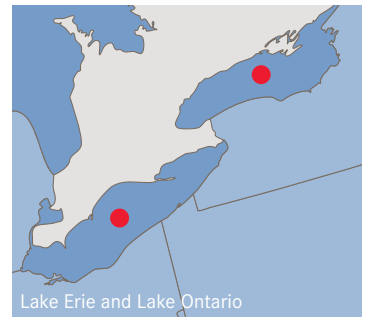


## Two new MTU powered research vessels help protect the Great Lakes



- Who:** Great Lakes Science Center
- What:** MTU Series 2000 engines
- Why:** Exceptional size relative to horsepower, solid fuel economy and low engine noise
- Where:** Lake Ontario and Lake Erie, USA



**To help protect the ecosystem of the U.S. Great Lakes, the Great Lakes Science Center has enlisted two new high-speed research vessels—the R/V *Kaho* and R/V *Muskie*. Both are powered by twin MTU Series 2000 M72 Tier 2 engines rated at 965 bhp at 2,250 rpm. The engine’s compact V8 configuration saves space below deck as well.**

The Great Lakes that border the United States’ northeast corner and Canada are the largest collection of freshwater lakes on Earth and hold 21% of the world’s surface fresh water. Protecting the delicate ecological balance in Lakes Superior, Ontario, Michigan, Huron and Erie is the job of the United States Department of the Interior’s U.S. Geological Survey Center (USGS) and its Great Lakes Science Center.

Invasive species such as the Asian carp threaten the health and biodiversity of the Great Lakes. This species can severely deplete the food supply of any waterway they inhabit by feeding on the plankton essential to sustaining native fish populations. In the decades since their arrival, Asian carp have been moving slowly towards the Great Lakes, where they might threaten a \$7 billion fishing industry and substantial tourist revenue.

### Floating laboratories

If the unwelcome fish do arrive, the researchers at the Great Lakes Science Center (GLSC, Ann Arbor, Michigan) will be among the first to detect their presence. In fact, although photos of Asian carp schools have attracted a lot of media attention lately, GLSC has quietly played a vital role in protecting and preserving the Great Lakes’ ecosystem and biodiversity for almost a century. It’s a mission as broad and deep as the Lakes themselves; accomplishing it is expected to get a bit easier soon, thanks to two new MTU-powered high-speed research vessels, the *Kaho* and the *Muskie*.

Don Barnhart, OEM application support, W.W. Williams  
“The MTU engines were selected for their size relative to horsepower, fuel economy and low engine noise level.”



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Powered by twin MTU Series 2000 engines, the R/V *Kaho* has a maximum speed of 15 knots and has the ability to be at sea for five days.

*Kaho* and *Muskie*, like the three other USGS vessels working on the Great Lakes, are multi-purpose vessels built for their primary mission to collect, analyze, monitor and communicate critical information about fishery, aquatic and coastal resources. The boats are equipped with wet laboratories and sophisticated sampling, fish detection and analysis gear.

Christened in 2011, R/V *Kaho* and R/V *Muskie* were purchased by the USGS for the GLSC at a combined cost of \$8.2 million, replacing two smaller, older vessels of the same names that were operating in Lake Ontario and Lake Erie, respectively.

R/Vs *Kaho* and *Muskie* will continue to perform the important scientific research work of their predecessors. Studies conducted aboard the old *Kaho* documented the spread of invasive zebra and quagga mussels, and was also used to collect fish and environmental samples for a wide spectrum of studies, including the Great Lakes Fish Contaminants Monitoring Program in cooperation with U.S. Environmental Protection Agency. R/V *Muskie*'s predecessor was the primary USGS research platform on Lake Erie, providing scientific information relevant to the restoration, enhancement, management and protection of fishery resources in Lake Erie since 1960.

At the *Muskie*'s commissioning ceremony, GLSC Director Russell Strach commented, "The R/V *Muskie* and R/V *Kaho* will provide safe and reliable platforms for scientists, and are equipped with state-of-the-art scientific instrumentation to

improve our understanding of deep-water ecosystems and fishes in Lakes Ontario and Erie."

#### **A team effort**

The new boats are designed by Murray & Associates and built in Cleveland, Ohio by Great Lakes Shipyard under construction supervision by Alion Science and Technology. Twin MTU 8V 2000 M72 Tier 2 engines rated at 965 bhp at 2,250 rpm provide the power. According to Don Barnhart, who heads up OEM application support at MTU distributor W.W. Williams (Cleveland, Ohio), *Kaho* and *Muskie* represent several USGS firsts. "USGS already uses MTU engines to power other research vessels, but these are the first MTU Series 2000s in their fleet, and the first to be installed by Great Lakes Shipyard. *Kaho* and *Muskie* are also the first aluminum boats to be built by Great Lakes," he says.

Barnhart credits a team effort between MTU, W.W. Williams and the shipyard for this latest engine sale to USGS, explaining, "Pat McElmeel, our former OEM sales manager and Chris Peifer, Great Lakes Shipyard's assistant V.P., engineering and project administration, worked out the engine specification and approvals required to get the project off and running. When Pat retired last June, I worked with Chris and his crew through the engine installations and sea trials. Ryan Kamphuis, MTU senior marine sales engineer, assisted us throughout the project."

#### **MTU power at sea**

The Series 2000 engines were ideal for the 70 ft. long, 18 ft. beam aluminum hulls, which can hit

17 knots—fast for vessels in this class. Each ship's propulsion and power plant systems are designed for quiet operation. Twin propellers, a bow thruster, and hydraulic anchor winch provide a variety of options for stationary sampling.

Carrying six crewmembers at sea for up to five days, space aboard the research vessels is at a premium—another reason MTU was the engine of choice. "The MTU engines were selected for their size relative to horsepower, fuel economy and low engine noise level. The compact 8V configuration was perfect for the vessels' engine rooms, which were designed to be as small as possible to maximize room for the crew and equipment," Barnhart explains.

Thanks to MTU's legendary engineering standards, the Series 2000 offers another advantage: lower maintenance costs. And if anything does happen, W.W. Williams is always ready to lend a hand. With experience as an MTU engine supplier to USGS vessels, W.W. Williams provides proven engine support, parts and service. Along with invaluable peace of mind.

Barnhart says the project went smoothly and helped build a very productive working relationship between W.W. Williams, MTU and Great Lakes Shipyard. "Working together was a very professional and pleasant experience. With Great Lakes' rapid growth, we look forward to having the opportunity to work together on future projects," he says.

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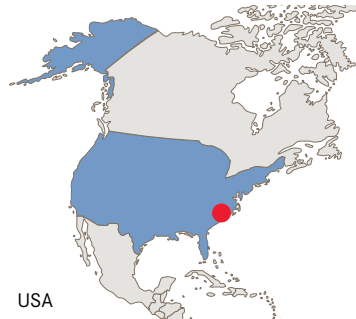


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# MTU helps SENESCO make the big push



**Who:** SENESCO Marine  
**Where:** Rhode Island  
**What:** Twin MTU 16V 4000 engines  
**Why:** Power and long-term dependability, with high load capacity



**One of the east coast's premier maritime transportation companies chooses MTU exclusively to power its latest generation of ATB tugboats.**

North Kingstown, Rhode Island — Half a dozen burly shipyard workers are squinting up into the glare of a brilliant New England winter sky, watching an MTU 16V 4000 M60 engine fly. Well, perhaps not “fly” so much as levitate on the near horizon, dangling from the boom of a mammoth crane positioned about eight stories below the deck of a half-built tugboat. The engine begins to slowly descend and while the shipyard crews prepare to carefully bolt the big blue MTU to its new home in the port side engine bay of the *Reinauer Twins*, Chris Reinauer looks on like an expectant father. Minutes later, the engine meets its motor mounts with a satisfying clank. “Perfect fit!” he exclaims with a smile.

In its bare-metal, partially-completed stage, the boat doesn't hint at what it will be in a few months: the newest, slickest, class-leading

Articulating Tug-Barge (ATB) tugboat to bear Reinauer Transportation Companies' red “R” logo. It's also the latest example of a loyal business relationship between supplier and customer that stretches back through three generations of Reinauers—including Chris's twin cousins for whom this tug is named.

### **88 years old and growing strong**

From its headquarters in Staten Island, New York and division offices in East Boston, Massachusetts, Reinauer Transportation manages a fleet of tugboats, barges and special-purpose industrial vessels that work the waters of the U.S. Atlantic coast from the Maine/ Canadian border southward to the Caribbean and the Gulf of Mexico coastline.

Founded in 1923 by Bert Reinauer, the company grew steadily through the post-WWII years and in

Chris Reinauer, director of special projects, Reinauer Transportation  
“They have plenty of power and we know from experience that they're extremely reliable—we're getting between 33,000 and 35,000 hours on them before we have to overhaul them.”



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With each twin 16V 4000 engine delivering 2,360 horsepower at 1,800 rpm, Reinauer's tug-barge can push a 500-foot, 100,000-barrel barge at 10.5 knots.

the 1990s, wisely adapting its fleet to double-hulled barge and ATB tugboat designs, investments that paid off quickly in increased business. Today, Reinauer's fleet of more than 30 double-hulled liquid cargo barges boasts an aggregate cargo capacity of over 2.5 million barrels for petroleum and chemical transportation.

Reinauer has grown both organically and via acquisition, including the 2006 purchase of full-service shipbuilder and service yard SENESCO. The addition vaulted Reinauer into the big leagues of the maritime transportation industry as the company made the most of its new vertical integration status with even more innovative ATBs, barges and other vessels. Along the way, Reinauer also acquired Boston Towing & Transportation of East Boston, New England's largest marine transportation company, thus expanding its reach and need for more tugs and barges to meet expanding customer demand.

Today, the company owns 75 vessels operating 24 hours a day, 365 days a year. For most of the last two decades, the company's diesel engines of choice for powering and repowering the tugboats in that fleet have been MTU and its legacy Detroit Diesel 2-Cycle engines.

Chris Reinauer says, "Every modern tug we've launched, including some that were repowered over the last few years, uses MTU engines, and before that, we had good experiences with Detroit Diesel 2-Cycle engines. We have a great relationship with (MTU marine sales manager) Jeff Sherman and Ken Houle at Atlantic Detroit Diesel-Allison, and we think MTU engines are the best fit for our newest ATBs."

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He continues, "The stresses on ATB engines are extreme. The tug locks into the bow of a barge and from a dead stop takes the engines to 100 percent load to get the barge moving. From that point and through the entire voyage, the engines run at 80- to 90-percent load."

