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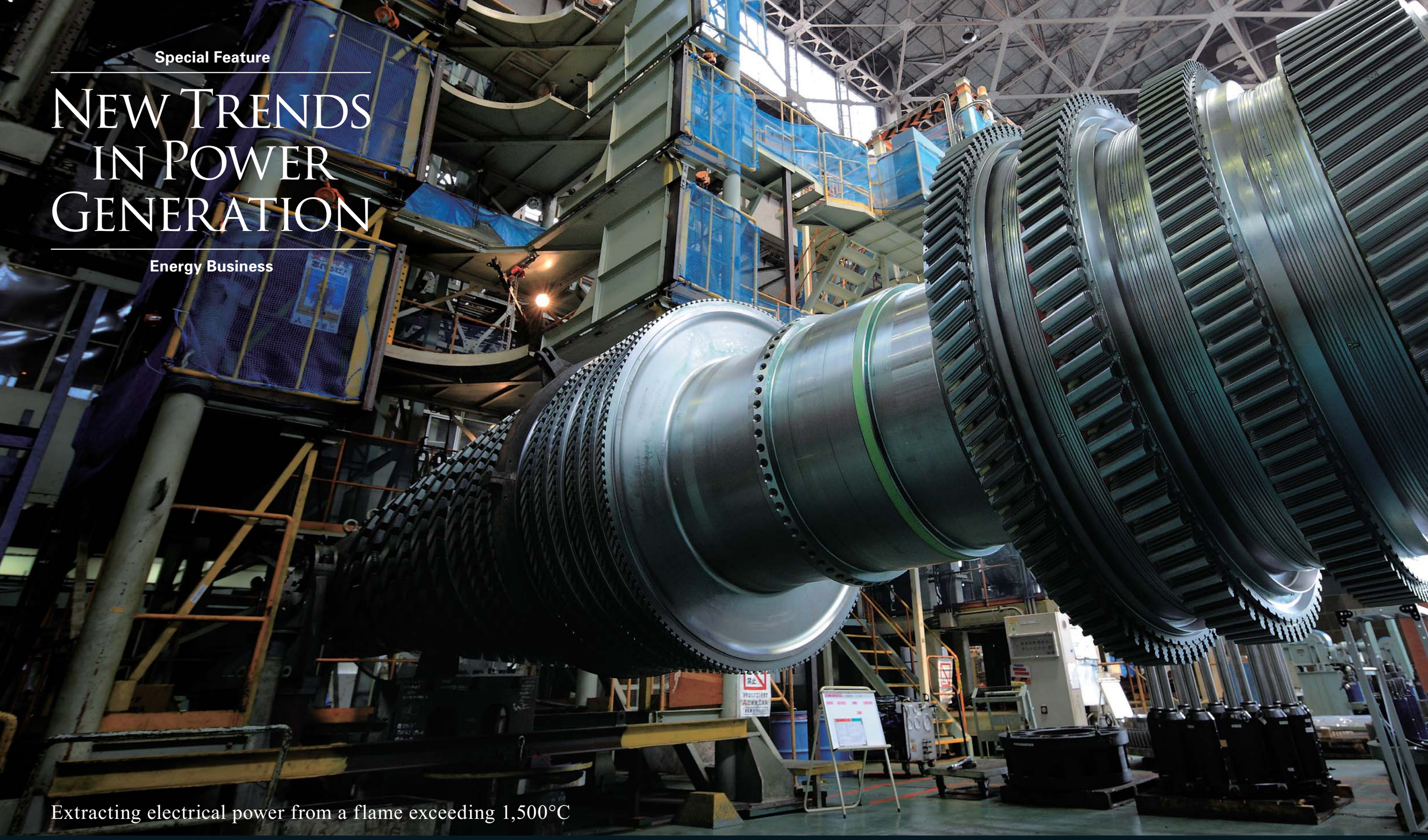
Special Feature

New Trends in Power Generation

Energy Business



Extracting electrical power from a flame exceeding 1,500°C

How is electricity generated at a gas-fired power plant? Within the gas turbine — the heart of the power plant — combustion gas reaches 1,500°C*1, hot enough to melt some metals. This hot gas races through the turbine, setting the special alloy turbine blades in rotation at speeds of over 3,000 rpm. This rotational energy is converted to electricity by the power generator fixed on the end of the turbine shaft. MHI's benchmark G-Series gas turbine generates around 330MW*2 of power, sufficient to provide electricity to 40,000 homes*3. Once in operation, our turbines are expected to constantly provide electricity, hence their need to show ultimate toughness and reliability.

