

First Ultra Steam Turbine (UST) Plant to Go Into Service This Autumn

UST Also on Order from Hyundai for PETRONAS LNG Carriers



Energy Efficiency and Reliability A Renewed Appreciation for Japanese Technology. for “Sayaendo” New-generation LNG Carrier and Expectations for UST



Accelerating Global Development through Engineering Business

An interview with Junzo Yanagisawa, Senior General Manager
Shipbuilding & Ocean Development Division Commercial Aviation & Transportation Systems
Mitsubishi Heavy Industries, Ltd.

Mitsubishi Heavy Industries Shipbuilding Technology

— After the economic downturn of 2008, the new shipbuilding market experienced a long period of adjustment, but by the end of last year, orders recovered, and the so-called “2014 Problem” (in Japan) has been resolved. How do you feel about the order recovery of the Japanese shipyards?
Yanagisawa: Before the economic downturn, the shipbuilding economy saw a lot of bulk carriers being built at emerging shipyards, many of which have been completed. Recently, the ship owners of the world seem to have renewed appreciation performance, such as for the thrust power, ships built in Japan. Japanese shipyards have an extremely good reputation, and there is renewed appreciation for our

technical capabilities. At MHI, we plan to make use of the technical capabilities we are known for, and place an emphasis on value-added ships such as cruise ships, LNG carriers, LPG carriers, special ships, ferries, high-speed ships, and more.

— Many of Japanese shipbuilders are differentiating themselves with environmentally-friendly “ecoships”. Could you tell us about MHI’s environmentally-friendly products?

Yanagisawa: At MHI, we place heavy emphasis on energy efficiency, which is a considerable concern of our clients. Environmentally, we have developed a hybrid SOx scrubber system that reduces SOx emissions from marine engines. We have also identified a growing demand for LNG as fuel vessels, and developed the first Gas Ship

Equipment Module and System (GEMS) for marine dual fuel engines in Japan. Also, we provide the Mitsubishi Air Lubrication System (MALS), which delivers air to the bottom of the ship to generate bubbles that reduce frictional resistance between the ship hull and the seawater. Now, the number of cargo ships, ferries, and passenger ships using MALS is growing. We plan to apply MALS technology to further ships in the future.

New-generation Spherical LNG Carrier “Sayaendo”

— As part of the MHI Group, we are working together on Project MEET*1 to create energy efficient, environmentally-friendly solutions that incorporate engines, propellers, turbochargers, and waste heat



New-generation LNG Carrier “Sayaendo”

recovery. You have already adopted many of our Project MEET products. Can you tell me your evaluation of these products?

Yanagisawa: We highly value your energy conservation technologies including waste heat recovery technology, and plan to continue working closely. Additionally, in light of the increased demand for LNG ships, we have high expectations for UST*2, which increases thermal energy efficiency through the use of re-heated steam in the main engine. Additionally, we have high expectations for development of gas (DF) engines. Currently, MHI-MME is developing engines that use high-pressure gas for fuel, but we believe there is also a need for low-pressure gas engines. In the near future, the IMO Tier III regulations will come into force, but the use of LNG as fuel will create a huge advantage in meeting these regulations. We are putting a lot of resources into developing LNG ships at MHI, such as the development of the “Sayaendo” new-generation spherical LNG carrier. The Sayaendo covers the spherical tanks with a cover that is integrated with the hull of the ship, helping to achieve a reduction in weight, and a major reduction in air resistance when the ship is in motion. By incorporating this with UST and other technologies, we will be able to improve fuel consumption by 20% or more compared to conventional ships.

— Our company’s gas engines use the same high pressure gas as our competitors that are ahead of us, but we’re developing an engine that can perform gas dual-fuel combustion even under low load. We will keep an eye on the development trends of the industry and identify market needs as we continue to make further improvements in our engine development. Meanwhile, at MHI, you are developing a marine engineering business on a global basis. Could you talk about that?

Yanagisawa: I think that there is still a need to grow the engineering business. We plan to use our company’s engineering technology to grow our business including hull

development, sales of design drawings, and sales of MALS, GEMS, scrubbers and other systems.

— MHI has some of the best marine technologies in the world, and I feel this is your core competence.

