



Volvo Construction Equipment

EXHAUST EMISSIONS REDUCTION

TOWARDS "STAGE IV/TIER4 FINAL" NON-ROAD DIESEL EXHAUST EMISSION STANDARDS
QUESTIONS & ANSWERS | September 2014



Emissions and Legislation.

QUESTION

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

2. What is particulate matter (PM)?

3. What is nitrogen oxide (NO_x)?

4. What are hydrocarbons (HC)?

5. What is carbon monoxide (CO)?

6. What is carbon dioxide (CO₂)?

7. CO₂ is a global issue. Are CO₂ emissions regulated?

8. How can CO₂ emissions from diesel engines be reduced?

Note: Stage IV = EU; Tier 4 Final = US (EPA)

ANSWER

The focus is on particulate matter (PM) and nitrogen oxide (NO_x). The exhaust emission levels of hydro-carbons (HC) and carbon monoxide (CO) are also regulated.

Particulate matter, or particulates, includes mainly soot (carbon particles) and residues of lubricating oil.

Nitrogen oxides include nitrogen monoxide (NO) and nitrogen dioxide (NO₂). Nitrogen oxides are formed when the oxygen and nitrogen from the air react at high temperatures and under high pressure during combustion.

Hydrocarbons are a family of compounds composed of carbon and hydrogen and consisting mainly of incompletely combusted fuel and oil residues. The concentration of hydrocarbons in diesel exhaust fumes is very low and will be further reduced by the use of high-quality fuels, an efficient combustion process and exhaust after-treatment.

Carbon monoxide is a compound of carbon and oxygen formed by incomplete combustion in the presence of insufficient air. Diesel engines work with a large surplus of air and, therefore, normally emit small quantities of carbon monoxide.

Carbon dioxide is one of two natural end products of combustion; the other is water. CO₂ is not toxic, and the quantity is directly proportional to fuel consumption. CO₂ contributes to the climate-impacting so-called greenhouse effect.

No, CO₂ is not regulated in the case of construction equipment, but governments, political parties and international and national bodies are placing increasing demands on the automotive and construction equipment industries, for example, to make products with lower CO₂ emissions. The responsibility is also on product users to operate them in the most fuel-efficient way.

The only way to reduce CO₂ is to lower fuel consumption. Thus, fuel-efficient engines and high-efficiency drivelines and hydraulic systems are important elements in the quest for lower CO₂ emissions.

Emissions and Legislation.

QUESTION

9. How can biodiesel reduce the greenhouse effect?

10. Can the new Volvo Stage IV/Tier 4 Final engines be run on biofuel?

11. Does Volvo have any particular development programs in the realm of the greenhouse effect?

12. What is sulfur dioxide (SO₂)?

13. What is the difference in the regulated emission levels of Stage IV/Tier 4 Final compared to Stage IIIB/Tier 4i?

14. When will Stage IV/Tier 4 Final regulations come into effect in the respective geographic areas (EU and N. America)?

15. Will all new machines available for sale in 2014 and beyond in the market areas concerned be equipped with Stage IV/Tier 4 Final-compliant engines?

ANSWER

The use of biofuels will reduce the greenhouse effect as the production of the biofuel will absorb some of the CO₂.

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

Yes, since fuel has the biggest impact on the greenhouse effect, Volvo is working in many areas, including renewable fuels and hybrid technology. Eco Operator trainings and the all-new Opti-Shift feature are other examples of our fuel-saving initiatives.

Sulfur dioxide is formed by combustion of fuels containing sulfur. Sulfur emissions from Stage IV/Tier 4 Final engines are very low as they need to run on sulfur free / ultra-low sulfur fuel with < 15 ppm sulfur content.).

Stage IV/Tier 4 Final calls for a reduction of NO_x by no less than 80 % and no change on PM compared to Stage IIIB/Tier 4i.

On January 1, 2014 for engines 130-560 kW.

In this regard, **the build date of the engine** is the crucial factor, i.e. all engines manufactured on and after the respective dates of the new legislation entering into force must comply with the new regulation.

