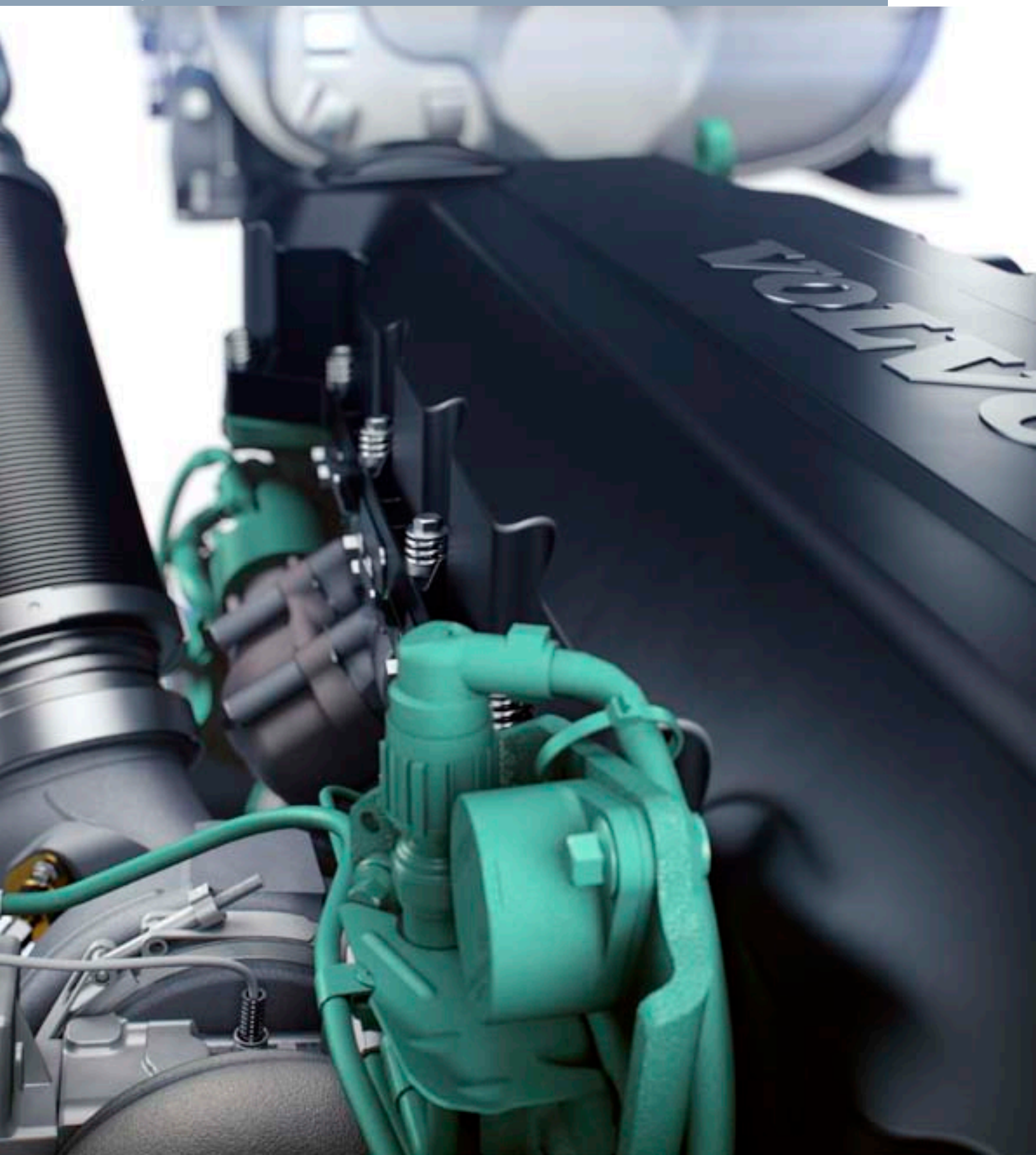


VOLVO CONSTRUCTION EQUIPMENT

# STAGE IV / TIER 4 FINAL ENGINES

215-469 hp



# WORLD-CLASS ENGINE MANUFACTURER SINCE THE 1800S.

With more than a 180 year history of innovation, Volvo Construction Equipment is at the forefront of technological development. Part of the Volvo Group, Volvo CE is one of the world's largest manufacturers of heavy duty diesel engines (9 to 18 liter / 550 to 1,100 cu in) and is in a unrivalled position thanks to the combined strength of the Group and all the benefits of shared technology. Using proven, smart technology experienced and skilled Volvo engineers have developed and rigorously tested a new engine system that meets the demanding Stage IV (EU) and Tier 4 Final (US) emission reduction requirements and improves fuel efficiency by up to 5%.



## Volvo design

Volvo is one of the few manufacturers that design and make both engine and machine – providing an exceptional advantage when it comes to creating optimized performance and efficiency. Volvo customers benefit from the increased quality that derives from having a machine designed, manufactured, assembled and serviced by one company. A perfectly matched all-Volvo powertrain delivers unrivalled performance, fuel efficiency, productivity and reliability.

## Application knowledge

Volvo is a global and leading supplier of premium construction equipment. Our engineers are experts at optimizing the integration of the engine and the machine – both are developed by Volvo and are perfectly matched to all the applications in which the equipment operates. The new Stage IV/Tier 4 Final engine has been comprehensively tested and validated in both bench and multi-application field testing to ensure maximum performance, productivity and durability.



