Scope

Kawasaki Heavy Industries Quarterly Newsletter

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Kawasaki

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in this issue...

KAWASAKI HEAVY INDUSTRIES, LTD.

Scope

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Enhancing Post-Conflict Safety: Meeting the Challenges of Landmine Clearance

With the ultimate goal of helping to eliminate landmines from the face of the earth, Kawasaki recently conducted a series of tests in Afghanistan on its MINEDOG detection vehicle and its MINEBULL clearance vehicle.

MINEDOG

MINEBULL

Landmines are a vicious legacy of wars and conflicts. It is estimated that over 110 million mines have been planted around the world, maiming or killing between 15,000 and 20,000 people per year, many of them civilians and children. These brutal weapons are indiscriminate in their destruction, and because they retain potency long after they are planted, remain a constant threat to conflict-torn areas. They also greatly hamper reconstruction.

When the Japanese government signed the Ottawa Convention, or the *Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on their Destruction,* which went into force in March 1999, it also established the Zero Victim Program, pledging support for mine clearance efforts and mine victims. The government encouraged the research and development of mine detection/clearance equipment technology to improve the safety and efficiency of clearing operations. In fiscal 2003, ended March 31, 2004, as part of its assistance program for the reconstruction of Afghanistan, it launched an R&D project for detection/clearance vehicles.

Kawasaki was one of the participants in the project. Following years of research on its own, Kawasaki had formed a project team in fiscal 2002 dedicated to the removal of AP (anti-personnel) mines and completed a prototype for a remote-controlled humanitarian demining system. The Kawasaki BULLDOG System, driven by proprietary technology, comprised a detection vehicle dubbed MINEDOG, and a clearance vehicle called MINEBULL. For over six months during 2004 and 2005, Kawasaki conducted a series of tests in test fields and actual minefields in Afghanistan. Based on the results, Kawasaki is currently taking the BULLDOG System to the next level in sophistication.

Development of Detection and Clearance Vehicles

Prototype completed in six months

Kawasaki began its development of a humanitarian demining system in October 2001. The associate director of Kawasaki's Aerospace Company, Ichiro Sumi, recalls, "It was not until June 2002 that we began full-fledged development, but we completed the prototype in six months."

Kawasaki had long been conducting research on mine detection/deactivation technology, as well as providing technical assistance to the Japan Defense Agency (JDA), for which it developed many prototypes to support the JDA's demining tests. The 2002 prototype leveraged the KHI Group's experience and expertise with its extensive technological assets in rolling stock, aerospace, plant engineering and many other high-tech fields.

The group's construction machinery technology contributed the most to the development of the new detection/clearance vehicles. The unmanned vehicles are equipped with detection sensors and a detonation mechanism that can be remotely controlled by an operator far away from the field, fulfilling Kawasaki's fundamental goal to achieve the utmost safety levels. The remote-control system is driven by a very sophisticated level of industrial robot technology.

Automatic mine detection with Ground-Penetrating Radar

The MINEDOG is 7 m long, 2 m wide and 3 m high, with radar antennas at the front. Its blast-proof, bullet-proof body is equipped with GPR (Ground-Penetrating Radar) sensors, detection circuitry, cameras to monitor the scattered surface mines, sensors and the vehicle's path, an ink marking system with nozzles and a GPS antenna for remote control. The tires are also blast- and bullet-proof.

The GPR sensors, the heart of the detection system, measure the size and depth of the mines and other explosive devices from their radar echoes. Installed side by side, they scan vertically based on surface undulation and transmit radar waves via new multichannel radar detection technology. The MINEDOG automatically detects AP mines planted as deep as 30 cm from the surface and AT (anti-tank) mines up to 50 cm deep.

The data on the detected objects are transmitted to the remote-control system for analysis. The results and the location of the objects are then sent to the MINEDOG and to the remote-control console, where the operator reviews them.

A Comprehensive System that Digs Out, Detonates Mines and Collects Fragments

After AP mines are detected, the MINEBULL then digs them out safely, bringing along the surrounding dirt, and detonates them. It also collects buried metal fragments.

The blast- and bullet-proof clearance vehicle, which is 9 m long, 3 m wide and 4 m high, is equipped with a high-speed, distinctively structured blast-proof digging drum with multiple blades at the front. It requires only a single operator, both when the vehicle is remote controlled or when an operator drives it. Other features include digging depth monitoring equipment, remote-control equipment, cameras to monitor the drum and the vehicle's path, a GPS antenna, a metal fragment collection bucket, a bullet-proof windshield and an air conditioner.

