DNV·GL

FERRY AND RO-RO UPDATE

No **01 2015**

Åland

Færgen

Fire safety

CONTENT

Masts from the *Pommern* museum ship at the port of Mariehamn.

DEAR READER,

Hans-Eivind Siewers
Segment Director
Passenger Ships and RoRo
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We see strong signs that the newbuilding market is recovering. Fuel efficiency and low emissions will be high on the agenda for new designs and we already have strict SOx restrictions in the SECAs. However, as early as in 2020, we will also see the EU enforce a stricter maximum sulphur content limit of 0.5% for passenger ships outside SECAs. For newbuilding contracts placed after 1 September 2015, a required EEDI (Energy Efficiency Design Index) value must also be taken into consideration for all newbuilds. It will be highly interesting to see the choice of design, technology and fuel for future vessels.

Fires on ro-ro decks have attracted a lot of attention in our industry during the past few years. The Nordic Association of Marine Insurers (Cefor) claims the only exceptions to the overall continuous positive reduction in claims frequency are fires on car, passenger and ro-ro vessels. We have to take this seriously. It is extremely important that the real reasons for these fires are discovered and shared. Unfortunately, such investigations tend to drag out. In the meantime, it is important that we work together, share best practices and continuously focus on how to best prevent accidents and mishaps such as fires.

We have also attended the Åland Maritime Day. It is impressive to see how this has developed into an extremely exciting event with a good mix of industry leaders, ship owners, suppliers, students, etc. Åland is truly an example of a complete cluster covering most aspects of shipping.

Enjoy the read!

FERRY AND RO-RO UPDATE

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MARITIME DAY ATTRACTS INTERNATIONAL VISITORS TO ÅLAND

"Åland is not just one island but a total of 6,757. Some 29,000 people call the Åland islands their home and these homes are spread over 60 of the islands," says Linnéa Johansson, Permanent Secretary at Åland's Ministry of Trade and Industry in the capital city of Mariehamn. Åland is a self-governing, demilitarized region. As the official language, Swedish is spoken by almost all the inhabitants and is on all official signs – but Åland belongs to Finland and the official currency is the European euro, not the Swedish krone. Both Finland and Sweden as well as Åland are members of the EU, but Åland has a permanent derogation from indirect tax regulation which benefits Åland. "Shipping is very important to Åland and is by far the cornerstone of our economy, accounting for about one-fifth of our revenues," explains Johansson, "and our tax arrangements are very important to us."

Linnéa Johansson, Permanent Secretary at Åland's Ministry of Trade and Industry

In order to explain why and how Åland has a special status, we need to go back in European history and especially look at Åland's strategic position in the middle of the Baltic Sea, at the crossroads between West European and East European influence. In short: First there was the Great Northern War (1713 – 1721) which caused most of the population to flee to Sweden for some eight years. Then there was the second war from 1808 to 1809 that ended in Sweden surrendering Åland and Finland to Russia. The Bomarsund Fortress was built by the Russians, and a huge customs house (still standing) was built at Eckerö harbour, the closest point to Sweden. Then came the Crimean War of 1853 to 1856, when Britain and France took sides with Turkey against Russia and the Russian forces at Bomarsund surrendered in 1854. Åland was declared a demilitarized zone – and it still is today. After World War I, Ålanders discussed joining their motherland of Sweden again, but then Finland declared independence in 1917. A referendum was held in Åland and of course the result was in favour of joining Sweden. Finland took the matter to the League of Nations in 1921, and the ruling there was that Åland should belong to Finland – and it still does. Åland was granted many exemptions and has the status of an autonomous, demilitarized and neutral province within the Republic of Finland. These exemptions include the duty-free tax laws, allowing the essential ferry services between Finland and Sweden to have a "duty free" stop at Mariehamn, Åland – the grand total here is 8,000 ship arrivals/departures, some two million passengers and 400,000 hotel nights a year.

"The Åland Parliament can decide on all domestic island matters such as health care, the postal system, trade & industry and education, whereas the Finnish government is responsible for foreign affairs, state taxes, the court system, customs and the church," explains Johansson. "We educate many seafarers here at Åland to become masters and other ship officers as well as running the hotel operations for cruise operators. We have ship owners that are into most aspects of seaborne trade and we also have a strong shipping supplier industry. In addition, we have international insurance companies. So we have a complete maritime cluster that we are proud of. The Åland Maritime Day has found its form as a global event and meeting place and we are happy to attract attention to Åland for a few days a year," says Johansson. "Topics for discussion attract

Silja Line heading for a "duty-free" stop at Mariehamn on its way from Sweden to Finland.

visitors from the entire Baltic region as there are many topics of mutual interest, such as safety, the environment, operations, education and recruitment as well as more political issues with regard to the EU and all the countries around the Baltic. We're pleased to be strongly involved in facilitating the Maritime Day and also about the support, not only in financial terms but also regarding the contents of the day, that we get from DNV GL."

DNV GL is one of the main sponsors of Åland Maritime Day, and we ask Helsinki-based DNV GL Area Manager Freddy Friberg why this is the case and what Åland means both now and in a historical perspective:

"I'm happy to say that DNV GL is one of the main organizers of the Åland Maritime Day. This is a truly exciting annual event for the shipping community. It attracts a good mix of industry leaders, ship owners and suppliers, not to mention students etc. This is a good opportunity to make an impact by promoting our purpose of safeguarding life, property and environment and sharing our passion to help our customers and society become safer, smarter and greener. So how do we do this in practical terms. We spend half of the day giving insight to our customers and society at large, with a mix of operational and technological foresights. So far, this has been highly appreciated and of course there is extensive planning beforehand, in which we ask the industry to suggest relevant topics.

"Åland is an important player in the Baltic trade and its unique position is due to its tax status. We have been represented in Åland since we opened our first office in Finland in 1957 and are proud to be a part of the Åland shipping cluster. This is also why we strongly support the Åland Maritime Day every year - in terms of conference contents, as a speaker and financially," concludes Freddy Friberg. ▮

Text: Magne. A.Roe@dnvgl.com

RECRUITING GODBY STYLE:

WE WANT YOU!

"Åland's Maritime Day started as a recruiting event," explains Eva Mikkola-Karlström. She is the Deputy Managing Director of Godby Shipping Ab, where her brother Dan Mikkola is the managing director. Actually you 'meet' him first when you enter the office building in Mariehamn, Åland in the form of a poster by the door with a US-inspired Åland version of the US picture of 'Uncle Sam' recruiting for the US military and pointing the finger at you: I want you. Mikkola says: I want you for our fleet – for Godby Shipping that is a fleet of seven ships, all to DNV GL class. The first Maritime Day was in 2001 and Eva Mikkola-Karlström has been the driving force behind the one-day event since the start.

Eva Mikkola-Karlström, Deputy Managing Director of Godby Shipping Ab

"This year was the best ever," continues Mikkola-Karlström. "The Maritime Day attracted some 1,500 visitors and we had 60 exhibitors. To me, the most important factor in addition to the programme is the excellent opportunity to mingle and discuss. The event is big enough to attract high-quality participants yet still small enough to find the people you want, and we still use the event for recruiting. There is also a dinner in the evening and this is always very popular. It is a day for business discussions and the feedback from all participants is very positive."

Godby Shipping Ab was established in 1973 and its aim is to have a modern fleet of ships tailored to the needs of not only Sweden's and Finland's forest industries, but also liner operators. The family-owned company started with second-hand ships and, over the following years, gradually modernized its fleet with newbuildings. Its newest ships are the Misana and Misida, built in 2007, which operate for Finnlines in North Europe. Then we have Miranda, built in 1999 and on charter to Italian Grand Navi Veloci operating between Genoa and Palermo. Its sister ship Mistral (also built in 1999) is chartered to P&O Ferries operating between the UK and Belgium. Then we have 1990-built Midas and Mimer on charter to CMA CGM and US-based Marinex Cargo Line for use in the Caribbean. Finally, we have the Link Star built in 1989 and chartered to Nor Lines, trading between Poland, Finland, Denmark and Norway. All the ships sail under the Finnish flag and have many crew members from Åland and Finland.

The company's slogan '40 Years of Quality Shipping' gives a good description of Godby Shipping's commitment towards its crew and customers and the environment. With this commitment to quality and safety and high focus on environmental goals, the company and its vessels have been chosen as 'The Safest Working Place of the Year' by Alandia Insurance several times over the past few years. ▮

"I want you for our fleet – for Godby Shipping that is a fleet of seven ships, all to DNV GL class."

Eva Mikkola-Karlström, Deputy Managing Director of Godby Shipping Ab

Text: Magne. A.Roe@dnvgl.com

ÅLAND MARITIME DAY – A KEY DAY FOR ALANDIA TOO

Alandia Insurance was founded in 1938 and is today a pan-Nordic insurance provider – with marine insurance being the most important segment for this Åland- and Mariehamn-based company. In total, Alandia insures some 3,200 ships, and also recently a fair number of Norwegian fishing boats – 850 ships - are insured by Alandia, bringing the grand total up to more than 4,000 vessels, typically with hull- and machinery and P&I coverage. In addition, Alandia offers cargo insurance as well as yacht and pleasure-boat coverage and this has been a strong growth area for the company over the past few years. As a key player in shipping, the Åland Maritime Day has become increasingly important to Alandia too. The company also runs individual programmes and some of its customers have dubbed the day "the Alandia Day".

"We used to have our separate seminar and customer event, but we 'merged' with the Åland Maritime Day in 2003 and it has been a joint event ever since," says Lars Janlöv, Loss Prevention Manager at Alandia. He is joined by Jan Limnell, Director of Marine Insurance. "The event has become more and more international, and in 2009 we switched the conference language from Swedish to English in order to cater to all our customers. To us, Åland Maritime Day has emerged as "The Day" when it comes to focusing on matters that are important to us: loss prevention. Here we have very good cooperation from DNV GL on matters of common interest. But almost just as important is, of course, the possibility to mingle with the shipping cluster," says Limnell.

Jan Limnell, Director of Marine Insurance and Lars Janlöv, Loss Prevention Manager at Alandia

"In order to make our event a contributing part to the Maritime Day, we spend considerable time creating an interesting programme for the participants. Most of the participants are ship owners, surveyors, maritime lawyers and broking firms and we hope to attract even more ship owners now that this event has become better known," says Janlöv. "Eva (Mikkola-Karlström, Godby Shipping Ab) makes efforts to find more participants who work with shipping on a day-to-day basis, and often with the more practical tasks such as daily operations, crewing and so on. So all in all this event has grown in importance to us.

"We're quite ambitious when it comes to growth but are keen on doing so without jeopardizing bottom line," continues Limnell. "From that point of view we are constantly focusing on the topic of loss prevention, and work through many channels to ensure that we can raise awareness of operating ships safely. But a more practical focus is also important to us, and what can be more practical than for example a seminar on hatch cover maintenance? Hatch covers are and always will be an area of concern and many cargo damage claims are due to a leaky or malfunctioning hatch cover."

"We have a history, we know the market, we have a strong and thriving shipping cluster here at Åland and the Maritime Day will continue to put Åland on the international shipping map," concludes Janlöv.

"From our point of view, Alandia is proactively trying to avoid shipping accidents and mishaps. I strongly welcome Alandia's efforts in this area and working together with maritime specialists is also rewarding for us. I believe that, in order to achieve our ambition of reducing fatalities by 90% below present levels, we need to work close with the industry. Achieving this target will require a new safety mind-set and continuous focus on multiple issues related to technology and how organizations are structured and functions," comments DNV GL Area Manager Freddy Friberg. ▮

"We have a history, we know the market, we have a strong and thriving shipping cluster here at Åland and the Maritime Day will continue to put Åland on the international shipping map."

Lars Janlöv, Loss Prevention Manager at Alandia

DNV GL-classed *Rosella* departing Mariehamn for the short three hour crossing to Kappelskär just north of Stockholm, Sweden.

Text: Magne.A.Roe@dnvgl.com

FERRIES CONNECT DENMARK

With an overall length of 113 metres, *Leonora Christina* is the largest high-speed car and passenger ferry constructed by Austal Shipyard in Australia. It was delivered in 2011 and built to DNV GL class. The ferry is named after Danish princess Leonora Christina, who was born 1621 and was a daughter of King Christian IV of Denmark. *Leonora Christina* connects the Swedish city of Ystad with Rønne on the island of Bornholm in the Baltic Sea. It belongs to Danske Færger (Danish Ferries) and is one of 12 ferries operated by the company known in Denmark as Færgen (The Ferry). "Last year, 4.4 million people travelled on our ferries, which link several towns in Denmark and also sail to Sweden and Germany," says John Steen-Mikkelsen, CEO of Danish Ferries and in addition the chairman of the Danish Car Ferry Association and current President of Interferry.

Færgen

"We operate seven different routes and had a total of 57,500 departures last year. Færgen employs 570 persons, mostly ship crew. The company has been transporting people by sea since 1866. Denmark consists of many peninsulas and islands, so ferries are important to our infrastructure. Although more bridges are being built, we still find that ferries are very competitive, even on stretches close to bridges. We just won a new ten-year contract for one of the connections we serve - to Samsø. Contracts are awarded by the Danish Ministry of Transport based on a bidding process. For our planning purposes, we are quite happy to see that the government has extended the contracts from six to ten years," says Steen-Mikkelsen.

John Steen-Mikkelsen has a lifelong commitment to the ferry industry, having also worked for Scandlines in different jobs - most recently as COO and Managing Director of the Group. Prior to that, he worked for the Danish State Railroads, operating the Danish ferry connection from Rødby to Puttgarden, and before that again he held management positions with Lion Ferries, a Stena subsidiary operating ferries between Sweden and Denmark.

John Steen-Mikkelsen, CEO of Danish Ferries, Chairman of the Danish Car Ferry Association and current President of Interferry.

Færgen has undergone a turnaround operation over the past few years, and has now produced positive results for the last two years. "Our traffic is growing by three to four per cent on an annual basis," continues Steen-Mikkelsen, "and we work closely with the different destinations and cities we serve to develop these as tourist destinations. This approach has proved to be very successful. We operate a number of ferries tailor-made for the routes – for instance Esbjerg to Fanø, a short route with 29,000 departures annually. We have a crew of mostly Danish nationals, among other things to satisfy the Danish authorities' requirements as to safety and emergency procedures. Consequently, the safety language is Danish."

In order to comply with the environmental regulations, Færgen has installed a scrubber on one of its ferries. The use of LNG for fuel has not been an issue so far for Færgen, but hybrid solutions may be a part of its future depending on the incentives provided by the Danish government.

The Danish Car Ferry Association

"Ferries will always be an important factor in Denmark. Last year, 32 million people made close to a total of 670,000 trips on 65 ferries. A ferry leaves a Danish port every 47 seconds. For our future as an industry, we have issued a report called "Green Ferries in Denmark". This concludes that hybrid solutions are the most attractive for Denmark, but also looks into electrical and LNG solutions. We are working closely with the Danish authorities to further develop these solutions for the future, as the industry I represent also has a strong desire to reduce its environmental footprint," says Steen-Mikkelsen.

Interferry

"We're celebrating a small jubilee this year as this is the 40th Interferry Conference. The last time we held it in Copenhagen was in 1981, so I'm delighted to see that the conference is now back in Copenhagen and we already have a record number of participants. This year's conference will have a special focus on fire safety, and here I also very much welcome the input from DNV GL as an important player when it comes to safety and overall expertise on the topic. The new rules on fire safety on ferries are an important step forward for us as a global industry, and the implementation of these rules will be important. Fires on the car-deck are unfortunately not all that rare and I sincerely hope that we can improve on this important issue. I truly look forward to discussing this at the Interferry Conference," says Steen-Mikkelsen.

"I've been fortunate to be Interferry president for a year, a position with a one-year term of office. I have travelled extensively during my period in office, meeting operators and authorities to discuss where we as an industry can improve on both safety and environmental requirements. We have a seat at IMO and I find it highly rewarding for Interferry to be able to influence and provide input to this organization.