1893

Volvo develops its first crude oil powered internal combustion engine which is followed by small two-stroke, low-speed (1000 rpm) diesel engines.



1946

Volvo introduces three and four cylinder diesel engines with direct injection which are followed by turbocharged, direct injection heavy-duty diesel engines.



1978

Intercooler technology is introduced leading to the world's first truly low-emission diesel engines - constant engine refinement ensures greater fuel efficiency.



1991

In anticipation of Tier 1 emission standards, Volvo introduces air-to-liquid intercoolers with a Twin Pump device for higher engine efficiency and lower emissions.



Volvo put customer needs at the heart of its design process and developed Stage IV/Tier 4 Final engine systems that improve fuel efficiency by up to 5% and provide superior quality, reliability, durability and ease of operation. Designed and built by Volvo's expert engineers, the powerful low-emission engines deliver the ultimate combination of high productivity and low fuel consumption.



2001

Volvo introduces the Engine Management System which ensures high performance and low emissions - this innovation precedes Tier 2 emission regulations.



2005

To meet Tier 3 emission regulations, Volvo introduces the Advanced Combustion Technology (V-ACT) allowing in-cylinder emissions control and helps lead the way to Tier 4 compliance.



2011

Building on V-ACT, Volvo's Tier 4i platform exceeds regulations - an accomplishment made possible by leveraging our extensive on-highway experience.



2014

Volvo Construction Equipment continues to develop V-ACT and delivers engines for the final tier of emission regulations with a technology proven through our on-highway presence.

# D8

Number of cylinders		6	
Displacement	L cu in	7.8	476
Rated output range	kW hp	160-250	215-335



## Engine Management System (EMS)

The EMS instantaneously adapts performance to each new operating situation. The new-generation, advanced EMS boasts a more powerful processor to support more functions, with higher precision and increased control speed.



## Selective Catalytic Reduction (SCR)

SCR is not new to Volvo – it's a technology that Volvo Trucks has used since 2005. The Volvo solution centers on AdBlue®/DEF being injected into the exhaust gas flow where it is heated and produces ammonia. This causes a chemical reaction in the catalyzer which converts  $\text{NO}_x$  to nitrogen and  $\text{CO}_2$  – both of which are naturally found in the air.

## Diesel Oxidation Catalyst (DOC)

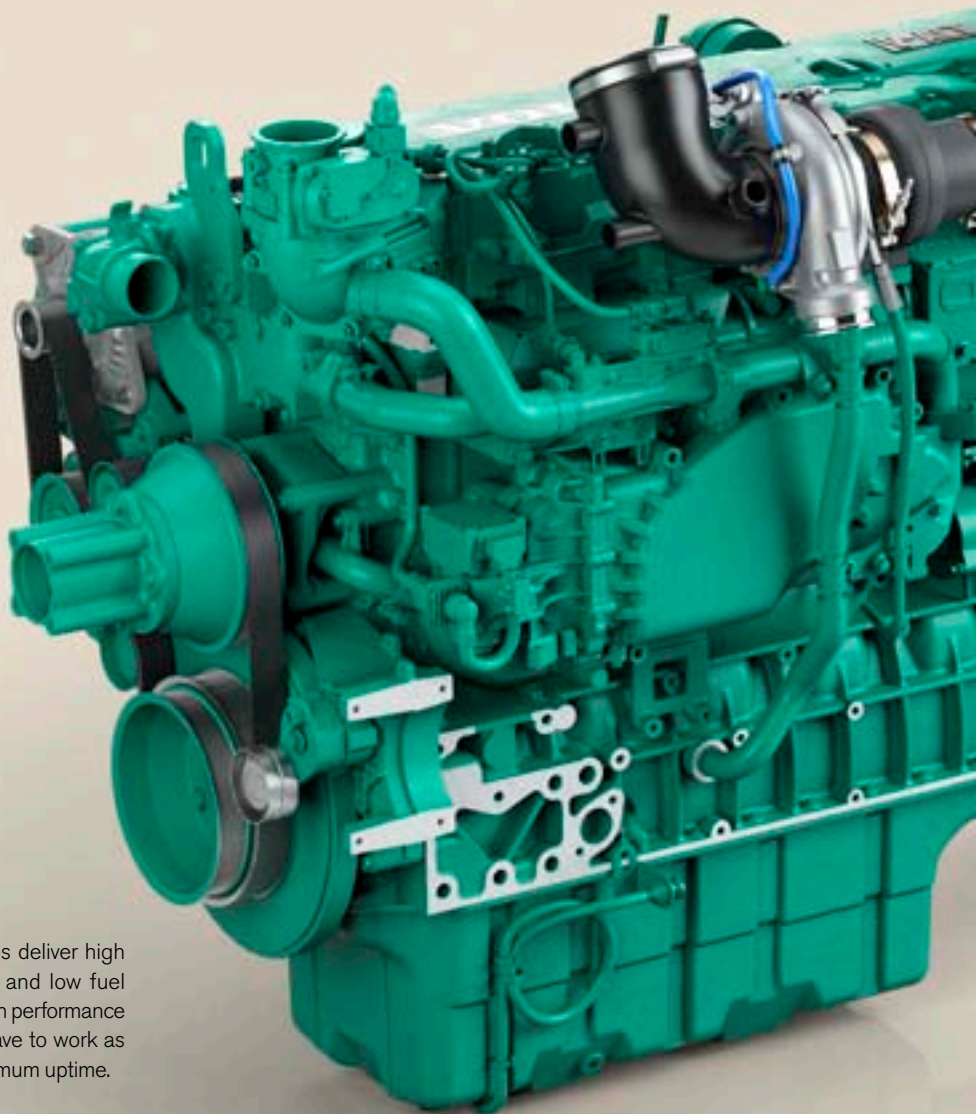
The DOC is used to reduce CO and HC emissions. During active regeneration, the DOC automatically raises the exhaust gas temperature which then flows into the DPF and burns the particulate matter.

