DNV·GL

OFFSHORE UPDATE

No **01 2015**

Improving offshore performance

Facing invisible threaths

The Lewek Constellation project

CONTENT

Front cover photo: © DNV GL/Thomas Revheim

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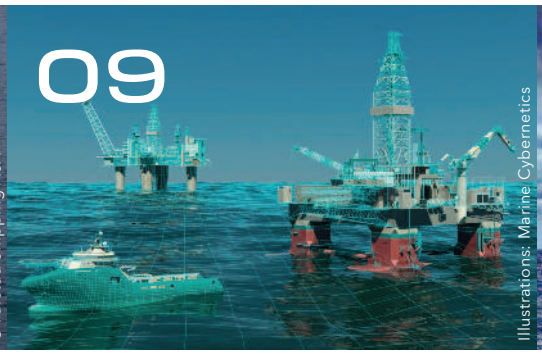

Illustrations: Marine Cybernetics

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THE OFFSHORE DOLDRUMS?

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So far, 2015 has proven to be a difficult year for most of the offshore vessel industry, with 2016 predicted to be even more challenging. Global spending on exploration and production is declining, sending strong signals that the past few decades' rising cost curve will not continue. With less demand for offshore vessels and oversupply of tonnage, current spot charter rates are not enough to cover the operational expenditures, and market prices are plummeting.

In some areas, more than 10% of the fleet is now in lay-up. At the same time, the fleet still on contract is subject to scrutiny based on cost and performance indicators such as safety and availability. This is the time when the oil majors can ask for more safety in order to keep vessels on charter, and when the high uptime of your fleet may be the reason for staying on contract. And let us not forget; the low oil price is forcing charterers to focus on cost reductions, even more so today than when fuel was more expensive.

In this edition, you can read articles about how safety, availability and lower cost can all be combined. Operational savings are not only about the onboard activity. They are equally or more about proper planning, charter expectations and logistical efficiency. The joint industry project in which ship owners and charterers worked together addressed this, and there is no better time than now to make the changes.

Advanced analyses can be used to learn how to reduce fuel consumption and how new technology simply can raise the bar for better vessel performance. The article on DP capabilities illustrates the importance of performance-based tonnage-selection criteria are good enough, better than that offered by the current environmental rating system. Connectivity is the new buzz-word, giving access to sensor data and aggregated information far beyond what was possible a few years back. And still; for those finding it necessary to lay up part of their fleet, it make sense to consider "what it is smart to do, and when".

The newly delivered Lewek Constellation set a new industry record for the highest tension ever experienced during rigid reeled-lay operations this spring in the Gulf of Mexico. You can read more about this advanced ship's construction in this edition. We believe those who focus on reducing the total operating costs – and increasing the total value of the operations to the charterer – have a good case in an offshore doldrums scenario in which preparations are being made for a higher level of activity.

Enjoy your reading!

OFFSHORE UPDATE

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IMPROVING OSV PERFORMANCE

Now that oil companies are responding to the lower oil price by actively hunting for cost reductions, all service providers feel the need to reduce the price of their services. “The hunt for reduced charter rates can be combined with an incentive model where best operational practices are implemented,” says Knut Ljungberg, DNV GL. He is referring to a joint industry project initiated and headed by DNV GL called Energy Efficient Offshore Partners (EEOP). The key focus was on saving cost (fuel) and at the same time reducing emissions from offshore vessels while benefitting both the ship owners’ and charterers’ bottom line. “This creates a win-win situation for the entire industry,” explains Ljungberg, who also headed this joint industry project.

Knut Ljungberg, Head of section Shipping Advisory DNV GL

When the oil price peaked before the financial crisis in 2008, the industry became more aware of the link between fuel consumption and emissions. Observing the trend within the offshore support/service vessel market towards more diesel electric propulsion and higher DP-redundancy, the power plants changed, becoming more diversified with respect to engine sizes. Or in other words; they now focus on optimizing engine utilization under any normal operative condition. “While the impact of improvements in technology was obvious, many asked ‘why not focus on pure operational excellence’ as a means to save fuel and reduce emissions,” Ljungberg continues.

To pursue this idea, ship owners and operators from the North Sea area were invited to participate in a joint industry project. Seven ship owners, operating a total fleet of 180 vessels, took part in the kick-off meeting in 2011. An important part of the initial discussion was the realization that if everyone can share their own common or best practice, even the best performers have something to learn from the other partners.

After mapping the status of operations – and sharing practices among the participants – an average operational fuel saving potential of 15% was estimated. This amounts to annual accumulated fuel savings of MUSD 80 for the owners participating. At this stage, all the participants, even the best, realized that they did have something to learn from the dialogue within the project group. “We also learned that realizing the savings potential would not be straightforward, as ship owners don't control all the elements that impact on the overall fuel consumption,” says Ljungberg.

“When charterers pay for the fuel, they are the ones who will save costs if the fuel consumption is reduced. While some of the savings potential can be achieved without extra cost, some will actually require an initial investment by the ship owner, and why should the ship owner invest if the charterer obtains the whole benefit? The partners concluded that charterers had to be included in a second phase of the project, where the key objective should be to explore shared incentive models to activate the mechanisms that will result in fuel savings,” Ljungberg explains.

“The savings and consequent benefits are substantial and I have an example from the engine performance improvements. Initially, the ship owner invests, for instance, USD 10,000 in improvements from a long list of possible actions. This investment will lead to savings of some USD 40,000 for the charterer, which reimburses the owner for the initial investment of USD 10,000. The remaining USD 30,000 is then the bonus that is split between the owner and charterer.” Typical activities that reduce fuel costs include logistics planning, speed management, DP-operation, propeller polishing, trim & draft optimization and an enhanced focus on communication with the crew, logistics base, offshore installations and charterer.

What now? With an oil price below 50 USD/b, the income for offshore oil majors is dramatically reduced, making it crucial to reduce their total expenses. “This is the time to revisit the EEOP

Børge Nakken, Vice President Farstad Shipping

"There is no better time to promote the leading and best practice for the fleet in service than when the industry realizes the circumstances are critical"

Børge Nakken

project's recommendations and seek a change in how charterers engage with those ship owners that over time have invested in new technology and operative excellence in order to achieve a net benefit for the charterer," says Børge Nakken, Vice President of Farstad Shipping. "Ship owners like Farstad that operate modern offshore support/service vessels have a unique insight into how they, together with the charterers, can save fuel and reduce emissions, hence reducing the charterers' overall operating costs. For example, in a spot market where the charter rates are from time to time lower than the OPEX, this is an ideal time for charterers to put extra effort into selecting the tonnage that gives the best value for money and then share the savings with the ship owner. We ought to implement these best practices now, supported by shared savings incentives from the charterers. There is no better time to promote the leading and best practice for the fleet in service than when the industry realizes the circumstances are critical," concludes Nakken. ▮

ENERGY EFFICIENT OFFSHORE PARTNERS (EEOP) IS A JOINT INDUSTRY PROJECT INITIATED AND HEADED BY DNV GL

The partners are;
- Statoil
- Conoco Phillips
- Solstad Offshore
- Farstad Shipping
- Siem Offshore
- Havila
- Eidesvik
- BOA Group
- Gulf Offshore Norge AS

The mandate is;
- To identify
- To assess
- To describe opportunities for the offshore vessel industry to operate with improved energy efficiency and lower emissions.

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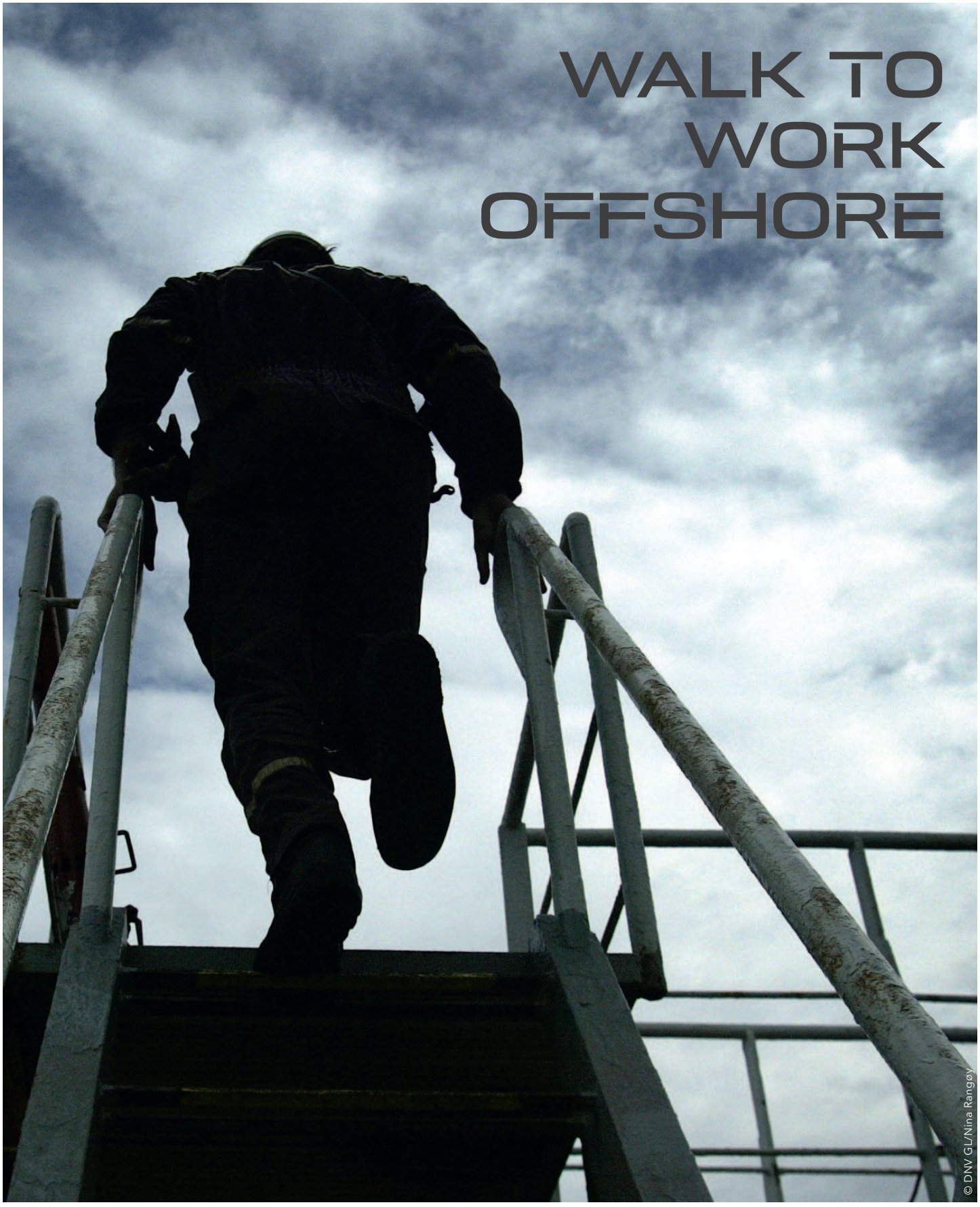
WALK TO WORK OFFSHORE



The transfer of personnel between an offshore facility and a marine vessel via a gangway system provides an alternative to other means, such as helicopters, basket transfers or boat landings. Otherwise known as Walk to Work (W2W), this approach can offer significant benefits, including greater manning flexibility, reduced lifecycle costs and improved safety. For these reasons, the use of this approach is growing, with greater numbers of W2W operations being considered each year. This has resulted in more attention from regulators and an increased focus on improving W2W implementation. To assist the offshore oil and gas and offshore wind industries, DNV GL has led two initiatives - firstly the development of a W2W guidance document and, secondly, the creation of a specific product certification standard for W2W gangways.

