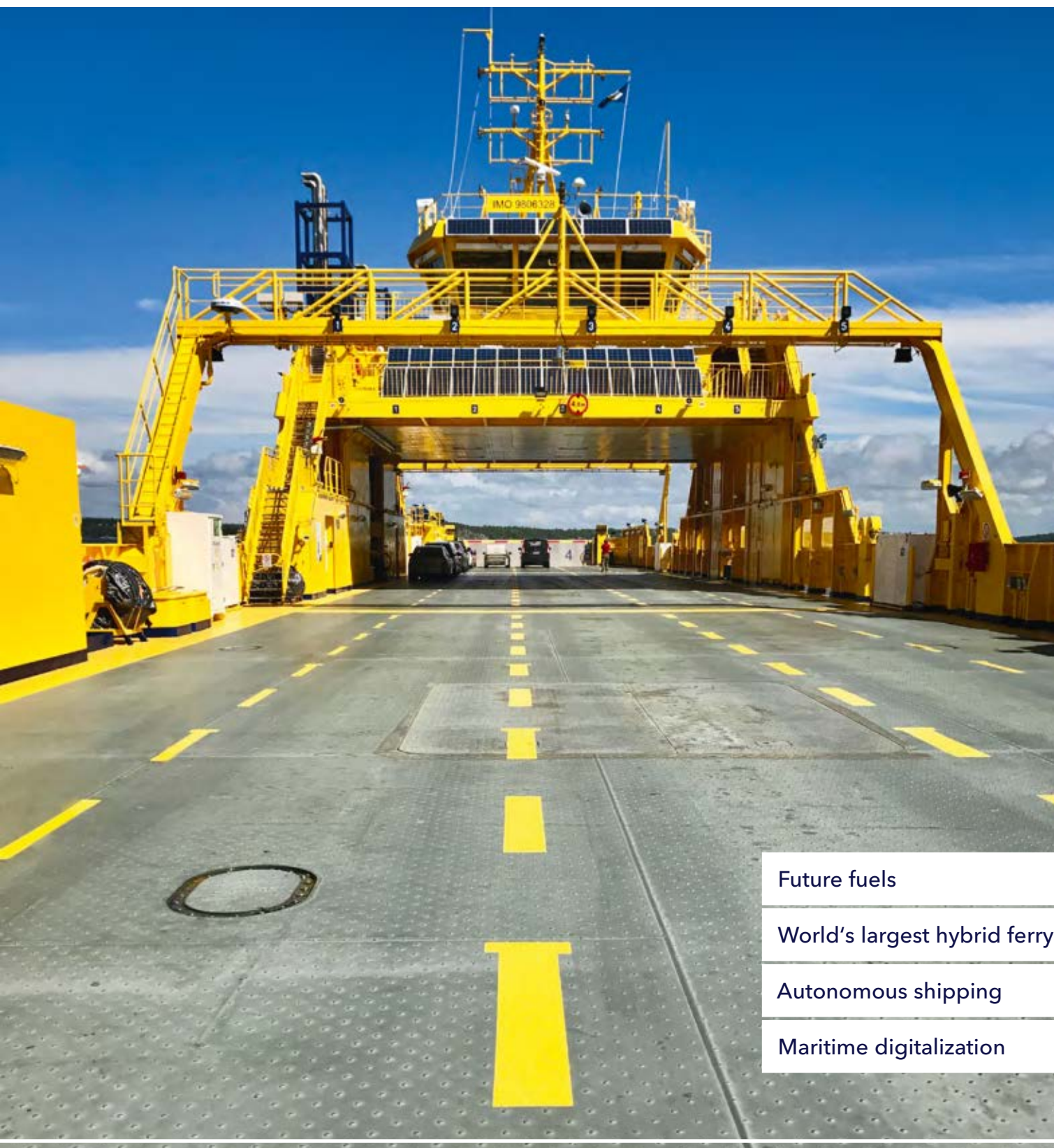


FERRY AND RO-RO UPDATE

2017



Future fuels

World's largest hybrid ferry

Autonomous shipping

Maritime digitalization

CONTENT

Zero emissions	04	DNV GL's digital journey	16
Clean air in the fjord	06	Clear view on the regulation front	19
Effective mitigation of fire risks on board	08	Managing watertight doors	22
Ensuring the viability of the ferry sector	10	Thinking ahead in ferry design	24
A new age of shipping	12	Dawn of a new era	26
Continuing the efficiency squeeze	14		

Cover photo: Finferries





Hans-Eivind Siewers
Segment Director Passenger Ships and Ro-Ro
hans.eivind.siewers@dnvgl.com

FERRY AND RO-RO UPDATE

Published by DNV GL
Maritime Communications

DNV GL - Maritime
20457 Hamburg, Germany

DNV GL - Maritime
1322 Høvik, Norway

Additional authors:
Andreas Kühner (AK), Sabrina Junge (SJ),
Jeannette Schäfer (JS)

Design and production:
printprojekt, Hamburg

Layout: Lohrengel Mediendesign,
Hamburg

© DNV GL AS
www.dnvgl.com

DEAR READER,

A number of new ships equipped with state-of-the-art technologies to meet future environmental regulations have been delivered over the past twelve months, such as *Elektra* and *SeaRoad Mersey II*. The development and adoption of innovative technologies is a hot topic for the ferry industry, where they can often be applied more easily than on ocean-going ships. For example, autonomous shipping will first be realized on inland routes where IMO regulations do not apply. There are no common international regulations as yet, a fact that is unlikely to change in the near future. Ferries are therefore an excellent testing ground for new technology. Batteries as an alternative energy source are rapidly gaining ground in the market, especially on vessels sailing in areas where environmental protection and noise reduction are key concerns. The new vessel *Color Hybrid* is a prime example. Meanwhile, various projects and studies in the field of fuel cells are paving the way for a wider adoption of this technology as a viable energy source. With more alternative fuels entering the market, some owners might find it challenging to decide which one to choose for a given project. Our experts at DNV GL are ready to provide advice and support.

This issue of FERRY AND RO-RO UPDATE also focuses on future developments beyond saving energy and reducing emissions. Anders Ørgård from OSK shares some thoughts on how to explore further areas for cutting costs while enhancing the experience of passengers on board.

The order books of traditional passenger shipyards are full, and we see new yards entering the segment. For example, Xiamen have been contracted by Viking Line to build their next LNG-powered ro-pax vessel.

Mike Corrigan, the new CEO of Interferry, presents his views on recent achievements as well as challenges facing the ferry industry, especially in terms of regulations. A summary of current and upcoming regulatory changes by our expert Eirik Nyhus alerts the industry to issues it will soon be dealing with.

It is good to see that the market is that active, and we at DNV GL are happy to further drive and support the developments on the classification side.

Enjoy reading!

ZERO EMISSIONS

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

The international shipping industry is facing an increasingly tight regulatory environment, especially when it comes to emissions to air. And with the recent decision to implement the global sulphur cap in 2020 and to add the North and Baltic Seas to the list of nitrogen oxide (NO_x) emission control areas, the pressure is on. For zero-emission solutions such as fuel cells, battery and hybrid technology, these developments have been a real boost.

Color Line's decision to order *Color Hybrid* is the latest milestone for the adoption of battery hybrid solutions in shipping.

A promising technology

As a plug-in hybrid, *Color Hybrid*'s batteries will be recharged either with a power cable with green electricity from shore or by the ship's on-board generators. Its bank of four to five MWh (megawatt hour) batteries will deliver sufficient power to enable fully electric operation for 30 minutes and enough to sail, silently and with zero CO₂, NO_x and SO_x emissions.

"To date, hybrid battery solutions have been mostly confined to smaller car ferries and on shorter ferry routes, like the *Vision of The Fjords*, operating in Nærøfjord on the west coast of Norway," says Narve Mjøs, Director Battery Services & Projects at DNV GL – Maritime.

Vision of The Fjords, owned by The Fjords and built at the Brødrene Aa shipyard in Norway, has a parallel hybrid drive, with a conventional MAN engine and two electric motors that can each power the ship separately or together. On top of that the two electric motors can be charged by the onboard diesel engine, or in just 20 minutes directly with onshore power.

However, innovative research conducted to develop batteries for the automobile industry means that today batteries boast

enhanced power density, and the cost of lithium-ion batteries has been lowered by up to 80 per cent over the past four years, making battery and hybrid technology a more attractive option for larger ship segments as well.

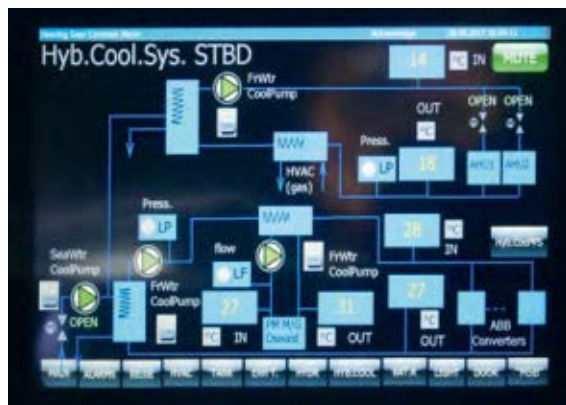
Last autumn Hurtigruten signed a contract with the Norwegian Kleven yard for two 140-metre-long hybrid cruise ships. DNV GL is the classification partner for both projects. The first of the Hurtigruten vessels will feature a battery-powered auxiliary engine for "peak shaving", where the battery dynamically responds to cover spikes in demand – this measure alone is predicted to cut fuel consumption by 20 per cent. The second vessel will have batteries capable of sustaining fully electric operation for 15 minutes, possibly more. If it proves successful, this more ambitious implementation will later be retrofitted to the first ship. "I am confident we will see battery and hybrid technology being implemented more passenger and ro-pax ferries. For example, operators could use battery power to eliminate emissions during port sailing and port operations and ensure noise- and vibration-free operations when sailing through spectacular tourist sites such as fjords. Battery power could also power tender boats and eliminate any vibrations and diesel smoke," says Mjøs.