## Intake throttle

The automatic throttle restricts the fresh inlet air to control exhaust temperature and EGR flow to improve the overall efficiency of the after treatment system under low loading conditions.

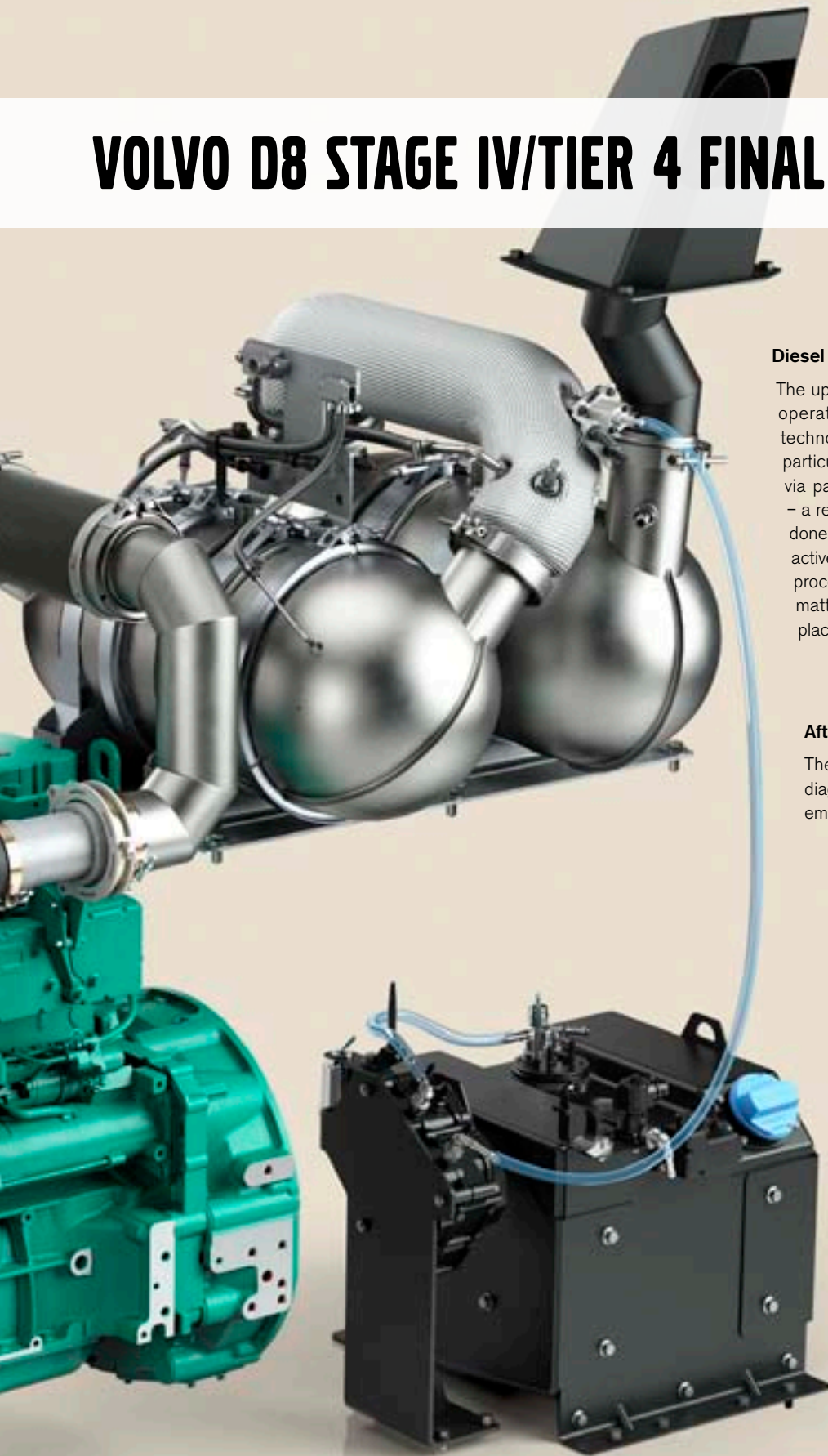
## High torque at low rpm

Volvo's premium Stage IV/Tier 4 Final engines deliver high torque at low rpm for superior performance and low fuel consumption. Because Volvo engines deliver high performance at lower engine speeds, the engine doesn't have to work as hard which ensures longer service life and maximum uptime.





