Scope

Kawasaki Heavy Industries Quarterly Newsletter

January 2008
NO.74

Kawasaki

Kawasaki Heavy Industries
Scope Quarterly Newsletter
No. 74 January 2008

in this issue...

About the Cover
SWIMO is a next-generation light rail vehicle (LRV) completed last fall. Powered by the Gigacell, Kawasaki's proprietary nickel metal-hydride battery, it is an innovative tram that does not require overhead lines.

KAWASAKI HEAVY INDUSTRIES, LTD.

Scope

Editor-in-Chief: Shunsaku Ban
Public Relations Department
World Trade Center Bldg., 4-1
Hamamatsu-cho 2-chome, Minato-ku
Tokyo 105-6116, Japan
Phone: 81-3-3435-2132
Fax: 81-3-3432-4759
URL: http://www.khi.co.jp

SWIMO's Excellence Demonstrated

Next-generation battery-powered low-floor light rail vehicle (LRV) is passenger- and earth-friendly

Testing of SWIMO's battery performance was conducted at a 1,600 m non-electrified test track at the Harima Works.

The SWIMO's profile. Its innovative 3-car, 3-bogie structure, with newly developed, compact bogies placed in the middle and at both ends, is a world's first.

The door is only 330 mm off the ground, less than half of a conventional tram's height, making it universally accessible.

On October 17, 2007, Kawasaki began testing its next-generation LRV, called SWIMO*, on a 1,600 m test track at its Harima Works. The tests were recently concluded and SWIMO currently is undergoing verification runs on a commercial line. Since the successful completion of testing, Kawasaki has received inquiries from Japan and overseas.

* The LRV was named SWIMO (Smooth WIn MOver) because the goal was to realize (WIN) a vehicle (MOVER) with smooth (SMOOTH) boarding and exiting, and smooth entry into non-electrified segments.

● Articulated 3-car, 3-bogie SWIMO

SWIMO is an articulated three-car, three-bogie tram with bogies at both ends and in the middle, a Kawasaki innovation that allows smooth curving. Powered by the Gigacell®, Kawasaki's proprietary nickel metal-hydride battery, it is an innovative tram that does not require overhead lines on all segments. It is also the first nickel metal-hydride battery-run tram in the world.

The 15 m long SWIMO features floors that are just 330 mm from the ground at the door area and 360 mm at the passenger section, whereas conventional tram floors are 800-850 mm off the ground. The narrowest aisle is 800 mm wide, which enables wheelchair access. SWIMO's passenger capacity is 62, with seats for 28 passengers, and it runs at speeds as fast as 40 kph, the maximum tram speed allowed by Japanese law. It can operate for over 10 km without requiring charging of the Gigacell (battery capacity 200 Ah).

● Renewed appreciation for people-friendly, earth-friendly LRVs

LRVs have been gaining renewed recognition for their suitability to urban transportation because of their easy accessibility and environmental friendliness.

Next-generation LRVs are especially appearing in Japan, offering a barrier-free, low-impact urban traffic alternative. In 2006, the Ministry of Land, Infrastructure and Transport set a policy to

Compact control panel.

Employment of a compact bogie and mounting of electric devices on the roof allows SWIMO to have all-flat floors at both ends of the passenger cabins, and therefore, flexible seat arrangements.

The low-floor design extends from the passenger cabins all the way to the operator's cab.

Sliding plug doors are located in the center of a passenger cabin. Batteries are installed under the seats.

Spacious 12 meter long low passenger cabin floors.

introduce LRVs in 10 cities before 2016.

There are many further advantages: LRVs produce less noise and fewer vibrations than traditional trams, and costs are said to be 1/10 that of creating a subway line. If LRVs become more popular, it may help reduce dependency on cars, thus reducing auto emissions and alleviating traffic congestion. Emissions of CO_2 would also be reduced.

Developers of the SWIMO actively pursued minimization of the height differences between LRV station platforms and the LRV's floor. The superlow floor was designed to meet the barrier-free needs of all types of passengers. The floors of the passenger cabins are perfectly flat at both ends, which is unconventional but allows a versatile arrangement of seats. This was achieved by placing newly developed, extremely compact bogies at both ends of the LRV and in the middle. Kawasaki is the first in the world to attempt such a distribution of bogies. Electric devices normally installed under the floor have now been mounted on the roof.

