

## Introduction of Product

# Introduction of Articulated Dump Trucks HM300/350/400-2

Satoshi Ogawa  
 Hirokazu Ashikawa  
 Satoshi Sawafuji

The new articulated dump trucks HM300-2, HM350-2 and HM400-2 came out on the market in January 2006. This time model change was focused on environmental and safety improvements, so that these products meet the EPA/EU Tier 3 emission and EU Stage 2 noise requirements.

**Key Words:** Articulated dump truck, EPA Tier 3 emission regulation, EU Tier 3 emission regulation, EU Tier 2 noise regulation

### 1. Introduction

The high productivity and excellent travel performance of the articulated dump trucks HM300, 1/350-1 and 400-1 were introduced to market beginning 2001 as new products enjoyed a high evaluation in the market. These high-performance products were used in developing new products meeting new regulations and pursuing economical efficiency (Photo 1).

### 2. Objective of Development

(1) Environment and safety

① A clean engine conforming to EPA/EU Tier 3 exhaust gas regulations that will be implemented beginning 2006 are equipped.

② Improvements have been made so that a lead-free aluminum radiator that does not use soldering can be installed and to prevent bleeding of oil from the axle considering the environment.



Photo 1 HM400-2

③ Safety consideration was considered based on EN474 (Safety regulations for earth-moving machinery for EU).

(2) Economical efficiency and productivity

① In order to improve fuel consumption that users are highly interested, the gear shift logic and hydraulic circuit of the transmission have been modified, improving fuel consumption during traveling.

② The engine torque of the HM300-2 has been increased to improve productivity to enhance the travel speed when the load is large, such as during climbing.

### 3. Model Series

The HM400-2, HM350-2 and HM300-2 have changed models (Table 1).

Table 1 Principal specification

	Unit	HM300-2	HM350-2	HM400-2
Body capacity	Maximum loading mass	t	27.3	32.3
	SAE (2:1) capacity	m <sup>3</sup>	16.6	19.8
Weight	Not loaded mass	kg	24040	31060
	Full loaded mass	kg	51340	63360
Engine	Model	—	SAAD125E-5	SAAD140E-5
	Piston displacement	ltr	11	15.2
	Drive output/Rated rpm	kW(ps)/rpm	254(345)/2000	304(413)/2000
	Maximum torque	Nm(kgcm)	1706(174)/1400	1991(203)/1400
Transmission	Model	—	Komatsu multi-axle transmission	—
	Inter-axle differential lock	—	Wet type multiple disc brake	—
	Lateral differential lock	—	L.S.D	Wet type multiple disc brake
	Maximum speed of vehicle	km/h	59	57
Brake	Service	—	Wet type multiple disc brake	—
	Parking	—	Dry type caliper	—
	Retarder	—	Wet type multiple disc brake	—
	Retarder absorption horsepower	kW(ps)	370(503)	444(604)
Regulation conformance	Exhaust gas	—	Tier3	—
	EU dynamic exterior noise	dB(A)	108	109

## 4. Product Features

### 4.1 Environment

To make construction machinery environmentally friendly, the following measures were taken:

- Clean exhaust gases
- Low exterior noise
- Consideration for the environment

#### (1) Clean exhaust gases

The EPA and EU Tier 3 exhausted gas regulations enforced beginning 2006 are complied with by equipping SAA6D125E-5 (HM300-2) and SAA6D140E-5 (HD350/400-2) that use Komatsu's state-of-the-art technology "ecot3."

Examples of emission gas measures are as follows.

A high pressure electronically controlled common rail system that injects fuel in multiple stages is adopted and equipped in the fuel injection system. The system injects the fuel at high pressure and achieves an optimum injection amount and multi-stage injection control, thereby making fuel combustion closer to perfect combustion and reducing PM (Fig. 1).

