

## Introduction of Products

### Introduction of Medium Size Wheel Loader WA380-7

Hideki Tsuji

Yutaka Tanaka

*KOMATSU's reputation of "Quality and Reliability" is carried over to the next stage with higher levels of "ecology", "safety" and "information communication technologies". As the result, the medium size wheel loader WA380-7 has been developed to meet Tier4 exhaust gas regulations and has been introduced to its market. The background to development and its technology are described and the sales feature of new product is introduced as well.*

**Key Words:** WA380-7, Wheel Loader, EPA Tier4Interim Regulation, EU Stage IIIB Regulation, Japan 2011 Regulation, Komatsu SmartLoader Logic, Large-Capacity Torque Converter, Lockup, Low Fuel Consumption, Multi-Monitor, Rearview Camera System, Environment, Safety, ICT

#### 1. Introduction

Meeting the Tier3 emission regulation, the conventional machine WA380-6 has won considerable global acclaim thanks to its Hydrau MIND system (variable capacity piston pump + CLSS (Closed Circuit Load Sensing System)), featuring economic fuel consumption and high work performance.

Komatsu has developed and launched a medium-sized wheel loader model WA380-7 meeting the Tier4Interim emission regulation recently enforced in Japan, the United States and Europe. A large-capacity torque converter with a lockup clutch in addition to the Hydrau MIND system and a work equipment system that has been acclaimed by users further enhance the WA380-7 travel performance. Additionally, the Komatsu SmartLoader Logic for engine control has achieved low fuel consumption. This paper describes the new product WA380-7 and the new technologies it incorporates.



**Fig. 1** Model WA380-7

#### 2. Development Objectives

As well as meeting the Tier4Interim emission regulation, higher levels of "Ecology," "Safety" and "Information & Communication Technology (ICT)" were pursued and incorporated as selling points based on "Quality and Reliability" that were previously integrated into Komatsu's products. The following selling points were incorporated in the WA380-7 based on the new technologies developed:

- 1) Environmental friendliness and economic efficiency
  - (1) The WA380-7 mounts an engine meeting the North American EPA Tier4Interim emission regulation
  - (2) Low fuel consumption via coordinated control among the engine, hydraulic system and power line using Komatsu SmartLoader Logic
- 2) Safety and comfortability
  - (1) Rearview camera installed
  - (2) Seat belt caution installed
  - (3) Newly-designed cab
  - (4) Electric work equipment levers mounted on the operator's seat
- 3) ICT
  - (1) Multi-monitor (Installed first on Komatsu wheel loaders)
  - (2) Support to reduce fuel consumption by ECO guidance
  - (3) Fuel consumption management by KOMTRAX
- 4) Maintainability
  - (1) Gull-wing type engine side door
  - (2) Swing-out type rear grille and cooling unit
  - (3) LED lamps

### 3. Main Features

#### 3.1 Engine Meeting Tier4Interim Regulation

The WA380-7 mounts a Komatsu SAA6D107E-2 engine that conforms to North American EPA Tier4Interim, EU Stage IIIB and Japan 2011 regulation. Compared with the Komatsu SAA6D107E engine that incorporates Komatsu Technology “ecot3” (ecology & economy technology 3), the Komatsu SAA6D107E-2 engine has been developed incorporating the following state-of-the-art technologies:

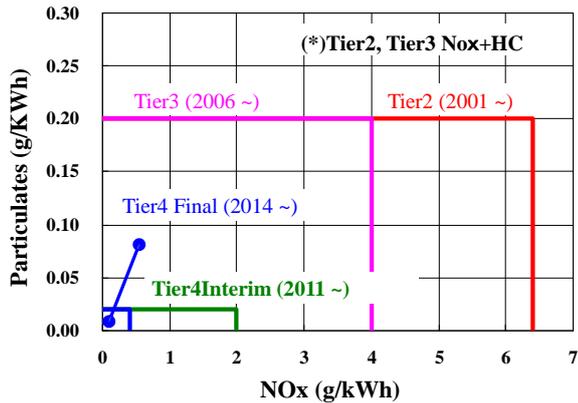


Fig. 2 EPA Off-Road Emission Regulation (130 to 560 kW)

#### (1) Komatsu Diesel Particulate Filter (KDPF)

The engine mounts the KDPF, which captures more than 90% of soot-like particulate matter (PM) contained in exhaust gas. The KDPF comprises an oxidizing catalyst and soot filter with a catalyst. PM is captured by a ceramic soot filter with a catalyst and only purified gas is released into the atmosphere.

