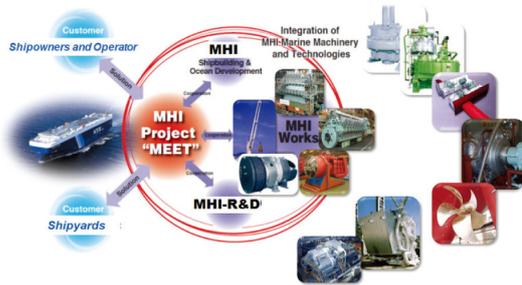


Energy-saving Marine Products of Mitsubishi Heavy Industries Marine Machinery & Engine Co., Ltd.



Mitsubishi Heavy Industries Marine Machinery & Engine Co., Ltd.
Technology integration & Project MEET Development Department

The marine product lineup of Mitsubishi Heavy Industries, Ltd. (MHI) possesses up-to-date technology with unique designs, as well as the high reliability established over 130 years of abundant experience. Our lineup includes a wide range such as the UE diesel engine, the MET turbocharger, propellers, the Ultra Steam Turbine (UST), and boilers for offshore use. The abundance of marine-related products including the aforementioned items exceeds any other global player. The operation of these product lines is now being undertaken by Mitsubishi Heavy Industries Marine Machinery & Engine Co., Ltd. to realize timely decision making and action for the rapidly changing business environment and to establish a strengthened business system that expedites technological development to cope with energy-saving and environmental regulations.

The basic business policy covers three strategies, which are implemented by our predecessor, MHI's marine machinery and engine division. The three strategies include the proposal of energy-efficient and green solutions through "Project MEET," "Globalization" with overseas production partners and domestic manufactures and "Reinforced Servicing" by providing secure and speedy services to our customers through the product life cycle.

This report introduces the environmental changes surrounding the marine machinery business, and examples of Project MEET products corresponding to the change (**Figure 1**).

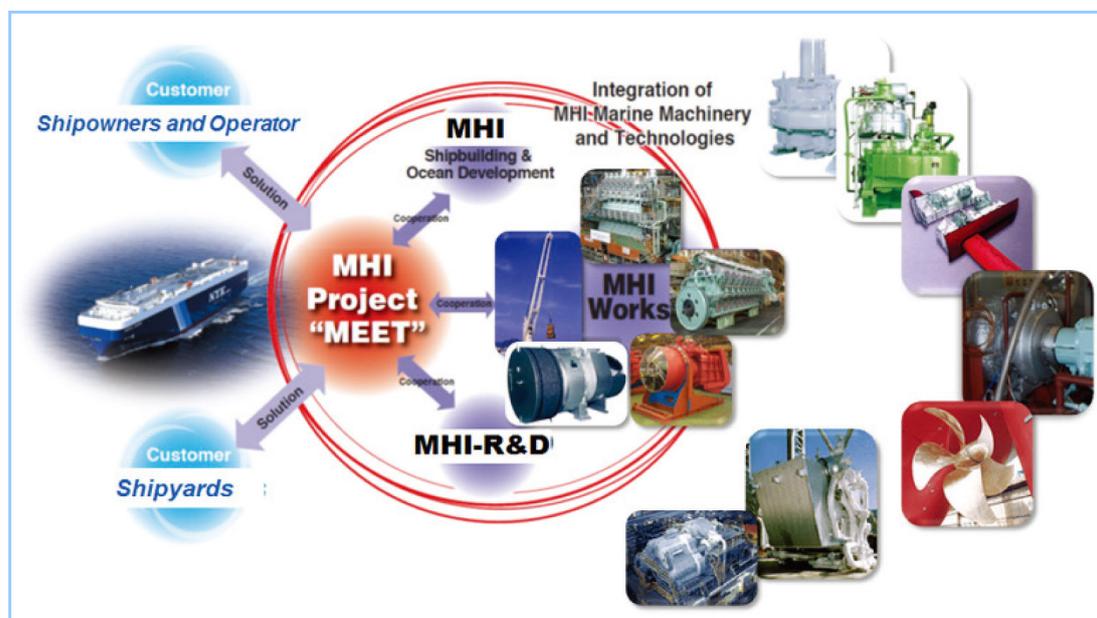


Figure 1 Examples of Project MEET products

1. Major environmental changes surrounding the shipbuilding and marine machinery business

The changes in the marine machinery field are summarized below:

- (1) Promotion of energy saving

The need for energy saving is rapidly increasing because of fuel price hikes and excess tonnage sentiment after the Lehman crash. This can be regarded as the reduction of CO₂ emissions exhausted from vessels, and a strengthened reduction target of 30% (2025) from the current 10% (2015) in the Energy Efficiency Design Index (EEDI) conversion has been presented.