Michiel van der Geest, Product Manager Offshore Class DNV GL

The W2W approach, according to which offshore facilities are manned from a ship via a gangway, is being increasingly considered and used in the North Sea and other sea regions to replace or supplement traditional manning methods such as helicopters, flotels or barges. W2W manning can offer many significant benefits, including: cost reductions; increased productivity; greater and more flexible man-hour delivery; additional bed space; resource sharing; and a reduced risk of workers suffering major accidents.

W2W can take many forms, ranging from a simple crew ferry between land and an offshore facility, to an integrated large multi-role vessel with helideck, hotel, rescue and recovery, diving, ROV and crane facilities. A W2W solution may support a single offshore facility such as an oil platform, or multiple facilities such as wind turbines in an offshore wind farm.

To fully realize the advantages that a W2W solution may deliver, considerable time and effort are likely to be needed during implementation to work through a wide range of aspects. Effective alignment, integration and collaboration are required between the offshore facility operator, vessel operator and gangway provider, recognizing that the W2W solution will be safety critical, must have a high availability/reliability and will need to operate in a dynamic environment, heavily influenced by operational needs and sea and weather conditions. Most importantly, it also requires buy-in from the workforce who will use the W2W solution as well as from the various industry regulators and other bodies, such as the vessel classification society. To date, there has been a mixed response from both the workforce and regulators to some aspects of W2W.

To help assure the performance and quality of gangway systems used for W2W, a product certification process is employed. To date, the product certification of W2W gangways has been undertaken on a case-by-case approach, using existing, but only partly applicable, standards like DNV GL's recognized 2.22 Standard for Lifting Appliances. The absence of a specific product certification standard has a negative effect on the predictability and efficiency of the certification process and weakens the product quality assurance.

To help implement W2W, DNV GL has firstly led a Joint Industry Project (JIP) on W2W to develop a comprehensive W2W guidance document and, secondly, drafted a specific product certification standard for gangways intended for W2W operations.

A broad range of partners and stakeholders across the industry participated in the W2W Guidance JIP, ranging from: gangway suppliers such as Ampelmann, UpTime and Marine Aluminium; offshore facility operators such as BP, Shell, Statoil and Statkraft; and ship developers such as Damen Shipyards, Vroon Group, Wagenborg Offshore and Babcock. Input to the guidance was also received from regulators: the UK Health and Safety Executive (HSE) and Maritime and Coastguard Agency (MCA) and the Norwegian Maritime Authority (NMA).

The W2W Guidance has been written to help those involved in W2W, primarily offshore facility operators that need a manning solution, to understand the important aspects which require consideration when selecting and implementing a W2W solution. This should encourage and expedite the development of safe, cost-effective and regulatory-compliant W2W solutions.

The DNV-GL-developed specific product certification standard for gangways provides a transparent, predictable and application-based background for certification. This will result in a more efficient and consistent certification process and a more robust and unambiguous assurance of the offshore gangway's safety and technical characteristics. Certifying a gangway to the DNV GL standard will make the various stakeholders more confident that the gangway is safe to use and fit for the purpose. ▮

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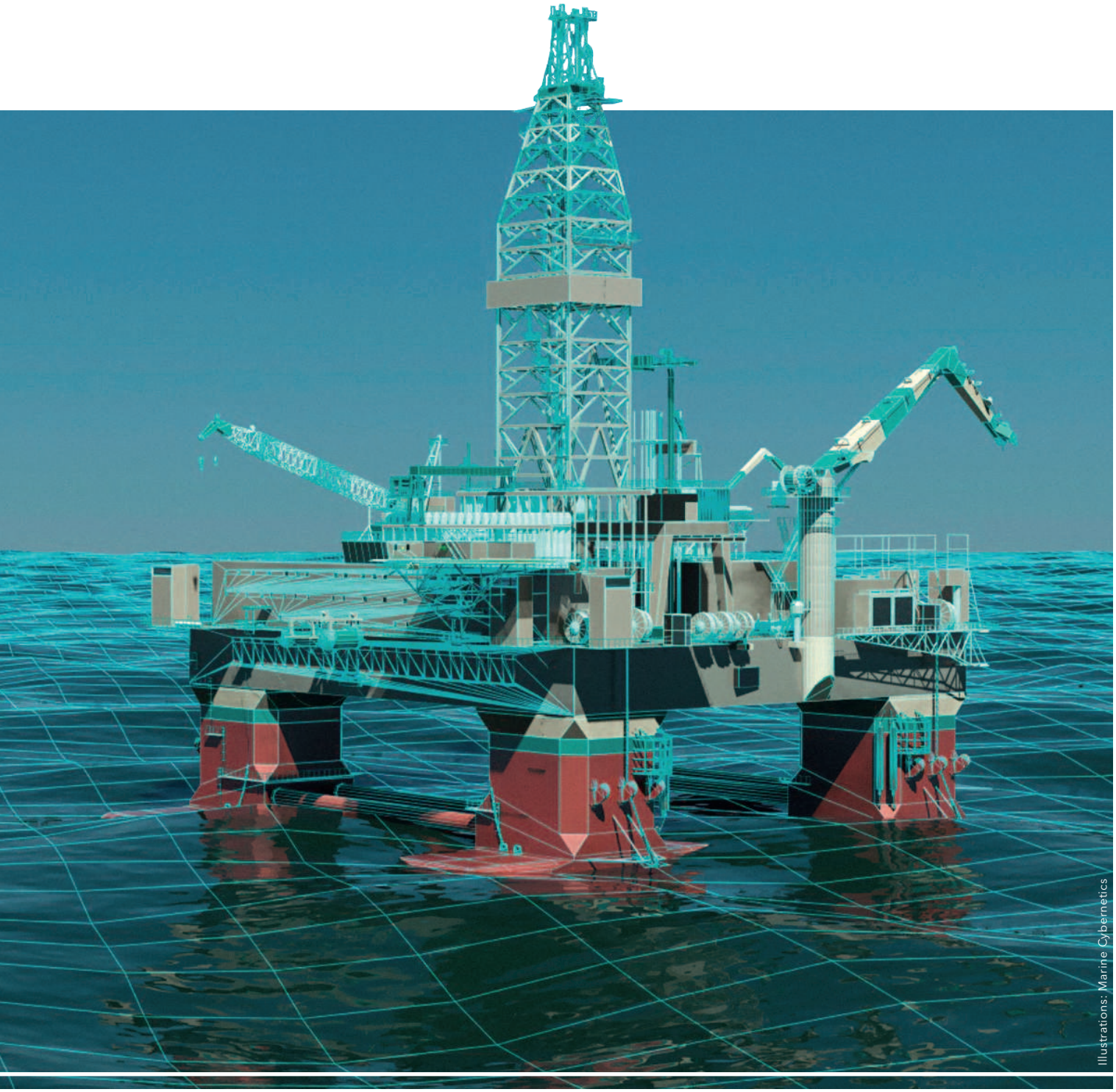
FACING INVISIBLE THREATS

As ships and offshore structures increasingly depend on programmable control systems, there is an urgent need for protection against cyberthreats. DNV GL has developed strategies for strengthening maritime cybersecurity.

Software-driven systems have conquered ships and offshore installations, and while individual on-board systems were kept isolated in the past, the general trend towards integrated control networks has caught on in the maritime industry as elsewhere. What is more, external connections allow advanced systems to transfer operational data to shore or perform software updates. "Ships and offshore structures are becoming more connected," said Tor E. Svensen, at the time CEO of DNV GL – Maritime and now Group Executive Vice President, speaking about cybersecurity at this year's CMA Shipping event in Stamford, Connecticut. "For example, it has become common practice to interlink bridge systems with machinery and safety systems."

Complex systems are vulnerable

System interconnections and online transactions harbour new challenges and security risks, however. Not only can the increasing complexity of on-board networks compromise system integrity; but all programmable components, including machinery, navigation, and communication systems, could fall victim to cyberattacks. "This is a weak spot," Svensen notes. "There are many ways something can go wrong with systems or software, whether caused by technical malfunction or human error. Cyberattacks exploiting existing vulnerabilities pose an additional risk. This applies to all industries, of course."



Illustrations: Marine Cybernetics

Statistics show that most cyberattacks target the energy sector. For example, the Norwegian National Security Authority has received reports of more than 50 cybersecurity incidents in the Norwegian oil and gas sector. The maritime industry is not immune to these threats: the recent manipulations of AIS, ECDIS and GPS data have demonstrated that ships are equally vulnerable.

Identifying blind spots

Why are automation and control systems vulnerable? Typically, external network connections are used for remote debugging and maintenance. Commercial off-the-shelf products use commercial operating systems, which might not be regularly patched and use unsecured communication protocols. Additionally, security policies and procedures are often inadequate, partly due to a lack of awareness and suitable training.

"In the end, it doesn't matter what causes systems to fail," Svensen says. "We need to have the right procedures and technology in place in order to minimize the risks and deal with the consequences."

In response to the increasingly complex technology in the offshore sector, DNV GL began to formulate procedures for software development and integration, then moved into testing of control systems and is now addressing vulnerability to external threats.

Integration testing examines the behaviour of a software application or module in conjunction with other software.

CURRENT STANDARDS

DNV GL has identified 35 standards pertaining to cybersecurity in the energy, oil and gas and maritime sectors. Much of the original development has come from the US energy sector.

- ISO 27001/2: addresses general information security; also relevant for ship and industrial facility systems; well established as a management system and policy guideline at the organizational level.
- ISA/IEC 62443: currently under development; addresses industrial automation and control systems. Testing laboratories offering certification to the stan?dard are expected to emerge eventually.
- ENISA (European Network and Information Security Agency) issued the "Analysis of Cyber Security Aspects in the Maritime Sector" in 2011.
- The Norwegian Oil and Gas Association published "Recommended Guidelines for Information Security Baseline Requirements for Process Control, Safety and Support ICT Systems".
- DNV GL offers testing against its own Enhanced System Verification Rules or Integrated Software Dependent Systems (ISDS) standard.

USCG: CYBERSECURITY STRATEGY ROLLED OUT

"The maritime industry is rather late in the game of addressing cybersecurity," says Blaine Collins, DNV GL Vice President, Group Government and Public Affairs in the US. "But cyberattacks on the consumer end, on financial institutions or even entertainment companies such as Sony have attracted a lot of attention. In the US, in general, cybersecurity has become a major concern."