No, the regulation contains provisions (transition clauses) that permit a certain degree of flexibility in its enforcement in order to ensure an orderly, rational transition from Stage IIIB/Tier 4i to Stage IV/Tier 4 Final at producer, dealer and end user levels.

This means that new machines produced prior to 2014, fitted with Stage IIIB/Tier 4i-compliant engines and still in manufacturer or dealer stocks, can be sold to end users after the year 2014, and that a limited amount of newly produced engines (produced prior to 2014) may be used to equip machines manufactured after 31. 12. 2013.

Also: "machine flexibility clauses" permit that, upon specific conditions, a limited quantity of Stage IIIB/Tier 4i engines may be built after the year 2014, thus providing the equipment manufacturers another rational option for a smooth transition.

Emissions and Legislation.

QUESTION

16. Are the regulated EU Stage IV and US (EPA) Tier 4 Final emission limit values identical?

17. Can I buy an EU-certified machine with an EU-compliant engine and export it to the US?

18. Will other areas/nations of the world apply exhaust emission regulations equivalent or similar to the EU Stage IV/US Tier 4 Final regulations? If so, when?

19. Will there be further 'non-road' diesel exhaust emissions reduction requirements imposed by the authorities at a future date?

20. After Stage IV/Tier 4 Final has come into effect, will there be a demand for upgrading of existing older-generation equipment as far as NO_x and PM emissions are concerned?

ANSWER

Yes, the limit values are, in principle, the same in both these geographic areas, within the power range in which our equipment operates.

No, the EU Stage IV-compliant engine receives a certificate only for the area concerned (EU) and is not allowed to enter the US. Likewise, a US (EPA) Tier 4 Final-compliant engine cannot be imported into the EU.

Japan will introduce regulations similar to Stage IV/Tier 4 Final in the same timeframe as EU and North America, and it is likely that other nations will follow in the foreseeable future. Korea, for example, will introduce similar regulations in 2015.

Yes, one further step is under discussion in the case of Europe (EU). The commission wants to introduce even stricter PM demands incorporating particulate number limits. This will probably take effect in 2020. In the US there are no new regulations known.

At the same time as the EU Parliament asked for a Stage V, it also expressed that the commission should develop rules for the retrofit of exhaust after-treatment devices to limit PM. Some member states have expressed the same demand. Whether this will happen is unclear. Some local regulations are, however, already in place; Switzerland is a case in point. In the US, local regulations do exist; California is a prime example. In the US, however, some regional and local areas do require retrofit of exhaust after-treatment devices/ systems, with reference to 'best available technology' (BAT) or 'best available retrofit technology' (BART). Focus is initially on PM reduction, but NO_x reduction may eventually enter the picture.

Emissions Reduction Technology.

A/ General

QUESTION

21. What technology options are available in order to achieve the demanding Stage IV/Tier 4 Final emission limits?

22. Could you briefly describe DPF?

23. Could you briefly describe SCR?

ANSWER

NO_x and PM reduction can be achieved in several ways, each one having its merits and, unfortunately, also its drawbacks. For example, in-engine NO_x reduction generally leads to higher PM emission levels, and the opposite, in-engine reduction of PM leads to high NO_x 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_x-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.

Diesel particulate filter (DPF) is a device in which the particulates are collected and then oxidized by passive or active regeneration. Advanced electronic control of the process is necessary to ensure effective PM removal in any and all engine duty cycles. In addition, the base engine has to be fine-tuned for either minimized engine-out NO_x emissions to meet the required, legislated NO_x level, or for optimized engine-out NO_x emissions matching the chosen base engine PM reduction technology.

Diesel particulate filter and selective catalytic reduction can be used either as single-exhaust emission control devices or together in an integrated system.

Selective catalytic reduction, SCR, is a technology in which a reagent is injected into the exhaust gas flow where, after forming ammonia, it is reduced over a catalytic converter that reduces the NO_x to harmless nitrogen and oxygen. The reagent is a mixture of 32.5% urea and 67.5% de-ionized water and is commercially called AdBlue® in Europe and diesel exhaust fluid (DEF) in the US.