"Ferries operate not only in highly developed countries, but also in developing nations where there has unfortunately been many bad accidents over the years, leading to substantial loss of life. We have been able to persuade IMO to pay more attention to safety matters, especially in Asia. It's important that IMO inspires and influences local authorities to actually ensure that vessels are only allowed to sail according to their capacity, for instance by implementing their legislation," concludes John Steen-Mikkelsen. ▮

Text: Andreas.Brandsaeter@dnvgl.com

BATTERY HYBRID SHIPS

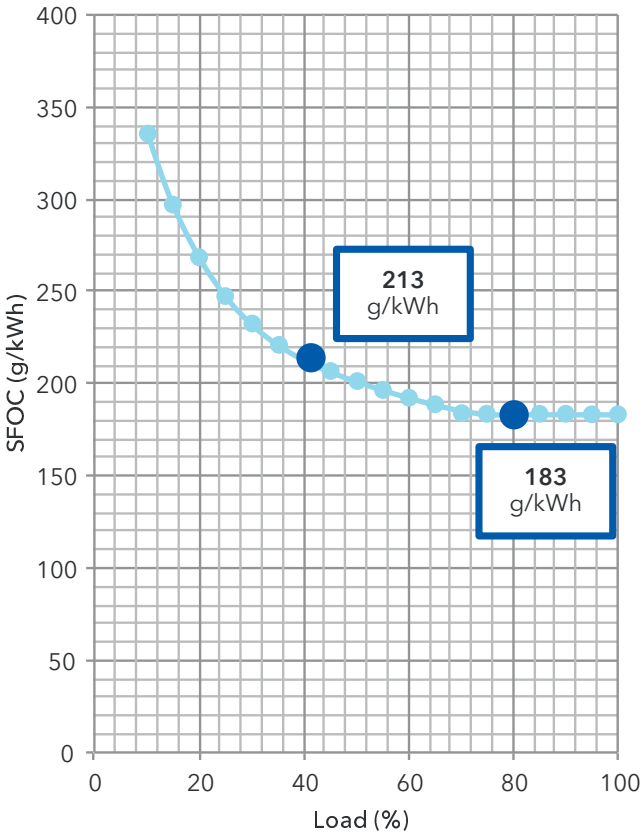
Full-electric and hybrid electric cars have seen a massive increase in popularity, motivated by rising fuel prices and environmental concerns. The introduction of hybrid technology to reduce energy consumption and emissions has not gained the same attention in the maritime industry yet, but the change has started and more and more ships are being equipped with batteries.

Anders Brandsæter,
Researcher, DNV GL

Like the car industry, we divide battery-powered ships into three types:

- Full-electric ships (ES)
- Plug-in hybrid ships (PHES)
- Hybrid ships (HES)

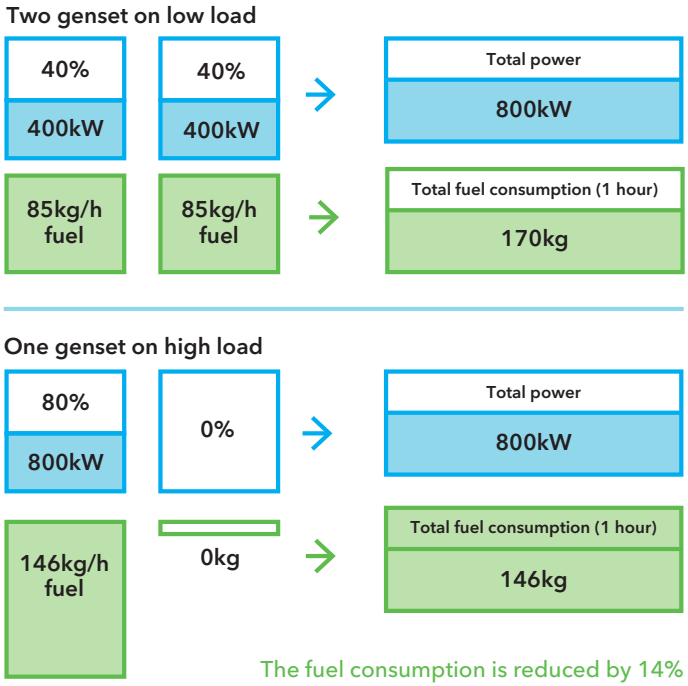
On a full-electric ship, all the power, for both propulsion and auxiliaries, comes from batteries. A plug-in hybrid ship, similar to a plug-in hybrid car (PHEV), is able to charge its batteries using shore power and has a conventional engine in addition. The ship can operate on batteries alone on specific parts of the route, when manoeuvring in port, during stand-by operations. A hybrid ship uses batteries to increase its engine performance and does not use shore power to charge its batteries.



The figure shows the specific fuel-oil consumption in grams per kWh produced energy at different loads for a typical 4-stroke diesel engine.

The specific fuel oil consumption of, and emissions from, an internal combustion engine depend on the engine load. Typically, engines are calibrated for optimum performance at high loads. For ship types that experience large load variations during operation, the introduction of batteries may allow the engines to operate optimally with respect to fuel oil consumption and/or emissions. This can be achieved by selecting engine sizes that operate at optimal loads for most of the time, with additional power obtained from the batteries when required. When power requirements are low, the batteries can be charged using the excess energy generated by running the engine at the optimal load. Alternatively, in operating conditions requiring very low loads, the ship may be able to operate on battery power alone.

This can also be beneficial for the engine's maintenance costs since engines operating at low loads may lead to incomplete fuel



Showing the total power generation and fuel consumption after one hour of operation for a ship with four 1000kW generator sets (gensets). By switching off one genset, the ship can make fuel savings of approximately 14%.

combustion, potentially leading to contamination of the lubrication oil and the build-up of carbon residue on vital engine parts. Thus, the engine's normal service intervals may be insufficient, leading to higher maintenance costs.

The engine emissions are also strongly dependent on the engine loads. The dependence varies for the various emissions. Specific emissions are normally higher at low engine loads. This is particularly evident for unburned methane (CH_4) emissions. CH_4 is a very strong greenhouse gas (GHG) (at least 25 times more potent than CO_2). Moreover, a diesel engine (using either heavy fuel oil or low sulphur diesel) is expected to have significant particulate matter (PM) emissions, especially at low loads. An accumulator may therefore also be used to reduce emissions by allowing the engines to run at optimized loads with respect to emissions.

Benefits of hybrid ships:

- Utilize energy from shore power
- Run engines at optimum loads
- Avoid transient engine loads
- Use power redundancy
- Reduce local emissions
- Reduce noise and vibrations
- Facilitate energy harvesting and energy recovery

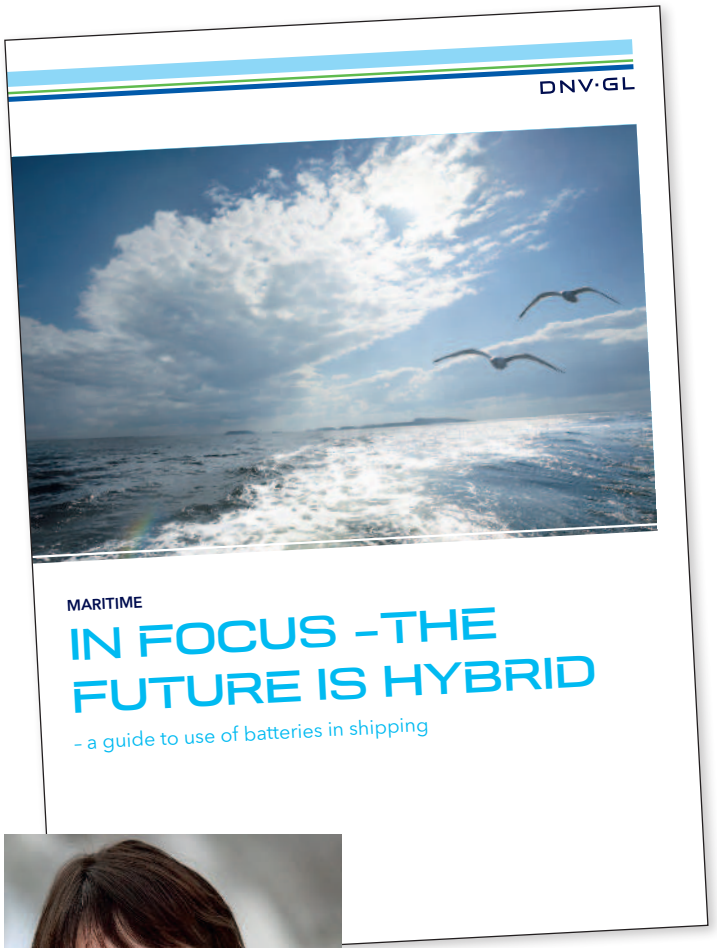
Let us illustrate this with an example. Assume that a ship's power demand varies between 500kW and 1100kW, with an average power demand of 800kW, meaning that the ship consumes 800kWh in one hour of operation. The ship has two generator sets installed, with a maximum total power output of 1000kW. Although the average demand is 800kW, the ship cannot run with only one generator set switched on since the demand sometimes exceeds 1000kW. Therefore, two generator sets must be running. The total fuel consumption of two generator sets is 170 kg/hour compared with 146 kg/hour if only one generator set is switched on. If a battery was installed, the battery could take care of the variations and the ship could run on only one generator set, with fuel savings of about 14%. ▮

Text: Gerd.Petra.Haugom@dnvgl.com

BATTERIES – THE NEXT BIG THING?

"BATTERY-READY" SERVICE
GET READY FOR THE FUTURE - TODAY

Electric and hybrid ferries with energy storage in batteries have the potential to reduce fuel consumption, emissions and maintenance costs. Battery solutions can improve ship responsiveness, operational regularity and performance, as well as safety in critical situations.



The guide can be downloaded from our website www.dnvgl.com

Gerd Petra Haugom,
Principal Consultant, DNV GL

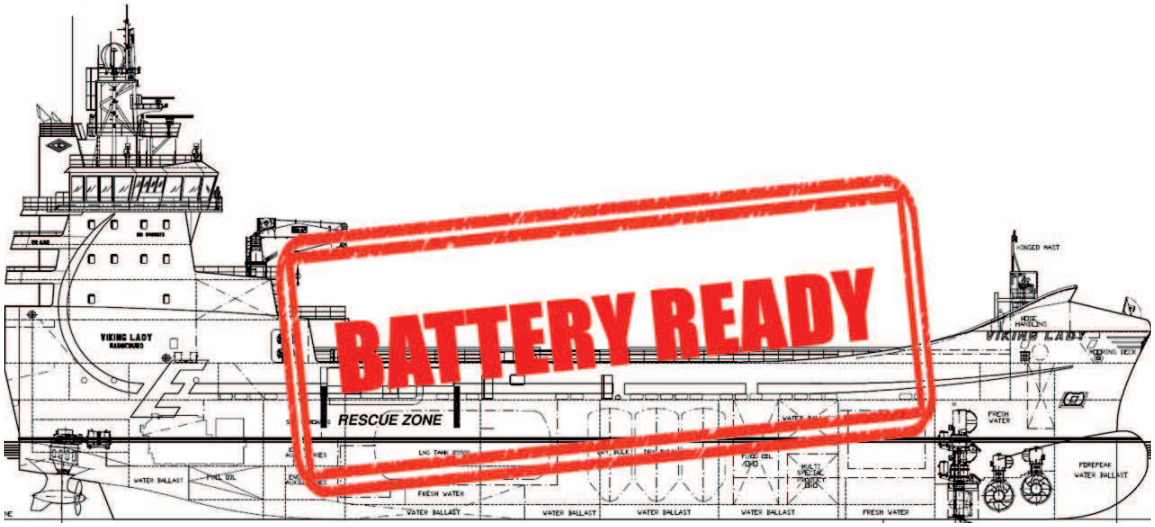
DNV GL provides decision-support to make vessels ready for future battery retrofitting or for battery operation today. Whether you are thinking about a pure battery, battery-hybrid or plug-in hybrid solution, DNV GL helps you to select the best option for your operational and environmental requirements. There are two ways to make a vessel "Battery Ready":

Ready for a future battery retrofit
Build a vessel that will use a diesel or gas-based power system which can easily be retrofitted with batteries in the future. This can be a good option for ships under construction or existing conventional designs.

Benefits
- DNV GL validates that the system is optimized for easy retrofit
- Minimum investment requirement
- Cost-benefit assessment pinpoints when a full conversion is attractive
- Increased confidence for the owner, charterer, investor and other stakeholders

Ready for battery operation today
Build or retrofit a vessel with a battery system and engines/motors installed and ready to run on a battery from day one of operation.

Benefits
- Cost-benefit assessment illustrates the vessel's performance to ship owners and charterers
- Cost reductions from optimizing the engine/ motor size versus battery size
- Install fewer or smaller engines
- Independent and credible battery service life assessment
- Avoid engine loads where Tier III solutions, such as LNG and SCR, have non-optimum emission performance
- Provide a storage platform for effective black-out prevention, energy recovery and renewable energy
- Greater negotiation power in relation to battery vendors.



DNV GL's "Battery Ready" process has four easy steps - from planning and concept design to approval in principle and final risk assessment. This will get you started on the course to fully utilizing battery solutions.

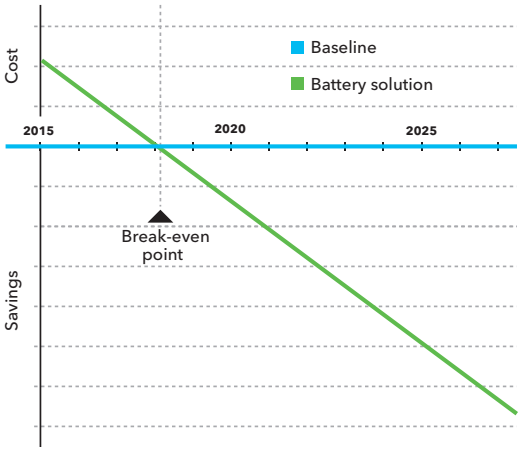
1. Power and energy system decision support

Technical feasibility:

- Battery/hybrid system location, sizing and range based on operational requirements and profile
- Engine/motor system location and sizing based on the ship's operational profile
- Outline of key requirements for a "Battery Ready" design

Financial analysis:

- High-level financial comparison of engine/motor options, power electronics and battery options including both investment cost and operational expenses
- Sensitivity analyses considering the impact of fuel/battery price developments



Cumulative total cost compared to baseline. Example showing investment costs and operational costs in a lifecycle perspective. The analysis illustrates the payback time and value of the battery investment over the ship's lifetime.

- High-level evaluation of the strengths and weaknesses (e.g. SWOT analyses) of alternative solutions with respect to technical issues, environmental aspects and economy

2. Concept review

- Development of novel ship designs and detailed technical feasibility studies tailored to the specific design and technical challenges
- Power system analysis
- Hazard identification (HAZID) review to identify hazards which could lead to high risks in operation
- Assistance with a review of the design and/or outline specification.