# VOLVO D8 STAGE IV/TIER 4 FINAL ENGINE.



## **Diesel Particulate Filter (DPF)**

The updated, fully automatic Volvo DPF system operates with advanced electronic control technologies to collect and gradually oxidize particulate matter at low exhaust temperatures via passive regeneration. Active regeneration – a reset regeneration, lasting 30 minutes and done in standstill conditions, where the system actively triggers and controls the regeneration process in order to incinerate the particulate matter at high temperatures – will only take place every 500-550 hours.

## **After Treatment Control Module (ACM)**

The ACM automatically controls, monitors and diagnoses the after treatment system to secure emission regulation compliance.

## **External Exhaust Gas Recirculation (E-EGR)**

The cooled E-EGR system lowers the amount of oxygen in the combustion chamber, reducing combustion peak temperature and in doing so lowering the formation of nitrogen oxides ( $\text{NO}_x$ ), a key requirement of the Stage IV/Tier 4 Final regulations.

## **AdBlue®/Diesel Exhaust Fluid (DEF)**

Stage IV/Tier 4 Final emission regulations now require construction equipment to use an additional fluid in the form of a urea and water based reduction agent. This is known as AdBlue® in Europe and DEF in the US.

## **Fuel injection**

The new generation of Volvo-Advanced Combustion Technology (V-ACT) engines feature ultra-high pressure variable fuel injection systems that control combustion temperatures. This leads to optimized fuel efficiency and ensures compliance with the Stage IV/Tier 4 Final regulations. The fuel injection system is also used for active regeneration of the after treatment system, by usage of late post-injection. The fuel injected will evaporate in the exhaust stream and oxidize in the DOC and DPF which increases the temperature, enabling incineration of particulate matter in the DPF.

# VOLVO D11 STAGE IV/TIER 4 FINAL ENGINE.

## External exhaust gas recirculation (E-EGR)

The E-EGR system lowers the amount of oxygen in the combustion chamber, reducing combustion peak temperature and in doing so lowering the formation of nitrogen oxides ( $\text{NO}_x$ ). The uncooled E-EGR is used to increase the exhaust gas temperature at low engine loads.

## High torque at low rpm

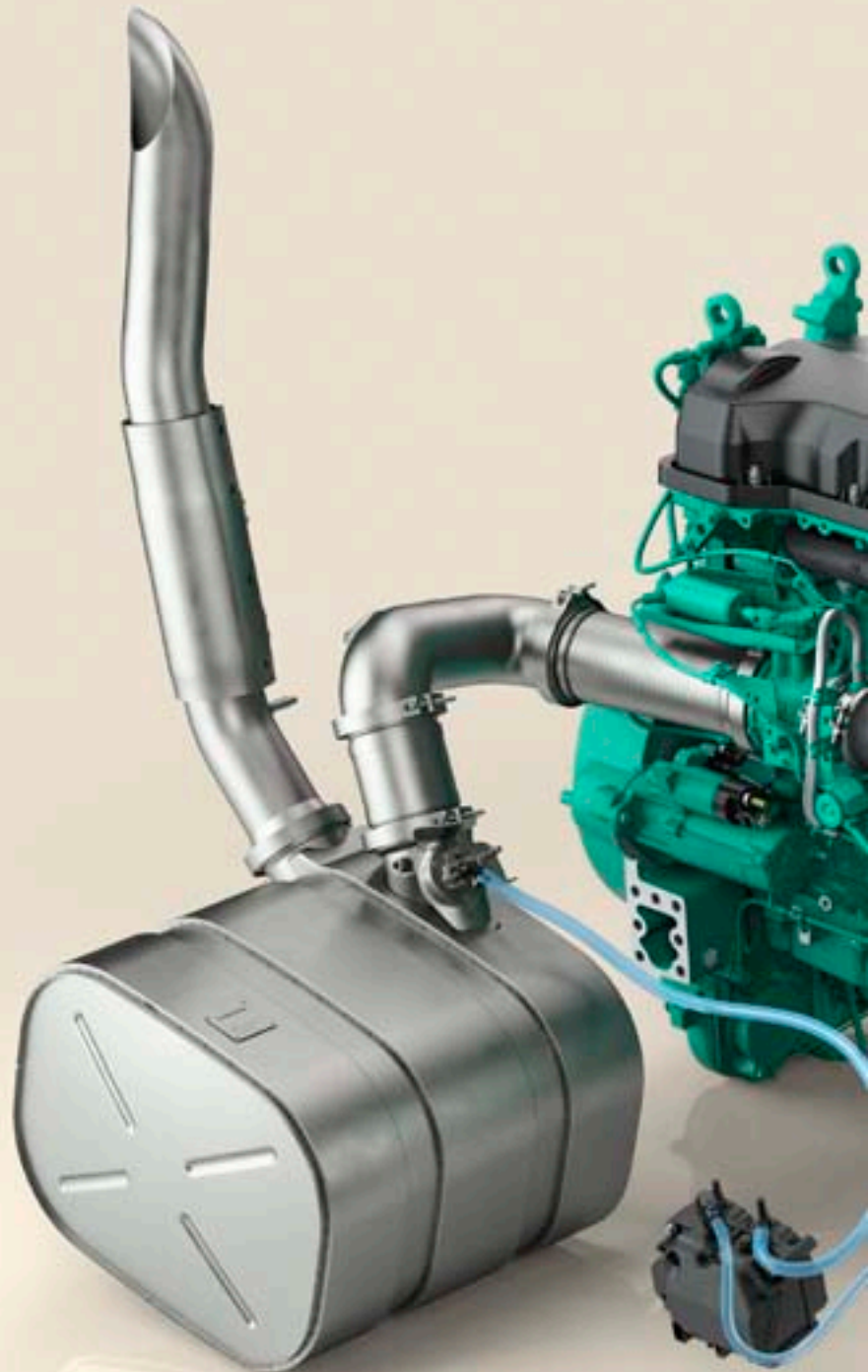
Volvo's premium Stage IV/Tier 4 Final engines deliver high torque at low rpm for superior performance and low fuel consumption. Because Volvo engines deliver high performance at lower engine speeds, the engine doesn't have to work as hard which ensures longer service life and maximum uptime.

