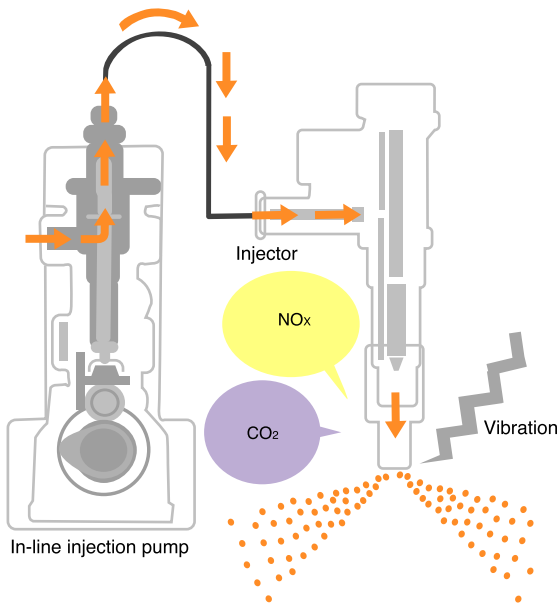


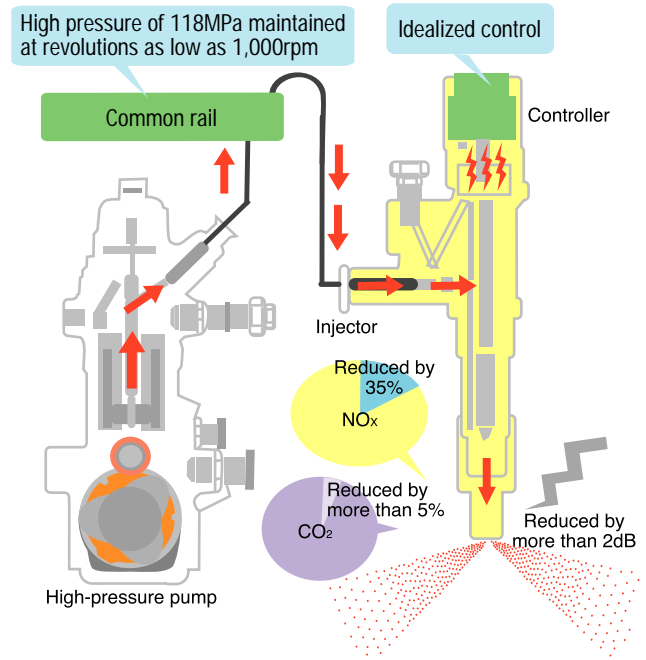


## Electronically Controlled, High-Pressure Fuel-Injection Common Rail System

Conventional fuel-injection system



Electronically controlled, high-pressure fuel-injection common rail system



### Improving Fuel Efficiency

Reducing the fuel consumption of engines brings following benefits:

- (1) to save resources (fossil fuels);
- (2) to provides major economic benefits for customers; and
- (3) to help reduce CO<sub>2</sub> emissions (created by burning fuel), which cause global warming.

Diesel engines used in Komatsu's construction equipment and other machinery offer better fuel efficiency than gasoline engines do. Moreover, they are internal combustion engines, which are superior in suppressing CO<sub>2</sub> emissions. By contrast, steps taken to cut nitrogen oxide emissions, a regulated component of exhaust gas, generally cause fuel consumption efficiency to decline. For this reason, achieving the twin objectives of cleaner gas emissions and lower fuel consumption simultaneously is a major challenge facing engine manufacturers today.

Taking up the challenge, Komatsu has joined forces with Cummins Inc., a leader in diesel engine manufacturing, to establish IPA, a joint-venture company engaging in R&D of diesel engines. The new company is working to develop engines with the world's lowest fuel consumption in their classes.

