Special Story 2
Development Story of Tier4-compliant Vehicles/Engines

Since 1996, the exhaust emission regulations applicable to construction machinery in Japan, the U.S.A. and Europe have become increasingly severe every five years, and from 2011, will enter into a stage with coming into force of the Tier4 regulations.

What was required was advanced technology that would make it possible to make exhaust gas “cleaner” and improve fuel efficiency. On the occasion of writing this report, we asked members of the Research and Development divisions who helped to overcome this hurdle to tell us about their passionate involvement in their work.

Emissions Standards for Japan, the U.S.A. and Europe (See page 12)

Vehicles with Tier4-compliant Engines

The Road to Tier4-compliant Hydraulic Excavators and Improved Fuel Efficiency (Reduction of CO_2)

Seiichi Fuchida, Group Manager
Research Division, Construction Equipment Development Center 1, Hydraulic Excavator Development Group

The following are the main issues faced in the development of Tier4-compliant vehicles:

(1) Improvement in engine exhaust heat rejection
(2) Space required to mount exhaust gas treatment equipment
(3) Creation of control logic for the exhaust gas treatment equipment
(4) Improvement in fuel efficiency

In earlier research, Komatsu confirmed the performance of Tier4 test vehicles after benchmark tests and tests of Tier3 vehicles. Tests were conducted under different climatic conditions, such as at high altitudes and in extreme cold, and assuming various loads. Tier4-compliance and improved fuel efficiency (10% lower than conventional equipment) were confirmed in the earlier research. A method for evaluating fuel efficiency was also established, so that our customers could actually see that they are saving fuel.

We encountered considerable difficulties in our development trying to satisfy the requirement for improved fuel efficiency. At the same time, we encountered problems that had not been experienced, such as freezing of the intake circuit and soot (PM) formation due to incomplete combustion by the Tier4-compliant Komatsu disel particulate filter (KDPF). However, regardless of how imposing the problems were, we overcame it by mustering all our resources.

I think this was due, firstly, to Komatsu’s technical capabilities and, secondly, to those who uphold the company’s corporate tradition. Our quest for environmentally friendly products will never stop.

Keeping this in mind, we will continue to focus our efforts on development.

PC220/PC240LC-10 hydraulic excavator

Development of Bulldozer D65-17 (Tier4-compliant)

Kazushi Nakata, Team Leader
Research Division, Construction Equipment Development Center 1, Small Equipment Development Group

The D65-17 inherited the low fuel consumption (5% lower than conventional equipment) achieved with the D65-16, and has been further developed to incorporate ICT (Information Communication Technology) and to feature higher environmental compatibility and safety.

We modified the engine in various ways, for example, by adding exhaust gas aftertreatment equipment and a variable geometry turbocharger. We tried not to compromise the vehicle’s performance, including its acceleration, responsiveness, and fuel efficiency. To confirm that the exhaust gas aftertreatment equipment works normally under different conditions, we conducted various environmental assessments, including high altitude tests in Nagano Prefecture and low temperature tests in Rikubetsucho, Hokkaido.

D65-17 bulldozer

This was followed by renewed testing of the control system, and included hardware fixes. Although our development schedule was tight, we were able to start mass production with minimum delay, thanks to the cooperation of all the development centers and manufacturing staffs.

The Road to Improved Fuel Efficiency (Reduction of CO_2) on Dump Trucks

Hitoshi Nakanishi, Team Leader
Construction Equipment Development Center 2, Dump Truck Development Group

With the articulated type dump truck HM300-3, we developed a product that has exceptionally low fuel consumption (8% less than conventional equipment), while being able to handle the same work load as the conventional dump truck. On top of this, the product features lower-noise, environmentally friendly operation.

To achieve this, we needed to use a variable piston pump to efficiently control the engine rpm and torque, as well as the hydraulic pressure. It took repeated tuning sessions to achieve maximum performance for the dump truck and to complete the development.

On screen eco guidance as a visual aid helps improving fuel efficiency.

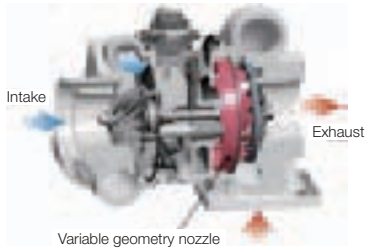
HM300-3 articulated type dump truck

Tier4-compliant Engines

Developing Engines Compliant with New 2011 Emission Standards

Yoshimi Tamura, Senior Manager
Development Division, Engine Development Center, Planning Office

Compared with Tier3, Tier4-compliant engine is required to reduce soot (PM) emissions to one-tenth, so the Tier4 emission standard is a very stringent requirement that cannot be met simply by extending the technology used for the transition from Tier2 to Tier3. Technology used in existing on-road trucks cannot be applied to construction equipment, so we devoted considerable time and effort to develop an aftertreatment device and a variable geometry turbocharger to reduce soot (PM) emissions. Leveraging Komatsu's in-house vehicle and engine development and production capabilities, we laid out a detailed set of check items and succeeded in developing a product that was differentiated from our competitors' products.

