

Featured Articles

EH-3 Series Dump Trucks Enhanced by Comprehensive Capabilities of Hitachi

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OVERVIEW: Building on the technologies used in its EH-2 Series, Hitachi Construction Machinery has developed the EH-3 Series of dump trucks with standard features that include an AC drive system and vehicle stability control jointly developed by drawing on the comprehensive capabilities of Hitachi. The EH-3 Series incorporates vehicle stability control to provide more stable driving than previous models while still maintaining the high levels of acceleration and electric braking performance for which they have earned a strong reputation. Hitachi Construction Machinery has also enhanced the competitiveness of the new series by offering it on the market with a choice of engines to suit different customer requirements, with either a Cummins Inc. (standard) or MTU (option) diesel engine able to be mounted in the same truck frame. It is also equipped with a peripheral vision support system to help prevent on-site collisions.

INTRODUCTION

HITACHI Construction Machinery Co., Ltd. released its EH3500ACII mining dump truck with a maximum payload in the 170-t class in September 2008, followed by the 220-t-class EH4000ACII in April 2010. These two models incorporated an alternating current (AC) drive system using insulated-gate bipolar transistors (IGBTs) made by Hitachi, Ltd. that earned them a strong reputation for their driving performance among other features. Subsequently, Hitachi Construction Machinery released the 290-t-class EH5000AC-3 mining dump truck in March 2013. The new model provided greater reliability and driving performance while still maintaining the high level of driving and handling performance provided by the AC drive that were features of the EH-2 Series. The EH5000AC-3 pairs with the EX8000-6, Hitachi’s largest excavator, and is experiencing rising demand. It was designed to win market share from its competitors. Hitachi Construction Machinery also released the EH3500AC-3 and EH4000AC-3 in December 2014. These dump trucks are upgrades of the EH3500ACII and EH4000ACII, augmented with features developed for the EH5000AC-3.

The following features are common to all EH-3 Series dump trucks.

- (1) Use of technologies from the EH4000ACII
 - (a) Cab support attached using bolts

- (b) Wide cab (same cab used on all models)
- (2) Vehicle stability control
- (3) Options available for all models in series
 - (a) Fuel tank suitable for 24-hour operation
 - (b) Option to use MTU Friedrichshafen GmbH engines
 - (c) Trolley option
 - (d) Peripheral vision support system

VEHICLE SPECIFICATIONS

Table 1 lists the specifications for each model.

TABLE 1. EH-3 Series Dump Truck Specifications
 The table lists the specifications of the EH3500AC-3, EH4000AC-3, and EH5000AC-3 dump trucks.

		EH3500AC-3	EH4000AC-3	EH5000AC-3
Nominal payload (t)		181	221	296
Payload capacity (m ³)		117	154	202
NMW (t)		141	163	204
Target GMOW (t)		322	384	500
Engine Model/ output (kW)	Cummins	QSKTA50-CE 1,491	QSKTA60-CE 1,864	QSKTT60-CE 2,125
	MTU (option)	12V4000 C21 1,510	16V4000 C21 1,864	16V4000 C20L 2,125
Length (m)		13.56	14.39	15.49
Width (m)		9.13	9.33	9.60
Height (m)		7.00	7.31	7.52
Tire size		37.00R57	46/90R57	53/80R63

NMW: net machine weight GMOW: gross machine operating weight

By keeping the net machine weight (NMW) to a minimum, the EH-3 Series achieves class-leading payloads. Hitachi Construction Machinery also takes advantage of its ability to choose which engines to purchase to offer customers a choice of engines from either Cummins Inc. or MTU, based on considerations such as emissions regulations, fuel costs, and the availability of engine support in the location where the trucks are to be used.

FEATURES OF THE EH-3 SERIES

The features of the EH-3 Series are the result of bringing together the comprehensive capabilities of Hitachi and offer significant potential for

differentiation from competing models. The following sections describe the vehicle stability control and the peripheral vision support system features.