Yanagisawa: We plan to strengthen the marine business as a pillar of our engineering business, and achieve growth in the future, including by investing human resources. Additionally, we are aiming to create a business model for our engineering business by building on our current activities, such as providing design drawings to overseas shipyards in places like Korea and China.

— What do you consider to be a promising future shipbuilding market aside from Japan, China, and Korea?

Yanagisawa: Currently, we are offering technical support to L&T Shipbuilding in India. This support includes training and technical support for areas in the commercial shipbuilding field including provision of design, material procurement, construction, quality control, and more. If India’s political policies become supportive to local shipbuilders, we may provide further technical support. We are also considering granting design drawings to Vietnam and other regions. We also believe that engaging in an engineering business tie-up with MHI-MME is an option.

— Though we also feel that India is still an undeveloped market, we are watching it closely, and talking with local suppliers. We have licensees of engines in Vietnam. In the shipbuilding and ocean development business, last October your investment in Brazil’s Ecovix was announced. Tell me about your intentions with that.

Yanagisawa: MHI is participating in the investment in Ecovix as the leader of a Japanese consortium. The goal of this is to provide advanced technology and management know-how to mutually advance both the Japanese and Brazilian shipbuilding

industries in line with national industrial development measures aimed at further development of Brazil’s offshore oil development. This is the first project in which a consortium of Japanese shipbuilding companies and a trading company has invested in a shipbuilding business in Brazil. We plan to offer substantial technical support including personnel support in the fields of FPSO, drill ships, and other fields, and we are planning to send our people there. As the Shipbuilding and Ocean Development Division of MHI, we are planning on pursuing business extensively around the world, with a focus on Ecovix.

— Thank you very much for taking time out of your busy schedule to talk with me today.

*1 Project MEET:
Mitsubishi Marine Energy & Environment
Technical Solution-System

*2 UST:
Ultra Steam Turbine Plant



Yanagisawa: Junzo Yanagisawa
Corporate Officer,
Shipbuilding & Ocean Development Division,
Commercial Aviation & Transportation Systems,
Mitsubishi Heavy Industries Co., Ltd

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

Power Generation Utilizing Unused, Low-temperature Engine Cooling Water

Organic Rankine Cycle (ORC)

In the past, engine cooling water below 100°C was dumped into the sea. ORC is a compact, energy-saving power generation system that uses this thermal discharge and utilizes an organic heating medium with a boiling point lower than that of water—also used in air conditioners—to generate power. “Organic” refers to the heating medium that is used, while “Rankine cycle” refers to the system that utilizes the evaporation and condensation of the heating medium to do its work.

This ORC system is a binary power generation system that create electricity using two heating mediums, which in this case are the engine cooling water and the organic heating medium. In the past, the engine cooling water was wasted because of its low temperature. However, by constructing an ORC using an organic medium that evaporates at an even lower temperature, it becomes possible to recover heat as a binary power generation system.

Product developers

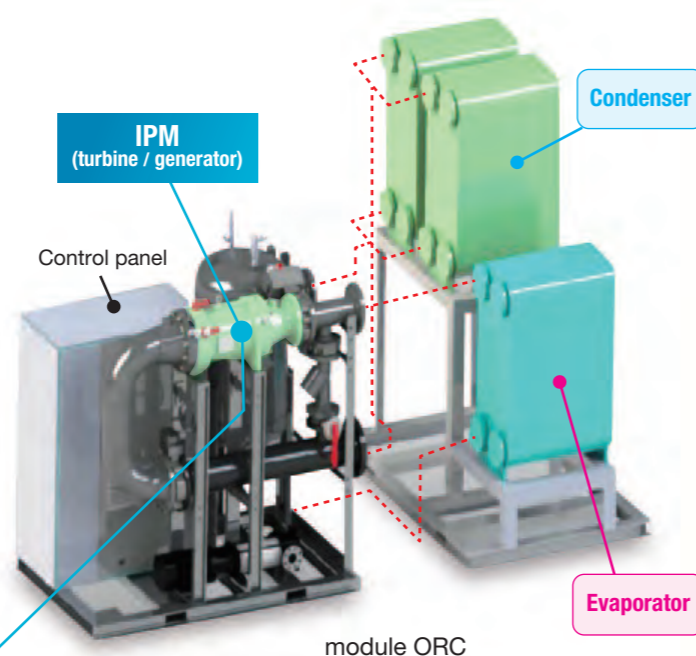


(Back row, from left) Takayuki Kanaboshi, Deputy Manager / Tadashi Imai, Manager / Akira Kawanami

