PROJECT MEET NEWS

Only One to the Seas of the World

6th Issue October 2014

Mitsubishi Marine Energy & Environment Technical Solution-System

UEC-35LSE-Eco

Fin Stabilizer

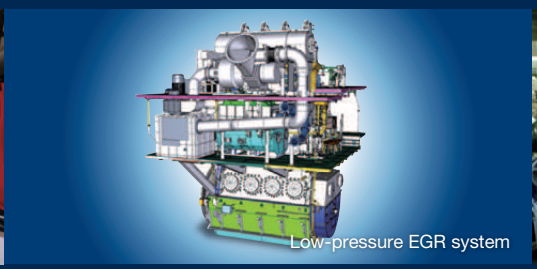
The Tachibana-Maru (Tokai Kisen Co., Ltd.), powered by the UEC-35LSE-Eco engine and installed with an MHI-MME fin stabilizer

Streams of Project MEET Products

Ship fitted with the first UEC-35LSE-Eco marine engine begins service

- Electro-assist turbocharger now applied to 4-stroke engines [Page 4]
- Fuel savings of 8% achieved in ship fitted with the Mitsubishi Energy Recovery System (MERS) [Page 4]
- Development of a low-pressure EGR (exhaust gas recirculation) system [Page 5]
- MET turbocharger with variable turbine inlet (VTI) receives high evaluation remark points [Page 7]

Electro-assist turbocharger



Low-pressure EGR system

Waste Heat Recovery System (MERS)

MITSUBISHI HEAVY INDUSTRIES
MARINE MACHINERY & ENGINE CO., LTD.

MHI GROUP MITSUBISHI HEAVY INDUSTRIES

Leveraging Maersk Line's sustainability performance in its relationships with customers and suppliers

Interviewing Mr. Ole-Graa Jakobsen, Head of Technical Operations, MAERSK Line, about various programs

— Today we would like you to tell us about the AP Moller group's sustainability efforts. But firstly, may I ask you to explain your views about marine marketing, including super slow steaming?

Jakobsen: The demand for global containers is growing but more slowly than in the past. Up to 2008, before the financial crisis, the container shipbuilding market was growing three times faster than the global economy. After the financial crisis, the volume growth of shipbuilding containers for seaborne trade has been equal to global economic growth, and we still see that the capacity of the container industry exceeds the volume of seaborne container cargo, and the capacity will continue to increase.

Considering this market situation, we focus on our slow steaming operations. Slow steaming is beneficial to the environment and permits flexible operations. Slow steaming gives us more flexibility in terms of our estimated arrival times. We do not need to speed up and wait to adjust port schedules.

— I agree with your point that the capacity of growth of shipbuilding for container ships is high. The number of mega container vessels is expanding rapidly. A lot of ship owners are trying to enter the market for 14k, 18k and even 19k containers and even bigger ones.

Jakobsen: That's what we call the vicious cycle of the container business. If you are not investing in new tonnage, you will have less advantage in terms of economies of scale and efficiency and you will lose to the competition. If you are investing, you will increase the overcapacity in the market, and everybody will lose. It is an evil cycle in the container business.

— So the flexibility for the operation and optimization of the system are key words in terms of slow steaming for Maersk Line?

Jakobsen: Yes exactly. Container rates come down in price due to the excess container capacity. It is extremely important for us to actualize the lowest transportation unit costs. We have been quite successful for 5-6 quarters. And we will continue pushing towards lowest costs in the market.

— It seems that you are the company that is winning in the market. How long do you think that super slow steaming will continue in the future?

Jakobsen: We will continue slow steaming as long as there is excess capacity of container vessels and high fuel prices.

— May I ask you to tell us about Maersk lines' focus on sustainability and environmental protection?

Olsen: The AP Moller group has always had a strong focus on sustainability, but in recent years we have probably become more systematic in our approach Today, I think sustainability is an integrated part of how we conduct our business. The shipping industry accounts for roughly 3% of global CO_2 emissions, and Maersk Line alone accounts for app. 0.1% of global CO_2 emissions, which has a big impact for us as a company. We are making efforts to reduce CO_2 and improve the efficiency of the business by retrofitting, slow steaming, network optimization, and investing in new and more efficient vessels. This has an immediate impact both in terms of costs and reducing our carbon footprint. Since 2007, we have reduced our CO_2 emissions with 34% per container moved. And we are planning to reach a 40% reduction by 2020.