Benefits of battery-driven SWIMO

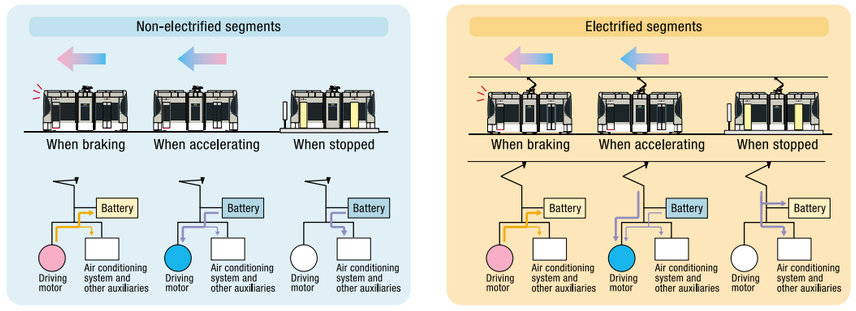
Kawasaki's Gigacell battery is tailored to large-scale applications, with quick charge/discharge capabilities. It also contains no hazardous materials such as lead, sodium or lithium, and is thus environmentally friendly. The downsized version of the Gigacell for railway car applications, which has been upgraded for larger output, is installed under the LRV's seats.

Because the SWIMO is powered by the Gigacell, it can easily compensate for voltage drop-off in areas that are far from power substations. This reduces the number of substations required, since one power sub-station can cover larger areas, and thus reduces the amount of maintenance as well.

Overhead lines are unnecessary for new lines or when existing lines are extended. They are also not necessary in areas where two tram lines are interconnected, because the SWIMO can run without them.

Overhead lines are considered unsightly, especially at curves where they can form a kind of spider's web. SWIMO has resolved this issue.

Overview of Battery-Powered System



Leveraging regenerative braking power

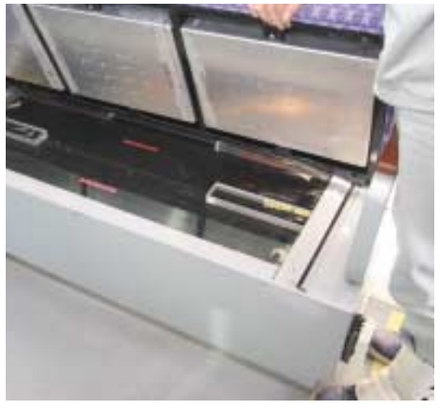
Trains normally receive power from overhead lines in order to run their motors. The LRV's regenerative brake utilizes the driving motor as a power generator when braking, controlling its frequencies and voltage to generate power and returning this "regenerative power" to the power lines. This mechanism enhances energy efficiency. However, if trains are not in the vicinity to consume the regenerated power, the driving motor cannot serve as a generator (regeneration cancellation) and braking is imposed mechanically, which lets the kinetic energy of the train evaporate as heat.

On the other hand, SWIMO achieves much higher energy efficiency than conventional braking because the Gigacell stores all regenerative power and provides power to start both the main and auxiliary motors. This makes the SWIMO even more environmentally friendly.

SWIMO also boasts a short charging time. Charging its onboard Gigacell takes only 5 minutes – equivalent to the length of time it takes to turn the LRV around at terminals.

In the leading bogie, the driving wheels are on the left. The low-floor passenger cabin is installed above the smaller wheels on the right.

The middle bogie is axleless. The middle car's center aisle is positioned between the bogie wheels.



Kawasaki's proprietary Gigacell battery is installed under the seat.

The nickel metal-hydride battery Gigacell has been downsized for vehicle applications and upgraded for larger output.

Major electric devices are mounted on the roof.

Looking Inside the Electronically Controlled Marine Diesel Engine

Bestselling Kawasaki-MAN B&W 2-Stroke Diesel Engine

In today's shipbuilding industry, the turbocharged 2-stroke diesel engine is the most popular marine engine.