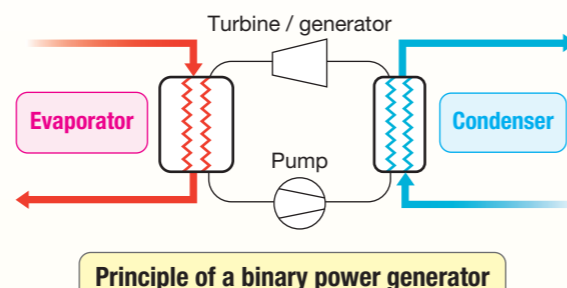
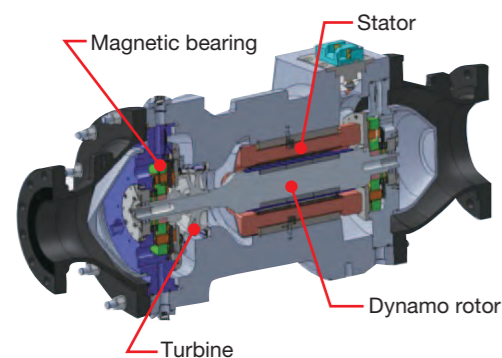
(Front row, from left) Ryuji Yoshida, Deputy Manager / Naoyuki Takao

Features and Structure

- Generating power : 100kW (NET)
- Heat source : Cooling water (85°C) for the main engine's cylinder jacket
- Cooling medium : Harmless medium with low boiling point (R245fa)
- Compact design
- Completely sealed module
- High-speed rotation of about 16,000rpm (variable speed)
- No gear box or lubrication system required
- Contactless, oil-free magnetic bearing adopted
- Easily retrofitted



Structure of the Integrated Power Module (IPM)



Principle of a binary power generator

To Be Completed in Japan and China in 2014

First UEC33LSE Engines

UEC33LSE are state-of-the-art compact engines intended for small chemical tankers under 20,000 dwt, domestic vessels, container ships, cargo ships, multipurpose vessels and the like. Technology cultivated through our LSE engines—such as lower rotation rates for improved propulsion efficiency and use of longer piston strokes for significant reductions in fuel consumption—have been fully leveraged in order to meet recent market needs like high economic efficiency and environmental friendliness. Furthermore, the footprint of existing UEC35LSE was used as the base for downsizing, and an effort was made to share parts in order to enable speedy development.

The UEC33LSE can be used to replace medium-speed engines, making it a strategic model that can also meet the demands of the market for small craft. Orders for the first UEC33LSE to be built by MHI-MME licensees Akasaka Diesels Limited (Yaizu, Japan) and Zhejiang Yungpu Heavy Machinery Co., Ltd. (China) have already been received and are scheduled to be shipped from the respective works during the first half of 2014.