*1 Combustion gas exceeds 1,500°C in the G-Series gas turbine, which is MHI's core product, and 1,600°C in the J-Series gas turbine, the world's highest inlet temperature
*2 When using the 50Hz 701G-Series turbine *3 Calculated based on one household of four people and using 2kW

Above : A rotor — the rotating part of the gas turbine is under construction, which consists of several stacked ring-shaped parts. Subsequently, an operation of attaching the turbine blades will follow.
Takasago Machinery Works, Hyogo Prefecture

Front cover : A massive gas turbine — 11.97m long, 3.4m (max.) in diameter and weighing approximately 100 tons — is stored in a turbine casing using a crane. When assembled, the clearances are in the order of fractional millimeters, hence the need for careful rotor installation. More than 10 workers slowly lower it while visually confirming its orientation and horizontal alignment with accuracy.
Takasago Machinery Works, Hyogo Prefecture

Ingenious Skills that Overwhelmed the world

One by one, with painstaking care, a worker using a specialized tool verifies the flawless machining of countless blade surface cooling holes created on the turbine blade via electro spark machining. Indeed, measures to cool the blades, which are continuously exposed to combustion gas heated to over 1,500°C for an extended period, are vital and cooling hole processing is one effective example. The high cooling effect is produced by ventilating a hollow-cavity blade with microscopic holes of 1 to 2mm in diameter, enabling cool air to circulate within and around the blade. Takasago Machinery Works, Hyogo Prefecture

A

B

C

D

E

A・B : Welding a cooling structure into the combustion chamber of a gas turbine is a challenging operation. To facilitate air and steam circulation for cooling, ultimate precision is required to attach various components to a heat-resistant metal workpiece of only 5mm thickness, while avoiding the tiny 2mm ventilation channels. It is truly a delicate operation and one that only skilled welders having passed a rigorous accreditation test can perform. Takasago Machinery Works, Hyogo Prefecture

C : A worker attaches a blade for a carefully constructed steam turbine. A "Stop Blade" is vitally important for safety. Up to the very last blade, every unit is painstakingly and accurately processed in the hands of technical experts. Nagasaki Shipyard & Machinery Works, Nagasaki Prefecture

D : An operation to assemble a rotor is underway, which will take three days and nights and involve using a total of twelve bolts to join large ring-shaped parts tightened to an incredible 600MPa pressure (approx. 4,500 tons in force). Takasago Machinery Works, Hyogo Prefecture