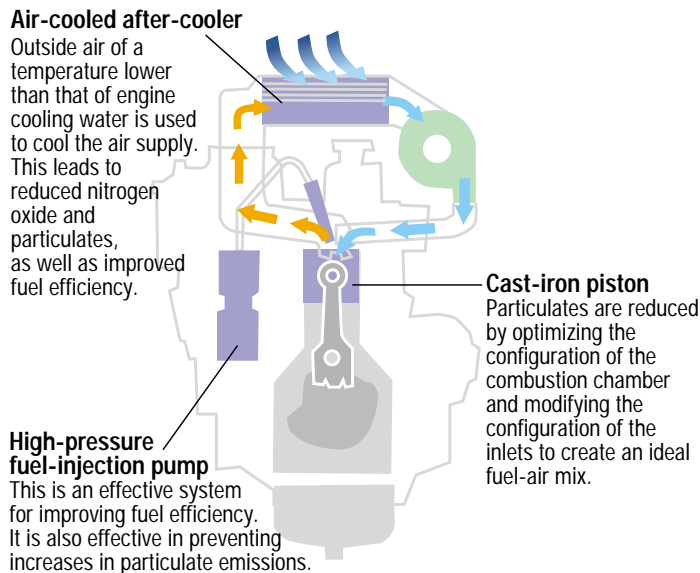
### Electronically Controlled, High-Pressure Fuel-Injection Common Rail System

An effective way to improve fuel efficiency is to accelerate the mixture of fuel and air by using a high-pressure fuel-injection technique. Turning its attention to this technique, in 1999 Komatsu began producing its 6D170 series of engines, equipped with its original HPI (high-pressure injection system). The HPI system is capable of achieving pressures up to 196Mpa, the highest level in the world. In the following year, we developed an electronically controlled, high-pressure fuel-injection common rail system for our 6D125 and 6D140 series of engines.

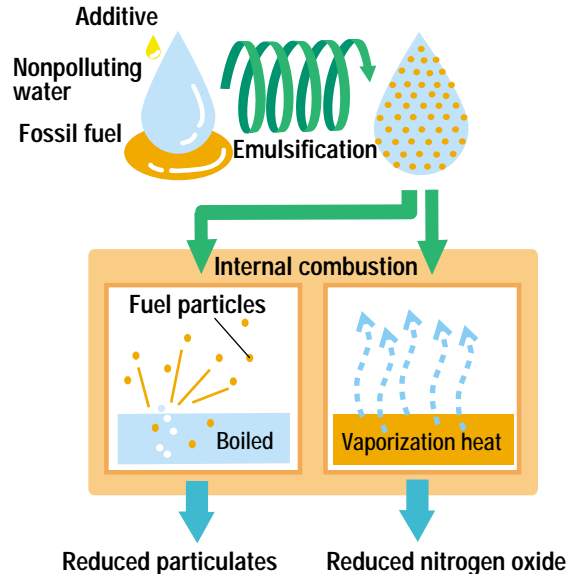
This fuel-injection system can maintain a pressure of 118Mpa at revolutions as low as 1,000rpm, which is a major benefit for construction equipment where low-speed performance is important. We have also equipped the system with Komatsu-made controllers, allowing the most suitable control of both construction equipment and power generation equipment.



### US EPA Tier2 Emission Regulation Certified Engine



### Water Emulsion Fuel



Compared with conventional methods, this system boasts nitrogen oxide emission reduction of almost 85 percent while maintaining excellent fuel consumption efficiency.

### Minimizing Exhaust Emissions

Regulations covering engine exhaust gas emissions target four components: nitrogen oxide, hydrocarbons, carbon monoxide, and particulates (miniscule suspended soot covered by hydrocarbons and water).

Diesel engines used by Komatsu easily conform to regulations covering hydrocarbons and carbon monoxide. The problem with nitrogen oxide and particulates, however, is that efforts to reduce the nitrogen oxide emissions cause the particulates emissions to increase. Reducing emissions of both simultaneously is a major technical challenge.

### Early Introduction of the US EPA Tier 2 Certified Engine

In response, Komatsu introduced a number of new and original technologies to reduce nitrogen oxide emissions and particulate emissions together. These include a high-pressure fuel-injection system, air-cooled aftercooler, and cast iron pistons. Using these technologies, we began full production of four series of engines certified to the US EPA Tier 2 Emission Regulations, ahead of the introduction of such regulations. These were the 5.9-liter 6D102 series, 11-liter 6D125 series, 15.2-liter 6D140 series, and the 23.2-liter 6D170 series.