## Selective Catalytic Reduction (SCR)

SCR is not new to Volvo – it's a technology that Volvo Trucks has used since 2005. The Volvo solution centers on AdBlue®/DEF being injected into the exhaust gas flow where it is heated and produces ammonia. This causes a chemical reaction in the catalyzer which converts  $\text{NO}_x$  to nitrogen and  $\text{CO}_2$  – both of which are naturally found in the air.

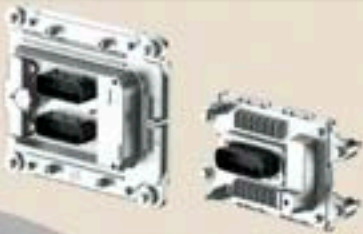
## Fuel injection

The new generation of Volvo-Advanced Combustion Technology (V-ACT) engines feature ultra-high pressure variable fuel injection systems that control combustion temperatures. This leads to optimized fuel efficiency and ensures compliance with the Stage IV/Tier 4 Final regulations.



# D11

Number of cylinders		6	
Displacement	L cu in	10.8	659
Rated output range	kW hp	235-265	315-355



## Engine management system (EMS)

The EMS instantaneously adapts performance to each new operating situation. The new-generation, advanced EMS boasts a more powerful processor to support more functions, with higher precision and increased control speed.



## After treatment control module (ACM)

The ACM automatically controls, monitors and diagnoses the SCR system to secure emission regulation compliance.

## Intake throttle

The automatic throttle restricts the fresh inlet air to control exhaust temperature and EGR flow to improve the overall efficiency of the after treatment system under low loading conditions.

## AdBlue®/Diesel Exhaust Fluid (DEF)

Stage IV/Tier 4 Final emission regulations now require construction equipment to use an additional fluid in the form of a urea and water based reduction agent. This is known as AdBlue® in Europe and DEF in the US.



# VOLVO D13 AND D16 STAGE IV/TIER 4 FINAL ENGINE.

## External Exhaust Gas Recirculation (E-EGR)

The cooled E-EGR system lowers the amount of oxygen in the combustion chamber, reducing combustion peak temperature and in doing so lowering the formation of nitrogen oxides ( $\text{NO}_x$ ), a key requirement of the Stage IV/Tier 4 Final regulations.

## Diesel Particulate Filter (DPF)

The updated, fully automatic Volvo DPF system operates with advanced electronic control technologies to collect and gradually oxidize particulate matter at low exhaust temperatures via passive regeneration. Active regeneration – a generation where the system actively triggers and controls the regeneration process in order to remove sulfur collected in the SCR system – will only take place every 450-500 hours. Both processes are done without interrupting machine operation, performance and productivity.