#### **A year in the making**

Watching engines "fly" on their way into a new tugboat at SENESCO is by now a familiar but still-exciting shipbuilding ritual for Chris, a self-described "nuts-and-bolts guy" who, like many members of the Reinauer family, grew up in the family business. Chris, along with SENESCO vice president and general manager Mike Foster and V.P. of operations Joe Bush, oversees the construction of every vessel.

Foster's office on the edge of the wind-whipped shipyard is dominated by a 50" flatscreen closed-circuit monitor displaying alternating close-up views of the various departments that contribute to the 12 month construction process of an ATB vessel like the Reinauer Twins. "We have 220,000 square feet under roof on 26 acres here, and the building plan for a tug is highly modularized," explains Foster. Each major component and/or subassembly of the tugboat is manufactured by SENESCO in separate but adjacent departments, each equipped with ultramodern fabrication technology and staffed by the skilled craftsmen needed to run it. For example, hull plates and other large vessel components are welded by a block-long computer-controlled Ogden Panel/Line Welder, reducing to just 10 minutes a formerly labor-intensive operation that once took up to 30 hours.

Near the welding department, the cockpit subassembly of another ATB tugboat, the *B. Franklin Reinauer*, named in honor of the company's founder, is propped up on a jig and swarmed by workmen. Gesturing toward it, Chris says, "She's going to be powered by twin MTUs, too."

"We built our first ATB, the *Nicole Lee*, in 1989. The popularity of it exceeded our expectations, and we've continued to build more, each of them either powered originally or repowered with MTU engines," he continues.

#### **Time is money**

In 2011, four ATBs have launched, each designed by Robert Hill of Ocean Barge Tug and Barge Engineering (Milford, MA) and powered by MTU 16V 4000 M60 engines, joining four existing MTU-powered Reinauer tugboats—*JoAnne Reinauer*, *Kristy Ann Reinauer*, *Jill Reinauer* and *Matthew Tibbetts*—that were repowered since 1997 with 8V and 12V 4000 engines.

"We have a great relationship with Atlantic, and have chosen the MTU engines because we think they're the best fit for this particular hull. Reinauer was actually the first workboat customer to use the 16V 4000 engines when they were introduced back in 1997," says Chris. He continues, "They have to be reliable, because in our business, time is money. With the 16V 4000s rated at 2,360 horsepower at 1,800 rpm, one of our 115-foot long ATBs will do about ten and a half knots pushing a 500-foot, 100,000-barrel barge. That tug won't stop for up to 14 days for anything other than fuel, food and water."

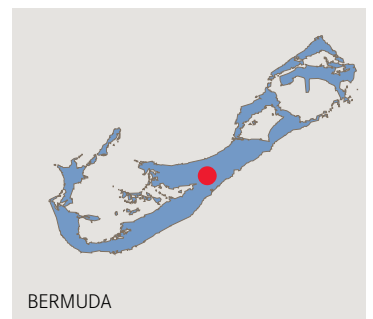
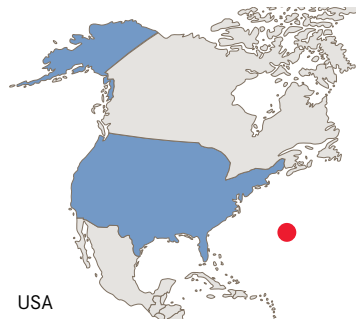


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# Bermuda's SeaExpress and MTU making waves



**Who:** SeaExpress  
**What:** Bermuda  
**Why:** MTU Series 2000 and Detroit Diesel Series 71  
**Where:** Reliability, performance and excellent service and support



**For maximum performance, efficiency and reliability, Bermuda's inter-island ferry service fleet is powered and supported exclusively by MTU.**

Hamilton, Bermuda – For reasons that quickly become obvious to first-time visitors, the sleek passenger ferries operated by Bermuda's SeaExpress are one of the most efficient ways to shuttle between the major cities and attractions that dot this postcard-perfect island in the Northern Caribbean.

Local laws preserving the natural beauty and laid-back British Territory vibe that make Bermuda a tourist magnet also make an affordable and reliable government-owned ferry service very attractive. Tourists aren't permitted to rent cars to navigate the winding roads covering the thin, G-shaped island, and taxis and buses, although as plentiful and efficient as any you'd find in downtown London, spend a lot of time crawling through high-season traffic. And then there's the cost to consider: a taxi from Hamilton to the

Royal Naval Dockyard can take almost an hour and cost over \$30. SeaExpress's appropriately-named *Serenity* zips straight through Bermuda's crystal-blue Great Sound and makes the same trip in less than thirty minutes for \$4, while passengers enjoy a sightseeing opportunity no land-bound vehicle can match.

Throng of tourists and many Bermudans rely on SeaExpress to get them where they need to be on time. Who does SeaExpress rely on? MTU.

### **Remote but not alone**

Today, as it's been since SeaExpress opened for business in 1999, every SeaExpress ferry and a variety of fleet support vessels is powered exclusively by MTU and Detroit Diesel engines. "We're 100 percent MTU here for several good reasons," explains Francis Richardson, Bermuda's

Francis Richardson, Bermuda's director of marine and ports  
"When it was time to upgrade our fleet to expand our service, we compared the MTU Series 2000 engines to competitors' engines. The MTU features won us over."



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Over the last 12 years, SeaExpress has purchased 20 Series 2000 engines for its fleet.

director of marine and ports. “First, the engines themselves have proven to be very reliable. One of our six catamarans, *Serenity*, for example, runs every single day up to 15 runs a day, and we’ve never had a problem with an engine. The same is true for all the engines we’ve purchased from our MTU distributor, Atlantic Detroit Diesel-Allison (Lodi, NJ, USA), from the old Detroit Diesel 2-Cycle Series 71s to the MTU Series 2000s we use in our newer boats.”

Richardson continues, “Second, the service we get from Atlantic and (director of technical services) Ken Houle is excellent. They’re responsive and very prompt when we need support. Because Bermuda is so remote, we have our own substantial parts and service operation here ourselves, but we depend on Atlantic to help us whenever we need them.”

With multiple degrees in marine engineering and maritime management, an eight-year stint in the Merchant Marines and more than 20 years of working his way up the ladder from machine shop apprentice, Richardson has an insider’s deep knowledge about every vessel in his fleet and their crews. From his office in downtown Pembroke, he has overseen the growth of SeaExpress over the last 12 years and with it, the strengthening of the unique transoceanic business relationship between the ferry service and MTU. During those dozen years, SeaExpress has purchased a total of 20 Series 2000 engines from Atlantic. Two high-speed catamarans—*Serenity* and *Resolute*—were launched in 2004 and are each fitted with twin MTU 12V 2000 engines. Two other cats—*Warbaby Fox* and *J.L.*

*Cecil Smith*—are powered by quadruple 12V 2000 engines and were introduced in 2006 and 2007, respectively, when SeaExpress increased its east-west ferry route service. Five additional single-engine catamaran and monohull ferries that utilize either MTU Type 8V Series 2000 or Detroit Diesel 2-Cycle 12V Series 71 engines round out the roster of passenger vessels.

“We keep one spare engine of each configuration in stock and rebuilt, ready to go at all times,” notes Richardson. Engines are changed out in rotation when they hit their allotted runtime.

In addition, all nine of SeaExpress’s support vessels—three tugboats, a cruise ship tender, a buoy tender, two pilot boats and two line boats—are fitted with Detroit Diesel 2-Cycle engines. A new pilot/rescue boat, built by Gladding-Hearn/Duclos Corporation, the same shipyard that built *Serenity*, joined the roster in 2011. The 61’ vessel is powered by twin MTU 12V 2000 engines producing 1,055 horsepower.

“Besides the great personal and business relationship we have with the people from Atlantic and MTU, our ferry service has always had a very positive experience with Detroit Diesel engines dating back to the 2-Cycle engines we started with in the 1950s,” explains Richardson. “When it was time to upgrade our fleet to expand our service, we compared the MTU Series 2000 engines to competitors’ engines. The MTU features won us over. The 2000 is a true marine engine, not an engine just adapted for marine use.”

### A ferry true to its name

According to SeaExpress Senior Ferry Pilot Giovanni Burrows, piloting the 87’ *Serenity* is exactly as it should be: predictable and uneventful. Leaving the no-wake zone outside of SeaExpress’s Hamilton dock, Burrows throttles up from a two-knot crawl to *Serenity*’s 23-knot cruising speed and the transition is so smooth it’s almost imperceptible to passengers. Other than a slight surge that lasts a few seconds, the ferry’s twin 975 horsepower MTU 12V 2000 engines make little more than a purr from their starboard side engine compartment. Mopeds and bicycles in bow deck racks barely move; passengers continue their conversations uninterrupted. Other than a jaw-dropping landscape passing outside *Serenity*’s windows of pastel architecture, blue water and impossibly beautiful pink sand beaches framing it all, you could be riding a city bus.

“The prop-drive cats like *Serenity* have a bit more bite in the water and get up to speed a little faster than the jet-drive cats do, but the cruising experience is very similar,” Burrows says. “Stable, smooth and reliable. She (*Serenity*) does up to 15 runs a day from about six in the morning to midnight, and the engines are excellent performers.”

It may seem odd that an island famed for its relaxed pace is also home to a fleet of hugely popular ferries that can cruise at up to 32 knots. The irony isn’t lost on Francis Richardson. “It’s easy to understand why people may ask, ‘It’s a beautiful island. What’s your hurry?’” he says with a smile.

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## *USS Coronado* protects coastal waters, armed with twin MTU engines.



- Who:** *USS Coronado*, Independence Class Littoral Combat Ship
- What:** Two MTU 20V 8000 diesel engines
- Why:** High power-to-weight ratio, fuel economy and low lifecycle costs
- Where:** Mobile, Alabama, USA



The nature of U.S. marine defense is changing. Swift, maneuverable Littoral Combat Ships (LCS) such as the *USS Coronado* have been commissioned by the U.S. Navy to protect the U.S. coastline from the threat of terrorism. Powered by two MTU 20V 8000 diesel engines, the *USS Coronado* can achieve speeds up to 44 knots (50.6 miles per hour), in waters as shallow as 14 feet. Reliable, quiet and fuel-efficient, the engines are meeting tough standards set by the world's premier naval power.

