

# **OPERATOR'S MANUAL**

**Generating set and industrial engines**

**16 liter (EMS 2)**

# Foreword

Volvo Penta industrial engines are relied upon throughout the world, in both mobile and stationary applications, under some of the most rigorous conditions imaginable. This is not by chance.

After more than 90 years of producing engines the name Volvo Penta has come to symbolize reliability, technical ingenuity, first-class performance and longevity. We believe that these characteristics are also ultimately your requirements and expectations for new Volvo Penta industrial engines.

**To make certain that your expectations are matched, we ask that you read carefully through the instruction book before starting the engine.**

Sincerely

**AB VOLVO PENTA**



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## Engine data

Engine designation ..... Product number .....

Serial number .....

Clutch, type/nr. ....

## Nearest Volvo Penta service location

Name ..... Telephone .....

Address .....

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# Safety information

Read this chapter very carefully. It has to do with your safety. This describes how safety information is presented in the instruction book and on the product. It also gives you an introduction to the basic safety rules for using and looking after the engine.

**Check that you have received the correct instruction book before you read on. If not, please contact your Volvo Penta dealer.**



Incorrect operation can lead to personal injury and damage to products or property. So read the instruction book through very carefully before you start the engine or do any maintenance or servicework. If there is still something which is unclear or if you feel unsure about it, please contact your Volvo Penta dealer for assistance.

 This symbol is used in the instruction book and on the product, to call your attention to the fact that this is safety information. Always read such information very carefully.

Safety texts in the instruction book have the following order of priority:

 **WARNING!** Warns for the risk of personal injury, major damage to product or property, or serious malfunctions if the instruction is ignored.

 **IMPORTANT!** Is used to call attention to things which could cause damage or malfunctions to product or property.

**NOTE!** Is used to call attention to important information, to facilitate work processes or operation.

 This symbol is used on our products in some cases and refers to important information in the instruction book. Make sure that warning and information symbols on the engine are clearly visible and legible. Replace symbols which have been damaged or painted over.

## Safety rules for operation and maintenance

### Daily checks

Make it a habit to always give the engine and engine bay a visual check before operation (**before the engine is started**) and after operation (**when the engine has been stopped**). This helps you to quickly discover whether any leakage of fuel, coolant, oil or any other abnormal event has happened, or is about to happen.

### Fuel filling

There is always a risk of fire and explosion during fuel filling. Smoking is not permissible, and the engine should be stopped.

Never over-fill the tank. Shut the tank cap securely.

Only use the fuel recommended in the instruction book. The wrong grade of fuel can cause malfunctions or stop the engine. In a diesel engine, it can also cause the injection pump to bind and the engine will over-rev, entailing a strong risk of personal injury and machinery damage.

### Carbon monoxide poisoning

Only start the engine in a well-ventilated area. When operated in a confined space, exhaust fumes and crankcase gases must be ventilated.

### Operation

The engine must not be operated in environments which contain explosive media since none of the electrical and mechanical components are explosion proof.

Going close to a running engine is a safety risk. Hair, fingers, loose clothes, or dropped tools can catch on rotating components and cause severe injury.

When engines are supplied without touch guards, all rotating components and hot surfaces must be protected after installation in their application, if necessary for personal safety.

### Ignition lock

If the instrument panel does not have a key switch, the engine room must be lockable, to prevent unauthorized persons from starting the engine. Alternatively, a lockable main switch can be used.

### Care and maintenance

#### Knowledge

The instruction book contains instructions for doing the most common service and maintenance tasks in a safe and correct manner. Read them carefully before starting work.

Literature for more major tasks is available from your Volvo Penta dealer.

Never do a job if you are not entirely sure about how to do it. Please contact your Volvo Penta dealer and ask for assistance instead.

#### Stop the engine.

Stop the engine before opening or removing the engine hatch/hood. Care and maintenance work should be done with the engine stopped unless otherwise specified.

Prevent the engine from being started by cutting the current with the battery isolator, or remove the cable from the battery positive pole before you start service work. Fix a notice by the operator's seat to say that work is in progress.

Working with, or going close to a running engine is a safety risk. Hair, fingers, loose clothes, or dropped tools can catch on rotating components and cause severe injury. Volvo Penta recommends that all service work which requires the engine to be running should be done by an authorized Volvo Penta workshop.

## Safety rules for operation and maintenance (contd.)

### Lifting the engine

The existing lugs on the engine should be used for lifting. Always check that the lifting devices are in good condition and that they have the correct capacity for the lift (engine weight together with auxiliaries, if fitted). The engine should be lifted with an adjustable lifting boom for safe handling. All chains or cables should be parallel to each other and should be as square as possible to the top of the engine. Please note that auxiliary equipment installed on the engine could change its center of gravity. Special lifting devices may then be needed to obtain the correct balance and safe handling. Never do any work on an engine which **just** hangs from a lifting device.

### Before starting

Re-install all guards which have been removed during service work, before re-starting the engine. Make sure that there are no tools or other objects left behind on the engine.

Never start a turbocharged engine without the air filter in place. The rotating compressor turbine in the turbocharger can cause severe injury. There is also a risk that foreign bodies could be sucked in and cause machinery damage.

## Fire and explosion

### Fuel and lubrication oil

All fuel, most lubricants and many chemicals are flammable. Always read and observe the advice on the packages.

