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electric & hybrid marine technology international

The future of e-propulsion maintenance revealed!

How drones and other innovative hardware solutions will ensure tomorrow's electric and hybrid vessels remain profitable and seaworthy for years to come

Exclusive conference speaker interviews

Caterpillar's advanced marine propulsion engineering manager and GE Power Conversion's marine navy solutions leader on their must-attend presentations!

Case study: Dynamiq GTT 115 Hybrid

The first superyacht with Porsche DNA is being pitched as a Gran Turismo of the seas thanks to its state-of-the-art, range-busting diesel-electric propulsion system

Small boats sector review

A snapshot of the current state of electric and hybrid propulsion technology for various watercraft – and what developments can be expected in the near future

Battery technologies | Hybrid systems | Fuel cells | Electric motors | Emissions-reduction technologies

Victoria of Wight, which will serve the crossing between the Isle of Wight and the English mainland, was launched at the Cemre shipyard in Turkey in February of this year

The recent launch of MV Victoria of Wight, UK ferry operator Wightlink's new US$45m diesel-electric vessel, marks the culmination of the company's biggest-ever investment

WORDS: **RICHARD N WILLIAMS**

Having slipped into the Sea of Marmara – the smallest sea in the world – to signal its official launch in February 2018, ferry company Wightlink's new flagship vessel, MV Victoria of Wight, is destined to become the most environmentally friendly vessel on the Solent, transporting passengers and vehicles from Portsmouth in the South of England to Fishbourne on the Isle of Wight. The US$42m (£30m) diesel-electric vessel is part of a US$63m (£45m) investment in one of Wightlink's two key routes, which also includes new two-tier upper and lower boarding ramps and some terminal improvements.

"At peak times, we have two major issues," explains John Burrows, project director at Wightlink. "The first is keeping vessels on time – trying to load three decks on our current vessel, the St Clare, means we are always late. Secondly, at peak times, we run out of space. There's demand to go to and from the Isle of White that we cannot satisfy," he admits.

Energy transformation

The Corvus Energy Orca energy storage system installed on MV Victoria of Wight is connected to a DC-Hub (below), the first ever supplied by Finland-headquartered company The Switch, following its acquisition of Wärtsilä's marine drives business in November 2016 – one year following the commissioning of the vessel.

The DC-Hub allows the generators on board MV Victoria of Wight to run at optimal efficiency, with batteries taking the strain of any necessary load changes. "Basically, it is a collection of frequency converters," says Asbjørn Halsebakke, general manager at The Switch Marine Drives Norway. "The DC-Hub makes it possible to connect lots of energy sources and use them in a good way."

The advanced power electronics of the system allows the batteries to be utilized as standby power sources, meaning generators can be turned off entirely and eliminates the need for large AC switchboards, creating a simpler system that enables cost-effective and environmentally friendly operation.

Below: Corvus's ESS works together with the Wärtsilä equipment and systems onboard to make it the most eco-friendly vessel in the Wightlink fleet

Left: Any potential power source can be connected to the DC-Hub

Bottom: The Voith Schneider propellers are powered by the Wärtsilä LLH system

components and replacing them with fewer LLC transformers, this not only saves weight, but also reduces the electrical losses. "The effect is better efficiency and since each variable speed drive is connected to different sections of the electrical bus, it greatly improves redundancy," adds Hinks.

Dagfinn Botnen, general manager for Power Conversion at Wärtsilä Norway, further explains the savings: "When we have run an LLH system on board other vessels, we have been seeing fuel savings of 12-17% compared with conventional diesel-electric setups," he claims.

However, this configuration was not the original plan for MV Victoria of Wight, as Hinks recalls: "This design started out as a conventional diesel-electric, but one thing that became clear early on was that Wightlink wanted to improve both efficiency and redundancy. Knowing we had a system that could do that, we proposed it."

More flexibility

With Wärtsilä's experience with offshore vessels, where redundancy is so important, MV Victoria of Wight's LLH system will, Hinks believes, provide far more flexibility and better efficiency for Wightlink than its other vessels. "When you compare it to the diesel-mechanical drive of the St Clare, it gives so much more flexibility and redundancy."

Furthermore, Botnen explains that, "With this system, you can keep just one engine running and the battery power for redundancy. The redundancy is very good and perhaps the biggest selling point of the LLH." Hinks agrees, remarking that the system "provides Wightlink with the reassurance that, in the unlikely event of a blackout, the energy storage will still give enough power for the vessel's systems and collision avoidance".

MV Victoria of Wight is also able to run all-electric in its present configuration, in what Wärtsilä refers to as Island Mode, helping to keep emissions and pollution to a minimum during harbor operation. "Redundancy, safety and efficiency are its key points," says Hinks. "And, of course, low emissions, which is so important these days."

