

Environmentally Conscious Products

Reducing Environmental Impact through Product Life Cycle Efforts for Construction Machinery

We manufacture construction machinery for transport, loading and unloading, at construction sites or factories under the philosophy that the production of construction machinery should enrich the lifestyles of people in the world, and help create comfortable spaces. Some of our actions to reduce our impact on the environment, mainly over the life cycle of wheel loader, are introduced here.



This is our first wheel loader, produced in 1962.

We have a stock of expertise accumulated over more than 40 years, and provide highly reliable products to the market.

1. Procuring Materials

Our products are kept "green" by using only those raw materials and components that pass our Green Procurement Guideline in them.

Green Procurement Guideline

- We procure "green" materials and components based on a relationship of trust with our business partners. The Green Procurement Guideline edited by the Construction Machinery Division in June 2006 is distributed to our business partners to request development of their own EMS and cooperation with our "green" efforts, such as prohibition or reduction of use of hazardous substances.

Substances banned for use or subject to elimination with respect to wheel loader

Green ranking	Main regulated substance
Banned for use	Asbestos, benzidine, polychloride biphenyl (PCB), ozone-depleting substances
Reduction in use (promotion or review of alternatives)	Lead, cadmium, hexavalent chromium, bromic flame retardant, selenium, arsenic, benzene, beryllium, nickel

2. Production

The focal points for our ongoing reduction in environmental impacts in production activities are the saving of resources and energies, reduction in waste generation, and reduction in use or emission of hazardous substances.

Resource- and Energy-saving Activities

- The main body of a wheel loader needs many components of great strength, and thick steel plates measuring 8 to 90 mm in thickness are used. When steel plates are cut to make parts of the necessary shapes, we cut them in such a way as to leave a smaller amount of cut waste, in order to increase the yield of steel plates and eventually reduce consumption of resources.
- For production of the hoist cylinder,*1 we revised the procedure by replacing the conventional cutting of cylinders out from cylindrical metal with producing near-net-shape cylinders in the first place and finishing them, thereby successfully reducing both energy for cylinder making as well as waste generation.



Hoist cylinder manufactured from near net shape

Reduction of Hazardous Chemicals

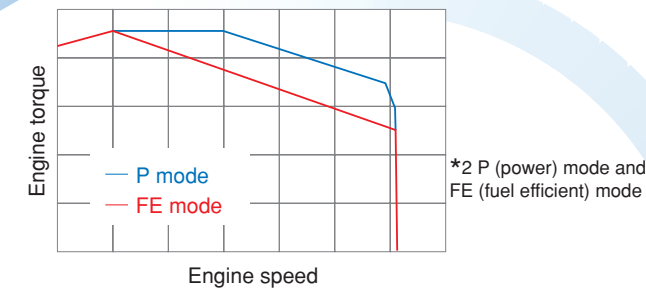
- We completely abolished the use of lead from all kinds of paint used in our production processes as part of our aggressive effort to reduce the quantity of hazardous chemicals in our painting work. In FY2007, we intend to use a type of high solid paint that contains less volatile organic compounds (VOC).

3. Use

In the life cycle of the wheel loader, the greatest environmental impact occurs during its use. Focusing on this point, Kawasaki has introduced various technologies related to energy saving, exhaust gas and noise.

Energy Saving and Emission Reduction

- The computerized engine that optimizes the combustion conditions to match the operation conditions, in addition to the capability to select either of the two types of operation modes,*2 allows our wheel loader to operate at the best condition to match the operation mode. The benefits of this technological feature are both an improved operating capability and energy saving.



- The turbo charger, which improves engine efficiency by raising suction pressure, in addition to the intercooler, which reduces the suction temperature that increases as a result of increased pressure, realizes both improvement of engine efficiency and reduction in NOx and dust and soot contents in the exhaust gas.



Engine fitted with turbo charger and intercooler

- Use of the exhaust gas recirculation system reduces the content of NOx and dust and soot in the exhaust gas by recirculating the exhaust gas with low oxygen concentration into the suction gas in order to lower the combustion temperature in the engine.
- Various measures are also taken to ensure energy saving for the hydraulic system. Examples are the hydraulic pump with enhanced efficiency, a system to start or stop the hydraulic pump to match the timing of loading or unloading, and reduction in pressure loss in the piping system.