In Maersk Line our long-term strategy is about achieving "Sustainable Profitable Growth." To us, this means that we always have to balance our sustainability efforts against our financial obligations and profitability targets. It has to make sense from a business perspective; otherwise it is not sustainable in the long run.

Take consumption of fuel as an example. This is an issue that is pressing both from an environment perspective, but certainly also from a business perspective. Fuel prices are increasing, and we have to prepare for a scenario, where we may run out of fuel or fuel prices are too high. We are therefore also collaborating with research institutions and other partners to explore alternatives to fossil fuels. One alternative, which is currently being tested in this research collaboration, is called Lignin, which is a substance you can find in plant cells. We are testing it, and we are collaborating to see if it is viable for shipping. The challenge is that it is not commercially viable yet because the volumes required

Lignin (Biomass)

would be very high. But we have many programs that we are studying from both a commercial and a sustainability perspective.

— You always stay one step ahead. My next question is about the future. Where is your focus in terms of reducing the NOx in the TierIII program? Are you going to adopt EGR, SCR or LNG as fuel?

Jakobsen: If you look at NOx, we have tested the EGR technology and we found that it is effective in terms of complying with the regulation.

—You have a lot of suppliers, and your emphasis is on responsible business partners. Could you please explain that?

Olsen: In addition to our environmental efforts, there is another aspect to our sustainability focus which is the social and ethical performance side. Over the past 10 years or so, our stakeholders are increasingly asking what our business practices are and are asking us to disclose information about child labor, corruption, how do we recycle our ships, what our requirements are for suppliers and so on. At one point some of our large customers also started sending us extensive questionnaires asking about our policies. In 2008, we signed up as members of the UN Global Compact, which is a strategic policy initiative for companies who are committed to conducting their business in line with internationally recognized principles for responsible business practices.

For example, in 2010 we launched our Responsible Procurement Program which tries to define standards for our suppliers in areas such as health & safety, labour rights, anti-corruption and environmental management.

On the other hand, we also work very closely with our customers on these issues. Today app. 21% of our total volumes represent customers who are asking us for information about our sustainability performance. The fact that we engage with both suppliers and customers on this issues reflect that we are right in the middle of the value chain. We commit to the big shippers to be a responsible partner, and we are likewise asking our suppliers to commit to being responsible partners. Similarly, when suppliers start asking the same questions to their suppliers, it will have a tripple effect even further up the value chain. When we share information with customers about our sustainability performance, we ultimately allow them to make better and more informed choices, when they select who they want to partner with in the long run.

— We hope that we are one of your responsible partners from this perspective. Going back to our products and services, we would like to ask you how APM Maersk or Maersk Line evaluates MHI-MME economical and eco-products? You use a good many MHI-MME products.

Jakobsen: We see your products and your company as a very important partner. To achieve our goals we must be striving for innovative solutions for the environmental challenges and regulations of this market. We have reduced our total costs by implementing a number of MHI-MME's waste heat recovery systems (WHRS), which are currently also on Triple-E vessels. We are looking for all kinds of ways to optimize tonnage to meet the current requirements in terms of both new buildings and retrofit. Being specific on the WHRS on the " WAF Class" , "SAM Class," and " Triple-E Class," they are meeting our expectations in general.

— Thank you so much, and we believe that we can continue being one of your important partner. Thank you so much for taking the time.

Jakobsen : Ole Graa Jakobsen
Head of Technical Operations,
Ship Management MAERSK LINE

Olsen : Mette Olsen
Senior Global Advisor, Sustainability, MAERSK LINE

Interviewer : Tomoo Kuzu
Vice President and Head of Business Development,
Mitsubishi Heavy Industries
Marine Machinery & Engine Co., Ltd.

Advantages Also Verified for 4-Stroke Engines

Electro - assist Turbocharger

MHI-MME developed and put to practical use a hybrid turbocharger that couples an electric power generator directly with a turbocharger rotor shaft. It can recover electricity from the surplus revolution energy of a turbocharger rotor or, conversely, provide electrical assistance to the turbocharger rotor.