It is certainly a project that Wärtsilä is very proud of. While the company used Corvus Energy and Voith Schneider for the batteries and propellers respectively, all of the main elements of this design comes from Wärtsilä, which has successfully integrated all these components together in MV Victoria of Wight.

Sea trials for the vessel are expected to take place at the end of April 2018, and then Wightlink will train its 11 crews, each consisting of 12 to 15 members, in using the vessel. "Everybody will roster through it," says Burrows. "We currently have four vessels on this route but, because of the extra capacity of the Victoria of Wight, the plan is to sell one of our existing vessels, keeping it to just four."

Care & repair

Experts debate the latest developments in propulsion system equipment maintenance hardware, software and technologies that are keeping today's vessels operational and seaworthy

WORDS: **TIM FISHT**

Arguably, one of the biggest benefits of using either a pure electric or hybrid-electric propulsion system on any maritime vessel – be it an inland canal boat, cruise liner or platform support vessel – is that there are fewer moving parts to contend with, unlike with a conventional diesel engine layout, which features far more mechanical systems. So, when it comes to maintenance, the benefits of using electric-based systems for propulsion would appear to be obvious – there are simply fewer components that require replacing and fewer potential areas of failure that require checking.

For example, with a diesel-electric propulsion system, an engine is connected to a generator and then a propeller. That's it. Sometimes the propeller may be driven by an electric motor, but when batteries are introduced into a purely electrically driven propulsion system, then the number of moving parts is actually closer to zero. There are no generators, no engines or alternator – just the propeller and electric motor driving the power to the vessel. Batteries don't move either, so energy storage systems only require monitoring and, furthermore, the lifetime of such parts is considerably longer and therefore they don't need replacing as often.

Maintenance is especially critical in the shipping sector. If a vessel is not at sea, then it is not earning money, so any reduction in the amount of downtime spent in port having repairs carried out can bring with it huge savings. Paul Winson, senior vice president at Norwegian Electric Systems (NES), a total systems integrator of electric and hybrid-electric propulsion systems, believes that, with fewer moving parts to keep an eye on, the industry is starting to see a shift in its approach to propulsion system maintenance.

"The trend is shifting from servicing to monitoring and predictive maintenance. You can be far more predictive with electrical system monitoring than you can with mechanical," says Winson. "It's no longer just the people on board who can monitor the vessel; the whole vessel itself can be monitored remotely by head office or a department that supervises the vessel. That way, they can see whether a piece of equipment is operating less efficiently and thus whether any maintenance is required."

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> Paul Winson, senior vice president, Norwegian Electric Systems

Vital signs

Helping these remote stations correctly read the vital signs of propulsion equipment are as many as two or three computers located on board any one vessel. With only one computer, it's just not possible to verify the readings and ensure there is nothing wrong with it or its algorithms. Monitoring equipment has indicators such as the voltage and these are set with various alarm parameters, so if there is an electrical spike that goes outside of those parameters, then a warning will be sent or a log will be made of what happened and when. It won't literally stop the vessel, but will keep the details of any incident, which can then be investigated.

"For example, a vessel might have met a strong current at a particular time on a particular day and, as such, with monitoring equipment it's very easy to read when and why the power increased dramatically for a period of time," explains Winson, who adds that this information can then be sent back to head office via the internet and subsequently tracked. "It's important because not all faults relate to the functioning of the vessel, and if there is a failure, then it could be down to bad equipment.

Top: A Norwegian Electric Systems technician performing system maintenance

Right: Advances in technology mean that entire vessels can be monitored remotely

Right: Monitoring of drive components and subsystems can help identify changes in system performance

Below: Energy storage systems require less maintenance, so off-board monitoring becomes a key activity

"Say you had a series of electric motors driving all your propulsion and one of them starts to develop a fault. You might want to investigate the others in case they also have a fault because they are from the same batch."

Meanwhile, others recommend that the temperature of an electric or hybrid-electric propulsion system's components and subsystems requires close monitoring. According to Asbjørn Halsebakke, general manager of The Switch Marine Drives Norway, all major electrical systems use either water-cooling systems, air-cooling systems, or a mixture of the two, to regulate temperature. There has to be a constant flow of water or air and no obstacles that could reduce flow.

Says Halsebakke, "There is measuring of temperatures, cooling water temperatures and critical parts temperatures that also measure cooling water flow. All of this data is sent to a monitoring system and on one screen you can see the different cooling temperatures and all the flows, and over time you can see if anything changes. For example, if the temperature increases by one or two degrees from the same time the previous year, that would indicate that you need to clean out your filter."

Crew cuts?

