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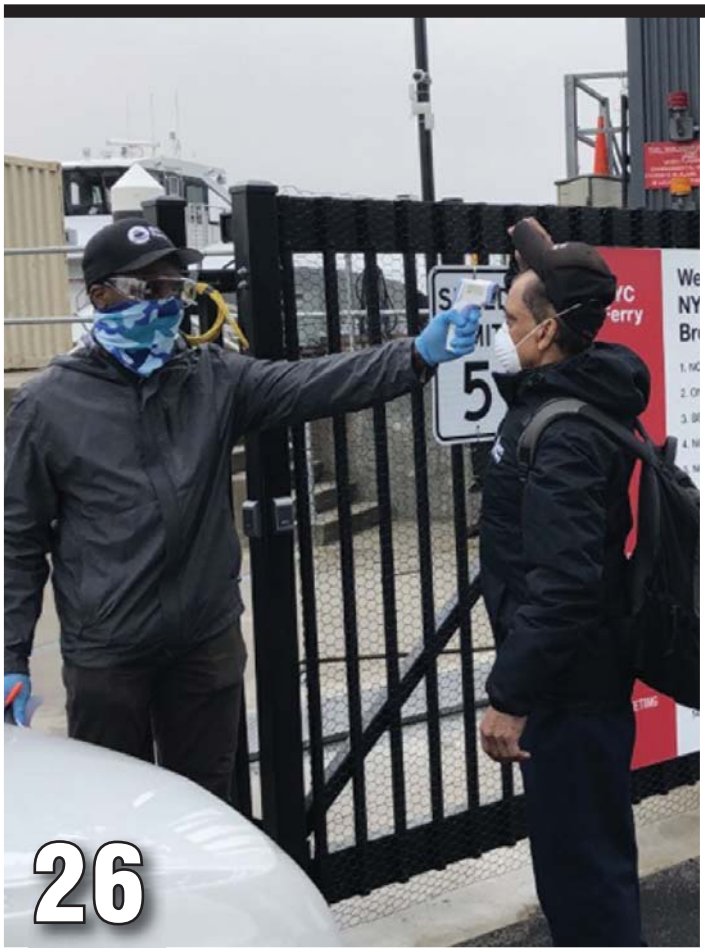

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On the Cover

The hybrid-electric ferry Waterman is equipped with twin BAE Systems HybriDrive propulsion systems, which cut down on fuel usage, maintenance costs and emissions.

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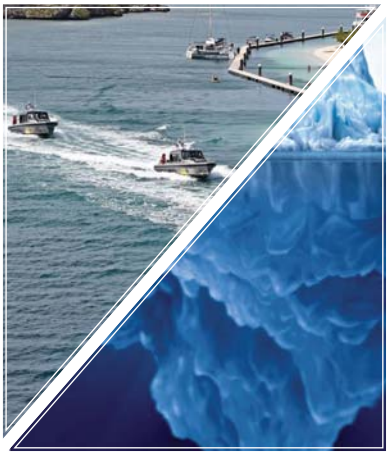

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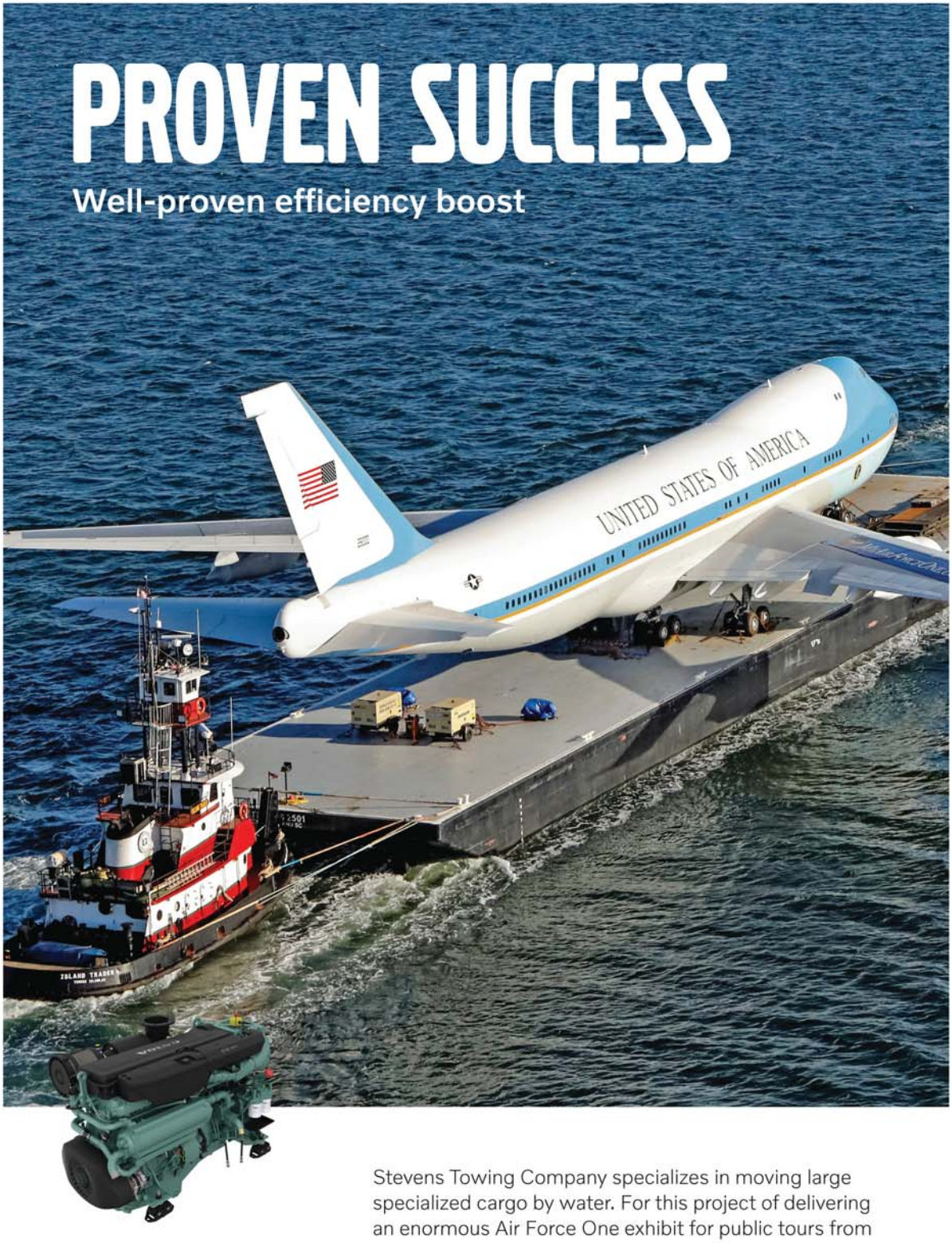

Stevens Towing Company specializes in moving large specialized cargo by water. For this project of delivering an enormous Air Force One exhibit for public tours from Rhode Island to Maryland, the tug *Island Trader* was up to the job. Stevens repowered the *Island Trader* in 2014 with Volvo Penta D16 650-hp engines. With more than 20,000 hours on them, the D16s are still going strong.

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EDITOR'S NOTE

Someone outside of the maritime community recently asked me about the types of stories I seek to share in these pages and on MarineLink.com. What's important to the maritime industry? What do readers want to see? The truth is this industry presents many, many types of stories worth telling, and if you're anything like me you'll find each is as interesting as the next.

That said, some of the best stories cover vessels or technologies, companies or crews, or anything else for that matter, that helps to deliver improvements to vessel safety, efficiency and eco-friendliness. The main topic of this edition, propulsion technology, affords a perfect opportunity to hit on all three.

At the most basic level, vessel owners are driven by regulatory requirements and the simple need to protect mariners, the environment and their bottom line. These owners must make a multitude of propulsion-related decisions when selecting the equipment that will power and propel their vessels for many years to come. Build a new vessel or repower? What type of engines, and how large? Which fuel? Which drives? . . .

These days, as new propulsion technologies continue to advance and be proven aboard working vessels, the number of viable solutions available to commercial operators is greater than ever before. In this way, it turns out that propulsion systems are a lot like story topics.

In the pages that follow are a number of columns, feature stories, tech files and even product spotlights covering various aspects of propulsion technology. There's a lot packed in, sort of like a vessel's engine room.

Eric Haun, Editor, haun@marinelink.com

U.S. Flag Stat Control 2019 Domestic Report

The U.S. Coast Guard's 2019 Flag State Control Domestic Annual Report presents information and statistics regarding inspections and enforcement of regulations on U.S. flagged vessels, ultimately providing transparency on the state of the domestic fleet and shedding light on trends regarding the relationship between safety culture and safety performance. Included are deficiency and detention rates for each type of inspected vessel, as well as performance metrics for Recognized Organizations that perform work on the Coast Guard's behalf.

The data contained in the report was compiled by the Office of Commercial Vessel Compliance (CG-CVC) using information from the Coast Guard's Marine Information Safety and Law Enforcement (MISLE) database system.

Presented is information reflecting the entire U.S. flag fleet, including barges, cargo vessels, passenger vessels, vessels operating on the Outer Continental Shelf, research and school ships, fishing vessels (though not part of the inspected fleet), and the newest members of the inspected fleet, towing vessels. With the addition of towing vessels, which started getting inspected under 46 CFR Subchapter M in July of 2018, the size of the U.S. inspected fleet grew by approximately 6,500 vessels to 19,679 in 2018. The total fleet grew again in 2019, standing at 20,064 vessels. Notably, the average age of the U.S. flag fleet grew significantly with the addition of inspected towing vessels, rising from 22 years in 2017 to 27.8 in 2018. But in 2019 this number decreased somewhat to 27.

In 2017, the first year for which the Coast Guard published the annual report, the its fleet of responsibility contained 12,189 vessels with active COIs. That year, Marine Inspectors conducted 18,424 inspections, or 1.5 inspections per vessel. In 2019, there were 20,064 vessels included in the inspected fleet, and Marine Inspectors conducted 21,471 inspections, roughly 1.1 inspections per vessel. The average number of deficiencies identified per inspection rose as well, up from 1.17 in 2017 and 1.26 in 2018 to 1.48 in 2019. According to the report, this can be attributed to the new towing vessel fleet, increased oversight inspections and post casualty inspection campaign conducted on small passenger vessels.

By the numbers, highlights from the 2019 inspection data looks something like this:

- 25: Percent increase in the number of deficiencies issued in 2019 compared to 2018
- 35: Average age of U.S. flag towing vessel fleet
- 111: Number of U.S. flagged vessels detained by USCG (64% increase from 40 in 2018)
- 60.4: Percentage of reportable marine casualties involving barges defined as collision, allision or grounding
- 2,561: Number of vessels involved with reportable marine casualty investigations in 2019
- 2,095: Number of reportable marine casualty investigations in 2019
- 2,365: Number of inspected barges (46.7%) participating in Streamlined Inspection Program (SIP)
- 5,061: U.S. flag barge fleet, representing 25.2% of the overall U.S. inspected domestic fleet
- 7,063: U.S. flag towing vessel fleet, representing 35.2% f the overall U.S. inspected domestic fleet
- 3,271: Number of deficiencies for Subchapter M vessels over the course of 2,536 inspections
- 20,064: Number of U.S. flag vessels subject to inspection
- 21,471: Number of inspections (US flag) conducted by USCG personnel
- 31,738: Number of deficiencies found during those 21,471 inspections

It should be noted that the 2019 report is the first to include 12 full months of data for inspected towing vessels, since these vessels only started being included after the compliance date for implementation of towing vessels on July 20, 2018. In 2019, the number of inspections rose 7%, in part due to the addition of towing vessels to the inspected fleet. Again noteworthy, the majority (62.5%) of vessels involved in marine casualty incidents were towing vessels. Nearly half (46.1%) of these were categorized as collision, allision or grounding – which not coincidentally is also the leading casualty type for barge incidents (60.4%). Material failure/malfunction was the top casualty type for all other vessel categories.

Interestingly, passenger vessels, which make up 33.5% of the U.S. flag fleet, accounted for 71.5% of deficiencies and 44.1% detentions. However, based on vessel population, cargo vessels received a highest ratio of deficiencies and detentions per vessel, with an average of 4.29% and 2.3% respectively. To be fair, the passenger vessel sector is of course one of the most highly regulated and closely watched – as perhaps it should be, given the millions of lives at stake.

In addition to evaluating Coast Guard inspection data, the Flag State Control Division also considers data and information on U.S. flagged ships collected by the Paris Memorandum of Understanding (MOU) and Tokyo MOU Port State Control Regimes. The data from these sources provides

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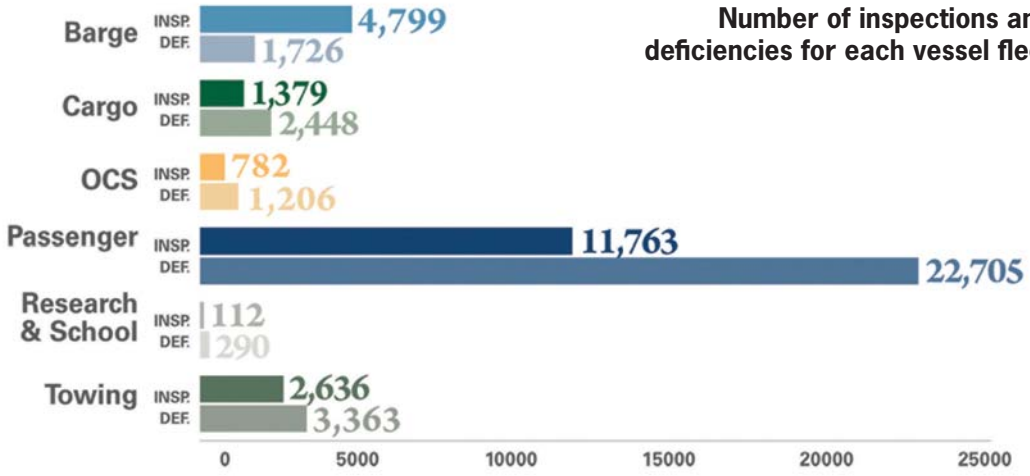
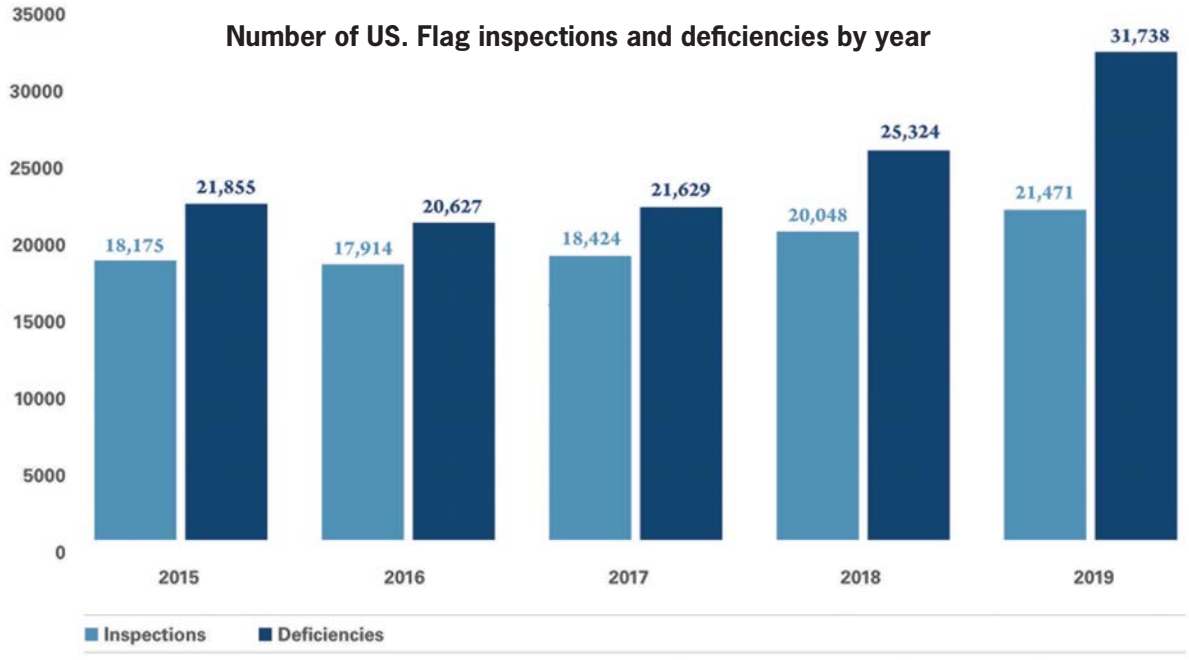
some insights into the performance of the U.S. fleet abroad. For example, as per the Paris MOU 2017 Performance List, effective July 1, 2019, U.S. flag vessels are on the "Grey List", which indicates average performance. Encouragingly, the Tokyo MOU 2018 Annual Report placed U.S. flag vessels on the "White List", which represents flags with a consistently high performance record.

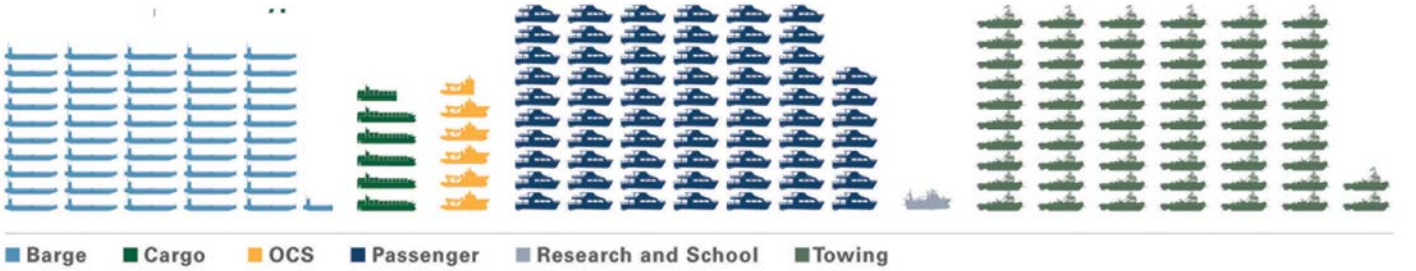
While not counted in the report, the Coast Guard estimates that there are nearly 58,000 vessels in the domestic commercial fishing fleet. These include fishing vessels, of course, as well as processing vessels and fish tender vessels. As the Coast Guard only maintains totals for vessels which are enrolled in the decal examination program, these numbers are based on a combination of state and federal sources.