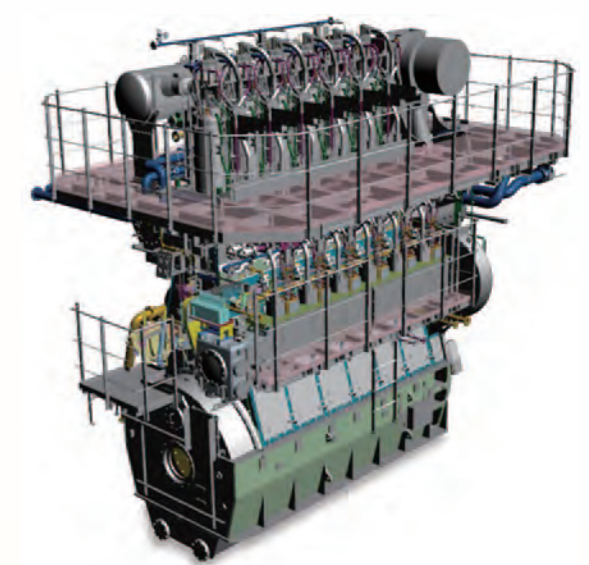
Product developers



(From left) Tai Kakimoto / Katsumi Imanaka, Deputy Manager / Satoshi Fujii

Development Concept

- Output and rotation speed ratings that could not be covered by competitors' low-speed engines
- Fuel consumption reduction through longer piston strokes and improvement of the Energy Efficiency Design Index (EEDI)
- Enhanced propeller propulsion efficiency through lower rotation speeds
- Achievement of low costs by sharing parts with other small UE engines and construction of a domestic and overseas supply chain
- Reduction of cylinder oil consumption through the use of Advanced ECL system
- Use of the footprint of UEC35LSE jointly developed with Wartsila and incorporate latest UE engine technology
- Create a best-fit engine that thoroughly reflects customer needs, such as doing away with the lubricating oil for driving the exhaust valve, making it possible to select the position for dropping oil onto the bedplate and positioning the turbocharger to the rear



UEC33LSE Engine

【UEC33LSE Engine Main Data】

| Engine format | | 6UEC33LSE-C2 |
|-------------------------|-------|-----------------|
| Cylinder bore | mm | 330 |
| Piston stroke | mm | 1,550 |
| Stroke to bore ratio | - | 4.7 |
| Output | kW | 4,230 (P1) |
| Rotations | min-1 | 142 (P1) |
| Mean effective pressure | MPa | 2.25 |
| Fuel consumption rate | g/kWh | 177 / 176 (Eco) |
| Weight | Ton | 79 / 81 (Eco) |

Jiangsu Masada Heavy Industries Co., Ltd

Stronger Collaborative Relationship through Support for Steering Gear Technologies

Jiangsu Masada Heavy Industries was a manufacturer of deck machinery that was founded in 2005 through the merger of Masada Ironworks Co., Ltd. (Head office: Nishiku, Osaka), a Japanese winch manufacturer, and an industrial machinery manufacturer in Jiangsu province. Jiangsu Masada has a plant in Nantong, Jiangsu province.

Our relationship with Jiangsu Masada began in 2008 when MHI licensed its deck crane technology to the company. It was at that time that the aspirations of the two companies matched in the Chinese marine market that was seeing significant growth—Jiangsu Masada's was seeking to expand its business by upgrading its product lineup, and MHI was looking for ways to develop its market in China by establishing a local manufacturing base.

With MHI's full backup, Jiangsu Masada established a plant dedicated to the manufacturing of deck cranes, delivering its first crane in 2009. We continued to provide manufacturing and quality-related guidance, and the company is now regarded highly by customers not only in China but overseas as well. Jiangsu Masada has been steadily increasing the number of units manufactured and delivered, with more than 200 units scheduled for 2014.

In 2012, Jiangsu Masada concluded a license agreement with MHI for steering gears and deck machinery in addition to deck cranes.

It became the only manufacturer in China that can supply a variety of products—deck cranes, steering gears and deck machinery—under the Mitsubishi Heavy Industries brand.

This move has been showing synergistic effects on the sales front, such as the packaged sale of the aforementioned products. Orders, including informal orders, for more than 200 deck machinery and over 70 steering gears have already been received. The first units of both products manufactured under the license agreement were delivered during 2013.

With a great number of orders being received, it has become difficult for Jiangsu Masada to meet customer demand through its existing plant. Therefore, Jiangsu Masada plans to enhance its production capacity by building a new factory in the suburbs of Nantong and relocating there in 2015.

Going forward, we will continue to maintain and develop a good collaborative relationship with Jiangsu Masada while aiming to expand the presence of the Mitsubishi Heavy Industries marine products in China. We will continue to proactively provide manufacturing and quality guidance to Jiangsu Masada as well as carry out sales support-related activities.



Jiangsu Masada Heavy Industries head office



President Huang Wu

Exhibitions and Seminars

To Be Held Proactively Around the World Again in 2014

In FY2013, MHI-MME technologies and products were shown at seven exhibitions, and we also hosted seven seminars. Our products were thereby shown in even more countries than usual—Japan, China, Singapore, Greece, Norway, Brazil and India. Among these, User Seminars were held for the first time in Singapore and Imabari (Japan), creating valuable opportunities to hear the voice of our customers.

We will be showing our new technologies and solutions proactively again during FY2014 at exhibitions and seminars. If you are interested in attending, please contact us at info_meet@mhi-mme.com.