As the world's geopolitical landscape evolves, the U.S. Navy must employ new strategies to stay one step ahead. According to a 2006 RAND National Defense Research Institute report prepared for the Navy, "...the nature of conflict is changing, and the United States no longer can consider itself to be an unassailable sanctuary." RAND further warned that defense budgets would come under increasing scrutiny, pressuring policymakers to ensure that military assets be fully utilized.

The U.S. Navy created the Littoral Combat Ship (LCS) program in 2002 to combat terrorism and other threats to the U.S. coastline. The program forms a new class of surface combat ships that can defeat littoral (near-shore) threats. These small, fast and agile ships are designed to

operate either independently in shallow waters or as part of larger, more conventional strike groups. Missions can include finding and destroying mines, hunting submarines and engaging in surface warfare. The program mandated that the new LCS is cost-effective, adaptable to multiple mission requirements and equipped with the most advanced, integrated digital equipment to minimize the cost of operations and future upgrades.

Rather than rely on a single source for the LCS program, the Navy contracted with two suppliers: General Dynamics (Falls Church, VA) and Lockheed Martin (Bethesda, MD). Both contractors were commissioned to submit vessel design plans to meet LCS Program specifications. The results were two very

Dr. Craig Hooper, vice president of sales, marketing and external affairs, Austal USA

"These ships are built to move—fast and frequently—and MTU makes that possible with engines that are powerful, reliable and robust."



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The 418-foot *USS Coronado* is powered by two MTU 20V 8000 diesel engines, featuring a high power-to-weight ratio and exceptional fuel economy.

different ships—Lockheed-Martin’s monohull Freedom Class LCS and General Dynamics/Austal’s trimaran Independence Class LCS.

Regardless of the design, the LCS has to meet strict requirements. According to the U.S. Navy, “...the LCS must be capable of operating at low speeds for littoral mission operations, transit at economical speeds and also excel in high-speed sprints.” MTU engines are at the heart of each propulsion system, capable of propelling the vessel at high speeds in littoral areas.

#### Fully up to speed

The keel for the *USS Independence*, Austal’s first LCS and major U.S. project, was laid in 2006. Since then, the Australia-based company has become one of the fastest-growing companies in Alabama and one of the state’s largest employers. In 2012, Austal USA completed its second Independence Class ship—the *USS Coronado*.

Built in Mobile, Alabama, the *Coronado* is 418 feet (127.1 m) long and 104 feet (31.4 m) wide. An angular, rakish bow is designed to minimize radar signatures. On deck, it’s permanently armed with an array of passive and active weapons, including a Raytheon SeaRAM Rolling Airframe Missile system, automated chaff and flare dispensers, a 220 rounds-per-minute MK 110 57 mm naval gun and four .50 caliber machine guns. *Coronado*’s enormous flight deck can carry two SH-60 Seahawk helicopters, one CH-53 Sea Stallion helicopter or several Unmanned Aerial Vehicles (UAV), incorporating a payload capacity larger than most destroyers.

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At 11,800 square feet (1096.3 square meters), the mission bay is designed to carry multiple mission modules to support a wide variety of deployment objectives, along with up to four lanes of combat ground vehicles such as Strykers, armored Humvees and other hardware. It’s also equipped with an elevator so that equipment can be loaded and stored while the vehicle is at sea.

#### Unique trimaran design

The trimaran hull configuration produces low hydrodynamic drag, allowing for high speeds in water as shallow as 14 feet (4.3 m). “The aluminum trimaran hull is inherently stable and able to handle a much larger payload than a conventional monohull warship, and can operate in waters much shallower than a monohull vessel of similar size,” says Mike Rizzo, MTU program manager for governmental/naval business at Tognum America. The *Coronado* exhibits exceptional power-to-weight ratio, with main propulsion provided by a combination diesel and gas (CODAG) system, featuring two MTU 20V 8000 diesel engines, each driving a Wärtsilä waterjet and delivering 9.1 megawatts of power. When additional power and speed are needed, two General Electric gas turbines are activated, producing a sustainable 44 knots (50.6 miles per hour).

Dr. Craig Hooper, Austal USA vice president of sales, marketing and external affairs, says, “These ships are definitely not built to sit; they’re built to move—fast and frequently—and MTU makes that possible with engines that are powerful, reliable and robust.”

#### An essential force below deck

The MTU 20V 8000 engine may be the *USS Coronado*’s most powerful weapon. In addition to high power density and compact design, the engine boasts simple operation, straightforward maintenance and low lifecycle costs. Advanced engineering reduces noise levels, essential for stealth operations. Impressive fuel economy keeps operating costs low during long-range missions. Proven engine support, parts and service are available onsite, from two full-time Tognum America service technicians. And wherever the *Coronado* goes next, MTU’s worldwide service network is ready to provide support.

In addition to the two main propulsion engines, the ship includes four MTU 8V 396 generator sets—two each for vital and non-vital power, respectively—and another 8V 396-driven “hydraulic prime mover” to power the *Coronado*’s azimuth retractable bow thruster. The cross-functionality and redundancy of the engines and the systems they power contribute towards the self-sustainability required of the Independence Class LCS. “For example, the hydraulic prime mover engine alone can get the ship to safe port if absolutely necessary,” Rizzo explains.

#### Maintaining sea dominance

As the largest supplier of propulsion engines and systems to the U.S. Navy and U.S. Coast Guard, MTU has provided trusted and proven engines for decades. Since 1950, MTU has—along with its predecessor companies such as Detroit Diesel—delivered more than 30,000 engines and systems to almost every navy in the world. By supplying reliable power to the Independence Class Littoral Combat Ship project, MTU is poised to help the U.S. Navy meet new challenges for the 21st century.



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## USCG Bernard C. Webber relies on MTU for fast response

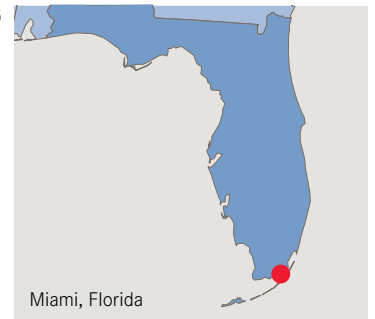


**Who:** USCG Bernard C. Webber, Fast Response Cutter

**What:** Two MTU 20V 4000 diesel engines

**Why:** High power-to-weight ratio, fuel economy and low lifecycle costs

**Where:** Miami, Florida, USA



The U.S. Coast Guard has unveiled a new class of patrol boats, Fast Response Cutters, to protect American waters. The 154-foot *Bernard C. Webber* is the first FRC to be commissioned. Powered by two MTU 20V 4000 diesel engines, the ship can achieve speeds up to 28 knots. With a high power-to-weight ratio and exceptional fuel economy, MTU engines are perfectly suited to help the *Webber* execute its missions.

Through a relationship that spans decades, MTU is the largest supplier of propulsion engines and systems to the U.S. Coast Guard. MTU engines power motor lifeboats, coastal patrol boats, national security cutters and fast response cutters, conducting important missions in extreme conditions. Today, the Coast Guard depends on MTU for 100% of its new patrol and response boats.

The Coast Guard's new Sentinel Class Fast Response Cutter (FRC) is capable of deploying independently for waterways and coastal security, fishery patrols, drug and illegal migrant law enforcement, search and rescue, and national defense. The FRC program is the USCG's first new cutter initiative in more than 20 years. Named after Coast Guard enlisted heroes, the FRCs are replacing the Coast Guard's venerable Island-class 110-foot patrol boats.

"The Sentinel class of cutters is a tribute not only to the enlisted men and women serving in the Coast Guard today, but the many heroes that preceded them," says Coast Guard Commandant Adm. Robert J. Papp, Jr. "It will be a critical asset in securing and protecting our nation's maritime environment."

### A strong lineage

Built by Bollinger Shipyards in Lockport, Louisiana, the new FRCs will help the Coast Guard address its current patrol boat gaps and efficiently complete all potential missions. The boatbuilder provides new construction, repair and conversion products and services to the commercial offshore energy and marine transportation markets around the world, including the U.S. government and naval shipbuilding marketplace. Family-owned and operated since 1946, Bollinger maintains 10 ISO

Scott Theriot, vice president and general manager, Bollinger Shipyards  
"The MTUs have the right horsepower-to-weight ratio and the company has a great history of building high-powered, lightweight engines."



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The 154-foot *Bernard C. Webber* is powered by two MTU 20V 4000 diesel engines, providing a total power output of 4,300kW.

9001:2008 certified shipyards and a fleet of 28 dry-docks for shallow draft and deepwater vessels. Bollinger has earned a premier reputation for superior quality, value, timely service and delivery to its customers.

#### Head of its class

In April 2012, the Coast Guard commissioned its first FRC, *Bernard C. Webber*, in Miami, Florida. Built to accommodate a crew of 24 and endure a minimum of five days at sea, the ship has a length of 154 feet and a beam of 25 feet. Armament includes a Bushmaster remote-controlled 25 mm autocannon and four crew-served Browning .50 caliber machine guns. As the Coast Guard's newest class of vessel, the *Webber* is equipped with the latest technology. Its command and control systems are fully interoperable with USCG's existing and future assets and with the U.S. Departments of Homeland Security and Defense.

#### A powerful ally

Fast Response Cutters will enforce U.S. and international maritime law, and ensure security along the 95,000 nautical miles of U.S. coastline. Performing this important mission demands exceptional power below deck. With two 20-cylinder Series 4000 M93L MTU engines providing a total power output of 4,300kW, the *Bernard C. Webber* is ready to respond quickly to any situation. The bow thruster delivers 75kW power, while the propulsion system provides a maximum speed of over 28 knots.

Only MTU can provide the power density and design characteristics needed to meet the demanding requirements of the new Fast Response Cutter. Each engine produces 5,095 horsepower—a high output relative to the engine's compact size. "The MTUs have the right horsepower-to-weight ratio and the company has a great history of building high-powered, lightweight engines," adds Scott Theriot, Bollinger Shipyards vice president and general manager.

To meet FRC requirements, this engine had to meet the rigorous American Bureau of Shipping Naval Vessel Rules Standard (ABS/NVR). This certification required MTU to subject the 20V 4000 engine to a grueling 1500-hour bench test, running approximately 500 hours at 110 percent overload.