3. Approval in Principle

- Verification of the design concept and confirmation of compliance through DNV GL's Approval in Principle
- Help to identify and mitigate risks associated with a given design to ensure the development of a safe system right from the beginning

4. Risk assessment

- Risk assessment to identify, assess and manage safety and business risks
- Battery-space safety risk analysis (mandatory for DNV GL Battery Safety Class notation)

DNV GL's Battery Guideline and Class Rules will support the introduction of maritime battery and hybrid solutions. ▮

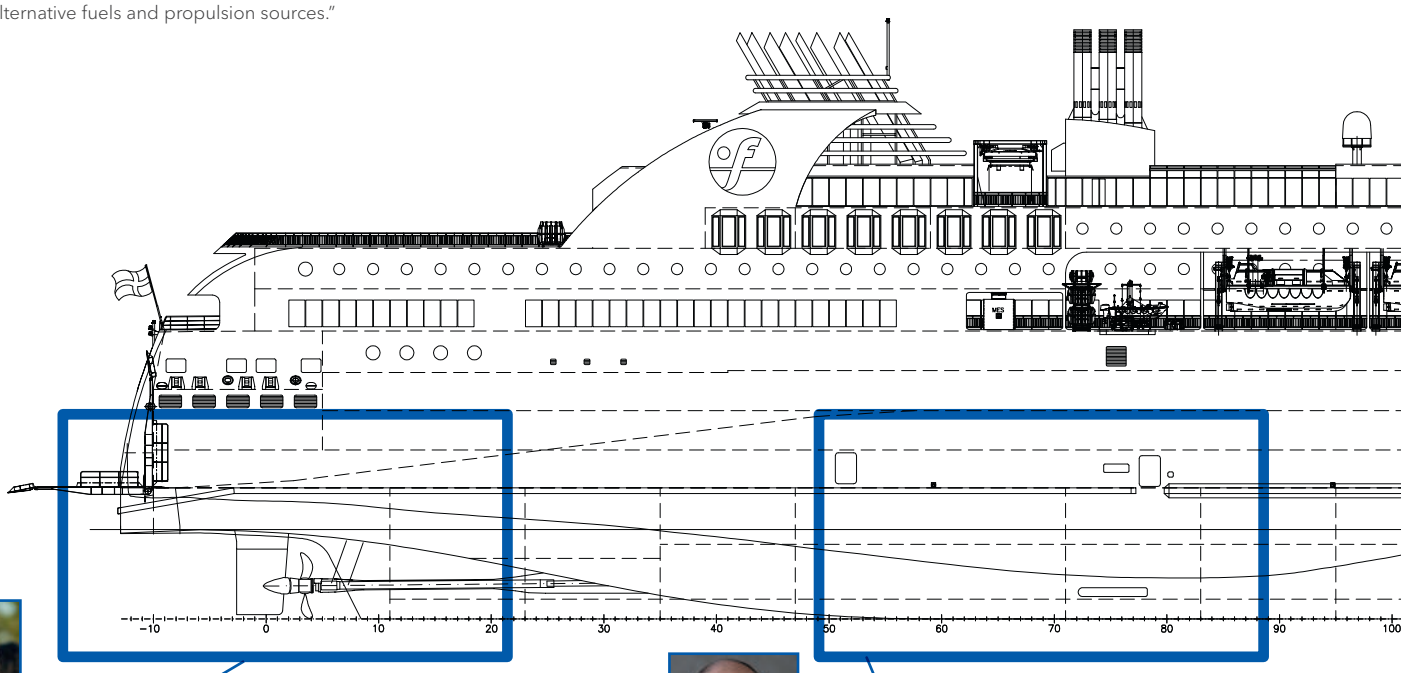
Text and illustration: Etienne.Gernez@dnvgl.com

HOW TO REDUCE YOUR FUEL COST

NEED FOR SHIP — DEFINE DESIGN SPECIFICATION — DESIGN SHIP

DAFNI SOFIADI AND ADAM LARSSON,
RESISTANCE AND PROPULSION AND EEDI COMPLIANCE
"The required EEDI for Ro-Pax vessels has now been in place since 1 September 2015 and stipulates a 5% reduction compared to the baseline curve. As opposed to other ship segments, a special speed correction factor means it is not feasible to reduce a Ro-Pax's EEDI value by reducing the design speed. This leads to an increased focus on hull design optimization and energy consumers on board. We recommend taking a multidisciplinary approach that combines hydrodynamics, machinery systems and operations, as well as looking into alternative fuels and propulsion sources."

UWE HOLLENBACH, **CONCEPT CONSULTANT**
"We observe that sometimes Ro-Pax vessels are being operated at slower speeds and deeper draughts than they have been designed for. This often leads to penalties in fuel consumption and stability, which can be corrected by modifying the hull with side-sponsons, or modifying the stern region with aft-sponsons, ducktails and/or trim wedges. Further gains can be achieved by fitting new rudders or possibly rudder bulbs and newly designed propellers. For a newbuilding project, it is critical to explore how the operating profile will influence the overall hull design, and we have the best tools in the market to guide our customers through this complex process."



KAI ABRAHAMSEN, **NOISE AND VIBRATION**
"By focusing on the propeller design and its interaction with the hull structure, we very often see that reducing noise and vibration also leads to fuel savings and enhanced safety and reduces maintenance costs. Underwater noise from shipping is an area of increasing focus in coastal areas, with the EU (Marine Framework Directive) and IMO (MEPC 66/17) urging nations to control, monitor and reduce noise levels. For noise levels inside the ship, IMO (MSC 337(91)) has recently published mandatory regulations for vessels exceeding 1,600 gross tons. DNV GL has extensive experience of these issues with its SILENT and COMFORT voluntary class notations."

TOMAS TRONSTAD, **MACHINERY AND SYSTEMS**
"We see a lot of potential gains in tailoring the machinery arrangements to the actual engine load profile for increased reliability, availability and fuel savings. Diesel/electric, hybrid arrangements, batteries and even new fuels are examples of technologies worth considering. We have a lot of experience in guiding our customers through the technical challenges associated with such complex decisions."

Illustration: MS Stavangerfjord, with permission from Fjord Line AS, for illustrative purposes only.

With challenging EEDI regulations and market conditions, we asked our experts in hydrodynamics and machinery their recommendations for optimal performance at all stages of the ship's life.

BUILD SHIP — IN OPERATION — END OF LIFE

HEIKKI HANSEN AND PETTER ANDERSEN,
ECO ASSISTANT AND ECO INSIGHT
"We see from experience with Ro-Pax vessels operating below their design speed and featuring a wide transom and a bulbous bow that, in spite of a narrow draught range, small changes in trim often lead to considerable fuel savings. By combining the ECO Assistant with the ECO Insight fleet performance management dashboard, we can now monitor a vessel's actual trim in order to ensure optimal fuel consumption on a daily basis."

HÅKON HUSTAD AND KNUT LJUNGBERG,
ENVIRONMENT AND SHIPPING ADVISORY
"We've been involved with the NOx Fund project in Norway for almost a decade now. Reducing NOx emissions is also about reducing fuel consumption. We have reviewed extensive data about the cost, efficiency and complexity of implementing 30 to 40 individual fuel saving measures related to hydrodynamics and machinery. In addition, through our Energy Efficiency Management projects, we see that the best results are always obtained when we combine technical and operational measures, focusing for instance on delay management, propeller polishing, trim optimization, the hull condition and all energy consumers' performance and utilization."

EIVIND RUTH, **RESISTANCE AND PROPULSION**
"Reliability in manoeuvring systems is key to the safe and profitable operation of Ro-Pax. The selection of thruster types and their location need to be carefully assessed in combination with the operating profile. In addition to saving fuel, well-designed thruster systems with smart control systems can make the vessel significantly easier to handle in port."

COSMIN CIORTAN, **RESISTANCE AND PROPULSION**
"We see from recent projects that many details matter when it comes to fitting appendages. Simply fitting a bow thruster with a scallop and a properly orientated protection grid can yield non-negligible fuel savings. We monitor the local quality of the hydrodynamic flow from bow to transom and try to reduce every single source of perturbation to ensure global hull efficiency."

Text: Tore.Relling@dnvgl.com

SAFETY IN THE FERRY INDUSTRY – TAKING THE NEXT STEP UP THE SAFETY LADDER

The main objective when working with safety is to reduce the number of injuries to or fatalities among the crew and passengers. Compared to the industry 'best practice' in OECD countries, the crew fatality rate is 10 times higher in the maritime industry. We have seen improvements in ship structure and system reliability and today's ships systems are technologically advanced and highly reliable. However, the fatality rate is still high. What are the obstacles to overcome to reduce the number of accidents?

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FACTS

DNV GL recently conducted a study of the root causes of grounding and collision accidents in Norwegian waters over the last 30 years. The study used data from the Norwegian Maritime Authorities' accident database as well as 18 accident investigation reports to discover the extent to which the different underlying causes were present. A causal network was established to identify the underlying causes behind each of these main categories. In the network presented below, theoretical connections are shown with a dashed line and identified links with a solid line. The more often the link is identified, the thicker the line.


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Tore Relling,
Senior Consultant, DNV GL

The ferry industry is responsible for a large number of passengers every year. There is instant public attention if an accident occurs and the consequences for the company involved can be dramatic. This article presents three different, but interlinked, goals for increased safety in the industry. The first goal is to use human error as a symptom of weakness in the system, rather than as an explanation for an accident. The second is to manage major accident risks, and the third is to assess and improve the safety culture.

Human error has been one of the most used explanations for accidents in both the maritime industry and other industries. While many other industries have managed to move on and search for more underlying causes, the maritime industry appears to be lagging behind and still blame the individual operator in too many occasions. People are making mistakes, but it is very seldom that the mistakes are deliberate. The reason for people making mistakes could be discovered by understanding what affects a person's performance. The causal network (figure 1) shows that the deliberate violation link is almost non-existing and that the wrong action or judgement is the main contributor to accidents. Further, the reason for this could be discovered by looking at a set of performance-shaping factors. The eight factors are presented in the rectangle in the network and represent both the areas that could negatively affect the operator and what could increase the likelihood of good performance.

To move from an old-fashioned view of blaming the operator to a modern perspective on safety, it is important that the company

asks itself 'why' when people are making mistakes. The answers can in most cases be found in one or more of the performance-shaping factors. A typical example of human error is a combination of the operator experiencing a situation he/she has not been trained for, the work load growing too high because of a lack of cooperation in the team, the procedure being too extensive and detailed, and the complexity becoming too great. When the operator then makes a mistake, we often see that the blame is laid on the individual rather than identifying all the contributing factors.

If the ferry industry wants to improve in this area, it needs to establish an understanding of the company's responsibility to facilitate good human performance. If human error occurs, it needs to be treated as a symptom of weakness in the system, and not as a standalone human error. If companies are able to make this shift, it will have a long-lasting effect on their organisation, preventing human error across vessels and fleets.

Managing major accident risk may seem difficult when looking at the variety of causes presented in the network. However, there is evidence that this is necessary and that a structured methodology would work. Major accident risk is often associated with the risk of ship accidents. In the maritime industry, about 900 lives are lost due to ship accidents every year. Nevertheless, in many shipping companies the everyday safety focus is on preventing occupational accidents, often called the slips, trips and falls. In such accidents, we often see a linear chain of events; hence it is easier to identify the reason(s) and to implement risk-reduction measures. The occupational safety measures help and great improvements can be observed. One example is the Norwegian Maritime Authority's increased focus on occupational accidents, which has led to a documented 50% reduction in Lost Time Injuries (LTI) over the last 10 years. However, in the same period, the number of vessels involved in serious accidents has increased. This indicates that we cannot keep chasing LTI statistics based on occupational accidents alone when the safety improvement potential is much higher in other areas. The industry needs to take a broader view on safety and the next step is to include the major accident risk in the everyday safety focus. One challenge with major accident risks is that they are more difficult to measure than occupational accidents. The reason for this is that the chain of events leading up to a major accident is much more complex. Managing major accident risk can thus often be seen as being about managing complexity. Good systems that capture this complexity and reduce uncertainty are needed to manage major accident risk. Barrier management is one approach to manage the complexity, and covers both technology and operations accidents. The purpose of barrier management is to reduce the major accident risk by establishing and maintaining barriers to prevent hazards from being realised or to mitigate the effects of a hazardous event. James Reason's "Swiss Cheese Model" is one of the most used models to explain barrier management. It is based on illustrating the barriers as cheese slices and the weaknesses in the barriers are illustrated as holes in the cheese slice. The model builds on the principles of 'defences in depth'. If there is a hole in one barrier, a new barrier should be able to prevent the hazard from leading to an accident.

For the ferry industry, it could be of interest to implement a barrier management process to a larger extent. The process of identifying barriers would highlight safety-critical equipment and the operational actions taken by humans to ensure safety. The concept also covers the methods of monitoring the barrier performance. This allows for adjustments if weakness is experienced in one of the barriers. By monitoring the barrier performance, the company will be able to identify leading indicators of major accident risk.

Safety culture is on the far left of the causal network and influences a large variety of the other nodes. Safety culture has been defined in many different ways in literature, however the saying 'it's what we do when no one is watching' sums up the definitions quite well. Safety culture is about the awareness of safety amongst the employees. Evidence from safety-critical industries suggests that a good safety culture can help make organizations less vulnerable to incidents and accidents.

Safety culture is not something that is in place or not in place. Some kind of safety culture always exists in a company, but it could be more or less mature. Organisations with a mature safety culture are often recognised by their open and sharing culture in which safety is prioritised and also seen as a profit not a cost. They are constantly searching for new ideas to improve safety and will never settle for the view that they are safe enough. At the other end of the safety culture scale, we find organisations that blame accidents on the people, and also explain accidents by the nature of the risky business they are doing. The majority of organisations are somewhere in the middle, and recognised by chasing statistics, focusing on audits and wondering why people are not doing as they are supposed to.

For the ferry industry, it could be beneficial to assess the culture to identify the current status and then implement improvement measures. The safety-culture assessment would identify how

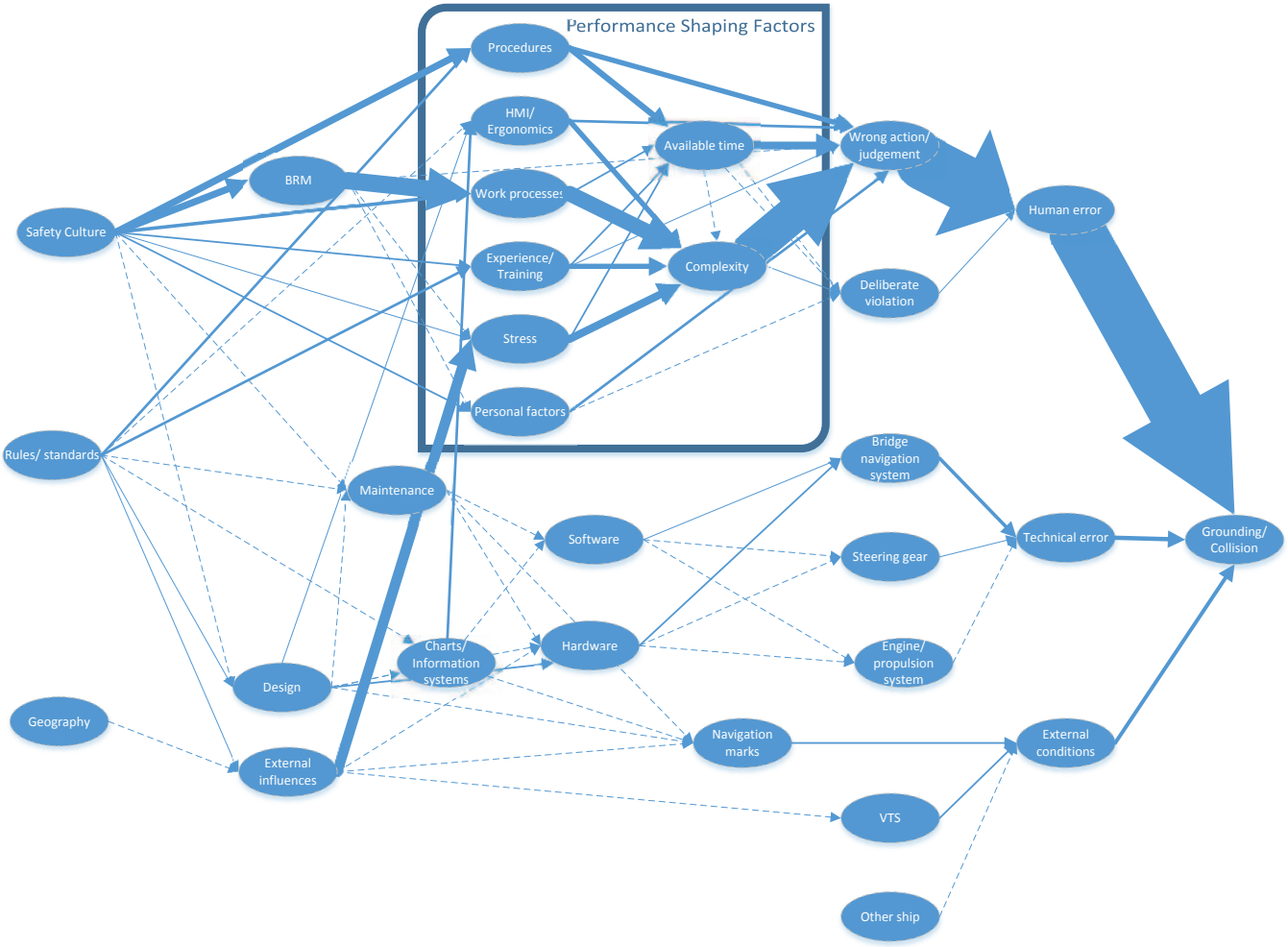


Figure 1: A network of causes of grounding and collision accidents: the thicker the arrows, the more evidence was found for the causal chain of events in accident investigation reports. The nodes in the rectangular box represent the performance-shaping factors.

mature the safety culture is in the company. Some assessments could highlight pockets of less mature safety culture in parts of the organisations, and also benchmark the company against other companies within the same segment and/or other segments. The reason for conducting safety-culture assessments is to be able to put the safety focus on the right place, and also to maintain and learn from the good initiatives which can be found in most organisations.