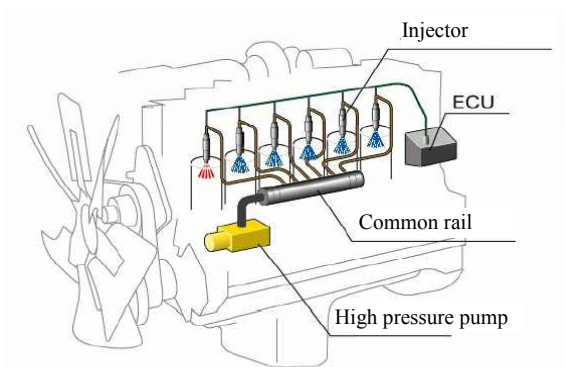


Fig. 1 Fuel injection system

Adopting a cooled EGR in the emission system, exhaust gases cooled by a water-cooled cooler are fed to the air inlet side to lower the combustion temperature, reducing the amount of NOx generated. Controlling the pressure balance between the inlet and emission sides at this time achieves an optimum EGR ratio. To prevent pausing of the EGR when pressure on the emission side is lower than pressure on the intake side, a bypass circuit is provided between the inlet and emission sides. Exhaust gases are fed to the inlet side through inlet air pressure by opening the bypass valve (Fig. 2).

#### (2) Low exterior noise

Vehicles destined for the EU are compliant with EU Tier 2 noise regulations under 2004/14/EC.

The exterior noise of articulated dump trucks is caused mostly by the fan and engine. For this reason, measures to absorb noise in the hood opening, to shield the noise of the hood and to reduce noise around the engine were taken. Figure 3 plots the regulation level.

① The following sound absorption and sound-shielding measures are taken.

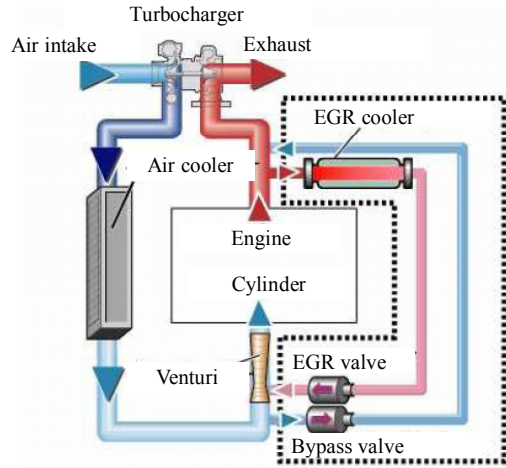


Fig. 2 EGR structure

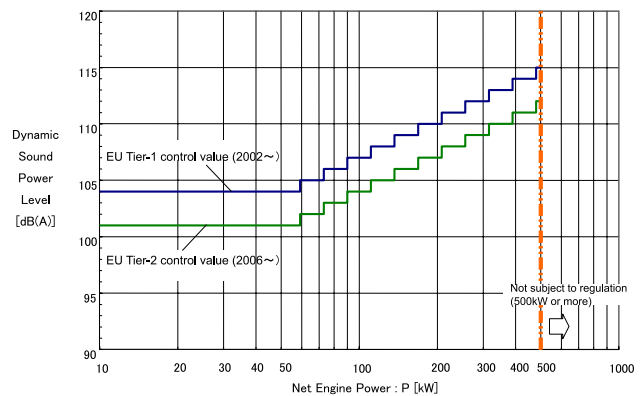


Fig. 3 EU dynamic noise regulation

- A noise absorption braid is mounted in front of the radiator to prevent the leaking of fan noise from the air inlet part to the radiator (Fig. 4).
- A sound-absorbing ventilator is mounted on the emission outlet that exhausts air, which cooled the radiator, to prevent the leaking of engine noise (Fig. 5).
- The seams between the hood and machine cover, etc. are sealed.

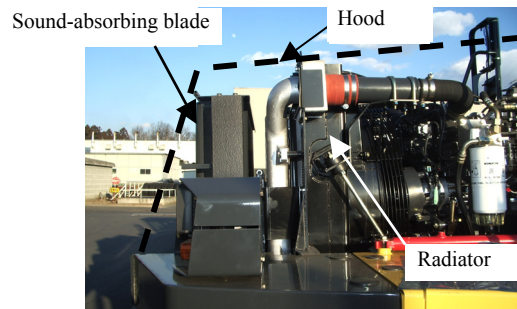


Fig. 4 Radiator air intake opening

- A sound-absorbing material is installed on the inner walls of the hood and under the cab.
- ② The following measures are taken to reduce the noise of sound sources.
  - The engine is modified to reduce noise around the vehicle body.
  - A large-diameter hybrid fan is adopted on the engine to reduce air-cutting sound.