Work on the fuel system must be done with the engine cold. Fuel leakage and spills on hot surfaces or electrical components can cause fires.

Store oil and fuel soaked rags and other flammable material in a fire-proof manner. Oil soaked rags can self-ignite in certain circumstances.

Never smoke when filling fuel, lubrication oil or when close to fuel filling stations or the engine bay.

### Non-original spare parts

Components in fuel systems and electrical systems on Volvo Penta engines are designed and manufactured to minimize the risk of explosions and fire, in accordance with applicable legal requirements.

The use of non-original spare parts can cause an explosion or fire.

### Batteries

Batteries contain and give off an explosive gas, especially when charged. This gas is very flammable and highly explosive.

Smoking, open flames or sparks must never occur in or near to batteries or the battery locker.

Incorrect connection of a battery cable or start cable can cause a spark which can be sufficient, in its turn, to make the battery explode.

### Start spray

Never use start spray or similar preparations to help in starting an engine with air pre-heating (glow plugs / starting heater). They may cause an explosion in the inlet manifold. Danger of personal injury.

## Hot surfaces and fluids

A hot engine always offers the risk of burns. Be on your guard against hot surfaces: the exhaust manifold, turbocharger, oil pan, charge air pipe, starting heater, hot coolant and hot lubricating oil in pipes, hoses etc.

## Chemicals

Most chemicals, such as glycol, rust preventer, conservation oils, degreasers etc. are hazardous. Always read and observe the advice on the packages.

Some chemicals, such as conservation oils, are flammable and also hazardous to breathe. Ensure good ventilation and use a protective mask for spraying. Always read and observe the advice on the packages.

Store chemicals and other hazardous material out of the reach of children. Hand in surplus or used chemicals to a recycling station for destruction.

## Lubrication system

Hot oil can cause burns. Avoid skin contact with hot oil. Make sure that the oil system is de-pressurized before starting work. Never start or run the engine with the oil filler cap removed, because of the risk of oil spillage.

## Cooling system

Avoid opening the coolant filling cap when the engine is hot. Steam or hot coolant can spray out at the same time as the pressure built up is lost.

If the filler cap, coolant hose etc., still has to be opened or removed when the engine is hot, undo the filler cap slowly and carefully, to let the pressure out before removing the filler cap completely and starting work. Note that the coolant can still be hot and cause scalding.

## Fuel system

Always protect your hands when searching for leaks. Fluids which leak under pressure can force their way into body tissue and cause severe injury. There is a risk of blood poisoning (septicemia).

Always cover the alternator if it is located beneath the fuel filters. Fuel spillage can damage the alternator.

## Electrical system

### Cut the current

Before any work is done on the electrical system, the engine must be stopped and the current cut by switching off the main switch(es). External current supply for engine heaters, battery chargers or other auxiliary equipment connected to the engine must be disconnected.

### Batteries

Batteries contain a highly corrosive electrolyte. Protect your eyes, skin and clothes during charging and other handling of batteries. Always use protective goggles and gloves.

If acid comes into contact with your skin, wash at once with soap and a lot of water. If you get battery acid in your eyes, flush at once with a lot of cold water, and get medical assistance at once.

## Electric welding

Remove the positive and negative cables from the batteries. Then disconnect all cables connected to the alternator.

Disconnect both connectors from the engine control module.

Always connect the welder earth clamp to the component to be welded, and as close as possible to the weld site. The clamp must never be connected to the engine or in such a way that current can pass through a bearing.

**When welding is completed:** Always connect the alternator cables to the alternator **and the connectors to the engine control module before** the battery cables are put back.

# Introduction

This instruction book has been prepared to give you the greatest possible benefit from your Volvo Penta industrial engine. It contains the information you need to be able to operate and maintain the engine safely and correctly. Please read the instruction book carefully and learn to handle the engine, controls and other equipment in a safe manner before you start the engine.

**⚠ IMPORTANT!** This instruction book describes the engine and equipment sold by Volvo Penta. Variations in appearance and function of the controls and instruments may occur in certain variants. In these cases, please refer to the instruction book for the relevant application.

## Environmental responsibility

All of us want to live in a clean, healthy environment, where we can breathe clean air, see healthy trees, have clean water in lakes and seas, and be able to enjoy the sunlight without fearing for our health. Unfortunately, this is not self-evident these days, it is something all of us must work for.

As an engine manufacturer, Volvo Penta has particular responsibility and for this reason, environmental care is a self-evident foundation of our product development. Volvo Penta has a wide engine program these days, where considerable progress has been made in reducing exhaust fumes, fuel consumption, engine noise etc.

We hope that you will want to preserve these values. Always observe the advice in the instruction book about fuel grades, operation and maintenance, to avoid unnecessary environmental impact. Please contact your Volvo Penta dealer if you notice any changes such as increased fuel consumption or increased exhaust smoke.

Please remember to always hand in hazardous waste such as drained oil, coolant, old batteries etc. for destruction at an approved recycling facility.

If we all pull together, we can make a valuable contribution to the environment together.

## Running in

**The engine must be “run in” during its first 10 hours, as follows:**

Use the engine in normal operation. Full load should only be applied for short periods. Never run the engine for a long period of time at constant speed during this period, this does not apply to GE engines.

Higher oil consumption is normal during the first 100-200 hours of operation. For this reason, check the oil level more frequently than normally recommended.