When improvement areas are identified, it is important that the changes aim to alter the culture, not only the symptoms. To change the culture, all parts of the organisation, including top-management, mid-managers and employees, need to be involved. If not, the initiatives will not lead to a lasting cultural change. The initiative needs to be anchored and communicated, prioritised and lived by the top-management. Mid-managers have key roles to play in following up the initiatives and must be role-models and prioritise the same areas as the upper management. The employees need to feel they are involved and responsible for maintaining and improving safety in the organisation. If the company manages to identify the right improvement areas and make cultural changes based on these, the risk of incidents and accidents will decrease.

The ferry industry, like the rest of the maritime industry, is under constant pressure to improve. Safety will be one of the most important areas in which to show continuous improvement. This article has suggested three goals to achieve in order to climb up the safety ladder. Awareness of the contributing factors of human error, managing major accident risk in everyday safety work and improving the safety culture could be focus areas that the ferry industry could consider when choosing its future safety work. ▮

Text: Magne.A.Roe@dnvgl.com

RO-RO DECK FIRES – STILL A HOT TOPIC!

"Fire – do we really have a fire? This is a typical question that unfortunately leads to slow responses to fires on board," says Anders Tosseviken, Principal Approval Engineer at DNV GL's Fire Fighting and Life Saving Department.

Anders Tosseviken,
Principal Approval Engineer, DNV GL

If we consider ro-ro spaces, we typically see that the response time from when a fire is detected until the fixed fire extinguishing system is released is five to 30 minutes on a ship with a water-based fire extinguishing system, and some 15 to 30 minutes on a ship with a CO_2 system. This is if the system works and the crew at all knows how to activate the fire-fighting system. If things go wrong, the response time can be more than 60 minutes.

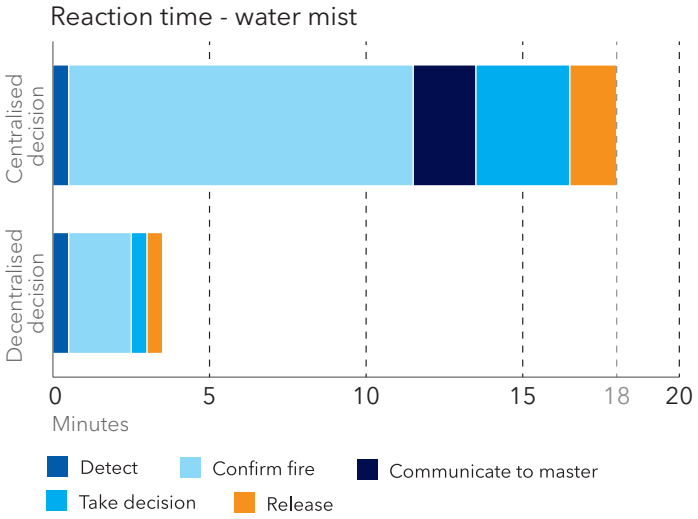
Some of these systems can be somewhat difficult to operate and a crew that has not been trained in how to release them will probably not be able to activate them during a stressful situation involving a real fire.

There are, however, several examples of the crew responding quickly to fire alarms and managing to extinguish the fire using portable extinguishers or limit the damage by releasing the fixed fire extinguishing systems at an early stage. A slow response by the crew to fire alarms will result in more extensive damage to the ship and its cargo. The total loss of a vessel is normally due to a slow response and the malfunction of the fixed fire extinguishing system.

We have closely studied world-wide casualty data and, generally speaking, the trend is not going in the direction we all want: fewer fires. On the contrary, for some segments the trend is towards more fires. Generally speaking, owners and operators have good practices and these data vary depending on the segment, such as ferries/RoPax, ro-ro cargo ships or PCC (pure car carriers). The likelihood of a fire on a ro-ro deck on a RoPax is about three times that of a fire on a ro-ro cargo ship or PCC. In our view, this is something we need to address. When it comes to fire sources, there are generally many of these; a reefer container powered by the vessel's electrical system or by a diesel unit, cargo items carried by trucks, food made by persons staying on the ro-ro deck and, of course, various faults in cars, buses or trucks (the electrical system, engine, etc).

In my view, operators should consider how to address all these hazards. Of course it is difficult to reduce the fire risk of each individual vehicle (screening can be carried out prior to loading) but there are ways to make operations involving reefer containers safer and maybe the policy of permitting persons access to some categories of ro-ro decks should be reconsidered altogether – this would prevent many mishaps.

Personnel in firefighter gear, participating in a training exercise that involves putting out a fire in a compartment on the deck of a ship.



Detection systems must be constantly monitored and there must be regular fire patrols on car decks.

Fully enclosed or fully open decks are found to be safer than semi-open decks (cargo decks that have openings in the ship's sides but are closed from above). The semi-open decks probably provide perfect conditions for a fire and the consequences for safety items (air intakes, lifeboats and escape routes) in the vicinity of such deck openings can be severe. Such designs should be carefully considered in the newbuilding phase.

To summarize, DNV GL has three main focus areas in which we advise ship owners to concentrate their activities:

1. **Implement procedures and a policy for risk control.**
- Define and revisit your policy on acceptable operations on ro-ro decks
- Define and revisit your criteria for accepting cargo on board ro-ro decks

2. **Be prepared to use the fixed fire extinguishing system(s).**
- Delegate the use of a water-based system to the lowest possible level
- Train in using CO_2-release procedures
- Define goals for the release time and implement realistic training ▮

Text: Hans.Eivind.Siewers@dnvgl.com

PREVENTING FIRES ON RO-RO DECKS

Preventing fires on Ro-Ro decks is high on the agenda for all operators and owners. We asked a well-known Ro-Ro owner, Wilh. Wilhelmsen, which measures they implement to prevent fires. “One of the measures is an increased focus on cargo inspections,” says Capt. Filip Svensson, Vice President Marine Operation.

Capt. Filip Svensson, Vice President Marine Operation, Wilh. Wilhelmsen

Do you feel there is any increased focus on this subject (by customers, insurance companies, port state authorities, etc)?
We have experienced additional pressure from some industry stakeholders, such as insurance companies, which we believe is as a result of several recent major fire incidents on Ro-Ro decks on RoPax vessels in the Mediterranean and some deep-sea car carriers. We haven't seen any increased focus by port state authorities and/or flag states on fire hazards on board our vessels.

What, in your opinion, are the major reasons for fires on Ro-Ro decks?
Many of the recent fires are related to second-hand/used cars and refrigeration units in operation during the transit. We believe the fire risk is higher for such types of cargo than it is for new vehicles normally loaded on deep-sea Ro-Ro carriers. In our view, the main fire risks on deep-sea Ro-Ro vessels are substandard vehicles and the possible shifting of cargo during severe weather conditions.

How does the type of cargo influence the risk?
The fire risk from new cars and other vehicles is minimal, the major risk is related to second-hand cars unless a strict control regime prior to loading is implemented. This means that used cars represent a higher risk than new cars. As mentioned above, we believe there is a higher fire risk for refrigeration units in operation while in transit, which is more related to short sea shipping.

Do trade patterns such as short sea/deep sea shipping influence the risk?
Trading patterns influence the risk but this is not necessarily so much related to the trade as it is to the types of cargo that dominate the specific trade. Transporting new cars in a short sea trade will have a similar risk profile to that of transporting new cars in deep sea trades. However, the volumes of used cars in deep sea trades are marginal compared to the volumes of used cars in short sea Ro-Ro trades. Ro-Pax vessel for example has more or less 100% used cars. Additionally, the short sea transportation might have an issue with implementing a control regime to ensure that no substandard vehicles are loaded on board, and they are more exposed to stowaways/migrants who tend to hide in the cargo or cargo spaces and whose onboard activities might cause an increased fire risk.

What are effective measures to prevent fires on a Ro-Ro deck?
As stated before, having a strict inspection regime for cargo prior to loading, as proper housekeeping in all spaces on board a vessel is extremely important to minimize the risk of fire. Crew training using vessel fire-fighting equipment is of the utmost importance to ensure that the reaction time is minimized if a fire starts on board.

What do you do in Wilh. Wilhelmsen to prevent fires?
We have a very strict cargo inspection regime, we have constructed our latest series of vessels to the DNV GL FMCA notation and we have also installed cameras on the high and heavy Ro-Ro decks to ensure early detection. In addition, we are looking into the possibility of enhancing the existing fire detection systems to make them more sensitive and thus enable us to detect an increase in the cargo temperature at an early stage prior to an actual fire starting. We also believe the latest requirements outlined in MSC91/338 are sensible and have implemented these for ships where the requirements have not been mandatory.

What is important to consider when transporting new types of cars?
First of all, it's important to note that the fire risk in AFVs (alternative fuelled vehicles) is not greater than in normal vehicles (petrol/diesel-driven). The challenge with AFVs is that the fire characteristics are different from those of traditional petrol/diesel-driven cars. 'New' types of batteries are being used in larger numbers. Additionally, new fuels with different characteristics such as density, explosion limits, etc, are becoming more common. Furthermore, there is not a common extinguishing media for those types of fires, so the main task will be to ensure that cars are not exposed to secondary fires on board. If a fire does occur, cooling will be more important than for conventional vehicles. We are currently running an AFV fire project with several industry stakeholders, such as manufacturers, charterers and research institutes, to gather best practices and knowledge about the different types of fire scenarios involving AFVs.

Are more regulations needed on this subject?
We don't believe that any additional regulations are needed in the deep sea Ro-Ro segment; however the industry should be more willing to state the reasons for fires on board vessels to ensure that best practices can be shared in order to minimize the likelihood of fires on board. ▮

Text: Andreas.Ullrich@dnvgl.com

INSTALLING SCRUBBERS IS THE SOLUTION FOR TT-LINE

TT-Line operates a fleet of six Ropax ferries sailing out of Travemünde and Rostock in Germany as well as the port of Świnoujście in Poland to the southernmost city in Sweden, Trelleborg. TT-Line operates solely within the European SOx Emission Control Area (SECA) and transports some 650,000 persons and 400,000 cargo units annually.

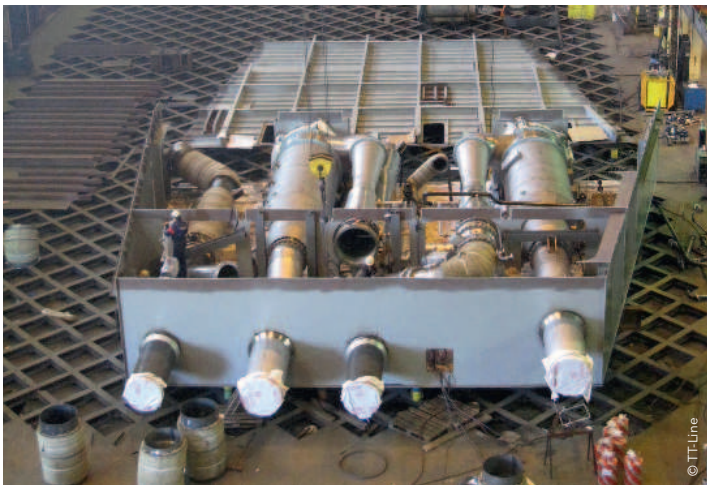
In order to remain competitive and also to satisfy the new emissions requirements, installing scrubbers was the company's preferred solution. TT-Line Head of Nautical/ Technical Department Jan Seemann explains why.

What was TT-Line's motivation for installing a scrubber system?
First of all, following the ratification of the new Marpol Annex VI regulations, we began an investigation to protect our company against these increased fleet costs. TT-Line trades between Germany, Poland and Sweden, so it means we are always sailing in the SOx Emission Control Area (SECA). The main challenge for our short sea traffic is the direct competition with road and rail transport. We had to find a way to minimize our additional costs compared to those of our competitors. Different studies showed a high risk of the traffic moving from the sea to the road. The scrubber was one way to safeguard our competitiveness.

Why did you choose a hybrid system?
TT-Line has been trading in the Baltic Sea for over 50 years. We decided to install a hybrid scrubber system for several reasons. At first, we will run our vessels equipped with a scrubber completely in non- discharge mode when in port, as we are aware that we are trading in a very sensitive area.

Furthermore, we have gained quite a lot of experience since installing both systems. We made use of this when designing the next project to be realized this winter. Finally, we are more flexible with a combination of an open and closed loop system. The limited depth under the keel inside the ports or coastal waters could lead to problems with the suction of the very high capacity scrubber water.

Can you tell us how you have experienced the design and installation process?
In general, we can describe the development of the design from the beginning as simple and cheap and, in the end, a more and more complex and expensive installation. The makers should not offer a standard solution for all existing vessels anymore. Each vessel needs special solutions for its relevant trade and existing design. Most makers have gained experience from shore plants, but on vessels the stability, hull strength and limited space must also be taken into consideration. Finally, the project plan for the installation should minimize the vessel's time out of service.



Prefabrication of the new scrubber funnels.

TT-Line is one of the first ferry companies to apply this technology. What are the advantages and disadvantages of being an "early mover"?
The scrubber system for existing vessels is not 'off the shelf' equipment. Each scrubber project is a challenge and has the nature of a pilot, so it means that we still need long-term experience to improve future installations. We have already made use of a lot of our experience in our next project for this winter.

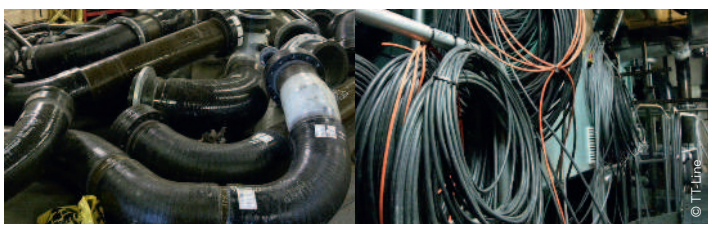
The disadvantage is the varying interpretations of the relevant rules. Mainly during the commissioning of the system, we learnt that the different administrations' interpretations of the rules are partly not harmonized.

Raising the new funnels.

Have you decided what to do with the rest of the fleet?
Yes, the Nils Holgersson will be the next vessel. The hybrid scrubber will be installed while it is docked this winter. By the way, on this ship we have to connect five engines to the scrubber system. Afterwards, we will install hybrid scrubbers on our vessels Robin Hood and Peter Pan.

What is your operational experience so far?
In simple terms, the open and closed loop systems are working fine.

We still have to think about the resistance of materials over a longer period, although most pipes are made of glass reinforced epoxy (GRE). Our operational experience over the next few months will give us more information so we can adjust the intervals of our Planned Maintenance System. During the commissioning of the scrubber system, we learnt that it is not easy to calibrate analysers. The differences compared to shore plants are the permanent load changes, which mean the analyser has to measure under a different temperature. These circumstances require special heating elements to keep the temperature constant.



Installation of 2,000 components, 17,500m of cable and 700m of GRE pipes.

Do you see any challenges in the time to come?
Yes, first of all it will be necessary to give the captains and chief engineers a clear and harmonized international guideline on the control procedure for the scrubber system from the port state and other administrations. This will improve the legal safety of the crew and owner of the vessel. Up to now, we observe different interpretations by local authorities. Furthermore, so far the European countries have not harmonized the Baltic Sea wash water regulations.

Finally, the classification societies' association should harmonize the approval procedures and commissioning requirements.

What is your message to the ferry industry related to scrubbers?
"A healthy European short sea network is necessary for inter-European trade. Annually, more than 700 million passengers, 125 million passenger cars and next to 30 million trucks are transported in this network. Due to the SECA regulations applicable as from 2015, immense investments in environmental technology, especially in exhaust gas cleaning systems, are required during the coming years. To ensure the fast upgrade of the European short sea fleet (infrastructure) and the necessary competitiveness of the European short sea network, substantial financial support is needed. On a European level, the TENT-T/MOS programmes are a good instrument.". ▮

The vessel leaving the yard with the new scrubber.

Text: Magne.A.Roe@dnvgl.com

GOTLANDSBOLAGET SIGNS CONTRACT WITH SHIPBUILDER GSI FOR A SECOND VESSEL

After ordering one LNG-propelled passenger ferry from Chinese yard GSI (Guangzhou Shipyard International), Swedish ship owner Gotlandsbolaget has now exercised its option to order a second.

The vessels are due for delivery in 2017 and 2018. Both are being built to DNV GL class, including comfort ratings for climate, noise and vibration. The ships will carry 1,650 passengers and have 1,750 lane metres for cars, camper vans, trailers and buses. The vessels will operate between the Swedish mainland and the island of Gotland in the Baltic Sea.