Depending on the engine duty cycle, the urea usage corresponds to between 3 and 7% of fuel consumption. The base engine has, in any case, to be fine-tuned for a minimum of engine-out PM emissions as required by the Stage IV/Tier 4 Final emission regulations or if used in combination with DPF, to a level where a fuel efficient regeneration strategy can be maintained. **Ultra-low sulfur fuels and low-ash lubricating oils will be necessary** for these technologies to function properly.

Emissions Reduction Technology.

B/ Volvo Construction Equipment (Volvo CE)

QUESTION

24. Will Volvo CE's Stage IV/Tier 4 Final solution be based on the existing engine platforms, or will a new design be required?

25. What technology will Volvo CE use to achieve Stage IV/Tier 4 Final emission levels?

ANSWER

Our engine platforms are designed to cope with the higher internal loads associated with the new performance requirements of Stage IV/Tier 4 Final. Some design changes will, however, be introduced in order to further enhance the performance of the engines.

It is worth mentioning that the engine platforms that we will use for our Stage IV/Tier 4 Final applications have been used since 2007 by Volvo Trucks in their "US 07"*-compliant on-road vehicles. We have adapted the most recent solutions used by Volvo Trucks in the area of emissions reduction to achieve the performance and the reliability/durability required in demanding construction equipment applications.

The engine platform has hereafter, with some difference in technical setup from case to case, been utilized for Japan PNLT, EU5, US10, Tier 2, Tier 3, Tier 4i, US13 and EU6 emission legislations.

PNLT, US13 and EU6 are the **on-road emission legislations that most closely correspond to the (EPA) US Tier 4 Final **off-road** regulations.*

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 a 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.

Emissions Reduction Technology.

B/ Volvo Construction Equipment (Volvo CE)

QUESTION

26. What are the main features of the 'non-road' EGR system to be used in Volvo construction equipment for Stage IV/Tier 4 Final compliance?

27. What type of diesel particulate filter (DPF) will Volvo CE use and which features of the DPF system are of particular importance?

ANSWER

The purpose of exhaust gas recirculation (EGR) is to dilute the amount of oxygen in the combustion chamber, thereby lowering the combustion peak temperature, which, in turn, reduces the formation of NO_x. Cooling and mixing the re-circulated exhaust gases and the incoming fresh air before they enter the combustion area enhances the reduction of peak combustion temperatures, leading to considerably lower NO_x levels. This, in turn, reduces the amount of DEF/AdBlue® required for sufficient NO_x conversion in the SCR and achieves the lowest possible cost of operation.

We have chosen to use cooled EGR in combination with an inlet throttle and with a VGT (variable geometry turbo) type turbocharger or, for some applications, a waste-gated turbo-charger that, in both cases, drive the recirculation process, and an electronically controlled EGR valve that manages the desired mix of re-circulated exhaust gas and incoming fresh air in each instance of engine operation. The VGT features a sliding nozzle that allows the speed of exhaust flow into the turbine wheel to vary in order to provide a rapid and powerful boost and excellent torque and engine response across the entire engine speed range. The waste-gated turbo provides similar benefits. The engine's electronic control unit (E-ECU) controls the action of the entire system. Accuracy of metering the re-circulated gas and inlet air is crucial to achieving full control of NO_x and PM emissions while maintaining the required engine performance and fuel economy.

For most applications, we will use an **exhaust after**-treatment system that consists of a DPF containing a catalytic, coated, ceramic particulate filter element of 'wall-flow' design.

The exhaust gas is forced to flow through the many channels of the filter element's porous walls, which causes the PM (soot) to remain inside the pores and on the surface of the filter element. The collected soot is continuously burnt off in a process called regeneration. More on this below.

The DPF also has a diesel oxidation catalyst (DOC) mounted upstream, which, in combination with the catalytic coating of the DPF, is a vital part of both the passive and the active regeneration process. It also contributes to reducing HC and CO emissions far below limit values.

The entire exhaust after-treatment system is fully integrated into the engine system, controlled by the E-ECU, and has been designed for demanding operational conditions.

The DPF and/or SCR replaces the muffler.

Emissions Reduction Technology.

B/ Volvo Construction Equipment (Volvo CE)

QUESTION

28. (1/2) What is **DPF regeneration** and why is it needed?