Type / # U.S. Flag	Avg. Age (# years)	Inspections (#)	Deficiencies (#)	Deficiencies	PCT of All Inspections	PCT of All Deficiencies
Barges (5,061)	17	4,799	1,726	(ratio)/vessel	22.4%	5.4%
Cargo Vessels (571)	29	1,379	2,448	0.34	6.4%	7.7%
Pass. Vessels (6,731)	28	11,763	22,705	4.29	54.7%	71.5%
Towing (6,190)	35	2,636	3,363	3.37	12.3.4%	10.6%
OCS / OSV (578)	19	782	1,206	0.48	3.6%	3.8%
School/Research Ships (60)	31	112	290	2.09	0.5%	0.9%





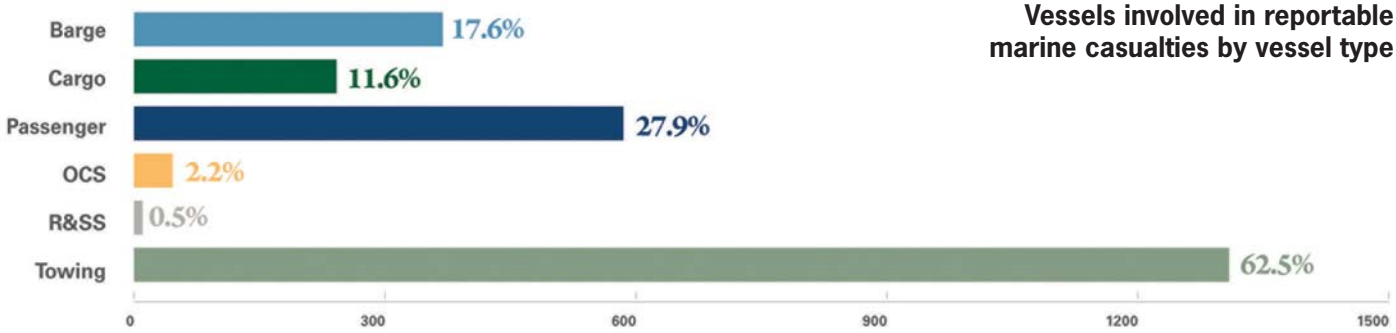
Number of U.S. inspected vessels of each type in calendar year 2019



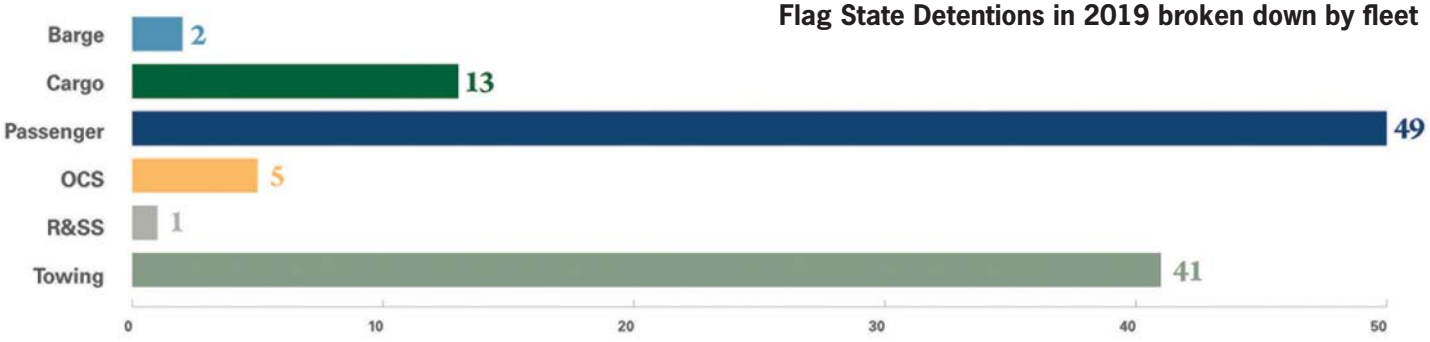
5,061 Barge | 571 Cargo | 578 OCS | 6,731 Passenger | 60 Research & School | 6,190 Towing (Subchapters I & M)

Average age of vessel fleets

Vessels involved in reportable marine casualties by vessel type



Flag State Detentions in 2019 broken down by fleet



Cummins

Eddie Brown

Director of Business Development, Marine, Cummins, Inc.

How do you see business today, and where is Cummins looking for opportunities as COVID-19 and volatile oil markets generate market uncertainty?

Even in the current state, we are still seeing a solid level of interest and activity in the commercial marine space. Scheduling has been impacted and some areas have slowed down, but overall, the marine industry is very much still active around the world.

When we take a closer look at some of the segments within the commercial marine space, differences begin to emerge. In the commercial transport sector, where they have operated throughout the pandemic, we are still seeing a need for new builds as well as repowers. But in other areas, for example the fishing industry, operators are experiencing lower demands so there could be some follow-on effects later in the year or into 2021.

Our engines are known for their durability and during this time, as always, we are working with customers to extend the life of their engines and manage operating costs. An example of this is extending filter change intervals through application and fluid analysis.

There are some opportunities on the horizon. As Tier 4 implementation increases, we anticipate seeing more opportunities for our solutions in U.S. vessels. We are also seeing some movement around windfarms. While not as common in the U.S. yet, conversations have begun around how that industry could take shape. Cummins is working with operators to understand their needs and will look to leverage our extensive experience in the area of offshore support and services as we are sure there will be some parallels in this developing market.

For the most part, our customers continue to build and operate, even if constrained, but it remains to be seen what to the longer-term impacts could be in 2021 and beyond.

What have been the greatest challenges to maintaining operations throughout the health crisis?

During this crisis, we have all been challenged to manage

those things in our control as well as those out of our control. To help the industry make it through this, we continue to focus on the things that we do well to keep our customers operating. Supply chain management, or manufacturing, is a fundamental area where Cummins exceeds. With our global manufacturing footprint, and extensive experience working with suppliers, we have been able to manage through the extensive challenges presented with quarantines and pandemic and have effectively returned to close-to-normal efficiency in our plants.

Another area that sets Cummins apart is our global service and support network. As the virus spread, we quickly found ways to adapt to social distancing and travel restrictions, continuing to provide customers with the support that they rely on to continue their missions. Here in North America, engineers such as Carl Hadler and other members of our team have worked tirelessly to keep essential vessels moving up and down the rivers.

Other members of our team have implemented additional remote diagnostics tools, continued sea trials on new vessels, and worked closely with customers needing a new vessel or a retrofit. For example, the install of the QSK38 Tier 4 solution on the field test vessel, which is a retrofit, has been completed and the vessel has returned to normal operations.

Given the current state of the market, do you see appetite for new products? Is Cummins planning to roll out anything new for the marine sector in the coming 12 months or so?

Cummins marine continues to innovate. Our IMO III line, which was announced last year, is fully released and we are taking orders for our QSK60 and QSK38 Tier 4 solutions. To date, across all our industrial markets, Cummins Tier 4 solutions have accumulated more than 10 million hours in the field. Also, there is a forthcoming genset package in the 99kW range that will pair well with our propulsion solutions that are used on inland waterways vessels. We realize that power is just part of what our operators need to run a successful fleet, which is why we will be releasing a new connected vessel solution later this year.

How will last year's Hydrogenics acquisition impact Cummins' marine business? Are there any projects underway to speak of?

Hydrogenics is the foundation for Cummins' hydrogen fuel cell business and will be the primary channel for development and new hydrogen-related product launches.

Hydrogenics' Fuel Cells Power Modules can be used for both auxiliary and propulsion power. With on-board hydrogen storage, fuel cells can produce power for the length of most trips. In addition to power, our fuel cells modules offer other potential benefits including reduced noise and vibration, reduced maintenance, improved part-load efficiency and flexible design based on manufacturer or operator needs.

Hydrogenics has successfully integrated fuel cells modules into 13 different boat designs and counting, including the first hydrogen-powered ferry in North America.

What are some of the main R&D focus areas for Cummins?

Cummins is looking at a few different areas. We're still very focused on diesel as a fuel and working to make our engines as clean and efficient as we can. There's plenty of discussion on renewables and carbon and that—all very important conversations—there's still very much a drive that the diesel technology is going to be around for a while. I think in the midst of that, and in a lot of the work going on whether it be EPA 4, IMO III, a lot of R&D is going into simply meeting emissions requirements and adding value to those products.

Electrification is another example. We have a lot of that applications and other markets, so we're looking at how we can expand beyond existing markets and bring it into the marine space.

Cummins, in general, is looking at some other opportunities such as fuel cells, as mentioned with the acquisition of Hydrogenics, and some others. We're certainly trying to look into renewables and understand how that's going to play out and eventually deliver solutions. In the last year, we created a new power business unit to have a group very focused on looking at technologies that may be outside of the traditional diesel space. Fuel cells, battery technologies, telematics and hybrids; All of that sort of stuff is parked in that business unit. We're very focused on, again, making acquisitions in those spaces, both I think the battery space and in the fuel cell space, among a few other things.

But I would say it's a bit of a duel path. Our efforts are certainly still very focused on diesel, but really planning for the future as we go.

Why has EPA Tier 4 been a bit slow to catch on for inland river operators? Is it because of cost, or maybe engineering challenges?

I think there's several reasons. Customers on the rivers tend to be a bit more conservative in what technology they're adopting. As a customer, they're often the ones looking at it a little longer than others, sometimes watching and waiting.

Another thing is they still have other options. Inland river vessels live a long time, and sometimes find a second life. So, owners have options to repower their vessels rather than build new ones. Most of the newbuilds are coming as a result of a

shortage in the fleet, or a particular customer making a strategic move to grow their fleet and try and win some business. So right now, I think they've managed through by just not building a whole lot of new boats and just repowering what they have. And I can't say if that's strictly tied to challenges on the river where there isn't a growing business, or that is more of intentional and watching and waiting.

And there were some customers that knew the regulation was coming and they spent the years leading up to it building new boats so that they didn't have to use the new technology. That's something we've seen in other areas around the world as well, where they actively try and build the fleet before a new regulation hits. And that can be either a complexity or a price issue, and certainly we understand that as well.

We do believe customers will get back to building some new boats. We believe there will be an adoption. On the inland rivers it's just been a little slower uptake than we've seen in some other segments.

Would you say the operational profile of these vessels also plays a part?

It certainly impacts how we develop a solution, but I don't think this is a driver for not adopting new technology.

One of the challenges specific to marine is that there are so many different ways people operate boats. On the inland rivers, there are a number of vessels that are not taking big tows. Maybe they're organizing the tows. They could be sitting around idling for a large percentage of the time. That's a specific challenge for developing systems that generally like to have heat going through them, such as aftertreatments. We have to pay attention to what's going on with both the engine and the aftertreatment to manage that for the different duty cycles.

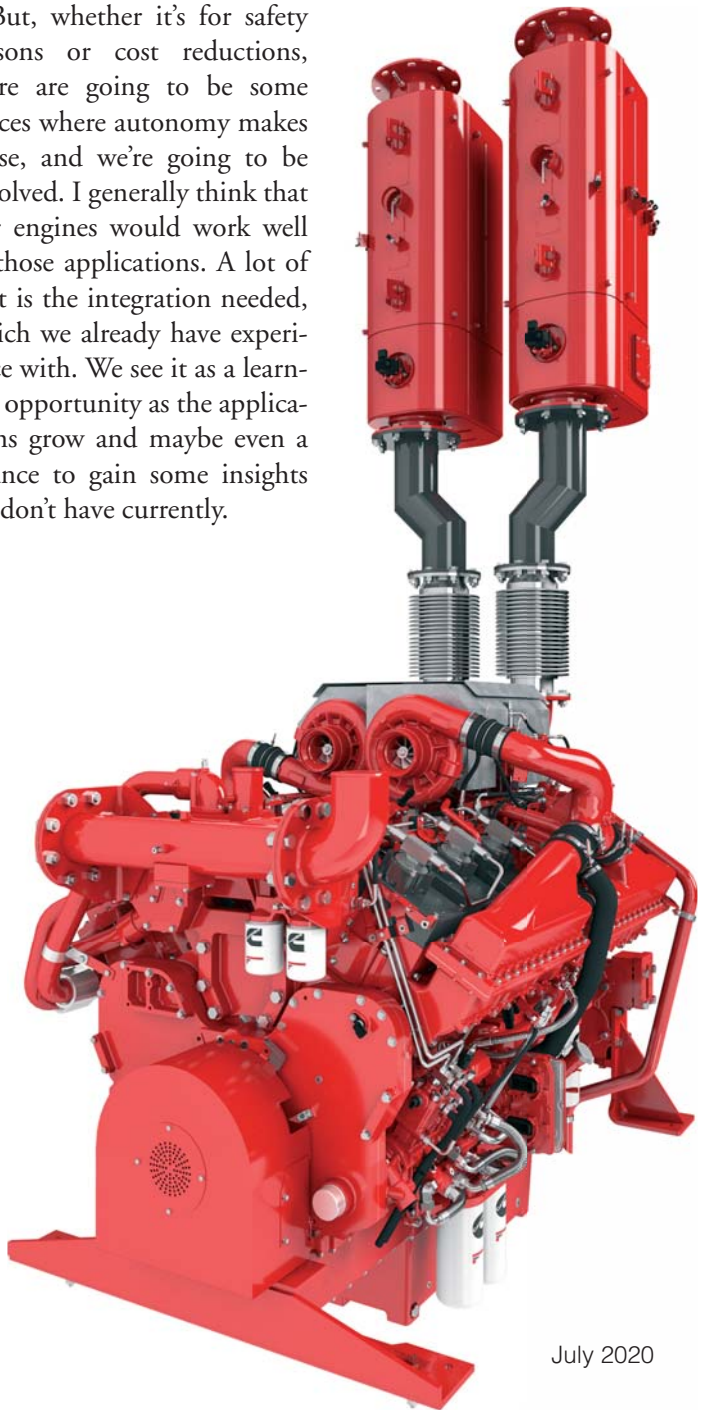
So again, the challenge of the inland rivers is the amount of time that they idle. But that's not all. The mission of that vessel and the complexity of operating on a river with a large number of barges going under bridges so safety is paramount so we're thinking about that as well.

Are you seeing much interest in autonomy and automated vessels? Do you expect wider adoption of these technologies in the near future?

We're involved in some dialogues with customers on autonomous vessels. In the government and defense space, there's a number of projects that are being talked about, and we've been involved in those discussions. There are going to be some places where they're going to make that work, and already making it work. There are some examples out there. So, it's not one of those things you can say, "I don't believe it's going to work." The question is, "Where is it going to work and where is it really going to be a differentiable service with an autonomous vessel versus a non-autonomous vessel?" So, I think the future is still bright for captains and operators of vessels.

One of the big challenges we see is maintenance of these vessels. How long are they going to operate autonomously before they get somebody onboard to service it? That's one thing we've been discussing with the customers. How long are the intervals where these engines will not see any kind of service or maintenance so that we design the right components and take the right approaches to setting that up so that becomes successful?

But, whether it's for safety reasons or cost reductions, there are going to be some spaces where autonomy makes sense, and we're going to be involved. I generally think that our engines would work well in those applications. A lot of that is the integration needed, which we already have experience with. We see it as a learning opportunity as the applications grow and maybe even a chance to gain some insights we don't have currently.



LNG as Fuel

By Joshua Padeti, ABS Senior Engineer

Padeti

A snap poll recently conducted by ABS found that as many two-thirds of global shipowners had yet to select a technical pathway to meet the International Maritime Organization's (IMO) mandatory decarbonization targets for 2030 and 2050.

With the technologies supporting a myriad of new low-carbon fuels evolving at vastly different speeds, any tendencies to wait for information to mature before making significant long-term capital commitments are understandable, and pragmatic.

With that in mind—and with the initial deadline for global emissions-reduction targets less than a decade away—ABS just published the first in a series of sustainability white papers offering 'practical considerations' to support owners with their decision making. It follows the introduction of ABS' Three Fuel Pathways approach breaking down the way ahead into three routes: light gas, heavy gas and alcohol and bio/synthetic.

It is not possible to condense all the technical information offered in the 24-page paper within to the constraints of this article, but here are a few insights.

The Sustainability White Paper: LNG As A Fuel describes LNG, which is the first in the Light Gas Pathway, as an option—when combined with technological and operational improvements—that will help owners to meet the IMO's CO2-reduction targets for 2030 (lowering 'carbon intensity' [CO2 emissions per transport work] by at least 40% against output from 2008); in some cases, switching from heavy fuel oil to LNG can reduce a vessel's carbon footprint by as much as 20%.

It is certainly the most market mature of the new fuels. But there are many elements to investigate when considering whether to use LNG in a shallow-draft or blue water environments, including vessel design, operating profiles and technology advancements.

LNG is comprised primarily of methane. Its carbon-to-hydrogen ratio can reduce carbon dioxide (CO2) emissions, but the potential 20% reduction value does not include the greenhouse gas impact from methane slip, a potential issue for two- and four-stroke engines that use LNG in the Otto cycle.

Minimizing methane slip is critical to a wider commercial adoption of LNG and its bio-, renewable (RNG) and synthetic (SNG) derivatives, which is why the industry is currently developing in-cylinder emissions-control strategies that can be combined with after-treatment systems.

By minimizing methane slip, future fuels such as bio-LNG and SNG/RNG could offer carbon-neutral propulsion.

As a low-carbon fuel, LNG can be combined with new technologies and/or operational measures to meet the 2030 emissions-reduction goals; and if blended in future with bio-LNG or SNG/RNG fuels, it also could contribute to further reductions, relative to the amount of renewable fuel used in the blend.

Given the carbon neutral promise of bio-LNG and SNG/RNG, the commercial application of these solutions is being explored at pace.

LNG Combustion

Environmental control areas and trans-urban waterways have proven attractive early testing grounds for LNG-fueled and LNG-hybrid propulsion technology. Ferries, tugs and offshore support vessels have been early adopters of the technologies.

Both manufacturers of slow-speed two-stroke marine engines—MAN Energy Solutions and Winterthur Gas & Diesel—offer dual-fuel options. However, each offers a different combustion process for operating in gas mode: a low-pressure engine using the Otto cycle; and a high-pressure engine using the Diesel cycle.

The Winterthur dual-fuel engines (X-DF) use the Otto process in gas mode and the Diesel process when it is in oil mode. While the MAN engines (ME-GI) use the Diesel process in both the oil and gas modes.

For both concepts, the gas is ignited by a pilot injection of liquid fuel from the fuel-injection system, or from a dedicated pilot-fuel system.

MAN has also announced the development of a low-pressure dual-fuel engine (ME-GA), which it intends to make available in 2021.

The different designs lead to different performance and emissions characteristics. But, overall, the suitability of a concept, or engine type, for a ship is very much a case-specific decision, with the ship's operational profile one of the key influences.

Separately, some owners may be uncomfortable with high-pressure gas and the increased complexity and cost associated with those supply systems. Others may have concerns with the Otto cycle's sensitivity to a number of operating parameters (methane number, ambient conditions, etc.), or the contribu-

tion of methane slip to their fleet's decarbonization strategy.

Dual fuel engine conversion

Specific fuel-supply systems are required to feed gas into dual-fuel engines at the right pressures and temperatures. The main dual-fuel engine, the components of which are broadly similar to conventional diesel-engine designs, also require key foundational engine components to operate in gas mode.

Furthermore, a diesel engine's potential to be easily converted to dual fuel is an important consideration; for example, if an owner is selecting a 'Ready' notation in preparation for converting the ship to burn natural gas at some point after delivery of the vessel.

The fundamental engine design of the MAN ME-GI is the same as its standard ME engines; 'GI' (gas injection) refers to all gas-related components that are necessary to allow an ME engine to operate on gas. As the 'GI' concept is an add-on to the ME engine, the latter can be considered "gas ready".

While Winterthur's X-DF engine offers the same general design as their standard X engine (diesel), several other base engine components are different, in addition to the added gas-related components.