In a recent report, the Government Accountability Office (GAO) also recommended that the USCG assess cyber-related risks and use the assessment to give maritime security guidance. Accordingly, the USCG has set cyber security as one of four focus areas for 2015. "We expect the USCG Cybersecurity Strategy to be rolled out sometime soon," says Collins.

In 2014, DNV GL acquired Marine Cybernetics, an offshoot of the Norwegian University of Science and Technology at Trondheim which has been developing hardware-in-the-loop (HIL) testing methods to assess control systems and their robustness (refere to illustration on the right). "Control systems provide millions of options, but in a sea trial you can only test a few procedures," Svensen explains.

While the primary customers for the HIL testing programme have been drilling rig operators who specify it in contracts for new rigs, new customers have emerged in the offshore support and subsea construction vessel segments.

The main concern for merchant ships is to ensure that system integration avoids conflicts between systems, and to test the software thoroughly. Furthermore, care must be taken to minimize system exposure to cyberthreats when performing software upgrades via the Internet.

"Networked systems are the future," Svensen adds, "but we must integrate appropriate safeguards that do not rely on the crew to function properly."

Supporting the US Coast Guard

It´s long-standing experience in addressing risks related to integrated information systems has enabled DNV GL to provide consultancy services to organizations such as the US Coast Guard (USCG) on building a regulatory framework and implementing maritime cybersecurity standards. "DNV GL is well positioned to

Illustrations: Marine Cybernetics

WHAT IS HARDWARE-IN-THE-LOOP (HIL) TESTING?

"HIL tests examine the functionality and robustness of control system software, making sure that software is functioning correctly," explains Jan-Tore Ervik, VP Sales and Marketing US of DNV GL's independent business unit Marine Cybernetics. "We use in-house CyberSea technology and independent testers to ensure unbiased results. We have tested more than 300 systems on 150 vessels, encompassing a total of 60,000 test cases and 10,000 findings."

Testing often includes integration between different systems. HIL tests help verify that control system software is resistant to failure, whether caused by technical fault, human error or cybercriminals.

HIL testing uses a simulated system environment to verify the functional reliability of a device.

contribute to regulations and establish rules, class notations, recommended practices and guidelines," Svensen underlines.

Today, DNV GL offers information security and consulting services to customers in the energy, maritime and oil and gas sectors, building on established risk-based approaches and taking requirements from relevant own, national and international standards (see info box on page 10).

Software to directly address cyberthreats

DNV GL introduced its own Integrated Software Dependent Systems (ISDS) standard in 2009. Originally developed and optimized for the offshore industry, ISDS helps to ensure that a vessel's integrated and stand-alone control systems perform reliably and safely. Unlike other class notations, ISDS requirements address the development process rather than the finished product.

Other DNV GL services such as cybersecurity audits or "health checks" take things to the next level. DNV GL's independent business unit Marine Cybernetics offers a combination of hardware- in-the-Loop (HIL) and cybersecurity tests to address typical threats such as network storms and penetrations, password attacks, disconnections and communication failures.

Moving forward

There is already much that can be done to improve protection against cyberattacks. Nevertheless, all industry stakeholders should share more information on cyberevents so as to learn and progress. To mitigate risks, Svensen recommends frequent cybersecurity self-assessments as well as third-party assessments, audits, testing and verification for asset owners and operators.

"Once you have taken care of software integrity, installed data protection and assessed the risks with HIL testing or ISDS, you are in a good position to take the next step in improving cybersecurity," he says. ▮

Text: Thomas.Revheim@dnvgl.com

THE LEWEK CONSTELLATION PROJECT

© DNV GL/Thomas Revheim

IT'S ALL ABOUT THE RIGHT PEOPLE

Thomas Revheim, DNV GL Project Manager Approval

Introduction

Ezra Holdings Ltd and its operating brand EMAS were established in 1992 by Mr Lee Kian Soo. After working on offshore support vessels since the mid-1970s, Mr Lee embarked on a remarkable journey with his company. In a short span of 20 years, the company evolved from ship handling to owning vessels and then to its current offshore operations and engineering organization with revenues beyond a billion US dollars.

Part of its growth strategy was to move into the very expensive and technically challenging sector of subsea engineering and construction services. In 2011, Ezra Holdings Ltd, spearheaded by Group MD Mr Lionel Lee, successfully acquired Aker Marine Contractors and established EMAS AMC. The company's new flagship, the Lewek Constellation, was being designed at the same time, paving the way for making EMAS AMC a world-class service provider in the subsea engineering and construction business, along with players like Subsea7, Technip, Saipem and others.

Partnership for success

The Lewek Constellation is one of only two in her class in the world and is an ice-classed, multi-lay offshore construction vessel with ultra-deep-water pipe-laying and heavy-lift capabilities.

Deciding to build the Lewek Constellation was a bold move. The designer, Navnautik Pte Ltd, was a relatively small Singapore-based company. The yard was Ezra Holding's own, Saigon Offshore Fabrication & Engineering Ltd (SOFEL - now TRIYARDS Vung Tau).

As part of the project planning, several classification societies were considered. DNV (at that time) had several discussions with EMAS. Recognizing the strategic importance of EMAS' growth into a segment where DNV GL is strong, this opportunity was more than 'just another project' for DNV. For EMAS, DNV represented valuable expertise and quality assurance in what was for them a new vessel segment.

The project kicked off with trust in the local expertise provided by Navnautik and TRIYARDS, strong project management from EMAS and quality assurance from DNV – and with all parties committed to delivering a successful project.

Dedicated team members, late evenings and video conferencing
There is no doubt that this project faced many challenges during the design and construction phases. Part of the designer's team was located in Kolkata, India. Part of the DNV approval team was located in Norway. The yard was in Vietnam. All the work was coordinated out of Singapore. Video conferencing, teleconferencing, Skype, Lync and face-to-face meetings were part of daily business throughout the project period.

The engineering manager and person responsible for the project in TRIYARDS, Vinod Janardanan, used to jokingly ask why he could not be given a desk in the DNV office since he spent more time there than in his own office for a while. Similarly, Navnautik director and naval architect Debabrata Banerjee spent an equal amount of time there, always carrying his large bag of essentials and having access to a hotline to the Kolkata office. Numerous evenings were spent with India or Norway, or just the DNV Singapore team, on the line in order to manage the parties involved.

Navnautik and EMAS may not have had experience of this particular ship type. However, Mr Janardanan and Mr Banerjee both had impressive classification, yard, designer and ship-owner experience from various previous positions – experience that was invaluable to the project's success. Solid naval architecture skills combined with extensive yard experience proved an extremely well-qualified 'management team' for handling the complex issues which are inevitable on such a ship. "I remember enjoying even the evening meetings," said Thomas Revheim, DNV GL Project Manager Approval. "When the formal agenda was completed, the meetings often extended into discussions and stories from Janardanan's and Banerjee's vast experience over the last 30-40 years in the industry."

He continued: "In hindsight, I see one major factor that ensured project success. Despite heavy discussions, arguments and some disagreements, we always ended up focusing on finding a common solution in order to move on. There was an open and honest dialogue, despite disagreements, which ensured well-informed decisions and actions, rather than the delays which often occur in less open organizations. I really must praise Mr Janardanan and Mr Banerjee for these abilities and the impact they had as role models in their organizations," said Thomas.

DNV GL - a strategic choice to develop yard skills through project scrutiny

Some thousand miles away from the safe environment of design and classification management, the yard and site surveyors were stepping up to a challenge never experienced before. Building a state-of-the art DP3 heavy-lift and pipe-laying vessel is a challenge even for the most experienced yards. TRIYARDS Vung Tau had never before built anything similar. Acknowledging that DNV is not a 'lenient' classification society, the classification contract was signed with some scepticism and concern.

However, as Mr BH Wong, who was Ezra's Technical Director at the time of the Lewek Constellation's conception and CEO of TRIYARDS during her hull fabrication, said, "The choice of DNV as classification society was a conscious one in this respect. Tapping into DNV's knowledge through close collaboration was part of the intention behind the choice of Class. Scrutiny from the DNV surveyors who developed shipyard competence while still managing project progress was, as such, very much welcomed."

Half-way through the project, Mr Andrew Mak, the former Director of Engineering in ABS Singapore, joined TRIYARDS as COO. Andrew brought overarching decision-making abilities to the project, spending a lot of time in the yard but also attending Singapore meetings whenever possible. Leveraging his thorough classification knowledge, he contributed greatly to progress in the yard, solving issues locally rather than escalating them to the Singapore design and approval teams.

"Singapore is not a big place; some 4.5 million inhabitants, including foreign workers. As a professional, you are very likely to meet people again and again wearing different 'hats' - working for different companies. Like always, good people will strive and succeed in the long run. The reputations of Mr Janardanan, Mr Banerjee, Mr Wong and Mr Mak among their peers prove that long-lasting efforts and honest, hard work will always pay off. I feel fortunate to have learned to know these people," said Thomas.

The Lewek Constellation on duty

Today, the Lewek Constellation is at work for Noble Energy in the Gulf of Mexico. The vessel was officially delivered by the yard in Vung Tau to EMAS AMC as the owner in January 2014. Afterwards, it sailed to Huisman's facilities in Xiamen so that the 3000t crane could be installed, was used in an intermediate job offshore Gabon and then went to Huisman's facilities in the Netherlands for the final installation and commissioning of the pipe-laying equipment.

Managing a 'part delivery' of a vessel by multiple outfitting yards requires skills. Most companies will manage to get the vessel into service – at some point in time. Managing on time is something too few experience. Securing contracts for such a vessel is, of course, imperative and often done well in advance of delivery, with heavy penalties for delays. Needless to say, the task for Hugo Heitling, EMAS AMC's representative as Owner of the asset, had the attention of quite a few stakeholders when he navigated through the final parts of the project so that the asset would be ready in time to take up the contract with Noble.

It's all about the right people

The Lewek Constellation project was an extremely challenging one right from the start. However, the success of this project is proof that, as long as they have the right people in key management positions and competent resources available, it is incredible what organizations can accomplish together when they are committed to a common goal. ▮

THE LEWEK CONSTELLATION IS A REMARKABLE VESSEL, BUILT BY A REMARKABLE COMPANY.

"Fun" engineering facts about the Lewek Constellation

- The largest ship hull to be launched using airbags (can be seen on Youtube)
- It has four independent engine rooms, an extremely rare arrangement in construction vessels, giving it a high degree of redundancy
- The vessel has a total installed power of close to 40MW, enough to light up a small city
- The vessel was wired with 700 km of cables, long enough to travel from Singapore to Kuala Lumpur and back
- The ship has a 3,000 tonne capacity crane

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REDUCED REGULATORY BURDEN FOR US-FLAGGED VESSELS

As an alternative to Codes of Federal Regulations (CFR), the US Coast Guard (USCG) offers the Alternate Compliance Program (ACP) and DNV GL is fully recognized and authorized under it. This means that DNV GL can help even owners of Jones' Act vessels to obtain a US flag.

Paal Johansen, Vice President and Regional Manager, DNV GL - Americas.

