.dnvgl.com/polar](http://www.dnvgl.com/polar)

Photos: DNV GL, Hansa Heavy Lift, Viceandvirtue - Dreamstime.com

In November 2016 the DNV GL-classed *HHL Valparaíso* became the first vessel to sail the Northern Sea Route open-hatch, delivering two giant ship-to-shore cranes to Russia.



In addition, they need to be accompanied by a nuclear icebreaker along sections of the route where ice may be present. This area normally stretches from the Kara Sea to the Bering Strait. A date and meeting point need to be arranged in advance and DNV GL recommends to

arrive ahead of time. Operators need to be aware that they may have to adjust their schedule at short notice, depending on the availability of the icebreaker.

- **Safety:** Even during the summer months there is a risk of encountering drift ice in the North-East

Passage. This will have an impact on the vessel's speed. Finally, the availability of search and rescue teams is somewhat limited on the Northern Sea Route. It may not always be possible to gain access to the nearest port, as some are open to Russian vessels only.

A guest contribution by Yasuo Tanaka

# LEARNING FROM BIG DATA

As shipowners and operators begin to embrace the use of operational data to identify areas for optimization, building a comprehensive network infrastructure is the next challenge to overcome. This opinion piece describes NYK Line's approach to big data.

When fuel prices were on a steep rise in 2005 and 2006, NYK Line began looking for new ways to lower bunker costs. Various technical solutions were considered, and fuel consumption was analysed in the context of vessel speed, location, sea region, and other factors – weather conditions in particular turned out to have a major influence on ship performance. Over time, NYK Line built a database of operational information and discovered various areas where we needed to change our operating patterns. For example, we found that the NYK operations centre in Singapore needed a better communication connection with the ships in order to interact with the shipmasters more effectively. We needed the ability to present the same data to fleet management and the captains at the same time and improve the dialogue between ship and shore.

## A dedicated research institute

In 2004, NYK Line established its Monohakobi Technology Institute, Inc. (MTI) as a strategic subsidiary for technology research and development. Tasked with investigating fleet operation and research optimization potential, the MTI began collecting and analysing data from ships around 2005, starting with just one vessel to test and confirm the data collection methodology. We then expanded our scientific work to include all vessels operating between Tokyo and the US West Coast.

The vessel-specific data was used to compare ships with each other so as to distinguish good and bad operating practices and identify improvement potential. The data allowed our business unit to ask specific questions about the reasons behind differences in fuel efficiency, while accounting for natural causes, such as seasonal differences.

The number one cause of deviations in fuel efficiency is bad weather. While we can't control the weather, analysing the ship data helped MTI develop ways of driving down fuel costs, for example through smart routing and addressing machinery issues proactively. Overall, about half a dozen different causes of increased fuel costs were identified.

Technical advances have since enabled NYK Line to refine its data collection and evaluation processes. Today every NYK Line vessel has a data collection system on board and optimizes operational efficiency



**Yasuo Tanaka**  
is President of  
MTI, a strategic  
subsidiary of  
Nippon Yusen  
Kabushiki Kaisha  
(NYK).

**"Classification societies such as DNV GL have been handling confidential information, including drawings and accident records, for a long time and are trusted by the industry."**

**Yasuo Tanaka**, President MTI





The fleet of Japanese NYK Line benefits from MTI's research and technical knowledge.

and fuel consumption using the information it provides. The next step is to interconnect the output of voyage data recorders, engine data loggers, the ECDIS and the ballast control system and connect it with shore-based Internet-of-Things (IoT) applications to enable services such as trim optimization, condition and health monitoring, diagnostics, environmental compliance, safe operation, collision prevention as well as fleet and schedule management and service planning. With powerful data mining technology in place, possibilities are nearly unlimited; eventually, even autonomous ship control may become a commercial reality.