What is meant by 'active' versus 'passive' generation, and what are the operational implications of the respective mode?

How often must filter regeneration take place (in the case of the Volvo construction equipment applications)?

Do you have to stop the machine for regeneration to take place?

What is the impact of the DPF regeneration process on fuel consumption?

ANSWER

(1/2) The meaning of the word 'regenerate' is 'to make something strong and vigorous again'.

Regeneration of the DPF actually means cleaning the filter by burning off soot and other particulate matter that has accumulated in the filter during operation, thereby restoring the filter's capacity. Regeneration is needed in order to prevent the engine's back-pressure from reaching undesired levels and to ensure proper engine, and machine, performance.

'Passive' regeneration means that the PM collected in the DPF is gradually oxidized during operation at low to medium exhaust temperatures.

A DPF-configured **'active'** features a system that actively triggers and controls the regeneration process. In order to achieve incineration of the PM by means of oxygen, typically a temperature of around 600 degrees Celsius is required.

Volvo machines equipped with a DPF for all medium- and heavy-duty engines, use passive regeneration for soot oxidation and, for D13/D16 engines only, supplemented by an active regeneration feature for conditioning of the SCR system, as well as soot regeneration in the rare cases that passive regeneration is insufficient because of very light load cycles.

If the passive regeneration on the D4-D8 engines is not sufficient to oxidize the PM, this will be handled by the recommended 500 hour service intervals, in combination with an oil change.

Emissions Reduction Technology.

B/ Volvo Construction Equipment (Volvo CE)

QUESTION

28. (2/2) What is **DPF regeneration** and why is it needed?

What is meant by 'active' versus 'passive' generation, and what are the operational implications of the respective mode?

How often must filter regeneration take place (in the case of the Volvo construction equipment applications)?

Do you have to stop the machine for regeneration to take place?

What is the impact of the DPF regeneration process on fuel consumption?

ANSWER

(2/2) For D13/D16 engines fitted with a DPF, the “active” regeneration is triggered automatically and periodically by a smart function called dynamic regeneration. SW algorithm maximizes the duration between SCR conditioning by taking advantage of Volvo’s exhaust after-treatment system (EATS) and low engine emissions. Intervals depend on the vehicle use and do not necessarily need to be the same for all machine usages. Setting optimum intervals for individual machines reduces fuel consumption and lowers overall engine emissions.

Regeneration will occur continuously during normal operation without any action from the operator. Regeneration is maintained without any loss of machine performance and without any interference with the normal operation of the machine.

Also, we have spared no effort to ensure the quality and durability of the components that make up the system and of the integration of the whole system into the end product. The entire design, cooling and packaging of the system have been given full attention, bearing in mind the demanding operational conditions of construction equipment.

The high efficiency of our regeneration system ensures that the impact on fuel consumption is very marginal. The impact varies somewhat depending on engine size and engine load/application.

Emissions Reduction Technology.

B/ Volvo Construction Equipment (Volvo CE)

QUESTION

29. What about **V-ACT, Volvo Advanced Combustion Technology?**

Will V-ACT be the subject of further developments?

Does V-ACT embrace all engine models/sizes?

30. Performance-wise, how will the Volvo Stage IV/Tier 4 Final-compliant engines compare to their existing Stage IIIB/Tier4 i-compliant counterparts?

31. What about performance at high altitudes?

32. Will there be an impact on fuel consumption due to the new technical solutions to be implemented to achieve Stage IV/Tier 4 Final compliance?

ANSWER

V-ACT is customized for demanding non-road applications and is characterized by combustion efficiency, emissions reduction and superb overall engine performance.

The technology platform that is the basis of V-ACT has evolved to cater to tougher emissions legislation and new end-user demands pertaining to performance and operational economy.

For example, **the fuel injection and air-handling systems will be enhanced** – including dual solenoid fuel injectors with multiple injection capability, ultra-high fuel injection pressure and the use of variable geometry or waste gated turbo-chargers. **A new-generation engine management system, boasting a more powerful processor with the capability to support more functions than its predecessor and with higher precision and speed of control,** will also be introduced.