"The new ferries are important for future reductions in the environmental footprint in the Baltic Sea," says Jan-Olof Grönhult, DNV GL's Key Account Manager for Gotlandsbolaget. "The vessels will comply with all current and future emission control requirements." ▮

Text: Kim Wei Doreena Tang, Veritas Petroleum Services Group

CONSIDERATIONS FOR EMERGENCY EQUIPMENT FUEL

"Lifeboat engines, emergency generators and emergency fire pumps have to be put into service quickly in an emergency and must be able to operate in a wide range of ambient conditions", according to Veritas Petroleum Services.

To avoid the formation of wax crystals which can stop the flow of fuel to the engine, the fuel's cloud point should be lower than the ambient temperature. The pour point of a distillate fuel can be suppressed by cold flow improvers whereas the cloud point cannot be changed. Some distillate samples tested recently had a pour point of -33o C while the cloud point was +17o C. Seasons and operational patterns have to be carefully considered and the required cold flow properties specified when ordering distillates.

However, very few samples from emergency equipment storage tanks are being tested.

Samples taken from lifeboat engine and emergency generator storage tanks that were tested by Veritas Petroleum Services recently show some alarming trends:

- 11% of the samples received were dark, indicating some contamination by residual fuels. Since the cloud point could not be determined for these samples, it is recommended that these fuels should not be used for emergency equipment.
- The cold flow properties of more than 40% of the samples indicate that these fuels are not suitable for use when ambient temperatures drop to around 0o C.
- Many of the samples had a large difference between the pour point and cloud point, indicating the use of cold flow improvers to reduce the pour point. Cold flow improvers can also lead to filter blockage.
- Some of the samples showed the presence of fatty acid methyl ester (FAME), which could lead to storage and handling complications.

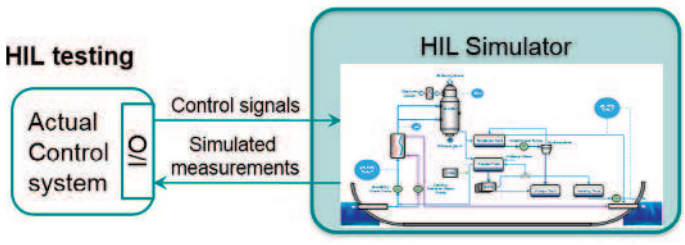
It is thus vitally important that fuel used in emergency equipment is verified to ensure it is fit for purpose at all times. ▮

Text: Ryanne.Jasmin@dnvgl.com

SCRUBBERS

Exhaust Gas Cleaning (EGC) System tested with Hardware-In-the-Loop (HIL) technology.

When performing HIL testing, the actual control system is isolated from the real system and instead connected to a virtual environment. Necessary actuators, dynamics and sensors are simulated in order to make the control system believe it is connected to the real system. The control system (with software from the specific vessel) is then thoroughly tested in this virtual set up.



Marine Cybernetics (MC) has performed the first EGC-HIL test for a major cruise ship owner! This marks a breakthrough for Marine Cybernetics, and is a reference project for future success as MC enters the cruise and ferry segment.

The test came as a result of DNV GL in Miami requesting MC to contribute on a specific project, and the test shows that HIL testing on an exhaust gas scrubber system is a valuable addition to the DNV GL Technology Qualification process.

MC's first test was finished in June 2015 on a retrofit project for a cruise vessel already in operation. The HIL test was a success; with

MC FACT BOX

- Established in 2002 as a technological "spin-off" from NTNU
- Headquarters in Trondheim, Norway
- Was acquired by DNV GL in May 2014
- 60 employees (majority MSc, PhD level)
- Introduced Hardware-In-the-Loop testing of computer control systems to the maritime and offshore industry
- Independent third party verification
- +11,000 findings from MC HIL testing to date
- over 150 customer project references
- 300 systems tested
- 60,000 test cases performed
- 300 systems tested
- 60,000 test cases performed

both the ship owner and the EGC system supplier very satisfied with the results.

Performed over a five day period at the FAT stage at the EGC system supplier site, the test revealed many findings related to non-compliance with Annex VI of the MARPOL Convention. According to vendor and ship owner, this test will reduce onboard commissioning time of the system, and most importantly reduce the risk of failures during operations, which could potentially lead to incidents and shutdown of the system.

Odd Charles Hestnes Project Director at Marine Cybernetics, overseeing all aspects of HIL testing. For further information please contact him on e-mail Odd.Charles.Hestnes@dnvgl.com

Exhaust gas cleaning (EGC) systems, also known as scrubbers, are being widely used in order to comply with Annex VI of the MARPOL Convention and other regulations, which regulate emissions from ships. The purpose of a scrubber system is to reduce SOx emissions from the exhaust. In order to reach the desired level of performance and to be in compliance with regulations, the EGC control system has to work seamlessly with sensors, pumps, valves, PLC's and the other integrated systems onboard the vessel. Hardware-in-the-loop (HIL) testing technology will help detect hidden software errors, erroneous configuration parameters and design flaws in the EGC control system.

Scrubbers are relatively new to the maritime industry, and with the combination of new technology, new vendors and new rule sets, this leads to a challenging environment for all concerned parties.

Many ship owners struggle with operational issues of their scrubber systems. They could be related to electrical, mechanical or software errors. The first two items can to a certain extent be fixed by onboard crew, but software issues requires software engineers from the EGC system supplier to come onboard. This will in most cases take some time. It is also well known that fixes done on any complex control system onboard can lead to the introduction of new failures in the system, which will appear at a later stage.

In Marine Cybernetics, we believe in doing thorough testing at a lab facility on a virtual set up as a complement to onboard testing. The Marine Cybernetics simulators used for the initial test, can then be re-used for testing system upgrades and troubleshooting during operation. With more than 10 years' experience testing complex control systems in the offshore industry, Marine Cybernetics is now looking forward to working in the shipping market as well. ▮

Text: wlaursen@bigpond.com

The new SeaRoad ship will transport mixed cargo, including containers, trailers, reefers, cars and other freight.

DRIVE-ON BUNKERING SIMPLICITY

SeaRoad Shipping's new RoRo vessel will feature an LNG bunkering concept that doesn't require any port infrastructure for refuelling, writes maritime journalist Wendy Laursen

Dale Emmerton, national marine manager at Australia's SeaRoad Shipping, has been watching what has been happening in Europe's short-haul RoRo market for the last couple of years. Faced with the challenges of cleaning up their heavy fuel oil (HFO) exhaust emissions, many European shipping companies have looked to installing scrubbers or burning diesel. Not content with either option, SeaRoad Shipping has come up with an innovative alternative.

SeaRoad's latest newbuild will feature a novel method for loading the ship's energy requirements. As in most ports, there is no direct infrastructure for refuelling liquefied natural gas (LNG) where the vessel will call, so locally available LNG will be bunkered by loading LNG road tank trucks directly onto the vessel during normal loading operations.

Energy for the future

The design features three LNG road tank containers connected to a permanent fuel manifold on the ship. They will be changed out after every round voyage for three tank containers that will have been filled the previous day at the local LNG plant. The tank containers will be secured to the vessel in a tank garage on the weather deck, aft, with multiple twist-locks.

The core business of SeaRoad Shipping is to provide logistics services to and from Tasmania.

This process is a relatively simple logistic task, particularly when compared with bunkering heavy fuel oil. "LNG as the primary fuel was chosen with an eye to both the present and the future," said Emmerton. "Currently our ships burn heavy fuel oil that is sourced overseas and imported into Melbourne by a single company for resale and delivery to the vessels. LNG is available locally from multiple sources and is seen as a more reliable and certainly cleaner energy source. Our eye to the future involved both the stability of supply and also the very strong likelihood that Australia will join other developed countries in banning the use of heavy fuel oil in the coastal waters where our vessels will exclusively trade. Australia has significant reserves of natural gas, which should ensure security of supply into the future."

Steel-cutting for the new ship started in Germany's Flensburger Schiffbau-Gesellschaft (FSG) shipyard at the end of September 2015, and DNV GL is providing full classification services including interpreting the novel concept in terms of the recently adopted IGF Code and also liaising with Australia's Maritime Safety Authority (AMSA) on its statutory requirements.

The project began back in 2008, said Timothy Holt, area manager for Australia and New Zealand at DNV GL – Maritime. "We saw the project as a pre-emptive partnership. LNG was just coming on as an option when SeaRoad needed to replace tonnage. DNV GL had been pushing for the adoption of LNG globally, and we felt we could step in as a technical partner both on the class side and the advisory side. So both parties saw the opportunity and had the intent to make it succeed."

Navigating regulations

Having won the tender for the project, the SeaRoad Shipping team met with a group of engineers in Oslo led by Torill Grimstad Osberg. The team conducted risk assessments and eventually granted approval in principle for the concept.

"At that stage all the development and rules were being based on large permanent tanks fitted below deck, but our local DNV GL surveyor was most supportive. Our method simplified the task of bunkering compared with conventional methods and made it much safer. This was quickly understood by the team in Høvik, and after the initial meeting, the DNV GL team was very quick to assist with solutions for achieving our idea. The rest of the story is almost history with the various codes and rules now taking into account portable-type tanks for short-haul, quick-turnaround ships," Emmerton said.

FSG, DNV GL and the Australian Maritime Safety Authority all participated in the risk assessment. Like heavy fuel oil, LNG is

To be built by FSG shipyard in Germany, the new RoRo vessel takes a simple approach to refuelling.

VESSEL DETAILS

SeaRoad Shipping's new RoRo vessel

Length	182m
Beam	26.6m
Draught	6.3m
Service speed	20kn
Cargo capacity	>1,960 lane metres
Propulsion	2 x MaK dual-fuel engines rated at 7.2 MW each
Power generation	2x MaK gensets rated at 2.5 MW
Start of construction	September 2015 at FSG shipyard, Germany
Classification	DNV GL ✠1A1 General Cargo Carrier RO/RO DG-P E0 NAUT-AW BIS GAS FUELLED TMON

classified as a dangerous product. "In the end the logic was quite simple. HFO is stored in tanks that are part of the ship's structure, and by proving that the LNG tanks can be securely fastened to the ship, they could also be seen as part of the ship's structure," Emmerton said.

The risk assessment led to the incorporation of a number of safety features to ensure appropriate levels of stability and fire safety. Heavier cargo units than an LNG tank would normally be secured by four twist-locks, however the gas tanks will have six.

Smart design ideas

The tanks take three cargo slots on deck, but the LNG piping system has no effect on cargo capacity. There are two main parts to the system: cryogenic and non-cryogenic. The cryogenic part includes the flexible pipes connecting the fuel tanks to a common manifold that feeds the LNG to a deck-mounted gas handling room where waste heat from the machinery plant is used to convert the -160°C liquid into a gas in specially designed heat exchangers. The cryogenic pipes have to be stainless steel and double-walled because of the very low temperatures.

Once the liquid has been heated and converted to gas, the piping is simpler but still requires ducts that are vented and monitored for potential leaks. When the gas reaches the engine room, it is supplied to the engines via gas valve units that regulate the gas pressure according to power demand.

"The uniqueness of the design means we had to go through a detailed approval process with DNV GL to take care of all the rules and regulations that are not yet 100% established with respect to the IGF Code," said Raimon Strunck, vice president of sales at FSG.

"The cargo mix has driven the design, because SeaRoad wants double-stack cassettes for shipping of containers on the main deck, a mix of trailers and cars in the lower hold and LNG trailers on the weather deck," Strunck added. There is also a specially designed area for the transport of live-stock. "Another cargo-related design driver is the fact that we have dangerous goods cargo in the forward part of the weather deck and, right behind it, reefers," he said. "This is rather unusual and normally not allowed due to explosion risks, but together with DNV GL we have found a design solution that ensures that this can be done safely and in compliance with class rules."

The core business of SeaRoad Shipping is to provide logistics services to and from Tasmania

Purpose-built for Bass Strait

The vessel's principal dimensions are 182m length overall, 26.6m beam and a maximum draught of 6.3m. Service speed will be 20 knots. The vessel's stern ramp is a split design to enable loading and unloading of two decks simultaneously. The design will streamline operations for truck drivers.

The newbuild will be twin propeller, powered by two MaK dual-fuel engines rated at 7.2 MW each. Two MaK gensets of 2.5 MW each will be installed to give the ship 100% electrical power redundancy, something that is critical considering the schedule that the vessel will keep and the high-value cargo that it will carry. "The main engines and auxiliaries are dual-fuel and the auxiliaries are unusually large for a RoRo, double the size in fact," said Strunck. "Melbourne experiences very hot summers, so SeaRoad needs the auxiliary power to run the reefer containers while they are in harbour."

The vessel is designed for the Bass Strait trade although it will be classed for worldwide operation. It will travel between Melbourne and Devonport, where high manoeuvrability is needed for turning and mooring at the pier. Strunck noted: "We have installed a specially designed flume stabilisation tank so rolling is reduced to a minimum, and we have optimised the hull shape to suit Bass Strait's prevailing conditions and provide good seakeeping behaviour while ensuring that the vessel's manoeuvrability meets the operational requirements."

A model for other short-sea routes

FSG is accustomed to meeting the unique and specific needs of shipowners. "The cargo mix is unusual, but it is a type of vessel you might also find here in Europe. Even though RoRo vessels might look similar from the outside, they are all purpose-built to the specific requirements of each customer," said Strunck.

"While LNG-powered RoRo vessels are relatively new and we know there will be many new developments along the way, we feel that the basic principle of our idea will lead to a growth in clean, reliable short-haul shipping that can be bunkered safely and quickly," said Emmerton. Strunck agrees the principle has significant potential in Europe and other parts of the world.

The newbuild is expected to commence service in late 2016. "Our masters have already manoeuvred the new vessel in the ship simulator in Western Australia after the hull design had been extensively tested in Denmark," said Emmerton. "We will definitely consider similar bunkering arrangements for our next newbuild. Some say we may not have a choice in the future." ▮

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MARITIME COMMUNICATION – HISTORY AND DRIVERS

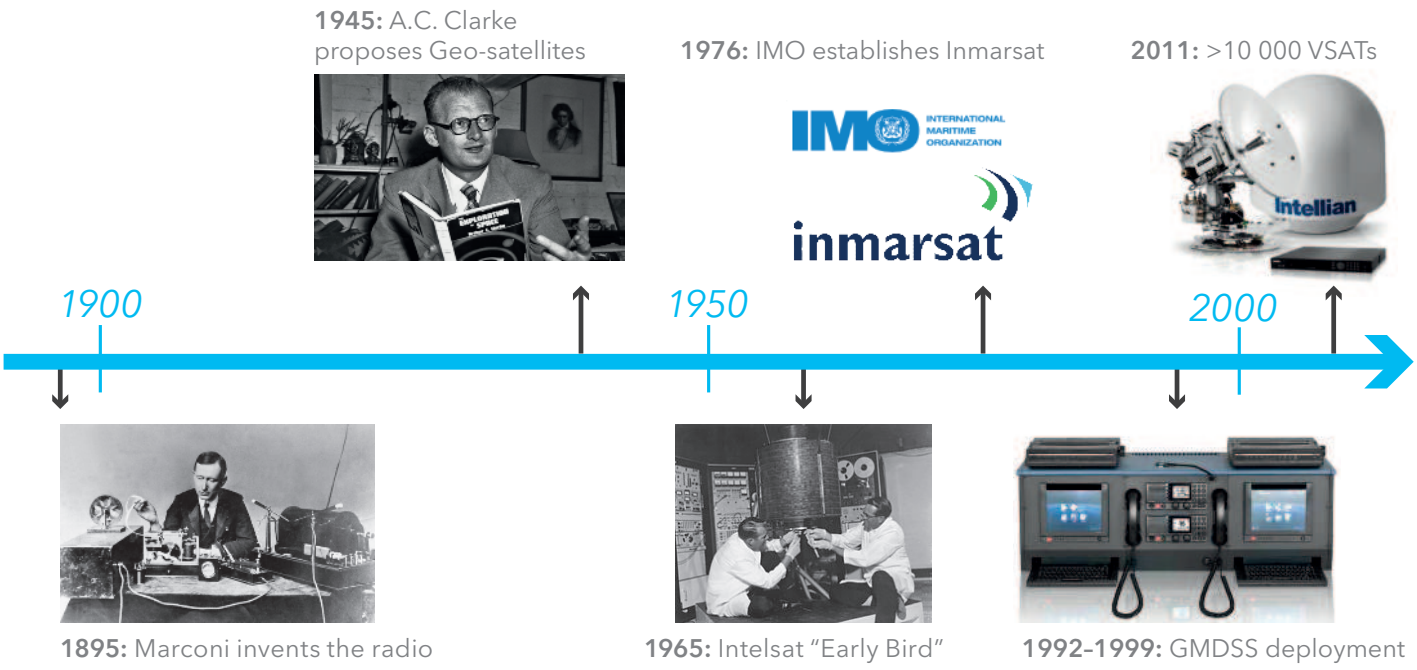

Figure 1 Maritime communications history - key milestones (Source: Norengros).