The computer-controlled, high-speed digging drum maintains the digging depth as it unearths AP mines planted as deep as 30 cm. They are then detonated by smashing them against the digging blades on the drum and the drum covers. At the same time, Kawasaki confirmed that buried iron fragments are collected into a bucket at a rate higher than 90%, which makes the search for remaining mines easier.

The system is normally controlled remotely. Manned operation, however, enables the MINEBULL to remove the AP mines from an area as large as 3,300 m^2 in just one hour. Kawasaki Aerospace's Sumi notes that it currently boasts the world's best performance for a wheeled demining system, with over 300 times higher efficiency than manual removal.

Testing in Afghan Minefields

In fiscal 2003, development of the MINEDOG and MINEBULL were subsidized by Japan's Ministry of Economy, Trade and Industry, and the New Energy and Industrial Technology Development Organization. Blast-proof capability tests were conducted at the JDA's Shimokita Test Center, followed by a test in Afghanistan in fiscal 2004 under a grant program financed by Japan's Ministry of Foreign Affairs.

The MINEBULL tests in Afghanistan were conducted three times for 155 days between June 23, 2004 and February 20, 2005; while the tests for the MINEDOG were conducted three times for 96 days between August 18, 2004 and February 20, 2005. The testing team comprised officials from the Afghan government and the United Nations, local NGOs and members of Japanese agencies and companies, including Kawasaki's representatives (Sumi and 10 others).

The MINEBULL's high-speed digging drum.

Iron fragments collected after running the MINEBULL for 50 m.

100 percent detection and removal achieved

Seven types of tests were conducted at sites outside the Afghan capital of Kabul: remote-control operation and effective distance tests; accuracy tests; performance tests (detection and clearance); durability and blast-proof tests (clearance vehicle only); detection tests using actual mines; clearance tests using actual mines; and tests on the integration of the detection and clearance systems.

These confirmed that the MINEBULL and the MINEDOG could operate remotely up to 965 m and 550 m away from the control system, respectively.

The detection tests were conducted in a flat area using actual mines provided by the UN, and Kawasaki's equipment achieved a 100% detection rate. Another perfect mark was received for its collection of unexploded ordnance in the former battlefield.

The actual AP mine-clearing tests were conducted in a mine-belt surrounding Kabul Airport. The clearance vehicle was controlled from a completely protected shelter, and achieved a 100% clearance rate, detonating 32 mines in a 50 m x 2 m area. After the tests at the battlefield, some 400 metal fragments were collected in a 100 m long operation, revealing the fierceness of the battles that had taken place there.

Blast-proof capability tests proved that the system can withstand successive explosions of antipersonnel mines, as well as confirming operator safety and ease of repair after exploding AT mine-like ordnance under the digging drum. In these tests, the measurement technology of Kawasaki's Aerospace Company was deployed to collect valuable data. To verify durability, tests were carried out in different types of terrain to see how the systems would withstand continuous operations.

For the system integration test, Kawasaki followed instructions provided by the UN. The system can create a digital map of a mined area from the area data provided by the UN. Using that data, the local NGO members first created a digital map with which to search for the mines, and after the map displayed the detected mines, were able to clear them. The test proved that mine clearance can be conducted safely and highly accurately.

Kawasaki Aerospace's Sumi comments, "The Afghan government's mine clearance team and the International Security Assistance Force gave the system high ratings after these tests. We developed a system anyone can operate as easily as a radio-controlled vehicle. The local NGO officials said it took them only three days to operate it with complete confidence."

Lunch gathering in one of the NGO tents (left). Kawasaki experts discuss mine removal test results with an International Security Assistance Force demining leader (right).

Members of the Afghan government, NGOs and local staff pose after the test.

Operating remotely behind a protective wall.

An EOD (Explosive Ordnance Disposal) member sets explosives for the MINEBULL's blast-proof capability test (left). A blast-proof test using AT mine-like ordnance (right).

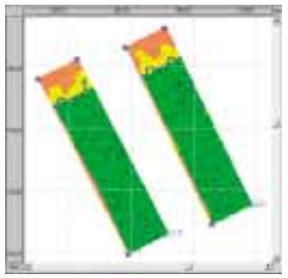
Pursuing necessary enhancements

Based on the test results from Afghanistan, the demining system is now being enhanced at Kawasaki's Banshu and Harima works.