The amount of captured PM is detected by a sensor and the PM is automatically combusted and purified by activating the oxidizing catalyst and raising the temperature inside the KDPF by engine control.

#### (2) Komatsu Variable Geometry Turbo (KVGT)

The Exhaust Gas Recirculation (EGR) rate must be raised to purify the NOx contained in exhaust gas. The KVGT is installed to achieve a high EGR rate and controls the exhaust gas flow rate by varying the opening areas of the exhaust turbine blades via a hydraulic actuator. The latter is used to ensure the high reliability and durability required for construction machinery.

#### (3) Cooled EGR system

A high EGR rate increases the EGR flow rate and heat. An increased EGR flow rate requires stable flow control from low to high, for which an EGR valve incorporating a hydraulic servo mechanism is installed for stabilization. An EGR cooler of a high-efficiency flat tube and of the inner fin type is used to reduce the heat build-up of EGR.

#### (4) Komatsu Closed Crankcase Ventilation (KCCV)

The KCCV is installed to remove the PM contained in blowby gas. The KCCV separates the PM and oil contained in blowby gas. PM is captured by the filter; purified exhaust gas is returned to the intake, while the separated oil is returned to the crankcase.

#### (5) New combustion chamber

A newly-shaped cylinder piston that achieves an optimum mixture of air and fuel is installed to reduce NOx and PM. The piston optimizes combustion, thereby reducing NOx and PM. Optimum combustion also improves fuel consumption and reduces noise.

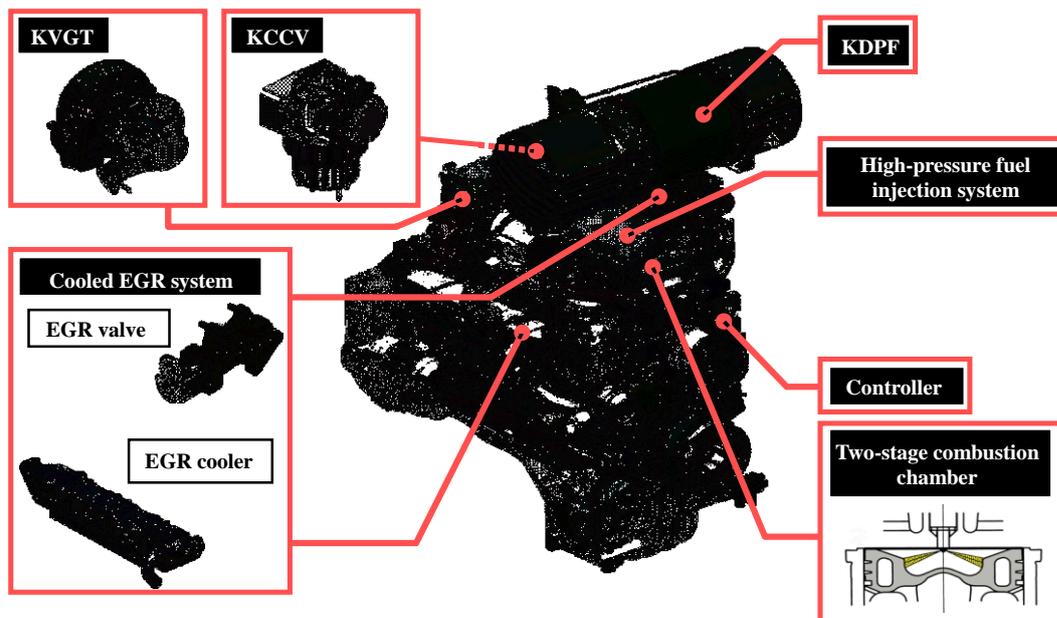


Fig. 3 Komatsu SAA6D107E-2 engine

### 3.2 Reduced Fuel Consumption

A large-capacity torque converter with a lockup clutch is installed to operate the engine in a low speed range ensuring high fuel consumption efficiency. The Komatsu SmartLoader Logic that optimally controls the hydraulic system load, travel system load and engine depending on the work condition is installed. These two features improve fuel consumption by 10% compared with the conventional model WA380-6.