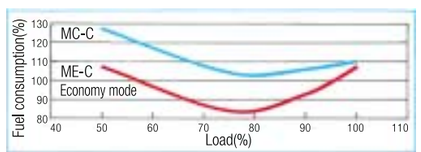
Kawasaki's history of diesel engine manufacture goes back to 1919. After it concluded a licensing agreement with MAN in 1923, Kawasaki produced many Kawasaki-MAN and Kawasaki-MAN B&W diesel engines. The MAN B&W 2-stroke diesel engines achieve low fuel consumption and low engine speeds thanks to their longer stroke. They also boast high operational efficiency as they give shipowners the choices of horsepower and engine speeds most economically suitable for the ship type. As of Dec. 31, 2007, Kawasaki had produced a total of 872 units of Kawasaki-MAN B&W 2-stroke diesel engines—enough to output nearly 12,976,000 horsepower.

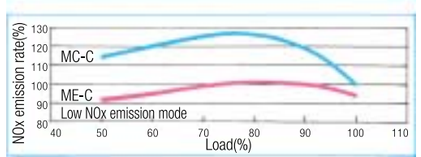
World's First Electronically Controlled MAN B&W S60ME-C Marine Engine with a 60 cm Bore Cylinder

In February 2005, Kawasaki completed its first electronically controlled marine diesel engine, the Kawasaki-MAN B&W 7S60ME-C (output: 15,820 kW; cylinder bore: 60 cm; cylinders: 7).

An electronically controlled version of the best-selling Kawasaki-MAN B&W MC engine, it enables ships to consume less fuel, as well as requiring reduced cylinder lubricants. It also operates stably during low engine speeds and thus offers higher maneuverability. The engine's many features include lower NOx and soot emissions (please see graphs) and other environmentally friendly qualities.

This landmark achievement was followed by completion of the world's largest class electronically controlled marine diesel engine, the Kawasaki-MAN B&W 12K98ME (output: 68,640 kW; cylinder bore: 98 cm; cylinders: 12) in April 2006. A total of 16 ME engines had been ordered as of Dec. 31, 2007.



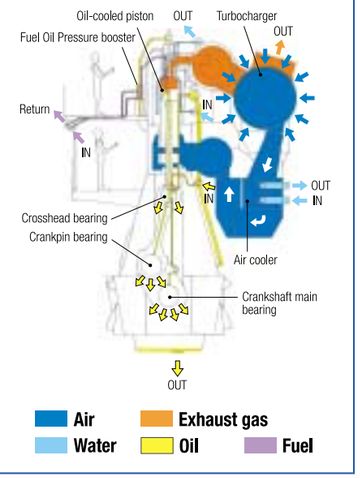


● Exhaust gas manifold
Exhaust gas from the cylinder is amassed here before it is sent to the turbocharger. This is called constant-pressure turbocharging, and it allows exhaust gas with reduced pressure pulsation to rotate the turbocharger.

● 2-stroke engine
The engine converts heat energy from fuel combustion in the cylinder into mechanical energy. In this type of engine, the piston's reciprocation is converted into the rotary motion of the crankshaft. "Two stroke" means that one combustion cycle is completed with two strokes (up and down) of the piston.

> From left
1. Piston moves up
2. Piston moves up further and the air is compressed
3. Combustion takes place and the piston lowers
4. The crankshaft rotates once during steps 1-3

● Turbocharging
In turbocharging, a turbine inside the turbocharger is rotated at high speeds by the engine's exhaust gas energy, and its torque drives the compressor wheel to compress the air to be delivered to the engine.



● Fuel oil pressure booster

● Exhaust valve actuator

● FIVA valve (Fuel Injection and Valve Activation valve)
In the electronically controlled diesel engine, control of fuel injection and the exhaust valve, which was conventionally controlled mechanically by the camshaft and chains, is performed by a computer-controlled hydraulic system with electromagnetic valves. A variety of settings, including optimum combustion mode and low NOx emission mode, can be changed during operation. The amount and timing of injection of lubricant for cylinders are also controlled electronically for optimum operation.