#### **A common data platform**

Many companies are already collecting their own on-board data, and some engine manufacturers equip their engines with devices capable of measuring engine performance information and transmitting it to shore automatically. Smart shipping applications will soon be commonplace across the industry. What is still needed is a common ship-to-shore platform enabling all stakeholders, from cargo owners to shipyards and equipment manufacturers, to utilize non-sensitive shipping information. The maritime community could benefit from such an open platform system in many ways, from comparative performance evaluation to technical and environmental research and development. Classification societies could use the data to improve ship and equipment design and detect new needs and issues as a basis for developing new, custom-tailored solutions for their customers.

All this would not only require a powerful computing and data warehouse environment, but also significant IT and ship engineering expertise, and the big question is whom to entrust with the operation of such

a data centre. Providers of cloud services have offered assistance and may be up to the challenge in terms of data processing. But in general, IT providers will want to make use of the data for their own purposes, which is not in the best interest of the shipping industry.

#### **The right partner to trust**

Classification societies such as DNV GL have been handling confidential information, including drawings and accident records, for a long time and are trusted by the industry. They have both IT capabilities and domain-specific expertise and are neutral international organizations, something other industries lack. Therefore, classification societies are in a unique position to operate a common data platform. Naturally, some of the operational data collected by shipowners and operators is very valuable and should not be in the public domain. The transfer of data should therefore be governed by agreements to ensure strict confidentiality.

Furthermore, the quality of data received from vessels is not always consistent. NYK filters its data prior to analysis. Data quality and integrity must be guaranteed to make sure those who pay for the privilege of utilizing the data get the quality they expect. Another question is cybersecurity: the emerging satellite-based data transmission technology must be protected against intrusion and abuse, such as hacker attacks. A classification society would be well-equipped to account for both concerns.

An open data platform offers multiple benefits to all partners of the value chain. It will accelerate the transformation of the shipping industry as it learns to embrace data intelligence to streamline operations and maintenance, while facilitating compliance and enhancing safety. ■

# DNV GL IN NORWAY

In a country that mainly consists of rugged mountains and an endless shoreline, shipping is a natural part of everyday life. And with more than 150 years of experience, a commitment to safety and sustainability and 750 maritime experts, DNV GL operates at the heart of Norway's maritime community.

Innovation in ship design, building, and operation has been Norway's lifeblood for generations. Just as the Vikings designed, built and sailed revolutionary ocean-going ships, over a thousand years later the Norwegian merchant and fishing fleets stepped in and helped design vessels to meet the harsh demands of North Sea oil and gas operations.

Today, 750 technical experts provide classification and technical expertise to the global maritime community from their waterside campus at Høvik just outside of Oslo. Surveyors and auditors attend to customer needs at any port of call along the Norwegian

coast, covering all ship segments from offshore drilling units and offshore supply to fishing vessels and fish farm supply vessels, LNG carriers, and a growing number of conventional and exploration cruise vessels – the latter using Norway as a starting point for Arctic adventures.

## Local presence

As local shipyards diversify into new segments and markets such as exploration cruise ships, offshore wind and cable-laying vessels, DNV GL stands ready to assist. "For DNV GL it is important to maintain our close relationship with the yards and suppliers and



"For DNV GL it is important to maintain our close relationship with the yards and suppliers and support them as they move into new territory."

**Jon Rysst**, Regional Manager North Europe at DNV GL - Maritime





The DNV GL headquarters (left) in Høvik and the new Veritas 3 building (right).



# 750

technical experts provide support to DNV GL's customers from their office in Høvik.

Photos: DNV GL, Andrey Armyagov/finkandreas - Fotolia

support them as they move into new territory," says Regional Manager Jon Rysst. Business Development Manager Frode Eriksen confirms this commitment: "We have solidified our strong position in the market with owners, yards and manufacturers by providing added value. Our focus is on cost-efficient tools and solutions, local presence, immediate response, and competent advice to meet complex challenges."

The proof of this winning combination can be seen in the order book of innovative projects DNV GL has recently won, including wind farm con-

struction support vessels, a stern trawler, a research and expedition vessel (REV), the world's largest hybrid ro-pax ferry, and the new Hurtigruten ice class explorer cruise ships (see also page 42).