**Table 1** Fuel consumption improvement over conventional model of Komatsu

Result in fuel consumption improvement*	-10%
---	------

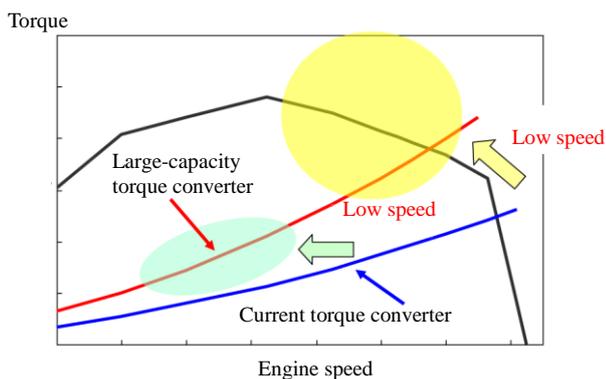
\*: In-house test data (Mode P)  
Improvement result in actual work varies according to conditions and work

#### (1) Komatsu SmartLoader Logic

A new engine control system called “Komatsu SmartLoader Logic” is installed to improve fuel consumption. The engine is operated in a high-efficiency region to reduce fuel consumption by estimating the work condition based on information received from the sensors installed on the machine and by optimally controlling the total engine torque and engine speed according to the hydraulic system and travel system loads.

#### (2) Large-capacity torque converter

The large-capacity torque converter, widely acclaimed in the WA430-6, is installed. While the machine is in travel, a large-capacity torque converter matches the low engine speed range which ensures high engine efficiency and reduced fuel consumption. Also during work in the field, sufficient torque can be obtained in a low engine speed range, allowing over stepping of the accelerator to be avoided and hence reducing fuel consumption.



**Fig. 4** Matching between engine and torque converter

#### (3) Expanded use of the lockup function

The lockup function is included in the standard specification of the WA380-7 (Optional with the conventional model WA380-6). Previously, the lockup function was only enabled at the maximum machine gear speed (3rd or 4th). The engine control by Komatsu SmartLoader Logic enables the lockup function in 2nd to 4th gear speeds in addition to the maximum

gear speed. The Komatsu SmartLoader Logic controls engine torque to facilitate gear shifts and expanded usage of the efficient lockup function has greatly improved fuel consumption from low- to high-speed range. This achieves low fuel consumption through high transmission efficiency; not only in load and carry work, but also V-shape loading work in 2nd gear speed. Needless to say, the large-capacity torque converter with a lockup clutch has significantly enhanced the travel performance.

**Table 2** Travel performance

#### (a) Travel speed (Torque converter mode/Lockup mode)

Unit: km/h

	WA380-7	WA380-6
F1	6.6 / -	6.6 / -
F2	11.7 / 12.4	11.5 / -
F3	20.9 / 22.5	20.2 / 21.7
F4	36.1 / 40.0	34.0 / 35.7

#### (b) Uphill travel speed (10-degree slope)

Unit: km/h

	WA380-7	WA380-6
Torque converter mode	9.3	8.7
Lockup mode	11.3	----

#### (4) Auto idling stop (North American and European specifications only)

The auto idling stop function is installed to reduce idling time, with counting commencing 30 seconds before the set idling time is over. The engine automatically stops when the set time arrives, while the parking brake and work equipment lock are activated. This shortens the idling time and reduces fuel consumption.



**Fig. 5** Auto idling stop

#### (5) ECO guidance

An ECO guidance system is installed to give advice on operations to improve fuel consumption through the multi-monitor. During work, messages are displayed on the monitor screen in real-time and advice on operation methods is displayed on screen. When starting key is off, a message is displayed on the end screen. The operator can check the frequencies of seven items on screen, which are also transmitted to KOMTRAX.

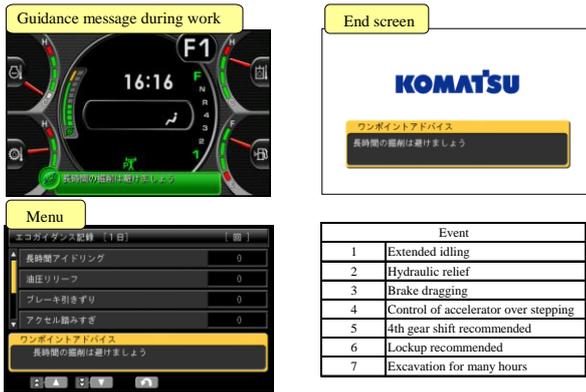


Fig. 6 ECO guidance messages

### 3.3 Enhanced Operator Comfortability and Workability

#### 1) New-design cab

A new-design cab is installed to enhance comfortability and visibility for the operator. It has been ergonomically designed, with various switches installed on a round dashboard to facilitate operation by the operator. The round dashboard allows enlargement of the side and front glass panes downward and visibility has been enhanced. Operator comfortability has also been enhanced by installing a 7-inch color multi-monitor, a console installed to the right of the operator's seat mount and by other measures. Additionally, enhanced cab airtightness, optimum layout of new sound absorbing material and other measures achieved 68 dB(A) on the EU specification for noise close to the operator ears. (72 dB(A) with the conventional model WA380-6)