Steinar Låg,
Principal Researcher, DNV GL

In 1899, ten miles off the coast of Deal, near the Straits of Dover, the East Goodwin Lightship sent the first distress call using radio technology, which had been invented by Marconi a few years earlier. During most of the last century, maritime communications were solely based on radios using the VHF, MF and HF bands. Over 70 years later, in the 1970s, satellite communications equipment started to be deployed, initially just for analogue telephone calls and telexes and then with limited messaging data capabilities to support the GMDSS (Global Maritime Distress Safety System) in the 1990s.

During the past two decades, we have seen vessels being equipped with satcom equipment capable of transferring data of increasing bandwidth, such as VSAT (Very Small Aperture Terminal).

Whilst the original purpose of maritime communications was safety, typically driven by regulatory requirements, the current drivers are quite different. Today, ship owners deploy broadband communication on a voluntary basis in order to support data applications which improve ship operations and provide welfare and entertainment for crew and passengers.

THE VSAT BOOM

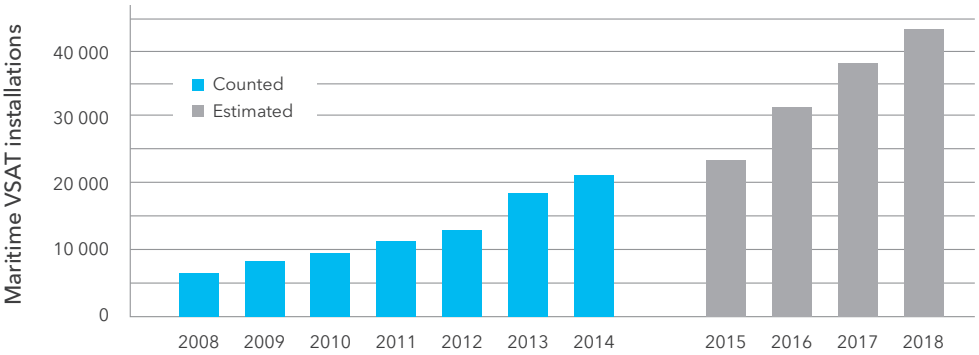

Figure 2 Maritime VSATs in service by year (Source: COMSYS [2]).

Figures from COMSYS show that the number of maritime VSAT installations in service increased from 6001 in 2008 to 21,922 in 2014, corresponding to an annual growth rate of 24%. Forecasts for the next few years indicate that the growth is set to continue, and that the number of maritime VSAT terminals will exceed 40,000 by 2018.

The available network capacity is also growing due to new systems deploying high throughput satellites (HTS) that provide many times more throughput than a classical FSS (Fixed Satellite Service) satellite for the same amount of spectrum. Some of the HTS systems which are expected to have the largest impact on the maritime sector over the next few years are listed in Table 1.

Table 1 New HTS systems

Name	Service launch	Comment
Inmarsat GX (Fleet Xpress)	2015	5MBps (uplink)/50 MBps (downlink)
Intelsat EpicNG	2016	Each new satellite has 10x capacity of existing fleet
Iridium Next	2016	Broadband service Certus 1.4Mbps, >10x of existing offering (Iridium Openport)
O3B	2014	Up to 500Mpbs
Telenor's Thor VII	2015	2-6Mbps (uplink), tens of Mbps (downlink)
Telesat Vantage2	2016	
ViaSat2	2016	2.5x capacity of existing satellite (ViaSat1)

With the rollout of these new satellite networks, Euroconsult has estimated that the overall VSAT bandwidth utilization in maritime regions will increase from 2.4 Gbps in 2011 to 12 Gbps in 2016, a five-doubling in just five years. [3]

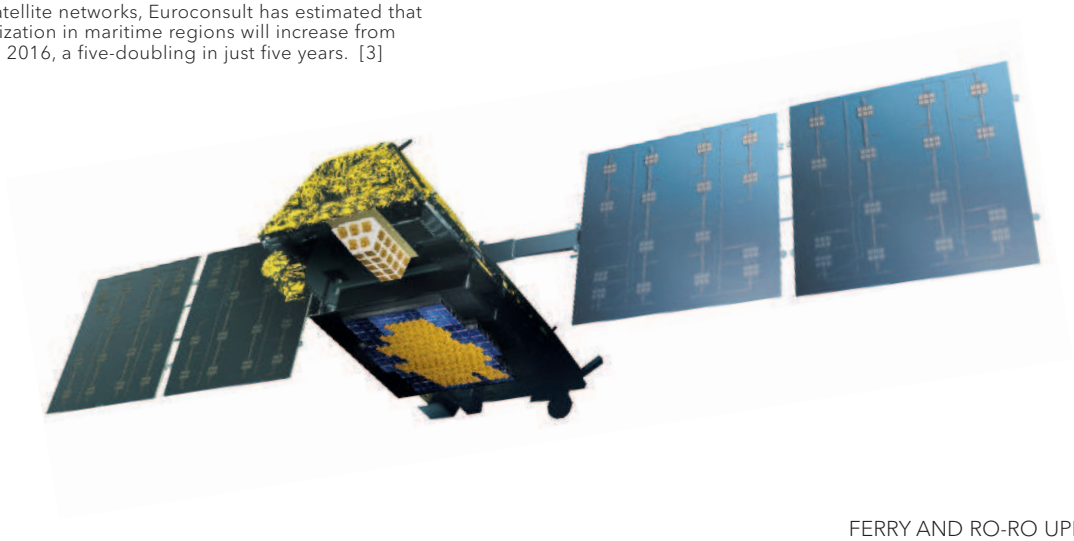

Figure 3 Iridum NEXT satellite (Source: Iridium Satellite LLC).

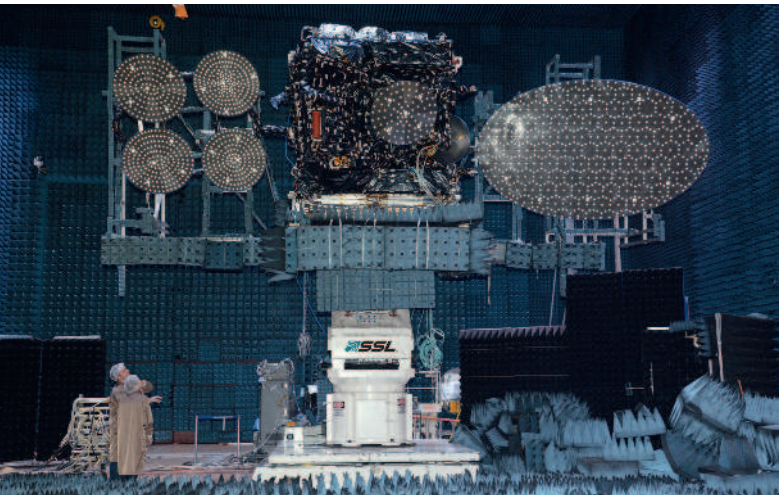

Figure 4 Telenor's new HTS 'Thor VII' inspected in factory (Source: Telenor Satellite Broadcasting).

Figure 5 Augmented Reality (AR) technology may be used to provide real-time shore-support for onboard maintenance (Source: http://daqri.com/).

NEW APPLICATIONS

The additional capacity being introduced by the new HTS systems will lead to increased data rates and reduced cost-per-bit for the user. Through increased availability and capacity, the improved ship connectivity is expected to enable and accelerate the uptake of new maritime applications such as:

- Condition monitoring
- Remote diagnostics and maintenance
- Autonomy and remote control
- Vessel traffic control/E-Navigation
- Risk-based classification and surveys
- Energy-efficiency optimisation
- Safety applications
- Environmental monitoring

OPPORTUNITIES AHEAD

The new possibilities enabled by the improved connectivity will create both opportunities and challenges for the maritime players. For ship owners and operators, the potential benefits include:

- Improve cost-efficiency and reduce downtime due to smarter vessels equipped with advanced ICT and sensor systems.
- Gain better insight and learn from how the onboard systems are performing and how they are operated by the crew.
- Use operational data for analysis and to make comparisons between vessels in order to deploy best practices across the fleet.
- Attract the best crew and passengers by offering internet connectivity.
- Provide better support from shore offices to the vessel and crew.
- Deploy monitoring and automation to reduce the crew.
- Provide a safer and more interesting workplace for the remaining crew.

However, there will also be challenges to be tackled in order to realize the new ship connectivity applications. For example, the reliability of the communication links, cyber security, data quality and lack of standards, as well as legal and commercial challenges. ∎

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3D PRINTING FOR THE MARITIME INDUSTRY

Shan Guan, Principal Consultant, DNV GL

Recent years have witnessed a wonderful expansion of innovative 3D printing technologies and applications in a variety of industrial areas, including in the maritime industry. The emergence of modern 3D printing can be traced back to the mid-1980s when Charles W. Hull was granted a patent on stereolithography. Today, 3D printing has established an impressive worldwide market, with mergers and acquisitions in full swing. As reported (Lux Research), the global market for 3D printing consisting of all products and services is expected to reach USD 12 billion by 2025. A survey of 105 manufacturers of 3D printers showed that Industrial/Business Machines, Consumer Products and Motor Vehicles were the three leading industrial sectors (Fig 1). Although the application of 3D printing to other areas, including maritime, currently constitutes only about 5% of the total market, rapid growth is anticipated. [1]

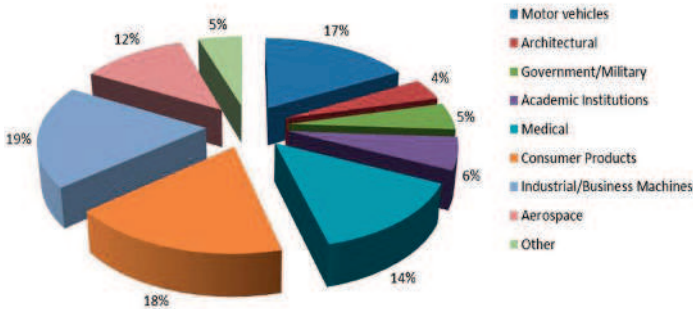

Figure 1. 3D printing industrial applications in 2014

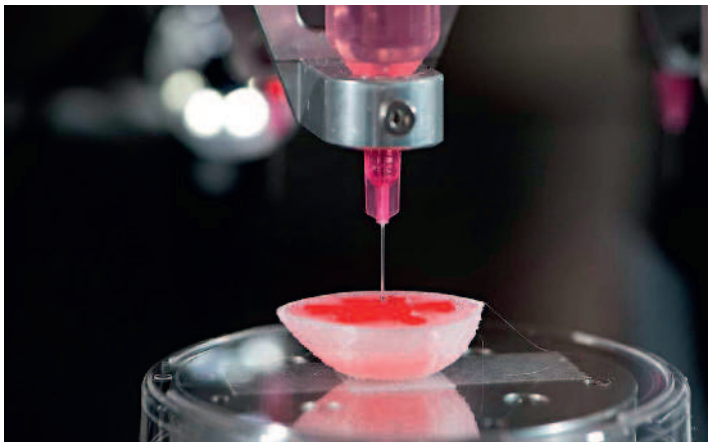

Figure 2. 3D printing of a "kidney" (www.popsci.com/science/article/2013-07/how-3-D-printing-body-parts-will-revolutionize-medicine.)

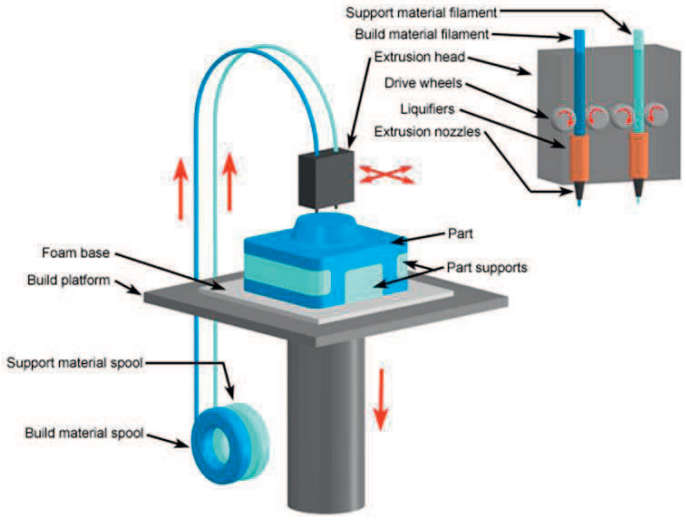

Figure 3. An illustration of the Materials Extrusion process. (Image courtesy of CustomPartNet, Copyright © 2008)

3D printing, also more academically known as Additive Manufacturing, builds parts by selectively adding material in a layer-wise manner (Fig 2). Seven types of processes, i.e. Materials Extrusion, Powder Bed Fusion, Directed Energy Deposition, Binder Jetting, Materials Jetting, Sheet Lamination, and Vat Photopolymerization fall into the domain of 3D printing technology. Among these technologies, the first three types are identified as having a high potential for implementation in producing parts for maritime applications. [2-3] Materials Extrusion (Fig 3) is mostly used for forming plastic 3D structures by forcing material through a nozzle. If 3D-printed metallic parts are needed, Powder Bed Fusion (Fig 4), which selectively fuses metallic powders using thermal energy, is probably the best choice. An example of a product using this technology is the fuel nozzles (Fig 5) for General Electric's CMF Leap jet, which is regarded as one of the most successful applications of 3D printing as the new nozzle is 25% lighter and five times more durable than that made in a conventional manufacturing process. [4] Directed Energy Deposition is yet another type of 3D-printing

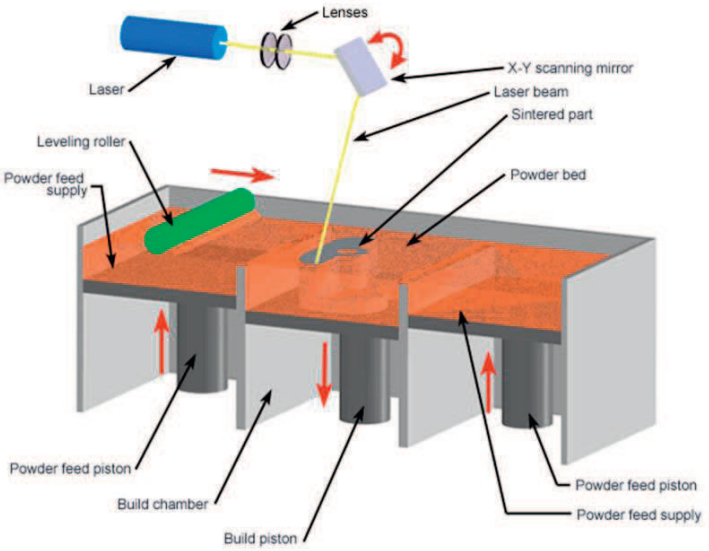

Figure 4. An illustration of the Powder Bed Fusion process. (Image courtesy of CustomPartNet, Copyright © 2008).

Figure 5. General Electric's fuel nozzles for CMF Leap jet made using direct metal laser melting. (See reference 4)

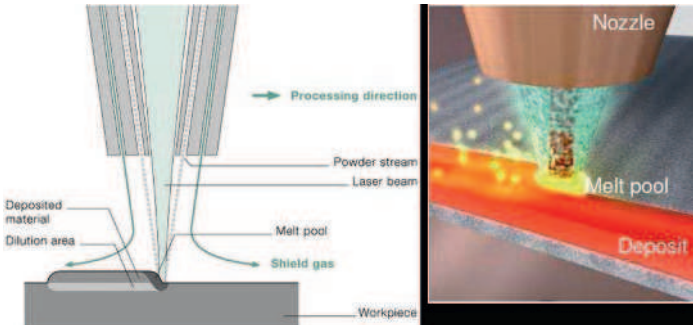

Figure 6. An illustration of the Direct Energy Deposition process. (Image courtesy of LPW Technologies and TRUMPF Laser).