In the case of 2-stroke engines, the electro-assist function makes it possible to pressure-feed combustion air in the place of conventional auxiliary blowers. But, what kind of an effect does it have on 4-stroke engines that essentially do not have auxiliary blowers? To verify this, MHI-MME carried out an operational test with the cooperation of Akasaka Diesels in which a high-speed motor was connected to the rotor of an MET22SR turbocharger that was mounted on an Akasaka Diesel 4-cycle diesel engine used for testing.

It was found as a result of the operational test that the electro-assist turbocharger has a significant effect in the reduction of smoke when starting up the engine and in the saving of fuel during low load operation. By rotating the turbocharger by motor in advance of starting up the engine, a significant reduction of particles within emissions was achieved when the engine was started. Furthermore, during low load operation, by increasing the turbocharger's rotation frequency using fractional supplied electrical power, combustion was improved through an increase in air volume. Net engine fuel savings of nearly 3% was achieved.

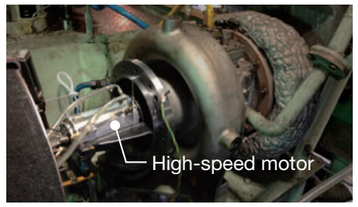
It is conceivable that this technology is valid not only for the propulsion engines of domestic vessels that must stop and start its engine frequently but also for generators, which require rapid load increases. Going forward, MHI-MME plans to roll out electro-assist turbochargers in the compact MET-SRC series and contribute to the improvement of 4-stroke engine performance.

Product developers

(From left)
Venky Krishnan (Director, Calnetix)
Ken Wicks (Senior Power Electronics Engineer, Calnetix)
Jim Fincham (Senior Project Engineer, Calnetix)
Takeshi Tsuji (Manager, MHIA)

Amount of reduced fuel consumption with respect to supplied electrical power

	Supplied electrical power (ratio of engine output,%)	Turbocharger rotational frequency (rpm)	Boost pressure (Barg)	Turbocharger exhaust gas inlet temperature (℃)	Main engine fuel consumption reduction rate	Net efficiency improvement
Load: 25%	0 kW	14,611	0.20	420	Ref.	—
	1.3 kW (0.7%)	16,000	0.25	400	2.7 %	2.0 %
	5.3 kW (2.9%)	18,000	0.32	370	5.7 %	2.8 %
Load: 35%	0 kW	19,240	0.3	445	Ref.	—
	3.5 kW (1.4%)	21,000	0.45	420	4.1%	2.7 %
	5.9 kW (2.3%)	21,810	0.49	400	4.2%	1.9 %



Operational test with an MET22SR

8% Fuel Savings for ORE Carrier installed in MERS

Mitsubishi Energy Recovery System (MERS)

To meet ship power demand, using a steam turbine-driven generator by way of exhaust gas economizer as the main diesel engine's waste heat recovery equipment is an existing technology.

At the same time, MHII-MME has recently developed a combined power generation system (Steam turbine + Power turbine) to drive a power turbine (Gas turbine) with the waste gas and to assist steam turbine in line, and has already delivered this system to 50 in-service ships.

MERS power generator installed on the ore carrier

This article provides the practicalization of a hybrid system where this combined power generator has been expanded and a shaft motor, added as a new application not only to meet ship power demand, but also to assist the main engine and help improve its fuel efficiency by sending the excess power generated back to the shaft motor.

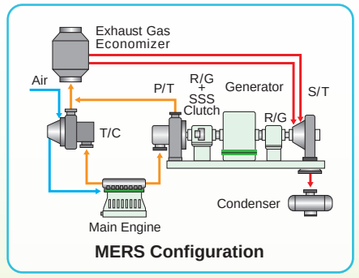
This enables the new system to be installed on any kind of vessel, and the main engine' s fuel efficiency can be improved from a perspective separate from enhancement of the main engine's internal efficiency.

This new system completed its factory operation and installed to ore carrier built at Namura Shipbuilding Co., Ltd., and owned by Mitsui O.S.K. Lines, Ltd. And also she goes into service and is able to reduce fuel consumption by approximately 8%.