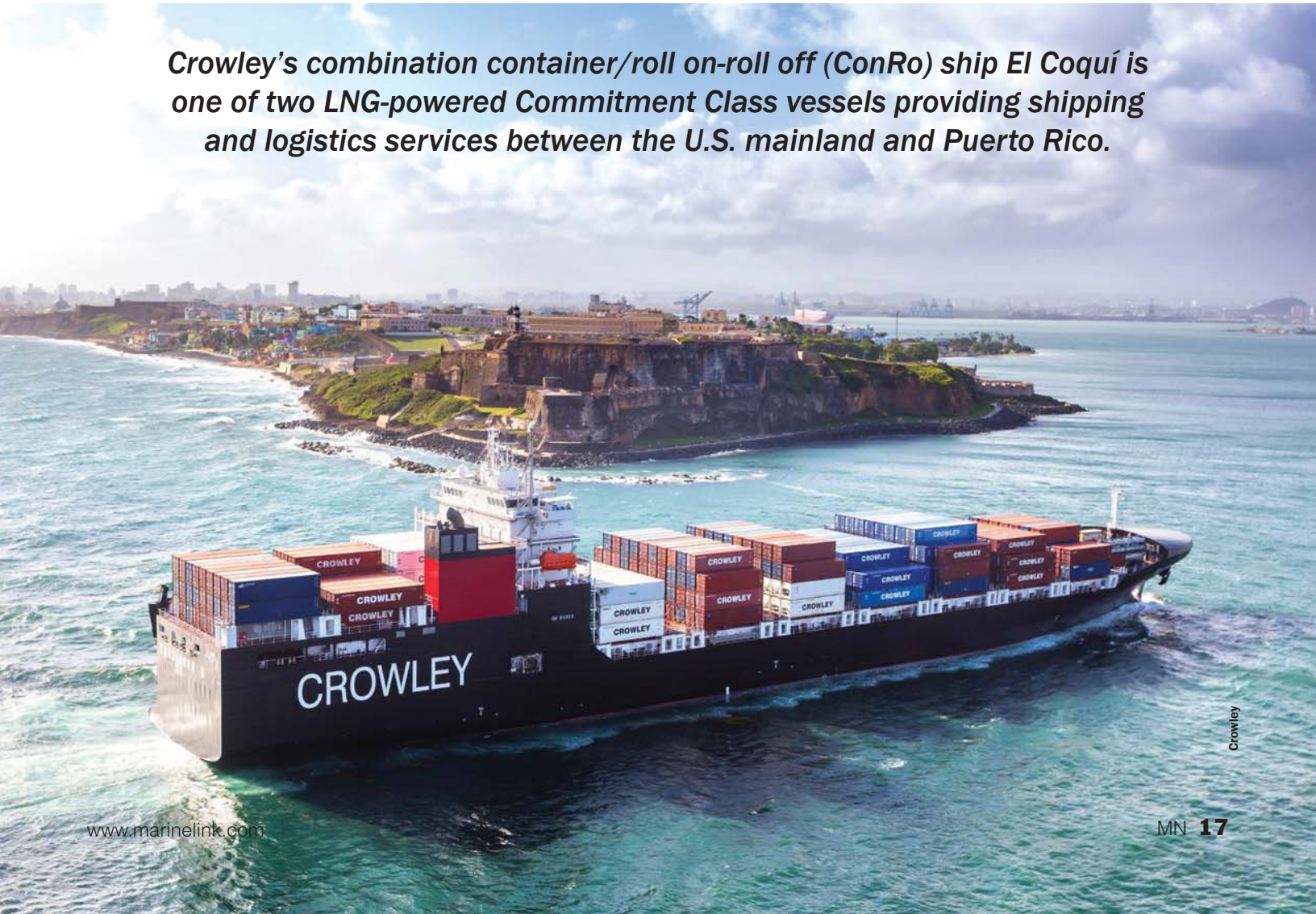
Dual Fuel Engine Emission Profiles

Natural gas and other low-flashpoint fuels, which are inherently low in sulfur, also can help owners to comply with the SOx emissions limits of MARPOL Annex VI. They also offer other SOx reductions and the sulphate portion of particulate matters because their sulfur content is typically less than 30 parts per million.

Their NOx formation is linked to peak-combustion temperatures, which are significantly higher for diesel than they are for gas engines. Similarly, dual-fuel engines using the Otto process to burn natural gas have much lower NOx emissions than those using the diesel combustion process.

ABS is continuing to develop a range of information and initiatives to support the industry's transition to low carbon operations.

To help drive decarbonization strategies, ABS has published Setting the Course to Low Carbon Shipping: Pathways to Sustainable Shipping, the second in a series of industry outlook documents — the first was published in June 2019 — to reference available carbon-reduction strategies and inform the shipping industry as it enters the uncharted waters of the 2030/2050 emissions challenge.



Crowley's combination container/roll on-roll off (ConRo) ship El Coquí is one of two LNG-powered Commitment Class vessels providing shipping and logistics services between the U.S. mainland and Puerto Rico.

Crowley

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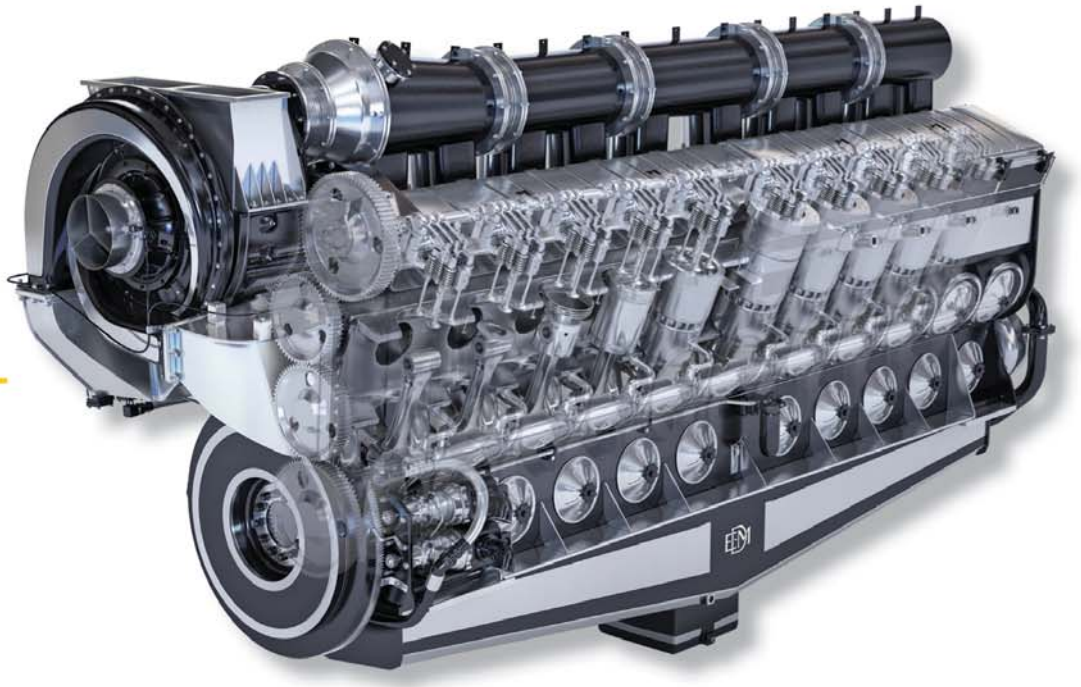

The E 23 (IMO II-EPA T3) and E 23B (IMO III-EPA T4F) are available in 8, 12, 16 and 20 cylinder configurations with power ratings from (1675 hp) to (5500 hp).
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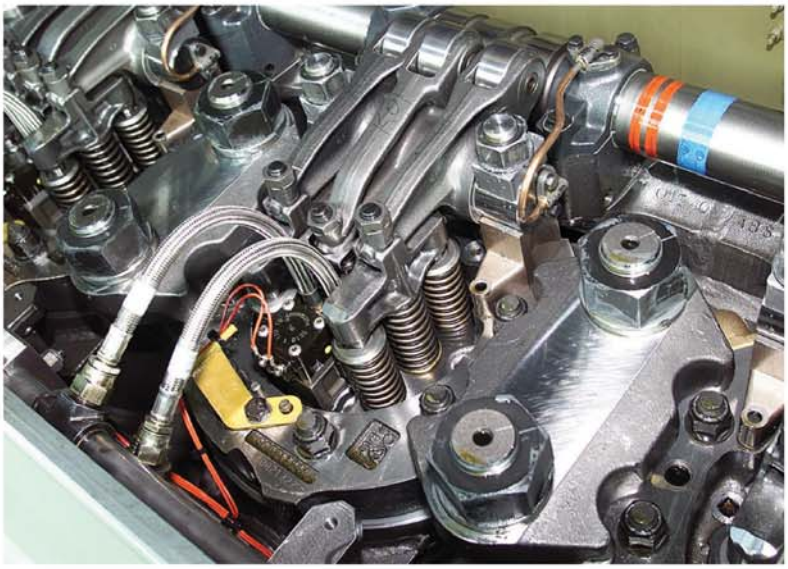

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Considering an All-electric Future

By Sean Caughlan, PE – Senior Marine Engineer, Glosten

Caughlan

One can hardly read industry news these days without seeing mention of hybrid vessels or batteries. We've all heard the praise and the pitfalls discussed by proponents and critics alike. This article is not intended to convince you if batteries are right for you or not. Instead, for owners wondering if batteries are feasible for their operation, the optimal vessel characteristics and operational parameters for all-electric vessels are presented and discussed.

Hybrid vessels, generally defined by having both a diesel engine and batteries, come in different flavors but offer advantages of reduced emissions and fuel use. All-electric (battery powered) vessels, unlike hybrid vessels, primarily draw their energy from the shoreside power grid, burn no fuel, and produce zero emissions at the point of use. Naturally, all-electric vessels, like hybrid vessels, are not suited for every type of vessel or operation. Limitations of the technology need to be considered and weighed against the benefits.

Lithium-ion batteries have revolutionized the energy storage industry and enabled a host of applications that were simply impractical only a decade ago. However, compared to No. 2 diesel fuel, marine batteries can only store about 2% of the useable energy by volume. So how can we overcome these limitations to realize the benefits of clean and quiet electric propulsion?

There are a few broad vessel characteristics that alone may seem obvious, but when taken together they act synergistically to enhance the performance and affordability of a battery powered vessel.

- ***Short travel distance:*** The shorter the distance between stops at port, the better. It's all about the need to carry stored energy. Short distances mean less energy and fewer batteries, which reduces capital cost, weight, volume, and the amount of power needed for charging.
- ***Back to base operation:*** These operations typically start and end the day at the same location and may return to that location multiple times per day. Ferries, harbor tugs, pilot boats and patrol boats, to name just a few, generally operate from a fixed point. Operating from a base location allows access to a potential charging location, which is essential for electric vessels due the limited energy storage on board.

Glosten

Glosten is working with Ray Hunt Design and the Canaveral Pilots Association on a pilot/demonstration project for the design, construction and operation of an electric pilot boat. Marking a first for a pilot boat in the U.S., the vessel will feature a battery-electric propulsion system with an emergency 'get home' diesel engine.

• ***Shore power:*** Typically, all-electric vessels will need to charge periodically throughout the day. For example, ferries operating on a fixed route may charge every one-way trip or every round trip to minimize the size of the battery bank. Shore power must be sized appropriately to recover the energy used in the available time at dock. For vessels with a high operational rate, the power levels can become very large, often in the megawatt range. High voltage shore power is sometimes necessary to keep cable sizes reasonable. Understanding shore power needs, availability, and limitations should be one of the first feasibility criterion to assess.

• ***Slower speeds:*** Speed is especially challenging for battery power. High speed means high propulsion power and low vessel weight. Since energy is power multiplied by time, high-speed vessels operating even on shorter routes can consume large amounts of energy. Slower vessels often have hull forms that are less weight and volume sensitive, meaning batteries and power electronics can be more easily accommodated.

• ***Operational frequency:*** Operational frequency should be carefully considered when evaluating the feasibility of an electric vessel. All things being equal, a vessel that operates less often will be easier to design or convert to all-electric. For example, a ferry operating 10 short round trips per day will have fewer challenges than one operating 20 or 30 round trips per day. Fewer trips mean more time to charge between trips, lower charging power, and simpler charging logistics. Furthermore, the lifetime of lithium-ion batteries is dependent on the number and depth of discharge cycles. Increasing battery life is typically accommodated by increasing the quantity of the batteries that are carried. It is not unusual for a battery to only be cycled to 30% of the nameplate capacity. This means you may be carrying three times more energy capacity than the vessel typically uses between charging cycles. The increased battery lifetime comes at the penalty of weight and capital cost.

On the other hand, energy from the electrical grid costs less than diesel fuel. The more energy that is consumed, the higher the potential savings and the shorter the payback time. Vessels that burn very little fuel could have long payback times, even if technical feasibility is established. While there are many good reasons for owners to consider an all-electric vessel, economics will often be one of the most important.

Before considering a new electric vessel project or a conversion, owners should carefully consider all these factors as part of establishing the technical feasibility for their operation. To start this process, it is important to gather as much information as possible about your vessels operational profile. The profile should establish propulsion and auxiliary power requirements over the vessel's normal operation. Contact the utilities to discuss availability and costs for shore power. If the expertise doesn't exist within your organization, discuss your operation with an experienced naval architect with knowledge of battery electric vessels.

The marine industry has always been understandably conservative about embracing new technology. While hybrid and battery powered vessels are emerging quickly, energy density (weight and size), cost, and cycle life will all need continuous improvement for the technology to become more widely adopted. With battery improvements and increasing pressure to reduce emissions, more owners will ask whether all-electric technology is right for their operation. Given the complexities of integrating emerging technologies and shoreside utilities on top of a typical vessel acquisition or conversion timeline, owners should consider their operations in light of these criteria to be prepared for their future.

Navigating an Emerging Landscape

By Martin Bjuve, President and CEO, Volvo Penta of the Americas

Bjuve

The past few months have been full of uncertainties and even as we look ahead, we don't know exactly what the future will hold. But we do know that as an industry, we'll need to prioritize and plan differently. Within the Volvo Penta organization, the team is working hard to understand how to adapt our business as the world around us continues to adjust to a changing economic and societal landscape.

As I reflect on what's transpired since the start of the pandemic, I'm proud of the professionalism and creativity shown by our Volvo Penta team in rising to the challenges.

I'll give you an example. Technical training is a critical part of our business as we ensure that a high density of skilled technicians stand ready to serve our growing marine commercial customer base. Last year alone, more than 1600 service technicians attended our in-person training sessions in the Americas. When the coronavirus hit, we had to cancel in-person sessions, but within a few weeks our team launched a new series of online instructor-led classes. We'll continue to expand these virtual offerings, conducted by our certified trainers, not just in the near-term but into the future as well. The courses will become a regular part of the curriculum, giving dealers a broad range of training options to better suit their needs.

I am also happy to report that the Volvo Group parts regional distribution centers, including the one-million sq. foot facility in Byhalia, Miss., remained in full operation. Orders were processed regularly and on-time, ensuring uninterrupted delivery of parts to our power centers, dealers, shipyards and mission critical operators in the field.

We've also placed stronger emphasis on leveraging technology to communicate with customers. We've been on the forefront of using virtual platforms for internal communication purposes for a long time now but this situation helped us discover new ways to connect with customers when face-to-face may not be an option. These techniques will no doubt remain an efficient complement to in-person meetings in the years ahead.

A foundation for growth

Our commercial marine business remains resilient and has demonstrated annual growth consistently in North America. Last year the increase was attributed to a significant retrofit

business as well as newbuilds.

Key market segments for Volvo Penta globally include Coast Guard and patrol boats, pilot boats, short-sea and river transport, crew and supply vessels, research vessels, passenger ferries and sightseeing vessels, workboats, tugs and towboats, self-propelled and articulated barges, commercial fishing boats and wind farming vessels. In addition, we're supplying engines to power pumps on fuel barges.

The offshore wind sector has been a core segment for Volvo Penta from a global perspective for quite some time now, with a significant presence in crew support vessels throughout Europe and beyond. We believe this proven track record positions us for success as the industry continues to develop in the U.S.

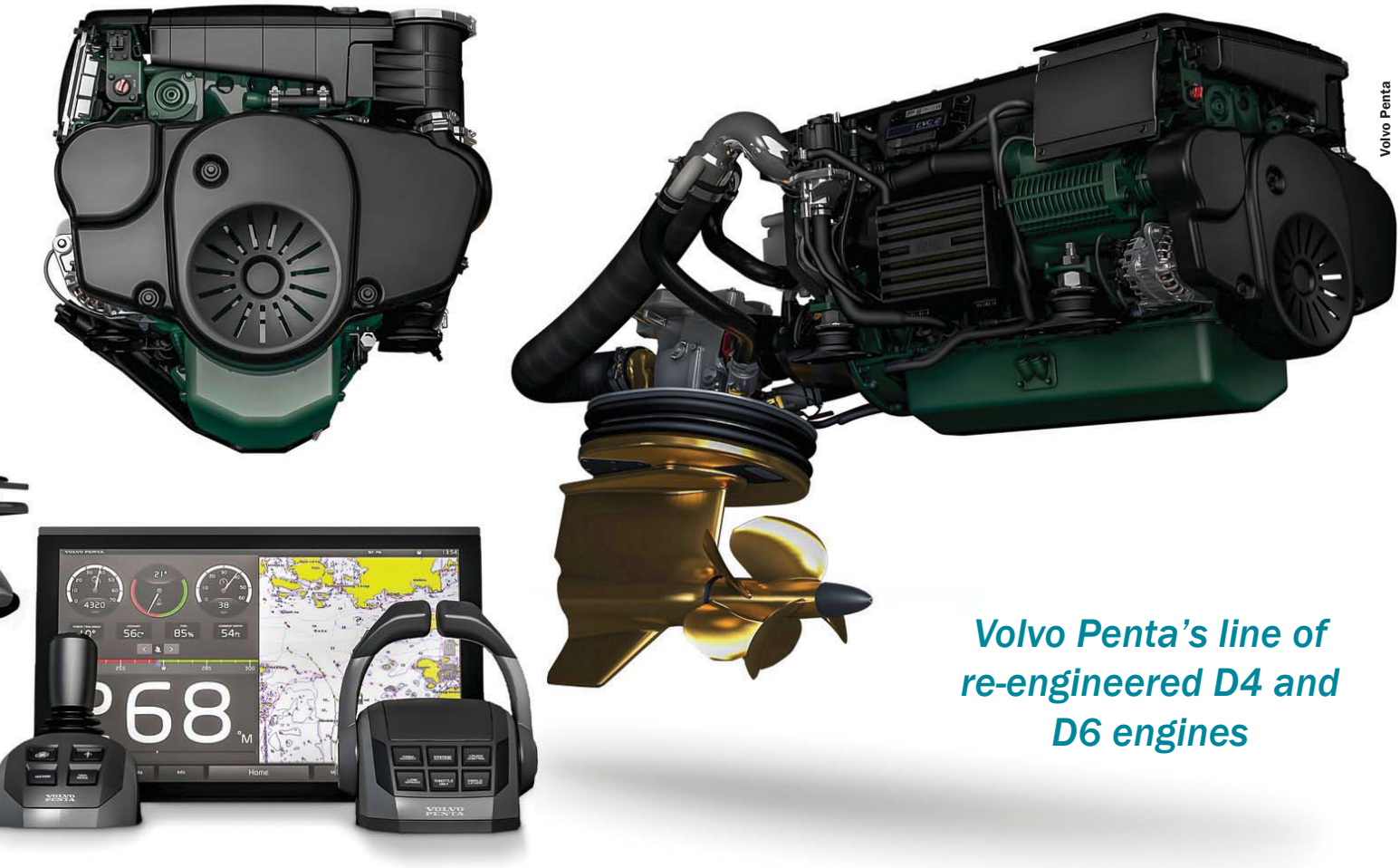
I believe we have the building blocks in place for continued success in our key commercial segments. Internally, this has been built upon innovative engineering, proven products, and a strong in-house team. Externally, our momentum has been established through an outstanding network of power centers and good working relationships with shipyards, naval architects and commercial fleet managers.