(2) Strengthened environmental regulations

The reduction of NO_x and SO_x exhausted from vessels is required. The reduction target of 80% (2016) of NO_x has been presented, and the implementation timing is being discussed in the IMO and other organizations. For the reduction of SO_x, a target of 98% (2020) of SO_x contained in fuel has been presented.

(3) Alternative fuel (incl. LNG as fuel)

Previously, low quality heavy oil has been used as the main fuel. Now, more ecological fuel gasification is rapidly increasing in importance as vessel fuel in accordance with the low-cost supply of shale gas from the U.S.

(4) Acceleration of globalization in shipbuilding and marine machinery production areas

The main production bases of shipbuilding and marine machinery were Japan and Korea. However, the competition now includes China in addition to the two countries.

2. Approach to Project MEET and examples of main products

To cope with the changes to the business environment noted above, Project MEET, which is the solution combining our unique energy-saving and new environmental technologies to develop our abundant product groups and products, has been established.

The solution suggests an optimal system, by functionally-combining marine products and technologies suitable for customer uses and purposes, such as products compliant with stricter environmental regulations or a reduction of fuel cost. The whole system is integrated by one company, and everything from product supply to after-sales service is totally covered by the company to ensure customer ease and satisfaction.

As examples of installation in real vessels, employment cases of this solution on energy-saving products and an LNG carrier are presented below.

Figure 2 shows an example of application to a vessel. An electronic control adopting our unique idea to allow all-around operation including energy saving and slow cruising is being developed for UE main engines.

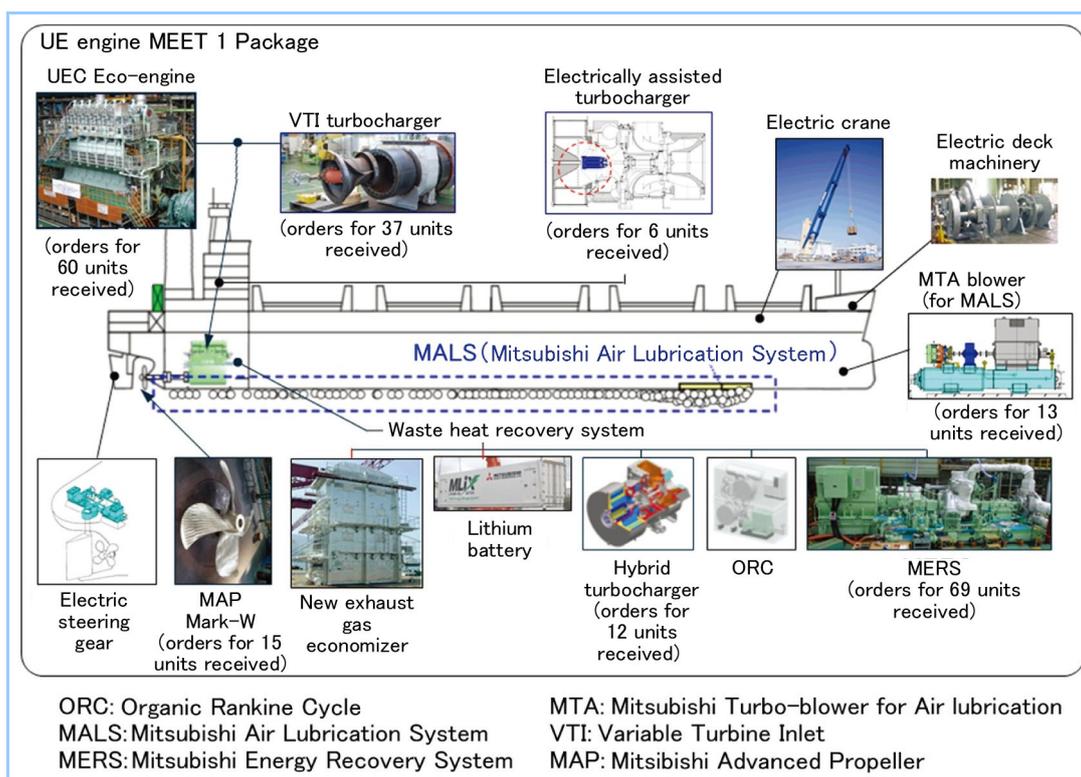


Figure 2 Example of Project MEET application to vessels

The development of the MET-MB turbocharger series is accelerated to respond to the need (higher compression ratio and efficiency) for an energy-saving main engine. The development of a hybrid turbocharger which contains a high-speed generator to recover the exhaust heat from the turbocharger and an electrically assisted turbocharger which contains an electric assisting motor to improve the main engine performance (at slow steaming operation) has been finished, and now their lineups are being expanded.