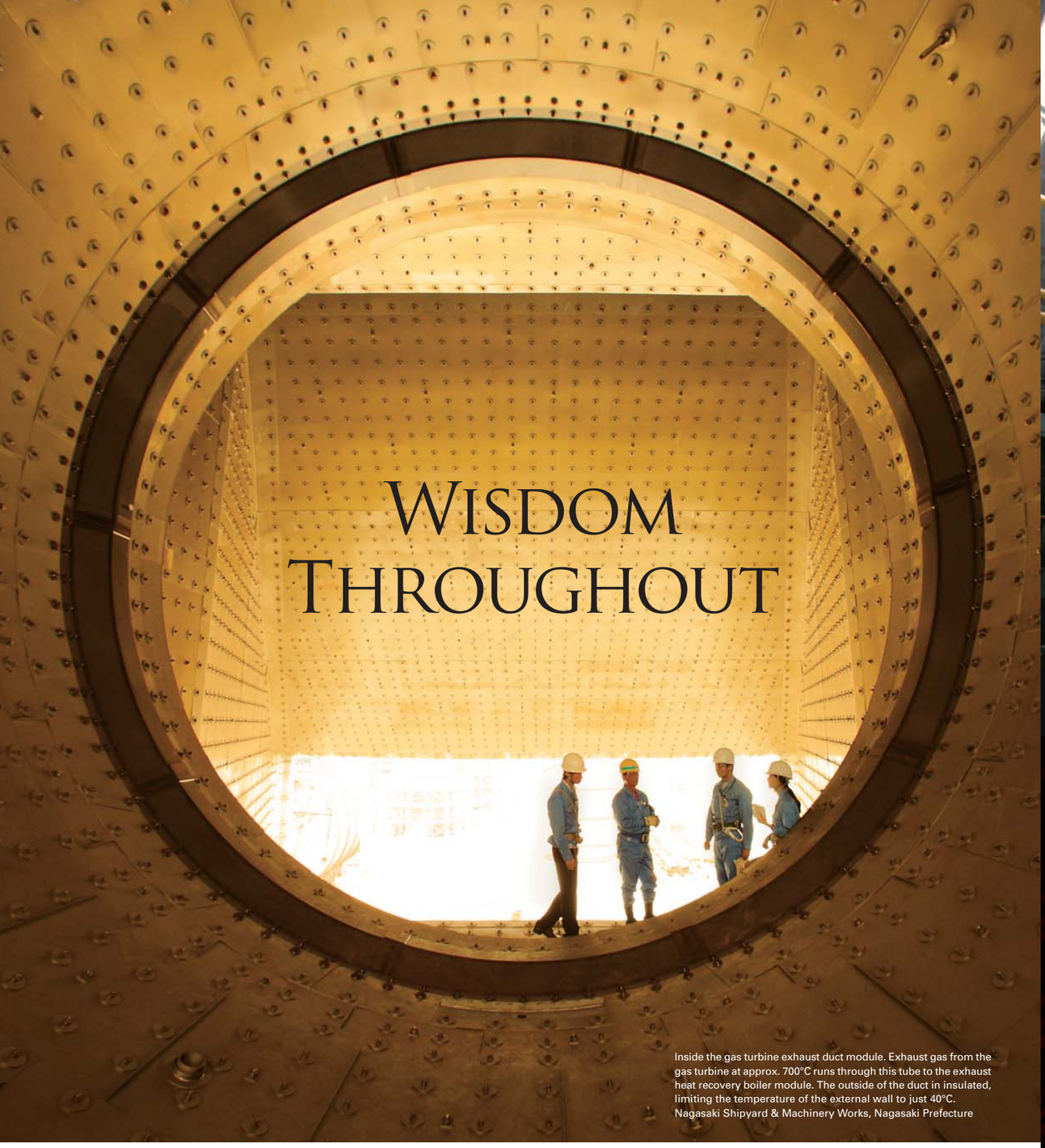
E : Blades for steam turbines are individually inspected by skilled technical experts. Since even the slightest damage could trigger a major accident, the inspections are carried out with meticulous care, pre- and post-assembly. No matter how small the parts involved, all workers engaged in such operations do so with responsibility and pride, and remain constantly aware of the ultimate goal, namely to ensure "stable electric power supplies."
Nagasaki Shipyard & Machinery Works, Nagasaki Prefecture

World-class skills reflecting technique and *monodzukuri*

Although renewable energy power generation has recently attracted attention, thermal power generation, which has long been supporting power supply, is also making tremendous progress in efficiency.
Perhaps the most prominent example is the J-Series gas turbine, which achieved an inlet temperature in the 1,600°C class. The J-Series turbine can be applied to "Gas Turbine Combined Cycle (GTCC) power generation" that conducts secondary power generation by a steam turbine, utilizing the exhaust heat expelled after rotating the gas turbine.
This application realizes the world's highest thermal efficiency (exceeding 60%)* and generating power (460MW). This accomplishment, which paves the way for new applications in the field of thermal power generation, would have been impossible without ceaseless efforts to research technology coupled with abundant experience.

* The ratio of electric energy (power generation) which can be effectively produced from thermal energy via burned fuels.
For example, the thermal efficiency for a gasoline-powered car would be in the 30% plus range.