USCG senior chief engineer Richard Libbey says, "The Series 4000s perform really well and are very dependable. They're way more technical than the older MTU engines on some of our other cutters, like the 87-footers, but they're still simple to operate," he says. "We start them up for a patrol by opening all the cooling valves and fuel valves, push a button and the engines start. We idle them for about 30 to 45 minutes. They'll run on 10 cylinders first, and then all 20 kick in as the engines warm up. After that, we're set. We simply monitor their performance during the patrols."

#### Ready to serve

The powerful 20V 4000 is the perfect fit for the *Bernard C. Webber*. Engineered for a low operating noise level, the engine's advanced technology ensures exceptional fuel efficiency, compared to other engines in its class. Ease of serviceability, fuel economy and MTU's legendary reliability ensure low lifecycle costs—especially important since each FRC is expected to perform at a high level for decades.

Just like the Coast Guard, MTU is always on call. Engine support, parts and service are readily available—wherever and whenever a Fast Response Cutter is on patrol. Bollinger and the Coast Guard receive excellent service and support from MTU and distributor Florida Detroit Diesel Allison (Miami, FL) for the FRC's twin engines. MTU also provides end-to-end support for the USCG's MTU engines, through its dedicated worldwide distribution network.

The *Bernard C. Webber* and other new FRCs will deliver vital capability and readiness to the Coast Guard. With twin Series 4000 engines under its deck, each ship is well equipped to save lives, enforce laws and protect U.S. ports and natural resources.

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# MTU engines keep Viking yachts moving at full throttle



**Who:** 70-foot Viking Convertible  
**What:** Twin MTU 16V 2000 M94 engines  
**Why:** Performance, reliability, fuel efficiency, maneuverability, reduced noise and serviceability  
**Where:** New Gretna, New Jersey



**In the luxury sportfishing yacht industry, Viking yachts are making waves. “Building a better boat every day” is the company philosophy—and it exemplifies Viking’s passion towards design, craftsmanship and performance. Below deck of the 70-foot Viking Convertible, MTU engines meet the high expectations of Viking’s founders—and Viking boat owners around the world.**

The Viking Yacht Company was started by brothers Bob and Bill Healey in 1964, with the purchase of a small, struggling wooden sportfishing boat company on the edge of the Bass River in New Jersey. Today, Viking is one of the world’s leaders in semi-custom fiberglass yacht production with over 4,000 Vikings delivered all over the world. It remains a family-owned and managed business, building over 60 luxury sportsfishing yachts a year, ranging from 42 to 92 feet.

### All hands on deck

The Healey’s passion towards boatbuilding has attracted like-minded partners. Since the 1970s, Viking has worked with Johnson & Towers, the largest MTU pleasure craft distributor in North

America. Back then, the distributor pioneered the industry by customizing 2-Cycle Detroit Diesel engines for marine use. This was the only way to produce enough horsepower to reach the Healey’s performance objectives. While the nature of the business and technology has changed dramatically since then, the partnership continues to this day.

“It’s a great team. And we couldn’t do it on our own. We get the support we need from MTU factory personnel too. The distributor, the factory and Viking—the three of us work together to provide a quality product and superb service,” says Robert Shomo, senior vice president of engine sales at Johnson & Towers.

Peter Frederiksen, director of communications, Viking Yacht Company

“People want that speed, they want that reliability, and MTU engines do a great job, and we’re very happy with them. The 70-footer is very fast for a boat that weighs 130,000 pounds.”



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Powered by twin MTU 16V 2000 M94 engines, the 70-foot Viking Convertible moves at 40 knots (46 MPH) at full throttle.

### Craftsmanship by design

As the Viking Yacht Company continues to grow all over the world, it stays grounded in the values that made it so successful. For nearly five decades, Viking's philosophy has been to build a better boat every day. The commitment towards superior craftsmanship, design and performance permeates the entire company.

From multiple CNC routers for cutting wood parts to a pair of five axis profiles valued at \$1.5 million to create foam plugs to build complex molds, Viking defines cutting edge. Other than a few major components, such as engines, propellers and appliances, 90 percent of every Viking boat is designed and manufactured on the premises. Whether it's a fiberglass fuel tank, custom engine beds or a wiring harness labeled every eight inches with its function, virtually every part is built at its state-of-the-art manufacturing facility. This maintains quality control and ensures that everything works together seamlessly.

### The ultimate fishing machine

A Viking's interior resembles a floating luxury condominium, featuring designer touches such as curved doorways, exquisite woodworking and TVs that rise from teak cabinetry at the touch of a button. Below deck, you'll find the heart and soul of the boat—the engine room. Here, the vessel reaches another level of extreme—centered on speed and performance.

Powered by twin MTU 16V 2000 M94 engines, the 70-foot Viking Convertible moves at 40 knots (46 MPH) at full throttle. Also known as "battlegoons," the yachts excel at tournament

fishing, where the fastest boat gets to the best fishing grounds first. Speed is also important when fish aren't biting. If you find out that prime fishing grounds are 20 or 30 miles away, the ability to pick up your lines and run to that area is crucial. Moving quickly could make the difference between holding up a trophy at tournament's end, or shaking hands with the winner.

Many first-time Viking owners have bought a Viking after getting passed by one on the water. "People want that speed, that reliability, and those engines do a great job, and we're very happy with them. The 70-footer is very fast for a boat that weighs 130,000 pounds. It really gives the owner a charge to be able to pass people," says Peter Frederiksen, director of communications, Viking Yacht Company.

As an engineering-driven company, Viking takes great pride in its engine rooms. "When most people walk into a Viking engine room, they're speechless," says Frederiksen. "The room and the engines are white. It's a very clean, antiseptic space. It's easy to spot leaks or anything out of the ordinary. It's designed for easy access for maintenance. If you make it easy for a person to perform daily oil and fluid checks, chances are it's going to get done. MTU, Johnson & Towers and Viking have made that engine room a very hospitable place and you don't mind spending time down there."

### Going above and beyond

And if there are service issues, experienced personnel are always standing by. In addition to its New Jersey facility, the Viking Yacht Company is the only manufacturer to provide its

owners with a satellite service facility in Florida. MTU distributors are located all over the world, ready to lend a hand as well. Johnson & Towers is on call 24/7 to provide service and support. Recently, a boater was stranded 50 miles offshore in Florida, unable to restart the engine. Over the phone, the owner reached out to Robert Shomo at Johnson & Towers for help. Robert walked the owner through what was needed to get his engine started. The engine came to life, and the owner returned to shore safely.

"All MTU distributors are expected to maintain that quality of service," says Shomo. "You're buying the best marine pleasure craft engine in the industry. It's quiet, fuel efficient, reliable, aesthetically beautiful, and it's the right power for that particular boat and that particular market."

The Viking Yacht Company continues to look toward the horizon. The design group is putting the finishing touches on the plans and drawings for its biggest vessel yet—the new 92-foot Convertible, equipped with twin MTU 16V 2000 M96 engines. And as always, while Viking adds new models to its production cycle, it will continue to refine all of its current boats in its product line for gains in performance. As kindred spirits with Viking, MTU shares this same passion for constant innovation and superior engineering.

"Our relationship with MTU and Johnson & Towers has been long and strong," says Frederiksen. "That's very reassuring for our customers. We put our boats through a lot of work to perform. It's a very concerted effort, by a lot of people with the same goal—building a better boat every day."

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# MTU marine engines offer considerable upgrade to new Outer Banks ferries

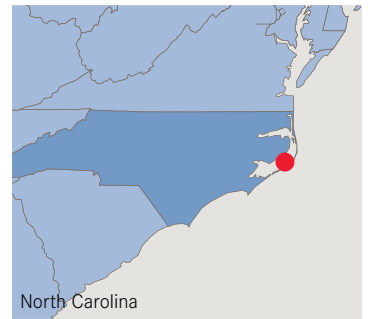
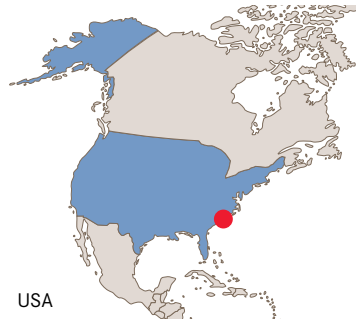


**Who:** North Carolina Department of Transportation—Ferry Division

**What:** MTU 8V 4000 M60 marine propulsion engines.

**Why:** Quieter operation, more reactive control of vessel, dramatic improvements in fuel efficiency, power capacity and reliability.

**Where:** The Outer Banks, North Carolina, USA



**Two new MTU-powered ferries were recently launched in the Outer Banks, a 200-mile stretch of barrier islands off the coast of North Carolina.**

The North Carolina Department of Transportation (NCDOT) operates the second largest state-owned ferry system in the United States.

Within the short choppy winds of this natural phenomenon known as the Outer Banks, its 32 ferry vessels serve seven routes, operate over 200 sailings daily, and transport more than 1.1 million vehicles and 2.5 million passengers annually across five bodies of water. Residents of North Carolina's coastal communities depend on the Ferry System for transportation to work, school and as a means of emergency evacuation. Regularly traversing ocean waters on ferries, Outer Banks residents have a unique tie to nature. The North Carolina Department of Transportation honors the coastal area's values by ensuring new additions to their fleet are clean-running and abide by the Environmental

Protection Agency's marine emission requirements.

In 2010, NCDOT replaced two 20-year-old ferries in its fleet with newer, larger and cleaner-running vessels named *Sea Level* and *Swan Quarter*. In NCDOT's search for EPA Tier 2 compliant diesel engines, MTU triumphed over other marine power industry heavyweights and won the bid to power the new vessels. MTU outfitted the new ferries with two MTU 8V 4000 M60 engines. MTU engines were selected for their competitive price point, reliability and low lifecycle costs, which make them the ideal fuel-efficient passenger-friendly marine propulsion system. The 1,000-ton ferries are 43 percent larger than the retired ferries and can carry 50 cars—or four tour buses—at a time.

Joe Waldrep, marine design engineer, NCDOT, Ferry Division

"It's really smooth. That's one thing everyone's noticing. You don't hear the boat. In other boats, you shake, rattle and roll."



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The MTU Series 4000 M60 engine delivers 700-800 horsepower at 1400 RPM.

The new ferries, each with capacity for 300 passengers, have been well received by tourists and operators alike. *Sea Level* and *Swan Quarter* carry day-tripping tourists across the Pamlico Sound to and from Ocracoke Island, an Outer Banks gem that boasts 16 miles of pristine wild beaches. And, thanks to the 250-foot increase in passenger-friendly space, tourists are able to explore the vessel's passenger lounge and front and back decks while enjoying the picturesque Outer Banks scenery en route. Running from North Carolina's Cedar Island and Swan Quarter ports, the vessels complete four, two-hour runs per day through the open water, where they can experience waves up to seven feet high.