Vehicle Stability Control

Hitachi drive control is a vehicle stability control system that uses new control software developed utilizing the comprehensive capabilities of Hitachi and has succeeded in improving productivity and safety by performing precise torque control. Advances in driving control technology of this sort have been achieved as a result of working with technologies of Hitachi, Ltd. honed over many years in electrical control and motor development. The technology not only reduces driver workloads, but is also expected to

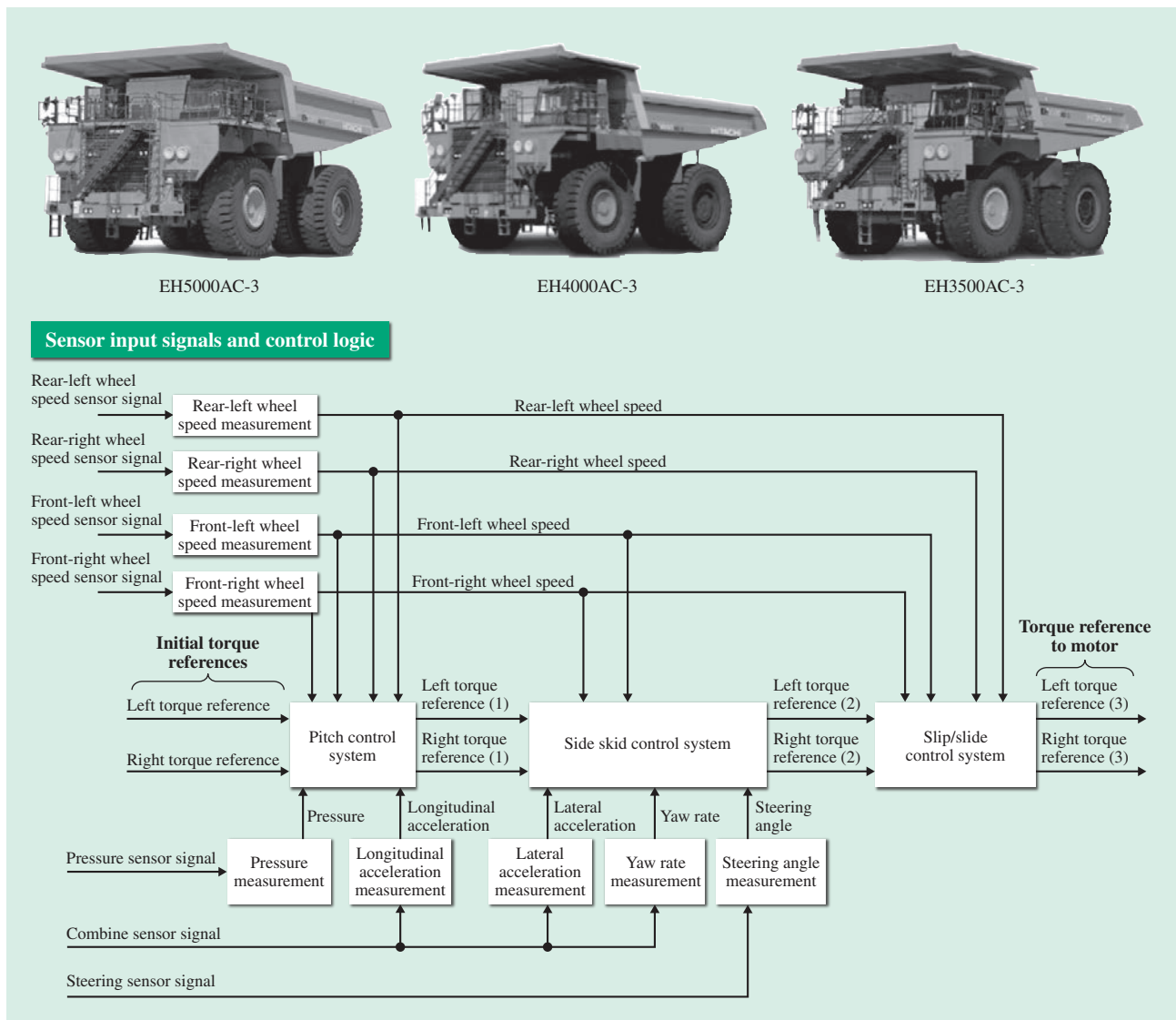


Fig. 1—EH-3 Series Dump Trucks and Configuration of Vehicle Stability Control. The photographs show the EH3500AC-3, EH4000AC-3, and EH5000AC-3 dump trucks. The diagram shows the sensor input signals and control logic used to implement the Hitachi drive control vehicle stability control system.