Wisdom Throughout



Inside the gas turbine exhaust duct module. Exhaust gas from the gas turbine at approx. 700°C runs through this tube to the exhaust heat recovery boiler module. The outside of the duct in insulated, limiting the temperature of the external wall to just 40°C.
Nagasaki Shipyard & Machinery Works, Nagasaki Prefecture

Following a series of trials and examinations, a steam turbine undergoes its the final inspection before shipment. At a GTCC plant, hot steam generated in the heat transfer tube is propelled into the steam turbine and electricity is generated through its rotating mechanical energy. In accordance with the output and specifications of the GTCC plants to be delivered, various sizes of steam turbines are manufactured.
Nagasaki Shipyard & Machinery Works
Nagasaki Prefecture

Inside the exhaust heat recovery boiler module. Red heat transfer tubes, which convert water into steam, are inserted flush in the space through which hot exhaust gas flows, with more than 13,000 tubes housed within an area of L13.5m × W18m × H8.5m. In addition, for enhanced heat absorption, the tube periphery is densely packed with conducting fins, allowing heat to conduct to the water inside the tube at optimal efficiency.
Nagasaki Shipyard & Machinery Works
Nagasaki Prefecture

Building safer plants with knowledge of the entire process

MHI leads the world in cutting-edge gas turbine development with a professional expertise of exceptional scope and depth, covering the entire plant development and production process.
For GTCC, MHI exclusively undertakes development and manufacturing work beginning with the duct that channels the hot exhaust gas from the gas turbine. From there, the hot exhaust gas travels to heat recovery boilers that convert water into steam. Finally, the steam is used to power a steam turbine and its associated generator.
Furthermore, MHI is boosting efforts for a safer power generation by aligning all facilities and ensuring optimal balance, namely performing product verification via the verification facility of GTCC, plant-wide piping work, module welding, and control and prevention. This comprehensive capability showcases MHI's true value.

Conveying Electricity To The World

The Nagasaki Shipyard & Machinery Works manufactures steam turbines for GTCC power generation as well as large-scale modules, such as exhaust air duct and exhaust heat recovery boiler modules. The exhaust heat recovery boiler module shown in the photo weighs approximately 4,000 tons, making it the world's largest modularized boiler. With piping and electric equipment pre-installed in the module, work periods at the power plant where the module is delivered can be significantly reduced, and likewise the on-site management burden.
Nagasaki Shipyard & Machinery Works, Nagasaki Prefecture

New dimensions of quality and capability challenge next-generation gas turbines.

The development of gas turbines is a fight against "heat." Since power generation efficiency improves with increased combustion temperature of fuels channeled into turbine blades, CO_2 emission per unit output can be reduced. MHI has continued to pioneer turbine development, starting from the D-Series turbine in the 1,200°C class, followed by the F- and G-Series at 1,400 and 1,500°C classes, respectively. Finally, MHI is set to launch the state-of-the-art J-Series turbine, boasting a turbine inlet temperature of 1,600°C in the very near future.

Indeed, breaking an incremental 100°C barrier in this temperature range is truly a challenge. To do so, MHI applied not only the F- and G-Series gas turbines' high temperature design technology but also gas turbine element technology in the 1,700°C class developed through a Japanese national project — in particular turbine cooling, heat-shield coating and high-performance turbine technology.

In addition, the cutting-edge J-Series technology can be widely applied to existing F- and G-Series turbines, both of which can then benefit from ever-greater performance and reliability. In a sense, this means that most MHI gas turbines can become state-of-the-art, rapidly advancing in efficiency and reliability.

Worldwide Delivery of Advanced Japanese Power Generation Technology through Globalization

GTCC is expected to grow in both advanced and emerging countries in the future. As well as fuel efficiency alone, other reasons include the discovery of low-cost unconventional gas (shale gas) and growing demand for alternatives to coal-fired power generation.

Although thermal power generation involves environmental concerns, with the cutting-edge J-Series gas turbines employed in GTCC power generation systems, environmental loads could be mitigated, reflecting a project to successfully curb CO_2 emissions by 50% over conventional coal-fired power generation. However, no matter how such outstanding power generation technology is developed and obtained, failure to ensure its global penetration and use would see it lose all significance. This is the catalyst behind MHI's proactively promoted global launch, including the establishment of local factories and a joint venture for the international market.

To cite recent examples, a factory in North America to meet demand for power generation systems and one to repair hot turbine parts for the Asian market were completed in the U.S. (Georgia) and Thailand, respectively. These initiatives will both reduce cost and enable prompt and high-quality service. MHI is well underway towards establishing a foundation to ensure the smooth global delivery of Japanese high technology standards.