Noise Reduction

- Noise from vibration of the engine and hydraulic equipment is always a nuisance to the environment. Our solutions to the noise problem are use of the low-noise engine, introduction of the operation system in the low-rotation range, where less noise and vibration is generated, and improved strength of the surrounding structure for vibration prevention.



Resonant muffler

- We tackle the sound of exhaust by applying the resonant muffler effective in absorbing the sound of specific frequencies that cause noise problems.
- As our solution to the noise of the engine cooling fan, we changed the cooling fan from the engine-direct-driven to the remote-fan-driven by using the hydraulic motor that rotates in the low-noise rotation range.

Sales and After-sale Service

Our order entry system that "produces the product designed to meet the specifications required by the user to meet the desired delivery date," born out of the market-in idea in sales, is supported by an advanced production system that features 14 days for production lead time (period from order placement to shipment). This arrangement allows us to produce the wheel loaders with the required capabilities only in the required quantity, thereby eliminating unnecessary production. Equipped with a nation-wide network, quick responses to troubles, and appropriate maintenance capabilities, our after-sale service can maintain the original functions of the products and support the elongation of their service life, ensuring their long and efficient use.

Kawasaki Machine Systems, Ltd. is in charge of sale and after-sale service, and their services are explained in detail on page 34.

4. Disposal and Recycling

The viewpoint concerning effective use of resources is indispensable when it comes to the disposal of wheel loaders. Reuse and recycling is actively promoted to do justice to our wheel loaders whose service life have expired.

Ease of Recycling

- What is important to promote ease of recycling is that our wheel loader is easily disassembled despite its sturdy structure. For example, FRP parts in which metal was embedded were once used in the rear grill, but such parts were eliminated. Many other ideas that make the machine easier to recycle are integrated into our wheel loader, 98% of which is now recyclable weight ratio.



Rear grill for which use of composite materials is banned

Rebuilding Project (Restoration of transmissions)

- We recover recyclable parts such transmissions or torque converters from the disassembled wheel loaders before disposal. These parts are overhauled, cleaned, and their expendables (if any) replaced with new ones, and rebuilt as service parts for maintenance use.



Transmission being restored in the rebuilding process

*1 Cylinder that operates the bucket (container to load sediment, etc.) of the wheel loader

Environmentally Conscious Products

Reducing Environmental Impact through Product Life Cycle

Efforts for Consumer Products, including Motorcycles and Personal Watercraft

In fields such as motorcycles and personal watercraft, we set clear targets for environmental conservation, namely cleaning exhaust gas, 3R design, elimination, reduction, and management of environmental substances of concern, and we continue our efforts to fulfill those targets.

Cleaning Exhaust Gas

In FY2006, we installed a new computerized fuel injection system in two models of our motorcycles (126 to 250 cc class), ESTRELLA and 250TR, to realize cleaner combustion. We also applied KLEEN*¹ that combines KCA*² which draws in fresh air to the exhaust port to reburn exhaust gas, and the honeycomb catalyzer, which promotes decomposition of HC (hydrocarbon) and CO (carbon monoxide) to remarkably improve of exhaust gas quality. ESTRELLA, 250TR which fully comply with the Japanese motorcycle emission regulation that became much tougher in 2006, were put to market in February 2007.



ESTRELLA, whose emission passed the Japanese motorcycle emission regulation in 2006



Engine fitted with fuel injection system

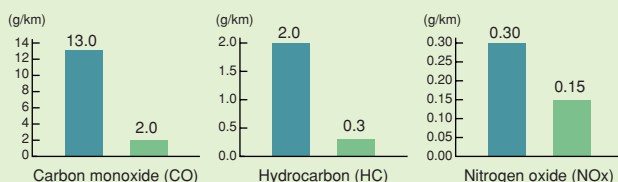
For motorcycles of larger size (251 cc class and over), we were able to clean the exhaust gas by applying a set of clean emission systems combining a computerized fuel injection system, a variable valve timing system that optimizes the timing of valve opening/closing depending on the rotational speed, three-way catalysts and a feedback system.*³ 1400GTR, one of our new products, debuted in Europe, and it fully complies with Europe's motorcycle emission regulations, which have been severely tightened since 2006.



