

Introduction of Products

Large-size Wheel Loader WA600-8

Katsuhiro Tsutsumi

Minoru Wada

Masaaki Imaizumi

Large-size wheel loader WA600-8 has been developed and put on the market which meets the fourth emission regulation (Tier4 Final) which has begun in Japan, US, and Europe, and pursues a higher level of “environment,” “safety,” and “information and communication technology (ICT)” based on Komatsu’s “quality and reliability.” The major features are introduced.

Key Words: *WA600-8, wheel loader, Tier4 Final, Komatsu SmartLoader Logic, bucket to improve excavation performance, automatic excavation, low fuel consumption, rear-view camera*

1. Introduction

The conventional model WA600-6 has been highly acclaimed by wide area of users since put on the market in 2005, however, ten years have passed since its model change and so the revision has been required because competing products changed their models, and also the fourth emission regulation (Tier4 Final) which becomes effective in 2014 in Japan, US, and Europe has required to be satisfied.

Due to this background, we have developed and put on the market the WA600-8 which includes the newest technologies and satisfies both of productivity and economic efficiency, and the outline is introduced in this report.



Fig. 1 WA600-8

2. Aim of development

Listed below are the selling points of the WA600-8 which meets the fourth emission regulation (Tier4 Final), pursues a higher level of “environment,” “safety,” and “information and communication technology (ICT)” with maintaining the “quality and reliability” which was built up by the conventional models, and includes the developed new technologies.

- (1) Environment and economic efficiency
 - 1) Mounting the engine satisfying the fourth emission regulation
 - 2) Achieving low fuel consumption with applying “Komatsu SmartLoader Logic”
 - 3) Bucket to improve the excavation performance for increasing work efficiency
- (2) Safety and occupant comfort
 - 1) Equipping a rear view camera
 - 2) Mounting around the seat a lever for work machine and Advanced Joystick Steering System
 - 3) Equipping a right-side rear access ladder

- (3) ICT
 - 1) Easy operation applying automatic excavation function
 - 2) Shockless control of work machine
 - 3) Adoption of color liquid crystal multi-monitor
 - 4) Support for reduction of fuel consumption applying eco-guidance function
 - 5) Vehicle control applying KOMTRAX Plus
- (4) Maintenance performance
 - 1) Feedback-type hydraulically powered fan
 - 2) Easy maintenance of exhaust-gas aftertreatment device
 - 3) Sun gear braking service brake
 - 4) Equipping battery disconnect switch

3. Main features

3.1 Environment and economic efficiency

- (1) Mounting the engine satisfying the fourth emission regulation

Komatsu SAA6D170E-7 engine has been developed to satisfy the regulations such as EPA: Tier4 Final for North America, Stage IV for EU, and the 2014 regulation for Japan, and include the following newest technologies.

- 1) Komatsu Diesel Particulate Filter (KDPF)

The engine is equipped with a KDPF which can trap more than 90% of particulate matter (PM) such as soot contained in exhaust gas. The KDPF is composed of an oxidation catalyst and a soot filter equipped with catalyst. PM is trapped by the ceramic-made soot filter equipped with catalyst, and only purified gas is emitted into the outdoor air.

In addition, the trapped amount of PM is detected by a sensor, and the PM is automatically burned and removed by activating the oxidation catalyst with the engine control to raise the temperature in the KDPF.

- 2) Selective Catalytic Reduction (SCR)

The engine is equipped with the system which reduces through catalytic function the NOx generated with engine combustion into nitrogen and water using ammonia. In the vehicle, a harmless urea aqueous solution, used instead of ammonia, is sprayed from an injector under high temperature to be converted into ammonia to be used.

- 3) Komatsu Variable Geometry Turbocharger (KVGT)

The removal of NOx contained in exhaust gas requires the percentage of Exhaust Gas Recirculation (EGR) to be increased. The engine is equipped with a KVGT to achieve high EGR percentage. The KVGT controls an exhaust gas flow rate by controlling the opening area of exhaust gas turbine blade using a hydraulic actuator. The hydraulic actuator is adopted to ensure high reliability and durability which are required for construction machine.