Three components comprise the engine system: the hydraulic power supply, which distributes pressurized hydraulic control oil to each cylinder; the hydraulic cylinder unit, which controls fuel injection and exhaust valve opening/closing timings; and the engine control system, which integrates the computerized control units, the operational panel in the control room, and other units through a network.

● Computerized control unit

● Crankcase (bedplate and framebox)
The lower half of the crankcase is the bedplate and the upper half, the framebox. The bedplate houses the crankshaft's main bearing and bearing support. There is a door on each cylinder for access to the crankcase for inspections. The bedplate and framebox are built of welded steel plates.

● Crosshead
A large 2-stroke diesel engine typically has a piston and piston rod attached to the crosshead, located at the top of the connecting rod (crosshead diesel engine).

● Connecting rod

● Crankshaft

● Piston rod

● Hydraulic power supply
Engine-driven pumps and electronic pumps that supply the fluids are stored here.

● Cylinder cover

● Exhaust valve
Air taken in from the bottom of the cylinder is released as exhaust gas from the exhaust valve located at the top of the cylinder. Called uniflow scavenging, this allows efficient scavenging for long-stroke, large engines.

● Scavenging air manifold

● Piston

● Cylinder liner
Kawasaki's electronically controlled marine diesel engines come in a wide variety of cylinder bores, from 50 cm to 98 cm, allowing shipbuilders to select the most economical size for their ship types.

Ahead (forward)
Astern (backward)
Output

● Propeller

■ The illustration shows the Kawasaki-MAN B&W 6S60ME-C. The engine is a 6-cylinder version of the electronically controlled MAN B&W S60ME-C engine, with a 60 cm bore.

Successful First Flight of Fixed-Wing Patrol Aircraft for Japanese Defense Ministry

The #1 test XP-1 (formerly called P-X) fixed-wing maritime patrol aircraft completed a successful first flight in September.

Capt. Akihiro Sekido, copilot Yoshinao Baba of Kawasaki's Flight Section, and nine other crew members conducted a successful hour-long flight after taking off at 9:38 a.m. from the Japan Air Self-Defense Force's Gifu Base. The captain commented, "From the moment we took off, I felt quite confident because operating the plane was identical to simulated operation. It demonstrated extremely high stability at a level I've never experienced before and both the flight system and the engine worked fine. It was a perfect flight and went as planned."

The Ministry of Defense began concurrent development of the XP-1 and C-X transport aircraft in 2001 to replace the current P-3C and C-1 models. In November 2001, Kawasaki earned prime contractor status to develop these airplanes with aircraft manufacturers and other participating companies.

Kawasaki will continue with in-house flight tests for the XP-1 at its Gifu Works. The aircraft is scheduled for delivery to the Ministry by the end of 2008.

New KPM Core Parts Plant Begins Production

Kawasaki Precision Machinery (KPM)'s new manufacturing plant at its main factory in Kobe recently started production of core parts for hydraulic pumps and motors used in construction machinery.

Construction of the new plant began in September 2006 with an aim to boost production efficiency and capacity by centralizing core parts production facilities that had been dispersed throughout KPM's main factory. Following the completion of the buildings in April 2007, processing machines were installed to begin operations. The new plant produces pistons, shoes, cylinders and valve plates, which are the core parts of hydraulic pumps and motors. The integrated production system covers everything from machining to heat treatment. These core parts are provided to KPM's own assembly lines and to KPM Group plants overseas.

The outlook for the global construction machinery market is bright. Both domestic and foreign demand remain steady as infrastructure development in BRIC and VISTA countries continues, and the pace of mineral resource exploitation picks up overseas. The new plant will significantly boost KPM's core parts production and heat-processing capacity to meet the increasing demand from construction machinery makers around the globe for precision hydraulic pumps and motors.

KPM's core parts plant is located at 234 Matsumoto, Hasetani-cho, Nishi-ku, Kobe, Japan. The two-story building encompasses a floor area of approximately 13,000 m^2. Staffed by 50 employees, this facility will boast a production capacity of 400,000 sets per year once full-scale production begins in March 2008.