### New Generation Water Emulsion Fuel and Compatible Engine

Water emulsion fuel, created by mixing nonpolluting water with fossil fuel, provides two important benefits:

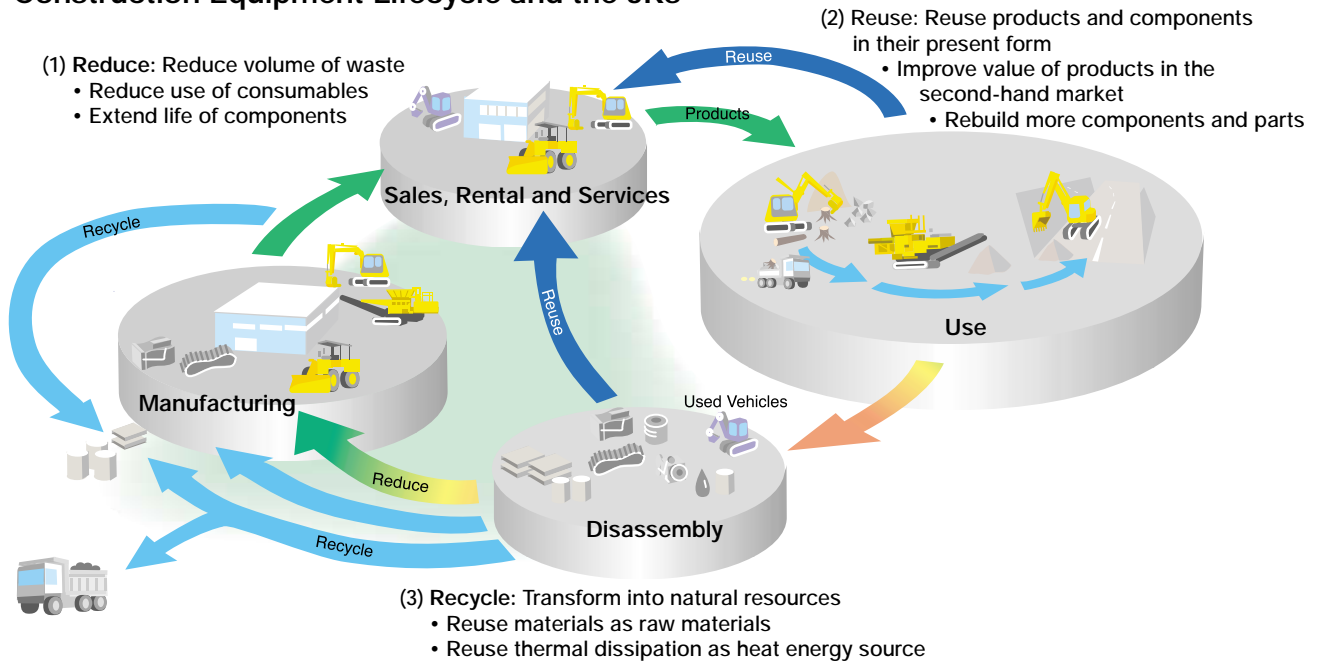
- (1) water vaporization helps lower combustion temperature, facilitating the reduction of nitrogen oxide emissions; and
- (2) water particles burst out when at boiling point, causing fuel particles to scatter, which creates a good mixture of the fuel particles and air which produces less particulates.

Problems with the system are that fuel containing water is difficult to burn, causes corrosion of engine components, and encourages friction and engine seizure. Maintaining engine reliability and durability thus becomes difficult.

We applied our expertise to water emulsion fuel and made further refinements to its diesel engines, thus overcame the problems associated with water emulsion fuel. As a result, we have unveiled a diesel engine generation system with extremely low emission levels. The system can be used in distributed-type urban generation facilities, where the operation of diesel engines was previously inappropriate.



### Construction Equipment Lifecycle and the 3Rs



### Raising Recyclability

#### Targeting Higher Levels of Recyclability

Seeking to make recycling easier, in 1992 Komatsu led the industry in creating a number code system to classify materials in plastic components. In 1993, we introduced 3Rs approach, which embodies our fundamental recycling stance from the perspective of protecting the environment and natural resources.

Aiming further to raise recycling levels, in 1998 we established the following Definitions and Standards of Recyclability to expedite the in-house knowledge sharing process about recyclability ratio.