Sumi explains that sand granules in the Afghanistan desert are smaller than 1 micron in diameter and often caused mechanical failures when they invaded the equipment. To protect the system from these granules, dust-proof housings for the MINEBULL's sensor box, electrical equipment and cabin were created, and their maintainability improved. The same enhancements were made to the MINEBULL's digging drums, belt conveyer, cabin and electrical equipment.

Enhancements were also made to the MINEDOG's detection capabilities in high-temperature, low-humidity environments, and in its overall detection and analysis of explosives. In the MINEBULL, the lowering of blast pressure inside the cabin has enhanced operator safety, as has the implementation of a double-winch rescue system, which allows the MINEBULL to be removed from the minefield in the event of vehicle failure.

Sumi comments that the Afghan NGO officials contributed greatly to Kawasaki's improvement of the equipment and methods by providing many suggestions. "We are determined," he says, "to work toward the ultimate goal of completely eliminating anti-personnel mines, in order to live up to the expectations of these officials."



MINEDOG sensors (left). A map indicating detected mines in the test area (top right). The locations of detected mines are marked with red paint (bottom right).

Based on the test results, the MINEBULL (left) and MINEDOG (right) are being enhanced at Kawasaki's Banshu and Harima works, respectively.

International bestseller 70ZV.

Behind the Powerful, Highly Maneuverable ZV Wheel Loader

The giant 135ZV in a quarry.

The 95ZV at work in a lumber yard.

The 90ZV loading crushed rocks at a tunnel construction site.

60ZV carrying silage.

Impressive Performance, Wideranging Applications

The Kawasaki ZV wheel loader, powered by a large diesel engine, is designed to dig, carry and load materials into dump trucks or hoppers at crushing plants and other sites that require heavy-duty jobs. The engine powers the hydraulic pumps that drive the loading equipment, as well as powering all four wheels via a torque converter and the transmission. An assortment of attachments allows the ZV loader to serve a wide range of applications—from carrying lumber at lumberyards to moving silage at livestock farms.

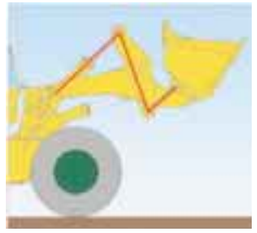
Global Popularity for 70ZV

Featured here is Kawasaki's bestselling 70ZV, which is already in 500 applications around the world since its launch in 2003. The midsized model of 11 wheel loaders in the lineup, it is equipped with Kawasaki Z-bar linkage, renowned for its power, and employs a center-pin, articulated design that allows the front and rear wheels to follow the same path. With a large, powerful engine, the high-performance wheel loader is powerful enough to carry out heavy-duty jobs while ensuring ease of operation and riding comfort.

● Cab safety

To ensure operator safety, the 70ZV has a rollover protective structure (ROPS) designed to withstand the loader's weight and provide a protective zone around the operator in the event of an overturn, as well as a falling object protective structure (FOPS) that prevents injury even if an object as large as 40 cm in diameter and weighing 300 kg falls on the cab from 4 m above.

Rollover Protective Structure ROPS 転倒時運転者保護構造 Falling Object Protective Structure FOPS 落下物保護構造