Euro III compliant 1400GTR debuted in 2006

Comparison of Japanese Motorcycle Emission Regulations (Motorcycle Mode Standard)

■ 4-cycle regulated by 1998/1999 standard
 ■ Light motorcycle and compact motorcycle regulated by 2006/2007 standard



Start of the 2006/2007 Regulation for Japanese Motorcycle Emissions

Motorcycle Category	New Products	Existing Products
126 - 250 cc category	Oct. 2006	Sept. 2007
251 cc and up category	Oct. 2007	Sept. 2008

Promotion of 3R Design

Kawasaki, three other Japanese motorcycle manufacturers, and 12 importers voluntarily operate the motorcycle recycling system, in which used motorcycles are accepted from users and recycled, smoothly and successfully.

As a result of the operation of this recycling system, which began in October 2004, we achieved a recycling ratio of 86.7% (weight basis) in the third year (April 1, 2006, to March 31, 2007).

We are also implementing the use of materials that are easier to recycle, as well as the use of material identifying labels on resin parts, and motorcycles that are being newly sold in FY2006 are being built with a recyclable weight ratio of over 90%. We also apply the same design approach to personal watercraft and general-purpose gasoline engines to enhance their recyclable weight percentage.

As for our efforts in weight reduction, we continuously increased the use of light weight aluminum frames in medium- and large-size motorcycles.



Light weight aluminum frame

Elimination, Reduction and Management of Environmental Substances of Concern

With regard to motorcycles, we tackle the challenge of the elimination and reduction of environmental substances of concern to fulfill the goals voluntarily set by the Japan Automobile Manufacturers Association, Inc. (JAMA). We apply the approach to environmental conservation we take towards motorcycles to other products as well, including personal watercraft, in order to eliminate and reduce environmental substances of concern.

For lead, we completed the elimination program at the end of December 2005 except for solder used in electronic

boards, electric parts and bearings in motorcycles. We also completed the replacement of lead-containing coatings with lead-free ones in March 2006 and are working on the reduction of lead in other parts for general-purpose gasoline engines.

The use of mercury was abandoned at the end of September 2004, except for the use of a very minute amount in parts that are essential for motorcycle traffic safety. Cadmium, which had been used in few electric and electronic parts, was fully abolished at the end of December 2006 for motorcycles, personal watercraft and general-purpose gasoline engines.

Also, hexavalent chromium had been used in the rust-preventative treatment of various parts including metal components, bolts and nuts, but in 2005 we started a sequential shift to hexavalent chromium-free parts for motorcycles sold in Japan. Now we are certain that all parts containing hexavalent chromium will be gone by the end of December 2007, which is the goal set by JAMA voluntarily in their effort to reduce environmental substances of concern.

As for hexavalent chromium contained in chemical conversion coating agents used in rust-preventative treatment and the coating base preparation treatment of aluminum parts for personal watercraft and other products, those coating agents were fully replaced with clean ones by the end of December 2006.

For bolts and nuts used in personal watercraft, general-purpose gasoline engines and for-export motorcycles we are increasing the number of parts free of hexavalent chromium, and planning to complete the full shift within 2007.

Schedule for Reduction and Elimination of Environmental Substances of Concern in Motorcycles

Substance	2004	2005	2006	2007	2008
Lead		Completed reduction plan at end of December	(not more than 60g/210kg vehicle weight; battery excluded)		
		Completed reduction plan at end of December	(except for solder on electronic boards and electric parts, bearings, etc.)		
Mercury	Eliminated at end of September	(except for the use of a very minute amount in parts that are essential for motorcycle traffic safety)			
	Completed elimination at end of September				
Hexavalent chromium		Eliminated in motorcycles newly sold in Japan at end of December			
		Elimination scheduled for end of December			
Cadmium		Eliminated at end of December			
		Completed elimination at end of December			

*1 KLEEN (Kawasaki Low Emission System) is an exhaust gas cleaning system consisting of KCA and honeycomb catalyzer.