When an opening clutch is installed, this should be checked more carefully during the first days. Adjustment may need to be done to compensate bedding in of the friction plates.

## Fuel and oils

Only use the grades of fuels and oils recommended in the instruction book (please refer to the “Maintenance” chapter under the fuel and lubrication system headings). Other grades of fuel and oils can cause malfunctions, increased fuel consumption and eventually even shorten the life of the engine.

Always change the oil, oil filter and fuel filter at the specified intervals.

## Maintenance and spare parts

Volvo Penta engines are designed for maximum reliability and long life. They are built to withstand a demanding environment, but also to have the smallest possible environmental impact. Through regular service and use of Volvo Penta original spare parts, these qualities are retained.

Volvo Penta has a world-wide network of authorized dealers. They are Volvo Penta product specialists, and have the accessories, original spares, test equipment and special tools needed for high quality service and repair work.

**Always observe the maintenance intervals in the instruction book, and remember to note the engine/transmission identification number when you order service and spare parts.**

## Certified engines

If you own an emission certified engine, which is used in an area where exhaust emissions are regulated by law, it is important to be aware of the following:

Certification means that an engine type has been checked and approved by the relevant authority. The engine manufacturer guarantees that all engines made of the same type are equivalent to the certified engine.

**This makes special demands on the care and maintenance you give your engine, as follows:**

- Maintenance and service intervals recommended by Volvo Penta must be complied with.
- Only Volvo Penta original spares may be used.
- Service to injection pumps, pump settings and injectors must always be done by an authorized Volvo Penta workshop.

- The engine must not be converted or modified, except for the accessories and service kits which Volvo Penta has developed for the engine.
- No installation changes to the exhaust pipe and engine air inlet ducts may be done.
- No seals may be broken by unauthorized personnel.

The general advice in the instruction book about operation, care and maintenance applies.

 **IMPORTANT!** Delayed or inferior care/maintenance, and the use of non-original spares, parts means that AB Volvo Penta can no longer be responsible for guaranteeing that the engine complies with the certified version.

Damage, injury and/or costs which arise from this will not be compensated by Volvo Penta.

## Warranty

Your new Volvo Penta industrial engine is covered by a limited warranty, under the conditions and instructions compiled in the Warranty and Service book.

Please note that AB Volvo Penta's liability is limited to the specification in the Warranty and Service book. Read it carefully, as soon as possible after delivery. It includes important information about warranty cards, service intervals, maintenance, which it is the responsibility of the owner to know, check and carry out. If this is not done, AB Volvo Penta may fully or partly refuse to honor its warranty undertakings.

**Please contact your Volvo Penta dealer if you have not received a Warranty and Service book, or a customer copy of the warranty card.**

# Introduction

TAD1640GE, TAD1641GE, TAD1642GE, TAD 1641VE and TAD1642VE are in-line, direct injected, 6-cylinder industrial diesel engines.

All engines are equipped with electronically controlled fuel management (EMS 2), turbocharger, intercooler, thermostatically controlled cooling systems and electronic speed control.

## Technical description

### Engine and engine block

- The engine block and cylinder head are manufactured of alloyed cast iron
- Seven bearing induction hardened crankshaft
- Wet, replaceable cylinder liners
- Cast aluminum pistons with oil cooling
- Three piston rings, with a “keystone” type top ring
- Induction hardened, overhead, seven bearing camshaft with
- Four valves per cylinder
- Replaceable valve seats and valve guides

### Fuel system

- Microprocessor based fuel supply control unit (EMS 2)
- Gear driven fuel supply pump
- Centrally located unit injectors with electromagnetically controlled fuel valves
- Spin-on secondary fuel filter and water trap

### Lubrication system

- Water cooled oil cooler
- Gear driven oil pump
- Two full flow filters and a spin-on bypass filter