A primary driver of success is our long tradition of continuous product improvement and innovation. It's also the unique features and benefits we offer that make Volvo Penta stand out from the rest such as trademark torque, unsurpassed fuel efficiency, longer service intervals and more. A good example is the recent comprehensive re-engineering program for our D4 and D6 marine engine platform, resulting in more power and reliability and reducing operating costs by a third. The updates included redesigned engines with higher horsepower ratings, a completely new Aquamatic DPI sterndrive characterized by silent and smooth shifting, an updated IPS drive and an upgraded Electronic Vessel Control System.

Last year we also upgraded our D16 genset engines to meet the increasing market demand for more powerful marine generators.

Another key asset is our team of talented and motivated professionals. Volvo Penta was named Employer of the Year by Diesel Progress in 2019, and we were certified as a Great Place to Work by a national organization for the second year in a row. Our strategy is to hire the best people, commit to their professional growth, support them and give them the tools they need to succeed.

We also continue to build out our infrastructure of Power



Volvo Penta

Volvo Penta's line of re-engineered D4 and D6 engines

Centers and authorized dealers. For instance, we just appointed a new Power Center to support our growing market in Mexico.

What's in our crystal ball?

We see several trends that will continue to impact the marine commercial industry, both in the near and long-term.

First, integration. Shipyards and vessel operators are increasingly looking for complete propulsion solutions designed, supported and warranted by a single trusted supplier with a strong local service presence. That's been a hallmark of Volvo Penta's approach through the years. We don't just make and sell engines. We make fully integrated helm-to-prop propulsion systems, and our national network of Power Centers provide a critical link between us and our customers. We also have a robust supply chain which allows us to source the most

Volvo Penta

optimal components for our solutions.

Second, digitalization. The way we work, go-to-market and support customers will evolve with a growing dependence on digital forms of engagement. For a long time, we've placed an emphasis on physical communication when it comes to things like preparing our dealer network to deliver high-quality technical support in the field and handling installations. And while we're still proponents of face-to-face interaction when it becomes possible again, this situation has taught us that technology can be a valuable asset and complement for collaboration. Take for example an interesting case study from the wind farming sector on how we've adjusted as a company during the coronavirus in providing remote support for vessel launches. Amid travel restrictions, the Volvo Penta team led a completely remote installation of quad IPS units to repower Northern Offshore Services (NOS) vessel, The M/V Traveller, for operation in the North Sea.

Third, connectivity. The industry has seen an escalating demand for maritime digital services. From a Volvo Penta perspective, we see an opportunity to support increased uptime and productivity through advancements in connectivity solutions.

Finally, sustainability. The coronavirus has revealed the vulnerability and fragility of our people and societies and we believe the movement toward preserving the climate will accelerate. We've recently witnessed a positive impact on the environment as we've travelled, transported and produced less. How fast we can decrease CO2 emissions will be influenced by the way countries around the world handle legislation, with an expected increase in the regulations we've already seen impacting our industry in many ports throughout the globe. I believe we will become more conscious about protecting the environment as a whole, and that sustainability awareness will translate into more demand for environmentally-friendly product development.

Volvo Penta diesel engines power the fuel pumps and gensets on this new ATB recently delivered to OSG.

Maritime Training amid COVID-19

Hornblower

By Eric Haun

Good maritime training provides much more than the certifications, licenses and documentation needed to qualify for the job. It goes beyond preparing crews to carry onboard functions safely and efficiently day in and day out. Well-trained mariners have the skills and knowledge to handle almost anything thrown their way – even when confronting the unexpected. But what happens when the unexpected is a pandemic?

COVID-19's effects on industries across the globe have been widespread and diverse, forcing businesses to adjust to an entirely new set of global circumstances. The maritime industry has certainly adapted, but vessel crews cannot simply work from home to avoid exposure to the novel coronavirus, just as cargo cannot be transported over Zoom.

"Mariners have continued to report to work, vessels have continued to operate and the industry has adapted to maintain operational continuity and readiness," said American Waterways Operators president and CEO, Jennifer Carpenter, in her testimony before the House Transportation and Infrastructure Subcommittee on Coast Guard and Maritime Transportation in May.

Carpenter stressed the resiliency of the U.S. domestic maritime supply chain and highlighted the key role of the American tugboat, towboat and barge industry in maintaining the flow of vital commodities and guiding ships into port throughout the conronavirus health crisis.Vessel operators, which routinely emphasize sound safety practices (including training) as part of their regular course of business, were able to react quickly to keep crews safe and cargo moving. Critical to maintaining operations during the pandemic were the swift prioritization of crew health and safety, Carpenter noted. "The industry's extensive experience with contingency planning, safety management systems and incident command structures has served it well in managing the health, safety and operational challenges posed by the pandemic," she said. "Companies quickly put in place – and have continued to refine – procedures aimed at keeping the virus off their vessels."

One company that moved quickly to implement measures to protect its workers (and thereby the flow of maritime commerce) is Crowley Maritime. The organization enacted new safety practices and procedures surrounding sanitation, proper handwashing, personal protective equipment (PPE) use and social distancing on board its vessels, and has been emphasizing best practices for safety on crew change, says Ira Douglas, Crowley's vice president, labor relations. He says a Ship Operations Cooperative Program (SOCP) Safety and Health Working Group, led by Capt. Cole Cosgrove, working group chair, and vice president, Crowley global ship management, helped to manage crew changes as safely as possible.

So far, the additional safety measures have been paying off. "The COVID-19 infections on commercial vessels at this time have been infrequent, relatively, because of mariners' work and dedication and cooperation among. Labor providers, terminal operators, industry oversight organizations, and vessel owners/operators," Douglas says.

"I think some of these practices will remain, certainly, be-

A new bill – H.R. 7456 introduced by Congresswoman Sylvia R. Garcia (Texas-29) – aims to make available **$200 million in grant funding for community and technical colleges offering training programs for maritime industry professions.** *"Maritime industry jobs are a critical part of our nation's economy. Yet research has shown that there may soon be a shortage of maritime industry workers," said Congresswoman Garcia. "Therefore, it is essential that Congress act to support community and technical colleges providing training for the next generation of workers in this industry to avoid a future workforce shortage."*

cause the experiences are reinforcing the need for safety to support the global supply chain, even by companies such as Crowley that prioritize safety as a core value," Douglas says. "I think the attention to sanitation and hygiene, especially in high traffic areas, will become more normalized. I would expect once we are on the other side of this, that social distancing will not continue, however."

Crowley's regular training practices have also had to be adjusted in parallel. "The COVID-19 pandemic has significantly impacted our approach to training, primarily for courses traditionally completed in person," says Vicky Ellis, director, marine development and learning.

Ellis says the company had already begun shifting a significant portion of its training to an online, at-home format before the coronavirus outbreak. Once the pandemic hit, Crowley was able to work with many of its vendors who traditionally only offered in-person classroom instruction to move courses online to a virtual classroom format using video and web conferencing software. "This shift allowed us to keep our crews safe by being able to quarantine and not travel during the pandemic. As a side benefit, it also resulted in significant cost savings for the company," Ellis says. "Even as areas and schools begin to reopen, we are in conversation with vendors on how we can continue to offer virtual training opportunities, especially for courses that are largely lecture in nature. We continue to learn and take advantage of technology to promote training and safety."

While many in the passenger vessel segment have been forced to suspend voyages due to COVID-19, a small number of operators, including NYC Ferry operated by Hornblower, have remained operational as an essential service throughout the health crisis.

Richard J. Paine, Jr., Regional Director, HSSQE, for Hornblower, says training leading up to the pandemic involved a mix of classroom style, online/computer-based/virtual and traditional hands-on programs, each providing a specific emphasis on certain phases of the operation. "In order for us to continue to train during this period, we reduced the size of training sessions, conducted in outdoor settings and conducted while observing social distancing requirements," he says. "Our virtual training platforms remained operable and we are currently implementing a training plan to introduce webinar-based classroom training conducted with a live instructor."

Paine says most training changes related to COVID-19 aren't necessarily new training subjects for Hornblower, but more of an updating and revising previous training content. For instance, the operator added subject matter such as PPE usage, good hygiene practices, proper cleaning and disinfectant procedures. "The COVID-19 training that has been developed because of this pandemic include practicing social and physical distancing, face-coverings, effective communication to passengers, as well as, continued training on the ongoing guidance provided from elected officials and health-care professionals." he says.

Of course, not all training can be completed at home. "The U.S. Coast Guard and other regulators have very strict guidelines on what courses be delivered online. STCW, by its very nature, requires hands-on learning and assessments but we are all learning and adapting," notes Captain Ted Morley, COO and academic principal at Maritime Professional Training (MPT) in Fort Lauderdale, Fla.

"Even before COVID-19 we designed our main campus to fight viruses and improve air quality," Morely says. "We have UV sterilizers in our AC system and hospital grade hepa filtration, along with hydroxyl units and disinfectant fogging systems. We also pre-filter and pre-condition all the air coming into the building. Currently we are expanding our online portal to include virtual classrooms and more distance learning options."

Long term, as technology continues to improve, Morely expects a "blended approach" to learning that includes more video conferencing and virtual simulations, but with hands-on, in-person instruction where needed.

"The blended approach will allow students to receive the classroom material early, review and develop a baseline, complete pre-entry familiarization, and then be ready to shift to a classroom setting to complete the learning process and the assessment criteria as established by the STCW Code and the various regulatory agencies," he explains.

Asked whether COVID-19 could spur new health and safety training requirements, Morley said it's hard to say whether regulations will arise, but added MPT is already working with some of its vessel operators and shoreside terminal operators to develop operational guidance and procedures. "I think we will see more companies working on ways to improve safety for their mariners and staff; a big part of that is training on prevention, mitigation, cleaning and contact tracing."

Offshore Wind's *Lift Off*

By Eric Haun

Offshore wind currently represents just a small piece of the world's energy supply. But that's changing faster than ever before as new and existing players look to tap the huge resource potential—and market opportunities—being unlocked by shrinking costs and technological advances, as outlined in a recent market report.

In the coming decades, the rapidly maturing offshore wind market is expected to become a trillion-dollar business as the pace of installed capacity growth accelerates, according to World Energy Reports' (WER) Outlook for Offshore Wind Power: The Frontier of Future Energy, published in June. A webinar presented the report's key findings on June 17.

GROWING, WITH HUGE POTENTIAL

Globally, the total installed energy capacity for both onshore and offshore wind farms at the end of 2019 totaled 651 gigawatts (GW), or about 10% of global electricity generating capacity, according to the WER report. While just 25.5 GW, or less than 0.5%, of that installed capacity is currently located at sea, the rate of new installations offshore has been growing at a much faster rate since 2010: 26% compound annual growth rate (CAGR) compared to 14% for onshore. Even amid the current coronavirus pandemic, WER expects this trend to continue, with 16 GW of additional offshore capacity to be added in 2020 and 2021, driven primarily by ongoing activity in the well-established Northern European sector as well as the newer, fast-growing Chinese market. China, already the leader onshore, emerged as a major offshore wind player in 2018 and has continued to expand its substantial project pipeline.

When comparing onshore wind vs. offshore in terms of untapped potential, it's clear that offshore is simply unmatched. The WER report estimates global offshore wind potential to be technically capable of supporting more than 120,000 GW of electricity production capacity (equating to approximately 420,000 TWh), which is more than 20 times greater than current world demand.

By 2040, WER forecasts offshore wind capacity will increase to somewhere in the range of 340 GW-560 GW, led by Europe and China, with newer entrants the U.S., Japan, South Korean and India among top markets. The report iden-

tifies some 500 GW of projects and development zones currently in the planning and development stages, mainly coming from Europe, Asia and the U.S. Details for each project are laid out in the report as well as in a corresponding online database (**http://www.worldenergyreports.com/wind-db**).

LOWER COSTS

Offshore wind farms are not new; they have been around for decades. So why is offshore wind taking off faster now than ever before? WER's report points to a combination of factors helping to grow offshore wind's role in the word energy mix. The simplest but most important reason for growth is that offshore wind has made great strides over recent years to become increasingly cost competitive compared to other energy sources, including fossil fuels. In the years ahead this momentum will only build as costs continue to fall.

The growing volume and size of offshore wind projects, along with improving supply chain competencies larger, more efficient turbines (the current largest is 14 megawatts (MW)), and the utilization of offshore transmission substation hubs have all helped to reduce offshore wind's levelized cost of energy (LCOE). According to WER, LCOE has declined from a global average $170/MWh in 2010 to strike prices of $60/MWh to $110/MWh in 2016 to 2018 European and U.S. auctions. Recent prices have been seen as low as $47/MWh in recent European auctions. WER says declining LCOE is allowing offshore wind to compete with fossil fuel projects in European and Chinese markets. It's still a different story in the U.S., but WER sees cost parity by the end of next decade. Today, installation capital expenditure (capex) cost for bottom-fixed turbine projects averages just over $3,000 per kilowatt (KW) with transmission. WER projects this will fall to fall to $2,500/KW by 2030 and $1,900/KW by 2040.

FLOATING FUTURE

Another significant factor leading to a major jump in projected installed capacity over the coming years is the advancement and commercial demonstration of floating offshore wind turbines, which open up new areas to exploit: specifically, in deeper waters where the construction of wind farms was not previously feasible. Currently almost all offshore

wind power generation comes from bottom-fixed turbines, which are restricted to water depths of about 60 meters or less. However, as concepts continue to evolve and become proven, floating turbines will enable wind farm construction in deeper waters that hold some 80% of the world's wind capacity potential. Representing another boost for overall capacity potential, these areas are typically further from shore where the wind generally blows stronger, resulting in higher turbine capacity factors.

Today's most proven floating wind turbines are Equinor's Hywind, employed on the 88MW Tampen project, and Principle Power's WindFloat, being used on the 50MW Kincardine project, but WER's report looks at more than 50 floating wind concepts in various stages that are being studied across the globe. Just as is occurring for traditional fixed-base turbine projects, the increasing size of floating projects and the industrialization of the hull construction process is helping certain concepts reduce project LCOE. For example, as Equinor matures the technology, it aims to bring the LCOE of Hywind projects to €40 -60/MWh by 2030.

A pipeline of more than 50 GW of floating capacity requiring $93 billion to $148 billion of capex investment has been identified by WER. As is the case in the bottom-fixed segment, the U.K. presently has the largest floating pipeline at more than 25 GW, followed by Norway (more than 5 GW) and Japan, the U.S., South Korea, Ireland, France and Taiwan, each with multi-GW pipelines. WER's report highlights the development of a much large pipeline after the middle of this decade, with potential zones discussed in the U.S., Japan, Norway, U.K. and France.

Ørsted

BIG POTENTIAL MEANS BIG OPPORTUNITIES

Forecasted near- and long-term increased activity bodes very well for the global supply chain. WER expects offshore wind projects will require between $1 trillion and $1.5 trillion of capex over the next two decades. Much is still on the table for the gamut of suppliers and marine services firms, as 80% of offshore wind projects detailed in the report and database are still in early stages of planning and development.

With a pipeline of activity so large, there's plenty of work to be had by exist-


Ørsted

ing players and new entrants alike. We've already seen a number of traditional offshore oil and gas players—from operators such as Shell, Total, Equinor and Repsol, all the way down the supply chain—transfer their skillset into the offshore wind market over the years. For these firms and others, including traditional offshore oil and gas players such as yards for jacket and HVDC substation fabrication, as well as for construction and assembly of floating foundations, opportunities abound as projects get larger, deeper and further from shore.

Offshore wind farms need servicing, creating even more work for a wide range of support providers—from boatbuilders to turbine technicians. In Europe, for example, onshore operation support bases are having associated positive impacts (long-term direct jobs, and bolstered local supply chains) in port regions that had been historically active but have struggled more recently due depressed oil and gas and shipping markets. Using the current UK $94,000/MW/year operational expenditure (opex) cost, the current pipeline of projects could require up to $46.6 billion of annual opex spend within the next decade, says WER.

Principle Power's WindFloat

Bourbon Subsea Services towed the third and final Windfloat Atlantic project's floating wind turbine to the offshore location located 20 km from Viana do Castelo on the Portuguese coast. The turbines are installed aboard Principle Power-patented WindFloat floating support structure. Windfloat uses seawater ballast to submerge approximately 2/3 of the structure below the mean water line. Its mooring system is a catenary configuration connected to drag embedment anchors.


Bourbon

Siemens

World's most powerful offshore wind turbine

Wind turbine maker Siemens Gamesa unveiled a new SG 14-222 DD offshore Direct Drive wind turbine with 14 MW capacity. The capacity can reach up to 15 MW using the company's Power Boost function, a 222-meter diameter rotor, 108-meter long blades and a 39,000-square-meter swept area. Approximately 30 SG 14-222 DD offshore wind turbines could cover the annual electricity consumption of Bilbao, Spain, Siemens Gamesa said. The turbines have already been earmarked for the proposed 2,640-MW Dominion Energy Coastal Virginia Offshore Wind (CVOW) project in the U.S. The prototype will be ready in 2021 with the turbines expected to be commercially available in 2024.

All American Marine

A Quiet Revolution

BAE Systems' HybriGen technology is creating a path to zero emissions.

The rise in planet-warming greenhouse gases is driving a need for cleaner transportation on the ground, in the air and on the water. Leaders in the marine industry are taking note, and vessel operators are making the move to green power and propulsion systems.

BAE Systems is creating a path to cleaner harbors and waterways with its HybriGen Power and Propulsion system. The system has three configurations to provide operators with options on their way to zero emissions. Each option not only cuts emissions, but creates a smoother ride for passengers and helps operators save on fuel and maintenance costs.