#### Power and control

The upgrade to MTU Series 4000 M60 engines has offered operators more power and control, giving them more confidence maneuvering in close quarters. With 700-800 horsepower at 1400 RPM, the turbocharged engines are powered to run at speeds faster than 14 knots.

According to Joe Waldrep, marine design engineer for the NCDOT Ferry project, the second turbo only kicks in when the vessels are approaching 12 knots. Once the vessels hit 12 knots, operators are able to back off the throttle and continue the voyage at one turbo. This increase in power capacity allows the vessels to run at 60 percent of their power, which saves fuel and reduces wear and tear on the engine. Since the ferries run at a fraction of their power, they're able to use the ferry's reserve power to catch up

to schedule or power through inclement weather. "We could leave five to 20 minutes late and still get passengers there on time," said Waldrep.

#### Fuel burn

Though the vessels are dramatically larger than the ferries they replaced, they burn the same amount of fuel due to their efficient, yet powerful MTU diesel engines. The Series 4000 engine's common rail fuel system, coupled with turbocharging, leads to a drop in fuel burn and a leap in efficiency and performance.

"Everyone was concerned that the new ships would burn a lot of fuel because of the size increase, but we're not. We're pushing a lot more boat through the water and still not burning more fuel," said Waldrep.

According to Jeff Sherman, MTU Marine Sales Manager, 95 percent of an engine's overall cost is fuel and any fuel savings an engine can achieve translates into major cost savings.

#### Standard MTU practices elevate customer satisfaction

With MTU's reduced maintenance schedule, including extended oil changes and infrequent valve adjustments, *Sea Level* and *Swan Quarter* will experience exceptional uptime and reliability, both of which contribute to lower lifecycle costs. Outside of this schedule and normal daily maintenance, NCDOT crews are finding the engines require minimal repairs or changes.

One of the most dramatic differences is in the low level of engine noise detected in the new ferry. According to Waldrep, the engine is undetectable in the passenger lounge. This significant reduction in noise can be attributed to the mounting of the engine—MTU's engines in these ferries are isolated on rubber mounts designed specifically for MTU, while other engine manufacturers sometimes still use the "mount on a hard surface" practice.

"It's really smooth. That's one thing everyone's noticing. You don't hear the boat. In other boats, you shake, rattle and roll," said Waldrep. "MTU only mounts on soft mounts, they do not put engines on hard mounts. It's a standard MTU policy—I love it."

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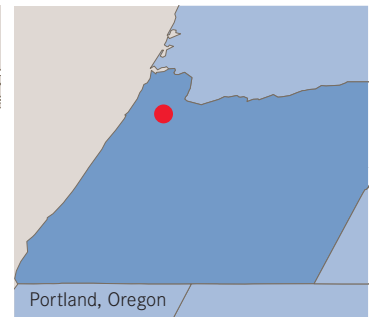
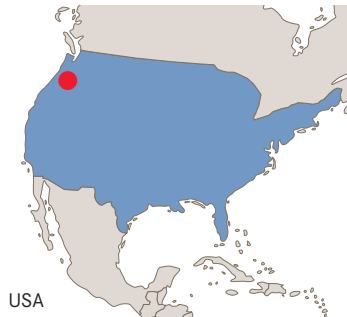


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# MTU power improves performance of Shaver Transportation tugboats



**Who:** Shaver Transportation  
**What:** MTU 12V 4000 M60, 12V 4000 M63 marine propulsion engines  
**Why:** Dramatic improvements in lifespan, reliability, durability and fuel efficiency  
**Where:** Portland, Oregon, USA



**Shaver Transportation's tugboats have been crisscrossing the Columbia-Snake River System, the largest grain export gateway in the U.S., for more than a hundred years. Along with modern towing demands comes the need for the most modern and efficient engines. As their original equipment becomes dated, Shaver has begun a strategic cadence of tug repowers with MTU Series 4000 marine propulsion engines to ensure their fleet is both reliable and efficient. These engines meet the demands of their unique tugs that, unlike most, excel in both hauling and ship assist.**

Shaver Transportation is one of the oldest, most established inland water freight operations in the Pacific Northwest, and has led river-borne transportation on the Columbia-Snake River System since its inception. Founded in 1880 by George W. Shaver as a steamboat company, Shaver Transportation remains family owned and managed more than a century later. Today, the company focuses on harbor services, and inland bulk commodity barging from the farming communities in eastern Washington and Idaho for international export.

For five generations, the Shaver family has prided itself on having the most modern and powerful fleet of ship assist tugs on the Columbia River. As their once top-of-the-line vessels began to spend

more time in maintenance and less time on the river, Shaver Transportation looked to Pacific Power Products and MTU for engine repower options. The first candidate for repower was the *Deschutes*, a 91-by-36-foot 3,540 horsepower towboat, which was built in 1997.

The *Deschutes* repower marked the beginning of Shaver Transportation's practice of repowering viable vessels with MTU's Series 4000 marine propulsion engines to improve durability and to lower fuel consumption. The *Deschutes* was repowered when the Series 4000 marine propulsion was first available in the early 2000s, replacing two dated Detroit Diesel Series 149 engines.

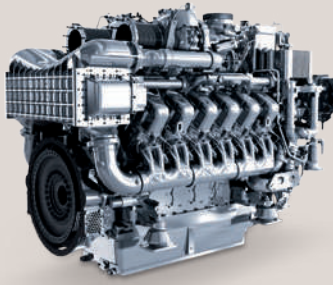
Steve Shaver, president, Shaver Transportation

"The ability of the MTU engines to maintain maximum output under the heaviest loads certainly makes a difference for our operators."

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The MTU Series 4000 marine engine is engineered for maximum durability and low fuel consumption.

“We needed engines that were not only capable of being efficient and high performing in a short haul scenario, but we also needed dependability, reliability and fuel efficiency for long haul work,” said Steve Shaver, president of Shaver Transportation.

The caliber of Shaver Transportation’s fleet has remained cutting-edge by working closely with its MTU distributor, Pacific Power Products. With strategic MTU repower recommendations as engines reach the end of their lives, the Shaver fleet has made dramatic improvements in fuel efficiency, durability, reliability, noise and vibration.

#### **Proven durability**

Principally powered by MTU engines, Shaver Transportation boasts the largest, most modern and most powerful ship assist tugs on the scenic but treacherous Columbia River, and some of the cleanest, most reliable and fuel-efficient fleets in the industry. Each of its upriver line tugs can push up to four barges. At their maximum load of 15,000 tons of cargo, their hauls measure about 650 feet long and 84 feet wide, which is comparable to the length of two football fields. A tug’s sail, or the height of its air draft, is nearly 30 feet high—the height of a three-story building. Enormous in scale, each of these mammoth hauls can face wind gusts up to 80 miles per hour created by atmospheric pressure differentials that cause a wind tunnel effect in the Columbia River Gorge. The Shaver fleet faces these violent winds while carefully maneuvering the heavy flow and steep gradient that occurs in the Columbia River Basin, which is surrounded by

the Rocky Mountains to the east and north, the Cascade Range on the west, and the Great Basin to the south.

Measuring 1,243 miles long, the Columbia River is the fourth largest river in the United States by volume, and it has the greatest flow of any North American river draining into the Pacific. At its mouth, the river’s strong currents and shifting sandbar between the river and the Pacific Ocean make it one of the most hazardous stretches of water to navigate in the world, earning it the nickname “Graveyard of the Pacific.”

“The MTU engines are reliable. We don’t have the concern of running them hard with heavy tows and heavy winds that we did with the engines they replaced,” said Rob Rich, vice president of marine services.

With more than 100 years’ experience navigating waters that have wrecked scores of vessels, Shaver Transportation has established itself as a family institution of naval expertise in the Pacific Northwest, and in the industry.

The Shaver family members serve as their own naval architects and consultants. Case in point: President Steve Shaver didn’t just inherit his position; he started as a deckhand and worked his way to the presidency and his status today as a master mariner. Guided by Steve Shaver’s on-the-job expertise and boardroom perspective, Shaver’s barge fleet has a combined capacity of nearly 55,000 tons and is capable of moving any freight by barge on the powerful, steep flow of the Columbia-Snake river system.

“It’s impressive—I don’t know how they do it. The fleet navigates locks and tight bends in the river while the wind is blowing violently. If something were to go wrong, you could lose the tow. It says a lot to have the confidence and the power to do these demanding jobs,” said David Dombrowski, marine sales engineer for Pacific Power Products Company.

#### **Unique breed**

These multipurpose tugboats have a varied job description. Shaver’s vessels are unique in the industry in that they are purpose-built to excel in both ship docking and line-haul barge towing. These two tasks are mutually exclusive for most tugs.

“These vessels aren’t built for a single purpose. Depending on the job, our vessels could be on very short cab-like trip, or on week-long haul,” said Steve Shaver. “The ability of the MTU engines to maintain maximum output under the heaviest loads certainly makes a difference for our operators.”

#### **A family affair**

All of Shaver Transportation’s repowers are determined by justifiable returns on investment. For each repower, the ultimate cost of the vessel in operation, the state of the existing equipment, the cost of the repower, and the ultimate improvements in uptime and fuel and oil savings are examined closely to ensure Shaver Transportation’s profit is maximized.

Rob Rich, vice president of marine sales, Shaver Transportation  
“The MTU engines are reliable. We don’t have the concern of running them hard with heavy tows and heavy winds that we did with the engines they replaced.”



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Shaver Transportation has the largest, most modern and most powerful fleet of ship assist tugs on the Columbia River, each with greater than 3000 horsepower.

Taking the leap to transition to MTU with the initial repower of the *Deschutes* was a risk for Shaver. Estimating a five percent fuel savings, the company weighed the upfront cost of the repower with the potential long-term savings. After introducing the first pair of MTU Series 4000 engines to their fleet, Shaver has experienced 32 percent fuel savings in addition to an enormous 90 percent decrease in lube oil consumption, with comparable horsepower over the engine that was removed. With the original engines, the *Deschutes* used upwards of 300 gallons of lubrication oil on a seven-day trip, and with the new MTU engines, the tow only uses 12 to 15 gallons maximum. Nothing in the tow but the engines changed. The propulsor (Z-drive), and propellers stayed the same, and the tug was tasked with the same work, on the same route.