#### **From fish to oil and back**

While the Norwegian offshore industry has not been spared by the recent downturn of the oil and gas business, Offshore Director Ernst A. Meyer offers an upbeat perspective: >





**"Our focus is on local presence, immediate response and competent advice."**

**Frode Eriksen**, Business Development Manager at DNV GL - Maritime

> "We currently see activity picking up, with a record number of mobile offshore units available to the industry. On top of this, there are new opportunities in the offshore classification business, such as installation vessels for the offshore wind market. What is more, we are heavily involved in the development of rules and standards to ensure safe and reliable operation of innovative fish farms in harsh offshore waters."

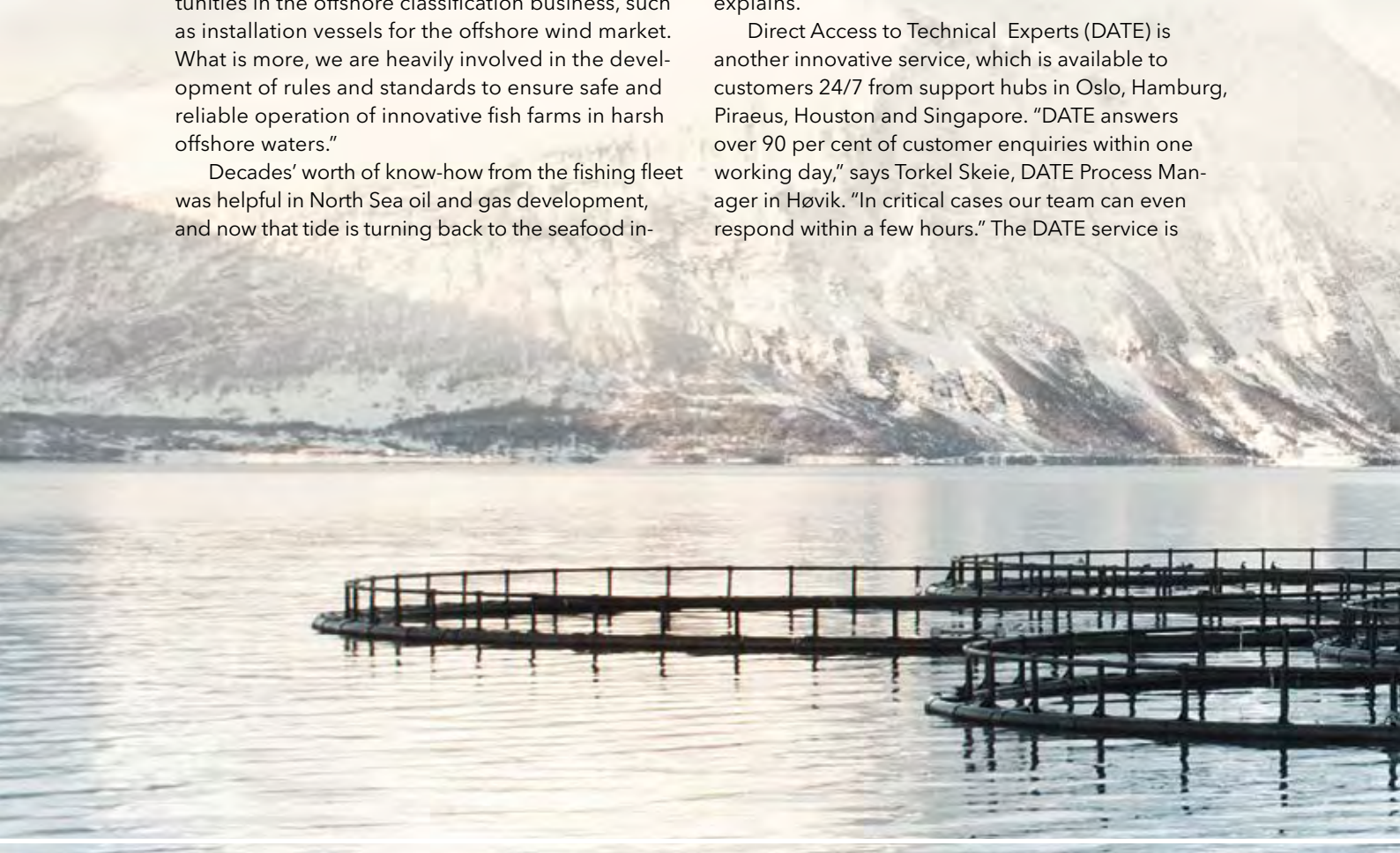
Decades' worth of know-how from the fishing fleet was helpful in North Sea oil and gas development, and now that tide is turning back to the seafood in-