The superior energy-saving performance of this system was highly recognized and won the 2014 Japan Society of Naval Architects and Ocean Engineers Award.

Product developers

(From left) Shinichiro Egashira, Manager (MIES) , Haruki Tanaka



MERS Configuration

※MERS:Mitsubishi Energy Recovery System

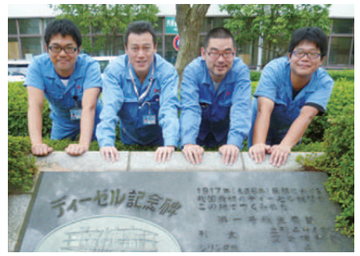
Technology Meeting with IMO Tier III NOx Emission Limits

Low Pressure EGR (Exhaust Gas Recirculation) System

The low pressure EGR (Exhaust Gas Recirculation) system is a technology that responds to the IMO NOx TierⅢ regulations that will be applied to ships whose construction begin on or after January 1, 2016.It recirculates a portion of an engine's exhaust gas to the engine inlet and suppresses the generation of NOx by changing the combustion state within the engine. MHI-MME has confirmed through test engines that it is possible to reduce NOx levels to levels that meet IMO TierⅢ regulations—something that had been thought difficult to achieve with only an EGR.

The MHI-MME EGR system is a low pressure system that recirculates low pressure exhaust gas exiting an engine turbocharger to the turbocharger gas intake. Its advantage is that it can keep both initial costs and running costs lower than a high pressure EGR system that utilizes high temperature, high pressure exhaust from a turbocharger intake. An onboard test is currently being planned.The overall system, including the water treatment device, will be optimized so that the system can be made smaller and optimal operational parameters established.MHI-MME will achieve environmental friendliness while enabling the engine's normal performance to be exhibited.

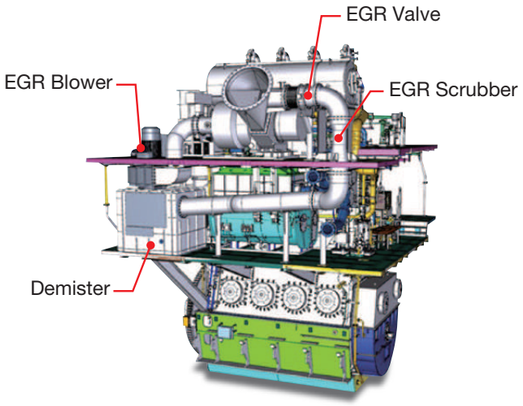
Product developers



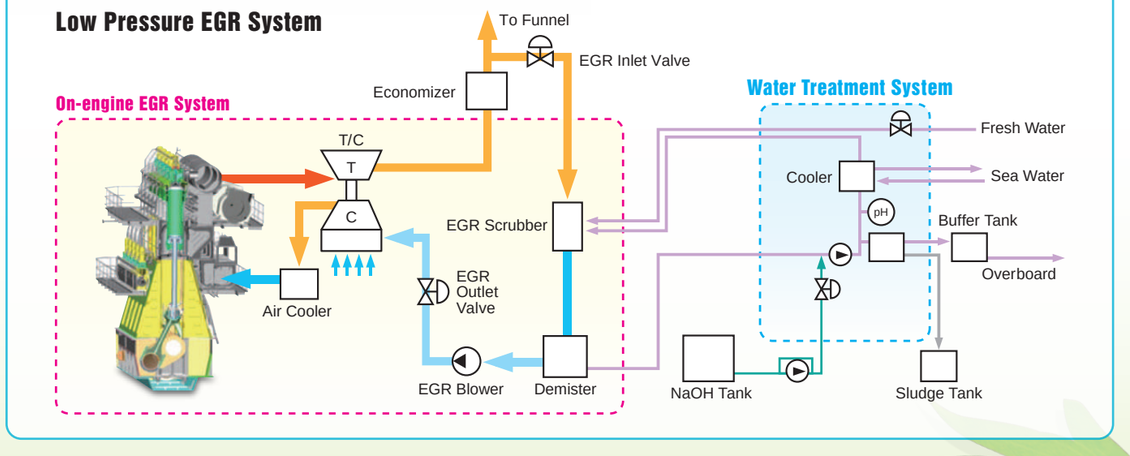
(From left) Mr. Nakagawa, Mr. Hiraoka (Manager) , Mr. Ito (Deputy Manager) , and Mr. Ueda