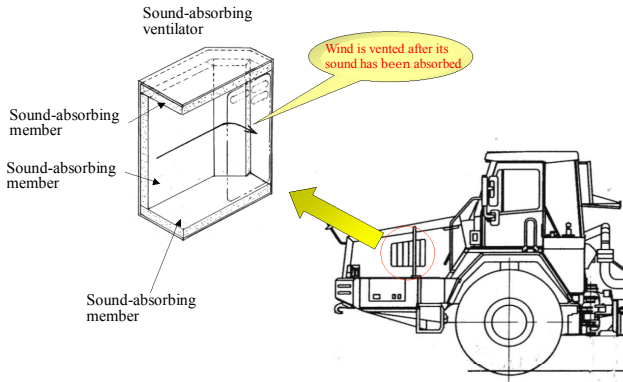


Fig. 5 Hood exhaust opening

- (3) Consideration for the environment
  - Adopting an aluminum radiator  
An aluminum radiator is adopted to prevent environmental pollution by lead.
  - Bleeding of oil from the axle is prevented.  
To prevent bleeding of cooling oil from the floating seal of the axle as much as possible, the following improvements are made.

① Low cooling oil pressure

A brake-cooling valve (BCV, see (3) "Improvement of brake-cooling circuit" in 4.3) is installed in the brake-cooling circuit to reduce pressure applied to the floating seal by directly draining some of the oil from the BCV to the tank when the brake is inactivated.

② The floating seal is changed from a cast iron seal to a thermally sprayed seal to improve the lubricity of the surfaces of the seal.

Oil bleeding could be significantly reduced through ① and ②. Furthermore,

③ An oil recovery tank is installed on each wheel. The system is adopted to accumulate any leaking oil in this tank and to recover the oil by a hand pump equipped on the vehicle during periodical maintenance servicing in case of leaking oil (Fig. 6).



Fig. 6 Oil recovery tank

## 4.2 Safety

The vehicles conform to EEN474. As one example, visibility is described below. Front and side underview mirrors are installed to secure nearby visibility and visibility of 12 m around the vehicle. The glass with heat wires is installed on the rear glass of the cab (Fig. 7).

Furthermore, for the vehicles for EU specifications, a rearward camera is installed (Fig. 8).

The rearward camera interlocks with the operation of the shift lever and displays an image on the monitor in the cab when the shift lever is geared to reverse. This allows the checking of blind spots created by the body.



Fig. 7 Locations of outside underview mirrors



Fig. 8 Rearward camera

## 4.3 Economical efficiency

The loss of horsepower is reduced, and fuel consumption is improved to enhance economical efficiency.

(1) The ratio of operation at low engine load is relatively high in road construction works in which articulated dump trucks are used. In these small load operations, fuel consumption is reduced by changing the gear shift logic of the transmission in the partial region (Fig. 9).

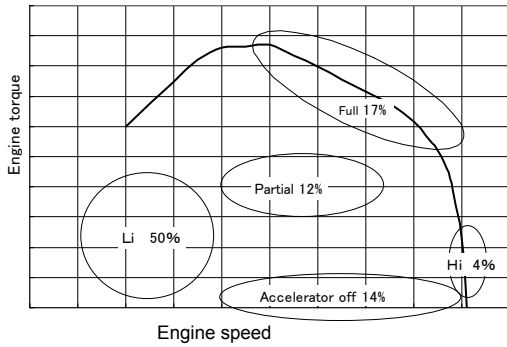


Fig. 9 Engine operation ratio (Example of use)

① The articulated dump truck uses automatic transmission of transmission by a controller. The engine speed during the gear shift is changed according to the engine load in order to reduce engine fuel consumption.

The engine speed is increased for gear shift up during uphill traveling, acceleration and travel with full loaded, when the load compared to the engine is large, to secure a large drive force.