- 4) Cooled EGR system

High-percentage EGR increases EGR flow rate and EGR heat quantity. For the increased EGR flow rate, the stable control of the flow rate from low to high flow rate is necessary. Hence, the engine is equipped with an EGR valve which uses a hydraulic servomechanism for the stabilization of the flow control. In addition, to reduce the increased EGR heat quantity a high efficiency flat-tube & inner-fin type EGR cooler is adopted.

- 5) Komatsu Closed Crankcase Ventilation (KCCV)

The engine is equipped with a KCCV to remove the PM contained in blow-by gas. In the KCCV, PM and oil contained in blow-by are separated: the PM is trapped by filter and the purified gas is returned to the intake, and the separated oil is returned to the crank case.

- 6) 200 MPa common rail fuel injection system

The adoption of both the electronic control common rail fuel injection system with 200 MPa of maximum injection pressure which has increased reliability and durability for construction machine and a new combustion chamber has achieved both the reduction of PM and better fuel consumption performance.

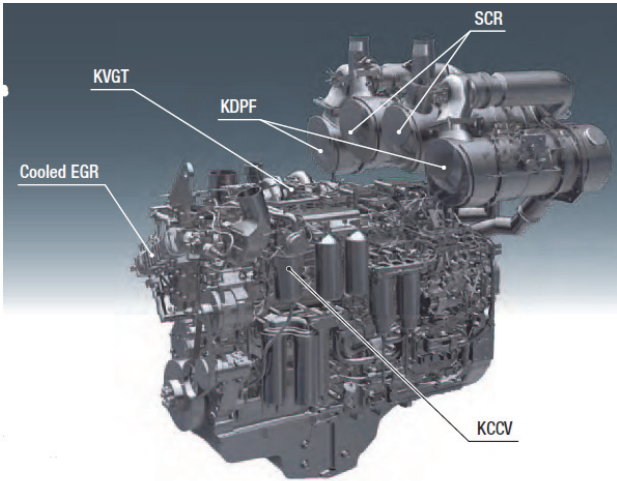


Fig. 2 SAA6D170E-7, Engine to Satisfy Tier4 Final

7) Engine room exterior duct structure

We have adopted the engine-room inside air discharge structure using air flow from radiator fan in which duct function is installed in engine room exterior to efficiently release the heat generated from the engine itself and exhaust gas aftertreatment device, which allows the opening size for heat release from the exterior to be minimized and achieves the compact disposition of engine aftertreatment device, the prevention of the overheat of equipment in engine room, and the ambient noise reduction from the engine.

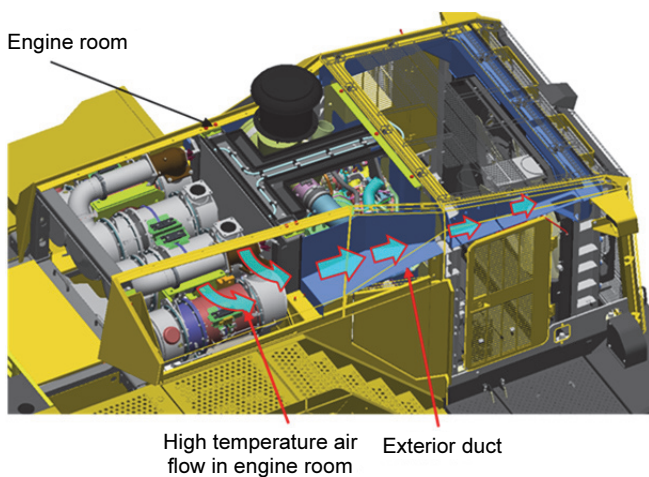


Fig. 3 New Technologies Incorporated in Engine (cited from in-house document)

For the WA600-8, the engine is equipped with 2 sets of KDPF and exhaust gas aftertreatment devices of SCR, and so the height of the engine hood is lowered and the rear view from the operator cab can be kept being the same as that of the conventional model, WA600-6.