## Selective Catalytic Reduction (SCR)

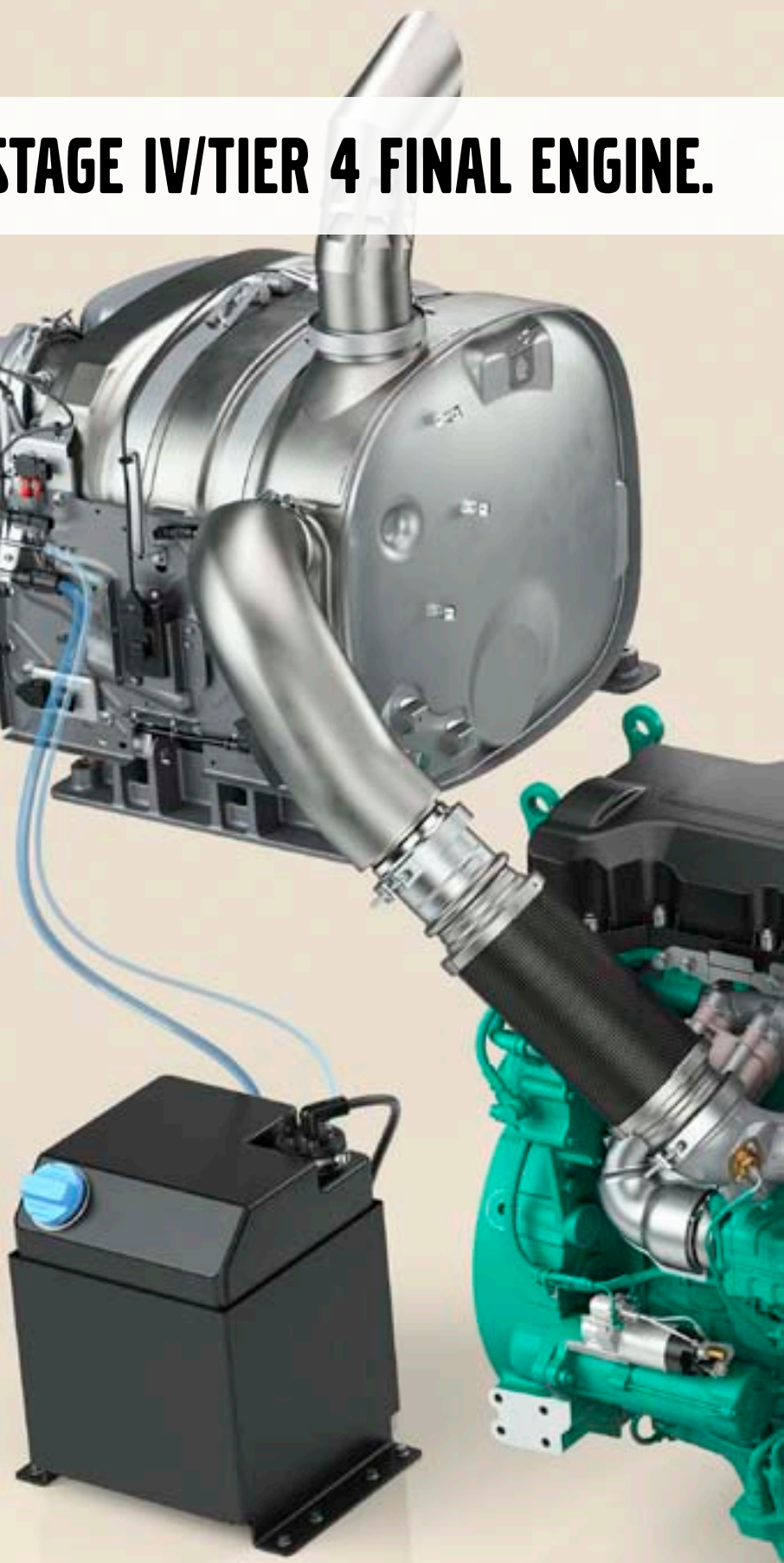
SCR is not new to Volvo – it's a technology that Volvo Trucks has used since 2005. The Volvo solution centers on AdBlue®/DEF being injected into the exhaust gas flow where it is heated and produces ammonia. This causes a chemical reaction in the catalyzer which converts  $\text{NO}_x$  to nitrogen and  $\text{CO}_2$  – both of which are naturally found in the air.

## After Treatment Control Module (ACM)

The ACM automatically controls, monitors and diagnoses the after treatment system to secure emission regulation compliance.

## Diesel Oxidation Catalyst (DOC)

The DOC is used to reduce CO and HC emissions. During a reset regeneration, the DOC raises the exhaust gas temperature which then flows into the DPF and the SCR, cleaning the DPF from soot and the SCR from sulfur.



## AdBlue®/Diesel Exhaust Fluid (DEF)

Stage IV/Tier 4 Final emission regulations now require construction equipment to use an additional fluid in the form of a urea and water based reduction agent. This is known as AdBlue® in Europe and DEF in the US.



# D13 / D16

			D13		D16	
Number of cylinders			6		6	
Displacement	L	cu in	12.8	781	16.1	982
Rated output range	kW	hp	220-329	295-441	350	469



## Engine Management System (EMS)

The EMS instantaneously adapts performance to each new operating situation. The new-generation, advanced EMS boasts a more powerful processor to support more functions, with higher precision and increased control speed.



## Variable Geometry Turbocharger (VGT)

The variable turbocharger helps increase power and provides instant torque at low engine rpm. It enhances engine performance which leads to improved fuel efficiency. The VGT also drives the exhaust gas recirculation process.

## Active Hydro carbon Injection (AHI)

During active regeneration, the electronically controlled AHI injects fuel into the exhaust stream. The fuel injected will evaporate in the exhaust stream and oxidize in the DOC and DPF which increases the temperature, enabling incineration of particulate matter in the DPF and sulfur removal from the SCR.