dustry as Norway readies itself for the post-oil economy: "DNV GL offers a wide spectrum of services to the fish farming industry. Apart from classifying technically advanced fish farm supply vessels and certifying fish farms, fish farming equipment, and service suppliers, we provide system and sustainability certification such as ASC Salmon and Global GAP as well," says Lars Sørum, Director Regional Food & Beverages.

#### Maritime expert advice

The Maritime Advisory (MA) North Europe unit of DNV GL employs 160 people in Høvik, Trondheim, Bergen and Ålesund, covering technical, safety, shipping and marine cybernetics advisory services. "We aim to harmonize technical issues with business considerations," says Head of MA North Europe, Ketil Aamnes. Amongst their wide spectrum of services, helping customers digitalize their operations is high on the agenda. "As an example, we promote the use of digital twin technology - a virtual model of an asset that is maintained throughout the life cycle of the physical asset and is easily accessible at any time. This powerful collaboration platform reduces costs and increases efficiency," Aamnes explains.

Direct Access to Technical Experts (DATE) is another innovative service, which is available to customers 24/7 from support hubs in Oslo, Hamburg, Piraeus, Houston and Singapore. "DATE answers over 90 per cent of customer enquiries within one working day," says Torkel Skeie, DATE Process Manager in Høvik. "In critical cases our team can even respond within a few hours." The DATE service is





DNV GL Group President & CEO Remi Eriksen (left) and Director Battery Services & Projects Narve Mjøs, whose team coordinates the Green Coastal Shipping Programme.



The innovative LNG plug-in hybrid *Kristian With* is the newest member of the Egil Ulvan Rederi fleet.

accessible to shipowners and ship managers through the customer portal “My DNV GL”. The portal also provides exclusive real-time fleet status information and other helpful services.

### Greener shipping

A good example of how DNV GL brings industry partners together to explore new opportunities is the Green Coastal Shipping Programme. This collaboration between the private sector and the Norwegian government has evaluated the emission reduction potential for all traffic in Norwegian

waters, and conducted various studies into zero- and low-emission solutions for public ferry services and commercial maritime applications. “The aim is to bring all major players in the maritime value chain together and build a complete ecosystem for the development and adoption of green technologies,” says Programme Director Narve Mjøs.

The vast global footprint of DNV GL reflects the seafaring history of Norway. And today, DNV GL is plotting a more ambitious course than ever, but always with the same unfaltering commitment to safety and sustainability. ■ CB

Photos: DNV GL, Multi Maritime, StrahilDimitrov – Thinkstockphotos





# TRAINING AT DNV GL



For the complete range of training courses offered by the Maritime Academy please visit: [dnvgl.com/maritime-academy](http://dnvgl.com/maritime-academy)