HybriGen Power

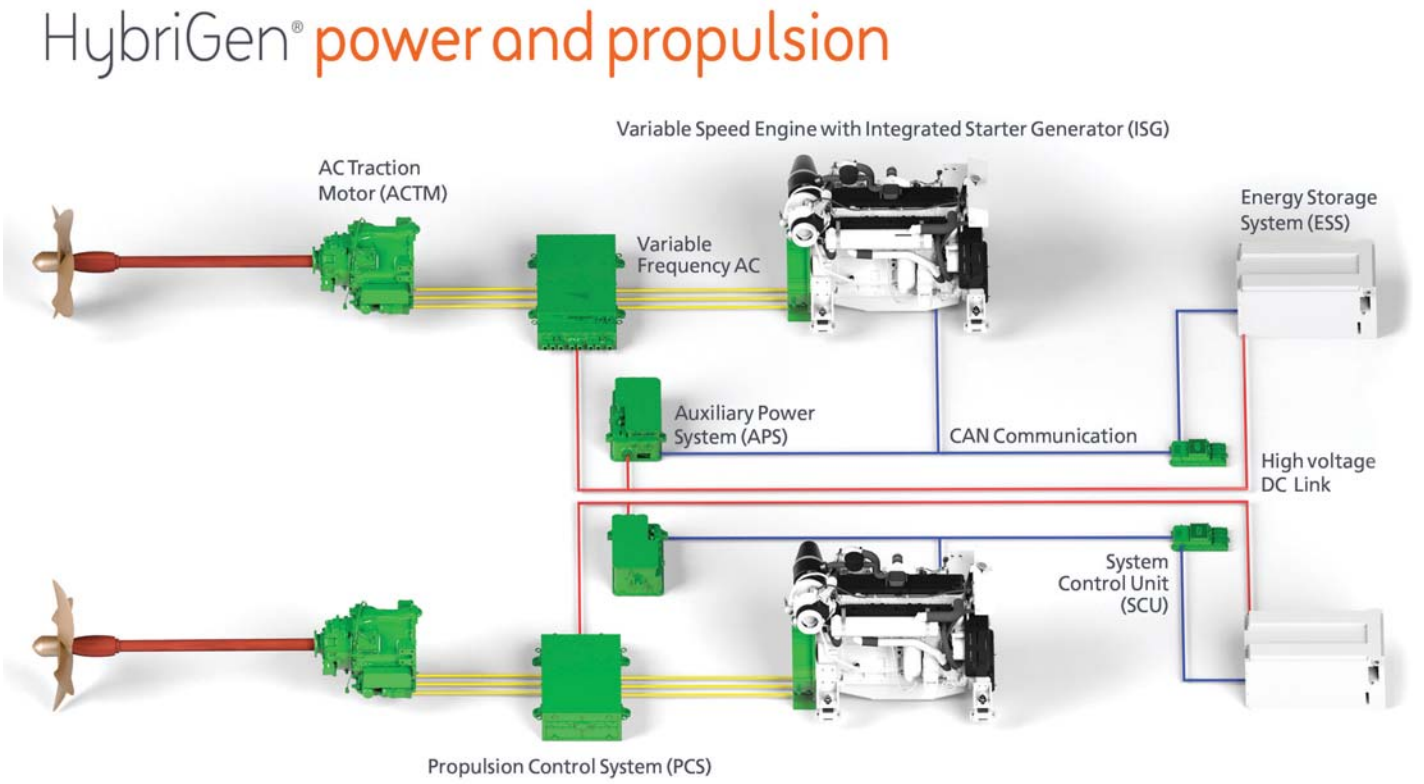
For many operators, the HybriGen Power system is the first step to zero emissions. It reduces the workload of diesel engines and runs nearly maintenance free – reducing operating costs, fuel use and emissions. The system provides electric power for the auxiliary hotel loads of a vessel such as heating, air conditioning, lighting, navigation devices and deck equipment.

How it works: BAE Systems' hybrid technology harnesses reserve energy from main engines that are already running. The system leverages a small generator and gearbox that attaches to a PTO shaft on the front of the main engine to create electric power. This eliminates the need for a much larger gen-set which would normally provide this power and creates added maintenance.

HybriGen Power and Propulsion

The HybriGen Power and Propulsion system can run free of emissions. Power needs can be fully sustained by the use of battery energy storage.

It produces enough power for both the propulsion system and auxiliary hotel loads. With two systems driven by one – it frees up space in the engine room and makes it easier for operator installation. For vessels requiring more



power, the system upgrades with ease to increase energy storage capacity.

How it works: The HybriGen Power and Propulsion system can be configured as an electric hybrid, battery electric or fuel cell electric system. It includes motors, battery energy storage, smart controls, and in some cases variable speed generators to create a clean form of power and propulsion for vessels.

HybriGen Assist

The HybriGen Assist system is a parallel hybrid solution. Operators can use the system in tandem with the core HybriGen Power and Propulsion system for optimal environmental and performance benefits.

How it works: The technology works with a main diesel propulsion system to provide added power to both the vessel's hotel loads and propulsion components. The system uses a PTI-PTO connection on the main diesel propulsion system to provide an electric hybrid interface and power the vessel at low speeds. It can also deliver a boost of power to the main diesel engines at high speeds. This eliminates the need to oversize those engines for the application and can avoid requirements for additional exhaust after-treatment.

Operators can choose to run the system in multiple modes:

- **Electric: Uses electric power for hotel loads and motors at low speeds.**
- **Mechanical: Operates as a traditional propulsion system.**
- **Power generation: Creates electric power for hotel loads and the energy storage system while the diesel engines are running.**
- **Boost: Provides a power boost to the engine for propulsion with clean electric energy.**

Operators using clean power

One of the first to make the jump to the HybriGen system was the Red & White Fleet. With its newest vessel Enhydra, the sightseeing company in the San Francisco Bay has been

operating on BAE Systems' electric-hybrid technology since 2018. Since then, the 128-foot excursion vessel has saved roughly 35 percent of its fuel, only needing to operate its combustion engine part of the time.

Just across the bay, the 70-foot Water-Go-Round passenger catamaran is expected to go into service in San Francisco later this year. It is the first commercial passenger vessel in the United States to use only fuel cells for power and propulsion. BAE Systems leveraged more than 10 years of experience and investment in the green technology to help make it possible. The vessel will use hydrogen fuel cells instead of variable speed gensets to create another clean form of transportation in the bay.

In Sausalito, Calif., the Call of the Sea powers a 132-foot wooden tall ship that teaches young people about maritime history while promoting sea stewardship. Kitsap Transit is also using an electric-hybrid system for its All American Marine-built passenger ferry, Waterman, which operates out of Washington State's Port Orchard.

On the East Coast, BAE Systems technology is also providing three vessels with complete electric power. Harbor Harvest is using the HybriGen Power and Propulsion system on their vessel Captain Ben Moore to create a new and sustainable form of short sea shipping. The environmentally friendly boat hauls locally made products and other cargo between Connecticut and New York on the Long Island Sound. Built by New York-based Derecktor Shipyards, the technology is helping the Spirit of the Sound and City University of New York (CUNY) conduct research along the coastline.

Investment in a cleaner tomorrow

As the pressure to get to zero emissions grows, more vessels

BAE Systems

will be in need of clean technology. BAE Systems has been working to reduce emissions for more than 20 years with electric power and propulsion systems in the transit bus industry. Now it's taking that expertise to the shipyard. The company's core technology powers more than 12,000 buses around the world. That expertise, paired with continued investment in its world-leading technical solution, will create a sustainable future for operators and their vessels.

It's an investment that goes beyond maturing technology. It will help shape a new vision for the future of marine solutions – one that creates cleaner harbors and waterways in the places where we live, work, and visit. So far, the company's technology has eliminated 300,000 tons of carbon dioxide each year – the equivalent of planting 4 million trees. If that is any indication of the future, BAE Systems is ready to make quite the splash.

Incat Crowther

Outfitting the Modern

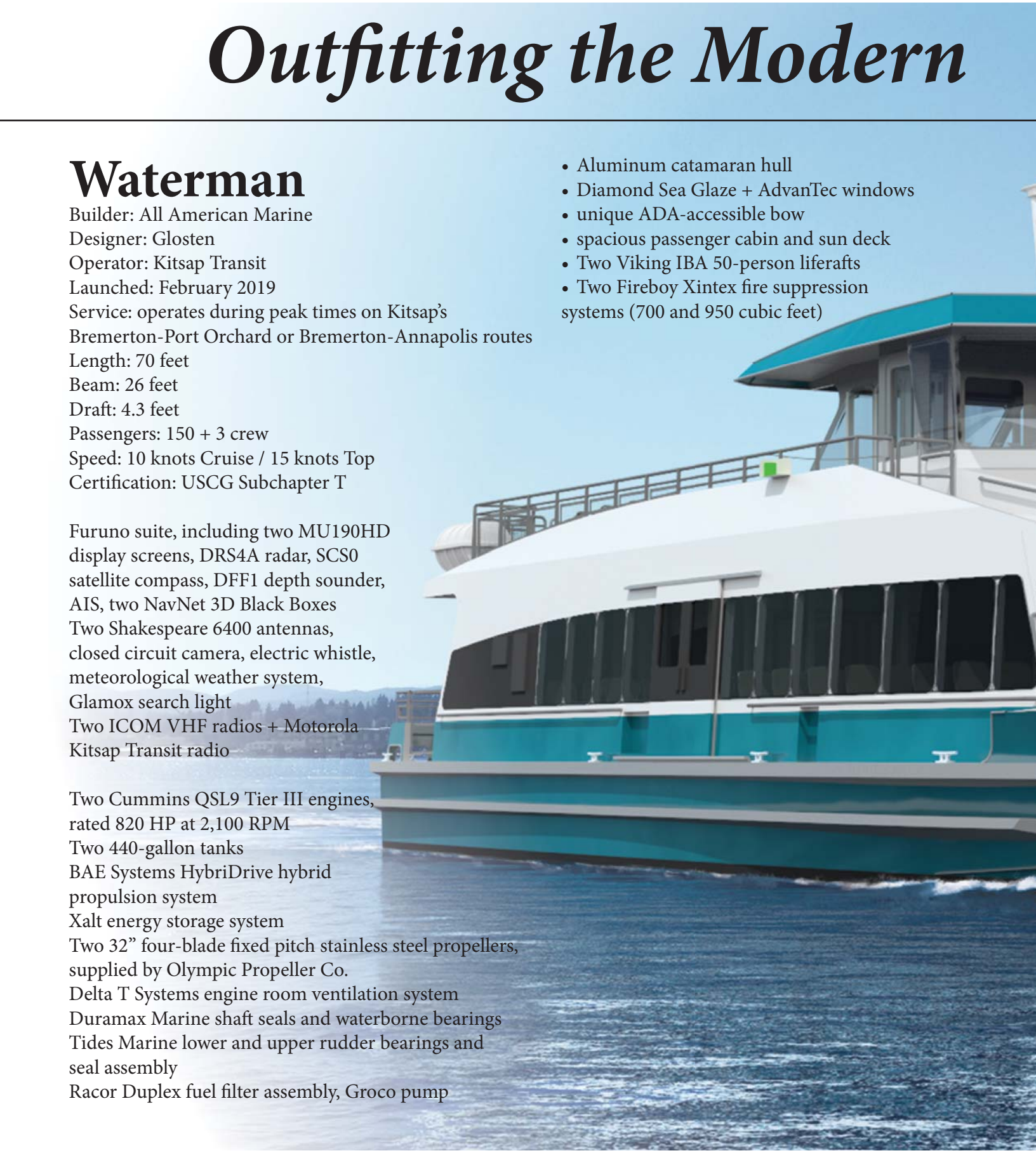
Waterman

Builder: All American Marine
Designer: Glosten
Operator: Kitsap Transit
Launched: February 2019
Service: operates during peak times on Kitsap's Bremerton-Port Orchard or Bremerton-Annapolis routes
Length: 70 feet
Beam: 26 feet
Draft: 4.3 feet
Passengers: 150 + 3 crew
Speed: 10 knots Cruise / 15 knots Top
Certification: USCG Subchapter T

Furuno suite, including two MU190HD display screens, DRS4A radar, SCS0 satellite compass, DFF1 depth sounder, AIS, two NavNet 3D Black Boxes
Two Shakespeare 6400 antennas, closed circuit camera, electric whistle, meteorological weather system, Glamox search light
Two ICOM VHF radios + Motorola Kitsap Transit radio

Two Cummins QSL9 Tier III engines, rated 820 HP at 2,100 RPM
Two 440-gallon tanks
BAE Systems HybriDrive hybrid propulsion system
Xalt energy storage system
Two 32" four-blade fixed pitch stainless steel propellers, supplied by Olympic Propeller Co.
Delta T Systems engine room ventilation system
Duramax Marine shaft seals and waterborne bearings
Tides Marine lower and upper rudder bearings and seal assembly
Racor Duplex fuel filter assembly, Groco pump

- Aluminum catamaran hull
- Diamond Sea Glaze + AdvanTec windows
- unique ADA-accessible bow
- spacious passenger cabin and sun deck
- Two Viking IBA 50-person liferafts
- Two Fireboy Xintex fire suppression systems (700 and 950 cubic feet)



Hybrid-electric Ferry

Each of the two turnkey hybrid systems includes:

BAE Systems supplied components:

- HybriDrive HDS 300 propulsion system
  - » Integrated Starter Generator, 300 kW rated
  - » Propulsion Control System, 300 kW rated
  - » AC Traction Motor, 300 kW rated peak
  - » System Control Unit
- Auxiliary Power Supply, level 2, 15 kW at 24v DC, 30 kW at 208v, 3 phase, 60 Hz
- Cellular Datalogger

Xalt supplied components:

- XPAND XMP energy storage system (ESS), 40 kWh
  - » Seven liquid-cooled battery modules, Lithium Ion, 100v, IP56
- Integrated battery monitoring system with fault monitoring and communication
  - » Ground fault detection
  - » Short circuit protection
  - » Thermal runaway anti-propagation
  - » Disconnects
- Battery Rack for ESS, steel

Cummins supplied components:

- Generator Engine
- Hybrid system controls, throttle and display panel
- Engine Control Panel (Pilothouse)

Other components:

- ESS Battery Charger, 2 kw nominal, 240 VAC input, 1 phase, 60 Hz, 600 to 700 VDC output
- ESS Battery Charger Control Panel
- 24v Hybrid Propulsion System Power Distribution Panel

Metal Shark

Konrad-driven

By Eric Haun

Konrad Marine has launched several iterations of its signature sterndrive since unveiling its first units in the 1990s. Konrad's latest lineup, the 600B series, was rolled out in 2014, with the first drives delivered to customers at the start of 2015 and strong market uptake ever since. Featuring the larger gears first introduced in its 600 series, Konrad's 600B drives also include a new larger transom with integrated steering.

"The biggest change when we developed the 600B series drive was our heavy-duty transom assembly," says Fred Sparling, senior application engineer. "Our original 500/600 series drives used a traditional tiller arm steering arrangement which was commonly connected to an internal hydraulic cylinder. The new 600B series drives no longer have tiller arm steering but now include integrated trim and steering cylinders on the transom assembly.

"The new 600B series also introduced our advanced technology in our trim/rudder feedback circuit which is connected via CAN bus to a newly designed digital display," Sparling adds.

The 600B series consists of three drives: 620B, 660B and 680B, each available in five gear rations, and each manufactured at Konrad's headquarters in Hudson, Wis. The baseline single-propeller option within the series is the 620B, considered the robust workhorse of the lineup, with a diameter range of 17.25"-20" and right- or left-hand rotation. Both the 660B and 680B are dual counter-rotating propeller offerings. The 660B, used for higher speed, lighter applications (25'-30' vessels seeking speeds up to 60 knots), has a propeller diameter range of 13.25"-16", while the 680B, used for heavier applications, with carry capacities up 18,500 pounds per drive, has a propeller diameter range of 15"-18.5".

The 600B series drives are used in many sectors of the marine market, from fireboats and high-speed interceptors to yacht tenders and commercial fishing boats, and have even been deployed in several autonomous applications for the U.S. Navy, says Josh Schroetter, a Konrad sales representative.

Schroetter shared with ***Marine News*** details on various recent delivery scopes, from assorted fast patrol craft to a 70-ton workboat. The reference list highlights not only the range of vessel types/applications, but also the diversity of engines Konrad's sterndrives can mate with.

Boatbuilder/Engine Dist. (# of vessels)	Vessel type, est. gross weight	Engine	Transmission	Konrad Supplied Equipment	Performance
Silver Ships (1) Delivered 9/2017	40' patrol/fireboat 29,232 lbs	2 x Cummins QSB 6.7L 550 HP @ 3,300 RPM	2 x Twin Disc MG 5075 SC Ratio 0.8:1	2 x Konrad 680B 1.74:1 ratio, PTO power steering kit, External Tie Bar, CV 32 Driveshafts, Propellers	30 kts
Metal Shark (12) Delivered 9/2017-9/2018	38' coast guard boat 23,000 lbs	2 x Cummins QSB 6.7L 550 HP @ 3,300 RPM	2 x Twin Disc MG 5075 SC Ratio 0.8:1	2 x Konrad 680B 1.74:1 ratio, PTO power steering kit, External Tie Bar, CV 32 Driveshafts, Propellers	42 kts
Shockwave Powercats (1) Delivered 2/2019	12m recreational catamaran 35,274 lbs	2 x Yanmar 6LY440 440 HP @ 3,300 RPM	2 x Konrad/Velvet Drive LH Ratio 1.00:1	2 x Konrad 680B 1.52:1 ratio, KVD Transmission, Bell housing & coupling, Electro Hydraulic Steering Kit, Propellers	30 kts
Metal Craft (1) Delivered July 2019	42' police patrol boat 26,896 lbs	2 x Cummins QSB 6.7L 480 HP @ 3,000 RPM	2 x ZF 280-1 Ratio 1.00:1	2 x Konrad 680B 1.43:1 ratio, PTO power steering kit, Secondary Helm, External Tie Bar, Propellers	36 kts
Palfinger (10) Delivered 3/2018-2/2019	6.2m patrol boat 7,607 lbs	1 x Yanmar 6LY2A-UTP 370 HP @ 3,300 RPM	1 x Konrad/Velvet Drive LH Ratio 1.00:1	1 x Konrad 660 1.67:1 ratio, KVD Transmission, Bellhousing & coupling, CV 30 driveshaft & adapters, Electro-Hydraulic steering kit, Propellers	40 kts
Kanter Marine Delivered 3/2019	10m transport craft 21,092 lbs	2 x Volvo D6 370 HP @ 3,500 RPM	2 x Konrad/Velvet Drive LH Ratio 1.00:1	2 x Konrad 620 1.55:1 ratio, KVD Transmission, Bellhousing & coupling, Power Assist steering kit, Internal Tie Bar, Propellers, Engine Isolators	33 kts
Kanter Marine Delivered 4/2019	14.5m workboat 140,000 lbs	2 x John Deere 4045AFM85 225 HP @ 2,600 RPM	2 x ZF 220 Ratio 1.00:1	2 x Konrad 620B 1.78:1 ratio, U-joint drive shaft & adapters, Electro hydraulic steering kit, Propellers	10 kts
Oceanos Marine Solutions (1) Delivered 4/2019	52' tour vessel 37,485 lbs	2 x Mercury/FPT 6.7 - 480 480 HP @ 3,200 RPM	2 x ZF 280-1 Ratio 0.814:1	2 x Konrad 680B 1.94:1 ratio, ZF 280-1 Trans, bell housing & coupling, U-joint shaft, ZF PTO power steering kit, External Tie bar, Propellers	25 kts
SIMA (7) Delivered 8/2019-12/2019	20m military transport vessel 50 metric tons	2 x Yanmar 6CH-HTE3 170 MHP @ 2,550 RPM	2 x ZF 220 Ratio 1.00:1	2 x Konrad 680B 1.94:1 ratio, ZF 220 Trans., Power assisted steering kit, External Tie Bar, Drive shaft adapters, Propellers	10-12 kts

Konrad 620-B **Konrad 660-B** **Konrad 680-B**

Many police and patrol vessels have speed, maneuverability and seakeeping requirements as well as a need for quick acceleration, which Schroetter says makes 600B drives a great candidate for these types of vessels. "Our drives have great speed potential, ability to maneuver well and are also highly efficient," Schroetter says, adding that Konrad drives are capable of carrying a variety of loads during displacement fluctuations.

High input torque rating and long maintenance intervals also make Konrad drives well-suited for commercial and military customers. Konrad's website says some U.S. Navy vessels reported 10,000 hours logged on single units designed to deliver 2,000 hours. The 680B has been tested well over 100 hours running full power at 580hp, 925 lb-ft diesel engine torque.

In addition, Schroetter says he has seen electric/hybrid applications become more and more relevant every year. "Being that the Konrad drives do not have any internal shifting mechanism the stern drive can be connected directly to the motor leaving the forward and reverse shifting to be done in the motor," he says. "This makes for a very simple and solid propulsion system and with our dual propeller technology. You will also see gains in efficiency."