A new generation of fuel cells

Another zero-emission technology which has gained traction is fuel cells. The European Maritime Safety Agency (EMSA) contracted DNV GL to provide a technical study on the use of fuel cells (FCs) in shipping to evaluate the potential and constraints as prime mover and energy sources in shipping. A risk assessment study to analyze possible safety challenges for maritime fuel cell applications on ro-pax vessels investigated 148 failure scenarios

Vision of The Fjords is possibly one of the most advanced sightseeing vessels ever built.





Vision of the Fjords's parallel hybrid drive allows the electric and diesel engines to be operated independently. The batteries (left, at right) can be charged using shore power or surplus energy from the diesel engine. The electric engine, which doubles as an alternator, has a state-of-the-art water cooling system (far left).

related to the usage of the three different types of fuel cells and fuels. As a result, for a total of 100 scenarios, additional mitigation actions were recommended. Taking these recommendations into account, the analysis team recognized that tolerable risk levels (ALARP) could be reached, with respect to operational and human safety. The study also provides an overview of major maritime fuel cell projects to date.

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

Successful pilots

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

In the Pa-X-ell project, DNV GL and the German cruise yard Meyer Werft are working together to trial high-temperature PEM fuel cells, powered by methanol, on board passenger ships. ThyssenKrupp Marine is heading another project called SCHIBZ, which focuses on the development of a scalable, integrated hybrid fuel cell system for ocean-going ships, with a rated power output of 50 to 500 kilowatts. This hybrid system has an electrical efficiency of approximately 50 per cent. Finally, the Rivercell project is dedicated to the design and development of a fuel cell hybrid system for inland vessels. "The pilot projects have successfully completed initial readiness tests for maritime deployment and have been installed on board ships for prototype trials," says Lars Langfeldt, Senior Project Engineer at DNV GL - Maritime, who works on the e4ships project. "All of them use fuels that are readily available in large quantities around the world," he adds. While Rivercell and Pa-X-ell use methanol as an energy source, the fuel cell system tested in the SCHIBZ is powered by low-sulphur diesel.

The second phase

Currently, the e4ships project partners are focusing on the next development steps and prototype tests as well as the design of decentralized on-board networks comprising several fuel cells.

Project phase II is scheduled to continue until 2021 - the ultimate goal is to present production-ready technologies.

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



DNV GL Expert

Dr.-Ing. Gerd Würsig, Business Director
LNG-fuelled Ships
Phone: +49 40 36149-6757
E-Mail: gerd.wuersig@dnvgl.com

INFOBOX FUEL CELLS

Fuel cells offer high electrical efficiencies of up to 60 per cent, as well as less noise and vibration than conventional engines. The main components of the fuel cell power systems are the fuel cells. They convert the chemical energy of the fuel directly into electrical and thermal energy by electrochemical oxidation. The direct conversion offers electrical efficiencies of up to 60 per cent, depending on fuel cell types and fuel used. Due to their high work-

ing temperatures, various fuel cell types offer the use of fuel reforming systems. Fuel reformers process fuel to a hydrogen-rich fuel to be converted in the fuel cells. In addition to pure hydrogen, fuel reformers offer the use of different fuels like natural gas, methanol and low-flashpoint diesel. Thus, fuel cells offer high reduction potential for emissions to air.

More information on alternative fuel are available at: dnvgl.com



CLEAN AIR IN THE FJORD

Maintaining its focus on advanced environmental technology for its new ships, Color Line has ordered the world's biggest hybrid ferry. The vessel will be able to operate exclusively on electric power while in Sandefjord and in the Strømstad area.

The vessel with the working title *Color Hybrid* is a ro-pax ferry, a new segment for Ulstein Verft where the ship will be built. Ulstein Group, with its subsidiaries Ulstein Verft, Ulstein Design and Solutions, and Ulstein Power and Control has been a major player in the design and construction of offshore vessels for decades. "When the offshore market almost disappeared overnight, we had to look into new ways and segments to utilize our 100 years of knowledge and competence," says Kristian Sætre, Managing Director and COO Shipbuilding from Ulstein, explaining his company's expansion into the ro-pax market. "Participating in the *Color Hybrid* tender and project has given us a very good position in this new segment. Backed by our comprehensive competence and our yard facilities, our ambition is to become a significant actor in designing and building ro-pax vessels and smaller cruise vessels," he continues. The yard is well prepared to build this vessel type since its shipyard facilities fit the construction demands very well with regards to both dock and crane capacities, and expertise from other segments.

The ferry *Color Hybrid* will be classed by DNV GL. The agreement with the class society is normally one of the first contracts signed after a shipbuilding contract has been confirmed. From that stage on, DNV GL accompanies the entire process until the ship leaves the shipyard. Joint meetings and workshops as well as mandatory and mutually agreed surveys make sure the design parameters are in compliance with the applied rules. "Quite

frequently we also rely on DNV GL experts as consultants when questions arise. We value DNV GL as a partner, and we have a common goal: to hand over a ship to the customer which fulfils his expectations," Sætre underlines the role of class. "It is important to us to be part of this innovative project, which rewards us for the effort we have put into the development of our additional class notation for battery power, and for various studies we have participated in to promote the use of batteries as an alternative power source," says Helge Hermundsgård, Business Development Manager at DNV GL. The additional class notation Battery (Power) is mandatory for vessels using battery power for propulsion during normal operation or as a redundant power source. The Battery (Power) notation confirms that the battery installations in a vessel meet increased safety requirements.

Award-winning design

Color Hybrid is a plug-in hybrid using both diesel and electrical power. The batteries are recharged with green electricity from the company's own shoreside facilities at the Sandefjord dock. They can also be recharged on board using the ship's own generators.

"There is a specific functional concept and philosophy behind the hybridization of *Color Hybrid*," Sætre explains. "We have found that in almost all projects we work on these days, battery power is taken into consideration as an option, regardless of the segment." Sætre also points out there is a trend toward hybrid vessels. In a



With an innovative hull design and a powerful battery pack on board, *Color Hybrid* can operate for up to 60 minutes without any emissions to air.

typical arrangement there is a dedicated space for battery banks of a certain size. To truly benefit from a battery installation there needs to be an operational philosophy, such as operating silently in certain conditions, utilizing the battery under peak loads to avoid having to start extra generators or to minimize the required generator capacity, or sailing in certain areas without polluting the air. "The investment in a hybrid solution may be high. Ulstein will assist customers in deciding whether and to what extent this investment would be beneficial," Sætre points out. For vessels being prepared for future utilization of batteries, the yard can design the relevant components to minimize the cost of the actual battery installation and configuration at a later stage. While in the waters of the Sandefjord, *Color Hybrid* will operate solely on battery power. No emissions of harmful greenhouse gases or nitrogen and sulphur compounds will harm this area. What is more, the exterior noise level at low speed and while moored, measured at 100 metres distance from the vessel, will be lower than that of a normal conversation. DNV GL's class notation "Clean" confirms the vessel's enhanced environmental design and performance standards.

Fosen Yard has designed the hybrid ferry in close cooperation with Ulstein Verft and Color Line. "Fosen Yard has extensive

experience with such vessels, and we work together to achieve optimum results," Kristian Sætre emphasizes. Design manager Per Edvin Tande of Fosen Yard says *Color Hybrid* will feature a new hull design. "There is a new and improved hull design which benefits from our experience and knowledge gained in past projects. Energy and environmental concerns are the driving design factors for the equipment on board the new ferry," says Tande. The battery package has a capacity of about 5 MWh (megawatt hours), enabling the vessel to manoeuvre or sail at speeds of 0-12 knots for up to 60 minutes. The waste-heat recovery system on board will use a heat reservoir system.

In May 2017 the design won the Next Generation Ship Award, which honours the most promising design for ships that will be at sea in the coming decade. The jury explicitly praised the good and professional cooperation between the three companies from day one with a focus on innovation and greener technology.

Biggest hybrid ferry to date

The natural environment is an accelerator to Color Line, whose company has installed shore power facilities in Oslo, Larvik and Kristiansand. With Sandefjord already established as a recharging port, all Norwegian Color Line ports provide access to shore power. "Our ambition is to be a leader in European short-sea shipping, and *Color Hybrid* is new proof of this," says Trond Kleivdal, CEO of Color Line.

With a length of 160 metres, *Color Hybrid* will have the capacity to carry 2,000 passengers and around 500 vehicles, making the vessel the world's biggest hybrid ferry, with almost double the capacity of the ship she will replace. The new vessel will be built according to Norwegian flag requirements and registered in the Norwegian Ordinary Ship Register (NOR).

Rolls-Royce will supply four Bergen B33:45L diesel engines to power the new hybrid ferry. The delivery of the engines is scheduled for March. *Color Hybrid* will be put into service between Sandefjord, Norway, and Strömstad, Sweden, in summer 2019. ■ JS



DNV GL Expert

Helge Hermundsgård
Business Development Manager
Phone: +47 468 91 590
E-Mail: helge.hermundsgard@dnvgl.com

COLOR HYBRID MAIN FEATURES

- Plug-in hybrid technology. Designed to be highly energy-efficient and have a low environmental impact.
- Zero-emission operations in port possible using high-voltage shore connection (HVSC) in combination with battery hybrid propulsion system.
- Good WHR (waste-heat recovery) capabilities utilizing a heat reservoir system.
- Extremely low noise emission during battery operation and during overnight port stays.
- Designed by Fosen Yards
- Built by Ulstein Verft
- Delivery in 2019
- Length: 160.0 m
- Beam: 27.10 m
- Draught (max.): 6.0 m
- Speed (max.): 17 kn
- Accommodation: 100 POB (Note: Subject to selected variant configuration)
- Water ballast: approx. 1,500 m³
- Fresh water: approx. 450 m³
- Classification: *1A Ferry A BIS Battery(Power) BW(M,T) Clean COMF(C-2, V-2) ECO F(M, C) Ice(1B) LCS(DC) MCDK NAUT(OC) Recyclable TMON(oil lubricated) VIBR



The requirements of the revised F (A, M, C) class notation are cost-efficient.