## Intake throttle

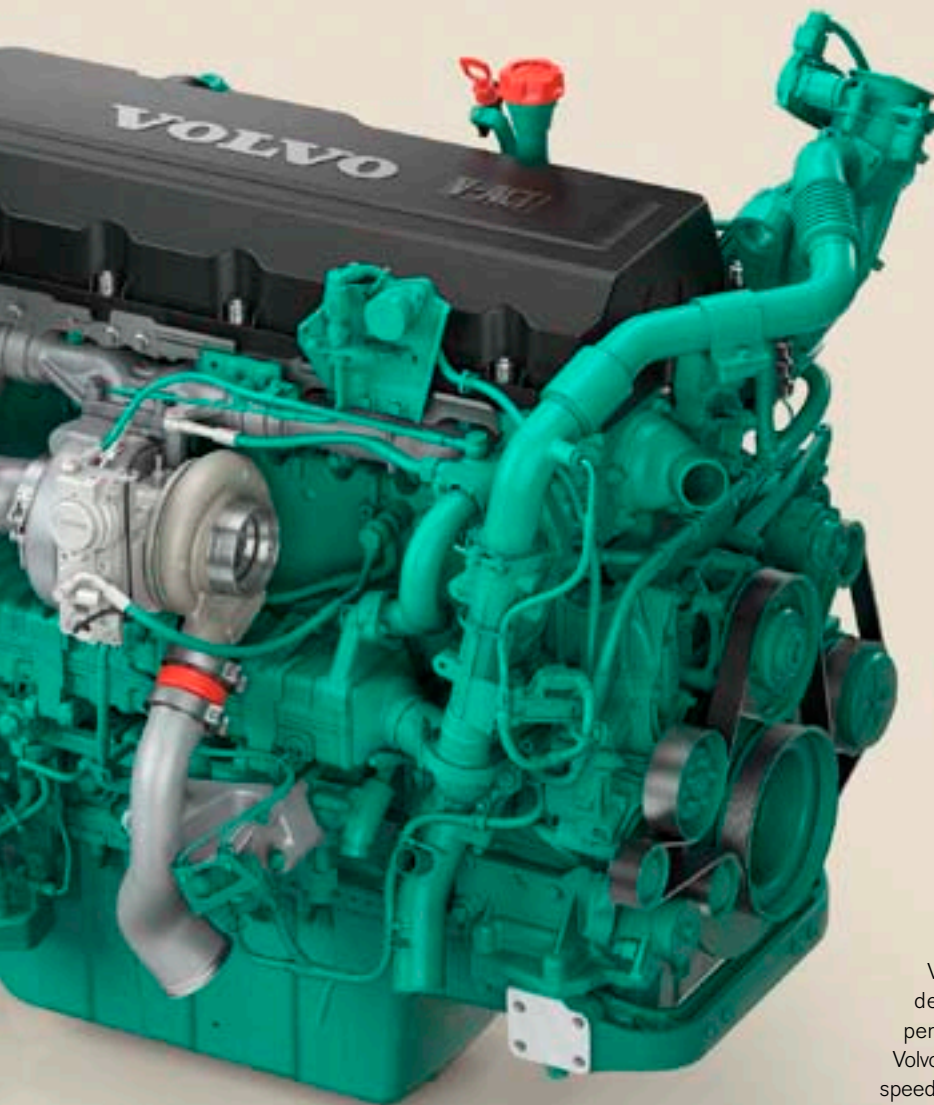
The automatic throttle restricts the fresh inlet air to control exhaust temperature to improve the overall efficiency of the after treatment system under low loading conditions.

## Fuel injection

The new generation of Volvo-Advanced Combustion Technology (V-ACT) engines feature ultra-high pressure variable fuel injection systems that control combustion temperatures. This leads to optimized fuel efficiency and ensures compliance with the Stage IV/Tier 4 Final regulations.

## High torque at low rpm

Volvo's premium Stage IV/Tier 4 Final engines deliver high torque at low rpm for superior performance and low fuel consumption. Because Volvo engines deliver high performance at lower engine speeds, the engine doesn't have to work as hard which ensures longer service life and maximum uptime.



# FIRST-CLASS SUPPORT.

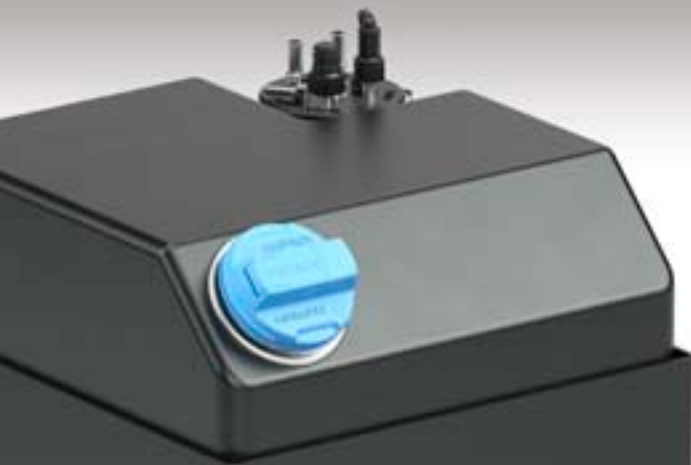
At Volvo we're not just committed to providing you with a quality machine fitted with a powerful and efficient Stage IV/Tier 4 Final engine – we can also deliver continuous state-of-the-art support through our soft product offering. Volvo's unique global dealer support network will ensure your machine's uptime and availability during its entire lifetime.

## DPF exchange services

Authorised Volvo Construction Equipment dealers offer an established Volvo Reman service exchange program. This is the most cost and time effective solution when it comes to cleaning the DPF.

## AdBlue®/DEF management

The Volvo AdBlue®/DEF reduction agent is quality assured – ensuring components are protected, fuel efficiency is optimized, emissions are minimized and the solution is entirely safe. A supply system has been established through the Volvo dealer network to ensure maximum availability and accessibility for Volvo customers.



## Customer Support Agreements (CSA)

Volvo Customer Support Agreements offer service and maintenance with maximum cost control and minimum downtime. The flexible system caters for a range of needs from total repair and maintenance to an inspection program covering vital parts and functions.

## Genuine Volvo Parts

Genuine Volvo Parts are designed, tested and proven to provide the highest levels of quality and long life.

## CareTrack

CareTrack is the Volvo telematics system which enables remote monitoring of a wide range of machine functions to improve productivity and efficiency. This includes fuel consumption data, location reports and service reminders.