The project's success led to the repower of the *Deschutes* sister ship the *Willamette*, and subsequently led to the repower of a number of older vessels that were powered with medium speed engines: The *Portland*, the *Clearwater* and the *Cascades*. The repower program will continue with the *Umatilla* and the *Vancouver*. Shaver Transportation is also opting for MTU power in their new vessel builds, such as the recently constructed *Summer S*.

#### Trusted allies

MTU's Series 4000 marine engines offer Shaver Transportation less downtime due to less frequent repair intervals. The original engines required intensive maintenance to components such as the cylinder heads, turbo chargers and injector replacements to keep the vessels in operable condition. Wanting to extend maintenance intervals, Shaver and Pacific Power worked side-by-side to customize a maintenance schedule that would help decrease vessel downtime without compromised performance. As a result, the *Deschutes* and *Willamette* have reached 30,000 operating hours before engine overhaul, surpassing the predicted 24,000 hours by a large margin. The *Portland*, *Clearwater*, *Cascades* and *Summer S* are also well on their way to similar performance.

"Pacific has done a great job supporting Shaver. As we like to say, sales sells the first engine and service sells the rest," said Jeff Sherman, MTU marine sales manager. "Shaver is a family business and we like to treat them as family at MTU, and support them in any way they need it. Pacific is complementary in working with customers in that respect."

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# MTU engine with SCR meets stringent emissions standards for California ferry

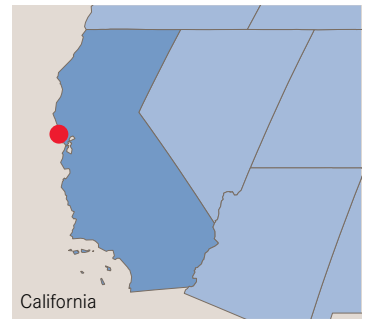
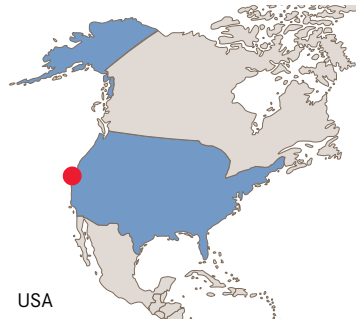


**Who:** San Francisco Bay Area Water Emergency Transportation Authority

**What:** MTU Series 2000 engine with “compact” SCR system

**Why:** To provide a super-clean power system for San Francisco Bay ferries

**Where:** San Francisco Bay Area, California, USA



**Paired with a custom-designed exhaust-treatment system, MTU Series 2000 marine engines help ferry builders meet the stringent pollution requirements of a San Francisco transit authority. Actual emissions are nearly 97 percent below EPA emission standards for Tier 2 marine engines, easily surpassing the transit authority’s 85 percent requirement.**

A pair of the nation’s greenest ferries have recently been launched by the Water Emergency Transportation Authority (WETA), an agency created by the state of California and Bay Area municipalities to develop and operate a water-borne transit system connecting communities on San Francisco Bay. The vessels feature an eco-friendly propulsion system that includes a compact pollution-control unit and a powerful but clean-running marine engine from MTU.

The vessels are part of a new ferry fleet meant to improve both emergency response and passenger transportation in the Bay Area. Despite the potential benefits of the new fleet, however, the ferries were originally opposed by

some environmentalists who contended that they generate more pollution per person than other means of transportation. Studies conducted on three ferries in the Bay Area provided evidence that the diesel engines actually generated less pollution than projected by those opposing ferries. As a compromise, WETA agreed to a strict pollution specification for new ferries. The specification requires cruise emissions to be 85 percent below the Environmental Protection Agency’s Tier 2 marine requirements at a vessel speed of 25 knots and 85 percent load – an emissions level one-tenth that of any other ferry operating in California waters.

Bill Mossey, corporate sales manager, Pacific Power

“The Series 2000 engine was a key part of our solution to this tough emissions problem.”



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MTU Series 2000 engines exceed EPA Tier 2 marine emissions requirements and were key to meeting project requirements.

### Emissions challenge falls to local MTU distributor

The emissions specification was placed in the contract WETA offered for four new ferries for San Francisco Bay. After the contract was awarded, the task of meeting the stringent pollution requirement fell to local MTU distributor, Pacific Power Products Company, Ridgefield, Washington. Pacific Power is the MTU distributor in the Pacific Northwest and provides sales and aftermarket support to marine, industrial and power generation markets. "Pacific Power was confident that an environmentally friendly MTU marine engine could do the job with an assist from an accompanying pollution-treatment system," says Bill Mossey, corporate sales manager, Pacific Power.

For the engine, Pacific Power chose the MTU Series 2000, which can operate on a blend of biodiesel and ultra-low-sulfur diesel fuel. Even without a pollution-treatment system, the MTU engine exceeds EPA Tier 2 marine emission requirements. "The Series 2000 engine was a key part of our solution to this tough emissions problem," says Mossey,

Besides being environmentally friendly, the Series 2000 engine features the highest horsepower in its class. A pair of these powerful engines helps each ferry meet WETA's demanding 25-knot speed requirement.

### SCR aftertreatment controls emissions

"The penalty for failure to meet the standard was complete rejection of the vessel – not just financial penalty, as is customary," said Mossey. "That represents a much greater risk for boat builders, so it was an absolute must to meet the requirement."

That meant deciding what type of pollution-treatment system would be paired with the MTU engines to bring emissions down to the required level. The firm had previous experience equipping a ferry with a system for selective catalytic reduction (SCR), an aftertreatment that uses an aqueous urea solution to form ammonia for converting smog-producing NOx in diesel engine exhaust into harmless nitrogen gas and water vapor.

When used to treat diesel exhaust, SCR can reduce NOx in excess of 95 percent and can allow for combustion optimization for lowest fuel consumption and particulate matter emissions. SCR has long been used to reduce pollution from stationary sources. But the size and weight of SCR systems have made them impractical for many mobile applications.

Nevertheless, Pacific Power decided that SCR would be the best pollution-treatment option to package with the MTU engines. But the WETA ferry application would require a custom-designed treatment solution that would be less bulky and lighter than conventional SCR equipment. So the distributor worked with one of its suppliers to design a "compact SCR" system about one-fifth the size and weight of SCR systems developed for stationary pollution sources.

### Results satisfy demanding customer

Acceptance testing done by WETA confirmed that Pacific Power's MTU engine/SCR package did the job – and then some. Actual emissions were nearly 97 percent below EPA emission standards for Tier 2 marine engines, easily surpassing WETA's 85 percent requirement. What's more, Mossey notes, no particulate filter was required to reach the emissions target due to the exceptionally clean-running MTU engine. The MTU engine/SCR package is so clean, he adds, that it would meet the WETA requirement even if the engine were burning low-sulfur No. 2 diesel fuel rather than the ultra-low-sulfur diesel fuel mandated by California.

The testing results equate to net tailpipe emissions that would approximate EPA Marine Tier 4 standard levels which go into effect beginning in 2016 for marine diesel engines. Tier 4 requires reduction in NOx and HC emissions of up to 75 percent and a reduction in particulate matter of 80 percent from current Tier 2 requirements.

With the MTU engine/SCR pollution-control package approved for duty, two of the ferries ordered by WETA, Gemini and Pisces, are now in operation in San Francisco Bay. The other two vessels should be plying the same waters by the middle of this year. Equipped with their capable and super-clean power systems, the four ferries should please both environmentalists and passengers for years to come.

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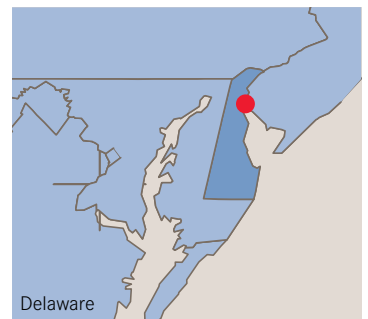
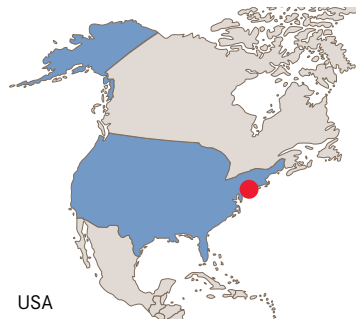


*Power. Passion. Partnership.*

## Wilmington Tug relies on MTU marine engines for safe and reliable docking of ships on Delaware River ports



- Who:** Wilmington Tug, a leading ship-assist company on the Delaware River
- What:** MTU Series 4000 engines with 8, 12 and 16 cylinders for fleet of eight tugs
- Why:** Reliable power is critical to ensure tugs are available on short notice and at full capacity to safely dock vessels
- Where:** Wilmington, Delaware, USA



**Installed in new tugboats and retrofitted into older ones operated by a Delaware tugboat company, MTU's Series 4000 marine engines provide the power and reliability needed to safely guide the largest vessels plying the Delaware River. Quiet and fuel efficient, the engines simplify the jobs of the tug operator's staff and are key to safe docking.**

From the merchant marine industry's point of view, the Delaware River and Bay is one busy place. Extending 90 miles from Cape Henlopen at the mouth to the northern port, Philadelphia, it's the largest freshwater port complex in the world and the second-largest oil port complex in the U.S., second only to Houston. That's 3,000 inbound vessels and over 70 million tons of cargo annually—and about 85 percent of the East Coast's oil imports. Given these impressive statistics, it's no wonder that the fleets responsible for guiding and docking the shipping traffic have high stakes in reliability.

Wilmington Tug, one of the leading ship-assist companies on the Delaware River, also has impressive statistics of its own. The company has doubled in size in the last decade to a fleet of eight tugs that assist about 2,000 ships per

year—with cargos ranging from oil and steel to bananas, lumber and cars. More traffic and less room on the river leave fewer margins for error. To ensure that its tug fleet performs with the reliability needed to safely dock ocean-going ships, Wilmington Tug's vessels are powered by MTU engines.

"In our business, which is primarily docking and undocking ships, reliability of the tugboat is critical," said Hickman Rowland, owner and president of Wilmington Tug. "Big tankers come up the river carrying a million and a half barrels of oil, and our tugs must be at full capacity to meet those ships. There is no second way to do that. In our work, you never know when the call is coming. Most important for us is that when we get the call to go to duty, we know the engines will start. And we need to

Chris Rowland, head of operations, Wilmington Tug

"We've been impressed by the ability of the Series 4000 engines to idle for a long time and then rev very quickly to full power."