EFFECTIVE MITIGATION OF FIRE RISKS ON BOARD

DNV GL has revised the voluntary F (A, M, C) class notation to account for findings from various fire incidents during the last decade and advancements in safety technology. The revised notations will be published in January 2018.

The last revision of the F (A, M, C) rules took place in 2005. That revision primarily focused on the F (M) engine room fire safety level. A recent evaluation of various fire incidents since 2005 revealed several trends, which have been taken into consideration for the latest revision:

- Engine room fires are still rather frequent. In many cases they can be contained quickly by the new water mist systems, provided that the system is released quickly. In other cases the system was released with a delay, and in a few incidents not at all. Global statistics show several fatal accidents, in some instances with multiple fatalities.
- Ro-ro fires have become a hot topic over the past ten years. The main area of concern are semi-open ro-ro decks on passenger

ferries. On the other hand, closed ro-ro decks and weather decks show much better results.

- Fortunately there have been few serious fires in accommodation spaces. Galleys are still a concern, and big laundries merit further close monitoring. There have been a few open-deck fires on cruise vessels involving plastic balconies, mooring decks and other areas where a fire can have a severe impact because of the proximity of crew and passenger cabins as well as public spaces. Design improvements in such areas are crucial.

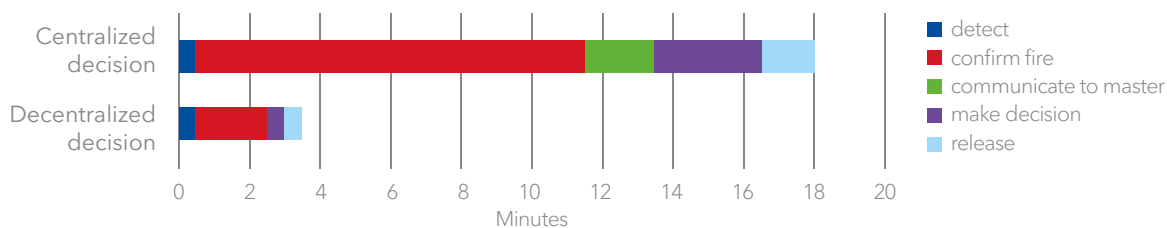
Safety in focus

The F (A, M, C) is a voluntary class notation. Rules will only be applied if requested by the builder and included in the class

A closed-circuit TV system (CCTV) on board a ro-pax vessel alerts crew members about a fire instantly by showing smoke and, in most cases, the seat of the fire. Combined with a decentralized chain of command, it can help cut response times dramatically.

REACTION TIME - WATER SPRAY (DELUGE) FOR RO-RO DECKS

Comparison of centralized vs decentralized decision-making



contract between yard and DNV GL. With the revised class notation the class role shifts from confirming compliance with a given safety level to confirming that the safety provisions for a specified segment ("Accommodation", "Machinery", "Cargo") not only comply with international regulations but also satisfy specific, relevant safety expectations.

F(A) Accommodation

New requirements for ventilation and smoke control in staircases and cabin/corridor areas have been defined for the F (A) class. Local alarms (buzzers) have been introduced for cabins. These new requirements will ensure rapid and safe evacuation in case of a fire in the accommodation area. As for galleys, the new version of the class notation contains a revised specification for shutting down deep fryers, and introduces a specification for the application of the F (A) class to passenger ships.

With these updates, DNV GL believes the additional water-carrying fire hose system requirement can be eliminated since the F (A) class specifies a sufficient number of portable extinguishers, fire hoses and lightweight firefighter outfits on board. The changes to the F (A) class are therefore cost-neutral.

F(M) Machinery

The updates focus on avoiding engine room fires by introducing oil leak prevention measures and ensuring that hot surfaces remain below critical temperatures and are oil-proof. These requirements are now covered by the basic F (M) class notation.

Recent incidents have prompted DNV GL to add requirements for additional protection of engine room casings on passenger

vessels, including suitable fire detection and water mist protection as well as control of the use of plastic pipes.

F(C) Cargo

Based on findings in its paper "Fires on Ro-Ro Decks" (2016-P012, issued in April 2016) DNV GL has made amendments to the F (C) notation for ro-ro decks on cargo and passenger vessels.

The existing requirements remain in force (CCTV for ro-ro decks on ro-pax vessels, robust CO₂ systems on cargo ships, extra and lightweight firefighter outfits, radios, etc.). The new requirements address the reliability and robustness of deluge systems protecting ro-ro decks. While SOLAS only requires manual release of section valves, the ability to release these valves remotely accelerates their activation. To reduce misunderstandings and failures, the section valves and remote-release installations must be marked, and general arrangement drawings posted.

A new policy for weather decks and open ro-ro decks as well as alternatively fuelled vehicles has been released.

On weather decks, water monitors must be installed which are accessible in case of a fire on a weather deck or ro-ro space. Open ro-ro decks are permitted but must be protected by steel roller shutters which can be closed when necessary. The revised rules also address survival craft, escape ways and ventilation systems with specific requirement on how these items and access to them are protected so that these essential safety systems are more likely to be available in case of fire on a ro-ro deck.

Additional requirements

In addition to the requirements of DNV GL's F (A, M, C) class notation, Anders Tosseviken, Senior Principal Approval Engineer for Fire Safety & Life-Saving, DNV GL recommends to implement procedures and a policy for risk control. "Operators should define and revise their policies regarding acceptable operations and cargo on ro-ro decks. To ensure effective use of fixed fire extinguishing systems, operators should delegate the use of water-based systems to the lowest possible levels, define the release times, and conduct regular, realistic training," says Tosseviken. ■ AT



Galleys and laundries continue to be areas of concern for on-board fire prevention.

Photos: DNV GL, Gary Bembridge - CC BY 2.0, xy - stock.adobe.com



DNV GL Expert

Anders Tosseviken (AT), Principal Approval Engineer, Fire Safety & Life-Saving
Phone: +47 922 27 193
E-Mail: anders.tosseviken@dnvgl.com

ENSURING THE VIABILITY OF THE FERRY SECTOR

Mike Corrigan, the new CEO of Interferry, gives his view on the latest regulatory achievements for the ferry industry and upcoming tasks that need to be faced to push along the current success story of the ferry industry.

What are the main focus areas for you within your position as CEO of Interferry?

Mike Corrigan: Interferry's key activities mirror what is important to the worldwide ferry industry: a focus on safety, fair and equitable regulatory treatment for the ferry sector within the shipping industry, and profitability and growth for ferry operators.

What challenges do you think the ferry industry needs to overcome in the near future, and what are your recommendations for handling them?

Corrigan: On the safety front, Interferry recently established a safety committee whose mandate is to determine the most effective way of establishing and sharing best practices in safety with ferry operators around the world, but particularly those in developing countries. Ferry operators in geographies that have strong safety regulations in place have much to offer and share with operators in geographies that don't yet share these standards.

On the regulatory front, Interferry has been intervening to ensure that regulations under development take into consideration all aspects of the shipping industry in general, and the ferry industry specifically. Interferry is fortunate to have consultative status at the International Maritime Organization (IMO), the main body for maritime regulations.

How do you rate the latest regulatory agreements with IMO, and what benefits will they bring?

Corrigan: In cooperation with the International Chamber of Shipping (ICS) and a number of flag states, Interferry reached the end of decade-long deliberations on requirements for ballast water management. For the global fleet of ships, a concern shared widely by the industry was how more than 50,000 ships would be able to fit ballast water treatment equipment on the day the requirements went into force. Interferry was pleased that the IMO resolved this issue through a staggering process related to a ship's dry-docking schedule. This has the effect of adding more years of compliance time, a move that Interferry's members support.

Are there specific regulatory developments that you want to drive?

Corrigan: We have already been instrumental in achieving significant changes to regulatory proposals at the latest sessions of IMO's safety and environmental protection committees. Together with other prominent stakeholders, we argued that on three major issues - the Energy Efficiency Design Index, the Ballast Water Management Convention, and damage stability - the potential technical solutions posed immense problems to the design and operational criteria for ferries. In each case, we won agreement for sector-specific amendments that will safeguard the regulatory objectives without threatening our sector's commercial viability.

Interferry was joined by several flag states that shared our concerns about the EEDI's energy efficiency requirement for newbuild ships. Our technical evidence resulted in the ferry requirement

DNV GL FERRY COMMITTEE: DEVOTED TO FERRY NEEDS

The DNV GL Ferry Committee meets twice per year, in conjunction with the Shippax Ferry Conference and Interferry Conference. Every meeting starts with an overview of the regulatory development and a review of all accidents involving ferries. Based on these insights members decide on the focus areas, and the agenda is set accordingly.

Key topics

Main subjects last year included safety and the environment. In

both areas regulatory initiatives relevant to the ferry segment were underway at IMO and the EU. "In particular, fire safety on ro-ro decks has been an important concern for the committee," says Håkan Enlund, chairman of the DNV GL Ferry Committee. It resulted in the development of several papers, best practices, IMO submissions and a new alternative class notation. The committee has also been a valuable discussion forum for the improvement of damage stabil-

ity requirements for passenger vessels in recent years. DNV GL has assumed the role of project manager for various important EU-funded consortium projects with participation of committee members and Interferry. The recent adoption by IMO of the amendments to SOLAS 2020, which raise the damage stability requirements for passenger vessels in the event of flooding caused by collision, are a result of these collaborative efforts. Furthermore, the emergence of



Håkan Enlund from Rauma Marine Constructions is chairman of the DNV GL Ferry Committee.

new technologies and alternative fuels has prompted debates on ways to improve operations and comply with new regulations while maintaining cost



“Interferry has relied on the DNV GL Ferry Committee as an integral resource in helping us achieve our overall mission, which is to improve ferry safety and operational best practices worldwide.”

Mike Corrigan, CEO Interferry

effectiveness. Since ferries differ from other ocean-going ship types in terms of design and trading patterns, the committee has been working to raise awareness of these differences among the regulatory bodies participating in the discussion. The development of the Energy Efficiency Design Index, or EEDI, and the application of ballast water management regulations to ferries in short-sea operation have been especially challenging issues for the ferry industry.