*2 KCA (Kawasaki Clean Air) introduces fresh air to the exhaust port to reburn the exhaust gas, thereby considerably reducing HC and CO.

*3 Feedback system enhances cleaning efficiency of catalysis by sensing the operating condition and optimizing air-fuel ratio.

■ Kawasaki's achievements
 ▼ Goals of Japan Automobile Manufacturers Association

Environmentally Conscious Products

Reducing Environmental Impact through Product Life Cycle

Efforts for each Product

Kawasaki is actively involved in the reduction of environmental impact through the life cycle of each product in all product fields as well as construction machinery and consumer products, as introduced previously.

Aircraft

We jointly develop and manufacture passenger aircraft with Boeing in the U.S.A. and Embraer in Brazil, and helicopters with Eurocopter in Europe, and thus our technology has resulted in a high international reputation.

The expectation for increasing use of aircraft in future makes it more urgent to take measures for environmental conservation, such as technologies for energy conservation and cleaning of exhaust gas.

One energy conservation technology currently under development for Boeing 787 etc. is the reduction of fuselage weight through the use of carbon fiber composite materials. With our advanced technology in carbon fiber composite materials, we jointly develop and manufacture fuselages for both Boeing and Embraer.

With our own environmentally conscious technology, we also jointly develop and manufacture TRENT 1000, the advanced jet engine of Rolls-Royce in the U.K.

During production as well, we are pursuing the reduction of environmentally hazardous substances by, for example, developing and applying high-solid-type coatings with reduced solvent in painting of fuselages.

Weight Reducing Improves Fuel Efficiency—Boeing 787



Weight reducing by shifting the fuselage material from aluminum alloy or titanium alloy to carbon fiber composite materials resulted in a 20% improvement in fuel efficiency.

Fuselage of Carbon Fiber Composite Materials

The fuselage of the Boeing 787 is made in one piece mold. The front of the fuselage was delivered from Kawasaki as its first shipment.



Ships

We develop and construct a variety of marine vessels, such as LNG carriers, LPG carriers, container ships, bulk carriers and crude oil tankers.

As important measures in reducing environmental impact, we are striving to reduce fuel consumption to begin with; we are working on technological developments to optimize hull shapes, improve the shapes of ship bows, and raise the efficiency of propellers. Our technologies to control the flow around the propeller for increasing efficiency include a Semi-duct System with Fins (SDS-F), a Rudder Bulb System with Fins (RBS-F) and newly developed propulsion system; or the Overlapping Propeller System (OLP).^{*1} We are pursuing to employ these technologies to many vessels.

The electronically controlled diesel engine, developed in 2005, is highly evaluated for its contributions in improving fuel consumption and the environmental impact from exhaust gas emissions.

We are also promoting to employ double-hull construction for fuel oil tanks as effective measures against marine pollution to prevent from leaking oil in case of accident.

Environmentally Conscious Technology for Large Bulk Carrier—Cape Progress



We are pursuing energy-saving measures, with employing a hull shape that receives little resistance, a fuel-efficient diesel engine, high-efficiency propeller, and RBS-F.

World's Largest Class Electronically Controlled Diesel Engine



The engine is equipped with an electronically controlled fuel injection and exhaust valve operation system, which realize the switchover between economy mode and emission mode in operation. Thanks to the above system, soot in the exhaust gas is remarkably reduced. It has been employed well in super-large container ships.

^{*1} Detailed information on the overlapping propeller is provided on page 9.

Rolling Stock

We manufacture a large variety of products, such as Shinkansen trains, limited express trains, commuter trains, subway cars, freight cars and locomotives.

The rolling stock is a means of transport with low CO₂ emissions, but it still needs further improvement. Concerning the environmental impact through the life cycle of rolling stock, as energy consumption is biggest when moving, energy saving during operation is a top priority. We therefore work toward technological cooperation with our customers and adopt technologies such as improving motor efficiency, regenerating electricity during braking, reducing the weight of car bodies, and creating car shapes with little air resistance in order to achieve high energy efficiency for rolling stock.