V-ACT embraces all medium- and large-sized Volvo six-cylinder diesel engines and certain four-cylinder versions.

We are confident that the Stage IV/Tier 4 Final-compliant engines will be considered equal or better when it comes to performance compared with previous engines.

All engines have some degree of power reduction resulting from the reduced air availability at high altitude. Due to the efficient turbo-charging system and the precise monitoring and adjustment of engine parameters by the E-ECU, Volvo Stage IV/Tier 4 Final-compliant engines have slightly better high-altitude performance compared to the Stage IIIA/Tier 3-compliant ones. They can be used without restrictions at all reachable altitudes in EU / NA (4000 m + / 13000 ft+).

Our target is to achieve enhanced performance, emission reductions and optimized fuel efficiency, which, depending on the engine duty cycle, will translate into somewhat lower fuel consumption compared to current levels. In some products and applications, the reduction will be up to 5%.

Equipment.

QUESTION

33. What emission-reducing technology will be used in smaller Volvo engines fitted in compact equipment, for example?

34. Will your 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?

ANSWER

We will choose the technology that is best suited to the applications of our products, power levels and regulations, and optimized to an end-user perspective.

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 the 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.

Volvo CE vs. Volvo Trucks.

QUESTION

35. What emission-reduction technology is being used on Volvo Trucks?

ANSWER

Volvo Trucks have used a combination of SCR and DPF in the US from 2010 and in EU from 2014. The system used on Trucks in EU is identical to the one Volvo CE uses for its 13 and 16 liter engines.

Service & Maintenance.

QUESTION

36. What about service intervals and serviceability and maintenance in the case of Stage IV/Tier 4 Final-compliant Volvo construction equipment?

37. What is the service interval of the DPF?

38. How do I service the DPF?

39. How does the Reman service exchange program work as to the cleaning of the DPF?
Do I get a warranty?

40. Can I service the DPF myself without voiding the warranty?

41. Will Volvo offer a 'cleaning service kit'?

42. How long is the machine down during a DPF change?

43. Will the dealer have the service exchange filters in stock?

44. Can I run without the DPF filter for a while?

45. Is there a 'limp home' strategy if the regeneration system fails or if the filter plugs up?

ANSWER

The service intervals will remain largely the same as for the current generation of equipment. There will inevitably be some differences as to serviceability and some minor differences as to maintenance, e.g. in the area of the UDS (Urea Dosing System).

Filter maintenance will be at 3000 hours for the D4 and D6 up to 130 kW and 4500 hours for all engines above 130 kW - D6 up to D16.

There is a Volvo Reman service exchange program covering the DPF already in place from the introduction of Stage IIIB/Tier 4i, which is the only solution provided by Volvo. This is the most cost- and time-effective solution, maximizing uptime.

Prior to the filter-cleaning process, the filter will be checked for defects on a test bench. Any filter with damages or any other sign of defect will be rejected and replaced with a new filter. In addition, the filter will be backed with a full Volvo warranty.

No, you are not allowed to do any service to the DPF during warranty time. Under normal conditions, the DPF does not need any service during warranty time.

No, all will be taken care of by means of the Volvo Reman service exchange kit.

A Volvo Reman DPF filter service exchange takes approximately one hour.

Our extensive dealer network will store the processed filters in order to keep uptime to a maximum.

No, you are not allowed to run the machine without a functioning DPF.

Yes, there is a limp home strategy, should the regeneration system fail or the filter plug up.

Miscellaneous.

QUESTION

46. Are you aware of competitors' technologies for Stage IV/Tier 4 Final? How do you rank Volvo's technologies vs. those of the competitors?

47. Can a Stage IIIA/Tier 3- or a Stage IIIB/Tier 4i-compliant engine be updated to meet Stage IV/Tier 4 Final emissions regulations?

48. Does Volvo offer any solutions to customers who might need to retrofit an exhaust after-treatment device/system?

49. Will there be any increased costs due to the new technology associated with Stage IV/Tier 4 Final emissions requirements?

50. Will Volvo develop and supply specific future engine variants for markets that don't require the advanced technology associated with Stage IV/Tier 4 Final requirements?