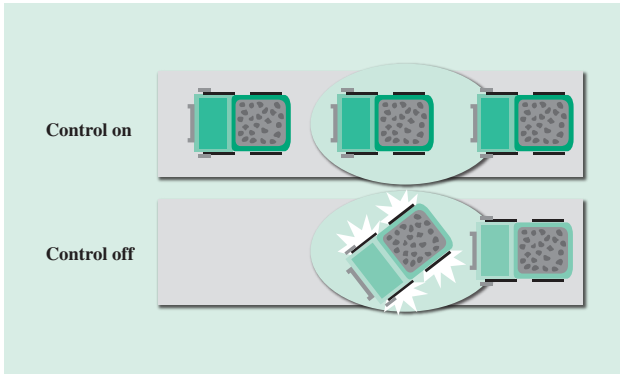


Fig. 2—Slip/Slide Control System.
In addition to providing stable acceleration and braking, the system also reduces tire wear.

reduce customers’ management and maintenance costs by reducing accidents and by extending the life of the vehicle and its components thanks to the reduced load on the vehicle.

Hitachi drive control consists of three different types of control: a slip/slide control system, a pitch control system, and a side skid control system. Fig. 1 shows a block diagram of the sensor input signals and control logic used to implement these systems.

(1) Slip/slide control system

This system provides smoother driving together with more stable acceleration and braking, including enhanced responsiveness, by reducing the traction motor torque when it detects the rear axle freewheeling or locking when starting, accelerating, or braking on slippery or uneven roads (see Fig. 2).

(2) Pitch control system

This system reduces cab swaying to improve ride comfort and prevents load spilling by reducing the traction motor torque when it detects pitching in situations such as when driving over uneven roads or when starting rapidly or driving uphill (see Fig. 3).

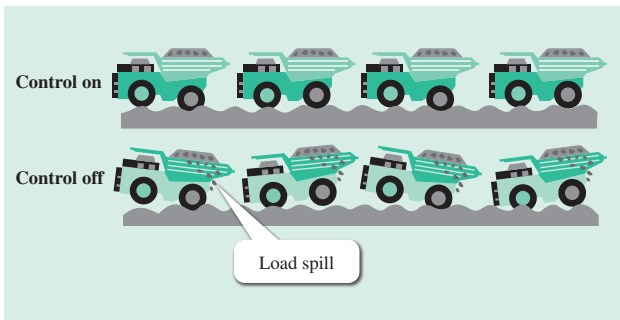


Fig. 3—Pitch Control System.
The system improves ride comfort, prevents load spilling, and reduces stress on the vehicle.

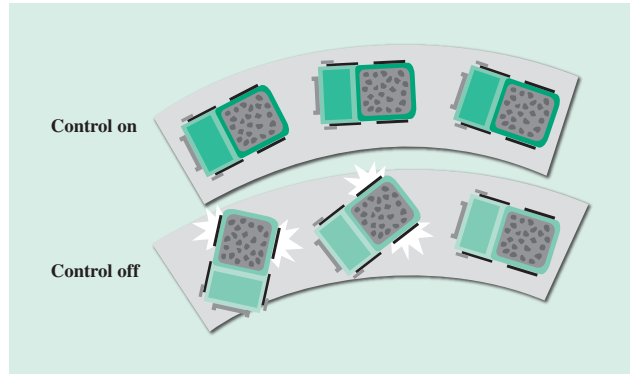


Fig. 4—Side Skid Control System.
The system provides a stable feel to steering when cornering.

(3) Side skid control system

This system provides a more stable cornering feel by controlling skidding during cornering to ensure smoother driving by reducing the traction motor torque when the rotation of each of the four wheels indicates that the vehicle has become unstable due to the steering, accelerator, and braking actions of the driver (see Fig. 4).

Peripheral Vision Support System

The potential for accidents such as collisions between dump trucks and service cars, graders, or other equipment is a safety issue at mine sites. Accordingly, there is a demand for systems that can minimize or prevent such accidents. To help reduce such accidents, a peripheral vision support system is available on the EH-3 Series as an option.

The system was developed based on technology for cars developed by Clarion Co., Ltd., a Hitachi Group company. Hitachi Construction Machinery and Clarion also worked together to overcome issues

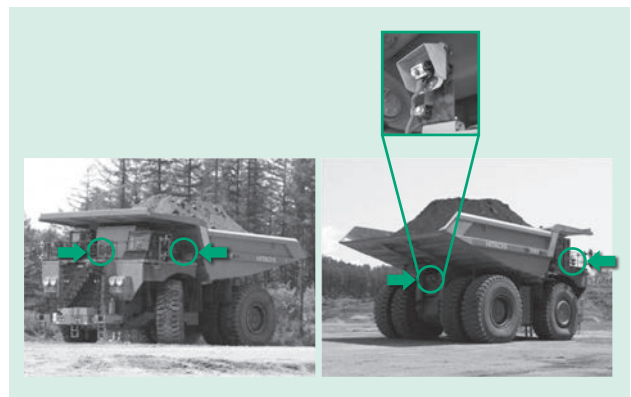


Fig. 5—Camera Locations.
Four cameras are mounted at the front, rear, and sides of the vehicle. The photograph shows an EH5000AC-3.