Schroetter says Konrad ended 2019 and started 2020

Silverships

strong, with several new application start-ups and a significant amount of parts sales before the coronavirus pandemic began to make its presence felt across the globe. But other than a few vendor-related delivery issues, Konrad has been able to maintain steady business, in part by carrying extra inventory to ensure shipments meet delivery deadlines.

"In terms of order volume, we have seen no decline to this point," Schroetter says. "We have continued to receive a fair amount of activity for quoting new applications."

Metalcraft

Østensjø Rederi

VARIABLE SPEED GENERATOR SETS OFFER ADVANTAGES FOR COMMERCIAL SHIPS

By Joerg Habermaas and Jochen Thurner,
Application Engineering, Commercial Marine & Offshore, MTU

Due to economic necessity, commercial ship operators have become increasingly focused on finding cost-optimized solutions to operate their vessels. In turn, power solutions providers like Rolls-Royce have been dedicated to finding ways to deliver the right technologies that will meet an operator's specific requirements.

In recent years, interest in variable speed units as a driver of certain commercial vessels has gained interest. Variable speed technology allows the speed of an engine to be regulated and adjusted according to the electrical load that is connected, which makes it more economical to run.

Compared to traditional, constant speed units, variable units can offer several advantages, such as up to 15% reduction in fuel consumption, up to 20% increase in time between overhauls, lower noise emissions and increased power density with less installation space.

Variable speed units are particularly useful in operating modes with a high percentage of low loads – such as when an offshore supply vessel (OSV) is in a standby phase.

Fuel efficiency

Common constant speed gensets are designed to optimize fuel consumption at high loads above 75%. The specific fuel consumption depends on load in relation to engine speed. To clarify, the functionality is comparable to a car with manually shifted gears. To optimize fuel consumption, the driver always intends to use a low engine speed (highest possible gear), as a slower running engine saves fuel for the same load.

To achieve these benefits, the frequency typically is adjusted in two steps via converters. First from AC (alternating current) to DC (direct current) and in a second step back to AC via an inverter. The single line diagram in Figure 3 shows one example.

Using the example of a wind-platform supply ship that has recently been in operation with a variable speed unit, we can give a glimpse of the advantages.

On a typical platform supply ship, four units with a capacity of approximately 2,100 kW each are used to power the vessel. An arrangement of the units with their electrical components is shown in Figure 3.

The high performance that this arrangement can offer is necessary due to redundancy requirements and comes in handy in cases of bad weather – but is not needed for a majority of a ship's operation time. Having this arrangement in place during typical use for diesel engines results in high proportions of low load

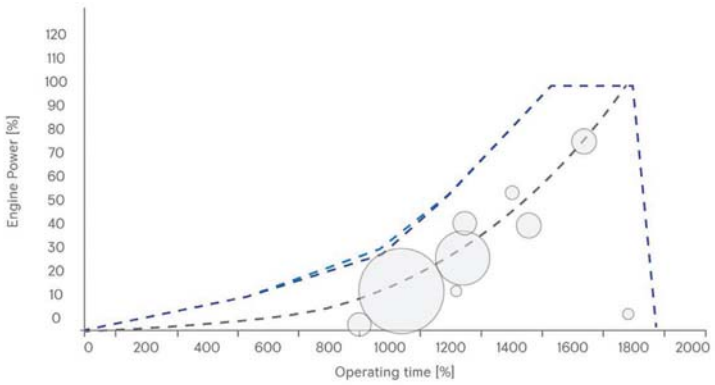


Figure 1: Typical diesel engine map with characteristic load points

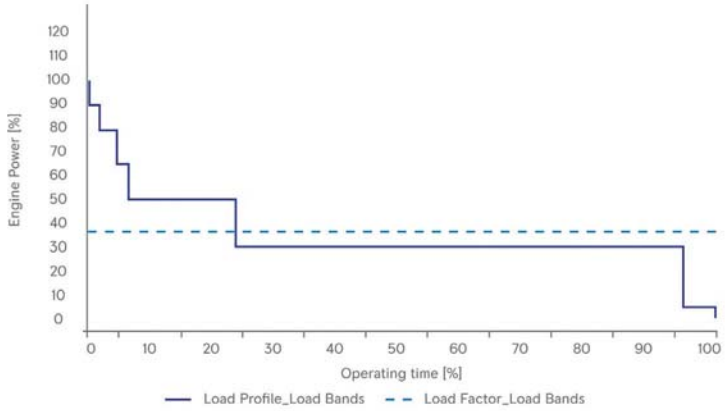


Figure 2: Load profile

phases that result in an average genset utilization of only about 35%. This is due to the ship being in a waiting position for extended periods while on-site and having to hold its position.

Figure 1 illustrates this. The time proportion is represented by the size of the circles. These load shares are further clarified by Figure 2.

To see the fuel savings that are possible with a variable speed unit, the following evaluation shows the results of the supply ship operating in the North Sea, powered by four MTU engines of type 16V 4000 M63L (variable speed) from which loads of <25% were driven approximately 80% of the time.

These operating points are associated with high specific fuel consumption for constant speed-operated units. This is where the decisive advantage of a variable speed unit comes into play: namely the fuel economy. In the present case, this amounts to about 15%, which roughly equals $280,000 per year or, with a term of 20 years, a total savings of about $4.5 million.

Figure 4 illustrates the percentage savings in specific fuel consumption between a variable speed and a constant speed diesel engine.

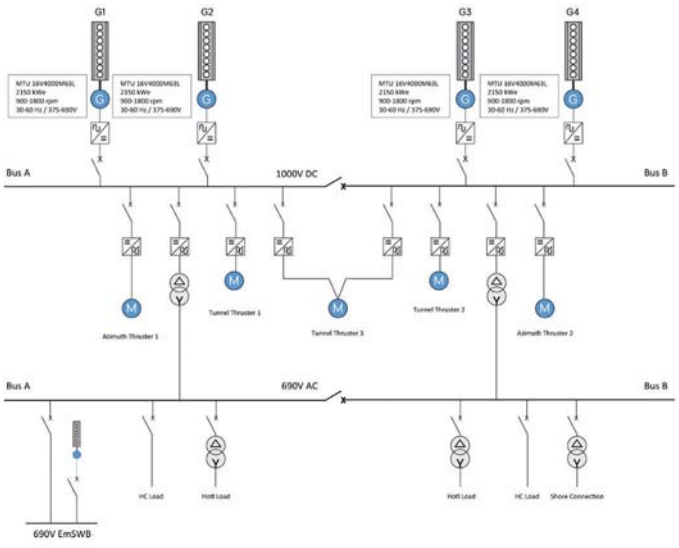


Figure 3: Typical platform supply ship

Comparison of fuel consumption between a variable speed and constant speed engine

The aspect of fuel economy is a vital part of the lifecycle cost (LCC) of such a ship, as Figure 5 illustrates.

In addition to the diesel engine and the generator, the electrical power conversion through various electrical components such as converters must be considered. Examination of another evaluation case has shown that efficiency advantages of up to 5% are possible with the generator at partial load.

Extended TBO

Another advantage of variable speed units is that the reduced speed enables the maintenance / time between overhauls (TBO) to be extended by approximately 20%, which results in lower costs. However, it must be noted that this contrasts with additional costs for the electrical components and increased programming effort of approximately 15% for the variable speed units.

Quieter operation

An additional benefit of a variable speed unit that is especially noticeable is the reduction of sound emissions. This plays an important role, especially in terms of comfort, as operating personnel on these ships is often exposed to noise and vibration emissions over very long periods.

Comparison of surface noise (sound pressure level) at a power of 500 kW (about 20% load):

- MTU 16V 4000 M63L (variable speed) at 1,135 rpm ◊ approx. 95 dB (A)
- MTU 16V 4000 M43S (constant speed) at 1,800 rpm ◊ approx. 101 dB (A)

At first glance, the difference of 6 dB does not seem to be

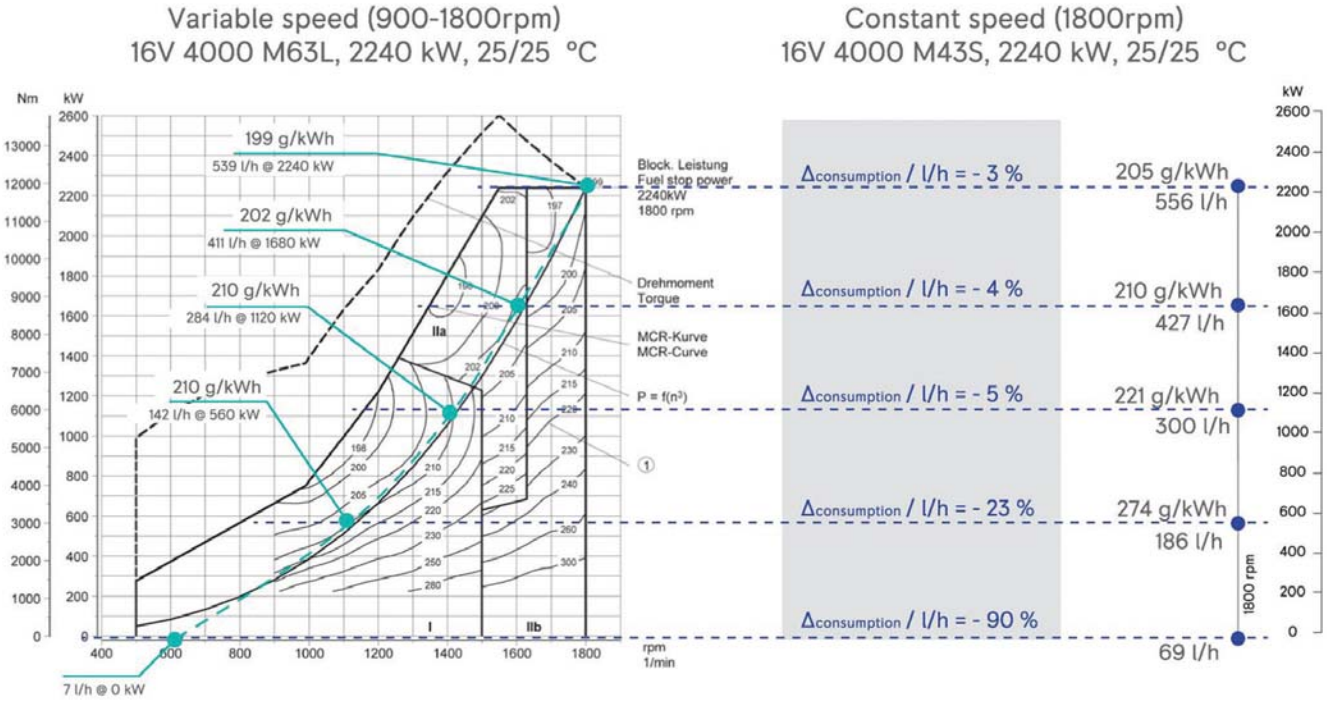


Figure 4: Fuel savings of variable speed vs. constant speed diesel engines

very significant. However, + 6dB means twice the measured sound pressure. And when considering that humans perceive an increase of 6-10 dB as being nearly twice as loud, this value shows in a very impressive way the advantages of a variable speed unit.

Flexibility

Overall, ship operators are looking for a flexible system with advanced technology that gives them the means to operate as efficiently as possible. With its variable speed MTU gensets, Rolls-Royce is able to create customized driving curves according to specific customer requirements through simulation testing.

This process takes into account various factors for each customer, including extreme operating conditions for vessels, as well as fuel savings and any specific safety needs.

Figure 6 shows the load step simulation from a defined low load operating point (1) to the operating point (3). A load reserve (safety margin) of 250 kWe has been taken into account which is a typical value for high power consumers on such vessels.

The ramp-up time of only 11 seconds in total impressively demonstrates how dynamically the MTU Series 4000 Genset can handle electrical loads. The values were confirmed both during factory acceptance tests and in real operation.

For all ships with a low average load and a high number of operating hours, the use of variable speed units can be recommended as very economical for the operator and beneficial for operating personnel.

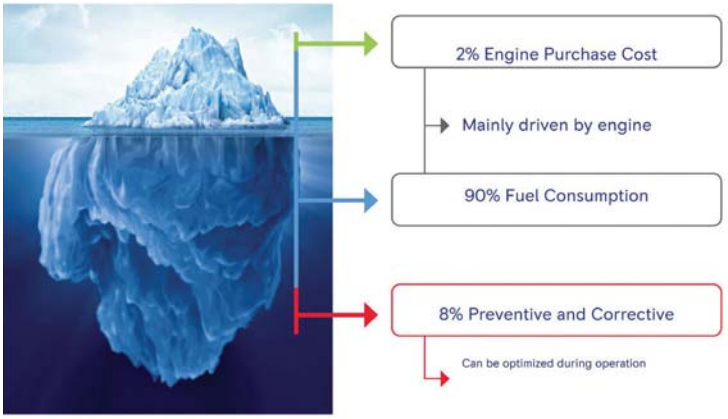


Figure 5: Average distribution of the operating costs compared to the investment costs for the engine

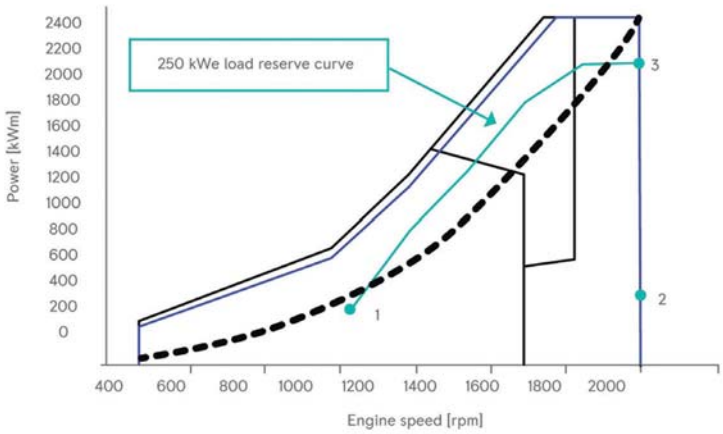


Figure 6: Typical operating curve for a variable speed unit

New Life for Miss Vivian

A Corpus Christi crew boat runs with renewed power and grace

Miss Vivian runs a top speed of 21 knots with three PowerTech 6135SFM engines.

All images: John Deere

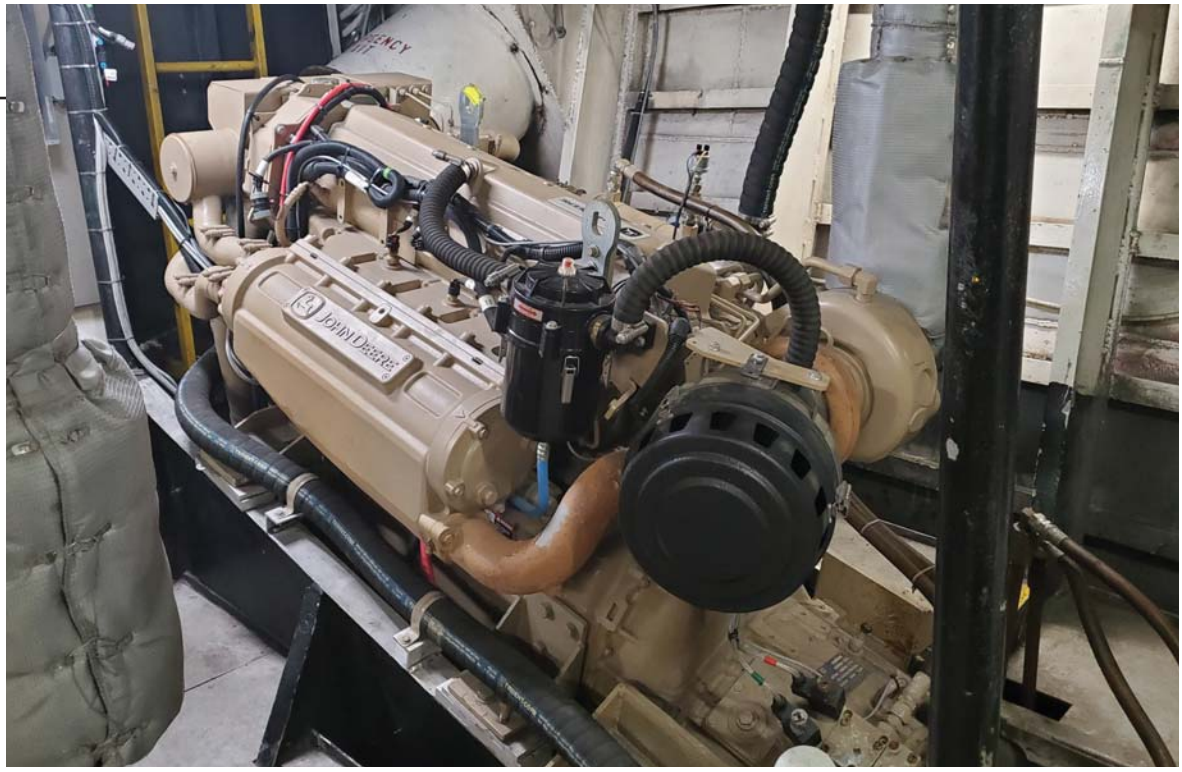
Miss Vivian has a commanding presence while plying the waters off the Texas Gulf Coast.

Hardworking crew boat Miss Vivian serves offshore oil platforms and large ships moored in Corpus Christi Harbor. Owned by Sea Level Marine, Inc., in Aransas Pass, Texas, the 28-meter (91-foot) welded aluminum vessel is U.S. Coast Guard-approved for 50 passengers, and its 15x5-meter (50x15-foot) deck offers ample space to transport food provisions, equipment, and other supplies to offshore locations.

There's a rather heroic side to Miss Vivian, too. Fitted with two life rafts and 50 life preservers, the crew boat responds to calls of distress. Miss Vivian was used to retrieve personnel from an offshore oil platform during an approaching hurricane. It rescued a shrimp boat that lost engine power. Equipped with fire pumps, the vessel was also used to help extinguish a shoreline fire in Aransas Pass, Texas.

However, after years of dutiful service, the 1979 vessel needed a new lease on life, according to Richard Palmietto, owner of Sea Level Marine. Miss Vivian underwent a refurbishing that included interior updates and new exterior paint.

Deep in the hull was a more serious problem. In an effort to minimize exhaust emissions and stay well within air quality attainment levels, some harbors no longer welcome boats with aging two-cycle diesel engines. "With the old engines,



The 429-kW (575-hp) PowerTech 6135SFM engines turn 76x76-centimeter (30x30-inch) props through ZF transmissions with a 2.3:1 gear ratio.

we would get a thrust of black exhaust on startup or throttle-up operations," recalls Palmietto. "Even on a calm day, we could see a slight bit of exhaust ash."

Getting the grant

Knowing a repower was a smart decision for Miss Vivian and the future of the business, Sea Level Marine applied for a grant through the Texas Emissions Reduction Plan (TERP), a program administered by the Texas Commission on Environmental Quality. Once approved, Palmietto turned to Land & Sea Services, a certified John Deere marine dealer in La Marque, Texas, which recommended three John Deere PowerTech 6135SFM marine engines.

Palmietto and the vessel's captain, Rueben Molina, were sold on the idea of repowering with John Deere engines. "We know of other boat owners who were getting rid of their two-cycle diesel engines and going to John Deere," says Palmietto. "We also liked having the support of two John Deere marine dealers for warranty work and parts with Land & Sea in La Marque and Mid Coast Engine & Transmission, Inc., in Aransas Pass."