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The MTU Series 4000 marine engine features common rail fuel injection, which significantly lowers fuel consumption.

know they'll run for the entire job and give us the power we need."

### **Tugs transition from Detroit Diesel 2-Cycles to MTU Series 4000 engines**

Harry Rowland, father of Hickman, founded Wilmington Tug in 1965. Hickman joined the company in 1971, and the two played a significant role in tugboat advancement by building the first Z-drive tractor tug. Introduced in the U.S. in 1977, Z-drive is a propulsion system that gives tugs greater maneuverability. On a Z-drive tug, the propeller can actually spin 360 degrees, allowing the tug to shift sideways, forward and backward—just the kind of flexibility required for ship docking.

Together with the Z-drive system, the early tugs were outfitted with Detroit Diesel 2-Cycle engines, the predecessor to MTU four-cycle engines. "Since the early days, we haven't had to worry about rebuilds every few thousand hours because we know the engines are reliable," said Hickman Rowland. But with cargo ships increasing and the margin for error dwindling, the Wilmington Tug crew realized their engines needed to advance with the times.

After a thorough search in 2001 for an engine meeting their specific requirements, Hickman Rowland and his colleagues found what they were looking for and installed two MTU Series 4000 engines in a new tugboat. "We were so pleased that we've put the engines in every new boat we've built since then," said Rowland. "And now we're starting to re-power our old boats with them. When we transitioned from the Detroit Diesels to the MTU engine, we were concerned

about going from a two-cycle to a four-cycle engine. But what surprised us was just how easy it was." Currently, four of Wilmington Tug's eight boats have Series 4000 engines, all of which were purchased from Penn Detroit Diesel, a Philadelphia-based MTU distributor. The engines include units with 8, 12 and 16 cylinders. Running at about 1,800 rpm, the 16-cylinder engines deliver almost 2,400 horsepower for tugging the largest cargo ships. Six of the tugs have a pair of engines that power twin screws, while the other two boats have a single engine apiece.

### **Designed as a complete package**

Hickman Rowland and his staff had many engine options to choose from, but Series 4000 engines stood out for several reasons. "We loved the way they're designed," said Bill Martin, Wilmington Tug's port engineer. "Rather than an assembly of parts bolted together, they're designed from the ground up as a complete package."

In addition, Martin and his colleagues appreciate the fact that the engines were built specifically for marine use. For example, he points to the triple-walled exhaust manifolds that limit heat rejection to a vessel's engine room, helping to keep temperatures down and allowing users to save on engine-room ventilation.

### **Engines make life easier for captain and deckhand**

In addition to reliability, Series 4000 engines help meet the special maneuverability requirements of tugboat operation. "Our business requires the tug to idle for long periods of time, but then bring the power up very quickly when it's needed," said Chris Rowland, head of

operations and son of Hickman Rowland. "We've been impressed by the ability of the Series 4000 engines to idle for a long time and then rev very quickly to full power."

This is especially true to ensure safe mooring, when cargo ships rely on tugs to push and pull them to their assigned places alongside docks. "Customers are very concerned about damage to ships as well as to piers, particularly when the ships are oil tankers because there's the possibility that oil can be spilled into the river," said Chris Rowland. "In the past, you never wanted to have an incident, but now it's a zero-tolerance world where docking errors are concerned."

Series 4000 engines also make life much easier for the captain and deckhand operating the tugs. "Nothing is worse in the tug business than a boat that vibrates and makes noise," said Chris Rowland. "It is totally disconcerting and very uncomfortable for the crew. So we are very keen to make our boats quiet and smooth. There's not one person who comes aboard our boats who doesn't remark on how smooth and how quiet they are."

### **Bottom line: engine reliability is key to Wilmington Tug's success**

Wilmington Tug's reliability record has been good for the company's bottom line. "We get paid for the jobs that we do," said Hickman Rowland. "When a tugboat sits at the dock, we're not being paid, so downtime is brutal for us." With Series 4000 engines powering his tugs, however, "the boats run and we can make it to all of our jobs."

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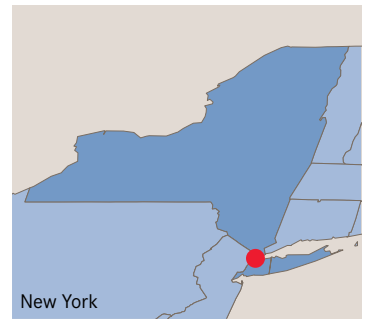
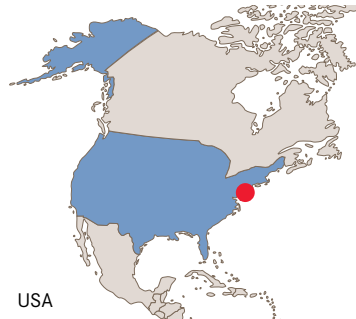
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Off-road, construction

## Engines from MTU power New York City fireboat with the world's greatest pumping capacity



- Who:** Fire Department of New York
- What:** Four MTU 12V4000 M70 diesel engines totaling 8,980 hp and the MTU Callosum ship automation system on board the *Three Forty Three*
- Why:** Propulsion and pumping deliver a top speed of 18 knots and up to 50,000 gallons per minute of water
- Where:** New York, New York, USA



**Named in honor of the 343 members of the New York City Fire Department who made the supreme sacrifice in the line of duty on September 11, 2001, the city's newest fireboat, the *Three Forty Three*, can reach fires quickly and pump huge quantities of water to douse flames like those that spewed from the World Trade Center.**

For both propulsion and pumping capacity, this waterborne firefighting marvel relies on four MTU 12V4000 M70 diesel engines totaling 8,980 hp. For the utmost in reliability, the fireboat is also equipped with the MTU Callosum ship automation system, which controls the propulsion system and continuously monitors various critical areas and functions of the ship.

"The name of this ship will remind every person who sees it in action protecting the Port of New York and the surrounding waterways, and every firefighter who operates aboard it, of the supreme sacrifice made by so many of our members on 9/11, ensuring that we never forget," said Fire Commissioner Salvatore Cassano, who commissioned the vessel along with New York City Mayor Michael Bloomberg.

### **Advanced fireboat brings impressive capabilities to the job**

In his remarks, Cassano also called the *Three Forty Three* "the most technically advanced fireboat in the world." At 140 feet long and with a 36-foot beam, the vessel has a top speed of 18 knots and can pump up to 50,000 gallons per minute (gpm), reportedly the highest volume of any fireboat ever commissioned. The need for such tremendous pumping capacity was made clear in the aftermath of 9/11, when FDNY fireboats supplied the only firefighting water available for many days following the attack on the Twin Towers.

Edward Mauro, pilot, *Three Forty Three*

"We're all firefighters from the beginning, but to pilot a boat like this is a thrill. Between the pumping power and maneuverability, the boat is twice as fast as anything we've had before."



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In the engine room of the *Three Forty Three*, four MTU 12V4000 M70 diesel engines deliver propulsion and pumping. The Callosum ship automation system (blue boxes) controls the entire propulsion system and displays the information on one of four touch screens throughout the vessel.

The *Three Forty Three* is the first of two such vessels to be commissioned by New York City officials. The second, named *Fire Fighter II*, is currently undergoing sea trials. The two new vessels replace the FDNY's longest-serving fireboats, both of which are more than 50 years old. Designed by Robert Allan Ltd. of Vancouver, B.C., and built by Eastern Shipbuilding Group of Panama City, Fla., the *Three Forty Three* can carry 27 firefighters along with a seven-person operating crew.

#### **MTU engines provide power for propulsion and pumping**

The distinctive red MTU engines are designed with two sets of performance characteristics, depending on whether they are being used for propulsion or water pumping. Each engine is equipped with a fire-pump clutch and pump assembly driven off the front of the engine. Pumping capacity for each fireboat is 25,000 gpm on two engines (when the vessel is in motion while fighting fires) and 50,000 gpm on all four engines (when the vessel pumps water from a fixed location).

Even with such powerful capabilities, the MTU engine delivers low life-cycle costs, long service life and easy maintenance, as well as environmental benefits. For example, individual four-valve cylinder heads allow for more efficient breathing characteristics.

A large ratio of cylinder displacement to horsepower and low break mean effective pressure (BMEP) ensure low fuel consumption and less mechanical stress on engine components.

With an EPA-certified Tier 2 rating, these engines have lower exhaust emissions than many other available engines. The common rail fuel injection system allows for significant reduction of soot emissions, especially at low speeds. Sequential turbocharging with charge air cooling means the turbochargers can more closely match and respond to the engine airflow requirements and deliver faster throttle response.

"The boat is tremendously fast," said Edward Mauro, one of 14 pilots being trained on the *Three Forty Three* and a member of the fire department for 29 years. "We're all firefighters from the beginning, but to pilot a boat like this is a thrill. The automation is unbelievable. Between the pumping power and maneuverability, the boat is twice as fast as anything we've had before and gets us where we need to be in a hurry."

#### **Complete package includes control and monitoring**

A key element in the vessel's overall performance is the MTU Callosum control and remote monitoring system, a modular system that enables the crew to monitor the power plant and propulsion system in addition to most other systems throughout the ship. MTU BlueVision engine controls interface with the Callosum system.

"The controls and monitoring system complete the package we were able to deliver, which was an important benefit for the fire department," said Ken Houle, marine sales manager for Atlantic Detroit Diesel-Allison in Lodi, New Jersey, the area distributor for MTU. "This comprehensive system not only controls the engines, it controls the entire propulsion system and displays the information on one of four touch screens throughout the vessel. Among other advantages, this means a third-party monitoring system wasn't needed, which saves space in the wheelhouse and simplifies overall boat operation."

For example, the Callosum system automates control of the Hundested variable pitch propellers. "The pitch of the blades changes based on throttle position," said Houle. "We programmed them so that the pitch and throttle work in conjunction; the operator does not have to control engine rpm and pitch separately."

**Ken Houle**, marine sales manager, ADDA  
"We are committed to training to help transition from older technology to state-of-the-art technology."



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“The most technologically advanced fireboat in the world” protects the Port of New York and surrounding waterways. Powerful MTU engines deliver low life-cycle costs and environmental benefits.