MHI's Power Generation Technology — Contributing to All Future Energy

What will be the mainstream of future power generation? The prospects vary greatly based on the resources obtained by each country and region as well as individual environmental policies. With this in mind, the scope of active fields for MHI, familiar with a diverse range of power generation technology, including thermal power generation — the core of electric power supplies — and nuclear power generation, will continue to expand.

For example, in the field of Integrated Gasification Combined Cycle(IGCC) power generation, fueled by abundant coal for gasification, MHI has achieved globally unrivalled efficiency. In addition, in the field of renewable energy power generation, MHI's technology can also be harnessed for all power generation requirements, including wind power generation and the growing demand for geothermal power generation, in which MHI is a top-class global provider.

MHI's reason for developing such wide-ranging products and technologies lies not only in the interest of business, but also in the desire of each MHI employee to contribute to providing a stable global electricity supply to support society's needs and activities.

MHI embraces this sense of mission as we look towards our energy future and its evolving technologies.

Services Ensure Optimal Operation of Gas-Fired Power Plants Worldwide

Teamwork Founded on 24-7-365 Monitoring

MHI developed a business model ensuring the long-term, optimal operation of gas-fired power plants, which was then fostered as its core business. Using the Remote Monitoring Center (RMC) located at MHI's Takasago Machinery Works, the 24-7-365 monitoring scope also extends to plants constructed overseas. The RMC has detected incidents and successfully prevented accidents, earning appreciation and acclaim from our customers. Let's examine the *"CS first"* — Customer Service First — approach employed by MHI and see how it is rooted in teamwork and guided by the Long Term Service Agreement (LTSA).

Power Systems Service Division
Takasago Power Systems Service Department

RMC of Takasago Machinery Works

Photo from the left:
Cormac Myers, Overseas Gas Turbine Customer Support Engineering Group
Tatsuya Nagae, Leader, Service Strategic Planning and Management Group, Overseas Service Department, Power Plant Service Division, Mitsubishi Heavy Industries Plant Construction.Co.,Ltd.
Koji Imakita, Acting Manager, Global Service Project Group
Naotaka Mikami, Remote Monitoring Systems Group
Katsuhiko Abe, Project Director, Takasago Power Systems Service Department
Chihiro Ikeda, Overseas Business Group A

Unwavering Commitment to Quality Service

The LTSA is a service package agreement that includes periodic plant inspections and parts replacement for six to ten years or more. MHI provides these services to ensure extended high-efficiency operations for power producers purchasing its gas turbines, some of which are contracted for over 10 billion yen. At a glance, this amount sounds enormous, but it is a reasonable cost from the power producer's perspective. For the power producer, losing power generation for even a single day is an unacceptable risk.

In fact, the LTSA is steadily growing overseas, including Europe, the U.S. and Asia, into what is now a cornerstone business of MHI's Power Systems. One contributing factor could be a global market environment, featuring an ever-increasing number of Independent Power Producers (IPPs) that are inexperienced in maintenance work. Another factor could be the liberalization of electric power markets, as well as unique aspects of MHI's technology. MHI has developed a system that automatically evaluates within a five-minute timeframe more than 150 major items from the roughly 2,000 data points normally retrieved and analyzed for each gas turbine.

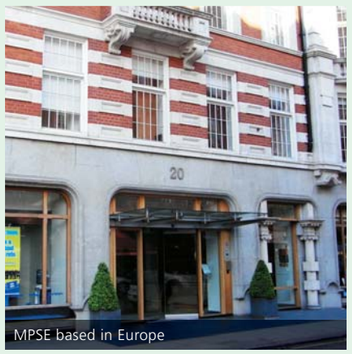
However, the main catalyst for growth of the LTSA lies elsewhere — namely in MHI's broadened range of quality services. Naotaka Mikami, of the Remote Monitoring System Group says, "There are various factors that lead to problems, but in our company, we of course monitor plant-related matters, but we also monitor the surrounding environment to include electric power transmission and fuel supply. If we notice anything abnormal, we immediately report it and take appropriate measures." By widening the scope of MHI's service to monitor more than just our delivered facilities, we provide close support to our customers and facilitate their power generation business.