● Kawasaki Z-bar linkage

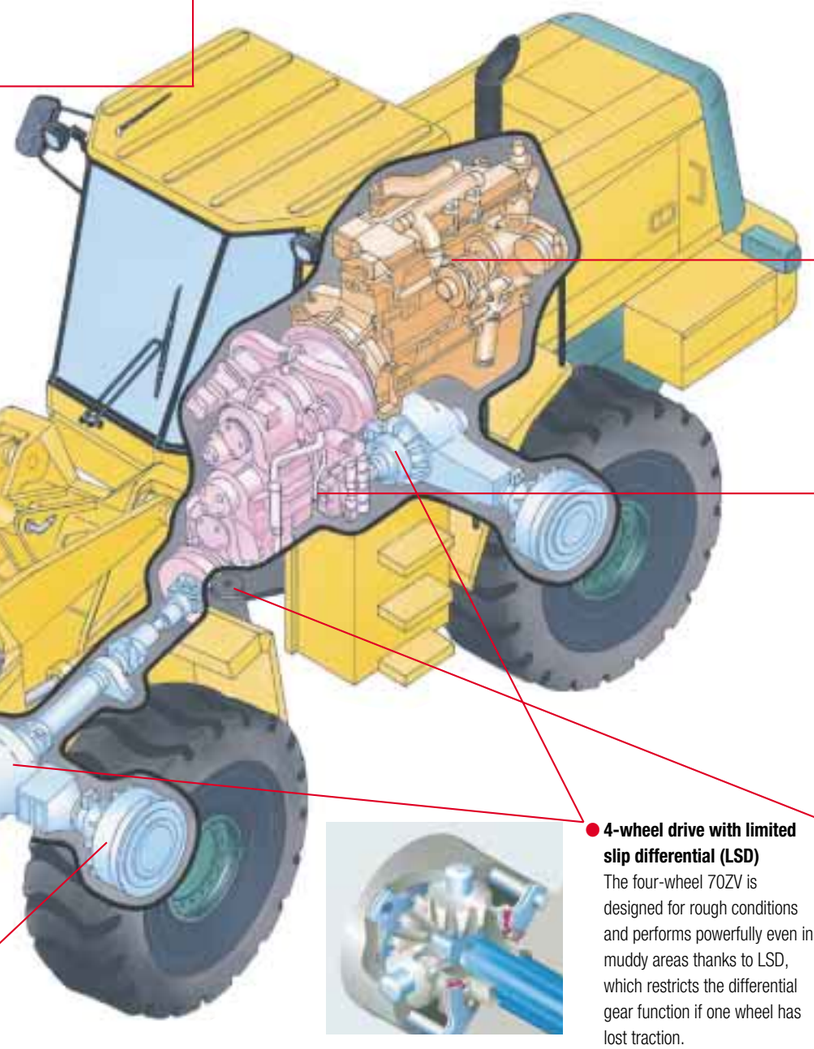
The Kawasaki Z-bar linkage utilizes the hydraulic cylinder's force when pushing is stronger than pulling. As a result, the loader demonstrates a bucket breakout force of 123.5 kN and maximum lifting capacity of 13 tons.

● Bucket

The 2.7 m^3 bucket comes with an anti-abrasive cutting edge.

● High-performance braking

The sealed wet disc brakes are designed for stable operations even in muddy areas. The two independent front and rear hydraulic circuits allow the operator to brake even if one circuit fails.



● Enhanced operator comfort

The cab is equipped with systems to enhance operator comfort, including a fully automatic air conditioner, an air suspension seat, and an adjustable telescopic and tilting steering wheel that moves vertically and forward/backward.

● Engine

The 70ZV has a 4-cycle, water-cooled, 6-cylinder in-line direct injection diesel engine, with a total displacement of 5.89 liters. While it demonstrates a powerful rated output of 125 kW (171 PS), the engine meets stringent international emissions standards.

● Fully automatic transmission

Because the wheel loader repeats back-and-forth movements as it digs and loads materials into the dump truck, the 70ZV is equipped with a transmission that features large-capacity clutches, enabling the operator to shift between forward and backward gears quickly, without braking. The operator can concentrate on the job and let the computer perform optimum gear shifting automatically.

● 4-wheel drive with limited slip differential (LSD)

The four-wheel 70ZV is designed for rough conditions and performs powerfully even in muddy areas thanks to LSD, which restricts the differential gear function if one wheel has lost traction.

● Center pin, articulated design

The loader's body "folds" at the center pin when the operator turns the steering wheel. Front and rear wheels follow the same path with no differential, ensuring ease of operation.

Kawasaki to Supply Large Wind Power System

Kawasaki recently received a full turnkey order from Windtech Oguni Corp. to build Japan's first commercial wind power system to be located in a national park. Delivery to Windtech Oguni, a joint venture between the town of Oguni, Kumamoto Prefecture, and Toyota Tsusho Corp., is scheduled for March 2007.

The 8,500 kW system will comprise five 1,700 kW generators supplied by Vestas Wind Systems A/S of Denmark. The system will be built within the Aso-Kuju National Park, located on the southern island of Kyushu, and be designed to blend into the landscape. One way it will do this is by using gray blades instead of the usual white—a modification that was necessary for the plan to be approved by the Environment Ministry.