New technology

Digitalization, cybersecurity, complex control systems and alternative fuels are key issues for operators ordering newbuilds that are expected to trade for the next 20 to 30 years. “In this environment, sharing experiences within the committee is more important than ever in the common interest of mitigating risk,” says Enlund. Members also give valuable feedback to class, helping DNV GL develop rules that enhance safety and environment while meeting current and future market needs.

Photos: DNV GL, Interferry, Rauma Marine Constructions

being reduced by 20 per cent. An upper size deadweight tonnage threshold was also agreed.

As part of our collaborative effort to achieve a successful outcome for the BWMC, we were able to get the compliance timetable extended by several years. The IMO also agreed to the adoption of our alternative Same Risk Area concept for ships operating in common waters.

Interferry has also long questioned damage stability proposals that essentially seek to produce an unsinkable ship by adding more steel. We were alarmed that the operational capability of ferries might be seriously impaired. We teamed with Japan and other countries to ensure that the technical guidelines could be achieved, especially for smaller ferries. Our interventions secured a set of reasonable regulations for ferries carrying less than 1,000 passengers.

Digitalization is one of the core topics at the Interferry conference this year. What do you believe are the main drivers of digitalization in the ferry industry, and what benefits can they derive?

Corrigan: Digitalization is driven by the desire of ferry operators to be safer and more efficient, as well as customers’ ever increasing expectations regarding technology and an integrated experience. On the safety and operational front, through digitalization, improved real-time information such as equipment performance, weather reports, navigational hazards, etc. allows operators to optimize the performance of their machinery and proactively deal with potential safety issues.

With regard to the customer experience, companies will be able to improve their on-time performance and overall reliability, and integrate with other transportation modes, allowing for a more enjoyable and seamless journey for the passenger.

How do you rate the collaboration with the DNV GL Ferry Committee, and what are their main contributions to the work of Interferry?

Corrigan: Interferry and its members have worked closely with the committee for a number of years. In fact, each year, one of the two annual committee meetings is held in conjunction with our annual conference. Interferry has relied on the DNV GL Ferry Committee as an integral resource in helping us achieve our overall mission, which is to improve ferry safety and operational best practices worldwide.

Through the expertise of committee members representing all sectors of the ferry industry such as manufacturers, shipyards, naval architects, operators, etc., we are able to share common learning across the industry that not only ultimately benefit each of the member companies but also the industry as a whole. This really does fit well with Interferry’s belief that the industry is “Stronger Together”. ■ JS



DNV GL Expert

Trond Arne Schistad
Secretary of DNV GL Ferry Committee
Phone: +47 907 06 832
E-Mail: trond.arne.schistad@dnvgl.com

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



A NEW AGE OF SHIPPING

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

The little craft bearing the DNV GL logo gingerly braves the waves, as it skippers across the Trondheim Fjord under the watchful eyes of Kjetil Mugerud and Henrik Alfheim from the Norwegian University of Science and Technology (NTNU) in Trondheim. Both students are investigating how advanced control systems and navigation software could control an unmanned vessel, using a 1:20 model of DNV GL's concept vessel *ReVolt*: "Advances in sensor technology, data analytics and bandwidth to shore are fundamentally changing the way shipping works. And as operations are digitalized, they become more automated," says Dr Pierre C. Sames, Director of Group Technology & Research at DNV GL.

Governments around the world are looking into unmanned shipping as a way to move more cargo to sea in order to contain the spiralling costs of road maintenance caused by heavy lorry traffic, not to mention air pollution. Norway has taken the lead in exploring innovative ways of tackling this issue and bridging its many fjords and sea passages to ease transit. Cost is a key consideration in all of this. In 2016 government agencies and industry bodies established the Norwegian Forum for Autonomous Ships (NFAS) to promote the concept of unmanned shipping. In support of these efforts, the Norwegian government has turned the Trondheim Fjord into a test bed for autonomous ship trials. Other nations, most notably Finland and Singapore, are pursuing similar goals.

DNV GL is in the midst of this development, following its mission to make sure the technologies enabling autonomous

ships will perform to the benefit of humans, their assets and the environment.

The human factor

"If we look at recent advances in driverless car technology, the thought of trying something similar with ships does not appear too far-fetched. After all, water has at least one great advantage:



there is less traffic than on roads and reaction times are usually longer," says Sames.

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

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

Small craft with great ambitions

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

Meanwhile two commercial projects are nearing completion: Rolls-Royce is supplying automatic crossing systems for two DNV GL-classed double-ended, battery-powered ferries the Norwegian operator Fjord1 plans to commission in 2018. Both vessels will navigate autonomously under the captain's supervision, and he has the option to take control at any time. The first ferry will still require human-controlled berthing, while the second one will be able to perform this task automatically as well.

Photos: DNV GL, Multi Maritime



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

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

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

The challenges

Overall, autonomous shipping opens up great opportunities for the ferry and ro-pax industries. But new competencies have to be built before autonomous ships can become a commercially viable reality. Key research must be done to improve sensor technology, the acquisition of high-resolution ranging data and instrumentation accuracy. Software plays a very important role in this scenario by enabling situational awareness, a prerequisite for automated decision management. While existing know-how from the aerospace and automobile industries can be leveraged, specific expertise in ship autonomy has yet to be built up, states Sames. Research activities at NTNU, sponsored by DNV GL and industry stakeholders, are instrumental in creating a new generation of highly skilled ship autonomy experts. Students are investigating how advanced control systems and navigation software could control an unmanned vessel, using a 1:20 model of DNV GL's concept vessel *ReVolt*.

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

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



DNV GL Expert

Dr Pierre C. Sames

Director of Group Technology & Research

Phone: +47 4770 7462

E-Mail: pierre.sames@dnvgl.com

CONTINUING THE EFFICIENCY SQUEEZE

The Finnish ferry company Viking Line has challenged Deltamarin to come up with a new design concept for a ro-pax vessel that exceeds the best current energy-efficiency levels. The resulting ten per cent saving potential is very promising and construction will begin soon. DNV GL is on board.

When Viking Line came up with the challenge to present a design that is even more energy-efficient in relation to cargo capacity than their *Viking Grace*, one of the most energy-efficient and sophisticated ferries on the market, Deltamarin was more than keen to take it up. For ro-pax ferries, which typically trade the same route for years, it makes sense to streamline the vessel design to match the given operational profile. Deltamarin has developed a simulation tool to better understand the behaviour of the engines over the vessel's operation profile while accounting for local climate variations. The results can be used to optimize the auxiliary equipment on board, including economizers, waste heat recovery equipment, pumps, frequency controllers, battery packs and more. Other energy efficiency measures focus on hydrodynamics or look for ways to minimize the lightweight tonnage. A good Safe-Return-to-Port strategy, an optimized fuel set-up and a well-designed execution plan for the building project are important factors as well. Automation harbours further opportunities for energy efficiency enhancements, for example in the areas of big data handling, crew decision support and routine operations on board such as berthing assistance, as Nina Savijoki, Sales Manager at the Finnish design office Deltamarin, explains.

Skilled teams

A number of joint workshops held by Deltamarin, Viking Line and DNV GL during the design stage for the new Viking ferry yielded very promising results: the new concept will be ten per cent more energy-efficient than *Viking Grace*. "DNV GL has

provided good support throughout the concept development and continues to do so during the current hull development stage," says Ulf Hagström, Senior Vice President, Marine Operations & NB at Viking Line. "We want to have a skilled team on our side during the design and construction processes," he underscores. Nina Savijoki from Deltamarin agrees that early cooperation between class, owner and designer will speed up the basic design process by establishing a mutual understanding of the approval criteria for the solutions applied.

The new ro-pax vessel for Viking Line will be 218 metres in length and have a gross registered tonnage of about 63,500 tonnes. It will have a passenger capacity of 2,800, and the combined length of its cargo lanes will be about 1,500 metres.

The passenger ship building market is experiencing an interesting time: while traditional, specialized yards have great order books, the lack of orders for other ship types forces many reputable, highly qualified yards to look for revenues in new

Viking Line's groundbreaking LNG-powered passenger vessel will be delivered in the spring of 2020.



market segments. Several yards have shown an interest in ferry and ro-pax orders, and some owners have already decided to take a chance and contract yards that have yet to gather experience in this segment. For its new design concept Viking Line, supported by Deltamarin, decided to place the order at Xiamen, as was confirmed this summer. "We chose Xiamen because they had the right attitude and were able to demonstrate that they have thought through the process of how to build a modern cruise ferry," Ulf Hagström from Viking Line explains his company's decision. "Our role is to support the owner and yard beyond the traditional vessel design by providing advice in additional areas such as project planning and construction support. Deltamarin, as a design office, is able to work with any yard, whether it is experienced or just entering the market," says Nina Savijoki, adding that Deltamarin is looking forward to cooperating with Xiamen again. The yard built the world's highest capacity pure car and truck carrier series for Höegh Autoliners, classed by DNV GL. The engineering and pre-construction project management support will be provided by the Deltamarin offices in Finland over an estimated

"DNV GL has provided good support throughout the concept development and continues to do so during the current hull development stage."

Ulf Hagström, Senior Vice President,
Marine Operations & NB at Viking Line

12-month period. Supervision and other construction support services will continue until the planned delivery of the vessel in 2020.

"Our intention is to run the vessel on liquefied natural gas (LNG)," said Jan Hanses, CEO of Viking Line. "Great emphasis has been placed on the planning work for environmentally sound solutions, including innovative, energy-efficient applications. The vessel will be equipped with two 24-metre Flettner rotor sails from Nordpower, which will save about 435 tonnes of LNG annually."

Optimized consumption

The ship will have six Wärtsilä 31DF medium-speed main engines on board, a type described by Guinness World Records as "the most efficient four-stroke engine in the world". The engines will deliver an average speed of 22.1 knots. The vessel will also be the first to feature LNG Cold Recovery. This technology recycles the ultra-low temperature of the LNG fuel, which is stored at -163 °C, for freezer and cold-storage use. All in all the vessel will use ten per cent less LNG per year than *Viking Grace*, and 22.6 per cent less per lane metre.