The blower for the Mitsubishi Air Lubrication System (MALS) has been developed by converting the high-efficiency blower in the MET turbocharger through cooperation with MHI's marine division.

The Mitsubishi Energy Recovery System (MERS) is an waste heat recovery system that recovers electricity from the exhaust gas of large vessels. The system arranges the steam turbine and power turbine on a single shaft, and this unique structure allows for waste heat recovery in a wide operational range including low-load areas. As a result, this system enjoys a global share of 90%.

The Mitsubishi Advanced Propeller (MAP) –Mark W propeller has a winglet shape modifying the blade tip shape with our unique idea to depress the cavitation, and also gain high propulsion efficiency.

We are also developing a marine Organic Rankine Cycle (ORC) to ultimately utilize a low-temperature heat source in vessels to recover energy as electricity.

Figure 3 shows the latest steam propulsion plant (Ultra Steam Turbine: UST), which we have developed with many improvements and has seen many implementations, for use as the main propulsion plant for an LNG carrier. The UST employs a reheat-boiler and reheat-turbine, with which we have significant experience on land (in power generation), and attains the equivalent propulsion efficiency to a 4-stroke Dual-Fuel Diesel-Electric (DFDE) propulsion plant. In addition to the conventionally attained maintenance-free characteristics, the UST allows for a drastic reduction of operating costs, and is suitable as the main propulsion plant for an LNG carrier.

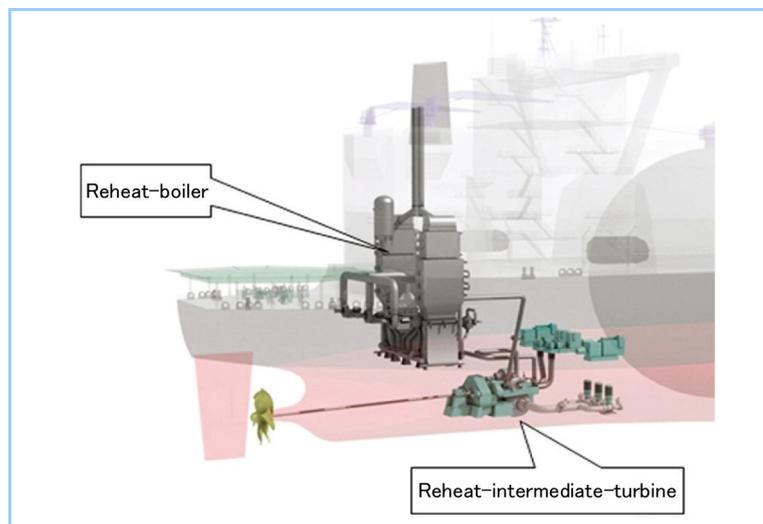


Figure 3 UST steam propulsion plant UST

3. Enhanced production in China and Korea by working with licensees

We are proceeding with the globalization of production and sales systems to ensure customer ease and satisfaction around the world, as well as in Japan.

We are actively promoting licensing to overseas companies mainly in Korea and China, which are major shipbuilding countries, in addition to domestic production bases, and the establishment of joint ventures with local partners. By producing various products of our brand at the optimal locations of the bases, we will provide new product lineups and various solutions which are closely-related to global customers and markets. **Figure 4** shows an example of globalization. We will continue the expansion of licensees, including in the propeller business, to Korea and China.