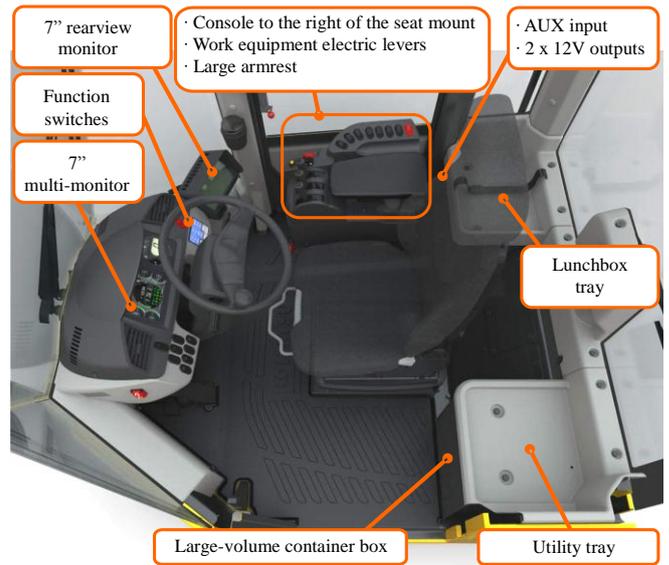


Fig. 8 New-design cab (Inside cab)

#### 2) 7" color multi-monitor and switches

A color multi-screen monitor that uses a 7" high-resolution TFT liquid crystal panel is mounted in Komatsu wheel loaders as a machine monitor for the first time. Compared with the WA380-6, the monitor visibility has been significantly improved and the function switches can display various informations of machine on the multi-monitor. ECO guidance and machine status are displayed in real-time during machine operation to assist the operator. A total of 25 languages are prepared and the desired language can be selected by a function switch, likewise the operation of the air conditioner.



Fig. 7 New-design cab (Comparison between models WA380-7 and -6)



Fig. 9 Machine monitor

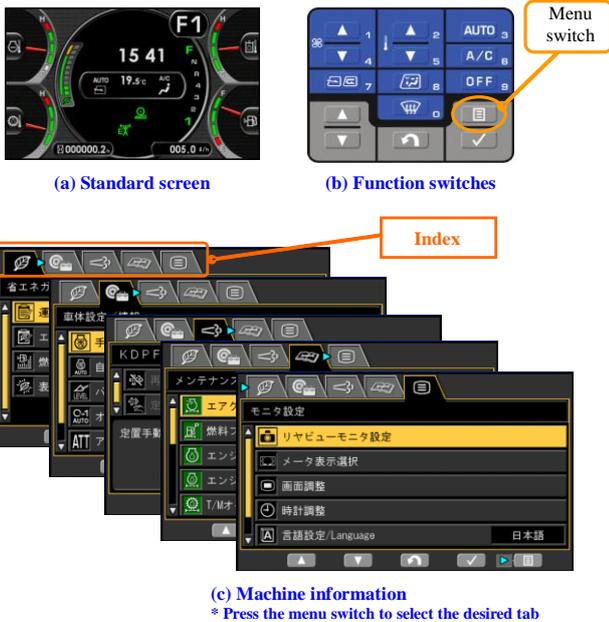


Fig. 10 7” Multi-screen monitor screen

3) Electric work equipment levers and right console mounted on the operator’s seat

The hydraulic work equipment levers mounted on the cab floor were changed in favor of newly developed electric work equipment levers and are mounted near the operator’s seat together with the right console to enhance operability. The right console can be moved longitudinally, while the height and angle of the armrest can be adjusted, allowing the operator to optimize their positional settings. These changes enhance the sense of togetherness between the operator and operational devices such as the electric work equipment levers, thereby upgrading operability. The following functions have been added through electronic control to further enhance the operability:

(1) Remote boom positioner function

This function allows random setting of high- and low-limit positions of the boom height from inside the cab.

(2) Remote bucket positioner function

This function allows the setting of the bucket angle near the ground surface to  $\pm 5$  levels from the horizontal position by operating it inside the cab and the ability to memorize three types of settings.