When traveling on a flat road when the load to the engine is low, the engine speed for shift up is set low. As a result, the loss of horsepower is reduced as follows.

- Reduction in racing loss of horsepower of the transmission
- Reduction in driving horsepower of fan
- Reduction in pressure loss of hydraulic circuit

(2) Reexamination of steering work equipment circuit

The HM300-2 adopts a tandem pump as a steering work equipment pump. Circuit pressure losses are reduced, and fuel consumption is improved by changing the distribution of the pump capacity and the circuit.

In existing machines, all the discharge flow rates of Pumps A and B that are required by the hoist circuit flow from the flow amplifier to the hoist valve. However, the amount of oil required by the steering circuit is smaller than that for the hoist circuit. In the new models, therefore, the discharge flow rate of Pump A' is matched to the required oil flow rate of the steering circuit, and oil is supplied to the flow amplifier only from Pump A'. The circuit is made to secure the required oil flow rate of hoist circuit by merging oil, which is to fill the lacking amount of hoist circuit, from Pump B' at the inlet of the hoist valve. This reduces the flow rate of oil flowing in the flow amplifier, and pressure losses are reduced (Fig. 10).

(3) Improvement of brake-cooling circuit

The dump truck forcibly cools the retarder brake installed in the axle by the oil that circulates in the brake in order to travel downhill at high speed. The brake-cooling valve (BCV) adopted in rigid dump trucks is installed in the cooling circuit. This reduces the oil flow rate in the retarder brake when the brake is inactivated:

- To reduce pressure losses of the cooling circuit.
- To reduce racing loss of horsepower of the axle.

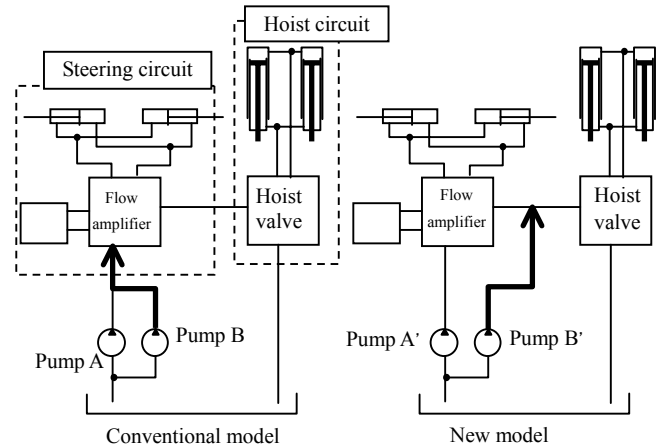


Fig. 10 Steering work equipment circuit

4.4 Productivity

(1) The maximum torque of the engine of HM300-2 is increased by 12% because of changing models.

This has increased the vehicle speed when the running resistance is large such as during traveling uphill and bad roads. The work rate is increased by 10% maximum depending on the process conditions.

Tuned to increases in the torque, the transmission, engine damper, propeller shaft and differential were reinforced.

(2) KOMTORAX II is equipped.

5. Conclusion

Achieving compatibility of the following was a challenge in the development of this product.

- Increased cooling capacity to meet the increase in heat rejection required by compliance with emission regulations.
- Shielding for noise control.

These challenges were addressed by establishing technology based on researches in advance, enabling the smooth development the timely introduction of the products onto the market.

**Introduction of the writer****Satoshi Ogawa**

Entered Komatsu in 1987.  
Currently belongs to Construction Equipment  
Technical Center 2, Development Division

**Hirokazu Ashikawa**

Entered Komatsu in 1991.  
Currently belongs to Construction Equipment  
Technical Center 2, Development Division

**Satoshi Sawafuji**

Entered Komatsu in 1981.  
Currently belongs to Construction Equipment  
Technical Center 2, Development Division

**[A few words from the writer]**

For this development, although the time was short to comply the regulations and meeting the quality target was challenging, we could finish the development in peace. As for the noise remedy, researches could be done with first innovation center in advance, which had the noise and the heat balance passed for first time and gave us spare time. That was a main reason for finishing the development in time.