12. - 16.06.17

**Superintendent Workshop - Managing Day-to-Day Operations**  
Hamburg, DE

15.06.17

**Cybersecurity - General Awareness Training**  
Piraeus, GR

16.06.17

**Conflict Management - Resolving Conflicts Effectively**  
Piraeus, GR

20.06.17

**Major IMO Convention Updates: SOLAS and MARPOL**  
Singapore, SG

20. - 21.06.17

**Management of Change - Risk Assessment**  
Istanbul, TR

20. - 22.06.17

**Train the Trainer for Shipping Companies**  
Gdynia, PL

21.06.17

**LNG as Ship Fuel**  
Singapore, SG

22. - 23.06.17

**Practical Incident Investigation and Root Cause Analysis - Methods and Tools**  
Rotterdam, NL

23.06.17

**Vessel General Permit**  
Hamburg, DE

26. - 28.06.17

**Internal Auditor of an Integrated Management System acc. to ISO 9001, ISO 14001 and OHSAS 18001 for Shipping Companies**  
Gdynia, PL

27.06.17

**PSC - Interactive Workshop**  
Piraeus, GR

27. - 28.06.17

**Energy-Efficient Operation of Ships - Masterclass**  
Piraeus, GR

27. - 28.06.17

**Internal Auditor ISM-ISPS-MLC for Shipping Companies**  
Hamburg, DE

28. - 29.06.17

**LPG Carriers**  
Piraeus, GR

28. - 29.06.17

**Practical Marine Risk Assessment**  
Marseille, FR

29. - 30.06.17

**Vetting Inspections**  
Singapore, SG

30.06.17

**Behaviour-Based Safety**  
Piraeus, GR

03. - 05.07.17

**Planning and Managing a Dry-Docking for Superintendents**  
Genoa, IT

03. - 06.07.17

**Approved HazMat Expert**  
Mumbai, IN

05.07.17

**Communicating and Leading Effectively**  
Singapore, SG

05. - 06.07.17

**Superintendent Course**  
Piraeus, GR

07.07.17

**Complying with the MLC 2006**  
Singapore, SG

07.07.17

**STCW for Crewing Managers**  
Rotterdam, NL

12.07.17

**Basics of a Quality Management System According to ISO 9001 for Shipping Companies**  
Piraeus, GR

13.07.17

**Preparing for the EU MRV Regulation**  
Istanbul, TR

13. - 14.07.17

**Internal Auditor ISM-ISPS-MLC for Shipping Companies**  
Genoa, IT

17.07.17

**Understanding ISM**  
Singapore, SG

19.07.17

**Hull Inspection Using 3D Simulator (Bulk Carriers)**  
Piraeus, GR

21.07.17

**Introduction to the Offshore Industry and Dynamic Positioning**  
Mumbai, IN

02.08.17

**Maritime Battery Systems Introduction Course**  
Singapore, SG

08.08.17

**Flag State Regulation**  
Dubai, AE

11.08.17

**Emergency Preparedness and Crisis Management**  
Singapore, SG

14. - 16.08.17

**Company/Ship Security Officer (CSO/SSO) Training Course**  
Singapore, SG



# EVENTS & EXHIBITIONS



Please also visit: [dnvgl.com/events](http://dnvgl.com/events) for a constantly updated list of events, conferences and exhibitions.

06. - 08.06.17  
**Electric & Hybrid Marine**  
Amsterdam, NL

06. - 08.06.17  
**Marine Maintenance World Expo**  
Amsterdam, NL

06. - 08.06.17  
**Offshore Wind Energy Conference**  
London, UK

14. - 15.06.17  
**Rina Warship 2017: Naval Submarines & UUVs**  
Bath, UK

20.06.17  
**European Maritime Cyber Risk Management Conference**  
London, UK

30.06.17  
**Seatrade Awards**  
London, UK

05. - 08.09.17  
**SPE Offshore Europe**  
Aberdeen, UK

11. - 15.09.17  
**London International Shipping Week**  
London, UK

12.09.17  
**A Regulatory Forum: Counting the Cost of Compliance**  
London, UK

12.09.17  
**Safety at Sea Awards**  
London, UK



**London International Shipping Week** will host an estimated 15,000 industry leaders across all sectors of the international shipping industry in September.