The monitoring system also sends this data back to the servicing department, which means that maintenance efforts – cleaning and inspections – can be planned in advance over a period of six months. According to Halsebakke, in most cases the crew has the equipment on board to do most, but not all, of the maintenance work themselves. "Crews are able to change all the critical and big parts themselves, but they are not allowed to change small electronic parts because then there is an increased risk of introducing another fault."

NES's Winson agrees that there is an issue with crew capability when it comes to maintaining more complex electrical systems: "One of the biggest problems is that there are mechanical experts in charge of electrical systems. So, I think it's better that they leave the monitoring to the companies that supply the systems – which those companies are happy to do."

This means that, depending on the operator and skill level of the crew, electrical equipment providers will perform different amounts of monitoring and servicing for their customers. Tore Markhus, general manager, E&A Services, Wärtsilä, believes that, with a service life of 10 years, not much onboard maintenance is required for battery energy storage systems. As such, off-board monitoring is a main activity. "It depends on what the customer wants, but we can constantly monitor such systems via remote checks and each year

"Crews are able to change all the critical and big parts themselves, but they are not allowed to change small electronic parts because then there is an increased risk of introducing another fault"

Asbjørn Halsebakke, general manager, The Switch Marine Drives Norway

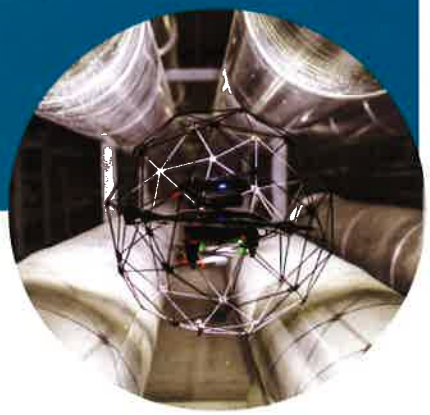
Help from above

New technologies are being used to reduce the amount of time that ships spend in port, particularly in relation to inspections. Flyability, a Swiss company that creates collision-tolerant robotics to access otherwise inaccessible places, has developed Elios, a drone that uses a small quadcopter surrounded by a lightweight exoskeleton, which is resistant to dust, humidity and dirty environments.

Although mainly used for the inspection of ballast tanks and cargo holds, Elios has a broad range of applications, including "engine rooms and confined spaces inside the hull where you may want to avoid human entry", says Flyability CEO Patrick Thevoz. Elios features a manual radio remote control and is fitted with a light and a high-definition digital camera and thermal camera. With a battery-powered flight time of around 10 minutes, it can access areas as small as 42cm (16.5in) in diameter and thus can speed up the time taken for checks by viewing areas humans can't physically enter. The data is then sent to a remote-controlled tablet for observation by an operator.

"Elios has flown in a chloride zinc environment, but its carbon-fiber materials make it relatively resistant to chemicals, and it can fly in temperatures of 0-50°C [32-122°F]," says Thevoz. "I have even flown it into an engine room that was shut following a fire, and thus oxygen free. It was hovering above the engine and I could check the parts.

"So, wherever there is a requirement for a visual inspection in a confined space, a robotic solution could be a game-changer in reducing the time to carry out the check."



Above: Flyability's Elios drone can access and inspect tough-to-reach areas on board vessels

"We can constantly monitor systems via remote checks and each year we'll perform state-of-health procedures on any battery systems that need to be documented"

Tore Markhus, general manager, E&A Services, Wärtsilä

we'll perform state-of-health procedures on any battery systems that need to be documented," he explains.

"Also, crews can operate a vessel's onboard monitoring and control system to check the state of the components and the batteries. Alarms can be set to go off when there are any issues and we can even connect a battery's monitoring system to a ship's vessel information system, or link up to vessels through various communications systems so that we can monitor everything from our office. But we need to have permission from the ship to do so.

"Furthermore, we can identify any negative trends and take precautions if needed. We assess if there are immediate actions needed, otherwise we can plan all the maintenance and prepare for it at a later stage by doing up-front planning," continues Markhus. "Some battery cells might be beginning to deteriorate, so we can come together with the customer and get to the port and get on board the vessel."

So, with fewer moving parts to handle and accurate monitoring technologies and systems located on- and off-board the ship, there is the potential to make great savings when it comes to maintenance. Some estimates are slated at about half the cost of conventional diesel mechanical vessels, especially when combined with the reduced requirement for onboard spares, pre-planned maintenance and reduced time in port.

Top: Battery monitoring systems, such as those on the Viking Princess, can be remotely observed from the Wärtsilä office, if the operator grants permission

Below: Though they may have the equipment, vessel crews may not be permitted to undertake certain maintenance work