Scene from the Imabari User Seminar (February)

Major Exhibitions for Participation and Seminars to Be Hosted in 2014

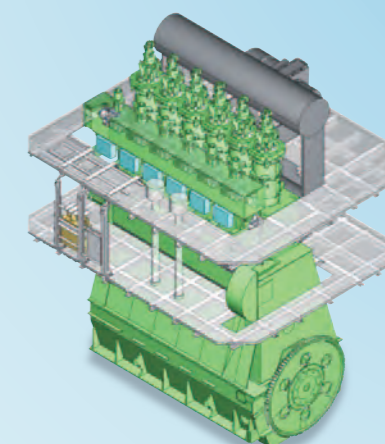
| Date | Exhibition / Seminar name | Content |
|----------------------------|-------------------------------------|--------------|
| February 20 | Imabari User Seminar | User Seminar |
| February 10-12 | SMP World Expo 2014 (Mumbai) | Exhibition |
| April 9-11 (scheduled) | Sea Japan 2014 (Tokyo) | Exhibition |
| June 2-6 (scheduled) | Posidonia 2014 (Athens) | Exhibition |
| August 13-15 (scheduled) | Marintec-S.A. 2014 (Rio De Janeiro) | Exhibition |
| September 9-12 (scheduled) | SMM 2014 (Hamburg) | Exhibition |
| TBD | Hamburg MEET Seminar | Seminar |
| TBD | Taiwan Seminar | Seminar |
| TBD | Singapore User Seminar | User Seminar |

Strong Interest in the UEC50LSH-Eco Engine:

First Order Expected Soon

MHI-MME received a number of inquiries for the UEC50LSH-Eco engine from shipyards both in Japan and abroad. This engine was introduced in the 4th issue of MEET NEWS, and we are expecting to receive the first order soon.

Based on rigid market surveys, the UEC50LSH-Eco engine has the optimal output and speed to power Handymax and Supramax / Ultramax bulk carriers as well as medium-range (MR) tankers and chemical tankers. Like existing UE engines, the fuel consumption rate is superior to other manufacturers' engines. In addition, long strokes and low speeds will realize enhanced propeller propulsion efficiency, further reducing the amount of fuel being consumed. The first UEC50LSH-Eco engine is planned to be completed in early 2015.



LSH engine concept drawing



UST (Ultra Steam Turbine)

Four Orders Received for Ultra Steam Turbine Plants from HHI

To Be Installed in LNG Carriers to Be Built in South Korea

MHI-MME received orders from Hyundai Heavy Industries Co., Ltd. (HHI) for four Ultra Steam Turbine (UST) plants. They will be installed in LNG carriers to be built by HHI for Petrolam Nasional Berhad (PETRONAS) of Malaysia. An option on additional USTs for four more carriers has also been tied.

MHI-MME is currently undertaking the manufacture of USTs for eight ships under construction by Mitsubishi Heavy Industries. Leveraging that experience plus receipt of its first external order, the company will aim for even more proactive sales of UST plants.

Electro-assist Turbocharger Unveiled

To Achieve 30% Energy Saving During Slow Steaming

MHI-MME developed an electro-assist MET turbocharger that achieves power consumption savings of about 30% as compared to when conventional auxiliary blowers are used, unveiling it on October 17, 2013, at the Mitsubishi Heavy Industries Nagasaki Shipyard & Machinery Works. It was developed using a high-speed motor supplied by partner Calnetix Technologies and is the result of collaboration between the two companies.

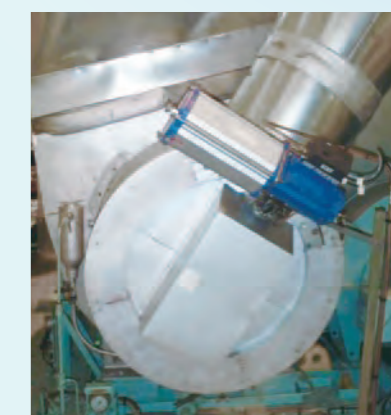
The electro-assist MET turbocharger comes with a built-in electric motor based on the high-speed motor-generator of the hybrid MET turbocharger, which has been made compact by stripping it to its motor functions. It realizes optimal plant efficiency during slow steaming. By enhancing the fuel combustion efficiency of the main engine, it enables the same or better performance compared to when an auxiliary blower is used while consuming less power.