Development concept

- To develop an unrivalled low pressure EGR (exhaust gas recirculation) system
- To use the low temperature, low pressure exhaust gas that has passed through a turbocharger as the recirculated gas; to recommend gas branch on the rear flow side of the economizer exhaust
- To realize the simple configuration and control enabled by a low pressure system; to attain maximum downsizing
- To achieve overwhelming superiority over other systems by the low initial costs and running costs made possible as a simple system
- To realize low costs in the water treatment system for cleaning scrubber water through maximum utilization of conventional technology
- To be easy to combine with SOx scrubbers
- To make installing possible not only for UE engines but also the engines manufactured by other companies



Overview of the 4UE-X3 test engine



MHI-MME Licensees

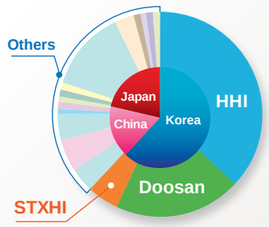
Hyundai Heavy Industries (HHI), Doosan Engine (Doosan) and STX Heavy Industries (STXHI)

MET Turbochargers by the Three Leading Marine Diesel Main Engines Manufacture in South Korea

In Korea, where known as the world No.1 manufacturer of 2-stroke marine diesel engine*,we are promoting "localization" of our MET Turbocharger.

Already, we had concluded license agreements with three largest engine builders in Korea,Hyundai Heavy Industries, Doosan Engine and STX Heavy Industries.The localization enabled us to supply more competitive turbochargers just in time.Going forward, we will continue to maintain and deepen collaborative relationship with those Korean Licensees by considering of localization of Electro Assist Turbocharger which is our latest technology and small size turbochargers for 4-stroke engines in order to meet customers' further demands in the Marine Machinery Market.

*bhp basis



Market share as marine engine builder
(MHI-MME estimate,As of 2013)

Hyundai Heavy Industries HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Established: 1972
Global market share: No.1
Year MET license agreement concluded: 2001

STX Heavy Industries stx Heavy Industries

Established: 1976
Global market share: No.4
Year MET license agreement concluded: 2011

Doosan Engine DOOSAN

Established: 1983
Global market share: No.2
Year MET license agreement concluded: 2010

After-sales Services

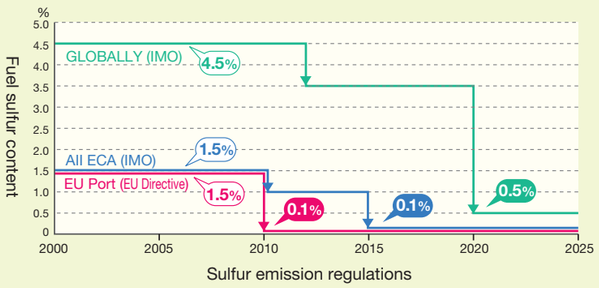
Boiler Modification for Low Sulfur Distillate Oil

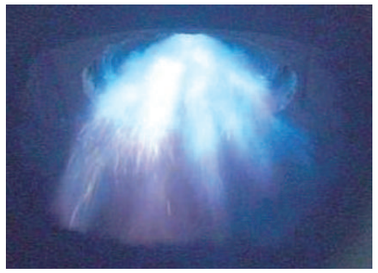
Air pollution due to toxic emissions from marine engines is a serious problem and is regulated by the annexes to the International Maritime Organization's (IMO's) International Convention for the Prevention of Pollution from Ships (MARPOL).Current regulations related to sulfur emission require that the sulfur content of marine fuels be reduced with the passage of time.The regulations are divided into application in global waters and in emission control areas (ECAs).

In January 2010, EU member states enforced sulfur limit regulations in its ports and harbors in advance of the IMO regulations taking effect.The fuel that was demanded at the time was for a sulfur limit of 0.1%, which is a significant reduction in sulfur content. Such fuel is called Low Sulfur Distillate Oil (LSDO) or Low Sulfur Marine Gas Oil (LSMGO).