The ACP is intended to reduce the regulatory burden on the maritime industry while maintaining existing safety levels and providing increased flexibility in the construction and operation of US-flagged vessels. It consists of class rules, international conventions and an approved US supplement that together form an alternative that is equivalent to the CFR.

DNV GL has the most complete set of authorizations from the USCG under this programme.

Compliance with this equivalent alternative standard is ensured by surveys and inspections conducted by authorized classification society surveyors. A Certificate of Inspection (COI) is issued by the USCG to a vessel enrolled in the ACP based on the classification society reports.

"Owners have expressed a desire to freely choose a classification society for US-flagged ships and we know there are many owners, designers, operators and yards that would prefer to work with DNV GL. The ACP is how they can do so and be confident of the entire regulatory process," says Paal Johansen, Vice President and Regional Manager, DNV GL - Americas. ▮

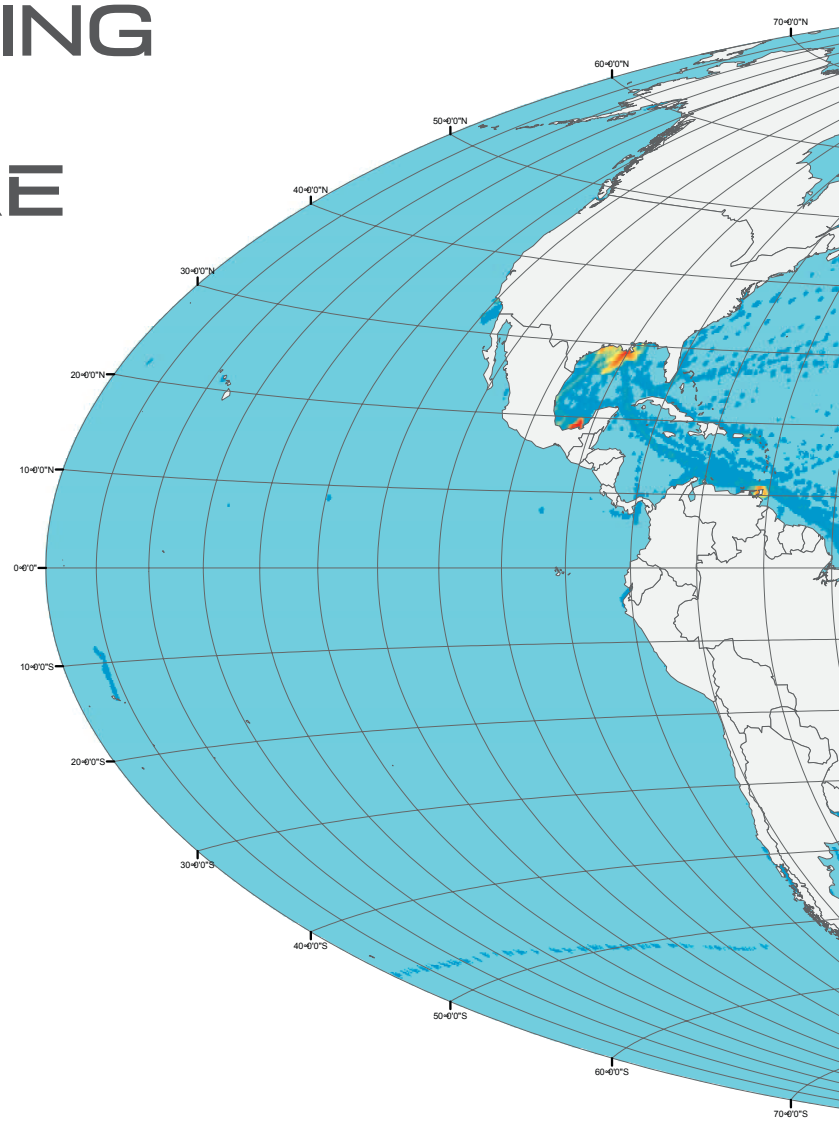
THERE IS A CHOICE OF CLASS IN THE US

DNV GL has the most complete set of authorizations by the US Coast Guard under the US Coast Guard Alternate Compliance Program – ACP

Source: AIS/RS Platou/Ship Data/DNV GL
Illustration: Viktor Sinding-Larsen/DNV GL

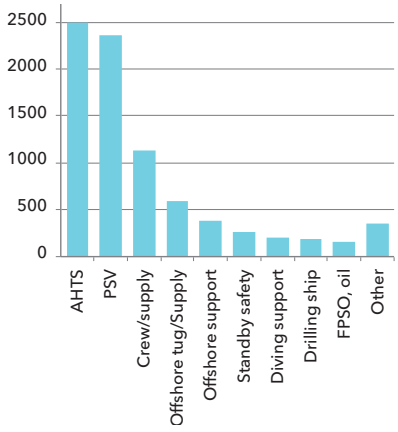
GLOBAL TRADING PATTERNS FOR OFFSHORE VESSELS DURING 2014

LOW NUMBER OF SHIPS OBSERVED → HIGH NUMBER OF SHIPS OBSERVED

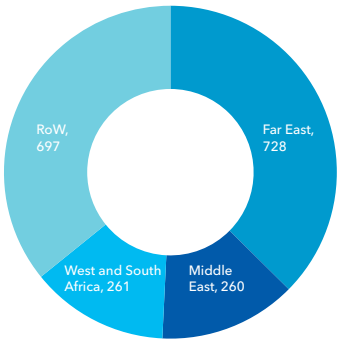


SELECTED FLEET DATA

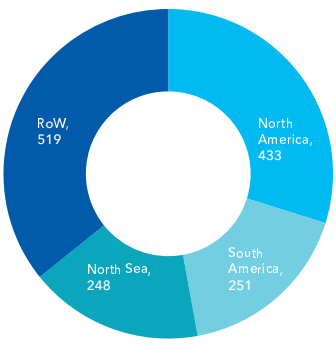
Offshore fleet by main ship types

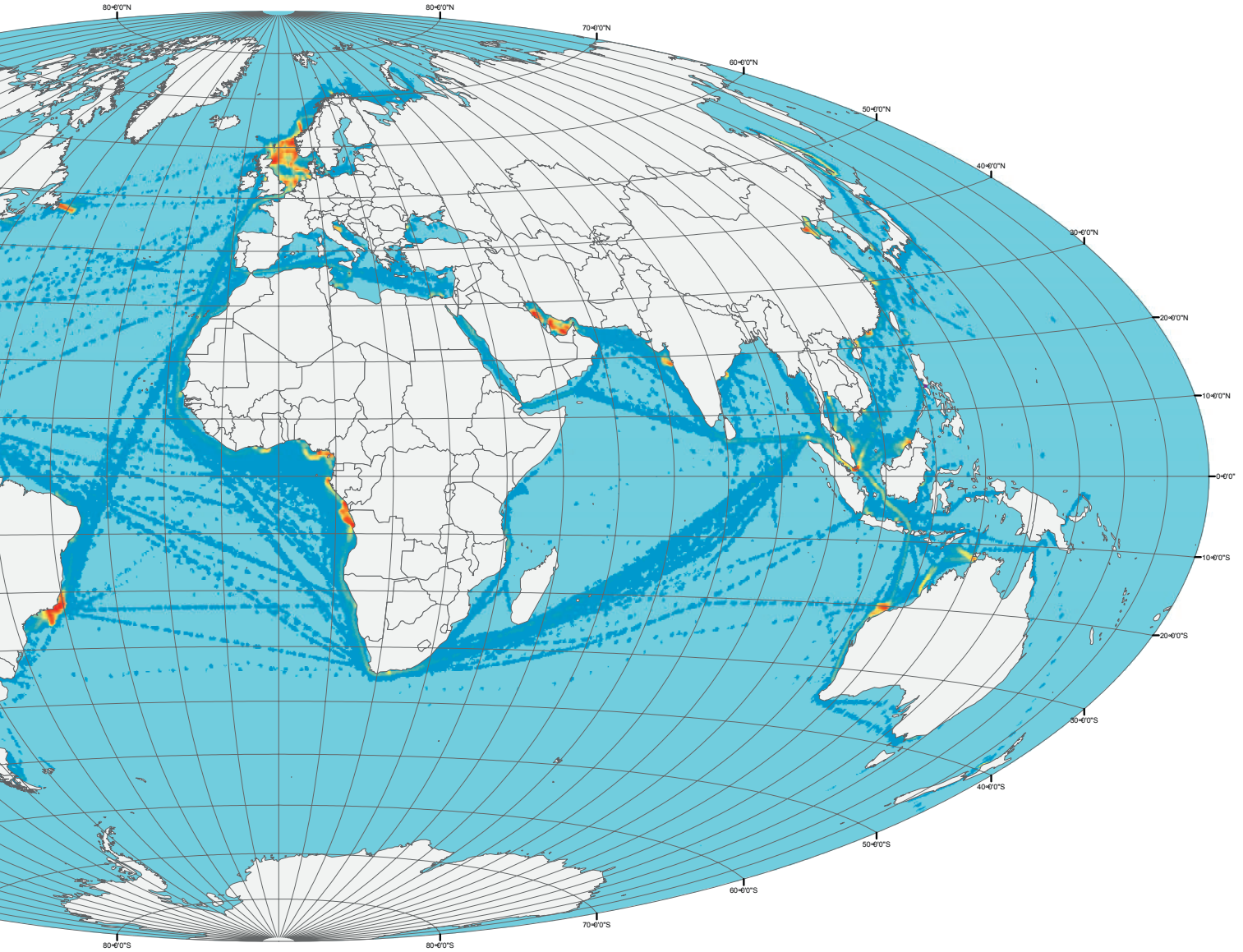


Global AHTS fleet by major locations

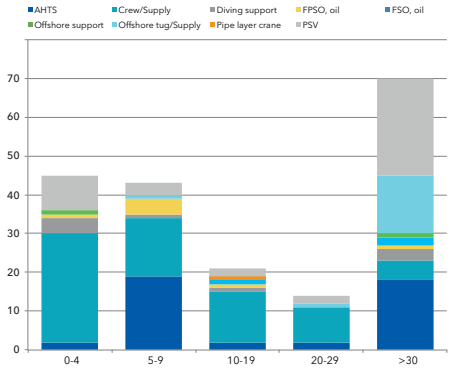


Global PSV fleet by major locations

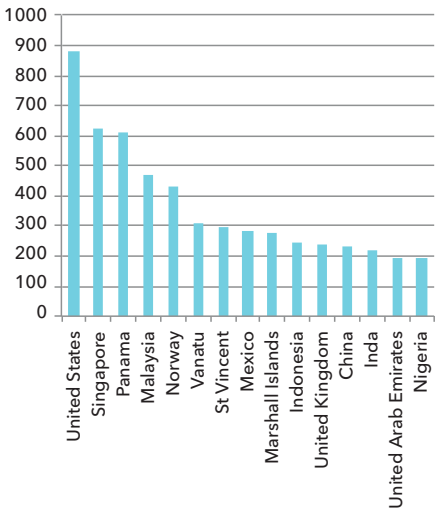




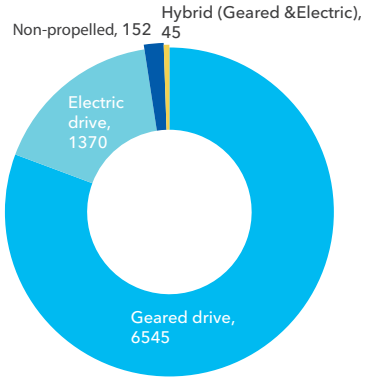
Nigerian flagged vessels by type and age distribution



Top 15 flag states number of vessels



Main propulsion systems



Text: Alexander Wardwell, Blue-C

ERS – EVERY SECOND COUNTS

While accidents at sea have declined over the past decade and shipping remains the safest form of transportation, accidents still happen. And when they do, a growing number of owners turn to DNV GL's Emergency Response Service (ERS™) to provide real-time support during the first critical hours of any crisis. DNV GL has ERS on 678 FPSOs, drilling and semi-submersibles, in addition 170 supply vessels to DNV GL class.