Each generator will have a hub height (from the ground to the center of the rotor) of 67 m, an outer blade diameter of 66 m and blades reaching 100 m. It will enable maximum generation of power at wind speeds of 4-25 m/s. All 16 million kWh of power generated per year, equivalent to the annual power demand of 5,100 households, will be sold to Kyushu Electric Power Co., Inc.

Fairing for H-IIA F9 Launch Vehicle Shipped

Kawasaki shipped a payload fairing for the H-IIA No. 9 (H-IIA F9) launch vehicle to the Japan Aerospace Exploration Agency (JAXA)'s Tanegashima Space Center in December. Designed and manufactured at the Gifu Works and shipped from the Harima Works, the fairing was installed on the launch vehicle carrying the Multifunctional Transport Satellite-2 (MTSAT-2), an air traffic control and weather observation satellite, into space. The H-IIA F9 was successfully launched on February 18.

A payload fairing is a cover installed at the tip of the launch vehicle to protect the satellite from aerodynamic heating and vibration during liftoff. After the launch vehicle leaves the earth's atmosphere, the fairing splits in two and is jettisoned, allowing the satellite to separate from the launch vehicle.

The fairing is 5 m in diameter with a single cover (5S), large enough for satellites like those carried by the U.S. space shuttle or the European Ariane V. Kawasaki is responsible for the development and manufacture of the fairing and the payload adapter, which separates the satellite from the launch vehicle.

State-of-the-Art LNG Carriers Take to the Seas

In November, Kawasaki Shipbuilding delivered the *North Pioneer*, a 2,500 m³ LNG carrier, to Japan Railway Construction, the Transport and Technology Agency and Japan Liquid Gas Transport Co., Ltd. The vessel, hull No. 1571, is only the second Kawasaki LNG carrier intended for domestic use. It marked a collaboration between Shin Kurushima Dockyard Co., Ltd., which built the hull, and Kawasaki Shipbuilding, which built the all-important cargo section.

North Pioneer

The 89.2 m compact LNG carrier features two cryogenic tanks developed by Kawasaki Shipbuilding that demonstrate its technological expertise. The insulated, horizontal cylinder tanks are independent of the hull, thus safely able to absorb temperature contractions.

In December, Kawasaki Shipbuilding delivered the *Nizwa LNG* (hull No. 1562) to Oryx LNG Carrier S.A. The vessel is the fifth in a line of internationally acclaimed 145,000 m³ LNG carriers boasting state-of-the-art facilities developed by Kawasaki Shipbuilding. It has four Moss spherical tanks that hold a total of 145,469 m³ of LNG. It also features ultra-efficient thermal insulation through Kawasaki's panel system, which achieves a boil-off rate of 0.15 percent per day. The cargo tanks are protected against direct damage by double-side shells and a double bottom.


Nizwa LNG

Other features of the 289.5 m long ship include a computer-controlled navigation system integrated into the wheelhouse to improve operability, and a 360° view window that enables single-operator oceangoing navigation. Kawasaki Shipbuilding also jointly developed an integrated monitoring and control system (IMCS) with Kawasaki Heavy Industries to control cargo handling operations and monitor engine conditions.

Kawasaki Wins Order for Heat Recovery Power Generation Systems in China

Kawasaki Plant Systems (K Plant) received an order in November from Chinese cement giant Anhui Conch Cement Co., Ltd. for power generation systems driven by waste heat recovery that will serve 11 cement plants in eight mills. The deliveries are scheduled to be made between July 2006 and January 2008.

When the systems are installed in the cement plants, electricity will be generated by a steam turbine generator after special boilers recover waste heat gas generated during the precalcination process of production. This technology has been adopted in most large cement plants in Japan, since it can achieve more effective use of waste gas, energy savings and environmental conservation. China now faces the challenge of rapidly accelerating power demand driven by economic expansion, and the environmental impact imposed by such expansion. These factors are believed to be behind Anhui Conch's decision to introduce K Plant's systems.

The latest order from the company, which is under the umbrella of the Anhui Conch Group, is for plants with power outputs of 8,300 kW to 30,500 kW, totaling approximately 200,000 kW. K Plant will manufacture the main equipment, provide designs for other equipment to be supplied by the client, oversee installation, and supply supervision and technical support.

Subway Cars Delivered to Taipei

Kawasaki recently completed shipment of the first three-car subway train to Taipei's Department of Rapid Transit System (DORTS). The train will go into service on the Xiaobitan Branch Line of the Xindian Line in early 2006.