51. Is the ash removed from the particulate filter hazardous?

52. Do I need to change my fuel supply with Stage IV/Tier 4 Final-compliant equipment?

ANSWER

We are confident that our technologies and the way that they will be applied in our products will prove to be very competitive. We believe that customer requirements such as uptime, operational convenience and full, uninterrupted performance in all conditions will be very satisfactorily met with our solutions.

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

No, Volvo CE does not offer any retrofit after-treatment devices.

Yes, all manufacturers will have to apply new, additional technology that will inevitably add some cost to the end product.

To markets where ultra-low-sulfur fuel will not be available, we will supply sulfur-tolerant engines.

Generally not; it does, however, contain a tiny quantity of metal particles. In California, NA, it is considered hazardous.

As explained earlier on in this booklet, the use of ultra-low sulfur diesel (ULSD) fuel will be required. High sulfur levels are incompatible with the exhaust after-treatment technology that will be used for Stage IV/Tier 4 Final compliance. ULSD furthermore contributes towards less PM and considerably less sulfur dioxide (SO₂) emission.

Miscellaneous.

QUESTION

53. What happens if diesel with a high sulfur level is used by mistake instead of ultra-low-sulfur diesel?

54. Can I use biodiesel in Stage IV/Tier 4 Final-compliant Volvo engines/equipment?

55. Do I have to use special oil? Will Volvo have suitable oil on offer?

Can I use such oil in my older Volvo machines?

56. What about exhausts from the crankcase ventilation system?

57. How much and in what way have you tested the new engines systems associated with Stage IV/Tier 4 Final compliance?

58. What about the life expectancy of a Volvo Stage IV/Tier 4 Final engine? Improved? Stable? Reduced?

59. What will be your pricing strategy for the Stage IV/Tier 4 Final-compliant equipment?

ANSWER

The higher level of sulfur will jeopardize both the catalytic function of the DPF and the conversion efficiency of the SCR system. This will cause malfunction of the regeneration system as well as emission non-compliance with respect to NO_x emissions. The filter can also clog, resulting in a meltdown of the DPF while high sulfur levels can corrode internal engine parts. Internal engine parts could also become corroded due to the formation of sulfuric acid from the sulfur content of the EGR gases.

"7% biodiesel" can be used generally; higher bio-fuel rates are generally not approved.

It is required to use the same, high-grade oil for the Stage IV/Tier 4 Final-compliant engines as already in use with the Stage IIIB/Tier 4i-compliant engines. This is required for the new technology to function properly. Through our dealer network, we provide the recommended oil - Volvo Ultra Diesel Engine Oil, VDS-4.

This oil is backwards compatible.

A centrifugal-type crankcase ventilation system on heavy duty engines is used to filter and recycle the oil mist in the crankcase gases. No periodic maintenance is required. Medium duty engines use an oil trap.

Solid RG (reliability growth) programs including validations of performance, quality and durability of components, subsystems, engine and machine systems have been in place since the start, several years ago, of the development of the new generation of Stage IV/Tier 4 Final-compliant equipment. Field-testing programs covering all relevant machine models across the product range have been and continue to run in parallel with all other testing and validation activities.

The service life is expected to be the same as that of earlier generations of Volvo engines.

There are, of course, unavoidable price increases associated with the introduction of the expensive new Stage IV/Tier 4 Final-compliant technology into equipment. As always, market developments, including competition and customer reaction, will be important factors for us to consider as we formulate our pricing strategy for 2014 and beyond.

Miscellaneous.

QUESTION

60. How will total cost of ownership (TCO) of my Stage IV/Tier 4 Final-compliant equipment be impacted?

61. Are you planning some specific actions to prepare the introduction of these new machines in the markets concerned?

ANSWER

The TCO will most certainly be affected due to various factors such as higher equipment purchase price, lower fuel consumption, higher productivity and other parameters, depending on application and site conditions.

Yes, there will be ample information available and training given to our staff, to our dealers and, to the extent necessary, to customers/end-users, particularly in the areas of operation, maintenance and service.

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Volvo Construction Equipment

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