The next tier will go into effect on January 1,2015, and will oblige ships sailing in European, American and other ECAs to operate with either fuel with a sulfur content of 0.1% or achieve emissions that are equal to that when the aforementioned fuel is used.

LSDO is characterized not only by its low sulfur content but also by low viscosity and boiling point. Safe operation is difficult without modification of existing, conventional devices. A wide range of components need to be modified in the case of boilers—combustion equipment, control systems, fuel lines, fuel pumps, and fuel tanks. MHI-MME has a track record of having carried out such modifications on more than 300ships with main and auxiliary boilers.





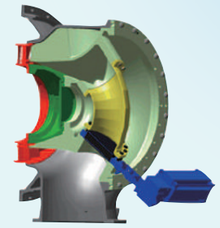
LSDO combustion flame

MET Turbocharger with Variable Turbine Inlet (VTI) fitted with MAN Diesel & Turbo for its Turbocharger Selection

The Excellent Reliability and Performance of VTI Turbochargers Recognized

More than 30 MET Turbochargers with variable turbine inlets (VTI) have already been delivered and are running smoothly.The lineup of VTI Turbochargers ranges from the MET48MB-VTI to MET90MA / MB-VTI, and they can be used with wide-ranging engine outputs.

MAN Diesel & Turbo, which is a leading licensor of low-speed diesel engines, highly evaluated the proven track record of many applications as well as the fuel savings enabled through the application of VTIs. As a result of confirming the reliability of MET VTI Turbochargers after extended use on an vessel in service, MAN Diesel & Turbo officially approved our VTI Turbochargers as one of the turbochargers capable of Variable Turbine area (VT) tuning.They are listed on MAN Diesel & Turbo's Turbocharger Selection webpages with a "-V" at the end of the model name, such as "MET66MB-V."
URL : http://turbocharger.man.eu / turbocharger-selection



VTI Turbocharger

Deck Crane with Synchronous Control Function Delivered

Deck crane installed on a ship

Synchronous Control System Developed for Loadingand Unloading Long Rails (150m)

MHI-MME delivered three 50t deck cranes with a synchronous control system that will outfit a long rail transport vessel being built by Shin Kurushima Dockyard.

The three cranes, which were arranged at intervals of approximately 50m along a 155m hold, have a synchronous control system that enables the three units to operate synchronized hoisting and lifting operations.The cranes can be operated not only from the cabin but also remotely from the deck.The delivery makes possible the stable and efficient loading and unloading of large quantities of 150m-long steel rails.

Steady Orders Being Received for Fin Stabilizers

High Performance Fin Stabilizers Being Provided for Replacement Ships Being Built Domestically ; Market Share in Japan Nearly 100%

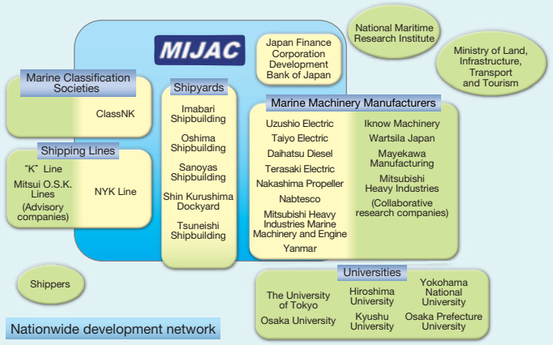
There is increased activity in the construction of domestic ferries and roll-on / roll-off (Ro-Ro) ships as replacement orders, and MHI-MME has been receiving orders back-to-back for fin stabilizers to be installed on such ships.

The technology for fin stabilizers was developed by Dr.Shintaro Motora of MHI in 1920.They reduce the roll motions of ships and are installed on many passenger ships, car ferries, and Ro-Ro ships as essential equipment from the viewpoint of preventing motion sickness among passengers or cargo collapse.

In 1988, MHI-MME developed the Mitsubishi Retractable Fin Stabilizer for general merchant vessels, with the first such fin stabilizer delivered for installation on Kyushu Yusen's New Tsushima ferry.The superior performance of these fin stabilizers, realized by optimized control—using the Fuzzy Theory—and a highly responsive hydraulic system, were later recognized, and a total of 150 fin stabilizers have been delivered to date, including 34 delivered overseas. In Japan, MHI-MME enjoys a market share in fin stabilizers that is close to 100%.