(2) Achieving low fuel consumption with applying “Komatsu SmartLoader Logic”

We have adopted the engine control system “Komatsu SmartLoader Logic” which can increase fuel consumption efficiency by generating an optimal engine torque for the work load. The fuel consumption has been drastically reduced by maximally utilizing, using the information from the sensors loaded in the vehicle, the mechanical potential of a large capacity torque converter with lock-up, a modulation clutch, a variable capacitor piston pump and closed center load sensing system (CLSS) which have been installed in the conventional models.

The lock-up function, which has been already installed in the conventional model, WA600-6, was only effective for the highest speed gear (the third or fourth gear). The engine control using Komatsu SmartLoader Logic allows the lock-up function to be used for not only the highest speed gear but also the second to fourth gears. This is because the engine torque control using Komatsu SmartLoader Logic enables smooth shift transmission, and also the expansion of the use of the efficient lock-up function has improved the fuel consumption in low speed to high speed area.

The in-house excavation-loading test (V-shape work) shows that the fuel consumption per hour has been decreased by 13% compared to the conventional WA600-6 model.

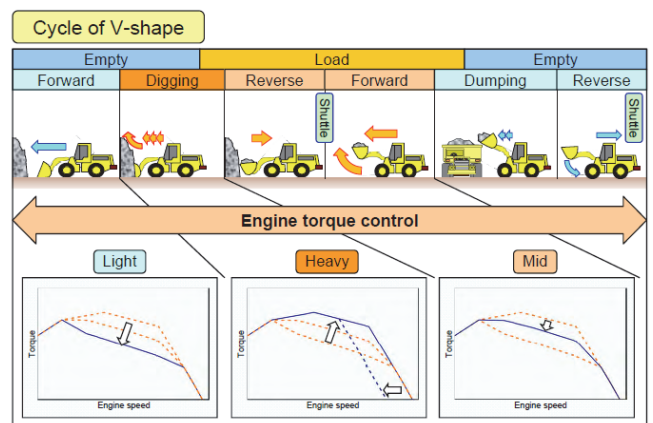


Fig. 4 Engine Torque Control Using Komatsu SmartLoader Logic

- (3) Bucket to improve the excavation performance for increasing work efficiency

Having the shape of bucket suited for excavation work has increased the work rate per fuel by 7% compared to the conventional bucket in the test conducted in the company. The test conducted with unskilled workers has shown the increase of the work amount and the improvement of the fluctuation of the loading amount.

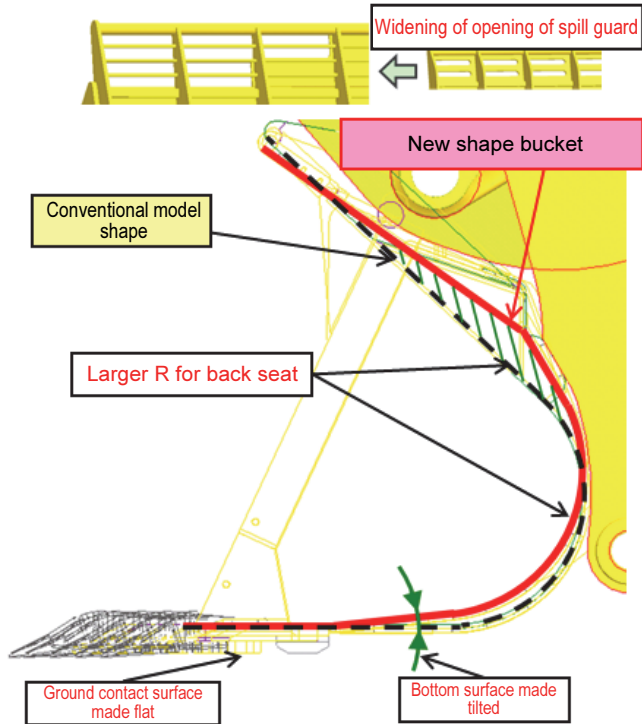


Fig. 5 Improvement of excavation performance of bucket

3.2 Safety and occupant comfort

- (1) Equipping a rear view camera

A rear view camera is installed to increase the rear safety of a vehicle. A camera is installed in the middle of the rear grill, and the situation can be checked with a rear view monitor installed in the right side of the dashboard. In addition, to facilitate the recognition of the rear status, the guidelines which show the vehicle width and the position 1.5 m rear of the body are displayed in the rear view monitor.