### Turbocharging system

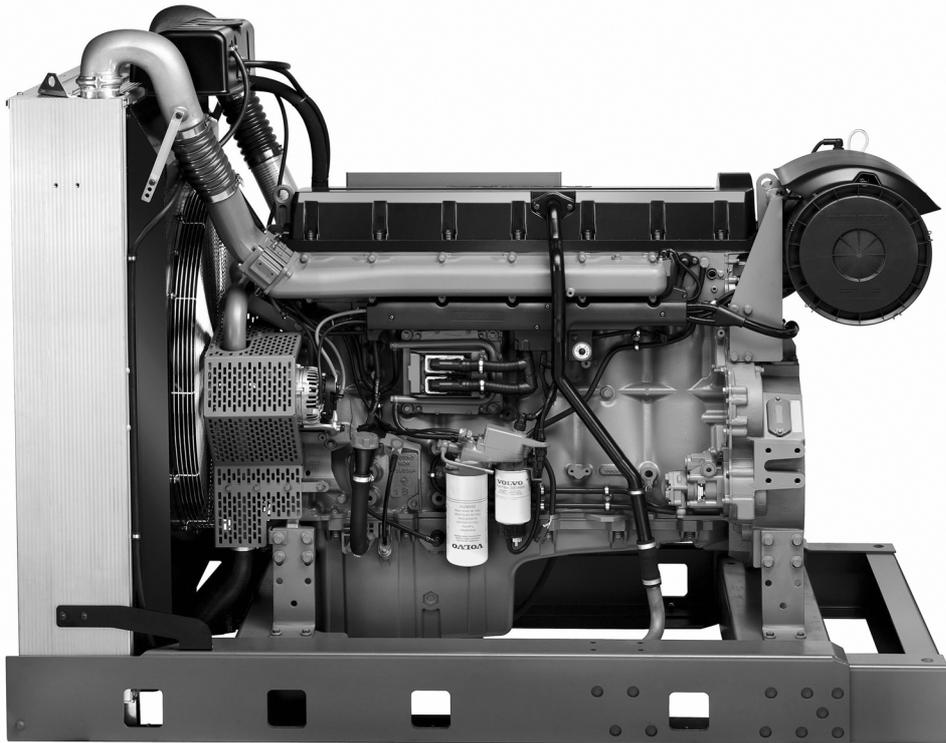
- Turbocharger

### Cooling system

- Radiator with expansion tank
- Air cooled intercooler
- Belt-driven water pump
- Piston thermostat

### Electrical system

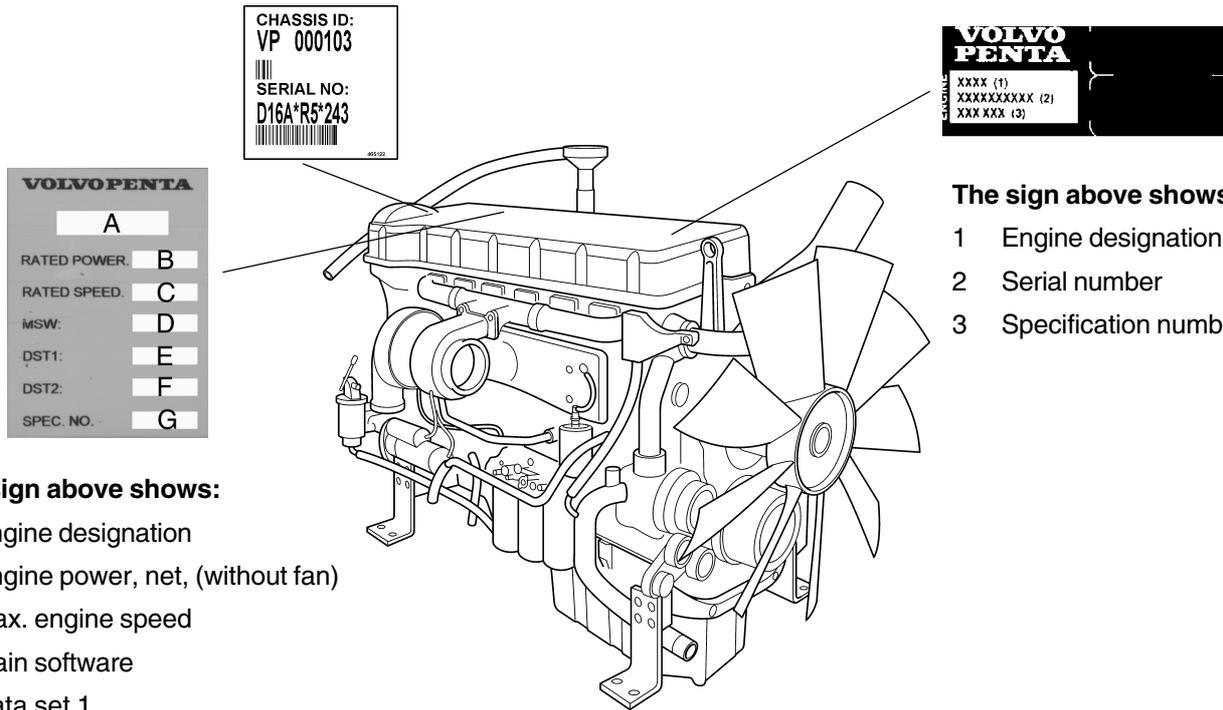
- 24 V electrical system
- Alternator with charge sensor  
80 A (110 A option)
- Engine mounted extra stop (AUX STOP)



TAD1640GE, TAD1641GE, TAD1642GE  
TAD1641VE, TAD1642VE

## Identification numbers

### Location of engine signs



**The sign above shows:**

- A Engine designation
- B Engine power, net, (without fan)
- C Max. engine speed
- D Main software
- E Data set 1
- F Data set 2
- G Product number

**Explanation of engine designation:**

E.g. TAD1641GE/TAD941VE

- T – Turbo
- A – Air to air intercooler
- D – Diesel engine
- 16 – Cylinder volume, liter
- 4 – Generation
- 1 – Version
- G – Generator unit engine
- V – Stationary and mobile operation
- E – Emission certified

## EMS 2

EMS 2 (Engine Management System) is an electronic system with CAN communication (Controller Area Network) for diesel engine control. The system has been developed by Volvo Penta and includes fuel control and diagnostic function.

### Summary

The system includes sensors, control unit and unit injectors. The sensors send input signals to the control unit, which controls the unit injectors in its turn.

### Input signals

The control unit receives input signals about engine operating conditions etc. from the following components:

- coolant temperature sensor
- charge pressure / charge temperature sensor
- crankcase pressure sensor
- position sensor, camshaft
- speed sensor, flywheel
- coolant level sensor
- oil level and temperature sensor
- oil pressure sensor
- fuel pressure sensor
- water in fuel indicator

### Output signals

The control module uses the input signals to control the following components:

- unit injectors
- starter motor
- main relay
- pre-heating relay

Information from the sensors provides exact information about current operation conditions and allows the processor in the control unit to calculate the correct fuel injection volume and timing, check engine status etc.