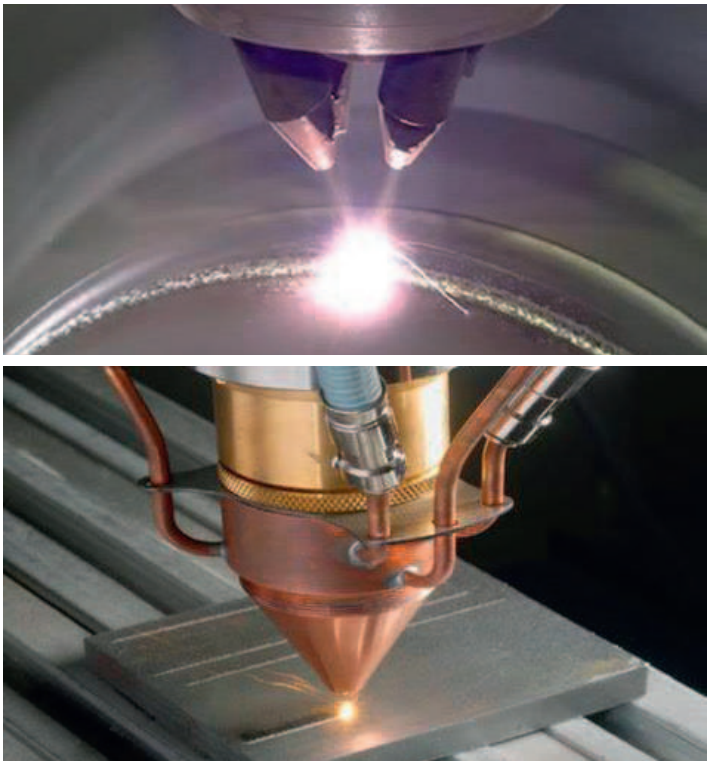

Figure 7. Examples of using the direct energy deposition process for part repair. (I. Gibson, D. W. Rosen and B. Stucker, ed., Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010.).

technology, and uses either a laser or electron beam to repetitively melt and deposit layers of a metal. In the maritime industry, this can be used to repair onboard parts when combined with suitable post-processing. (Figs 6 and 7)

Besides rapid prototyping, an attractive application of 3D printing in the maritime industry is the onboard printing of spare parts, which is desirable for reducing the inventory requirement. In a proof of concept test, the US Navy installed a Stratasys UPrint 3D printer on one of them and successfully printed an onboard oil tank cap and disposable ear speculum (Figs 8). [5] Not only the military, but also shipping companies, for example Maersk Tankers, have tested 3D printing at sea using the same type of 3D printer. [6] Although 3D printing is unlikely to become a disruptive technology in the maritime industry, it may affect the supply chain through onboard printing. Furthermore, once 3D-printed metallic parts, including the fuel nozzle, valves, heat exchangers, etc, are widely adopted on ships, the current classification procedure will

Figure 8. Stratasys uPrint SE Plus 3D Printer (www.stratasys.com/3d-printers/idea-series/uprint-se-plus).

Figure 9. BAYESIAN NETWORK ANALYSIS OF RISKS for 3D printing for an original equipment manufacturer (see reference 2).

inevitably be affected, i.e. standards and ship class rules may need to be revised. Therefore, this new technology brings both opportunities and risks for the maritime industry.

DNV GL researchers in Strategic Research & Innovation are exploring new risk assessment methods for the 3D-printing process from a material perspective. Based on their role in the supply chain, parties involved in 3D printing were divided into Original Equipment Manufacturers and End Users. For each situation, a risk mode framework was constructed using a Bayesian Network (Fig 9).

According to Narasi Sridhar, Programme Director of Materials, this is intended to answer the following questions: what is the risk associated with incorporating 3D printed components into systems? And secondly, which tools can be used to assess the risk added by using these parts? ▮

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LNG FUELS FERRIES AT AG EMS

Two ferries with LNG powered main drive and auxiliary systems started operating in German coastal waters this summer. DNV GL has been working with the owner and the shipyards to realize these green shipping concepts every step of the way. Both vessels will significantly cut emissions and be forerunners in green coastal shipping.

© AG Ems

The 30th of April marked an important day for AG Ems, when the German Shipping company's vessel *MS Ostfriesland* became the first German flagged ship to bunker LNG as fuel. In June, the retrofitted ferry will be joined in AG Ems' portfolio by a second LNG-fuelled vessel, the *MS Helgoland*. This newbuilding, currently in the final stages of construction, will be operated by AG Ems subsidiary Cassen Eils.

Both of these vessels will operate in the newly introduced ECA zone. The ECA – emission control area – extends throughout the Baltic and North Seas and means that all ships operating within the area must either use low sulphur fuels or treat the emissions from their engines to reduce the sulphur content, by using highly expensive marine diesel or installing a so called scrubber system for example. LNG is considered one of the most important alternative fuels to meet these restrictions and help the shipping industry reduce its environmental impact as vessels operating on LNG have greatly reduced SOx, NOx and particulate emissions while also emitting less CO_2.

Retrofit grows by roughly 15 metres

After successfully carrying out the first fuelling test with 40 cubic meters of LNG on board the *MS Ostfriesland*, the 94-meter RORO passenger ferry underwent sea and quay side trials before entering into service from Emden to the island of Borkum in the middle of June. Operating in an ECA would normally require the vessel to switch to marine gas oil or other low sulphur fuels. *MS Ostfriesland* will save more than one million liters of marine diesel per year as a result of the LNG conversion.

"As the aft section is being cut off completely and the new prefabricated section welded to the ship including a new engine room, so that the vessel will be operational shortly after conversion. That makes this project very special," says Henning Pewe, PTP Lead Gas technology expert at DNV GL – Maritime.

This new aft section and a large LNG tank have made the ship just over 15 metres longer than before. The vessel's new gas-electric propulsion system was installed using two different engine room concepts – a gas safe engine room and two emergency shut down engine rooms. The LNG tank is mounted centrally in the midships.

"The gas-diesel electric drive concept is tailored to the operating area. Four engines enable flexible operation modes both at sea and in port," Pewe says.

This cooperation inspired the promotion of LNG as ship fuel via the development of a draft LNG bunkering procedure for Germany and a draft training concept. "Through our close cooperation with AG Ems we advanced the project and managed to obtain relevant approval very quickly," he adds.

***MS Helgoland* can carry up to 1060 passengers**

"This vessel is the greatest investment in 170 years of company history," says AG Ems Director Dr. Bernhard Brons. "DNV GL was a very reliable partner in this project and we are convinced we are on the right track."

When completed, the *MS Helgoland* will be able to carry 1060 passengers from Cuxhaven and Hamburg to the island of Helgoland at a speed of up to 20 knots. And its LNG propulsion system makes it fully compliant with the ECA sulphur limits.

The 83-metre-newbuild will bunker 53 cubic meters of LNG. The eco-friendly drive concept will reduce CO_2 emission by 20 percent and cut nitric oxide (NOx) emissions by 90 percent and sulfur oxide (SOx) emissions by 95 percent, particulate matter emissions will be essentially eliminated.

The *MS Helgoland* is fitted with a twin screw propulsion system that has a maximum capacity of 5000kw. Each main engine drives a controllable pitch propeller and can be operated both with LNG and MGO. "A cold recovery system that uses the cold air emitted by the LNG during the fuel preparation process meets the ferry's need for heating, ventilation, or air conditioning without creating any additional energy requirements. A similar system is also installed on the *MS Ostfriesland*," Pewe explains.

With almost 150 LNG-fuelled vessels either in operation or on order, even though the technology is mature, in practice the infrastructure and practical operation is still evolving. Dr. Bernhard Brons is positive, but cautious: Currently we want to wait and see how LNG operation works in practice, before we consider retrofitting more of our vessels," says Brons. He also called for more common standards. "As a shipowner you want to have an engine that has a type certification, but this has not yet been realized for all of the engine parts on board." ▮

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THE NEW DNV GL RULES FOR SHIPS

The new DNV GL Rules are the classification society's signature, forming the basis of the organization and playing an essential role in DNV GL's work to make the maritime industry safer, smarter and greener.

Lars Christian Andersson, Ship Type Expert RoRo and Car Carriers, DNV GL

The new DNV GL plimsol mark

The competencies, cultures and history that stretch back 150 years, brought together through the merger of DNV and GL, have been the basis for the development of the new rule set. We are proud to put the DNV GL brand and logo on these rules, but we have not been acting alone. From the beginning of this project, the aim has been to develop a unique rule set reflecting the industry experience and input and to ensure that the rules deliver the quality, safety and process efficiency our customers expect. Due to this, our customers and stakeholders have been deeply involved throughout the development and implementation process. The contribution by leading yards, ship designers, manufacturers and ship owners world-wide has been beyond our expectations. Over 2,000 comments and suggestions were received, discussed and considered. Several hundred of these resulted in enhancements that have helped to make our rules the most market-relevant yet adopted by any class society.

In order to make the rules practical, clear, consistent and easy to use, their structure complements the typical design process. To give shipyards and designers starting out on a new project an easy entry point, 38 ship-type class notations have been defined. All ship-type-related requirements are now found in one place with a supporting class guideline.

One of the areas where we truly believe the rules will set a new industry standard is in relation to hull structures. The new advanced load concept is a major step towards a more realistic representation of the environmental loads. Along with our state-of-the-art capacity models and clearly defined acceptance criteria, this concept will increase the consistency in the safety level applied to the complete hull structure. It will also give designers and shipyards an improved framework for addressing critical areas and implicitly provide a better basis for optimizing the structure. In addition, this approach will accommodate the challenges related to the development of novel and unusual designs.

The feedback received from our customers and stakeholders during the consultation process and industry-involvement phase has been processed and incorporated into the rules. The publication of the rules took place 1 October 2015 and the new DNV GL Rules will enter into force on 1 January 2016.

With a rising tide of regulations and technology development, our customers face an increasingly complex and competitive environment. In response, we have a rule set that incorporates the most up-to-date standards, integrates advanced calculation tools and computational capabilities, and offers unrivalled flexibility to better respond to future developments. To support the application of the latest technology, we provide rules covering topics such as battery installations and hybrid technology, gas-fuelled readiness and LNG bunkering vessels.

Our clear ambition has been to develop the preferred industry standard while matching the individual needs of our customers. We are confident that our customers will experience the new rules as an improved basis for working with class, and we are committed to providing the best possible support. We are committed to supporting our customers and their suppliers throughout this phase so that they can experience the benefits of our rule set as early as possible. We are looking forward to working closely together on applying the rules to new and exciting projects.

The new DNV GL rule set also contains clear certification and documentation requirements, improved structural design principles and a significantly increased list of approved suppliers – all of which are important enhancements.

Impact on design

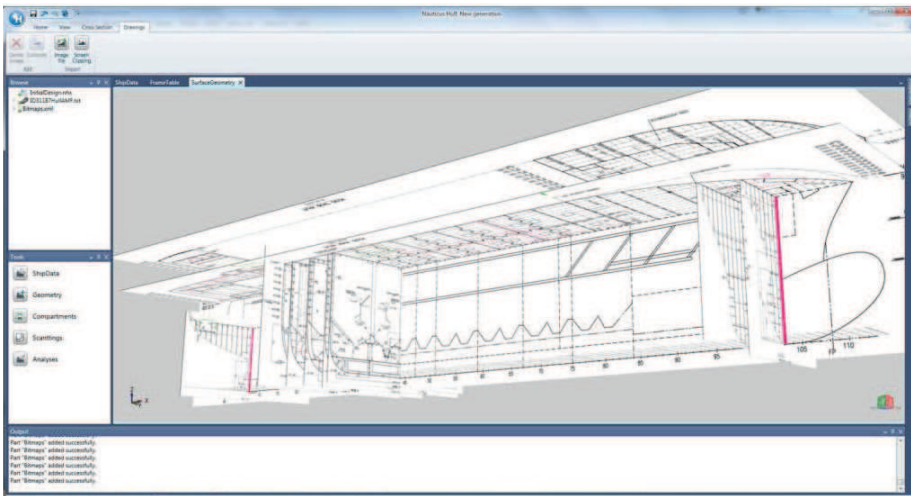
Based on new state-of-the-art capacity models, we see that there is potential for improving many existing designs. In general, steel will be added where it is really needed and reduced in structures that are less critical - based on a more accurate dynamic load pattern. The scope for direct assessments is unchanged, but alternative load application methods have been introduced.

The ship-type rules contain the ship-type-specific requirements beyond the general part for main class and clarify the required scope with respect to loads, direct calculations and ship-type-specific issues such as pillars, glass structures, balconies and system requirements. A supporting class guideline for passenger vessels and RoRo ships describes an acceptable method for assessing the structural calculation scope.

Software

In parallel with the rule development, DNV GL's calculation tools have been significantly upgraded and provide even more support for an efficient design process. These tools also contain elements to support the construction process.

New and exciting features will be included in the releases of both Nauticus Hull and POSEIDON in connection with the new rules. One which will be particular convenient for shipyards is the import of sections in bitmap and vector graphics with automatic scaling. This can be very useful to verify consistency between basic and detailed design drawings. (See the figure below.) ▮



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EEDI REQUIREMENTS FERRIES

Hamid Hemasi,
Senior Engineer, DNV GL

New regulations regarding the energy efficiency of ships have been included in MARPOL Annex VI and entered into force on 1 January 2013 for those ships engaged in international voyages. The requirements can be divided into two categories:

1. Design requirements applicable mainly to new ships, i.e. EEDI
2. Operational requirements for new and existing ships, i.e. SEEMP

A "new ship" means a ship which is contracted on or after 1 January 2013 or delivered on or after 1 July 2015. In this article, we take a look at the (EEDI) design requirements' applicability to and impact on ferries.

Ferries can fall under the definition of one or more of the following ship categories as defined in MARPOL Annex VI, Reg.2:

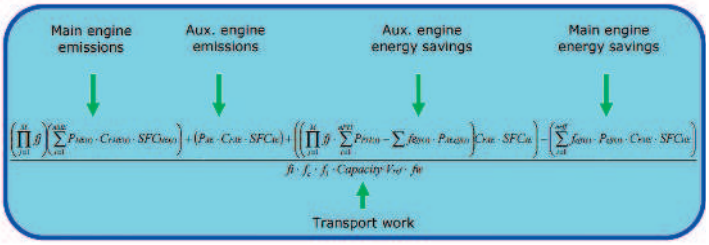
- Passenger ship means a ship which carries more than 12 passengers.
- Ro-ro cargo ship means a ship designed for the carriage of roll-on/roll-off cargo transportation units.
- Ro-ro passenger ship means a passenger ship with roll-on/roll-off cargo spaces.

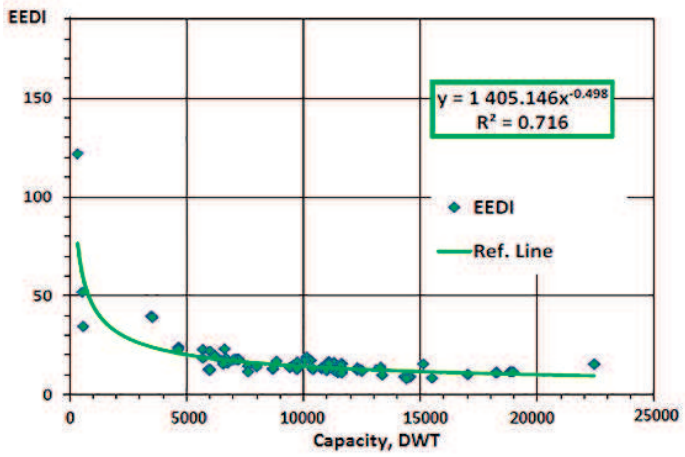
EEDI stands for Energy Efficiency Design Index. The purpose of the EEDI is to provide a fair basis for comparison, to stimulate the development of more efficient ships in general and to establish the minimum efficiency of new ships depending on ship type and size.