# FREQUENTLY ASKED QUESTIONS.

## EMISSIONS AND LEGISLATION.

Q

**What is the focus of the Stage IV/ Tier 4 Final emissions reduction legislation?**

The focus is on particulate matter (PM) and nitrogen oxide (NO<sub>x</sub>). The exhaust emission levels of hydro-carbons (HC) and carbon monoxide (CO) are also regulated.

Q

**What is the difference in the regulated emission levels of Stage IV/Tier4 Final compared to Stage IIIB/Tier4 Interim?**

Stage IV/Tier4 Final calls for a reduction of NO<sub>x</sub> by no less than 80% and no change on PM (particulate matter) compared to Stage IIIB/Tier4 Interim.

## EMISSIONS REDUCTION TECHNOLOGY

Q

**What technology options are available in order to achieve the demanding Stage IV/Tier4 Final emission limits?**

NO<sub>x</sub> and PM reduction can be achieved in several ways, each one having its merits and unfortunately, also its drawbacks. For example, in-engine NO<sub>x</sub> reduction generally leads to higher PM emission levels, and the opposite, in-engine reduction of PM leads to high NO<sub>x</sub> emissions. Optimization of fuel injection and air handling management, including different EGR (exhaust gas recirculation) configurations (cooled/non-cooled etc.), and various exhaust after-treatment technologies, including diesel particulate filters and the NO<sub>x</sub>-reducing SCR (selective catalytic reduction) technology are all part of Volvo's emissions reduction toolbox. The third-generation Volvo EMS-2 (engine management system) enhanced electronic controller, featuring a more powerful processor, makes the toolbox complete.

Q

**What technology will Volvo CE use to achieve Stage IV/Tier4 Final emission levels?**

Volvo is in the favorable position of being one of the world's largest manufacturers of diesel engines for both on-road (trucks) and off-road (construction equipment and marine/industrial applications) use, complying with the various on-road and off-road emission regulations in all concerned areas of the world. Because of this, Volvo Construction Equipment has, in-house, a unique, comprehensive and solid experience in the field of diesel engine exhaust emissions reduction technologies and their applications to meet the non-road emission reduction requirements of 2014 and beyond. With the technical knowledge and full toolbox of solutions, Volvo has chosen to apply a combination of "in-cylinder" and "external" solutions, after careful technical evaluations and marketing considerations for our construction equipment. For many applications, that includes EGR in combination with an integrated DPF-SCR system. For a few applications, only SCR will be used as emission-reduction technology. The choice has been made based on what we currently consider best suited to off-road applications and optimized in an end-user perspective. ➔

Thanks to being part of the Volvo Group our "new" SCR technology has, in fact, already been comprehensively tested in more than one million SCR-equipped trucks since the system was introduced in 2005.

Q

**Will Volvo CE's product offerings include different emissions solutions for different types of applications, or do you leverage the same emissions technology solutions for any given size range of engines?**

The main emission technologies will be generic, but each engine will be adapted to its application, with customized hardware and software in order to achieve required performance and maximum reliability and productivity. We will thus apply the technologies that are best suited to the respective power levels and regulations and optimized to an end-user perspective.

Q

**How often do I need to think about regeneration?**

Stage IV/Tier 4 final engines feature new after treatment systems which are more or less regeneration free. The DPF cleaning will use transparent passive regeneration. What is needed is an active regeneration at 450-550 hours, normally 2 – 3 times per year (or it can be manually activated earlier during servicing of the machine).

## MISCELLANEOUS

Q

**Can a Stage IIIA/Tier 3- or a Stage IIIB/Tier 4 Interim-compliant engine be updated to meet Stage IV/Tier4 Final emissions regulations?**

No. The cost impact would far outweigh the benefit. Also, a separate certification of that specific engine would be required.

Q

**Can the new Volvo Stage IV / Tier4 Final engines be run on biofuel?**

Yes. In some countries, the incorporation of bio-fuel is prescribed and can be mixed up to 7%.

Q

**What is Urea?**

Urea is a compound of nitrogen that turns to ammonia when heated. It is used in a variety of industries, perhaps most commonly as a fertilizer in agriculture.

Q

**What is Diesel Exhaust Fluid, or DEF?**

Diesel Exhaust Fluid (DEF), known also as AdBlue® (a 32.5% solution of urea in deionised water), is the worldwide operating fluid for SCR vehicles. A non-toxic solution; sprayed into the exhaust stream it converts to ammonia which, in the SCR catalyst, transforms harmful Nitrogen Oxide NO<sub>x</sub> emissions into harmless water vapor and nitrogen. AdBlue® (DEF) is a mandatory liquid for engines with an SCR catalyst and the engine will not function without it.

# VOLVO CONSTRUCTION EQUIPMENT



Volvo Construction Equipment is different. Our machines are designed, built and supported in a different way. That difference comes from an engineering heritage of over 180 years. A heritage of thinking first about the people who actually use the machines. About how to help them be safer, more comfortable, more productive. About the environment we all share. The result of that thinking is a growing range of machines and a global support network dedicated to helping you do more. People around the world are proud to use Volvo.

Not all products are available in all markets. Under our policy of continuous improvement, we reserve the right to change specifications and design without prior notice. The illustrations do not necessarily show the standard version of the machine.

# **VOLVO**

**Volvo Construction Equipment**  
**[www.volvoce.com](http://www.volvoce.com)**

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