"The fact that the grounding had no serious environmental consequences and resulted in only minor damage to the vessel speaks to the strength of Höegh's organisation and their emergency planning and execution."

Rossen Panev, DNV GL Head of Section (ERS™)

According to Rossen Panev, acting Head of Section (ERS™), the team is trained to focus on providing owners and managers with important information and advice within first two to six hours of the first call. "We are often working against the clock, so don't waste time trying to speculate on what caused the event," he says. "Our primary goal is to assess and bring understanding over the situation as it is and support the client as best we can to avoid adverse development of the situation, to minimise potential risks to personnel, property and the environment."

Panev says that the three most common accidents at sea are groundings, collisions and fire. "For a grounded vessel, our first priority is to see if we can safely get the vessel re-floated on the next tide," he says. "To do that, we need to collect information and come up with a good plan as fast as possible. The more time a vessel spends aground in a location with great tidal differences, the greater potential for hull damage and progressive flooding. This may later on compromise vessel's strength, residual buoyancy and ability to float safely. This is why we always check "worst case" scenario and help ship owners be prepared."

Making an action plan

DNV GL has access to vessel drawings and advanced prepared readily available computerized models of all of the 3,725 vessels registered with ERS™, information that is critical to performing load, stability and strength calculations. "Different vessels types have different designs and carry different types of cargo," he explains. "By analysing vessel's damage condition we can identify critical stability and stress points and recommend cargo discharge or re-stow, ballast water or fuel transfer to increase vessel's odds to survive. In other cases, where there is extensive hull damage, the advice may be against fast re-floating, so that the vessel is prepared for safe re-floating. "

Sometimes, accidents cause more damage to a company's brand than cargo or tonnage. The fact that the grounding had no serious environmental consequences and resulted in only minor damage to the vessel speaks to the strength of Höegh's organisation and their emergency planning and execution."

Busy year

It is unlikely they will be idle for long. Last year, DNV GL's ERS™ teams in Oslo and Hamburg provided support to owners on 33 different occasions, and so far in 2015, the team has been activated on 13 occasions. On two separate cases in 2015, both groundings, the ERS™ team was able to provide advice that enabled the vessels to be re-floated by their crew without significant damage to the vessel or the environment.

For Panev and the ERS™ teams, each incident is unique but the goal is the same: providing timely support for the client. "We also seek to develop the most cost-effective solutions that can help customers avoid expensive salvage operations when possible," says Panev. "Sometimes, that means telling our clients what not to do." For example, in cases that involve on-board fires, the natural reaction is to extinguish the fire at any cost. However, dumping tons of water on a vessel, where it can get trapped in void spaces, can impact and compromise a vessel's stability.

Enhancing preparedness

DNV GL also provides Emergency Preparedness Service (EPS) developed to help clients improve emergency response plans and increase their ability to handle complex maritime emergencies, and in the last year, has launched a special ERS™ ICE module, developed for owners with vessels operating in harsh environments.

"DNV GL's purpose is to safeguard life, property and the environment, so the whole organisation is working hard toward the day when ERS™ will no longer be necessary," says Panev. "Until that day comes, we are standing by, 24/7, ready to serve." ▮

ERS: GOOD ADVICE WHEN YOU NEED IT

With over 3,700 vessels registered DNV GL's ERS™ service is the largest in the industry. The service covers the following:

- Precise and verified advice on how to improve your ship's or MOU's condition in a distressed situation, with a plan for the quickest return to operation
- 24/7 access to damage stability and residual strength experts for immediate support to vessels in distress, from the incident and until vessel is safely in repair or in operation
- Communication checks and real-case scenario exercises for effective and reliable crew training
- Evaluation of your emergency response plan against reference best practices so you can improve and gain confidence
- Compliance with relevant international regulations and requirements
- Our ERS™ is available for all ship types, offshore units and inland vessels, independent of class

Text: Eivind.Ruth@dnvgl.com

IMPROVED OFFSHORE VESSEL DESIGNS

AIDED BY EXPERT USE OF COMPUTATIONAL FLUID DYNAMICS

Computational fluid dynamics (CFD) is a cost-efficient tool to support the design of offshore vessels.

Eivind Ruth, Senior Specialist, DNV GL

New analysis and visualization tools become important when traversing the design spiral. The early implementation of such tools may create a significant competitive advantage.

"I believe the possibility to predict roll motions, especially roll damping, is a significant step forward for designers of offshore vessels," says Eivind Ruth, Senior Specialist Hydrodynamics. For the past three years, he has been leading DNV GL's participation in the 'Energy efficient and environmentally friendly offshore service vessels' (EEOSV) project. "A lot of work has been done to gain experience with tools that also solve the viscous part of hydrodynamic problems," he says.

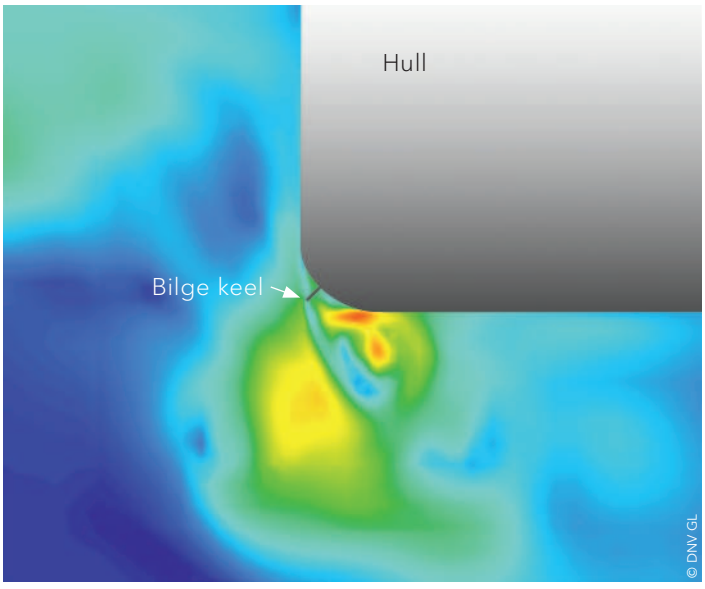
What is it that CFD may offer to the designer? In 2011, Vard Design, DOF Management, Marintek and DNV GL joined forces in the EEOSV project sponsored by the Norwegian Research Council. An important objective was to understand the potential use of viscous CFD (RANSE) in the design process, which traditionally relies on experience from previous designs, empirical methods and model tests.

Henning Borgen, Vice President Hydro Department at VARD Design, has been the EEOSV project manager. "The EEOSV project enables us, together with our technology project partners, to investigate and document a wider range of hydrodynamic performance items with RANSE CFD prior to model testing. This contributes to increased vessel performance and reduces the risk of discovering a performance deficiency at a late and costly stage of the engineering process in shipbuilding projects," he says.

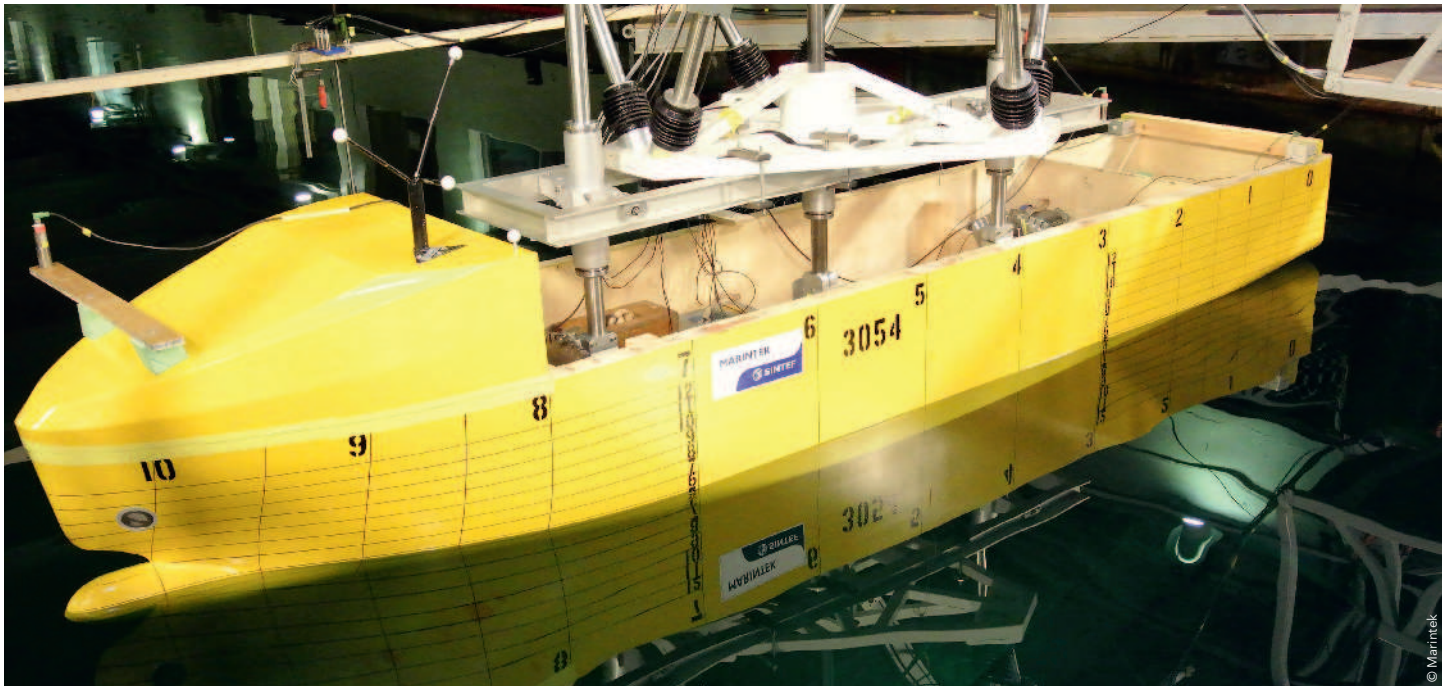
The introduction of CFD as a practical design tool is just starting

Robust commercial viscous CFD codes are available and may be run on relatively inexpensive high-performance computers. However, expert users and tailor-made work processes are required to achieve cost-efficient use. Each application benefits from specialized pre- and post-processing methods, and typically a lot of time is needed from a first attempt until a reasonably well-implemented approach is ready. Research institutes and classification societies are taking the lead in this work. They have large groups of specialists, extensive computing resources and generate revenue to cover expensive CFD licences. Another obvious reason is their aim to be at the forefront of technology in order to stay relevant for our industry. Basic and applied research as well as verification and validation services have been in focus.