25. - 27.09.17  
**Seatrade Offshore Marine & Workboats Middle East**  
Abu Dhabi, AE

27.09.17  
**Lloyd's List Global Awards**  
London, UK

27. - 30.09.17  
**Monaco Yacht Show**  
Monaco, MC

03. - 05.10.17  
**Pacific 2017**  
Sydney, AU

07. - 11.10.17  
**INTERFERRY Annual Conference**  
Split, HR

19.10.17  
**Tanker Operator**  
Hamburg, DE

26.10.17  
**Lloyd's List Asia Award**  
Singapore, SG

07. - 10.11.17  
**Euport Rotterdam**  
Rotterdam, NL

13.11.17  
**IBJ Awards**  
Amsterdam, NL

13. - 15.11.17  
**8th Gas-Fuelled Ships Conference**  
Hamburg, DE

13. - 16.11.17  
**Adipec**  
Abu Dhabi, AE

14. - 15.11.17  
**Tanker Shipping & Trade Awards**  
London, UK

24.11.17  
**Lloyd's List Greek Shipping Awards**  
Athens, GR

28.11.2017  
**Lloyd's List South Asia, Middle East & Africa Awards**  
Dubai, AE

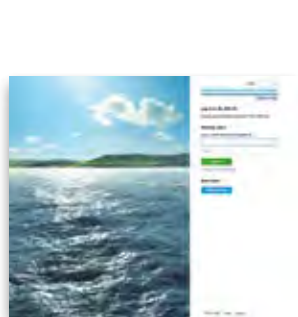
28. - 29.11.17  
**14th Maritime Security and Coastal Surveillance Asia**  
Singapore, SG

29.11.17 - 01.12.17  
**International WorkBoat Show**  
New Orleans, US

05. - 08.12.17  
**Marintec China**  
Shanghai, CN

# THE POWER OF INFORMATION

The maritime world is constantly in motion. New approaches to ship design, operation and management are being developed, tested, implemented and superseded. At DNV GL, too, we are always working to provide you with services and information that can help your business adapt to changing markets, regulations and advancements.



## MY DNV GL

The customer portal My DNV GL offers a single access point to all our digital services and exclusive information. With an intuitive interface and customized accounts, users can access the services they need to successfully advance their business.

[my.dnvgl.com](http://my.dnvgl.com)



## STUDIES AND PAPERS

Our research studies and white papers demonstrate insights of the maritime industry with long-term impact. They provide you with a broader view of our services and current maritime topics.

[dnvgl.com/mp](http://dnvgl.com/mp)



## TECHNICAL AND REGULATORY NEWS

Whether it is about incident causality information, new requirements released by the IMO/ILO or other authorities and bodies, guidance and advice on specific issues or Port State Control results: DNV GL keeps customers and business partners up to date.

[dnvgl.com/tecreg](http://dnvgl.com/tecreg)



## UPDATE - A NEW SIDE OF YOUR SHIP TYPE

Sharing our knowledge and experience to benefit our customers and the industry - our Updates offer an in-depth focused look at the issues, news and technologies of a specific ship type.

[dnvgl.com/mm](http://dnvgl.com/mm)



## THE APP

The DNV GL - Maritime app is packed with features and information, including NEWS & EVENTS, CONTACTS, VESSELS, MARKET INSIGHTS and TRAINING COURSES. There have never been so many ways to interact with us

and stay informed about the latest developments at DNV GL.

To download the app for your Android or iOS device, scan the QR code or visit Apple's App Store or Google Play and search for "DNV GL - Maritime".





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## DNV GL

Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil & gas and energy industries. We also provide certification services to customers across a wide range of industries.

Combining leading technical and operational expertise, risk methodology and in-depth industry knowledge, we empower our customers' decisions and actions with trust and confidence. We continuously invest in research and collaborative innovation to provide customers and society with operational and technological foresight. With origins stretching back to 1864, DNV GL's reach today is global. Operating in more than 100 countries, our professionals are dedicated to helping customers make the world safer, smarter and greener.

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**100**  
Countries

**15,000**  
Employees

**350**  
Offices

**13,000**  
Ships and MOUs in class