In addition, the modular Callosum system includes a vessel security system for monitoring the boat’s unique pressurized HEPA-filtered air chamber, which protects the crew from chemical, biological, nuclear and explosive agents. The monitoring system monitors doors, vents, stairwell dampers and other components.

Besides the monitoring and control and vessel security modules, the Callosum system provides an electronic diagnostic program that constantly monitors all propulsion-related processes. Each module features three-click technology, which means that every operation can be accomplished with no more than three clicks—a particularly important function on a fireboat where quick decisions are the norm.

#### **Commitment to the project**

“We have been working closely with the fire department since planning for the boat first began,” said Houle. “Both MTU and ADDA are committed to working with the shipyard by providing support for installation and operation on-site; now that the boat is in the commissioning phase, we are committed to training to help transition from older technology to state-of-the-art technology.”

Upon completion of crew training, the *Three Forty Three* will begin patrolling the waterways in and around New York City. For many years to come, the Three Forty Three will fight New York’s fires—and will also remind New Yorkers of the brave members of FDNY who made the supreme sacrifice the day the Towers fell.

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## MTU Series 4000 engines power new Boston Towing and Transportation tugboats used at major LNG terminals

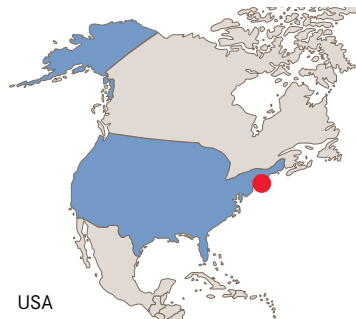


**Who:** Boston Towing and Transportation

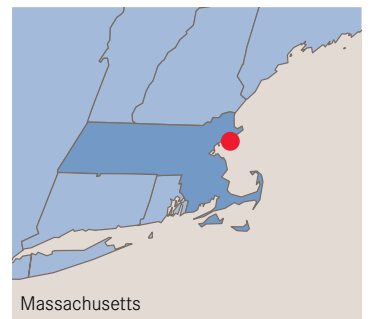
**What:** Two new tugboats outfitted with dual MTU Series 4000 16V engines

**Why:** With tugs operating 24 hours a day in all weather conditions, Boston Towing and Transportation needed engines that were fuel efficient, powerful, reliable and quiet

**Where:** Boston Harbor and Gloucester, Massachusetts, USA



USA



Massachusetts

**New high-speed diesel engines are ideally suited for ship-assist tugboats used to guide liquefied natural gas (LNG) tankers to both an onshore docking terminal in Boston Harbor and an offshore terminal near Gloucester, Massachusetts.**

BOSTON, Massachusetts – Boston Harbor has been an important shipping center for more than 300 years, from its influx of European immigrants to the wide variety of cargo it handles today. Since the early 1970s, the area has become a major center for unloading the liquefied natural gas (LNG) tankers that supply natural gas to much of the Northeast. Getting those tankers safely to their terminals is the job of ship-assist tugboats such as those operated by Boston Towing and Transportation (BT&T). When BT&T commissioned two new tugs for assisting LNG tankers belonging to global giant Suez Energy North America, it specified them with twin MTU 16V Series 4000 marine diesel engines. The new ultra-reliable, high-speed diesel engines are proving to be ideally suited to this challenging application.

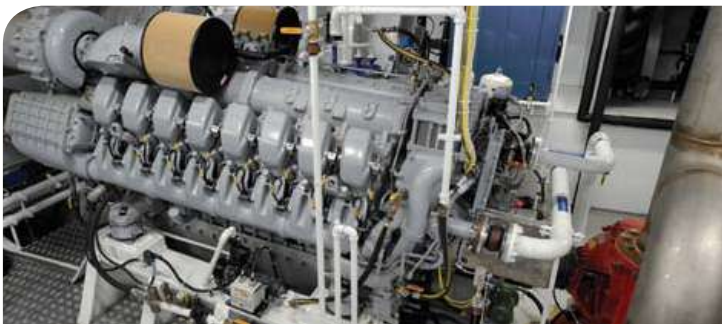
The two new BT&T tugboats are the 39-meter *Independence* and the 30-meter *Justice*. Both boats were designed by the renowned naval architectural firm Robert Allan Ltd. specifically to provide support for LNG ships in harbor and at sea in heavy weather conditions. The *Justice* was built by Martinac Shipyards in Seattle, Washington; the *Independence* was built by Derecktor Shipyards in Bridgeport, Connecticut. Boston-area MTU distributor, New England Detroit Diesel-Allison in Wakefield, Massachusetts, supplied the engines. The two new boats, the first in the fleet to be equipped with MTU marine engines, join a fleet of eight other tugs owned by BT&T.

Bill Skinner, marine superintendent for BT&T

“So far, the MTU engines have matched our mission profile perfectly.”



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The MTU 16V4000 M61 diesel delivers 2,700 horsepower with unexcelled fuel economy. Its high power-to-weight ratio and quiet operation help create workable engine rooms.

According to Bill Skinner, marine superintendent for BT&T, "Suez Energy North America is BT&T's largest customer, and they have contracted with us to handle LNG ships for the next 20 years. Based on that contract, Boston Towing was able to finance and build the new tugboats and take delivery of them in late 2009."

BT&T handles approximately 60 LNG tankers coming into the Port of Boston at Everett, Massachusetts, and also tends supplemental LNG shipments that arrive at the Neptune deep-water terminal in international waters about 12 miles off the coast of Gloucester, Massachusetts. The 30-meter *Justice* was primarily designed to help ships coming into the Port of Boston, while the 39-meter *Independence* was designed for use at the deep-water terminal offshore. Because of the harsher environment that the *Independence* works in, the larger tug is specially designed with deck and bulwark deicing for cold weather, and for high winds and steep seas.

"Our primary mission at the LNG terminals is emergency towing," says Skinner. "Our second mission is firefighting, and our third is personnel rescue using our crane-launched Ribcraft inflatable."

#### Power for propulsion and firefighting

Both new BT&T tugs are equipped with twin MTU 16V 4000 M61 engines, which deliver a combined 5,400 horsepower to twin controllable-pitch Rolls-Royce Z-drives. The Z-drives are in azimuth pods that rotate 360 degrees, giving the vessels virtually full power in any direction. Each tug has enough power to tow a 100,000-ton ship at a speed of three knots in a Beaufort scale force-five wind (18-24 miles per

hour) in up to six-foot seas. The boats are also equipped for firefighting and can pump a minimum of 10,500 gallons per minute from two nozzles to a minimum distance of 425 feet.

"Whenever we set out on a boat-building venture like this," says Skinner, "we ask ourselves a series of questions: What are the weather conditions likely to be? What is the load profile of the boat going to be? What endurance is going to be required? What's the load factor during that endurance? What's the size of the hull, and how much engine-room space do we have? So far, the MTU engines have matched our mission profile perfectly."

#### Powerful and compact engines

The MTU Series 4000 engines are high-speed diesels with a top end of 1,800 RPM. Many other tugboat engines of the same horsepower rating are medium-speed engines that top out at 750 to 900 RPM. Because they run slower, the medium-speed diesels have to be much larger and heavier — an issue that affects the design of the boat and working space in the engine room. "In our smaller new tug, *Justice*, engine-room space was at a premium, so the more compact MTU engines with their better power-to-weight ratio made a significant difference in creating a workable engine room," says Skinner.

While BT&T had not used MTU engines in its tugboat fleet in the past, it became aware of MTU through its parent company, Reinauer Transportation, which has had good experiences with MTU engines. During the design stage of the new tugs, Skinner was convinced to consider the MTU line of high-speed marine diesel engines after learning about their high power-to-weight

ratio, quiet operation, durability and excellent performance characteristics — including good fuel economy.

Another factor that favored using MTU diesel engines in this application was the operating profile of the tugs. Skinner says that the boats spend "less than one-tenth of one percent at full rack speed" and usually have an annual load factor of only 30 to 35 percent due to the high percentage of idling time. However, when full power is needed, Skinner says, "the MTU engines have excellent throttle response combined with a very clean stack."

#### Quiet operation is a safety factor

Engines with low noise and vibration play a big role in making a boat comfortable and safe for crews that work around the clock, says Skinner. Today's working boats have only half the number of crew aboard as in the past, so there has to be a lot of technology to support them. By keeping engine noise and vibration low, there is much less fatigue experienced by the crew.

"The living quarters inside both of these vessels are extraordinarily quiet," says Skinner. "Most of the time, we cannot tell the MTU engines are even running. In fact, the captains often don't know the engines have been started until they look at their gauges."

Another reason BT&T decided on the MTU Series 4000 engines was that they could provide power for propulsion as well as for running the firefighting pumps. Each engine can deliver 1,000 horsepower off the front of the crankshaft to drive a firefighting pump, leaving a combined 3,400 horsepower to power the propellers for

Ran Archer, sales manager for MTU mining engines, Tognum America

"If you're careful about [using clean fuel and performing recommended maintenance], MTU engines will run a long time and help drive down operating cost."



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The 30-meter *Justice* was designed to assist LNG tankers and other ships coming into Boston Harbor. Its missions include emergency towing, firefighting and personnel rescue.

towing or maneuvering. This capability eliminated the need for two separate auxiliary pump engines that would have taken up a lot of space and required long-term maintenance.

“This is also where the controllable-pitch Z-drives come in,” adds Skinner. “These Z-drives allow us to use the same engines for pumping and propulsion and not worry about overloading them. They also save fuel, produce a cleaner stack and result in gentler handling in close quarters because of reduced prop wash.”

#### **Scheduling maintenance on the go**

Maintenance on BT&T’s new tugs consists primarily of regular oil and filter changes performed by the MTU distributor while the boats come to the dock for six hours during a crew change. While the engines are under warranty, Skinner says they are changing the oil every 1,000 hours as recommended by the manufacturer. Eventually, they will alter that schedule as they’ve done with the rest of their fleet based on what Skinner called “a common-sense factor” that involves analyzing oil samples and slowly increasing the oil-change intervals in 250-hour increments until an ideal interval is determined for the application.

The MTU Series 4000 engine boasts a long interval between overhauls, but while it would normally be considered ready after 30,000 hours of operation, Skinner thinks the engines in the *Justice* and *Independence* are likely to go much longer than that. “With this application’s low duty cycle, I don’t think we’ll be measuring our overhaul interval in chronological hours but rather in the total amount of fuel consumed. In fact, I’m 54, and I’ll be retired before these engines have to be overhauled. That’s a nice thought.”

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