As one of our proposals for a new urban transit system, we are developing a super low-floor battery-driven light rail vehicle SWIMO equipped with the large-scale nickel-metal hydride battery Gigacell® of our own development.

In FY2006, we developed the Green Procurement Guideline to reduce the environmental impact through the life cycle of our products. We are moving our efforts forward in

cooperation with our business partners, setting hazardous chemical substances such as lead, hexavalent chromium, and cadmium as prohibited materials, and polyvinyl chloride, brominated flame-retardants, and nickel as managed materials.

SWIMO, Friendly to Users and the Environment, Scheduled for Completion in FY2007



The test run of SWIMO equipped with Gigacell® ended successfully. Attention was drawn to its advantages, such as running without trolley wire, and high energy efficiency using all of regenerated electricity.*2

Industrial Plants and Equipment

In the field of the industrial plants and equipment, the development of energy efficient products is crucial.

Industrial plants: Now drawing attention is the internationally proven energy-saving performance of cement plant waste heat power generation system for great reduction of CO₂ emissions.

Gas and steam turbines: Continuing the introduction of new technology is what characterizes our gas and steam turbines. Specific achievements incorporated are reduction in resource use from size-reducing and weight-saving, and extended life as well as improved efficiency.

Hydraulic equipment: In addition to improving efficiency, we are engaged in resource-saving and noise-minimizing by reducing size and weight.

Kawasaki Eco Servo, which is an electro-hydraulic hybrid system with great energy-saving merit, enhances the performance of plastic processing machines and other industrial equipment.

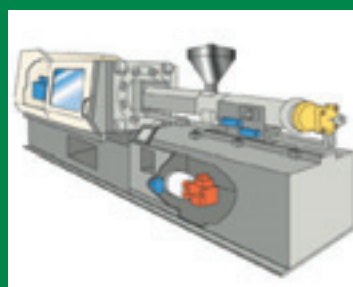
We are also working on applying bio-degradable fluid to eliminate environmental pollution caused by oil leakage.

A Strong Measure for Reduction of CO₂ Emissions—Cement Plant Waste Heat Power Generation System



This system, which generates electricity utilizing the waste heat of exhaust gas from the cement plant, supplies about 30% of power consumption in the whole cement plant. We have so far delivered 30 units of this system, which total reduction of CO₂ emissions of 1.6 million tons/year.

Kawasaki Eco Servo Enhances the Performance of Plastic Processing Machines



This rotates motors and hydraulic pumps only when needed. It succeeds in reducing excess energy loss and noise, which is expected in hydraulic equipment. Applied in plastic processing machines, it enhances performance, and therefore model quality improves.

*2 Electricity power recovered by the motor serving as a generator during braking.

Environmental Solution Products

Products Providing Solutions for Environmental Improvement and Conservation

We address reduction in environmental impact through the life cycle of each product, and are at the same time active in developing products to provide environmental solutions that directly improve or conserve the environment.

Energy Facilities

Global efforts to reduce CO₂ emissions are an urgent requirement for the prevention of global warming. Technologies, such as highly efficient use of energy and effective use of renewable energy, are in growing demand.

We supply energy-related high quality products, such as gas turbines, steam turbines, and boilers using a variety of fuels, and came up with power generation systems*1 made up of combinations of those individual products to match a variety of requirements, thereby contributing to highly efficient energy use.

For technologies of using renewable energy, we provide woody biomass power generation systems, wind turbine generation systems, photovoltaic systems, and geothermal

generation systems.

For technologies to enhance efficiency of energy utilization, we provide ice storage cooling systems that use night-time electricity usefully and the optimization and diagnosis of industrial energy system that optimizes the efficiency of energy utilization of factories and offices.

Promising technologies with great potential include large-scale nickel-metal hydride battery Gigacell[®] leveling the greatly fluctuating electric output of natural power generators, for use in microgrids that connect various dispersed power generation system to ensure stable supply and demand adjustment, in addition to liquid H₂ transport and storage technology towards a future hydrogen society.

Biomass Power Generation System with Internal Circulating Fluidized Bed Boiler



Power is generated from woody biomass, refuse paper and plastic fuel (RPF). The internal circulating fluidized bed boiler with a double partition of our own technology can prevent corrosion and allow mixed combustion of various fuels, thereby contributing to the saving of fossil fuels.