### Fuel control

The engine fuel requirement is analyzed up to 100 times per second. The amount of fuel injected into the engine and the injection advance are fully electronically controlled, via fuel valves and the unit injectors.

This means that the engine always receives the correct volume of fuel in all operating conditions, which offers lower fuel consumption, minimal exhaust emissions etc.

### Diagnostic function

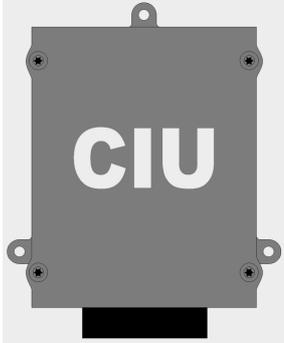
The task of the diagnostic function is to discover and localize any malfunctions in the EMS 2 system, to protect the engine and to ensure operation in the event of serious malfunction.

If a malfunction is discovered, this is announced by warning lamps, a flashing diagnostic lamp or in plain language on the instrument panel, depending on the equipment used. If a fault code is obtained as a flashing code or in plain language, this is used for guidance in any fault tracing. Fault codes can also be read by Volvo's VODIA tool at authorized Volvo Penta workshops.

If there is a serious malfunction, the engine will be shut down altogether, or the control unit will reduce the power delivered (depending on application). Once again, a fault code is set for guidance in any fault tracing.

## Instrument, EMS 2

**NOTE!** All instruments are accessories.

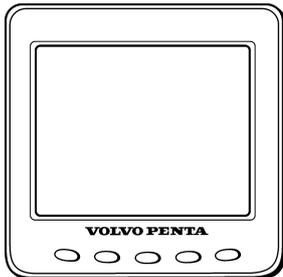


### CIU - Control Interface Unit

The CIU is the “translator” between the EMS 2 control unit and the customer’s own control panel. The CIU has two serial communication links, a fast one and a slow one.

The fast one is a so-called CAN link. All data related to instruments, indication lamps, connectors and potentiometers is controlled by this link.

The slow link manages diagnostic information for flashing codes etc.



### DU - Display Unit

The DU is an instrument panel which shows engine working values graphically on an LCD screen. It consists of an computerised unit for permanent installation in a control panel.

The DU is connected between the engine control unit and the CIU or DCU.

### Easy Link instrument (only together with a CIU)

The following “Easy Link” instruments are available:

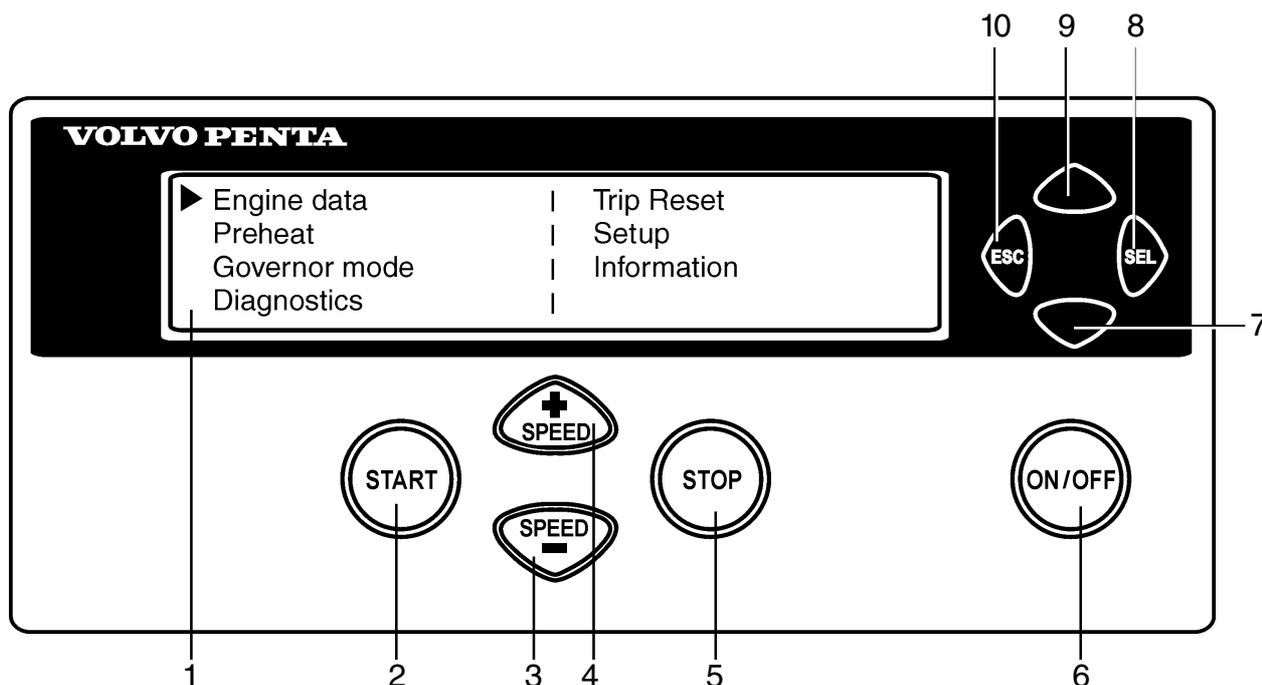
- Engine speed / hours counter (fault codes are also displayed on the tachometer display when the diagnostic button is pressed)
- Coolant temperature
- Oil pressure
- Oil temperature
- Battery voltage
- Alarm panel
- Turbo pressure

## DCU (Display Control Unit)

The DCU (Diesel Control System) control panel is available as an optional accessory for the EMS (Engine Management System) electronic control system. The DCU is a digital instrument panel which communicates with the engine control unit. DCU has several functions, such as: engine control, monitoring, diagnostics and parameter setting.