VTI System Retrofitted on Turbochargers

of Very Large Crude Carriers (VLCC) for A.P. Moller

On the occasion of the Maersk Ingrid's first dry docking in its third year of operation, the VLCC's main engine turbochargers were retrofitted through the installation of a Variable Turbine Inlet (VTI) system. It achieved fuel consumption reduction of 1.6-3.2% in the load range of 10 to 50% MCR.



VTI turbocharger with control valve

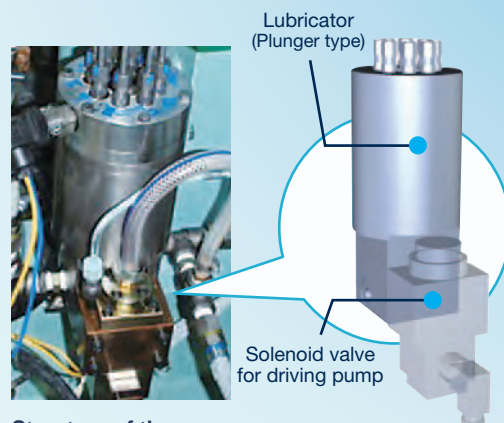
After-Sales Services Menu

UE Engine / A-ECL

MHI-MME offers a selection of solutions to help customers meet slow steaming needs, enhance the reliability of their main engines and realize reductions of operating costs. They include the Advanced Electronically Controlled Lubricating (A-ECL) system, which is an electronically-controlled state-of-the-art cylinder lubrication system; zero sac volume fuel injection valves, which further decrease the amount of unburnt fuel; and exhaust valves with corrosion resistance coating (an exhaust valve that enables a significant life cycle extension).

The A-ECL electronically-controlled state-of-the-art cylinder lubrication system was developed by MHI-MME. We have already received orders for its installation in more than 70 ship sets, including retrofitting.

Lubrication of the piston ring package at the appropriate timing enables a reduction of the lubrication rate as compared to conventional mechanical pulse lubrication systems. Furthermore, the A-ECL is highly regarded as a system that enables lubrication to be controlled to the appropriate amount during slow steaming.



Structure of the Positive-displacement Lubricating Oil Flow Control Timing Lubrication System
(Lubrication rate controlled through injection frequency)

News from MHI Offices Abroad



MHI KOREA LTD.

Yoshikazu Ito, Assistant Manager

I am stationed at the MHIK Busan Office and am assigned to providing technical support in South Korea for MET turbochargers.

South Korea is the world's largest manufacturer of marine diesel engines. Following Hyundai Heavy Industries and Doosan Engine, the first MET turbocharger manufactured under license was completed last year by STX Heavy Industries. MET turbochargers, which are used with marine diesel engines, have now become a brand that can be built by all marine diesel engine manufacturers in Korea.

Going forward, we expect to see increased manufacturing of MET turbochargers in South Korea. I will leverage the advantage of being stationed in South Korea, and provide swift and agile customer support towards inquiries from ship owners, shipbuilders, engine manufacturers and licensees. Please feel free to contact me if you have any questions, including technological questions in Korea related to the MET turbocharger.



View of Busan Harbor from the MHIK office



Group shot with MHIK employees
(I'm the fourth from the left in the brown vest)

Message from the President and CEO



Kazuo Soma President & CEO
Mitsubishi Heavy Industries
Marine Machinery & Engine Co., Ltd.

The boom in building new LNG carriers is expected to continue for the foreseeable future against the backdrop of the "shale gas revolution," issues related to nuclear power and strengthened environmental regulations. Steam turbines had long been the main propulsion plants of LNG carriers but were replaced by diesel engines (dual-fuel diesel-electric (DFDE)) from around 2000.

MHI-MME's new Ultra Steam Turbine plant (UST) utilizes reheat-regenerative cycle technology and high-performance blade rows to improve performance by about 15% as compared to conventional models. It is excellent at total lifecycle costs and boil-off gas management compared to DFDE and 2st-DF. Our first UST is currently undergoing final performance verification, etc., and is scheduled to go into service this autumn. The education and training of engine room crew members and enrichment of services, such as long-term maintenance, are scheduled going forward.

For inquiries, contact:

Mitsubishi Heavy Industries Marine Machinery & Engine Co., Ltd.
16-5 Konan 2-chome, Minato-ku, Tokyo 108-0075
(Mitsubishi Heavy Industries Building)