First Delivery of 40 ft Liquefied Hydrogen Container to Iwatani

In September, Kawasaki delivered its first proprietary liquefied hydrogen container to Iwatani International Corporation.

The ISO 40 ft container has self-pressurizing features and, since it is the largest allowed by container standards, boasts increased capacity. The container's pressurized vaporizer enables the dispensing of liquefied hydrogen without an external pressurizing unit, so it can be used for both refilling/dispensing at stationary tanks and as a parked container for dispensing liquefied hydrogen.

The commercialized container is the result of Kawasaki's advanced cryogenic technologies. In the past, Kawasaki developed and built one of the largest liquefied hydrogen storage tank systems, comprising three tanks with a capacity of 540 m^3 each, for launch facilities at the Japan Aerospace Exploration Agency (JAXA) Tanegashima Space Center. Prior to the 40 ft. version, it had developed a 20 ft. container, and in January 2005 achieved Japan's first successful transport of liquefied hydrogen to a hydrogen station.

Applications to rocket fuel and industrial gas have made hydrogen a popular source of power. Demand is expected to grow further with its application to fuel cell vehicles. The development of advanced liquefied hydrogen containers will contribute to its efficient mass transportation, since liquefaction reduces hydrogen's volume to 1/800.

NYC Transit to Order Additional 260 Subway Cars

Kawasaki recently received an additional order for 260 R160 subway cars from the MTA New York City Transit (NYC Transit*). The order, worth approximately $450 million (54 billion yen), is scheduled for final delivery in August 2009.

In October 2002, Kawasaki and France's Alstom Transportation Inc. were jointly awarded an order for 660 subway cars from NYC Transit. Kawasaki has manufactured and is now in the process of delivering 260 of these cars. The contract also includes two options. The first option is for an additional 620 cars and the second is for another 380 to 420 cars. NYC Transit has currently decided to exercise the first option. Kawasaki will manufacture 260 out of the total 620 cars.

Kawasaki is also serving as the engineering leader for the R160 contract, providing technical assistance that utilizes the experience it gained with the R143 car, which the NYC Transit has had in revenue service since 2002. Kawasaki also supplies bogies for all of the R160 cars, including those manufactured by Alstom.

The R160 subway cars have a stainless steel body and are equipped with highly reliable controls, HVAC, as well as door-operating and public address systems to guarantee optimum safety and passenger comfort. The carbodies are manufactured at Kawasaki's railcar plant in Lincoln, Nebraska. Equipment installation, final assembly and testing are performed at its plant in Yonkers, New York, prior to delivery to NYC Transit.

Kawasaki has started expanding its plant in Lincoln to increase production capacity for the future. This will enable the concurrent production of R160 cars for NYC Transit and 340 new PA-5 commuter train cars ordered by the Port Authority Trans-Hudson Corporation (PATH) in 2005. Production of the R160 cars is scheduled to end in 2009. Once that happens, Kawasaki plans to begin concurrently manufacturing the PA-5 cars and 300 M-8 AC/DC electric passenger cars ordered by Metro-North Railroad (MNR) in 2006. The PA-5 cars and M-8 cars are scheduled for delivery by 2011 and 2012, respectively.

Since its initial delivery of 325 R62 subway cars to NYC Transit in 1985, Kawasaki has received orders for 1,939 cars in total. Once all of its R160 cars are delivered, including those under the contract option, Kawasaki will have manufactured the major share of NYC Transit's subway cars. The latest order is a testament to Kawasaki's proven track record with NYC Transit, as well as its superior technological capabilities.

*NYC Transit is a public railway company affiliated with the Metropolitan Transportation Authority (MTA). Other MTA-affiliated transit services include the Long Island Rail Road and Metro-North Railroad.

LPG Carrier *BW Broker* Delivered

Kawasaki Shipbuilding Corporation delivered *BW Broker*, an 80,000 m^3 LPG carrier, to Fair Wind Navigation S.A. in June. The carrier, identified as Kawasaki hull No. 1583, is the 41st LPG carrier built by Kawasaki Shipbuilding and the second of the same model.