The menus in the DCU system can be used to check, and in some cases to set a number of different functions in the EMS system.

**NOTE!** The menus and illustrations shown here are the English version. The language can be changed, however. Please refer to the “Setup” menu.



- |                                    |  |
|------------------------------------|--|
| 1. LED display                     | 6. ON/OFF. Starts and stops the system     |
| 2. START. Starts the engine        | 7. Scroll downwards in menus               |
| 3. SPEED -. Reduces engine speed   | 8. SEL. Selects in menu                    |
| 4. SPEED +. Increases engine speed | 9. Scroll upwards in menu                  |
| 5. STOP. Stops the engine          | 10. ESC. Return to previous menu selection |

### Start

When the DCU panel is started up, the “Engine Data” menu is displayed. Press “ESC” to come to the main menu.

## Menus

There are several sub-menus under each main menu. There is not space for all the menu choices on the display. To scroll through the menus, use the “7” and “9” buttons on the display. Press the “SEL” button, no. “8” to make a selection. Please refer to the illustration on the previous page.

**NOTE!** The “Setup” menu can be used to select the language that you want to use on the display.

▶ <b>Engine data</b>		Trip Reset
Preheat		Setup
Governor mode		Information
Diagnostics		

### Main menu

- **Engine data**, relevant engine data.
- **Preheat**, manual activation of pre-heating
- **Governor mode**, activation of droop.
- **Diagnostics**, shows fault codes in plain language.
- **Trip reset**, resets trip data
- **Setup**, parameter setting
- **Information**, shows the data for the applicable hardware, software, data set and engine identification of the engine and DCU

▶ <b>Eng speed</b>	rpm		<b>Boost prs</b>	kPa
Cool temp	C		<b>Boost tmp</b>	C
Oil pres	kPa		<b>Oil temp</b>	C
Eng hours	h		<b>Batt Volt</b>	V

### Engine data

shows relevant engine data.

- Engine speed, can be controlled with the “SPEED +” and “SPEED –” buttons (rpm)
- Charge pressure (kPa)
- Coolant temperature (°C)
- Charge air temperature (°C)
- Oil pressure (kPa)
- Oil temperature (°C)
- Engine hours (h)
- Battery voltage (V)
- Fuel consumption (l/h)
- Instantaneous fuel consumption (trip fuel) (l)

**\*\*\* Preheat \*\*\***  
Press SEL to request preheat

## Preheat

manual activation of pre-heating. When it is activated, the EMS system senses when started if pre-heating is needed. For automatic pre-heating, please refer to the “Setup” / “Pre-heat on ignition” menu.

The pre-heating time is adjusted to suit the engine temperature, and can last for up to 50 seconds both before and after starting. Also refer to “Starting procedure, EMS 2”.

- Press “SEL”, the text “Preheat requested” is displayed.
- The display automatically returns to the “Engine Data” menu.

**\*\*\* Governor mode \*\*\***  
Droop mode

## Governor mode

activates/shuts off droop. To set the droop level, please refer to the “Setup” / “Governor gradient” or “Governor droop” menus.

- Select “Isochronous mode” or “Droop mode” with the SEL button.

**\*\*\* Diagnostics 7/9 \*\*\***  
20.0 h Engine oil pressure  
signal failure Inactive

## Diagnostics

shows the error list containing the 10 latest active and inactive faults. The fault code are shown as text on the display.

- Scroll through the error list with the arrow keys.

**\*\*\* Trip Data Reset \*\*\***  
Press SEL to reset trip data

## Trip reset

resets trip data, such as fuel consumption.

- Press the SEL button to reset trip data.

Setup	
▶ Set Application :	(Versatile)
Units :	(Metric)
Language :	(English)

## Setup

parameter setting in the engine’s control systems. Different menus appear under “Customer parameter”, depending on whether you select “Versatile” or “Genset” from “Set application”.

The parameters that can be set / selected (choice is made with the SEL button) are:

- **Set application**, setting of “Versatile” or “Genset”. Different menus appear under “Customer parameter”, depending on what is chosen here.
- **Unit**, selection of units of measurement (metric or US units)
- **Language**, selection of the language shown in the display. You can choose between English, French, German and Spanish.
- **Stop energized to**, setting for the external stop input. Activated at “Stop” or “Run”.  
**“Stop”**: The stop input must be connected to voltage to stop the engine.  
**“Run”**: The stop input must be connected to voltage to run the engine.
- **Customer parameter**, alarm limit setting. Please refer to “Customer parameter / Versatile” and “Customer parameter / Genset”.
- **Throttle input setting**, setting of speed control and voltage limits. See “Throttle input setting”.
- **Display setting**, display setting. See “Display setting”.