Fig. 6 Rear View Camera System

- (2) Mounting around the seat a lever for work machine and Advanced Joystick Steering System

To improve the manipulation performance of operator, the work machine lever which used to be mounted on a cab floor has been designed to be made lighter and mounted around an operator seat together with the left and right consoles. The consoles can be adjusted in the front and rear directions and the height and the angle of the arm-rest can be adjusted, and so the operator can set the most suitable position.

The adoption of the Advanced Joystick Steering System in the left side which has been highly acclaimed since the conventional models and the integration of an air suspension seat and the left and right operational levers into the arm-rest enable the work while maintaining the best position.



Fig. 7 Operator Seat Integrating Work Machine into Advanced Joystick Steering System

- (3) Equipping a right-side rear access ladder

In WA600-8, equipping an up-and-down ladder on a full fender of the right rear tire and two-stage opening/closing of a side cover enables both easy access during engine maintenance and safe moving up-and-down.



Fig. 8 Right-side Rear Access Ladder

3.3 ICT

(1) Easy operation applying automatic excavation function

The development of the “semi-automatic excavation” function which has been installed in the conventional models and the control using feedback signals from the work machine hydraulic sensor can easily ensure almost the same work amount for unskilled workers as that of skilled workers, and can lower the work load for skilled workers.

Without using the work machine lever, the “automatic excavation” function allows both the kick-down operation which shifts the gear down to the first gear to ensure the driving force during excavation and the lift/tilt operation required for excavation work. This allows the operator to focus on acceleration work, and therefore even unskilled workers can adjust their work amounts by controlling the pressing depth on an acceleration pedal.

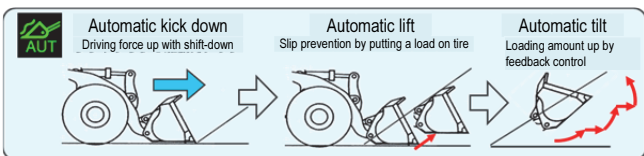


Fig. 9 Outline of Operation of Automatic Excavation Function

For the reduction of work load of an operator, the decrease of the work machine operation during excavation due to the use of “automatic excavation” reduces the load of right-hand lever operation of work machine by 20 to 30%. (In-house test: right-hand lever operation amount of work machine per cycle of V shape)

(2) Shockless control of work machine

Large-size wheel loader has large impact during collision because the inertia of the work machine is large. The impact when stopping at the position set by a bucket positioner or a boom positioner which has been used for the conventional models is lessened due to the normal stop function of the positioner, however, the impact due to the collision at the operation limit after excavation or earth removal is not lessened.

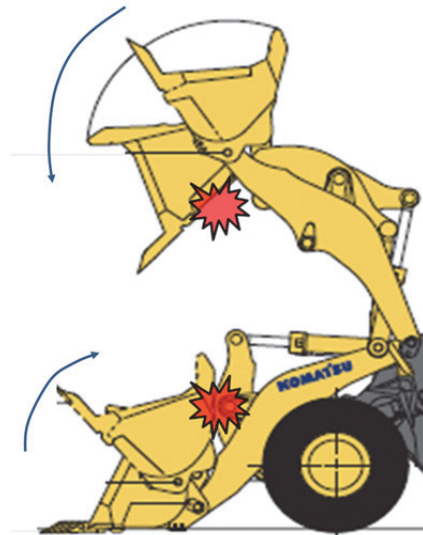


Fig. 10 Impact at Operation Limit after Excavation or Earth Removal

For WA600-8, we developed a new function as work machine shockless control to lessen the impact during collision. Impact lessening enables three-stage adjustment using multi-monitor.