The EEDI value is defined as the ratio between the environmental cost and the benefit to society, which in this context leads to the following formula:

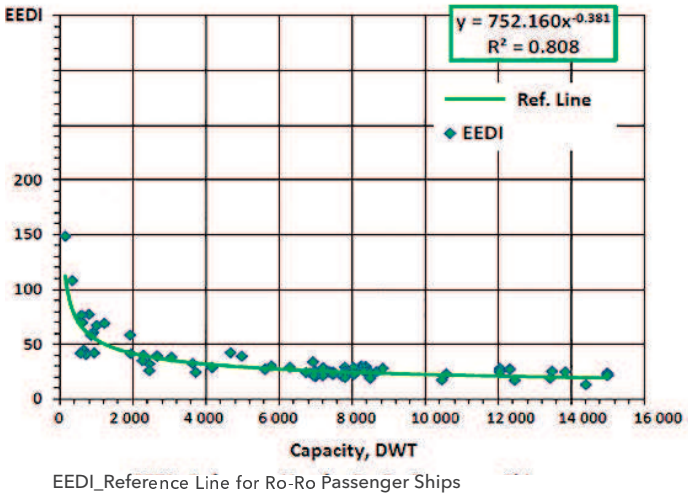
$$EEDI = \frac{CO2\ emissions}{\text{Transportation work}}$$

In mathematical terms, it leads to the following formula:





EEDI_Reference Line for Ro-Ro Cargo Ships



EEDI_Reference Line for Ro-Ro Passenger Ships

"The reference lines for ro-ro cargo ships and ro-ro passenger ships have been defined and are now in force for ships whose building contract is placed on or after 1 September 2015 or whose delivery is on or after 1 September 2019."

Hamid Hemasi, Senior Engineer, DNV GL

The unit of index is grams CO_2/tonne nautical mile. This means that the EEDI value indicates how many grams of CO_2 a ship will emit at stipulated conditions when travelling one nautical mile and transporting one tonne of cargo. The EEDI value is only calculated for one single design condition (e.g. fully loaded), at 75% MCR of the main engine and assuming the environmental conditions are ideal, i.e. no wind, no waves, no current and deep water with a temperature of 15°C.

The EEDI value is to be calculated for new ferries with a conventional propulsion system in which a main reciprocating internal combustion engine(s) is the prime mover and is coupled to a propulsion shaft either directly or through a gearbox.

The calculated EEDI value is called the Attained EEDI. The Attained EEDI shall be less than a reference line which is called the Required EEDI. The Required EEDI will be reduced every five years based on the initial value (Phase 0) and the vessel size.

A reference line is defined as a curve representing an average index value fitted on a set of individual index values for a defined group of ships. For the purpose of calculating the reference lines, data relating to existing ships of 400 GT and above taken from the IHSF database and delivered in the period from 1 January 1998 to 1 January 2010 are used.

Due to the high diversity of ro-ro cargo ships, ro-ro passenger ships and passenger ships, it has been very difficult to define the reference line for those types of ships during the first stage. Hence, in 2013 when the EEDI requirements came into force, only the Attained EEDI had to be calculated and there was no reference line/Required EEDI defined for ro-ro cargo ships, ro-ro passenger ships and passenger ships. However, since then reference lines for ro-ro cargo ships and ro-ro passenger ships have been defined and are now in force for ships whose building contract is placed on or after 1 September 2015 or whose delivery is on or after 1 September 2019. The reference lines for ro-ro cargo ships and ro-ro passenger ships are given below.

Please note that there is still no reference line for passenger ships but, if the design of a ship allows it to fall under more than one of the ship-type definitions, the ship's required EEDI value is to be the most stringent (lowest) one. This means that if a ferry falls under the definition of both a passenger ship and a ro-ro passenger ship, the reference line for ro-ro passenger ships must be applied.

What are the consequences for ferry owners, designers and shipyards?

The process of calculating and verifying the EEDI value includes verifying the reference speed, Vref. This normally requires the model towing tank tests to be carried out in a minimum of two loading conditions. One is the ballast condition and the other is the scantling draught condition. The tests should be witnessed by an EEDI verifier, which is normally a classification society carrying out the verification task on behalf of a flag administration. In addition, load variation tests at towing tank test facilities are required to be done for new designs. Industry practice may not be fully in compliance with current statutory requirements so it is very important that designers become familiar with mandatory requirements and involve the EEDI verifier at an early stage. The preliminary EEDI value is to be calculated and verified prior to the construction of the ship in order to indicate whether the ship will fulfil the requirements after the final EEDI value has been calculated too.

The contract speed is one of the newbuilding contractual terms between ship owners and shipyards, but has been excluded from the scope of agreements with classification societies. It should be noted although the verification of the reference speed is within the scope of EEDI verification by classification societies, verification of the contract speed is not. This means that the newbuilding contract between the ship owner and yard should focus on this.

The industry should pay special attention to the new standards and guidelines for conducting and analysing speed trials, i.e. ISO15016:2015 and ITTC 7.5-04-01-01.1-2. The new guidelines are already in force for all speed trials carried out after 1 September 2015. They contain well-defined conditions stipulating that speed trials should be conducted and analysed. The industry practice at speed trials has not been fully in line with the new standards and attention should be paid during the contract phase to implementing the new criterion and guidelines.

The EEDI is a design index that is calculated for only one single loading condition. So we advise the industry to take into account the ferry's operational profile and route when optimizing a design with respect to energy efficiency and to only consider the EEDI as a minimum efficiency requirement to comply with regulatory regimes. ∎

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ENVIRONMENTAL REGULATIONS ARE STILL EVOLVING – ARE YOU PREPARED?

Shipping's environmental impact remains a topic of keen interest for regulators, with both agreed regulations entering into force in the near future and new regulations being developed by various bodies around the world.

Eirik Nyhus, Director Environment, DNV GL

Over the past decade, shipping has seen a surge of environmental regulations. Political pressures and an increasing focus from society at large have driven the processes, leading IMO, countries and the EU to develop increasingly stringent environmental regulations. The consequence is a patchwork regulation system, where numerous overlapping regulations create challenges for operators seeking to stay compliant. There are unfortunately no indications in the policy landscape that this will improve. It is thus of utmost importance for operators to both understand the existing regulatory framework and be aware of forthcoming developments, both at IMO and elsewhere.

Ballast water management

Ballast water management has been one of the hottest topics for regulators for a number of years. At present, the Ballast Water Management Convention has been ratified by a sufficient number of nations to satisfy the entry-into-force provisions while the tonnage criteria remains unfulfilled. The combined tonnage from ratifying states is 2.14% short of reaching the threshold. It is worth noting that the combined gross tonnage of ships flagged with states signalling imminent ratification is 3.60%. We thus expect the ratification threshold to be reached in the not too distant future, with entry into force one year later. The content and interpretation of the convention is still evolving, with technical guidelines now undergoing revision and principles of "non-penalization" of early movers being generally agreed on by IMO. The ferry sector should note that IMO has not resolved the issue of the need for treatment when transiting between neighbouring sea areas - it is still the affected countries that determine any potential waivers. IMO has approved 57 different systems to date.

In the US, the domestic ballast water management regulations entered into force in 2013, with the first scheduled dry docking after 1 January 2016 becoming the critical date for the remainder of the existing fleet. There are presently no US type-approved systems on the market, but the US confirmed this spring that it has received documentation and type-approval applications for three systems. More than 50 AMS approvals have been issued; these are time limited (five-year) approvals for IMO-approved systems that will need full US approval before the AMS approval lapses. To ease the present entry-into-force transition, the US is being liberal about granting time-limited extensions to individual ships; once US-approved systems become available, the extension policy can be expected to become significantly more stringent.

SOx regulations

The sulphur oxide (SOx) regulations should be well known now, with the Sulphur Emission Control Area (SECA) requirement of a 0.1% maximum sulphur content having entered into force at the start of this year. The present discussions at IMO are centred on the question of the global 0.5% requirement entering into force in 2020 or 2025. A fuel availability study has been commissioned that will look at availability and demand figures and provide the technical and market basis for an IMO decision. The report will feed into the discussions at MEPC70 in October 2016, with a conclusion most likely being required by the spring of 2018. Taking IMO procedures into account, we will very probably know the provisional conclusion by the summer of 2017.

A complicating factor in the regulatory framework is the EU Sulphur Directive, which stipulates a maximum fuel sulphur content of 0.5% in all EU waters by 2020, irrespective of the IMO decision. If different dates are determined for international and EU waters, shipping will face a three-tier sulphur content regime. From an operational perspective, this will be challenging.

In certain EU countries, it should also be noted that the Water Framework Directive, as it applies to water discharge from ships, is putting constraints on the discharge of scrubber water. Belgium and Germany have in essence prohibited the discharge of scrubber water in most areas, leaving the users of open loop scrubbers in a position where they face severe constraints on how their scrubbers can be operated. Other EU countries are following suit to a lesser or greater degree.

An open question for shipping is the potential creation of new SECAs or domestic sulphur regulations. There are three candidate countries where this is on the domestic agenda; Mexico, which originally considered joining the North-American ECA, Turkey, which has been looking into creating an area for the Sea of Marmara and Bosporus Straits, and China, which is presently drafting the legal framework for domestic SECA-like requirements in the coastal areas outside Hong Kong/Guangzhou and Shanghai and in the Bohai Sea. We are confident that we will see Chinese regulations published in the near future, whereas Mexico and Turkey are somewhat more distant prospects.

NOx regulations

Like the SOx regulations, the NOx regulations should be well known by the industry. The key upcoming date is 1 January 2016, when Tier III requirements enter into force in the North-American ECA for ships constructed on or after the same date. In essence, anyone constructing a ship on or after this date needs to consider if operations in the North-American ECA will be part of the operations pattern upon delivery or in the future. If so, NOx control technology will be needed for that ship.

In contrast to the North-American ECA (which addresses both SOx and NOx), the ECAs in the North Sea and Baltic do not yet have NOx requirements. The involved countries have been discussing this for a number of years, but for reasons of politics no applications have been put forward. Recent signals indicate that the political impasse has been broken and that a joint North Sea/Baltic application may be forthcoming in late 2016 or 2017. A NOx ECA could then be established, with the earliest possible effective date being the date of adoption by MEPC.

CO_2 and energy efficiency

Climate change remains the driving force behind CO2 and energy efficiency regulations for ships. In the EU, regulations governing the Monitoring Reporting and Verification (MRV) of CO2 emissions have entered into force, in essence requiring all ships above 5,000 GT sailing to and from European ports to comply. Ships will also be obliged to report cargo data and average energy efficiency. The European Commission (EC) will make efficiency data publicly available on an annual basis. Ship-specific monitoring plans are to be submitted to verifiers by 31 August 2017, monitoring starts on 1 January 2018 and the first detailed results will be published by mid-2019. While the regulations have been finalised, there is extensive work ongoing to develop the practical framework for implementation. The EC is expected to make this available towards the end of 2016.

One of the stated purposes behind the EU MRV regulations is to encourage IMO to work on a similar mechanism with global, not only regional, coverage. If IMO agrees to such a mechanism, the EU has stated it will mothball the MRV regulations. However, at IMO the political sensitivities relating to the climate change issue are such that the work is proceeding with a significantly more limited scope. Presently, there is agreement on a need for a mechanism to collect fuel consumption data and that it should be limited to ships of 5,000 GT and above. There is no agreement on a number of fundamental issues, such as the collection of cargo data, calculation and reporting of energy efficiency, mandatory or voluntary application, etc. It seems unlikely that the present IMO efforts will be sufficient to satisfy the EU, implying that at some stage the shipping industry will have to deal with two different but overlapping reporting regimes.

In December this year, Paris will host COP 21, the next round in the international climate negotiations. As international transport remains outside the present framework of nationally reported emissions, there are pressures to include both aviation and shipping as distinct sectors to be regulated. While we do not expect major breakthroughs, there is an outside chance of an agreement that can have potentially significant implications for international transport.

Ship recycling

The entry into force of the Hong Kong Convention on Ship Recycling remains a distant prospect. Since its adoption in 2009, France, Norway and Congo are the only ratifying parties, rendering entry into force this decade an unlikely prospect.

However, the EU Ship Recycling Regulation has entered into force and may have an impact in the not too distant future. This regulation aims to end the scrapping of EU-flagged vessels on third-world beaches and will apply to EU-flagged vessels at the latest by 2018, depending on the recycling capacity of EU-approved yards. The list of such yards is expected by mid-2016. One key requirement will be the mandatory carriage of an Inventory of Hazardous Materials (IHM) which will apply to both EU and non-EU flagged vessels. The EU is also working on a financial mechanism intended as a barrier against reflagging to a non-EU flag prior to recycling. Details on this are also expected in 2016.

Wrapping up

The regulatory framework for shipping will evolve significantly over the next few years, in essence making regulatory developments a strategic driver. Understanding the impact is essential to making strategic business decisions.▮

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RULES AND REGULATIONS FOR GAS FUELLED SHIP INSTALLATIONS

Bergensfjord is a LNG powered ferry.

Linda Sigrid Hammer,
Principal Engineer, DNV GL

IGF Code

The International Code of Safety for Ships using Gases or other Low-flashpoint fuels (IGF Code) was adopted by IMO in June 2015. It will take effect on 1 January 2017. The IGF Code will be mandated by SOLAS and therefore serve as an addition to SOLAS. The IGF Code will only have detailed requirements for natural gas as fuel, but will also open for other alternative low flashpoint fuels by alternative design analysis. The goal is however to develop measures for other gases or low flashpoint fuels for inclusion in the IGF Code at a later stage. A phase two development of the IGF Code has been initiated to develop measures for methyl-/ethyl alcohol fuels, fuel cells and low flashpoint oil fuels.

DNV GL Rules

DNV GL has acknowledged the need to modernize the rules to keep up with the fast developing technology and keep the risk within acceptable limits. The new rules build on relevant real life experience as well as risk assessment tools. They contain functional requirements allowing for the ability to consider innovative solutions within the framework of the rules, but also include clear and prescriptive guidance for building safe gas-fuelled ships with known solutions. This means, for instance clearer guidance for spaces around "new" types of LNG fuel tanks and better requirements for cryogenic fuel piping going through the ship and for fuel preparation spaces. The updated rules also provide more precise certification requirements for components used in LNG fuel ship systems. Hence, the uncertainties for the owners and yards are reduced, both when looking into standard solutions and more innovative designs. The main outcome is, however, that the risks relating to gas-fuelled ship design are more efficiently lowered. The new DNV GL Rules for Gas Fuelled Ship Installations will be consistent with the IGF Code and are planned to enter into force in January 2016. ▮

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DNV GL GAS READY NOTATION

PREPARED FOR TOMORROW'S FUEL TODAY

DNV GL's new GAS READY notation gives owners, who at the new building stage want to prepare their vessel for a potential conversion to LNG operation after delivery, a useful framework for contracting. It provides a clear picture of the level of LNG-fuelled preparedness of their vessel, as well as guidance on the scope of the contemplated work to all involved parties.

"We developed the new GAS READY notation based on the experience we have gained from our LNG Ready service as well as the 50 LNG-fuelled vessels we already have in class with our GAS FUELLED notation", says Torill Grimstad Osberg, DNV GL Head of Section for LNG Cargo Handling & Piping systems. "This new notation enables owners to ensure that a future LNG-fuelled version of the vessel complies with the relevant safety and operational requirements, while also being very useful in helping owners specify and quantify the level of investment they are making at the newbuilding stage."

The basic notation with nominators D and MEc – GAS READY (D, MEc) – verifies that the vessel is in compliance with the gas fuelled rules in terms of its overall design for future LNG fuel operations and that the main engine can be converted or operate on gas fuel. The owner can also choose to add extra optional levels to the newbuilding under the notation. These cover selections such as structural reinforcements and the choice of correct materials to support future LNG tanks (S), preparations for future gas fuel systems (P), certification and installation of LNG fuel tanks (T), and the installation of machinery, which can be converted gas fuel, or which is already capable of burning gas fuel - putting the vessel further along the LNG track and thereby speeding and simplifying a later conversion. ▮

Gas Ready – basic notation and extended options (as at 2.12.2014):

GAS READY	D	The design for the ship with LNG as fuel is found to be in compliance with the GAS FUELLED notation rules applicable for the new-building, ref. Pt.1 Ch.1 Sec.2 A300
	S	Structural reinforcements to support the fuel containment system (LNG fuel tank(s)) are installed, and materials to support the relevant temperatures are used
	T	Fuel containment system (LNG fuel tank(s)) is installed
	P	The ship is prepared for future gas fuel system installations: pipe routing, structural arrangements for bunkering station, gas valve unit space, fuel preparation space if relevant (optional)
	MEc	Main engine(s) installed can be converted to dual fuel
	MEi	Main engine(s) installed can be operated on gas fuel
	AEc	Auxiliary engines installed can be converted to dual fuel
	AEi	Auxiliary engines installed can be operated on gas fuel
	B	Boilers installed are capable of burning gas fuel
	Misc	Additional systems and equipment are installed on board from new building stage

DNV GL's new GAS READY notation provides a clear picture of the level of LNG-fuelled preparedness of a vessel.

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