Setup (Versatile)	
▶ Idle engine speed :	rpm
Preheat on ignition :	
Governor gradient :	Nm/rpm

## Customer parameter / Versatile

- **Idle engine speed** - setting idling speed
- **Preheat on ignition** - activation of automatic preheating. The engine control system senses if preheating is needed and activates it directly when switched on.
- **Governor gradient (Nm/rpm)** - setting the droop level, when this has been activated. Please refer to “Governor droop” in the main menu for activation.
- **Oil temp warning limit (°C)** - setting the alarm limit for the oil temperature.
- **Coolant temp warning limit (°C)** - setting the alarm limit for the coolant temperature.

Setup (Genset)

▶ Primary engine speed :  
 Preheat on ignition :  
 Governor droop :

### Customer parameter / Genset

- **Primary engine speed** - selection of engine speed, 1500 or 1800 rpm.
- **Preheat on ignition** - activation of automatic pre-heating. The engine control system senses if pre-heating is needed and activates it directly when switched on.
- **Governor droop (%)** - setting the droop level, when this has been activated. Please refer to “Governor droop” in the main menu for activation.
- **Overspeed limit (%)** - setting the speed for the excess speed alarm, % of set engine speed.
- **Overspeed shutdown** - activation of engine shutdown when the excess speed alarm is activated. Please refer to “Overspeed limit” to activate the alarm limit for the excess speed alarm.
- **Oil temp warning limit (°C)** - setting the alarm limit for the oil temperature.
- **Coolant temp limit (°C)** - setting the alarm limit for the coolant temperature.

Setup(Throttle)

Setup throttle mode : \*\*\* OFF \*\*\*

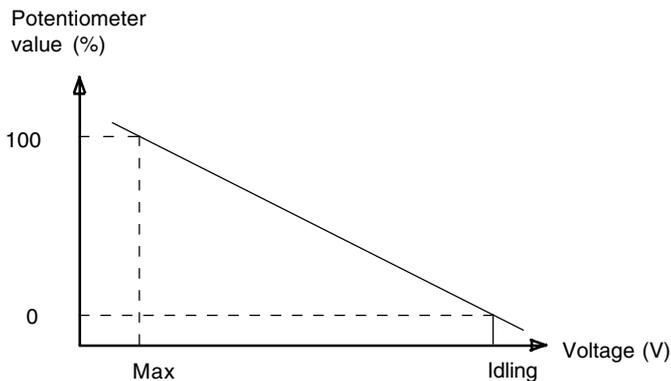
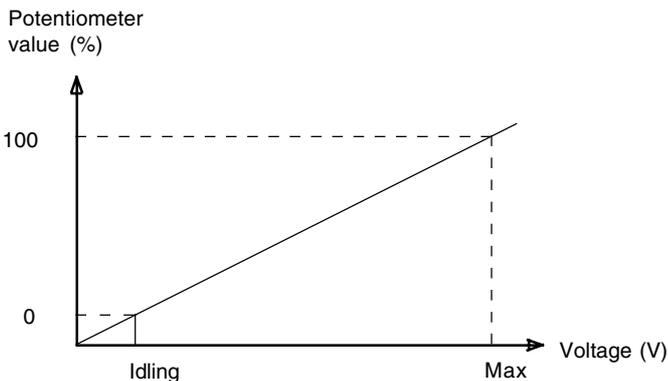
### Throttle input setting

speed control setting (throttle operation).

Setup(Throttle)

▶ Set throttle mode :  
 Set idle voltage :  
 Set mx voltage :

- **Set throttle mode** -  
 “OFF” - engine speed is controlled via the DCU panel.  
 “ext throttle input” - engine speed is controlled with a potentiometer (accelerator).  
 “ext voltage input” - engine speed is controlled by an external unit.
- **Set idle voltage (V)** - setting the voltage level at idle.
- **Set max voltage (V)** - setting the voltage level at maximum speed.



Setup (Display)		
▶ Set contrast	:	60%
Set backlighttime	:	5 sec
Set backlight brightness	:	10

## Display setting

settings for the display. Adjustment is done with the “7” and “9” buttons, please refer to the DCU panel in the illustration.

- **Set contrast (%)** - display contrast adjustment.
- **Set backlight time (sec)** - sets the time (in seconds) for background illumination in the display. The light is then switched off if the panel is not used.
- **Set backlight brightness** - adjustment of illumination strength in the display.

*** Information ***	
▶ Engine hardware Id	:
Engine software Id	:
Engine Dataset1 Id	:

## Information

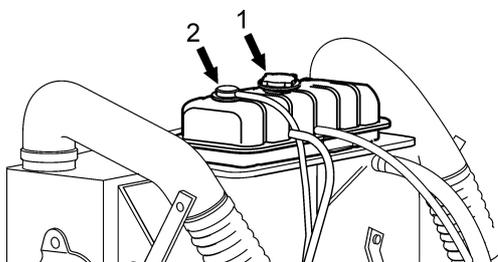
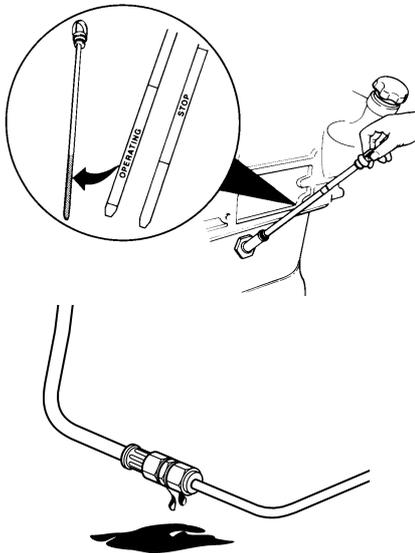
shows the data for the engine and DCU.