The ship will serve the Finland-to-Sweden route connecting Turku, the Åland Islands and Stockholm as part of the European Union's Motorways of the Seas project. ■ JS



DNV GL Expert

David Wendel, Business Development
Phone: +47 67 57 71 91
E-Mail: david.wendel@dnvgl.com



Photos: Marianne Wennesland, Viking Line

DNV GL'S DIGITAL JOURNEY

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

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

“For us, digitalization is not an end in itself, we see it as another means to fulfil our main purpose: ensuring safe operations at sea and protecting life, property and the environment,” says Knut Ørbeck-Nilssen, CEO of DNV GL - Maritime. “The role of class in ensuring the integrity of the vessel and safety of the crew will continue, but the way surveys are conducted may change significantly. Furthermore, digitalization enables us to become more efficient and improve our level of service,” he adds.

Single access point to all digital services

When our customers interact with classification, they want this to be as simple and efficient as possible. To help, we launched

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

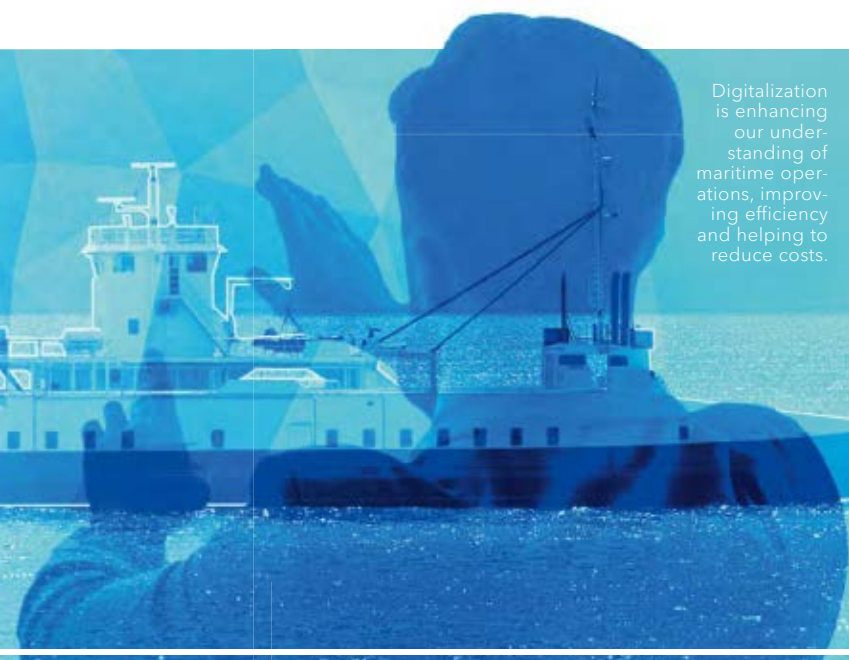
“And with the introduction of our new Smart Survey Booking tool in autumn this year, we will also start using intelligent software agents to help customers find the best time and place to book a survey,” adds Ørbeck-Nilssen (see info box - Smart Survey Booking). When customers have questions or run into a problem, they can get in touch with one of DNV GL’s technical experts through the DATE service. “This service has been a great success and now, to make it even better, we have introduced a tool that uses machine learning to automatically match our customers with the right expert for their question,” says Ørbeck-Nilssen. The tool has already analysed more than 200,000 requests and is continuing to learn (see info box - Machine

ELECTRONIC CERTIFICATES

Starting in October 2017, DNV GL will introduce electronic certificates for the class and statutory regimes. Accessible from anywhere in the world, electronic certificates bring many advantages to both DNV GL and its customers. By eliminating paper handling, they reduce the administrative burden on all stakeholders. A validation solution ensures that electronic certificates are just as safe as paper. In addition, electronic certificates are easy and convenient to share. Compiling

them in *My DNV GL* provides a comprehensive overview of key ship data that cannot get lost and is just a few clicks away. For DNV GL, electronic certificates help make processes more efficient, and they provide experts with easy access to certificates when they need to check up on something, be it during a survey or at a customer meeting. Electronic certificates will be rolled out gradually and will be implemented with a vessel’s next annual survey.





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



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

Knud Ørbeck-Nilssen, CEO of DNV GL - Maritime

Learning). “Soon, we expect it will be able to answer simple questions on its own,” he adds.

Modern survey methods

One of the most important ways we work to keep shipping safe is by conducting annual surveys on all of the vessels in our class. So far this has meant a surveyor needs to crawl and climb to reach every remote corner inside a ship. But new technologies are changing even how DNV GL does this. Already, surveyors have used camera-equipped drones to visually inspect large cargo holds and tanks. Using a drone opens up a lot of new possibilities. “In the future, drones could eventually be piloted remotely or even autonomously, meaning the surveyors could work from their desk thousands of miles away from the ship and inspect the vessel in virtual reality (VR),” says Ørbeck-Nilssen.

For our customers, the successful delivery and regular inspections of a vessel as well as interactions with class are just one part of a bigger puzzle. The other big questions are: How does the design perform in daily operations? Is the engine achieving optimal fuel consumption? And are the safety systems reliable at sea?

Turning data into business intelligence

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

DNV GL can also take this data and combine it with information from inspections and a 3D model of the ship to build a “digital twin” – a digital copy of a real object, modelled to exactly represent its properties. DNV GL experts can use the digital twin to find the best design, see how the networks on board respond to cyberattacks, test measures to improve performance and identify when vital equipment needs maintenance or replacement – throughout the lifetime of the vessel. Ultimately, >

SMART SURVEY BOOKING

The Smart Survey Booking tool will be launched in October 2017. It simplifies survey booking, fitting inspections into the customers’ schedule while saving time and costs. This is how it works:

- Customers are notified about the best time to order surveys and audits and notified shortly before the due date of the next survey.
- The tool proposes the scope of the survey and states how long a survey of this scope would take.
- A list of approved service suppliers in each port is provided, and helps operators to find out whether an in-water survey can be performed in a specific port.
- The tool offers up-front cost estimates including travel and overtime charges for survey combinations during any given port stays based on ETA (estimated time of arrival) and ETD (estimated time of departure).
- Based on automatically calculated cost estimates and the possible scope of the inspection in each port, customers can compare and benchmark various port-stay options.
- Once the date is set, the tool attaches relevant survey preparation notes to the booking confirmation to help the operator prepare for the inspection.

> digital systems could end up controlling ships entirely - without the need for a human crew. An autonomous ship would use advanced navigation software and smart control systems to follow a course, avoid obstacles and safely deliver its cargo. Of course, if the industry is going to rely on these systems, they need to be as reliable and secure as possible. With software-in-the-loop testing and a digital twin, DNV GL can check and correct weaknesses in the system.

A new industry data platform

All of these advances need many different project partners working together with accurate, reliable and secure data from multiple sources. And as decision-making and business models become more data-driven, trustworthy data becomes even more valuable. "Without trust in this data, truly cooperative projects cannot deliver the progress we hope for. At DNV GL, we have always been trusted with data, trusted to give an independent expert view and trusted to connect different industry players. That is why we have created a place for industry experts and data to come together securely: our new, multi-sided industry data platform called Veracity," says Remi Eriksen, Group President & CEO at DNV GL.

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

PSC PLANNER

Designed to help shipowners, managers and operators increase operational efficiency, the PSC Planner gives an overview of vessel or fleetwide PSC performance, which can then be benchmarked against the IACS-classed world fleet. The tool also assists the crew on board by highlighting specific areas to focus on when preparing for the next inspection.



Find out more at: www.dnvgl.com/maritime/mydnvgl-service-overview/psc-planner.html

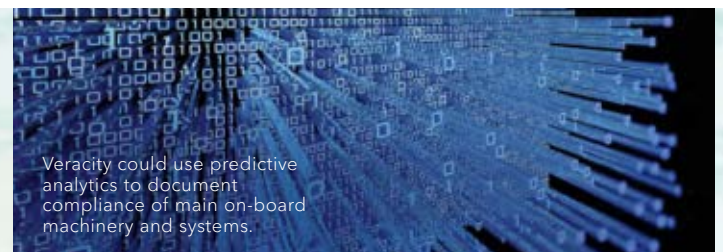
environment, and can trust domain experts, algorithms and analytics to combine and transform their data into real value. And Veracity could be a key component of a class-concept built around sensor-based data: securing and assuring data for use in the condition assessment of the hull and critical components.

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

MACHINE LEARNING

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

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



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

VERACITY

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

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

CLEAR VIEW ON THE REGULATION FRONT

The regulatory wheel keeps turning, so it is important to understand the developments when addressing compliance and making strategic business decisions. DNV GL gives owners and operators a heads-up.

To combat invasive species, approved ballast water treatment systems will be required on board all ships globally by 2024.

Photo: Dmitry Bruslov - iStockphoto

2017 has been a significant year for environmental regulations. Important decisions have been made, regulations finalized, and we now have a clearer picture of the regulatory landscape than a year ago.

Ballast water management

The Ballast Water Management (BWM) Convention entered into force on 8 September 2017. After complex discussions, with numerous twists and turns, MEPC also agreed a revised and extended implementation schedule at its 71st meeting in July this year. Briefly put, every ship in international trade will be obliged to comply sometime between 8 September 2017 and 8 September 2024. For ships of 400 gross tonnes (GT) and above the compliance date is linked to the renewal of the International Oil Pollution Prevention certificate through a set of somewhat intricate provisions, whereas ships below 400 GT must comply by 8 September 2024.

While the regulation in principle describes a ballast water discharging standard, the reality is that ships will be required to have an IMO-approved treatment system installed by the ship-specific compliance date at the latest. In practical terms this means the

entire world fleet is to be compliant within 2024. There are presently more than 50 IMO-approved systems on the market.