Sea Level Marine worked closely with Land & Sea Services to repower the vessel in early 2019, mounting all three John Deere engines onto the original engine beds. Making some modifications to the motor mounts, the John Deere dealer paired the 429-kW (575-hp) engines with new ZF transmissions, along with the original shafts and 84x76-centimeter (33x30-inch) props. "We were fortunate our shafts and propellers paired well with the new engines and transmissions," says Pamietto.

The repower took place Sea Level Marine's dock in Aransas Pass, Texas, without having to take the vessel out of the water.

A trio with torque

After the repower, the gear ratio increased from 2:1 to 2.3:1, and the overall weight of the engines decreased by 1,860 kilograms (4,100 pounds). "To prevent a change in stability of our deck carrying capacity, we bolted lead plates below the engines in the bilge," explains Palmietto.

An increase in horsepower and torque improved Miss Vivian's speed and performance. "I'm running about 21 knots, which is pretty fast for a boat this size," says Captain Molina. "The additional torque helps me maneuver the boat in tight spaces in the wind and waves."

The increase in speed is also attracting more business from offshore clients needing equipment and supplies as soon as possible. Molina says Miss Vivian is reaching platform destinations in half the time as other crew boats that are only running top speeds of only 8 to 10 knots.

The engines are proving to be financially rewarding in other ways, too. "They are extremely economical compared to the previous engines," adds Molina. "Before, I would run hard six hours and burn 500 to 600 gallons (1,893 to 2,271 liters) of diesel fuel under heavy load. Now, I run the same amount of time — with a comparable load — and the John Deere engines only consume 375 gallons (1,420 liters)."

Faster, more powerful, and fuel-efficient, Miss Vivian is better than ever, according to Molina and Palmietto. Plus, Miss Vivian is emissions-compliant now and is able to cruise into inner harbors without the disgrace of diesel smoke.

"We took a 1979 boat and made it like brand-new," says Palmietto. "We gave Miss Vivian another life, and hopefully she'll run another 20 years."

All images: Voith

A Unique Control of Thrust and a Glimpse of Future of Autonomous Operations

*By **Dr. Dirk Jürgens,** Vice President Research and Development, Voith Turbo Marine and **Ivo Beu,** Director of Sales, Marine Americas, Voith Turbo*

Just like there is a drive for autonomous long-haul trucks in overland shipping, there is also a growing push for autonomous marine shipping. One of the challenges for shipping is the lack of precision control in the face of an ever-shifting body of water. For land-based transportation, roads offer a reliable surface that is easy gauged during the design process. For shipping, the most challenging aspect is the chaos created by waves, wind and currents, and that calls for a propeller that offers precision maneuverability and a speedy response to control commands while providing the power expected. All these needs are met by the Voith Schneider Propeller (VSP).

What is the VSP?

The VSP is a cycloidal propulsion drive that combines propulsion and steering in one vertically oriented unit. This unique vessel propulsion solution was developed more than 90 years ago by Austrian engineer Ernst Schneider. With the VSP, magnitude and direction of thrust can be set steplessly and as necessary.

Its applications are evident in numerous marine vessels, including in ships used in the offshore wind industry, as well as double-ended ferries, river vessels, tugs and mine-countermeasure vessels that require high maneuverability. The VSP is an optimal solution for use in these applications. Apart from the fact that the VSP gives a ship high maneuverability in any water conditions, it also offers high efficiency, robustness against floating debris and the good underwater acoustics.

The design and engineering of the VSP

A modern Carousel RAVE tug equipped with two Voith Schneider Propellers, for example, creates very large forces at high and low speeds to perform its regular ship-assistance duties. Fuel consumption is minimal because mainly the hull is used to generate steering and breaking forces, and the VSPs are only on task, aligning the tug through high-precision control functions.

As a cycloidal drive, the VSP is quite different from classic azimuth thrusters. Because of its unique positioning and the required design structures in the hull, Voith is highly involved in the design process for each VSP order. The process includes optimizing ship hulls through CFD testing and modeling.

"Our goal is to fully integrate these propellers and support designers as they craft the hull to make the most of the VSP's capabilities," said Michael Palm, Head of Shiphydrodynamics at Voith Turbo Marine. "As a final check before production, the Voith team administers and analyzes a CFD propulsion performance model, which then allows for additional updates if needed. In addition to CFD calculations, Voith provides model propellers with a diameter of 200 mm, and these can be used in international ship model basins."

Inside the VSP assembly

The VSP is the ship propulsion system that provides the fastest and most accurate thrust, steering and stabilization forces, which make it a leading option for future use in autonomous operations. Even better, these functions are available simultaneously in the longitudinal and transverse directions of the ship. Figure 2 shows a look into the inner structure of the Voith Schneider Propeller. Depending on the VSP type, four to six blades are mounted in one rotor casing. While the rotor casing rotates, the blades are oscillating, which allows them to generate the thrust. Only the amplitude and the phase must be changed to control the thrust. This action requires very little energy and is performed very quickly. The resulting thrust generation is similar to the force generated by a dolphin's tailfin, and comparable in both elegance and efficiency.

Benefits of the VSP

The maneuvering performance of cycloidal drives truly stands out thanks to accurate dynamic positioning (DP). Even under rough environmental conditions, the VSP offers amazing aquatic agility, especially during fast approaches and departures from wind turbines and allowing for a safe and quick transfer of goods and personnel from offshore wind farms. Comparative calculations by DNV GL (Marine Cybernetics AS) have shown that a VSP-powered vessel can still work safely at significantly higher wave heights, delivering approximately 15 more working days each year. This provides a considerable economic advantage to ship owners and also speaks to its potential in autonomous operations as a reliable propulsion system for difficult conditions.

Due to its responsive and accurate thrust control, the VSP can reduce the roll motion of the vessel by approximately 70% when the ship is moving and while stationary, which is particularly important for service operation vessels (SOV). Voith roll stabilization has been successfully applied on numerous ships since 2007, both on offshore support vessels and on tugs. A good example of the performance provided by the VSP is the Forte, a large offshore tug operated by Edison Chouest Offshore.

The Staten Island Ferry operates in Upper New York Bay, transporting passengers between Manhattan and Staten Island. The route, which operate 24 hours a day, uses several ferries equipped with Voith Schneider Propellers.

VSP performance

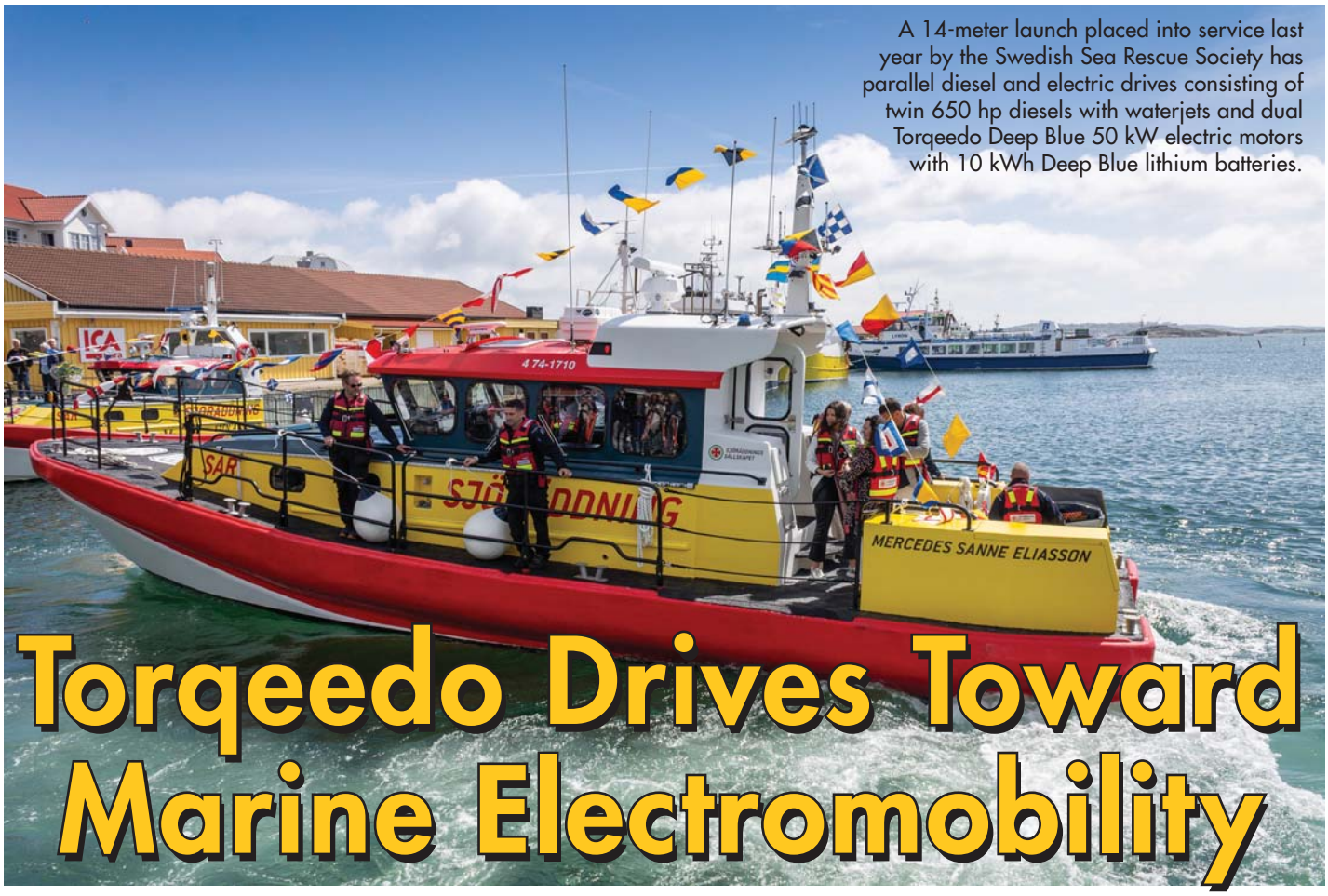
In comparative model tests with ducted screw propellers, which were carried out by independent test institutes, the VSP demonstrated a 15% efficiency advantage on average when measured in regard to the power requirement for transit modes. The VSP also features lower fuel consumption in the DP because it quickly counteracts disturbing wind, wave and flow forces.

The Staten Island Ferry has always been one of the most important applications for the VSP. The ferry operator decided that its three new ferries should be equipped with two large VSPs each. The challenges for this operator are extremely high – it transports a large number of passengers while being exposed to extreme wind, currents and ice. It is precisely because of these challenges that the VSP was adopted by the operator.

The future with autonomous shipping

What does the future hold for the VSP? Autonomous shipping is an important field in the future. The Voith Schneider Propeller is ideal for autonomous and remote-controlled vessels because propulsion can be managed very logically (according to X/Y axial logic) and it can allocate desired maneuvers quickly. Any sensor errors or errors in data processing can therefore best be compensated by the VSP. Together with partners, Voith has advanced the technology development to such an extent that remote-controlled tractors with VSP will soon be realized. In autumn 2020, Voith is planning a practical test for ship autonomy in Rotterdam with the Carrousel Rave Tug (CRT) of the Multraship/Novatug shipping company. At the same time, a major research project is underway in which Voith is working on a VSP ferry on the river Rhine which will sail autonomously.

"We look forward to the applications where the VSP can be applied, especially in the autonomous shipping field. There will be a time when remotely piloted or AI-piloted vessels will be the norm on the world's oceans, and we expect that the VSP will be a large part of that new era," said Philipp Koschorrek, Manager Automation Technology, Voith Turbo Marine.



A 14-meter launch placed into service last year by the Swedish Sea Rescue Society has parallel diesel and electric drives consisting of twin 650 hp diesels with waterjets and dual Torqeedo Deep Blue 50 kW electric motors with 10 kWh Deep Blue lithium batteries.

Torqeedo Drives Toward Marine Electromobility

All images: Torqeedo

By Eric Haun

The future is painted bright for companies dealing in hybrid and electric marine propulsion, as vessel owners and operators pursue cleaner technologies to comply with ever-stricter environmental regulations while also seeking ways to improve their bottom line.

Case in point is Germany-based electric drives manufacturer Torqeedo, which has to date delivered more than 100,000 electric propulsion products for a wide range of recreational and commercial customers.

The hybrid/electric market is one that's ripe for growth, says Dr. Ralf Plieninger, COO and CTO, Torqeedo. "We see a bright future for electric propulsion as designers, builders and operators come to appreciate its unique value proposition."

Torqeedo has been advancing steadily since its 2005 inception, expanding both its market footprint and product offering along the way, with double-digit growth year on year and a product portfolio that now includes drives from 0.5 to 100 kW, ranging from small electric outboards for kayaks and canoes up to fully integrated electric and hybrid inboard system for large yachts and workboats. In 2017, the firm was acquired by engine manufacturer DEUTZ Group, which Plieninger says places Torqeedo in a "strong position to ride the crest of the electromobility wave as market demand surges."

Plieninger says several factors contribute to the positive outlook for hybrid and electric propulsion systems, including the swift pace of technological advancement. "Electric propulsion technology is improving rapidly, especially when it comes to energy storage capacity, thanks largely to the massive R&D resources of the automotive industry," he says, noting Torqeedo's battery partnership with BMW. "More efficient batteries translate into longer range and higher speeds. At the same time, renewable energy sources, such as solar panels, are also improving, and can in many cases provide a boost to batteries underway."

Regulations demanding cleaner-running vessels, as well as a broader awareness of global warming and interest in sustainability, are also growth drivers for Torqeedo and its peers. This is especially true in coastal- and inland-operating segments like passenger ferries, water taxis, harbor service vessels and

excursion boats, which Plieninger counts among Torqeedo's key commercial marine markets. "Many harbors, lakes and inland waterways around the world have stringent emission standards. For instance, Amsterdam will require all boats on its canals to meet zero-emission standards by 2025. And the city of Paris has declared that all its waterways and public transit will be zero-emission before the 2024 Olympics. Many cities around the world are adopting similar legislation for their lakes and waters," Plieninger says. "For operators of passenger-carrying vessels, clean air and quiet operation offer an apparent competitive advantage."

"The value proposition [for electric drives] is multifold. It's clean and quiet, consumes no fuel and emits no fumes. Operating costs are minimal. So is maintenance," Plieninger says. "In addition, electric motors have an intrinsic steep torque curve that delivers a unique surge of power. This allows us to drive a larger propeller and push a heavier payload."

Torqeedo's Cruise product line incorporates outboards and pod drives from 2 to 10 kW, matched with Power 3,500 Wh or 5000 Wh lithium-ion batteries for smaller vessels up to 10 tons. For workboats and ferries, the company's higher-voltage Deep Blue series encompasses outboards and inboards from 25 to 100 kW, matched with BMW i3 lithium-ion batteries with a nine-year capacity warranty. Also offered is the Deep Blue Hybrid system, which includes a complete energy management system with generator backup. Renewable energy sources such as solar or hydrogeneration can also be integrated for recharging underway.

Asked about the capex and opex requirements for Torqeedo's electric drives compared to more traditional options, Plieninger says the electric systems available today will generally demand greater investment up front before delivering savings in terms of operational expenses over the life of the product. "The payback period depends mainly on how many hours you put on the boat annually and the price of diesel fuel locally," he says, noting electric drives typically require less maintenance, and therefore deliver better vessel uptime. "It's also worth noting that the cost of electricity is far more stable and predictable than fossil fuels," he adds.

On the water

Torqeedo continues to see uptake in the passenger vessel segment, Plieninger says, citing as a reference a new line of Torqeedo-powered electric water taxis recently introduced by Canadian boatbuilder Templar Marine. The Cruise 10.0 motor with six lithium-ion batteries provides up to seven hours of endurance at a cruising speed of five knots. Batteries are charged at the dock with a standard 15- or 30-amp shore power plug.

Another noteworthy reference is a 14-meter launch placed into service last year by the Swedish Sea Rescue Society, which has parallel diesel and electric drives consisting of twin 650 hp diesels with waterjets and dual Torqeedo Deep Blue 50 kW electric motors with 10 kWh Deep Blue lithium batteries. Plieninger says the vessel uses the electric mode when entering and leaving port, providing quiet and emission-free transit through Sweden's environmentally sensitive waterways. The diesels are used for high-speed runs to the rescue location, then the crew reverts to the "whisper-quiet" electric drive for search and rescue operations, he says.

"A major growth market for us currently is manned and autonomous surface survey vessels," Plieninger notes. Autonomous research vessels supplier SeaRobotics is putting Torqeedo Deep Blue Hybrid systems on its new class of Endurance 7.0 autonomous surface vehicles (ASV). The powertrain for the 7-meter aluminum boat consists of a DeepBlue 80i electric motor and BMWi3 battery, a water-cooled DC-DC converter and a 24 VDC lithium battery for the DC-DC backup and a 25 kW diesel generator. The system provides up to six days on station at survey speeds and up to 10 hours between automatic battery recharges from the generator.

"This year we started supplying electric power for a new line of aluminum twin-hull harbor clean-up boats being built by Water Witch in Liverpool," Plieninger says. "When we asked why they wanted electric power, they answered, 'It just makes good sense that a boat working to clean up pollution should not add to the problem by causing pollution in the water or through emissions.'"

Deep Blue inboard electric motor

Emissions-free Barging

ZES

A group of partners in Europe aims to use battery containers on board barges to supply environmentally friendly fully-electric propulsion in lieu of diesel for inland waterway shipping.

Supported by the Dutch Ministry of Infrastructure and Water Management, the concept is being spearheaded by the Zero Emission Services B.V. (ZES), a consortium including technology group Wärtsilä, ING Bank, energy and technical service provider Engie and the Port of Rotterdam Authority.

The project will launch first in the Netherlands, where inland navigation accounts for 5% of carbon dioxide (CO_2) emissions. Initially, the replaceable battery containers, called ZESPacks, will be used on converted and newly-built container carriers employed along the Zoeterwoude – Alpherium – Moerdijk corridor. Beer company Heineken has already signed on to be the first end customer for the enterprise, utilizing the service to transport beer from its brewery in Zoeterwoude to Moerdijk. Later, ZES aims to expand the use of ZESPacks to include the Amsterdam – Rotterdam – Antwerp corridor, making a connection to Nijmegen.

The interchangeable ZESPacks will be charged using energy from renewable sources across a network of open access charging points set up for exchanging depleted battery containers for ready-charged replacements. The battery packs are even designed to be used for multiple applications, enabling them to be utilized for temporary onshore use, such as stabilizing the local electricity grid or meeting short-term demand for electrical power, ZES says.

To make it easier for barge operators to sign-on to the concept, a 'pay-per-use' financing model has been developed.

First New US-flag Laker in Decades

The Interlake Steamship Company

A keel laying ceremony in June marked the official start of assembly on the first new U.S.-flagged Great Lakes bulk carrier to be built in more than 35 years.

During the ceremony held by The Interlake Steamship Company and Fincantieri Bay Shipbuilding, (FBS) the keel was laid within the shipyard's large graving dock in Sturgeon Bay, Wis. following more than nine months of engineering and prefabrication work of its modular sections by the FBS team. Though the build project is already well underway, the ceremony recognized the keel laying as the first joining of modular components, or the lowering of the first modules into place in the graving dock.

Interlake's Chairman James R. Barker, revealed at the event that the new vessel would bear the name of his son and second-generation leader of the company, Mark W. Barker.