Abnormally High Temperature Detected at the Bearing

Two years ago, a gas turbine at a power plant in Europe was shut down due to the error of a local worker while operating a pressure gauge during maintenance work. Although the problem was resolved, Mikami, who was checking a string of data prior to the shutdown at the RMC, discovered a suspicious signal late at night. Although it was only a fractional period — less than a minute — an abnormally high temperature reading was recorded in a bearing within the turbine shaft. Alert to everything, Mikami determined that continued plant operation could be dangerous and result in a major accident. Accordingly he called an executive of the power company and the power plant manager and urged them to postpone any restart.

Meanwhile, Mikami promptly implemented necessary measures. He requested dispatch of the required personnel from Mitsubishi Power Systems Europe, Ltd. (MPSE) to conduct an emergency check, while also alerting the MHI business sections in Japan responsible for the plant's design and construction. In response to Mikami's report, Tatsuya Nagae, who happened to be in Europe on business, rushed immediately to the scene that same night. "I immediately checked the bearing part and identified some damage. I lost no time in replacing the part and adopting appropriate measures, but the power company demanded an immediate operational restart and wanted to hurry the investigation to prevent any recurrence. I found it very difficult to persuade them that we should take appropriate measures to ensure everything was okay to restart," Nagae recalls looking back.

Conversely, Koji Imakita, who worked to coordinate the project, played a central role in Japan, engaging in discussion on countermeasures and sending those in charge of design and manufacturing to the plant. This was only possible thanks to close coordination with Nagae as well as the timely advice of Cormac Myers, who was thoroughly familiar with the local situation. Imakita recalls, "As a result, although it took four days to repair, it could have been more seriously damaged, taking around one year to recover, had we restarted without realizing the abnormal high temperature. That is how serious it was."



MPSE based in Europe

For the Sake of the Power Plant and its End Users

Katsuhiko Abe, who took over the task of performing the LTSA with this power plant, emphasizes the importance of teamwork by explaining, "I have been engaged in gas turbine design and field service work and have spent a decade handling both ever since joining the company. This type of project cannot be successfully implemented without cooperation among various departments, including sales, technical and construction." Chihiro Ikeda, in charge of overseas service sales, remains positive saying, "I would like to strive to enhance service matched with customer needs via cooperation with those around me."

MHI established the Power System service department of the Power Systems as a Division on April 1 of this year, reflecting MHI's declared intention to offer the dual pillars of plant engineering and construction, along with services. Currently, MHI monitors operations of its gas-fired power plants worldwide 24 hours a day, seven days a week, 365 days a year. It has expanded its hubs in Japan, the U.S. and Europe to broaden the framework for providing maintenance services to customers. These ongoing efforts have been implemented for the sake of our LTSA partners — the power producers — as well as to ensure that electricity safely reaches corporate and private end users.

The Forklift Industry: On the Road to Recovery and Growth

MCFA and Jungheinrich Join Forces to Boost Market Presence

The drastic downturn in global markets stemming largely from the collapse of Lehman Brothers was also felt throughout the forklift industry. However, during the past year MHI has witnessed a strong recovery in worldwide forklift demand with growth projected to continue over the next several years. Although regional demands vary, significant orders for intralogistic solutions are originating from Europe, North America, South America and Asia.

"In Europe and North America, we've been experiencing a recovery of the forklift market and anticipate that these regions will return to the same prosperous levels we saw back in 2007 and 2008," said Hans-Georg Frey, CEO of Jungheinrich. "In Asia and Latin America, we're seeing new business growth and opportunity. To be a successful international player, it is crucial to be well-positioned in each respective market and offer an array of products that meet local intralogistic needs."

Operational and environmental specifications differ by region and need to be taken into account when designing and developing forklifts. Warehouse management, safety standards, legal regulations and actual forklift utilization are but a few of the parameters applied in defining regional trends.

In the mature markets of North America and Western Europe, the increased sophistication of logistics and warehousing combined with wider environmental awareness are contributing to growth in warehouse equipment and electric forklift trucks. Orders for counterbalanced Internal Combustion (IC) trucks have decreased as these markets shift from a manufacturing-based economy to a distribution-based economy. This shift is especially prevalent in the U.S. where demand runs high for more warehousing products.

In emerging markets such as Asia and Latin America, demands remain centered on IC trucks and continue to grow. In almost all cases, customers use these forklifts in general industrial applications.