In the US the domestic ballast water management regulations entered into force in 2013. New ships must comply upon delivery, existing ships by the first scheduled dry-docking after 1 January 2014 or 2016, depending on ballast water capacity. USCG type approval is required for the ballast water treatment systems; five have been granted over the past year. The USCG has revised its liberal extension policy of granting deferred installation dates to more than 12,300 ships in the absence of approved systems now that type approvals have been granted. DNV GL expects the new, restrictive USCG policy on extensions to tighten further. Operators should now plan their installation dates based on the compliance dates in the regulation.

For more information on ballast water-related topics please visit dnvgl.com/bwm.

SO_x regulations

At MEPC 70 the IMO members agreed that the 0.50% global sulphur cap will be implemented from 1 January 2020. The

>



The EU's MRV requirements for CO₂ emissions apply to vessels above 5,000 GT.



The sulphur cap is a non-issue for LNG-powered ships such as *Ostfriesland*.

> decision has provided certainty to the maritime and bunker industries, but has also provoked an intense, ongoing discussion at the MEPC on the practicalities of implementation, and ways of ensuring robust enforcement and a level playing field. Supporting measures are unlikely to be agreed before MEPC 74 in Q2 2019 but are unfortunately not expected to have a major impact.

Ship operators will need to decide about their preferred compliance strategy, and this decision will have significant operational and financial implications. There is no one-size-fits-all solution on the table; scrubbers, LNG and "hybrid" fuels are all realistic options, but the vast majority of vessels are expected to default to MGO. Local availability issues and price volatility are expected as consequences of a dramatically changed fuel demand situation as of 1 January 2020. A significant number of non-compliance cases are likely to occur in a transitional period. Once supply and demand reach a new equilibrium, the situation should ease, but the transition will be a bumpy ride nevertheless.

Enforcement remains a critical concern, in particular on the high seas where flag states are in charge, as opposed to exclusive economic zones (EEZ) where enforcement is a port state matter. Reasonable questions are being asked about the readiness of all flag states to ensure uniform and robust enforcement, and thereby a globally level playing field. For reasons of international law the IMO cannot be expected to come up with effective enforcement measures.

More information is available at www.dnvgl.com/maritime/publications/global-sulphur-cap-2020.html and dnvgl.com/lowsulphur.

NO_x regulations

NO_x Tier III requirements have entered into force in the North American emission control area (ECA) for ships constructed on or after 1 January 2016. In essence anyone constructing a ship today needs to consider whether the vessel will – or might at some point – operate in the North American ECA. If so, NO_x control technology will be needed for that ship.

Additionally, MEPC 71 adopted the MEPC 70 agreement to apply NO_x Tier III requirements to ships operating in the North Sea and Baltic Sea ECAs. This will apply to ships constructed on or after 1 January 2021.

Energy Efficiency Design Index

MEPC 71 agreed to continue its EEDI discussions through a review set to conclude in 2019. The review will consider both the reduction levels and the timing of the implementation phases. Phase three may be brought forward, and a new phase four may be agreed commencing in 2025.

The MEPC also agreed to address the EEDI issues the ro-ro industry has been facing. After it was shown that the phase two reduction levels cannot be achieved for technical reasons, the MEPC decided to ease the ro-ro requirements for phase two by 20 per cent, and to remove a key barrier for large ro-ro vessels by applying a size threshold to the requirement curve. Nevertheless, while solving the problems for phase two it is not at all clear that this fix will also take care of phase three. The issue is therefore likely to result in a renewed discussion a few years down the road.

CO₂ and energy efficiency

Climate change remains the driving political force behind CO₂ and energy efficiency regulations. In the EU, regulations for monitoring, reporting and verification (MRV) of CO₂ emissions have entered into force for all vessels above 5,000 GT sailing to or from European ports. Ships must also report cargo data and average energy efficiency. The EU will make the data publicly available on an annual basis. Monitoring plans were due to be submitted to verifiers by 31 August 2017, with 2018 being the first year of reporting. The first data sets will be published by the EU in mid-2019.

By now all practical details have been defined and published. The final piece of the puzzle, a software system for voluntary use which will facilitate the information flow between the parties involved, is under development at EMSA.

Part of the purpose behind the EU MRV regulations was to encourage the IMO to work on a similar mechanism with global rather than regional coverage. The EU regulation itself contains a provision calling for its alignment with a newly developed international system once it is available.

It is therefore of great significance that MEPC 69 did agree on a global mechanism for mandatory monitoring, reporting and verification of fuel consumption data for all ships of 5,000 GT and above. The scheme, known as the IMO Fuel Consumption Data Collection System (IMO DCS), was adopted at MEPC 70, with 2019 as its first year of implementation. MEPC 71 put the final touches on the mechanism by agreeing on verification guidelines.

Importantly, the IMO DCS differs from the EU MRV in several significant aspects, including confidentiality of data, calculation of efficiency metrics, and requirements for data verification. While these are all issues where the EU has a strong preference for the requirements of its own system, the European Commission has nevertheless initiated a formal review process aimed at potentially aligning the EU MRV with the IMO DCS. A twelve-week public consultation process was launched on 8 September, and stakeholders are encouraged to provide their feedback to the EC.

Despite the encouraging sign of a consultation process being initiated, a word of caution is in order. In view of the political complexities of CO₂-related negotiations in Brussels, it will be a challenging and likely time-consuming process for the Commission, the Parliament and the Council to come to an agreement. Therefore the industry must be prepared to accommodate two different but overlapping reporting regimes for at least some years.

The IMO is also seeing a reinvigorated discussion on long-term CO₂ emission goals and the shipping industry's contribution

to emission reductions in response to the Paris global climate accord of 2015. Accordingly IMO has, in addition to establishing the DCS, also conceded that it needs to develop an IMO strategy on GHG emission reductions. The work is in progress and intended to result in an initial strategy at MEPC 72 next year, with a review in 2023. This could be of great significance to the maritime industry: not only will such a strategy have implications for future design and operational energy efficiency requirements, it may also lay the foundation for a carbon pricing scheme.

DNV GL believes that unless the IMO can build on its achievements so far and make significant progress on GHG matters, there is a real risk of other non-shipping bodies attempting to step in and regulate the shipping sector. This would not be a desirable outcome, least of all for the maritime industry itself.

More information on the EU MRV system is available at www.dnvgl.com/maritime/mrv-regulation.html

New regulations - damage stability of passenger ships

By adoption of the amended SOLAS Ch.II-1, new rules are coming into effect for passenger ships contracted on or after 1 January 2020 or, in the absence of a building contract, vessels with a keel-laying date on or after 1 July 2020 or delivery on or after 1 January 2024. Major changes included new, stricter requirements regarding damage stability standards as expressed by the required subdivision index "R", which is now only a function of the total number of persons on board. Lifeboat capacity and the length of the ship are no longer part of the formula. Furthermore, R is kept constant for up to 400 persons on board, then increases as that number rises.

The legacy version of Ch.II-1 included an option to permit certain watertight doors to remain open during navigation. This has been removed entirely. The new version also makes damage control drills mandatory for all passenger ships.

The new rules have various consequences for the design of new ships. For example, in the case of the new required subdivision index R it may be necessary to increase the ship's freeboard or breadth, or provide improved internal watertight subdivisions compared with current designs. The stricter regulation regarding watertight doors may also affect the internal subdivision arrangement and operations on board. ■ EN

All technical and regulatory news can be found at dnvgl.com/tecreg.



DNV GL Expert

Eirik Nyhus (EN), Director Environment
Phone: +47 926 23 818
E-Mail: eirik.nyhus@dnvgl.com



The amended SOLAS requirements will take effect in 2020.

MANAGING WATERTIGHT DOORS

Power-operated watertight doors are an essential aspect of ship safety – in the event of an incident they block and contain incoming water. But the safety of the crew and passengers also depend on the safe operation of watertight doors. Experts at DNV GL and Gard have compiled a joint industry information and training package to raise awareness of the correct use of power-operated watertight doors.



In an emergency, the proper use of power-operated watertight doors may save lives and assets.

The frequency of major shipping losses has decreased by some 45 per cent over the last decade, and it is evident that improved safety barriers for controlling flooding have had a strong impact on risk mitigation and ship safety. Foundering – by sinking or submerging – is still the main cause of losses, accounting for half of all losses over the 2005 to 2016 period. Grounding is the second most frequent cause (20%), followed by fire (10%) and collision (7.3%).

In the most common accident scenarios, including foundering, grounding and collision, controlling the ship's internal watertight integrity and, in particular, the watertight doors, can make a significant difference when it comes to reducing loss of life and assets. An open watertight door in a flooding scenario is a failure that may rapidly lead to capsizing or foundering without a chance of recovery, depending on the design of the given vessel.

Numerous risk factors

IMO recently also revised their guidance for watertight doors on passenger ships during their 98th session in July 2017. MSC 98 approved MSC.1/Circ.1564 on "Revised guidance for watertight doors on passenger ships which may be opened during navigation", where one of the amendments removed a provision in regulation II-1/22 that had permitted certain watertight doors to remain open during navigation if so authorized by the administration.

Watertight doors must be used safely and properly to avoid endangering passengers and crew who are passing through the doors or operating them. However, casualty statistics indicate that this is not always the case. Root cause investigations after incidents involving power-operated watertight doors have revealed that it has been common practice on board ships not to open watertight doors fully before passing through. Door safety systems have also been found not to be in full working order during inspections, and some doors were not properly maintained or tested. Most accidents involving people occur when the doors are in bridge-controlled "doors closed" mode.

"Managing watertight doors as a safety barrier sounds like an easy, everyday task. However, it is indeed a highly complex



A package of training materials prepared by Gard and DNV GL helps operators and crews understand the risks involved in watertight door operation.

“Managing watertight doors as a safety barrier sounds like an easy, everyday task. However, it is indeed a highly complex operation involving technical systems, people and processes.”

Trond Arne Schistad, Head of Statutory at DNV GL

operation involving technical systems, people and processes,” Trond Arne Schistad, Head of Statutory at DNV GL, explains.