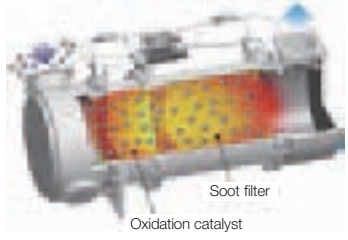


Variable Geometry Turbocharger

Challenge to Develop Tier 4-compliant Komatsu Disel Particulate Filter (KDPF)

Shinichiro Inoue, Team Leader
Research Division, Construction Equipment Innovation Center 3
Component Technology Unit 2

Having had experience in marketing tunnel construction machinery equipped with the KDPF since before the time of the Tier3 emission standards, Komatsu was initially under the impression that evolving this technology to meet the Tier4 requirements would be easy. But working on Tier4, we soon realized that conditions had changed significantly in comparison with Tier3, because of the drastically lower exhaust gas temperature. The problem we identified was that the soot (PM) collected in the KDPF did not combust naturally during operation but continued to accumulate. To solve this problem we needed to develop of a forced regeneration system that would combust the soot (PM) accumulated in the KDPF whenever it reaches a certain level. Due to these unexpected problems we had to work day and night to meet the deadline.

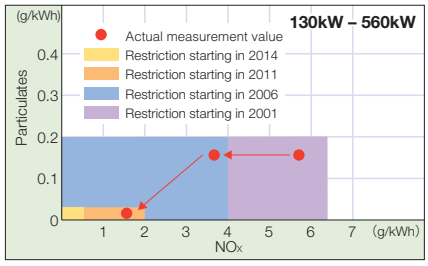


Komatsu Diesel Particulate Filter (KDPF)

◆Emissions Standards for Japan, the U.S.A. and Europe

	Restriction starting in 1996	Restriction starting in 2001	Restriction starting in 2006	Restriction starting in 2011	Restriction starting in 2014
Japan	Restriction starting in H8	Restriction starting in H13	Restriction starting in H18	Restriction starting in H23	Restriction starting in H26
U.S.A.	Tier1	Tier2	Tier3	Tier4 interim	Tier4 final
EU	StageI	StageII	StageIIIA	StageIIIB	StageIV

◆Komatsu's Actual Measurement Values under the Exhaust Emissions Regulation



◆Timetebles for the Emission Regulation of Japan, the U.S.A. and Europe

Restriction starting in 1996 | Restriction starting in 2001 | Restriction starting in 2006 | Restriction starting in 2011 | Restriction starting in 2014

	kW	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Japan	19 – Less than 37	8.0 / 0.80*1						6.0 / 0.40*1				4.0 / 0.03*1		
	37 – Less than 56	7.0 / 0.40*1						4.0 / 0.30*1				4.0 / 0.025*1		
	56 – Less than 75							4.0 / 0.25*1		3.3 / 0.02*1			0.4 / 0.02*1	
	75 – Less than 130	6.0 / 0.30*1						3.6 / 0.20*1		3.3 / 0.02*1				
	130 – Less than 560	6.0 / 0.25*1						3.6 / 0.17*1		2.0 / 0.02*1				
U.S.A.	Less than 19	9.5 / 0.80*2	7.5 / 0.80*2					7.5 / 0.40*2						
	19 – Less than 37	7.5 / 0.60*2						7.5 / 0.30*2				4.7 / 0.03*2		
	37 – Less than 56	7.5 / 0.40*2						4.7 / 0.30*2						
	56 – Less than 75							4.7 / 0.40*2		3.4 / 0.02*1			0.4 / 0.02*1	
	75 – Less than 130	6.6 / 0.30*2				4.0 / 0.30*2								
	130 – Less than 560	6.4 / 0.20*2			4.0 / 0.20*2				2.0 / 0.02*1					
	560 –	9.2 / 0.54*2			6.4 / 0.20*2				3.5 / 0.10*1				3.5 / 0.04*1	
EU	19 – Less than 37	8.0 / 0.80*1							7.5 / 0.60*3					
	37 – Less than 56	7.0 / 0.40*1						4.7 / 0.40*3				4.7 / 0.025*3		
	56 – Less than 75									3.3 / 0.025*1			0.4 / 0.025*1	
	75 – Less than 130	6.0 / 0.30*1				4.0 / 0.30*3								
	130 – Less than 560	6.0 / 0.20*1			4.0 / 0.20*3					2.0 / 0.025*1				

*1: NOx/PM *2: NOx+NMHC/PM *3: NOx+HC/PM (g/kWh)