The 226 m long vessel employs Kawasaki's SEA-Arrow (Sharp Entrance Angle bow as an Arrow) to minimize bow wave resistance and significantly boost propulsive performance. It is equipped with four independent cargo tanks housed in the cargo hold compartments, which are able to absorb temperature contractions for the storage of low-temperature liquefied gas. These urethane foam insulated tanks are made of special steel with low-temperature resistance characteristics that can hold LPG at temperatures as low as -46°C. The carrier is driven by the Kawasaki-MAN B&W 7S60MC-C diesel engine, an energy-saving, ultralong stroke, two-cycle, low-speed diesel engine. The Kawasaki rudder bulb with fins (RBS-F) has been employed to achieve maximum fuel economy.

Bus That Can Operate on Railway Tracks Developed

In April, test operations began for a dual-mode vehicle (DMV) codeveloped by Hokkaido Railway Company and Nichijo Manufacturing Co., Ltd., a subsidiary of Kawasaki. The DMV, which can operate on both railway tracks and roads, is being operated in an 11 km route connecting Hamakoshimizu and Mokoto, as well as on 25 km long roads in the vicinity. Nichijo joined the Hokkaido Railway-sponsored DMV development project in 2003 by producing the mockup. It is now codeveloping and manufacturing the bus.

The rubber tire-driven DMV is based on a commercial microbus to allow smooth commercialization and mass production, and to meet various regulations for railroads and automobiles. Use of the microbus also reduces production costs because it does not require specialized parts. It only takes 10 to 15 seconds for the bus to switch from road to railway mode.

Nichijo leveraged its hydraulic control technology—developed for its main products, snowplows and snow-grooming machinery—to develop automatic rear-biased weight distribution control for the DMV. This enables the prevention of tire wear, slippages and derailments due to insufficient axle weight of the iron wheels, and achieves stable operations even when the total weight shifts as passenger numbers fluctuate.

First Kawasaki Gas Turbine Power Generation System for Singapore

Kawasaki Gas Turbine Asia Sdn Bhd (KGA), a subsidiary of Kawasaki, recently received its first order for a gas turbine power generation system for Singapore. The order comes from CT Engineering and Construction Pte. Ltd. (CTec), a subsidiary of Perth, Australia-based Capital Turbines Australia Pty. Ltd. (CTA).

The system will be combined with boilers to form a cogeneration system that will be used by the Singapore energy company Banyan Utilities Pte. Ltd. Banyan will supply electricity and steam to the world's largest biodiesel plant, currently being constructed by Natural Fuel Limited (based in Subiaco, Australia) on Jurong Island, Singapore's petrochemical industry center.

The system is comprised of a natural gas-fueled gas turbine power generation system employing Kawasaki's proprietary M7A-02 gas turbine, incorporating the environmentally friendly low-NOx DLE (dry low emission) system. It will be combined with a heat recovery boiler and a package boiler to be used as a cogeneration system. The system will generate 5,605 kW of electricity and supply 45 tons/hour of steam for the plant's production lines, contributing to lower energy costs and a stable power supply. Kawasaki will supply the gas turbine power generation system for the cogeneration system, which is scheduled for completion in 2008.

Singapore is turning more and more to gas-based in-house power plants as a way to offset rising global crude oil prices and secure a stable supply of electricity. Demand for gas turbine cogeneration systems is expected to increase. This latest order demonstrates the superior environmental performance and lifecycle cost of Kawasaki gas turbine cogeneration systems, as well as it's outstanding technological capabilities and proven track record in Southeast Asia, including the Indonesian and Malaysian markets.

Kawasaki Green Gas Engine Tops World Record with 48.5% Generating Efficiency

Kawasaki recently developed the world's most efficient 7.8 MW 18-cylinder gas engine. During test runs in combination with a power generator that began in May, the engine not only achieved 48.5% electric generation efficiency, but demonstrated excellent environmental performance with extremely low NOx emissions of 160 ppm at 0% O_2.

Since Kawasaki released its first marine diesel engine in 1919, it has continued to actively develop, design and manufacture an array of diesel engines as well as power generation systems. Kawasaki leveraged its expertise to launch a gas engine development project and established the basic technologies to develop the 18-cylinder demonstration engine through performance tests on a single-cylinder test engine.