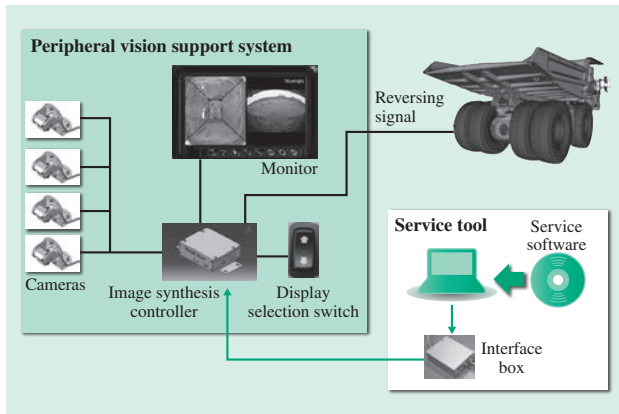


Fig. 6—Configuration of Peripheral Vision Support System. The image synthesis controller combines images from the four cameras. The driver can use the display selection switch to view what is happening around the vehicle as required.

specific to dump trucks, which are considerably larger than cars, based on technology developed by the Hitachi Research Laboratory of Hitachi, Ltd. The peripheral vision support system consists of four cameras at the front, rear, and sides of the vehicle, an image synthesis controller, display monitor, and display selection switch (see Fig. 5 and 6).

Fig. 7 shows where the display monitor is mounted in the cab and example screens. A display selection switch can switch between monitor images to allow the driver to view what is happening around the vehicle as required. The display can be switched between a number of options, including a combined wide-angle bird's-eye view and rear view, a medium-range bird's-eye view, a close-in bird's-eye view, and direct feeds from the left and right side cameras.

FUTURE DEVELOPMENTS

Deployment on Standard Dump Trucks

The EH-3 Series combines Hitachi's latest technologies to reduce management costs for customers and improve driving performance for drivers. In the future, Hitachi intends to establish a secure position in the market by further improving comfort, reliability, utilization, and serviceability, reducing fuel consumption, and striving to extend the range of special models it can offer for things like trolley operation, low noise, high-altitude operation, and high output.

Autonomous Haulage System (AHS) Dump

Although global demand for mining machinery has recovered from the low it reached in 2003, it has fallen again due to the slowing of economic growth

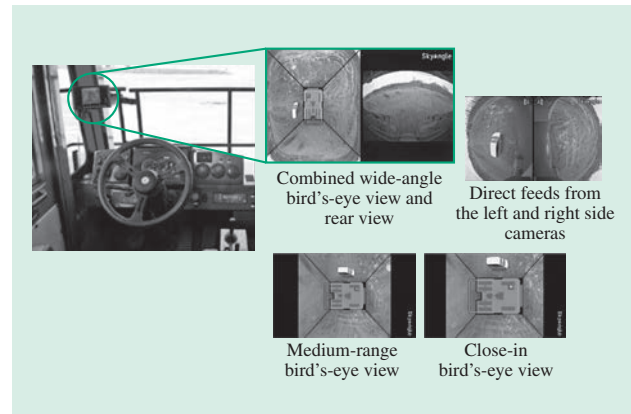


Fig. 7—Display Monitor Mounting Position and Example Display Images.

Images from the four cameras are combined to provide a realtime view of the area around the vehicle and display it on the monitor in the cab.

in China and elsewhere. Nevertheless, the long-term outlook through to 2020 is for the market to expand. On the other hand, because mines are characterized by poor living conditions and dangerous work, acquiring staff is becoming more difficult leading to rapid rises in labor costs. In response, Hitachi Construction Machinery is proceeding with the development of autonomous haulage systems for driverless dump trucks. Hitachi's existing technologies include railway traffic management systems, robotics, and car navigation, and the aim is to utilize these together with the comprehensive capabilities of Hitachi to implement such systems in the near future.

CONCLUSIONS

This article has focused on Hitachi drive control and a peripheral vision support system, two features of the EH-3 Series that were developed by drawing on the comprehensive capabilities of Hitachi.

In the future, Hitachi Construction Machinery hopes to enhance Hitachi drive control so that it can balance the loads on the front and rear axles with aims that include reducing tire wear and raising haulage speeds by increasing cornering speeds, and to develop a safety system that adds moving and static object detection functions to the peripheral vision support system.

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