(3) Adoption of color liquid crystal multi-monitor

The mechanical monitor is equipped with a color liquid crystal multi-monitor using a high-resolution seven-inch color liquid crystal panel. The visibility of the monitor is extremely improved compared to WA600-6, and the adoption of a function switch allows the display on the monitor of load weight of load meter function and various kinds of mechanical information such as seat belt caution and eco-guidance. The language to be displayed can be selected using a function switch from 25 languages. And also air conditioning can be manipulated by the function switch.

(4) Support for reduction of fuel consumption applying eco-guidance function

The operator is alerted in real-time on the multi liquid crystal monitor to long-time idling, excavation work, and hydraulic relief. The advice is given in a timely fashion about the most appropriate operation method for fuel consumption improvement by suggesting the lock-up function during high speed driving.



Fig. 11 Color Liquid Crystal Multi-monitor and Eco-guidance

(5) Vehicle control applying KOMTRAX Plus

KOMTRAX Plus can now additionally acquire various types of information such as vehicle position information, operation status, and fuel consumption information which are adopted in the Komatsu's models for middle or small size construction, and has a much more powerful data collection ability with a larger size memory capacity compared to the conventional models. This has greatly improved the function as a service tool, and also enables the service improvement for the clients such as recommendation of more accurate overhaul timing and more appropriate operation advice.

To facilitate a shorter-time and easy download of increased memory information, download function using

wireless LAN communication (Wi-Fi) is now a standard feature.

3.4 Maintenance performance

(1) Feedback-type hydraulically powered fan

The adoption of feedback control with fan rotation speed using a rotation sensor of a radiator fan can lower the fan rotation speed further down at low temperature compared to the conventional models and have achieved the improvement of air warming performance and the stabilization of cooling performance during the fluctuation of mechanical load.

The reverse rotation fan function allows the foreign objects which are clogged in the radiator core to be regularly blown away. The mount bracket of the hydraulic powered fan is a swing type and the structure is such that a core can be easily cleaned if a fan net is removed so that the core can be high-pressure washed from the inside during the maintenance.

(2) Easy maintenance of exhaust-gas aftertreatment device

For the easy maintenance of exhaust-gas aftertreatment device which is added to WA600-8, a door to facilitate access from above the vehicle is installed on the engine exterior.



Fig. 12 Swing-type Fan and Engine Exterior Door

(3) Sun gear braking service brake

For easy brake maintenance, the position of the service brake of front and rear axles is changed from wheels to sun gears, and a final is splittable structure.

A service brake being sun gear braking has increased the heat balance performance due to the downhill braking and also lowered the weight of the whole axle.

(4) Equipping battery disconnect switch

To improve the safety during the maintenance, a large size battery disconnect switch is a standard feature of WA600-8. In addition, the adoption of a circuit breaker enables the earlier restoration in case of failure.



Fig. 13 Battery Disconnect Switch

4. Conclusion

The vehicle we describe above has been developed to deal with the approaching time limit of the Tier4 Final regulation even after skipping the transitional Tier4 Interim regulation regarding the technically-challenging fourth emission regulation; and ends up having a unique system in which two sets of exhaust-gas aftertreatment devices are installed, and including many new technologies as a first model change in ten years; has become a well-balanced product even with many new technologies included based on our advantage that we internally make major components such as engines, powertrains, hydraulic devices, and controllers.

Introduction of the writers



Katsuhiko Tsutsumi

Joined Komatsu Ltd. in 1985.
GM, Large-size Loader Development Group,
Construction Equipment Technical Center 2,
Development Division, Komatsu Ltd.



Minoru Wada

Joined Komatsu Ltd. in 1991.
Team Leader, Large-size Loader
Development Group, Construction
Equipment Technical Center 2,
Development Division, Komatsu Ltd.



Masaaki Imaizumi

Joined Komatsu Ltd. in 1989.
Chief Engineer, Large-size Loader
Development Group, Construction
Equipment Technical Center 2,
Development Division, Komatsu Ltd.

[A few words from writers]

WA600-8 has already been put on the market sequentially area-by-area starting from North America, and fortunately the newly included functions are highly acclaimed by users, for which we feel we get rewarded.

To make the market introduction smoother, we would like to promptly and carefully follow the information from the market.