Scheduled for completion in mid-2022, the new River-Class, self-unloading bulk carrier is believed to be the first ship for U.S. Great Lakes service built on the Great Lakes since 1983. Measuring 639 feet long, 78 feet wide and 45 feet tall, with a deadweight of 28,000 tons, the ship will transport raw materials such as salt, iron ore and stone to support manufacturing throughout the Great Lakes region.

The Interlake Steamship Company, Fincantieri Bay Shipbuilding and Bay Engineering jointly designed the bulk carrier, complete with advanced vessel and unloading systems automation. Major partners for the project include: American Bureau of Shipping (ABS); ArcelorMittal, Bay Engineering (BEI); EMD Engines; Caterpillar; EMS-Tech, Inc.; Lufkin (a GE Company), Kongsberg and MacGregor.

Great Lakes Shipyard Launches Tug Wisconsin


The Great Lakes Group

The Great Lakes Shipyard launched the new tug Wisconsin, the fifth in a series of 64-foot Damen Stan tug 1907 Ice design harbor tugs that the Cleveland, Ohio shipyard is building for The Great Lakes Towing Company.

Wisconsin, like its sister tugs, is powered by two 1,000-horsepower MTU 8V4000 Tier III diesel engines, and generates over 30-tons of bollard pull. Its propulsion system includes the Logan FlexaDrive Hybrid power system, allowing the tug to operate on electric power while at idle, underway at low speeds or when under low loads, without the need to utilize the main engines, reducing emissions and the cost of engine maintenance.

The tugs Cleveland, Ohio, Michigan and Pennsylvania were the first new tugs built in the series as part of the Towing Company's fleet renewal program.

The firm has recently committed to building a sixth tug (yet to be named), which is currently under construction and scheduled to be completed in Spring 2021.

ABB Hybrid-electric Propulsion for WSF Newbuilds


Vigor

U.S. shipbuilding company Vigor has selected ABB to supply the hybrid-electric propulsion and energy storage systems for the newest additions to the Washington State Ferry fleet, setting the largest U.S. ferry system on course to drastically reduce greenhouse gas emissions and fuel use.

The new Olympic Class ferries, each with a capacity of 144 cars and 1,500 passengers, with the planned addition of charging capability at terminals, would reduce fuel consumption by up to 95%. Upon delivery in 2024, the initial vessel of the series will be the first newbuild in the WSF fleet to feature hybrid-electric propulsion and a high capacity ESS. The vessels will be able to fully operate on battery power, with the capability to revert to hybrid mode if needed.

Jay Hebert, VP, Marine Fabrication, Vigor, said the project is prompted by the commitment of Washington Governor Jay Inslee, the state legislature and WSF to replace aging ferries with clean technology. The 2019 legislature approved initial funding for the first of the new vessels, to be built at Vigor's Harbor Island shipyard in Seattle. "This landmark project supports Washington State's goal for 2050 to reduce emissions by 57.5% below the emissions level in 2019," Herbert said.

Leveraging ABB's onboard DC Grid power distribution system and drive technology, the new ferry design will optimize energy use, whether drawing on main engine power, battery power or a combination of the two. The battery power can also extend zero-emissions capability along the supply chain by using renewables and hydroelectric power.

"Moving toward a dramatically reduced-emission future relies on technologies that meet the environmental and cost needs of today – and offer flexibility to integrate future energy sources in the years ahead," said Juha Koskela, Managing Director, ABB Marine & Ports.

Washington State Ferries is the largest ferry system in the U.S. By 2040, the Washington Ferry System plan is to replace 13 existing diesel ferries with hybrid-electric newbuilds and to convert six other ferries to plug-in hybrid, with recharging capacity installed at many ferry terminals. All hybrid vessels will be capable of charging at the terminal, and some of the vessels will be capable of operating in fully electric mode on shorter routes. With the addition of newer-built, clean energy ferries to the fleet, fuel consumption is projected at 9.5 million gallons in 2040, compared to 19 million gallons in 2018, with CO2 emissions expected to fall below 2050 reduction targets by 2034.

Stewart

Parks

Merchent

Singleton, Gregg

Mellquist

Bordelon

Doyle

Brandes

Rekola

Loy Stewart: 1947-2020

David Loy Stewart Sr, former owner and Chairman of the Board at ship repair yard Detyens Shipyards, Inc. in North Charleston, S.C. passed away on Tuesday, June 30, 2020, at the age of 72.

In 1973 Loy went to work for his father-in law at Detyens Shipyards as a Machinist helper. By 1982 he had risen to the position of Secretary/Treasurer of the shipyard. In 1990, he bought the shipyard from his partner and began driving the shipyard to success, moving its location in 1995 to the Charleston Naval Shipyard and turning a small family owned business into one of the premier ship repair facilities on the East Coast.

Steve Parks: 1975-2020

Steve Parks, a long-tenured and well-known maritime media marketing persona, passed away suddenly of a heart attack on June 7, 2020. He was 45.

Steve began his career in maritime publishing in 1998. In 2014, Steve started his own marketing firm Wake Media to deliver business-to-business media and communications services to clients in the maritime and offshore sectors.

Merchant Takes the Helm at Halter Marine

ST Engineering North America, Inc. announced Monday that Robert "Bob" L. Merchent has been named President and CEO of Pascagoula, Miss. shipbuilder Halter Marine. He replaces outgoing President and CEO, Ron Baczkowski.

Austal COO Gregg Promoted to CEO

Australian shipbuilding group Austal announced its Chief Operating Officer Patrick Gregg will take over as Chief Executive Officer effective January 1, 2021, following a six-month transition from current Managing Director and CEO David Singleton.

Mellquist Named President at Volvo Penta

Heléne Mellquist has been appointed as President Volvo Penta and new member of Volvo Group Management. She will replace Björn Ingemanson, who is retiring.

SCA Elects New Leadership

The Shipbuilders Council of America, the national trade association representing the U.S. shipbuilding and repair industry, announced new board leadership. Taking over the helm of Chairman from Terry O'Brien of Austal USA is Ben Bordelon, president and CEO of Bollinger Shipyards. Joining him to lead the SCA Board is Brad Moyer, Vice President of BAE Systems Ship Repair serving as Vice Chairman.

Doyle to Lead Port of Baltimore

William P. Doyle, a former U.S. Federal Maritime Commissioner, has been hired to lead the Port of Baltimore as the new executive director of the Maryland Port Administration. Currently Executive Director of the Dredging Contractors of America, Doyle will take the helm at the Port of Baltimore effective July 22, succeeding Jim White, who announced he would step down at the end of 2019.

Toerner

Linden

Buzby

Sendagorta, Cudós

Brandes to Lead Port of Oakland

Bryan Brandes has been named Maritime Director at the Port of Oakland. The 25-year maritime veteran replaces John Driscoll who left to manage the Alabama State Port Authority.

Steerprop Promotes Rekola

Azimuth propulsion expert Steerprop said it has merged sales and project management with the appointment of Juho Rekola as the company's new Director Sales and Project Management. Rekola has been with Steerprop since 2017.

The Shearer Group Hires Toerner

The Shearer Group, Inc. announced a new addition to its naval architecture, marine engineering and marine surveying firm, Daniel Toerner. A recent graduate from Texas A&M University, College Station, with a Bachelor of Science in Ocean Engineering, Toerner joins TSGI as a naval architect.

Bristol Harbor Group Hires Linden

Bristol Harbor Group, Inc. said Tommy Linden has joined the company as a naval architect. Linden graduated from Webb Institute with a B.S. in Naval Architecture and Marine Engineering. During his time at Webb, Linden interned at BHGI, as well as the Naval Surface Warfare Center Carderock Division, Eagle Bulk, Newport News Shipbuilding and General Dynamics Electric Boat.

SCA Honors Buzby

The Shipbuilders Council of America honored Maritime Administration (MARAD) Administrator Mark H. Buzby with the SCA Maritime Leadership Award, given annually to national leaders who demonstrate exemplary dedication and support of the U.S. shipbuilding and repair industry.

New Leadership at SENER Group

Engineering firm SENER Group announced Andrés Sendagorta has been named President of the SENER Group, and Jorge Sendagorta Cudós its new CEO.

Furuno Acquires EMRI

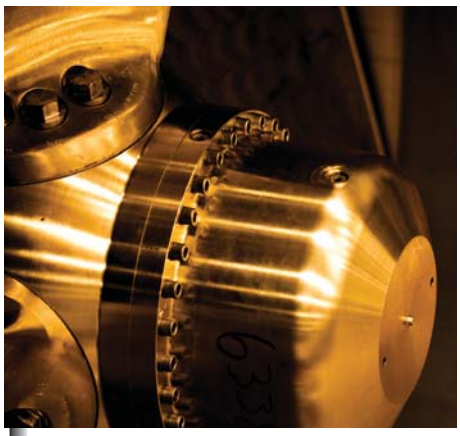
Maritime navigation, communication and acoustic systems supplier Furuno has acquired EMRI, a Danish company specializing in autopilots, steering control, joystick dynamic positioning and maneuvering systems.

Gula Skrinet Acquires Caterpillar Propulsion AB

Gula Skrinet AB reached an agreement with Caterpillar Luxembourg Sarl to acquire Caterpillar Propulsion AB and its subsidiaries. Caterpillar Propulsion AB, formerly Berg Propulsion AB, is a manufacturer of mechanically and electrically driven propulsion systems and marine controls for ships.

Austal USA Graduates Apprentices

Alabama shipbuilder Austal USA said it graduated 28 youth apprentices into full-time paid positions this spring. The graduates, high school seniors from Mobile and Baldwin County when they began the program, will work in production as Fabrication Trades Assistants, joining the workforce earning over $15 per hour with full Austal employee benefits.



Berg Propulsion AB

Austal USA youth apprentices

Lewis

IMarEST Names Lewis Chief Executive

The Insitute of Marine Engineering, Science & Technology has appointed Gwynne Lewis as its new chief executive.

In-Mar Solutions: Alu Pilot Chairs & Deck Rails

In-Mar Solutions offers a complete line of Alu Design & Services Marine Pilot Chairs and Deck Rails. There is a standard line in addition to the option for custom designs to suit specific needs. Sleek, modern design and maximum utility and comfort are emphasized.

www.inmarsolutions.com

Retractable Rim Thruster

SCHOTTEL launched a retractable variant of its rim thruster. Covering the power range up to 500 kW, and with internal propeller blades are hydrodynamically designed to be highly resistant to cavitation, the SRT-R offers low noise emissions and tailor-made solutions for a wide range of applications. The SRT-R is able to cover a thrust radius of 360 degrees, making it more versatile and adaptable to any requirement and operation profile, including dynamic positioning operation or as a take-home device.

Electro-Hybrid Drive

Waterjet propulsion specialist HamiltonJet unveiled its new Electro-Hybrid Drive (EHX) system, which it says offers all the advantages of electric drive with the full capabilities of diesel. The system delivers lower fossil fuel consumption combined with the speed, maneuverability, efficiency and safety of waterjets, the manufacturer says. With EHX, HamiltonJet delivers the electric motors, power electronics and control system seamlessly integrated with the waterjets, engines, gearboxes or clutches. There's an automatic setting, plus a manual setting delivering four different modes of operation: diesel only, electric only, charging or electric boost.

Electric Voith Schneider Propeller

Voith is pushing ahead with the continuous electrification of its drive technologies with its new With the new electric Voith Schneider Propeller. The eVSP uses a permanent-magnet synchronous motor as its main drive, which is fully integrated into the VSP, reducing required oil volume. No gears or transmissions are required, enabling stepless operation and virtually loss-free conversion of the electrical drive power with dynamic response characteristics. The low weight eVSP can be mounted without any shaft train restrictions.

Proteus ESS

LAVLE launched its flagship Proteus Lithium-Ion Battery Energy Storage System (Proteus ESS), engineered to overcome the limitations of conventional lithium-ion storage technologies. Proteus utilizes LAVLE's battery management system (BMS), which is designed to maximize reliability, lifetime and uptime, and further enhances Proteus' performance and safety characteristics, the manufacturer said. Proteus is currently undergoing certification by DNV-GL.

Vessel Health Management

Kongsberg Maritime introduced Health Management to its Vessel Insight portfolio of applications, to monitor onboard equipment via one unified interface and predict failures through early detection of abnormal behavior, both for Kongsberg and third-party equipment. Due for launch in August, the application will initially support Bergen engines, Kongsberg Maritime's low-pressure hydraulic winches, and rotating machinery such as KONGSBERG and third-party thrusters, pods, shaftline and auxiliaries. Additional equipment will be added over the coming months.

Hydrogen Electric System

In November 2019, electric mobility solutions provider eCap began a partnership with fuel cell technologies company Re-Fire Technology for the joint development of cross-sector fuel cell projects. The first milestone of this partnership was reached in May 2020 by achieving DNV GL Approval in Principle for a concept of maritime Re-Fire fuel cell application. The Hydrogen Electric System (H2ES) developed by eCap combines the Re-Fire fuel cell technology with the latest hydrogen and electrical components to form an innovative and environmentally friendly drive solution for shipping. The now-approved fuel cell solution can be installed on deck and encompasses cabinets for up to 440 kW power.

All-purpose Lubricant

The L.S. Starrett Company offers M1 Industrial Quality All-Purpose Lubricant for applications on metal equipment such as rollers, racks, conveyors, chains and virtually any metal components found in highly corrosive marine environments. M1 is not soluble in water, so it gets under moisture to lift it away from the surface to be protected. Starrett M1 Special Formula Lubricant protects metal against rust and corrosion damage by providing a molecular shield that locks to the metal. The lubricant can be used to protect working surfaces of machinery, in dip tanks to protect production parts in process, or apply on tools when stored.

Mobilgard 540 X

ExxonMobil has introduced Mobilgard 540 X, the latest addition to its advanced MobilGard cylinder oil range. The lubricant is specifically formulated for use with both 0.10% and 0.50% sulphur fuels and liquefied natural gas (LNG) and has been available from June 2020. Mobilgard 540 X is designed to meet the advanced cleanliness and protection needs of newer engine designs and meets WinGD's requirements for all three fuel types. Mobilgard 540 X has passed extensive fit-for-use testing on the most recent engine designs and is specifically formulated to combat deposit formulation with 'keep-clean' performance across low-sulphur fuels. The cylinder oil also allows for substantial feed rate reduction

Remote Services App

Liebherr developed a remote service tool aiming to improve assistance through visual information that ultimately leads to faster and easier troubleshooting. Features integrated into the newly launched remote service tool such as audio and video calls, a chat function, screen sharing, image and document exchange, as well as whiteboarding functions enable real-time customer support from Liebherr personnel worldwide.

Stability Evaluation Software

Herbert-ABS Software Solutions expanded its HECSTAB Stability Evaluation Software to include all vessel types and evaluation capabilities. Naval architects can easily evaluate multiple design options for both ship and offshore assets, with a versatile user interface featuring modern conventions, improved 3D viewports and flexible user customization. HECSTAB functionality also includes analysis templates for deterministic and probabilistic damage stability evaluations, and a wide range of pre-designed criteria and the tools to modify/create new ones. Other calculation methods allow models to be developed to analyze trim, intact stability, damage stability and longitudinal strength.

Body Heat Camera

JRC/Alphatron Marine introduced the AlphaFeverCamera, a Body Heat Camera for maritime and non-maritime industries. As COVID-19 continues to pose a threat in daily life and business operations, a safe and healthy environment on board and ashore is a priority. Alphatron Marine, in close collaboration with Alphatron Security and Alphatron Medical, contributes to this need by introducing the Body Temperature Measurement Camera which is able to measure object's temperature at a high accuracy in real time, with accuracy up to ±0.5°C.

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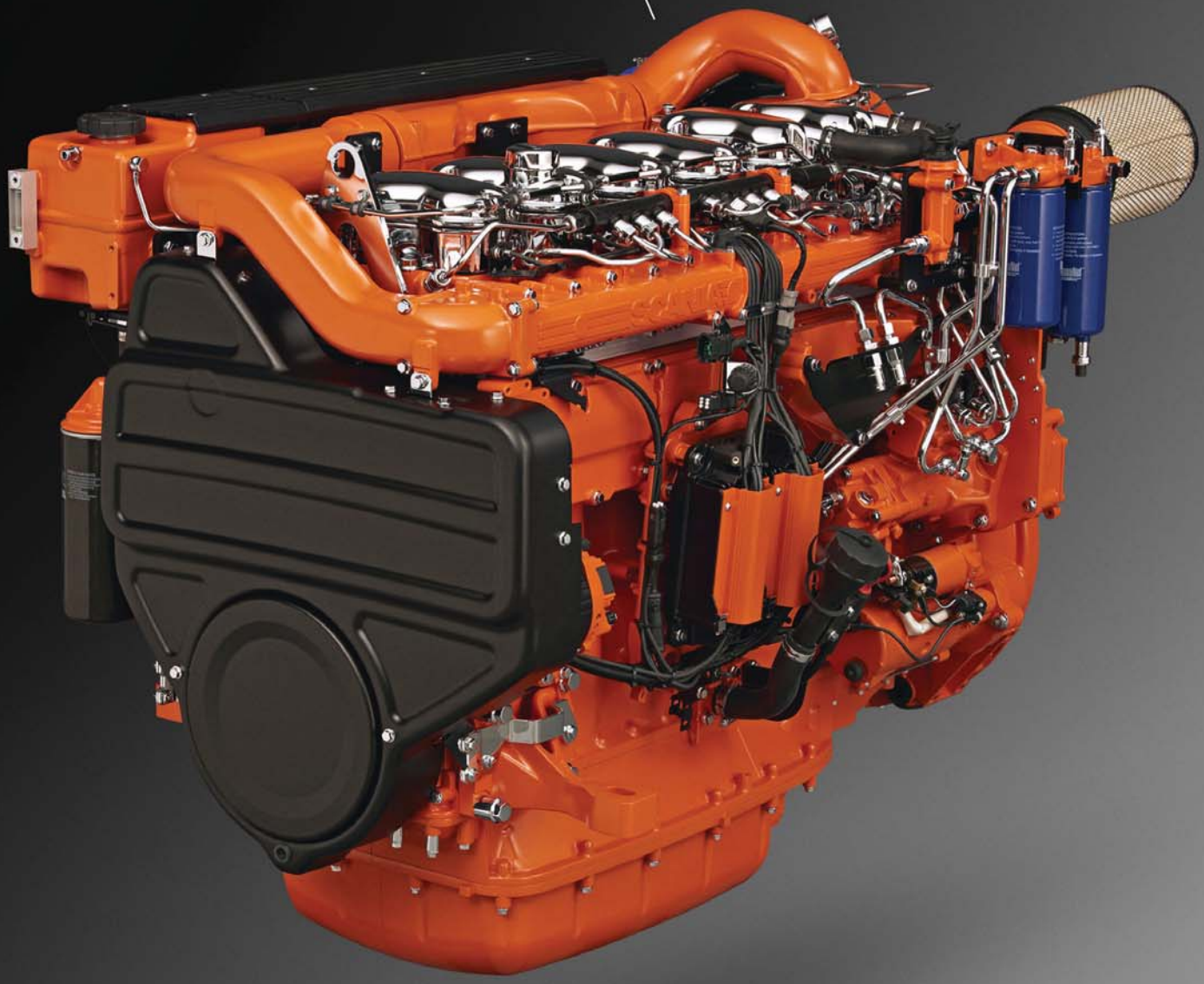

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