- (1) Use materials that are easy to recycle;
- (2) Adopt structures that facilitate recycling;
- (3) Prioritize use of recycled materials ; and
- (4) Reduce use of substances that impact the environment.

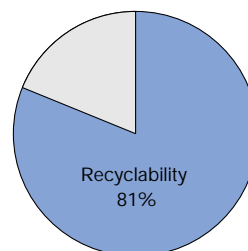
### Product Development Initiatives

In 2000, Komatsu developed a software system for calculating recyclability ratio. Using this software system has made it easier to calculate such recyclability ratio for construction equipment with a component chart under development.

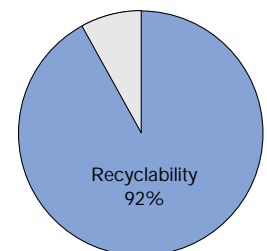
Because construction equipment consists almost entirely of iron and steel components, it generally shows a high recyclability ratio. However, the concrete counterweights of hydraulic excavators present a major challenge. For this reason, Komatsu is actively supporting the recycling efforts of counterweight manufacturers. Working with such manufacturers, we are striving to achieve medium- and long-term environmental targets pertaining to recyclability ratio.

Even in the area of hoses, which have traditionally been difficult to recycle, we have started initiatives aimed at replacing current materials with chlorine-free substances.

### Recyclability of Main Products



Hydraulic excavator (PC200-6)



Wheel loader (WA-100-3)



### Reman Process



### Komatsu's Reman Business

#### What is Reman?

Reman is Komatsu's new coinage to mean "remanufacturing." Following the process illustrated above, we renew components to replace worn parts during repairs and overhauls. Replaced components are then remanufactured at our Reman Centers, then resupplied to the market as Reman products.

#### Features of our Remanufacturing (Reman) Business

Our remanufacturing business not only protects the environment but also provides the following benefits to customers.

- (1) Quality: Customers can use remanufactured products with confidence, since the quality and performance are guaranteed to be on a par with those of new products;
- (2) Cost: Machine running costs can be lowered since remanufactured products are cheaper than new ones;
- (3) Delivery: Thanks to ample inventories of remanufactured products, parts can be replaced immediately, thus machine "down time" shortened; and
- (4) Ecology: Use of natural resources and waste emissions are reduced owing to the reuse and recycling of parts and components.

### Komatsu's Reman Business

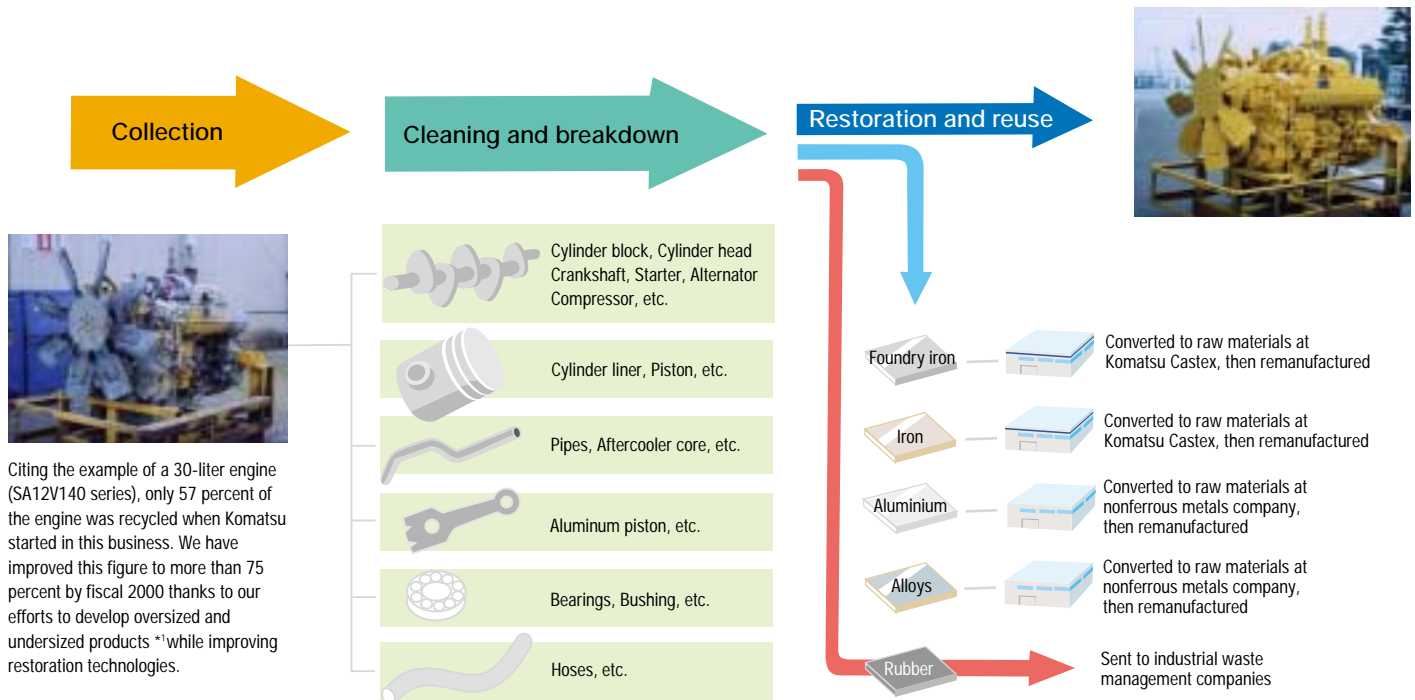
Komatsu has established Reman Centers in seven regions around the world and is working to expand its business in these areas.