Mitsubishi Caterpillar Forklift America (MCFA) is a joint venture formed by MHI and Caterpillar. In 2009, with the market share of MHI warehouse trucks on the decline in North America, the company signed a ten-year agreement to partner with Jungheinrich. The terms of the agreement included exclusive distribution rights of Jungheinrich-branded warehouse products in Canada, the U.S. and Mexico as well as the manufacture of products developed by Jungheinrich for these markets. As a result of this partnership and a revitalization of the economic climate, MHI experienced an upturn in 2010.

With one of the best distribution networks in the industry comprised of hundreds of MCFA dealers strategically located throughout North America, the company now offers the choice of Caterpillar lift trucks, Mitsubishi forklifts and Jungheinrich products. The versatility and variety of this advanced warehousing technology lineup give dealers confidence that they can provide customers with an unparalleled choice of products best suited to their individual needs

Jungheinrich's Houston Design Center (HDC) is currently developing a new range of warehouse products designed for and manufactured in North America. The new products are expected to have significant influence on the further growth of MCFA's warehouse equipment business within the region.

Offering enhanced IT solutions that improve work efficiency and operations are essential elements for remaining competitive in the forklift industry. Low power consumption is an equally important new issue that suppliers also need to urgently address. Accordingly, MHI has developed a number of new battery technologies in-house, including a lithium-ion battery for industrial use that is significantly more efficient than conventional lead-acid batteries. The company has already developed engine-battery hybrid forklift trucks using a lithium-ion battery and was the first manufacturer to launch such a product in commercial markets. MHI is continuing to explore different applications for the usage of this battery.

MHI currently ranks seventh among all manufacturers in the global forklift market. Backed by the strength of its high-quality products as well as its distribution network and support and service capabilities, particularly in North America, MHI is expected to climb in future rankings. The combination of existing networks and Jungheinrich's leading-edge products will also help MHI to become a leader in North America, a market that will remain one of the largest forklift markets in the world.

With the mid-term goal of becoming a significant player in the material handling industry, MHI's collaboration with Jungheinrich will serve a crucial role in its growth strategy. MHI remains keen on strengthening and expanding its partnership with Jungheinrich and looks forward to future opportunities and endeavors arising in markets around the world.

Comments from Hans-Georg Frey, CEO of Jungheinrich AG, May 24, 2011 by Alexandra Osmani

In 2004 Jungheinrich and MHI formed a business partnership with MHI supplying power trains for internal combustion counterbalance trucks to Jungheinrich, and Jungheinrich providing intralogistic solutions such as warehouse trucks to MHI. Throughout this long-standing relationship, MHI has constantly remained a reliable and reputable partner with high-quality products, excellent service and skilled professionals.

In 2009, we entered into a 10-year manufacturing and distribution agreement with Mitsubishi Caterpillar Forklift America (MCFA), encompassing the entire North American market. MCFA now serves as the exclusive distributor of our warehouse technology in the U.S., Canada and Mexico, with MCFA overseeing all relevant business and services activities. As a part of this agreement, we design new products for the North American market that are then manufactured by MCFA. The development of new products is already well underway with target launchings set for 2012.

Currently, we are ranked third among forklift suppliers worldwide. With approximately 20% of the global forklift market located in North America, this region remains extremely important for us and warrants significant focus. The recent recovery and growth witnessed in this market has been exceptional, and we expect it to eventually regain the same position of strength it held prior to the economic downturn.

We joined forces with MCFA to market products tailored to specific regional warehousing demands. Success depends strongly on a well-implemented service infrastructure, and MCFA provides that capacity, serving an integral role in our North American operations. Their extensive dealer network offers solid sales leads for us, and our warehousing expertise benefits them in return.

Jungheinrich values quality and innovation, particularly in fields where energy-efficient technologies are realizing lower power consumption. We believe our long-term partnership with MHI and its affiliates will continue to grow, based on mutual goals and shared values.

Finally, as MHI is headquartered in Japan, we continue to wish the company, its employees and their families a rapid recovery following the devastating earthquake that struck in March and hope they can soon look forward to a prosperous future.

Sincerely,
Hans-Georg Frey
CEO Jungheinrich AG

MHI NEWS!