(3) Auto kickdown function

This function automatically kicks down to 1st gear speed by judging that the machine is in a digging condition based on machine information such as the work equipment position.



Fig. 11 Electric work equipment levers and right console mounted near the operator’s seat

	Transmission Gear Speed			
	1st	2nd	3rd	4th
WA380-7	Auto kickdown		Automatic gear shift	
WA380-6	Kickdown switch		Automatic gear shift	

Fig. 12 Auto kickdown

4) Version upgrading of KOMTRAX

The version of KOMTRAX installed with effect from WA380-3 was upgraded. The newest version receives energy-saving guidance information from the machine such as fuel consumption logs and ECO guidance, in addition to information on the KDPF installed to meet the Tier4 Interim emission regulation. The customer can hence receive enhanced operation support reports.



Fig. 13 Energy-saving guidance information (Multi-monitor)

### 3.4 Enhanced Safety

1) Rearview camera system

A rearview camera system is installed to enhance the rear safety of the machine. A camera is installed in the center of the rear grille and the condition can be checked through a rearview monitor installed to the right of the dashboard. To improve rear visibility, the rearview monitor displays guidelines showing the machine width and a position 1.5 m behind the machine.



Fig. 14 Rearview camera system

2) Seat belt alarm

To urge the operator to wear the seat belt if this is not done, a seat belt alarm is installed. An alarm sign will light up on the multi-monitor in case the seat belt is not fastened.



Fig. 15 Seat belt alarm

3.5 Maintainability

1) Gull-wing engine side door

Gas springs are installed with the engine side door to facilitate opening and closing. The side door opens and closes in two levels. Daily inspections are made in the first-level position and periodic inspections in the second. Independent from the side door, a plastic rear fender horizontally opens with those machines that are installed with a rear full fender (option). This prevents falling mud from soiling the operator during the inspection, while allowing the side doors to be opened or closed free of the weight of snow and mud attached to the rear full fender.



Fig. 16 Gull-wing engine side door

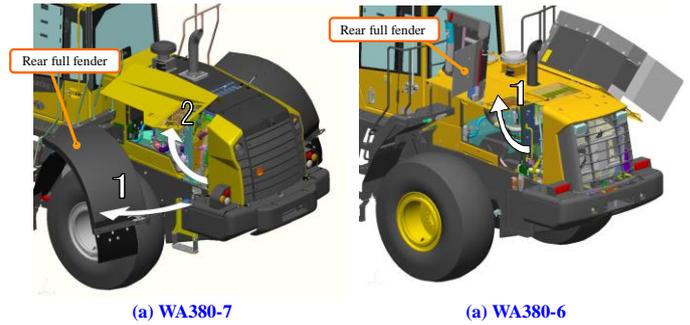


Fig. 17 Opening and closing of the engine side door on machines installed with a rear full fender (option)

2) Swing-out rear grille and cooling unit

A cooling unit with rectangular fins with wide fin spacing to reduce clogging of the cooling unit by small debris, prevent overheating and prolong the cleaning intervals of the cooling unit is installed. To facilitate cleaning work, the rear grille and cooling unit are of the swing-out type.



Fig. 18 Rear grille and cooling unit of the swing-out type

3) LED rear combination lamps (North American and European specifications only)

The stop and backup lights are changed to LED lights to enhance the durability of the rear combination lamps and save energy.

4. Conclusion

The WA380-7 is a product that meets the Tier4 Interim emission regulation and incorporates hydraulic and engine technologies unique to Komatsu and featuring high quality and reliability, as well as state-of-the-art electronic control technologies such as the Komatsu SmartLoader Logic. As a result, a new product that is eco-friendly, features high reliability and is Dantotsu (Unrivaled) in terms of fuel consumption could be built, considerably benefiting its users. The WA380-7 features a stylish appearance and is expected to win wide customer acclaim.

**Introduction of the writers**



**Hideki Tsuji**

Entered Komatsu in 1990.  
Currently assigned to the Construction  
Equipment Innovation Center 2, Corporate  
Research Division.



**Yutaka Tanaka**

Entered Komatsu in 1990.  
Currently assigned to the Construction  
Equipment Development Center 2,  
Corporate Development Division.

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

The WA380-7 has become a well-balanced product through the cooperation of the Awazu Plant, Production Department, Component Development Centers and Test Centers for engines, hydraulic equipment, power trains, controllers and cabs, and Research Division.