"I believe the possibility to predict roll motions, especially roll damping, is a significant step forward for designers of offshore vessels."



Flow velocity magnitude around the bilge (hull cross-section).



Setup for the forced roll motion model tests.

Benefits of CFD

CFD may promise results in a shorter time and a larger set of geometries may be evaluated during an early phase. Such advanced analysis tools provide a more complete picture based on access to all flow characteristics. Visualization of large amounts of data is key. Importantly, the designer can evaluate the effect of geometry changes on, e.g., wake properties or the steady wave field within hours. CFD provides a controlled environment and full-scale properties may be simulated, e.g., it is possible to achieve both Reynolds number and Froude number similarity. More users lead to standardization and community best practices. Costs are brought down and accuracy and reliability improve.

EEOSV achievements

The project started out by comparing pure resistance simulations with model tests. During the project, this kind of analysis has matured and is now considered to be standard. Further, simulations of contra-rotating and ducted propellers have been performed. The results compare well with model tests for both open-water and self-propulsion tests.

In addition to calculations related to fuel efficiency, CFD has become highly relevant for sea-keeping analyses of offshore vessels. Custom-made experiments were performed by Marintek to validate tools for predicting roll damping and added resistance in a seaway. DNV GL carried out simulations on selected cases to validate the numerical tools. The results showed that DNV GL can add significant value in the design process by performing reliable roll and added resistance simulations, for instance to optimize the roll damping of an offshore vessel. The results have been presented in two technical papers at recognized international conferences.

"Roll damping due to viscous effects has up to now been handled empirically by our hydrodynamic software," says Eivind. "These developments allow an opportunity to determine the roll damping much more accurately by using numerical simulations. For designers, such tools are a gift box. They can make design changes and not only predict the effect on the roll damping, but also obtain significantly increased understanding of the underlying physics by looking at velocities and pressures anywhere in the fluid. For example, it was discovered that it is not the forces on the bilge keel that contributed the most to the damping, but the effect of the bilge keel on the flow around the hull. This may have an impact on the bilge and bilge keel design dimensioning."

Henning Borgen in VARD Design concludes: "The bilge keel studies and resulting CFD methodology provide a new opportunity for us as ship designers to tailor-make the roll damping system for our vessels. The physical insight into the effect bilge keels have on roll damping obtained in the project is a good foundation for improving the operability of our ships in the future."

Developments that matter

The EEOSV project has shown that CFD tools which accurately account for viscous flow effects are highly relevant for designers. Recent developments in competence, tools and computational resources at DNV GL have made it possible to assist designers in an efficient and reliable manner. In addition to predicting the properties of interest to the designer, the tools allow unique insight into the physics behind the results. ▮

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UNDERSTANDING AND CONTROLLING ROLL DAMPING

DNV GL is developing roll damping design services to aid the design shift from empirical design to case-specific and optimized solutions.

Daniel Edward Nordås, Engineer, DNV GL

Offshore service vessels are to a large extent measured and contracted on their ability to perform reliably, including in demanding weather conditions. Providing a stable platform for cargo and crane-lifting operations that expands the vessel's operational window will increase the efficiency of the maritime operations. Well-designed roll damping measures are hence of key importance to improve operational availability and thus competitiveness.

Understanding vessel operations

"Vessel motion criteria related to vessel operation are becoming increasingly important in the design process," emphasizes Margareth Urheim Gram, Naval Architect M.Sc. with the Norwegian ship designer SALT Ship Design. SALT constantly seeks to take advantage of the best available technologies in the design process.

A large number of offshore vessels have both anti-roll tanks and bilge keels to provide enough roll damping. At the same time, an oversized anti-roll tank may occupy important storage space and hamper vessel-design optimization. The dimensions and positioning of roll damping measures have up to now been based on experience, empirical formulas, simplified model tests and linearized calculation methods.

DNV GL roll package

By focusing on efficiency and simplicity, DNV GL has developed a toolbox to help designers utilize the full potential of specific designs. The toolbox comprises a range of services, applying Computational Fluid Dynamics (CFD) to provide cost-efficient and reliable input for designers and yards during the early design phase. The aim is to provide information and support for designers to make better qualified decisions during the multi-objective design optimization stage, with a particular focus on roll behaviour. The design package can replace experience-based methods and simplified model tests. The services range from damping-moment curve calculations that mimic model tests with regular roll motion to a fully coupled seakeeping and damping-force analysis where complex phenomena can be studied.

Anti-roll tank design

When designing anti-roll tanks, it has been common practice to estimate a moment curve based on general model tests of simplified geometries that only include damping grids. The moment curve is used to modify the linear ship motion characteristics and obtain Response Amplitude Operators (RAO) that account for the linearized effect of the anti-roll tank. The RAOs are required input to evaluate the operability of the vessel design.

DNV GL is able to calculate the moment curves for a specific design with a more exact reconstruction of the actual geometry, including the internal structure, compared to traditional methods. Due to the relative ease of changing the CFD geometry model, several design solutions can be evaluated.

SALT Ship Design has in cooperation with DNV GL chosen to explore the possibilities of utilizing more advanced technology. Urheim Gram explains: "CFD calculations allow us to obtain better anti-roll tank characteristics by taking into account the exact shape of the tank and the effect of the inner tank structure. We get a better picture of the damping effects for a range of periods and filling levels, and it's easy to compare several tank variations. The CFD results allow us to tune our calculation methods and hence improve the method for both the current project and future projects."

A large part of the total effort is to produce proper geometry input to the CFD model when there is a lot of complex internal structure. "DNV GL works to improve the overall efficiency of such applications by tailored pre- and post-processing," says Daniel Nordås, Hydrodynamics Engineer in DNV GL.

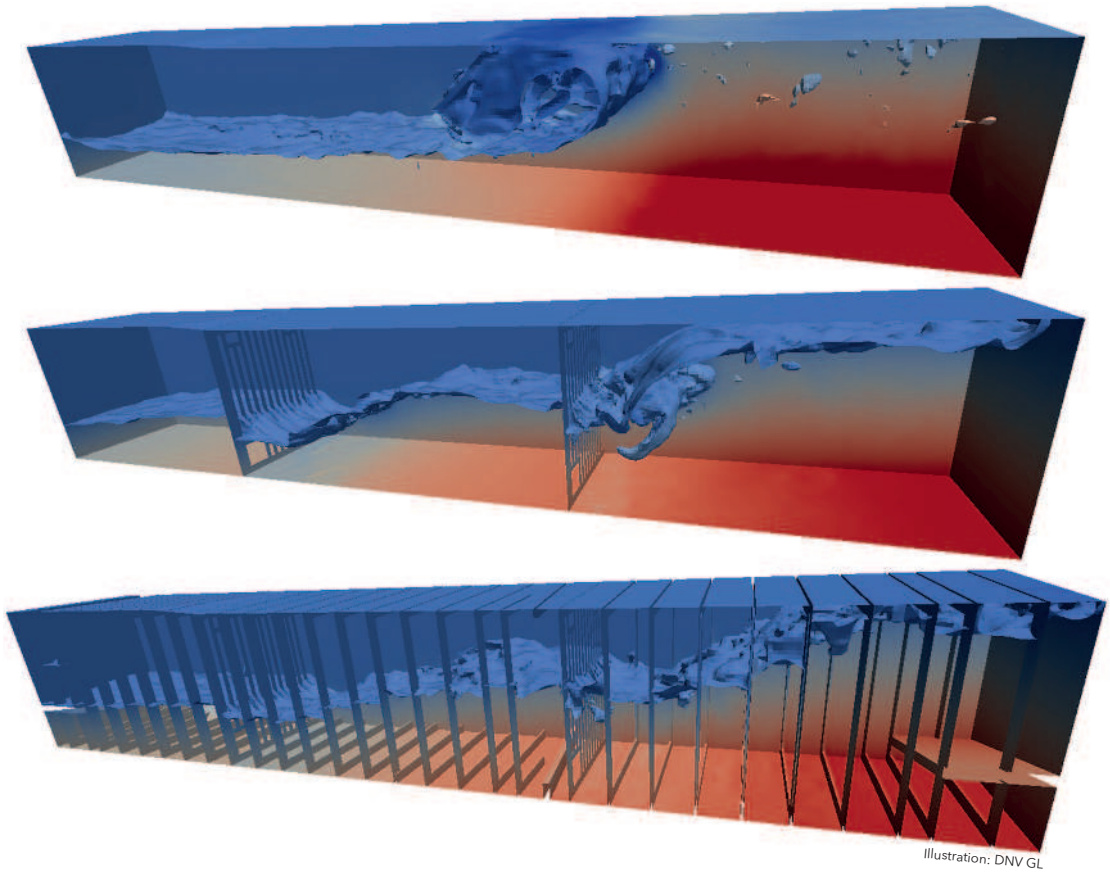

Illustration of the influence of the anti-roll tank's internal structure obtained from a visual inspection of regular prescribed motions. The bottom picture includes all major features obstructing the flow, while the top picture shows an open box.

Anti-roll tank design: Investigating more complex phenomena
DNV GL has developed tools that can prescribe regular tank motions for moment curve calculations as well as irregular motions in all 6 degrees of freedom to investigate the damping characteristics in more realistic conditions.

The traditional approach of scaling moment curves linearly by motion amplitude may be non-conservative, see Figure 1. This may lead to a ship design with a too small damping capacity in harsh weather. Figure 2 illustrates that it may take a long time to get steady-state results. In reality, the ship motions are irregular and it is unphysical to apply tank moments that take too long to stabilize. This effect may result in too conservative damping estimates.

Applying irregular prescribed motions is the next step to obtain a more accurate picture of the tank's actual damping capabilities, as important transient physical effects are not captured in regular motion tests.

Anti-roll tank design: Taking it one step further
The final development goal of a computer aided design process concerning the damping effect of an anti-roll tank is to be able to

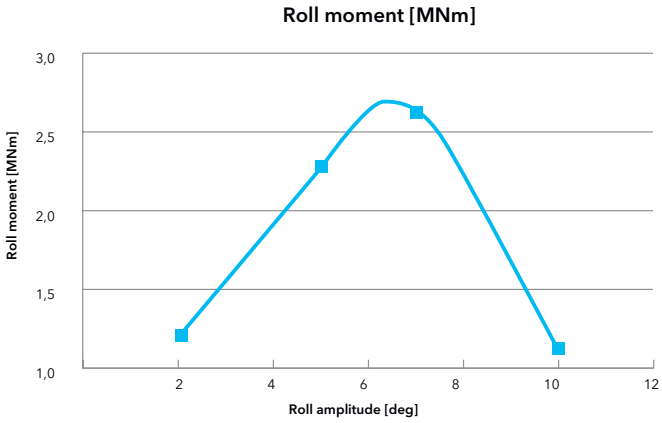

Figure 1: The line shows the absolute steady-state moment amplitude for a given roll amplitude. The plot shows how the absolute moment in this case does not increase with an increase in roll motion, as assumed by the concept of using one damping moment curve for all roll angles.