Poland's First PTA Plant Completed

Pillar of New Petrochemical Industry in Economy-Booming Poland Begins Operations

Project members at plant start-up


Picturesque town of Wloclawek, where PTA plant was constructed. The Vistula River, in foreground, was used to transport large items from the Baltic Sea. The river freezes over in winter and cannot be used for transport.

MHI Oversees PTA Plant Completion

The PTA Project, which is the construction of Poland's first petrochemical plant for manufacturing PTA (purified terephthalic acid), officially started operation on June 2, 2011. In this project, MHI was responsible for the supply of main equipment, detailed engineering, equipment procurement, and onsite supervision. The plant uses a Mitsubishi Chemical technology process for PTA manufacturing and has a production capacity of 600,000 tons per year — equivalent to approximately 20% of all European output. Construction of the project began in July 2008, and took approximately three years to complete at an investment of around 1 billion Euros, which also covered the construction of the feedstock plant.

Wloclawek, site of PTA plant, located about 160km WNW of Warsaw, the capital

PTA Production: High Polish Expectations

On the day following the official opening of the PTA Project, the name "Orlen" graced the headlines of all newspapers in Poland. PKN Orlen is the company that ordered the plant and is the biggest enterprise in central Europe, dominating the chemical and refinery industries. Polish Prime Minister Donald Tusk also attended the plant's opening ceremony and discussed the project's importance for Poland and his expectations for the future development of Orlen and the plant.

"The safety standards of this plant are unrivalled, and this plant will also benefit its workers and the environment," said Prime Minister Tusk, who also added "The development of Orlen will lead to stable domestic fuel prices." MHI President Hideaki Omiya also attended the opening ceremony, which included a live Chopin performance by a famous Polish pianist. MHI was introduced as an Orlen business partner, and although it normally operates as a contractor, plans to work together with Orlen to boost the relationship between both companies and pursue further opportunities.

Orlen President Krawiec, MHI President Omiya and other members celebrate completion of construction

Orlen newsletter highlights opening ceremony with Prime Minister Tusk (center)

Arrival of PTA for Polish Petrochemical Industry

PTA is a white powder used in the production of polyester, plastic bottles, and other petrochemical products. In recent years, the Polish economy has been booming and has seen demand for such petrochemical products soar. Moreover, although PTA had previously been imported, the plant's recent completion will enable domestic production of a wide range of products. For example, products currently sold in glass jars are now being replaced with plastic bottles. Orlen was originally an oil refining company, and the completion of the PTA plant has boosted the efficiency of their oil refining business.

Refining crude oil yields naphtha (crude gasoline) and diesel (light oil). Naphtha is the raw material used in making PTA, whereas diesel is the main transport fuel used in Europe. Export demand for naphtha as a gasoline feedstock remains low. However, there is a much stronger demand for naphtha when it is converted to PTA for export. This will allow Orlen to fully exploit the naphtha it produces as well as diesel transport fuel. Additionally, demand for PTA is forecast to grow significantly in Central and Eastern Europe.


Recently completed PTA plant

The Story Behind Project's Success

Organizing human resources and technology is a key task for MHI, and its EPC (engineering, procurement and construction) business is a dynamic part of the company that oversees entire projects. In addition to manufacturing, MHI's strengths also include integrated project management, human resources, financing, facilities, and logistics, and tightly adhering to project schedule. During the recent PTA plant project, MHI mainly worked together with Orlen — our customer, and also with Mitsubishi Chemical, which has a PTA manufacturing process license, local Polish construction companies, and other businesses.

MHI has built PTA plants in India, China and the Middle East and has experience in optimally resolving unforeseen issues, such as additional specifications and nonconforming conditions, while concurrently managing schedules and controlling costs. By leveraging this experience in the Poland project, MHI effectively optimized the project schedule through the entire construction period — our proudest achievement. Poland's winter temperatures can fall to nearly -30°C, and it is not possible to work efficiently outside for three months of the year. In keeping with the challenging schedule, MHI made extraordinary efforts to meet our customer's expectations. Everyone who worked on the project had a unique experience, and not only in terms of work. The recent completion of construction was achieved through the positive human relationships established with the Polish people, who are friendly towards Japanese. I believe that these individual relationships and unique experiences represent the true story of our EPC business projects.


PTA Project Director
Hiroshi Ohira
Deputy General Manager
Environmental & Chemical Plant Division
Machinery & Steel Infrastructure Systems