In Japan, Komatsu Reman Co., Ltd., is promoting remanufacturing, using CR Units as major components in its construction equipment, including engines, transmissions, torque converters, and hydraulic cylinders.

### Global Reman Business

Location	Reman Center Name
United States (Lexington)	Komatsu Reman North America
United Kingdom (Newcastle)	KEISA Reman Center
Japan	Komatsu Reman
Indonesia (Balikpapan)	P.T. Komatsu Remanufacturing Asia
Australia (Perth)	Komatsu Australia West Coast Reman Center
(Brisbane)	Komatsu Australia East Coast Reman Center
South Africa (Johannesburg)	KSA Reman Center
Brazil (Sao Paulo)	KBI Reman Center

## Engine Parts Recycling Flow



\*1 When the surface of a cylinder block is ground and reused, the ground portion is compensated for by using an oversized gasket, then refitted to an engine with the same specifications.

### Reman Manual

In an effort to raise the reuse ratio at the Reman Centers, Reman manual was produced in cooperation with the Development Division, manufacturing plants, and Reman Centers. It covers such areas as setting standards for reuse ratio of components and scope for restoration of components. The manual enables our Reman Centers to undertake environmental initiatives based on consistent standards.

### Reman Initiative 1: Reduce (Extend Component Life and Establish Restoration Technologies)

Each company in the Komatsu Group is striving to raise the longevity of components while at the same time developing products with high remanufacturing potential. Main endeavors are described below.

- (1) Discuss to set appropriate overhaul intervals for components, maximum number of overhauls, and ultimate appropriate life span;
- (2) Work with seven Reman Centers to gather data on construction equipment operation and component wear and tear and to promote development of enduring components upon setting specific longevity targets for each component;
- (3) Develop methods to restore worn and torn components, to avoid disposal; and
- (4) Study a structure that enables easy component restoration from the initial development stage.

### Reman Initiative 2: Reuse (Set Reuse Standards and Raise Reuse Ratios)

Our Reman business covers breaking down of components returned by customers and cross-referencing of each component with standards for potential reusability. The goal is to raise the reuse ratio of our products. Increasing the number of components reused helps reduce natural resource consumption while also lowering costs.

### Reman Initiative 3: Recycle (Reuse Basic Materials)

Previously, worn-out components were disposed of by our customers and distributors. Now, however, they are sent to Reman Centers for reuse. More than 98 percent of our engines are now returned to Reman Centers.

In Japan, components are restored and reassembled at Komatsu Reman Center. Cast-metal components that cannot be restored or reused are sent to the Komatsu Castex Oyama Plant, where they are melted down and remade as components for new products. Other items, such as aluminum, alloys, and rubber, are collected and separated, then sent to refineries and other facilities, where they are reborn as raw materials for new products.