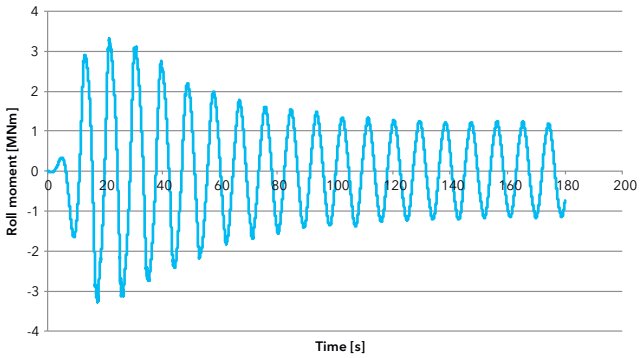

Figure 2: The roll moment develops over several periods for a roll amplitude of 10 degrees. The steady-state moment amplitude is in this case significantly lower than the initial moment due to transient effects in the first phase. The first period is subject to ramping of the roll motion.

couple the seakeeping analysis with an exact force model. This model should be the same CFD model used to calculate the moment curves. DNV GL has developed a time-domain, nonlinear sea-keeping tool that can be coupled with CFD to achieve this.

By coupling the tools in a time-domain analysis, it is possible to capture the actual non-linear interaction between the anti-roll tank and the vessel motion response in irregular waves. This improves the accuracy of the seakeeping and operability analysis, and provides a unique tool for final verification of the vessel roll motion.

Bilge radius and bilge keel dimensioning

Besides anti-roll tanks, the other traditional way to increase roll damping, bilge keels, have been designed in the same way based on empirical methods and "rule of thumb" approaches.

Drawing on experience from projects like the "Energy Efficient and environmentally friendly Offshore Service Vessels' (EEOSV) project" on page 22, DNV GL has developed a methodology to investigate the design of bilge keels in more detail.

DNV GL provides studies, based on viscous CFD in both 2D and 3D, on the relationship between the bilge radius, bilge keel size and length, answering questions such as: is it possible to reduce the bilge radius and by doing so increase the hull volume and at the same time increase damping from the bilge keels?

Bilge keels also represent additional hull resistance. DNV GL has experience in optimizing the position of the bilge keel along the hull to minimize the added resistance. This replaces the traditional paint test, which gives indications based on streamlines in one condition. Using CFD, it is possible to assess the impact over an operating profile, ensuring efficiency for a wider range of operations.

Creating a toolbox for the future, utilizing design margins

As it is not limited by empirical methods, DNV GL's new toolbox now makes it possible to perform more iterations in the design loop and reach better supported decisions along the way.

Margareth Urheim Gram foresees that the importance of CFD in ship design will increase. "To be able to do more advanced simulations where the effects of bilge keels, anti-roll tanks, etc, are taken into account will allow more vessel motion optimization. Optimization through CFD calculations at an early stage in the design process gives design advantages due to opportunities to make large design changes with little cost and risk," she concludes. ▮

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SETTING THE STANDARD FOR DYNAMIC POSITIONING

DNV GL has a long history and commitment relating to DP and heads a joint industry project called the DP Capability Assessment (DP-CAP) Project. There are some 1,400 vessels with DP capability to DNV GL class and as such DNV GL has the experience and competence required to take the lead in developing a common global standard by working with many internal and external stakeholders, ranging from oil majors to ship owners and charterers. A key person in developing the new DP-CAP has been DNV GL expert Aleks Karlsen, who was awarded the Distinguished Achievement Award 2014 by the Marine Technology Society.

"The industry has been lacking a DP standard that provides uniform information on DP capability, and we are now working closely with the rather new DNV GL company Marine Cybernetics to make the standard available and also to assess each individual ship. But this is the end result of a long process in terms of studies and tests," says Karlsen. "The standard's objective has been to supply the industry with a uniform calculation of positioning capacity. This will be a valuable tool for input to the design, operational planning and risk management of DP operations. The standard will be available in the second half 2016."

The key question in the project has been: "Why is there a need to assess DP capability?" Three different parameters – operations, safety and design - have been the key parts of the project. The project's operations parameter has included two key questions: firstly, does the vessel have the capacity required for the type of operations? Secondly: charterer requirements and specifications as well as need to compare vessels in order to make chartering decisions. The stakeholders here include operators and charterers as well as ship owners.

The project's second parameter addresses the safety issues. Does a vessel have enough capacity to operate in the prevailing environmental conditions? What are the margins? And is there enough capacity to prevent a drift-off in the case of equipment failure? The stakeholders here include the navigation officer, ship owner, operator/charterer, insurance companies and authorities.

The third parameter has focused on design: what kind of vessel design and equipment are needed to meet charterer requirements? The stakeholders here include the ship builder, designer, owner and equipment suppliers.

"All in all, a truly multidisciplinary project which has included Statoil, BP, Damen, Seadrill, Wärtsilä, Technip, VARD, Marine Cybernetics, Ulstein, Rolls-Royce, Havyard, MERWEDE, Farstad and Kongsberg in addition to DNV GL," says Karlsen. The DP-CAP project has aimed to establish a common standard that results in a common playing field and has been divided into two phases. In 2014, the objective was to "Create a basis for a new industry standard for position-keeping capability assessment". Phase two in 2015 is to: "Create a DNV GL Recommended Practice for DP position-keeping assessment". ▮

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DNV GL BATTERY RULES

DNV GL has class rules for battery-driven vessels and large lithium-battery systems.

The new DNV GL Rules for Dynamic Positioning (DP) systems stipulate requirements for the use of batteries as a power source.

Sverre Eriksen, Principal Engineer, DNV GL

The class rules cover the use of batteries as part of a vessel's propulsion energy in either hybrid battery solutions or "pure" battery-driven vessels. The rules have been official since 1 January 2012. A new revision of the rules will be published in 2015.

Battery safety
The battery rules cover battery-installation safety requirements relating to the vessel's arrangement and environmental controls, including of temperature and ventilation.

To prevent thermal incidents in battery spaces, the rules stipulate requirements as to fire integrity, detection and extinguishing measures. The whole battery installation must be covered by a safety assessment that takes into account internal failures, ie, failures in the batteries, and external failures, like fires and flooding.

Battery power
When the battery is used as a main source of power (propulsion power), the redundancy requirements for "ordinary" ships apply. The rules stipulate the required location of the battery systems and associated electrical systems. An energy management system (EMS) must be installed and control the available energy and state of health (SOH). In addition, the battery's energy-supply time or range must be calculated and taken into account in the planned operation/voyage.

Battery certification
The batteries on a classed vessel must be certified. The certification requirements are stated in the Battery Power class rules. These rules cover the requirements relating to battery safety, the Battery Management System (BMS), the environment and tests.

In addition, DNV GL offers a type-approval service for battery systems. This type approval will on a generic level verify that the battery system fulfils the DNV GL class rules' requirements, including those relating to applicable type tests (safety and environmental tests). The type approval does not replace the "case-by-case" certification, but will limit the scope of this.

Batteries and the Dynamic Positioning rules
Yes you can use batteries in DP operations.

The new DNV GL Rules for Dynamic Positioning (DP) systems stipulate requirements for the use of batteries as a power source.

The batteries will represent a time-dependent source due to their limited stored energy. DP operations using batteries as one of the redundant sources are limited to operations that can be terminated within the timeframe represented by the batteries' available capacity.

The battery with its battery management system (BMS) and energy management systems (EMS) must be so arranged that the actual available energy can be determined and communicated to the DP control system.

The DP control system (consequence analysis) is to consider the average power and thrust consumption.

The calculations of available energy (and then backup time) are to be based on the prevailing weather conditions and experienced operating pattern, for example the mean net power consumption during the relevant timeframe of the actual operation.

Any uncertainty in the accuracy of the state of charge (SOC) and state of health (SOH) must be accounted for by the use of "conservative" time estimates. In addition, it should be evaluated at which level of charge the battery should be considered to be empty.

It must also be considered if the termination process will result in additional power consumption. In such cases, this additional consumption needs be taken into account as well.

A DP vessel that uses batteries as one of its redundant power sources must comply with the Rules for Battery Power and have the class notation BATTERY POWER.

Battery installations on DP vessels that are not used as an energy source, but only used for peak shaving, handling dynamic responses in the power system, etc, may not have to comply with these "battery DP" requirements. ▮

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MANAGING VESSEL LAY-UP

The industry is currently seeing another wave of lay-ups following the one in 2009. Many rigs and offshore vessels are either being laid up or entering lay-up due to the decreasing oil price.

Richard Tao, Disapline leader, Technical Operation Ship Lifecycle Management, DNV GL

For rigs, the term used for lay-up is "stacking". "Cold stacking" means the complete stopped operation of a rig and its machinery and reduced manning. "Warm stacking" refers to temporarily taking a rig off the market. During "warm stacking", rigs still maintain basic operations and are mostly crewed.

The main reason for a lay-up is always to cut costs. In the current market situation in the offshore oil and gas industry, cost savings are a major concern of offshore asset owners and the lay-up of assets is playing an increasingly weighty role. The global offshore rig utilization statistics, updated by Rigzone on 19 August 2015, show a clear decline from 72.8% to 57.6% during the past one-year period.

	2014.08	2015.02	2015.07	2015.08
Rig Working	658	605	536	522
Total Rigs	904	906	903	906
Utilization	72.8%	66.8%	59.4%	57.6%

Risks during vessel lay-up

Whether or not to lay up a vessel or stack a rig in order to reduce costs is a serious decision for the owner to make. It is essential for the vessel owner and other stakeholders to be aware of the relevant risks involved and have a plan to control these risks.

A laid-up vessel will in general be subject to less risk than while it is in operation. However, certain risks will remain or might be even higher. The statistics of a major H&M insurer show that the following risk scenarios may arise during lay-up:

- Suitable lay-up sites are usually limited and often close to a major port area or yard facilities. There is a high risk of the laid-up vessel being struck by another vessel. Even if the laid-up vessel is not to blame, the possibility of the other vessel having limited liability may result in significant unrecoverable costs.
- Laid-up vessels often have their machinery systems shut down and crew removed. If the mooring system fails, the vessel cannot manoeuvre and the risk of colliding with other vessels is high. In addition, anchor dragging is the most frequent cause of grounding, and having ships anchored close to the shoreline increases this risk.
- Low security. Limited manning on board a laid-up vessel or only security guards for vessels in cold lay-up will lead to a risk if situations occur and they are not familiar with the ship and face problems finding their way around the vessel or operating the equipment on board.
- Cumulative damage. Many vessels are laid up in blocks, so that a fire on board one ship can spread to other ships moored to each other.
- Flooding. A laid-up vessel's seawater system is often left open to dry off for preservation purposes, and this increases the risk of flooding if the sea direct valves are not properly secured.