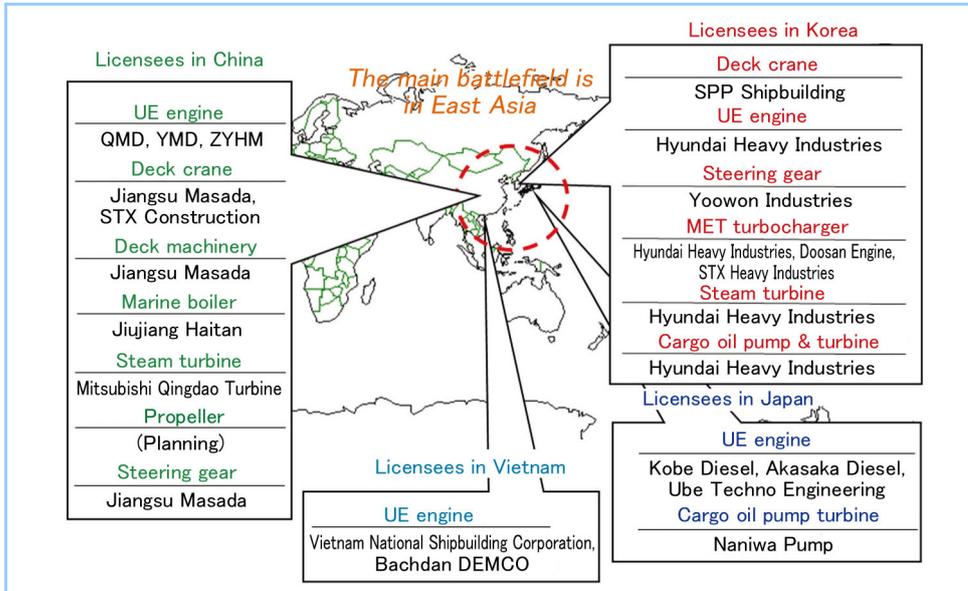


Figure 4 Expansion of licensees

4. Reinforcement of global after-sales services of our bases and sites through collaboration with Authorized Repair Agents (ARA)

In parallel with the global production and sales systems noted above, we are also proceeding with the reinforcement of the after-sales service network to ensure the sound operation of vessels. We have established bases at Nagasaki, Tokyo, Osaka, Kobe and Imabari to promote the service quality at each base in Japan. In overseas offices in Hamburg, Busang, Shanghai and Singapore, staff with full knowledge of marine products are stationed. Their functional roles are to be contact points for our customers, to coordinate after-sales service operations and to provide technical support to our authorized repair agents (ARA). We will strengthen and expand collaboration with the ARAs, and establish a global after-sales service network. (Figure 5)

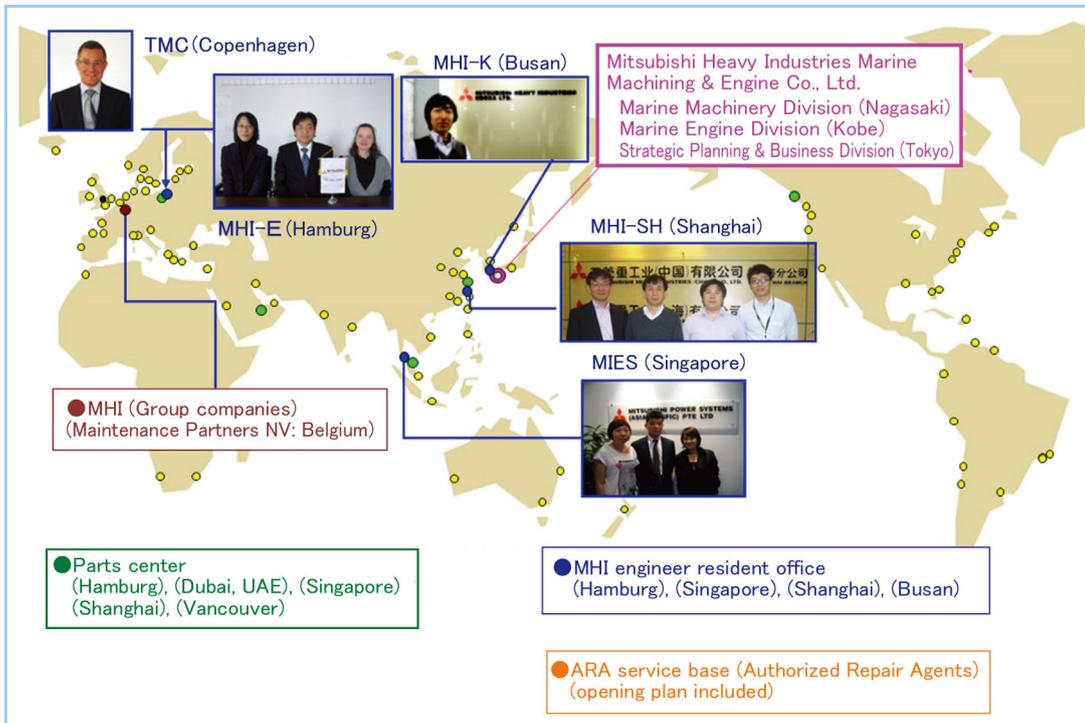


Figure 5 After-sales service network