A watertight door comprises several technical systems (structural, electrical, hydraulic, control) with many possible failure modes, and the doors are constantly subject to wear and tear. In addition, efficient barrier management depends on procedures describing correct operation during voyages and in emergency situations as well as correct and efficient maintenance. Finally, the human element needs to be addressed as well: crew and officers, their awareness of the risks involved and their knowledge and motivation to operate the system correctly during normal operation and in cases of an emergency.

In support of their customers’ efforts to eliminate safety risks related to watertight doors, experts at DNV GL and Gard, a leading Norway-based marine insurance company, have compiled a package of training materials to raise awareness of the correct use of power-operated watertight doors. “We have produced a video and a presentation that identify the key risks and technical and operational issues involved in using power-operated watertight doors, and provide some practical steps the maritime industry can take to address them,” Schistad summarizes the main content of the training material.

The key: being prepared

The material provides shipping customers with specific recommendations relevant to daily operation. These include tips on what a crew should be aware of, outline the actions the ship and shore-side management should take, and consider contributions from other industry stakeholders, such as manufacturers, class societies and flag administrations, to the reduction of risks related to the operation of watertight doors.

“A key element of the campaign is to develop a proactive door-closing culture. This means being prepared for possible external events such as a collision or grounding or bad weather,” Jarle Fosen, Loss Prevention Executive at Gard, describes the ambitions of the project team. “We want to increase the confidence of the crew in watertight doors as a barrier in case of flooding, and create a better understanding of how watertight doors are designed and how they should be operated and maintained,” he explains.

Fosen continues: “We also found that it is essential to create awareness of the occupational risk of incorrect use of watertight doors, and to reflect on the potential conflicts this may create.” The project team has also been working with the industry on assessing work orders in planned maintenance systems related to watertight doors. An example of a work order and case study information are part of the awareness campaign package.

Excellent training material

The training material has been sent out to customers and tested successfully, as Captain Zissis Koskinas, Fleet Captain of Celebrity Cruises, reports: “This is excellent training material on this extremely important subject and therefore Celebrity Cruises has instructed our crews to use that material for training, although we already had material of our own. This initiative is essential and much needed for the ships’ watertight integrity and safety as well as for the safety of the crew operating those doors in order to prevent fatalities.”

After all, incorrect operation of watertight doors could put the safety of a vessel’s crew and passengers at risk, threaten the environment, and cause lasting damage to a company’s reputation. Schistad and Fosen recommend using the watertight doors awareness material in safety training as well as during safety meetings and officer conferences. Customers can contact DNV GL and Gard directly for further support. ■ JS

The training material is available for download here:



www.dnvgl.com/maritime/watertight-doors-awareness.html



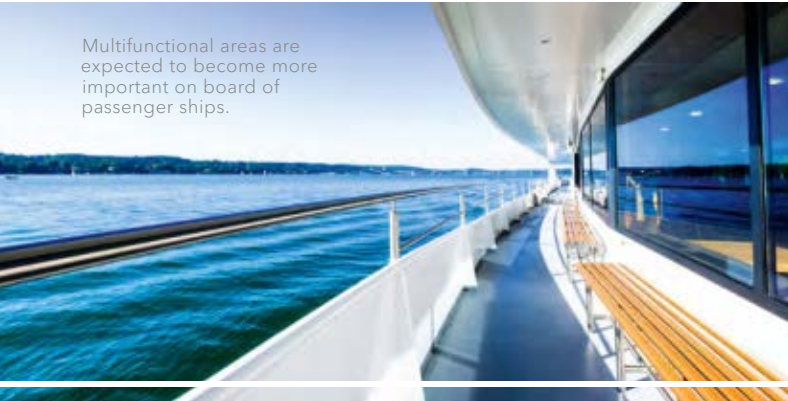
www.gard.no/web/content/watertight-doors-awareness



DNV GL Expert

Trond Arne Schistad
Head of Department - Statutory
Phone: +47 907 06 832
E-Mail: trond.arne.schistad@dnvgl.com

Multifunctional areas are expected to become more important on board of passenger ships.



Anders Ørgård, who has been the owner of OSK for more than ten years, is well known in the industry for his fresh ideas. When asked about the key factors that make a ferry future-proof he says he believes the industry has been limiting its focus too much on technology, fuel types and energy consumption in recent years. Now that advanced technologies below deck are commonplace, it is time to think about other aspects of ferry design, especially those affecting the passenger experience.

In particular, Ørgård expects flexible accommodation capable of catering to different seasonal customer expectations to be a key differentiator in the coming years. "If you look at the layout of a vessel, you have to imagine scalable passenger flows and strive towards an interior design that is flexible," he emphasizes. For many years Ørgård has been talking about adapting to seasonal changes in ferry occupancy by varying the crew sizes. Now it is time to take the next step and adjust the accommodation spaces to account for these seasonal variations.

Flexible on-board environments

"Today we spend much more effort on looking at the future of accommodation spaces, since ferries have a lifetime of as many as 30 years. Passengers want an on-board experience that matches the respective season, so we want our ferries to take this concept into the future," Ørgård explains. To achieve this, the interior outfitting must consist of a basic layout, including fireproof ceiling systems, and variable arrangements, such as preprinted foils with different decorations to create seasonally appropriate atmospheres. Likewise, LED-based lighting systems will bring more flexibility to interior design, allowing the production of various moods in specific interior areas.

These options do not necessarily have to be provided in every single section of the vessel, but they make sense wherever a change can be realized without causing major disruption. To give an example, modern airports feature small-scale product placements that change from time to time. A similar approach could be taken on board ferries: "You could have a corner in a room that is set up as a bar but can be used for other purposes as well," Ørgård points out.

As far as seasonal scalability is concerned, the focus is mainly on being able to close down parts of the passenger accommodation during the off-season. This will allow the operator to reduce the crew and cut costs. Closing off some of the passenger spaces

THINKING AHEAD IN FERRY DESIGN

While the industry is still focusing on innovative propulsion technologies, optimized hull forms and new fuel types to reduce costs and the environmental footprint of ships, the Chief Commercial Officer of OSK-ShipTech sees a new trend: enhancing the interior flexibility of ferries and creating a new passenger experience to boost on-board revenue is the next big thing in this industry, he believes.

will have consequences affecting safety requirements, however, such as emergency escape routes, which must offer an appropriate amount of flexibility as well.

In addition, the interior design must support fast and easy changes, allowing all interior rearrangements to proceed quickly, without interfering with the normal operation of the ferry. It must be possible to make these modifications within a few days, preferably during periods with low numbers of passengers, and without requiring shipyard assistance.

Two design contracts for the development of flexible ship interiors were signed this spring, and an initial concept design is already in existence. Some owners will begin implementing the idea in limited areas. So far it can be observed that changes on land take place much faster than on board, but Anders Ørgård is confident that this will change in the future as well. "It is all

“Today we spend much more effort on looking at the future of accommodation spaces, since ferries have a lifetime of about 30 years.”

Anders Ørgård, Chief Commercial Officer of OSK-ShipTech



about selecting the right system technologies available today that will enable future vessels to have more flexibility,” he is convinced.

3D printing will be an essential part of achieving the desired atmospheric changes on board in record time. Cassette ceilings are a perfect example since additive manufacturing is perfectly suited for reproducing the geometric patterns. Hans Eivind Siewers, Segment Director Passenger Ships & Ro-Ro at DNV GL, agrees with Ørgård’s forward-looking philosophy: “OSK has always understood the importance of being innovative in this industry. This applies to all parties, from designers, yards and owners to class, equipment makers and others. If you do not put this on your agenda in some way, you will soon be irrelevant.”

Port infrastructure plays a key role

The time ferries spend in port is a major cost driver and another area where Anders Ørgård sees savings potential. As energy costs go up, it becomes more attractive for owners to have full control of their port interfaces. “Every minute we can save in port is actually worth three times as much in money because it can save fuel costs,” he explains. Just recently Ørgård launched a study for a European ferry owner whose route has a crossing time of approximately 1.5 hours. Reducing the turnaround time by five minutes

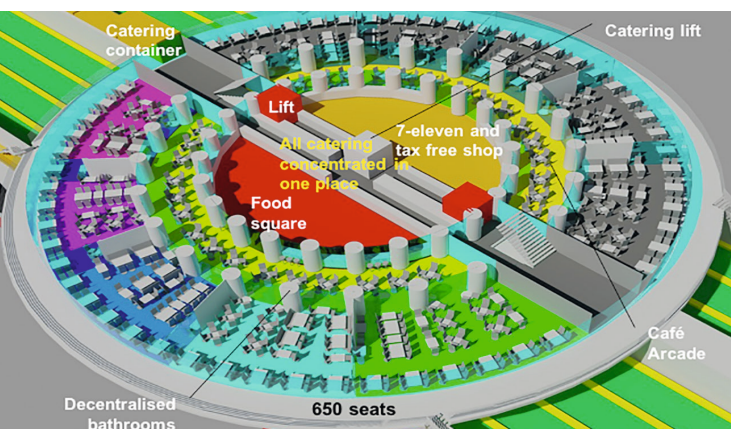
is worth close to seven megawatts of installed power. In the long run, it will save the owner money to invest in an upgraded port infrastructure that enables a more flexible interaction between ship and shore with rapid loading and unloading.

Future hull forms should also be developed to support in-port operations. Designers should focus on improving the way a vessel is brought to shore and the cargo is taken on board, Ørgård says. Standardized car lanes will play an important role in speeding up these processes; a car deck with more space on each side of the car allows vehicles to be driven on and off the vessel much faster while enabling people to exit their cars more easily. Wider ramps will affect bow shapes. The lashing of trailers, still the greatest bottleneck in port operations, could be accelerated by standardizing the lashing systems on board all ferries.