Preservation is also a very important issue. Rigs and OSVs are expensive assets with a lot of important equipment which is vulnerable to environmental conditions. Shortcuts in lay-up preservation will have adverse effects on the value of the asset as well as on the reactivation time and cost.

The following challenges are often experienced during vessel reactivation:

- The HFO in a tank turns solid after months of being laid up.
- Water build-up in the combustion chamber during the lay-up period causes hydraulic locking when the engine is restarted.
- Failures due to equipment deterioration in general. The atmosphere and especially the humidity may not have been monitored during lay-up, resulting in corrosion and deterioration.
- Failures due to corrosion inside piping systems and valves (hydraulic, pneumatic systems).

- Heavy machinery components sit statically in the same position or are turned with insufficient lubrication film.
- Starting-up problems with malfunctioning regulators and control equipment.
- Failures because components have not been cleaned or opened up after months of being out of operation.
- Electronic equipment start-up failures after months without power.

DNV GL's solutions

DNV GL released the guideline "Lay-Up of Vessels" on 1 April 2009 and updated it in March 2012. The Guideline provides a systematic and cost-effective approach to preparing a vessel for lay-up and maintaining it in a safe and cost-effective condition during lay-up.

An overview of relevant lay-up considerations, such as a 'hot' or 'cold' lay-up, the lay-up site, lay-up period, recommissioning time, class, insurance and flag requirements, is given as a means for the ship owner to make the best possible choices considering the unpleasant alternatives. Practical procedures for recommissioning the vessel are also stated.

Since 2009, DNV GL has been providing advisory services to help owners lay up their vessels in a safe and cost-efficient way. These services range from advice on the lay-up site, mooring arrangement and lay-up plans to advice on lay-up, declarations, safe lay-up, preservation during lay-up and managing project risk during recommissioning. ▮

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VIKING LADY REAL-LIFE SHIP PERFORMANCE

The *Viking Lady* is an offshore supply vessel (OSV) in daily operation in the North Sea and a full-scale real-life "test laboratory": LNG-fuelled with battery-hybrid propulsion. The onward focus is on extensive monitoring of real-life operational conditions and performance to optimise operations and prove reliability and safety.

Figure 1. *The Viking Lady* OSV: the first full-scale hybrid-electric vessel.

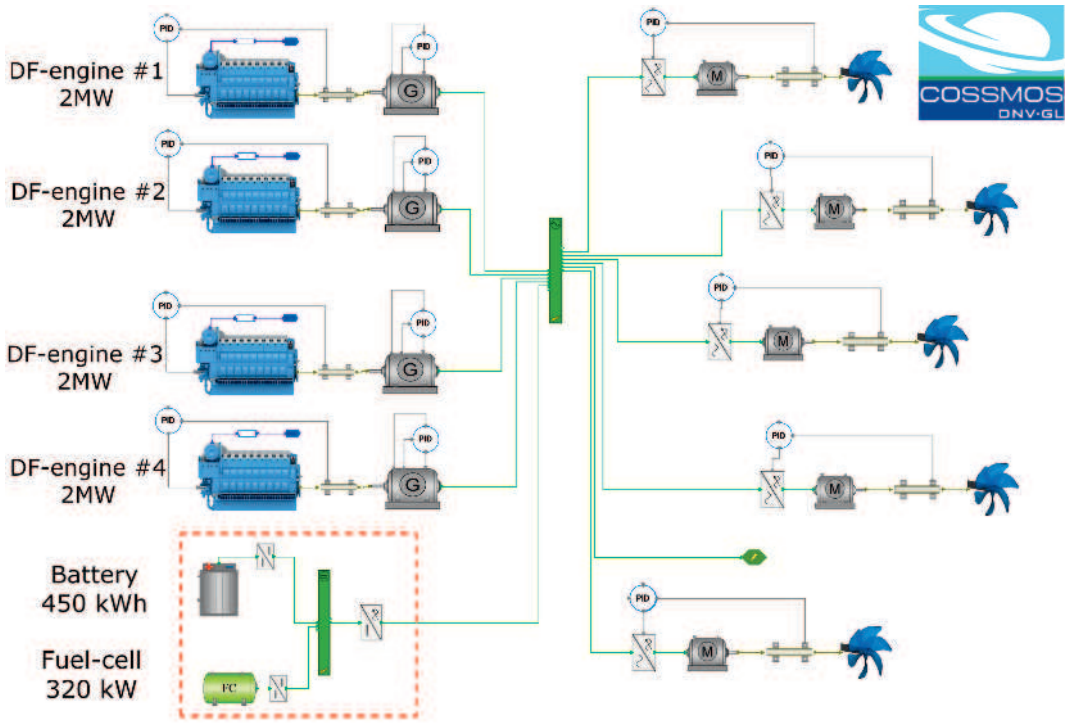

Figure 2. COSSMOS model of the battery-hybrid propulsion system on board the Viking Lady. The battery acts as an energy buffer covering the intense demands that occur especially during DP and standby operations.

Nikolaos Kakalis, Manager, DNV GL Maritime Reseach & Development, Greece

Recent developments in ship electrification have made ship machinery hybridization and smart power management possible, leading to more efficient use of energy on board. High-power and high-energy density batteries are suitable for full or hybrid electric propulsion, paving the way for near-zero emission shipping. Battery technologies like Lithium-Ion (Li-ion) exhibit efficiencies of up to 98% at a currently estimated cost of about 600 USD/kWh.

The Viking Lady is the first merchant ship to be powered by a battery-hybrid propulsion plant. She is a 92-metre-long DNV GL-classed offshore supply vessel owned by Eidesvik Offshore ASA and operates daily in the North Sea, Figure 1. Built in 2009 with dual-fuel engines and conventional diesel-electric propulsion, her energy system was gradually hybridized with full-scale energy conversion and storage technologies within the FellowSHIP series of research and development projects.

The first phase of the FellowSHIP project (2003) was dedicated to investigating the feasibility of onboard Fuel Cell (FC) technologies, and resulted in the development of the first classification rules for maritime FCs. During the second phase, a 320kW Molten Carbonate Fuel Cell (MCFC) was fitted on board the Viking Lady for supply of auxiliary power. In the third FellowSHIP phase, a 450kWh capacity Li-ion battery was added to the power train, converting the vessel to a battery hybrid-electric propulsion one. FellowSHIP III was coordinated by DNV GL, with shipping company Eidesvik Offshore ASA and manufacturer Wärtsilä as project partners. The project was co-funded by the Research Council of Norway.

DNV GL's in-house modelling and simulation platform COSSMOS (COmplex Ship Systems MOdelling and Simulation) played a key role in the project. It was instrumental in performing early-stage feasibility and performance analyses of the integrated hybrid system. Advanced COSSMOS simulations identify the optimal power management strategies to maximise the energy gains while ensuring the vessel's safety and operational capabilities. Figure 2 shows the COSSMOS model of the Viking Lady's hybrid-propulsion plant. As the gen-sets provide the lower base loads, the integrated system consumes less energy and has increased redundancy, making operations safer and more efficient. Other benefits are lower levels of noise and vibration.

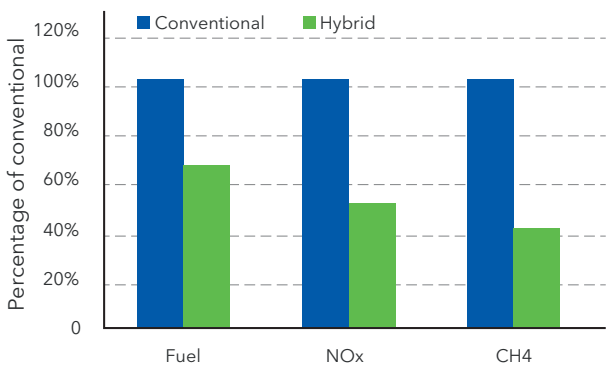

Figure 3. Sea trials: hybrid system performance in DP mode during calm weather.

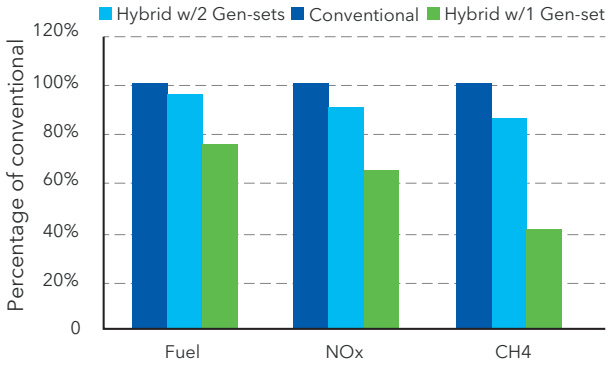

Figure 4. Sea trials: Hybrid system performance in DP mode during bad weather.

The battery-hybrid installation was tested in sea trials in 2014. The fuel cell stack was not operated. Figures 3 and 4 summarize the sea trial results for DP in good and bad weather, respectively. The hybrid operation is compared to the conventional one (only gen-sets). In both figures, the green columns (hybrid) show the benefit of switching off one gen-set while operating on batteries. In hybrid operation, significant fuel savings and emissions reductions are achieved by the combination of appropriate battery sizing and optimal power-management strategies. An annualised projection of the results for all of the vessel's operational modes (transit, DP, standby, harbour) show that a 15% reduction in fuel consumption, 25% reduction in NOx emissions and 30% reduction in GHG emissions can be realised in practice, with marked improvements in DP operations in particular.

DNV GL has developed classification rules to ensure the safe installation and operation of large battery power packs on ships. The rules have been official since 2012, covering all of the significant aspects of using battery packs in a maritime context, from design through to installation and verification. A new revision of the rules will be published in 2015.

Driven by such research and development, the number of ship-electrification projects for small and large vessels are increasing, while a variety of DNV GL decision-support tools and services are becoming available, including the DNV GL Rules for Battery Power, the DNV GL Guideline for Large Maritime Battery Systems and the Battery Ready Service1.

DNV GL invests 5% of its revenue in research and innovation every year; investments leading to technology development and better services. DNV GL has invested over USD 2.5 million in the FellowSHIP series of projects to improve the safety and sustainability of our industry in practice.

Ongoing activities

During the next two years, DNV GL will continue this work in the fourth phase of FellowSHIP. The main focus will be on the extensive monitoring of real-life operational conditions and performance – in particular those of the battery pack, in order to prove reliability, safety and operational benefits. The Viking Lady's existing sensor network will be extended and ship motions due to wind, waves and currents will be measured. The focus will also be on improving further operations and the control strategy for the hybrid-energy and propulsion systems. The advanced control system that makes use of our advanced COSSMOS model-based methods for the power system combined with hydrodynamic model predictions are key enablers for such an efficient power-production system. Demonstrating this kind of control will be a breakthrough in efficient vessel operations. ▮

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MARITIME

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