Kawasaki received an order for 321 subway cars from DORTS in 2003. Of these, DORTS will assign 144 cars to the Xinzhuang Line and the Luzhou Branch Line, both opening in 2011. The remaining 177 cars will be added to existing lines for increased capacity. Production on half of the remaining order will begin soon at Kawasaki's Hyogo Works, with the other half to be produced by a local firm in Taiwan under the government's Industrial Cooperation Program (ICP). Deliveries will continue until June 2009.

The subway cars are made of weather-resistant stainless steel and have four external doors on one side. Electricity (DC 750V) is supplied via a third rail and the trains operate using the latest insulated gate bipolar transistor (IGBT) inverter control, installed on Kawasaki's bolsterless bogies. Maximum operating speed is 80 km/h. Special features include a train supervising information system (TSIS) to assist driving and maintenance, a closed-circuit television (CCTV) monitoring system in the driver's compartment to enhance passenger safety, and bicycle storage space to meet diverse passenger needs.

Hydraulic Components Subsidiary Established in U.S.

In January, Kawasaki Precision Machinery (KPM) established a subsidiary to sell hydraulic components in the U.S.

KPM has been selling the components through the sales division of Kawasaki Motors Corp., U.S.A., a subsidiary of Kawasaki Heavy Industries, Ltd., KPM's parent company. Component sales in the U.S. have nearly quadrupled in the 10 years since they were launched.

The new subsidiary, Kawasaki Precision Machinery (U.S.A.), Inc., based in Grand Rapids, Michigan, is expected to enhance KPM's managerial decision-making processes and resource allocation. It will also expand its sales and service capabilities, as well as enlarging its customer base and business in the U.S., where demand for hydraulic machines is expected to remain brisk in coming years.

KPM plans to fully utilize three major bases: its headquarters and main factory in Kobe, Japan; KPM (U.S.A.); and KPM (U.K.), its production and sales subsidiary in Europe. Together with subsidiaries Flutek, Ltd. in Korea and KPM (China), which begins operations in August 2006, the bolstered KPM is now poised to effectively meet customer needs worldwide and further enhance customer satisfaction.

COMPANY PROFILE

Name: Kawasaki Precision Machinery (U.S.A.), Inc.

Location: 5080 36th Street S.E., Grand Rapids, MI 49512, U.S.A.

President: Kazuo Hida

Established: January 1, 2006

Paid-in Capital: US$ 5 million (100% owned by KPM)

Principal businesses: Import and sales of hydraulic components (pumps, motors and valves), after-sales services and related businesses

Number of employees: 20

First GPC70PLUS Cogeneration System Delivered

A GPC70PLUS like the one delivered.

In December, Kawasaki delivered its first 8,000 kW-class flexible heat and power gas turbine cogeneration system to Denso Corp.'s Toyohashi Plant in Toyohashi, Aichi Prefecture. The GPC70PLUS system is equipped with a newly developed steam-injection gas turbine.

The GPC70PLUS comprises the M7A-02ST, part of the proprietary 7,000 kW-class M7A-02 gas turbine power generator lineup, which uses steam injection to enhance power output; and a heat recovery steam generator (HRSG). When the demand for heat is low, surplus steam is injected into the gas turbine to increase the power output. The introduction of this cogeneration system will enable the Denso plant to optimize significant seasonal load fluctuations in electricity and steam.

GPC70PLUS Specifications

	During Electricity Generation *1	During Steam Generation *2
Electric Output (kW)	8,000	7,050
Steam Production (kg/h)	7,070	12,800
Electrical Efficiency (%)	34.0	31.1
Heat Recovery Efficiency (%)	21.2	40.0
Overall Efficiency (%)	55.2	71.1

*1 When surplus steam is injected into the gas turbine
*2 When surplus steam is not injected into the gas turbine but used for heating and other purposes

Achieving new heights in technology

Kawasaki Heavy Industries, Ltd. is constantly developing the latest technology.
It continues to support people and society in the realms of land, sea, and air.

Motorcycles, high-speed trains, next-generation aircraft, and LNG carriers—
Kawasaki is transforming its state-of-the-art technologies into reality in the field of transportation.
Its remarkable achievements are also found in large-scale infrastructure projects around the
globe in the form of shield machines, high-efficiency gas turbine generators,
wind-power generation plants, environmental plants, steel bridges, and more.

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