Improved approach to EEDI

Energy consumption on board is another cost factor harbouring savings potential. There are ways to better meet the requirements of the Energy Efficiency Design Index (EEDI), says Ørgård. “When we look at the hull form itself, it would make sense to pay much more attention to the annual fuel consumption than the design speed as provided by future EEDI requirements. During the next phase of the EEDI, we would be expected to optimize the vessel for the EEDI speed only. But at OSK we have a very large computational fluid design (CFD) cluster that allows us to explore and utilize the margin the EEDI offers towards optimizing fuel consumption on an annual basis,” Ørgård explains. “It is much better to save five per cent on fuel on routes where we sail with fewer passengers during nine months of the year than during those three months per year when we are fully loaded. To date, ships have been optimized for full speed and full load. The optimizations we propose require a lot of computer power and a thorough understanding of the EEDI requirements. We are fortunate to have these resources.” ■ JS

Photos: fototo - stock.adobe.com, Miroslav110 | Dreamstime.com, OSK-ShipTech, pappamaart - Stockphoto



Flexibly designed passenger areas: One half of the round structure can be closed during the off-season to reduce the required crew.



DNV GL Expert

Hans Eivind Siewers, Segment Director Passenger Ships and Ro-Ro
 Phone: +47 67 57 99 00
 E-Mail: hans.eivind.siewers@dnvgl.com

When ferries pass the stunning scenery of Norway's Hordaland County today they leave a sizeable pollution and CO₂ footprint behind. Hordaland's 20-vessel ferry fleet has an average age of 29 years and emits as many noxious fumes as all the buses of the county combined. With the current contracts expiring between 2018 and 2020, this seemed to be a good starting point for a review of the entire fleet and the definition of new, low emission targets. And the ambition went high. The county administration commissioned Skyss, the agency organizing public transport, tasking them with a significant reduction of emissions and energy usage. "We were to cut down emissions at least to levels in line with the global two-degree target," Karl Inge Nygård from Skyss explains. The complex process of building a successful tender for new contracts with a ten-year term required a sophisticated tendering model. External expertise from the industry was essential for defining appropriate targets and measures. "In relation to both the preparation and the implementation of this procurement project we have been fully dependent on special expertise in environmental technology at sea," Nygård explains. In a separate tender, DNV GL was selected as the partner to support the process of establishing an environment-friendly ferry business for Hordaland. "We are very pleased with the quality of the assistance we have received from DNV GL," Nygård says. "From DNV GL's side, the key challenge was to help the client walk the talk on real change, not just moderate improvements. This has been possible thanks to the combination of highly ambitious industry players and a courageous public procurer," says project manager Martin Christian Wold from DNV GL.

Ambitious targets, surprising outcome

The tendering model rated environmental performance 30 per cent of the total contract value. This was vital to push operators to think about innovative solutions as the competition was in principle technology-neutral, Nygård points out. But since

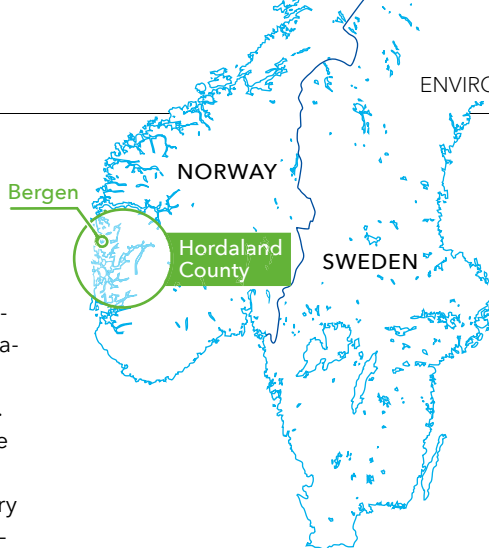
DAWN OF A NEW ERA

The environmental ambitions of the politicians in Hordaland were very high when it came to cutting emissions from ferry operations. A tender for new ferries, supported by DNV GL, resulted in a record investment of 140 million euros in zero-emission technology.

electrification was a preferred political target, the project team had to adopt a new way of thinking. "To enable the use of electric ferries, Skyss drafted new schedules that left a few minutes extra between arrival and departure to allow electrically powered ferries to recharge their batteries," Nygård explains. Another challenge was to qualify for financial support mechanisms such as Enova and the NO_x fund for environmental investments. With help from DNV GL, Skyss developed a way of integrating Enova support into public tenders for battery-powered ferries - which was not straightforward but paved the way for other counties to follow suit. DNV GL came up with an innovative model that ensures the predictability of Enova financial support for Hordaland, which may vary significantly depending on the solutions offered by the shipowners.

The environmental outcome of the tender was more than satisfying for all parties involved. All of the contracts are for

Protecting the residents and the beautiful scenery of Hordaland was at the heart of a tendering process whose results exceeded expectations.



With its many fjords and islands, Hordaland is highly dependent on its ferries.

Overview of the contracts signed following the complex tendering process.

fully-electric ferries, a result that had not been considered realistic in the beginning. "We expected some degree of electrification on most ferry connections but were surprised about the high degree of electrification we ended up with," Nygård says. "The 30 per cent weighting of CO₂ emissions and energy usage in our tender undoubtedly contributed to this," he continues. "Clearly there was a maturing and growing confidence in battery technology amongst the competitors during the negotiations - the development in the ambition levels from the first to the final offers was very impressive," Wold adds.

The future is electric

The next step is to follow up with the operators on the contract requirements. After all, this is about the cost-efficiency of a public investment of nearly 900 million euros on ferry services, including new ferries as well as 140 million euros for low-emission technology both on board the vessels and for the charger infrastructure on shore. This sum covers battery systems on board the ships, automatic mooring systems to keep the ferries still and save energy while charging, buffer batteries on land and upgrades to the power grid. Charging and battery technology as well as prices have evolved significantly in recent years, which means that most ferries in Norway will be able to operate electrically in future. DNV GL expects no new LNG-fuelled vessels to be ordered for Norwegian trade; in fact, some existing LNG ferries will likely be retrofitted for electrical or hybrid propulsion. ■ JS/MCW

Contract	Number of routes	Number of ferries	Ferry sizes (approximately)	New operator
Route package 1	7	8	3 × 40 CEU ¹⁾ 5 × 120 CEU	Fjord1
Route package 2	4	6	2 × 60 CEU 3 × 90 CEU 1 × 130 CEU	Fjord1
Route package 3	2	2	1 × 12 CEU 1 × 25 CEU	Norled
Route package 4	1	1	1 × 20 CEU	Wergeland
Route package 5	3	3	1 × 12 CEU 1 × 40 CEU 1 × 50 CEU	Boreal
Total	17	20		

1) CEU = car equivalent unit



DNV GL Expert

Martin Christian Wold (MCW), Senior Consultant, Environmental technology and compliance
Phone: +47 45275212
E-Mail: martin.wold@dnvgl.com



Ampere is one of the role models for advanced, eco-friendly ferry operations along the Scandinavian coastline.

THE TENDERING MODEL

There are several ways to achieve good environmental performance in a tender. A technical specification detailing the exact solution has historically been most frequently used in the maritime industry, both for government tenders and in the private sector. In recent years the national road authorities in Norway, supported by DNV GL, have developed a technology-neutral tendering model based on functional selection criteria. The motivation is to let the industry decide on technology because it has the best understanding of what technical solutions are best suited and most cost-effective. This makes environmental innovation a strong element in the competition and, when applied correctly, stimulates creativity and new ideas across the supply industry.

The tender for the Lavik-Oppedal route in Norway, which was won by the first fully electric ferry in the world, Ampere, gives evidence to this. The maximum score in a competition is 100 points; typically 20 to 30 points are awarded for environmental performance (CO₂, energy usage and NO_x are usually applied in various combinations depending on the target). In the Hordaland tenders, CO₂ emissions and energy consumption were each valued at 15 points, and price was valued at 70 points. The best offer on each selection criterion is awarded full score, the others receive a proportionately lower rating. Failure to reach the promised environmental performance will result in severe financial sanctions.

DNV GL believes this to be a highly efficient tool for achieving the best and most cost-effective eco-friendly solution. At the same time, this approach provides a highly flexible toolbox for any tender.

Regional Maritime offices

Americas

1400 Ravello Dr.
Katy, TX 77449
USA
Phone: +1 2813961000
houston.maritime@dnvgl.com

Greater China

1591 Hong Qiao Road
House No. 9
200336 Shanghai, China
Phone: +86 21 3208 4518
marketing.rgc@dnvgl.com

North Europe

Johan Berentsens vei 109-111
Postbox 7400
5020 Bergen, Norway
Phone: +47 55 9436 00
bergen.maritime@dnvgl.com

South East Europe & Middle East

5, Aitolikou Street
18545 Piraeus, Greece
Phone: +30 210 41 00 200
piraeus@dnvgl.com

Germany

Brooktorkai 18
20457 Hamburg, Germany
Phone: +49 40 36149-8786
region-germany.maritime
@dnvgl.com

Korea & Japan

18F Kyobo Bldg.
Jong-ro 1, Jongno-gu
110714 Seoul, South Korea
Phone: +82 2 734 7326/7
region.korea@dnvgl.com

South East Asia & India

16 Science Park Drive
118227 Singapore
Singapore
Phone: +65 65 0 837 50
sng.fis@dnvgl.com

West Europe & Africa

3 Cathedral Street
Palace House
London SE1 9DE
United Kingdom
Phone: +44 207 357 6080
london.maritime@dnvgl.com

DNV GL - Maritime

Brooktorkai 18
20457 Hamburg, Germany
Tel: +49 40 36149-0
www.dnvgl.com/maritime

DNV GLAS

NO-1322 Høvik, Norway
Tel: +47 67 57 99 00
www.dnvgl.com

About DNV GL

DNV GL is a global quality assurance and risk management company. Driven by our purpose of safeguarding life, property and the environment, we enable our customers to advance the safety and sustainability of their business. Operating in more than 100 countries, our professionals are dedicated to helping customers in the maritime, oil & gas, power and renewables and other industries to make the world safer, smarter and greener.

DNV GL is the world's leading classification society and a recognized advisor for the maritime industry. We enhance safety, quality, energy efficiency and environmental performance of the global shipping industry - across all vessel types and offshore structures. We invest heavily in research and development to find solutions, together with the industry, that address strategic, operational or regulatory challenges.

Disclaimer: All information is correct to the best of our knowledge. Contributions by external authors do not necessarily reflect the views of the editors and DNV GL.