The engine features an optimized combustion chamber form and individual control of each cylinder to improve anti-knocking performance and cycle efficiency. The addition of a prechamber spark ignition system does away with the need for additional liquid fuel for ignition and realizes easy operations. Kawasaki's fluid dynamics technology was employed in developing the prechamber to ensure stable combustion.

The engine is applicable to a wide range of markets, with models offering outputs from 5 to 7.8 MW. It is available in four different combinations, including 12, 14, 16 or 18 cylinders, with a cylinder diameter of 300 mm.

Kawasaki has a proven track record in the area of industrial gas turbines, supplying stand-by power generation and cogeneration systems since 1974. The Company employs state-of-the-art low-emission technologies in an extensive lineup of gas turbines from, 150 kW to 20 MW class turbines, with the L20A at the high end. These highly efficient gas engines have been added to the product lineup to meet a diverse range of customer needs. Kawasaki's gas turbines are dubbed Green Gas Turbines because of their superior environmental performance. The newly developed gas engine has also been named the Green Gas Engine to communicate its world record-breaking environmental performance.

Kawasaki Presents Ninja 250R and 12 Other Models at Tokyo Motor Show

Kawasaki exhibited 13 models at the 40th Tokyo Motor Show held at Makuhari Messe for 16 days from October 27. One of the models made its world premiere at the show, while four others made their debut appearances in Japan. Some models have enhanced environmental and safety features in compliance with Euro-3 exhaust emission regulations, as well as anti-lock braking (ABS) systems.

Kawasaki presented the Ninja 250R, a stylish and rider-friendly 250 cc supersport bike with a full fairing.

Also exhibited was the KLX250, a dual-purpose motorcycle*1 with enhanced off-road performance and all new styling, plus the D-Tracker X, a motard model*2 with an outstanding suspension design that boosts its signature light handling performance.

Kawasaki also presented the Ninja ZX-10R as a full model change to its large-displacement supersport motorcycles, which have earned high marks overseas. Applying lessons learned on the race track to the engineering behind this superbike has resulted in significant improvements to the engine and a sturdy chassis to match it.

Also on display was the ZZR1400, Kawasaki's flagship model, which has been highly rated by motorcycle magazines around the world since its debut in 2006. The 2008 model incorporates changes to the intake/exhaust systems for reduced emissions and higher riding performance.

*1. Dual-purpose motorcycle generally refers to a motorcycle designed for both on- and off-road riding.

*2. Motard model generally refers to an off-road motorcycle fitted with smaller on-road tires.

Ninja 250R

M7A-03

Best Efficiency in Its Class

Working to Preserve the Environment for Future Generations

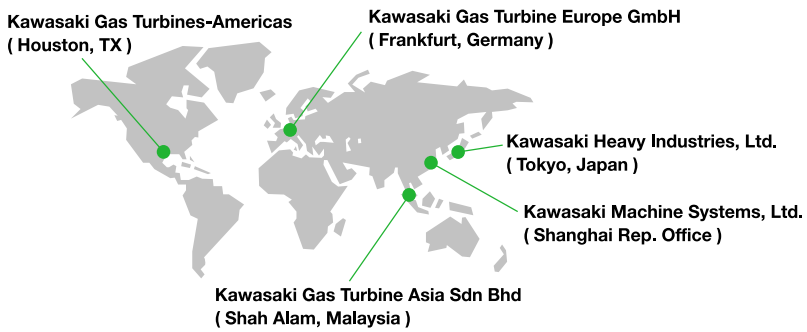
YAKUSHIMA
JAPAN

GREEN
Gas Turbines

" Get Reliable Eco-friendly Energy Now "

In recent years, environmental problems caused by energy consumption have become a more and more prominent threat to the earth. The prevention of further damage relies largely upon the reduction of CO_2 emissions. The energy efficiency of Kawasaki Gas Turbine Co-Generation Systems contributes to the prevention of global warming and therefore reduces the burden on the environment.

Kawasaki Gas Turbine World Wide Distributors



Kawasaki