MHI-MME fin stabilizer (MR3)

Investment Made in Maritime Innovation Japan Corporation (MIJAC)



Participation in a Nationwide R&D Framework

In April 2014, MHI-MME invested in Maritime Innovation Japan Corporation (MIJAC). Established in April 2013, MIJAC was founded for the purpose of carrying out R&D on technologies related to ship design, construction, and operation, technologies for the reduction of the emission of CO_2 and toxic substances from ships, and technologies for the utilization of oceanic energy.

Participants to date are Imabari Shipbuilding,Oshima Shipbuilding, Sanoyas Shipbuilding, Shin Kurushima Dockyard, Tsuneishi Shipbuilding, Nippon Yusen (NYK Line), Nippon Kaiji Kyokai (ClassNK),and various manufacturers of marine machinery. MHI-MME is contributing to the development of Japanese maritime clusters through its participation in MIJAC.

MHI-MME Offices Abroad

Mitsubishi Heavy Industries Europe, Ltd. (MHIE)

General Manager Isao Uchida

Our office was originally established in Hamburg, Germany in 1993 to serve as the contact point for MHI marine diesel engines customers in Europe and the Middle East as well as the base for the provision of after-sales services. We were carrying out energetic activities there until we relocated to London, England in April 2014. The objective of the move was to further reinforce and expand the support framework for customers in the aforementioned regions to include, in addition to diesel engines, marine equipment in general that is handled by MHI. Such new activities are now underway.

The London Office, where we have begun our work as a new overseas base for Europe and the Middle East, is located close to Holborn London Underground station. The office faces Kingsway, which is one of the widest roads in central London (100 ft).

The London Office took over all of the operations that had been handled by the Hamburg Office. We have a new structure in place that now makes it possible for us to handle all MHI products—a dispatchee from the marine equipment business unit has been newly assigned here in addition to the dispatchee from the marine engine business unit.

There are many users of MHI products located in Europe and the Middle East, and we are carrying out our activities with an eye to enhancing customer services and providing swift response from similar time zones.

As you probably know, London is very conveniently located in terms of travelling to various European cities. We also leverage the economic, political, and cultural advantages of London as the heart of Europe, and carry out face-to-face communication with our customers.

London cityscape

MHIE Marine Machinery & Engine
(From left) Tomo Kanazawa,
Isao Uchida (General Manager)
Naozumi Jimichi (Deputy General Manager)

Message from the President and CEO

Kazuo Soma
President and CEO

超えていく。
130TH
Anniversary

Mitsubishi Heavy Industries, Ltd. is celebrating its 130th anniversary this year. But you may be surprised to hear that the history of our marine equipment business predates MHI's founding by several decades.

It was in 1853 that Commodore Matthew C. Perry and his fleet of four "Black Ships" arrived off the coast of Uraga, leading to the opening of Japan the following year. Out of a sense of impending crisis that the country would fall under foreign rule unless steps were taken, the feudal government decided to establish a modern navy in Japan. It established the Nagasaki Naval Training Center (Kaigun Denshu-jo) in 1855, and purchased steamships from the Netherlands for training purposes. Under the tutelage of the Dutch, Katsu Kaishu, Enomoto Takeaki, and other competent young men from various feudal domains were brought to Nagasaki to undergo training. Meanwhile, repair and maintenance of the training ships were carried out at the Nagasaki Ironworks that was constructed in 1857 on the opposite shore. This was the precursor to the Nagasaki Shipyard, and the origin of our company's marine machinery business. In the 157 years since, we have continued to develop our marine machinery-related technologies, providing products and services that match the needs of the world's shipbuilding and shipping industries.

The Nagasaki Shipyard around the time of establishment

Note : Mitsubishi Heavy Industries was founded in 1884 after Mitsubishi took over management of the shipyard from the Japanese government.

At present, the greatest interest of our customers is in achieving further fuel savings as well as meeting environmental regulations. MHI-MME will respond to customer needs by improving the performance and functions of individual products as well as by proposing solutions that combine various products.

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