Delivered to Tokai Pulp & Paper Co., Ltd.

Woody Biomass Gasification, Combined Heat and Power System

This system, of our own development, is composed of a fixed-bed gasifier, a gas cleaning system and a gas-engine generator. Lumber waste is used as fuel and electricity and heat (hot water, hot air and cold water via an absorption refrigerating machine) are supplied to the laminate lumber factory.



Delivered to Sekisui House, Ltd.

*1 Detailed information on the gas turbine cogeneration system and combined cycle power generation system is provided on page 10.

Air Pollution Control

Kawasaki's air pollution control technology to reduce acid rain and air pollution caused by photochemical oxidants or suspended particulate matter acquires high reputation from overseas.

We started development of air pollution control technologies, such as De-SO_x/De-NO_x plant and dust collector for flue gas from boilers in the 1970s, and have supplied many systems to various places in the world. Our R&D efforts of low NO_x combustion technologies for various conventional combustion products have enabled us to complete low NO_x gas turbine generation systems, low NO_x coal-burning boilers, and low NO_x heavy oil burning boilers.

Other than combustion equipment, we develop road tunnel ventilation and dust removal system with electrostatic precipitator for cleaning vehicle exhaust gas in road tunnels.

China's Largest-Scale Flue Gas De-SO_x Plant



We supplied flue gas De-SO_x plant for coal-fired power plant in China, which inherently has large environmental impact. Air pollution can be improved by removing SO_x in flue gas.

Waste Treatment and Recycling

It is an urgent task in the field of waste to promote recycling, reduce final disposal waste, and make hazardous substances innocuous.

We develop high-performance refuse incineration systems (stoker type furnaces, fluidized bed furnaces) and refuse gasification and melting systems (fluidized bed gasification and melting furnaces, shaft gasification and melting furnaces) for treatment of urban waste, and supply these to various locations in Japan.

We also supply a refuse derived fuel (RDF) production system and RDF-burning power generation system. By these systems, domestic waste is turned into RDF by the area, and RDF is taken to a single location and used for RDF-burning power generation system with high efficiency.

We are taking measures to prevent environmental pollution with preparing fully functional system for above-mentioned systems to remove and thermally decompose harmful dioxins in the flue gas or fly ash.

Sophisticated Refuse Incineration System and Recycling System



Delivered to Kishiwada City, Kaizuka City Clean Center

Sophisticated refuse incineration system (advanced stoker-type furnace), equipped a plasma ash melting system and a recyclable waste recycling system, generates power at a high efficiency, reduces and cleans flue gas.

Our involvement in recycling system is the development and supply of bulky waste crushing and recycling systems, utilization system for fly ash and coal ash, and recycling systems that turn bottles, cans, PET bottles and plastic containers and packaging into resources.

Plastic Container and Packaging Recycling System (building appearance, compression and baling machine)



Delivered to Otsu city, Shiga prefecture

Intended to contribute to develop a recycling-based society envisioned in the Containers and Packing Recycling Law, this system compresses waste plastic containers into a cube about 1 m on a side and bales them. These baled plastic cubes are available as materials for new plastic products or as an energy source.

Water and Soil Pollution Control

Deterioration of water quality and pollution of soil are serious problems that have impact on the human living environment.

In the field of water treatment, we have established technologies for advanced sewage and sludge treatment system and deliver many sets to various locations in Japan. We also developed various systems using membranes for use in advanced treatment of drinking water and purification of leachate from landfill.

As a facility providing effective uses of sludge, we supply sludge utilization systems that convert sludge into activated carbon, fuel and compost.

Furthermore, we have also developed an on-vehicle sludge drying system that can go around several small and medium-scale sewage treatment facilities.

Methane Fermentation System for Biomass Waste

This system can treat mixture of organic wastes such as



Delivered to Suzu city, Ishikawa prefecture

sludge or human waste and garbage generated from fish processing. The system uses methane gas generated by methane fermentation to heat the facility and dry sludge. Dry sludge is also returned to the local community as organic fertilizer. A great reduction in treatment cost results from this system.