- **Engine hardware ID** - part number of the engine control module
- **Engine software ID** - part number of the software in the engine control module
- **Engine dataset1 ID** - part number of engine data set 1.
- **Engine dataset2 ID** - part number of engine data set 2.
- **Vehicle ID** - chassis number
- **DCU hardware ID** - part number of the DCU.
- **DCU software ID** - part number of the software in the DCU.
- **DCU dataset1 ID** - part number of DCU data set 1.
- **DCU dataset2 ID** - part number of DCU data set 2.

# Starting the engine

Make it a habit to give the engine and engine bay a visual check before starting. This will help you to discover quickly if anything abnormal has happened, or is about to happen. Also check that instruments and warning displays show normal values after you have started the engine.

**⚠ WARNING!** Never use start spray or similar products as a starting aid. Explosion risk!



## Before starting

- Check that the oil level is between the MAX and MIN marks. Please refer to the “Maintenance, lubrication system” chapter:
- Open the fuel taps.
- Check that no leakage of oil, fuel or coolant-occurs.

- Check the coolant level and that the radiator is not blocked externally. Please refer to the “Maintenance, cooling system” chapter.

**⚠ WARNING!** Do not open the filler cap (1) when the engine is hot. Steam or hot fluid could spray out.

**NOTE!** Only open filler cap (1). Do not open filler cap (2).

- Turn the main switch(es) on.

**⚠ IMPORTANT!** Never disconnect the current with the main switch(es) when the engine is running. This can damage the alternator.

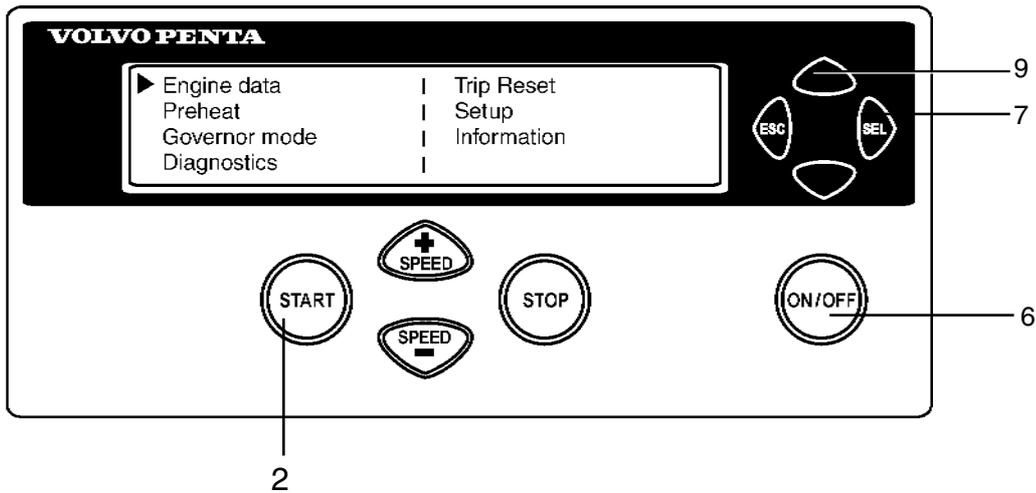
- Move the engine speed control to idle, and release the opening clutch/gearbox if installed.

## Starting method EMS 2

The pre-heating time is adjusted to suit the engine temperature, and can last for up to 50 seconds both before and after starting.

The starter motor connection time is maximized to 30 seconds. After that, the starter motor circuit is cut for 80 seconds to protect the starter motor against overheating.

**NOTE!** Preheating must be activated at temperatures below 0°.



### With pre-heating

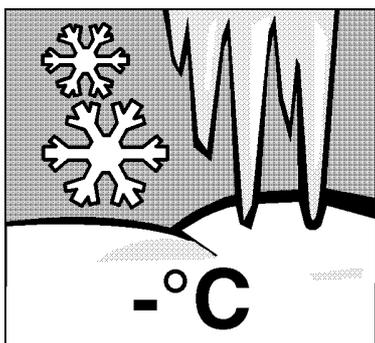
1. Depress the "ON/OFF" button (6).
2. Press the "SEL" button (7) to come to the main menu.
3. Scroll down to **Preheat** with button (9). Press the "SEL" button (7).
4. In the pre-heat menu, press the "SEL" button (7) to select pre-heating. The text "Preheat active please wait" is shown in the display.
5. Wait until the text has gone out and then press the "START" button (2).

### Without pre-heating

1. Depress the "ON/OFF" button (6).
2. Press the "START" button (2).

Leave the engine to idle for the first 10 seconds. Then warm the engine up at low speed and under low load.

**⚠ IMPORTANT!** Never race the engine when it is cold.



## Starting in extreme cold

Certain preparations must be made to facilitate engine starting, and in some cases to make starting possible at all.

Use a winter grade fuel (of a well-known make) which has been approved for the relevant temperature. This reduces the risk of wax deposits in the fuel system. At extremely low temperatures, the use of a fuel heater is recommended.

For fully acceptable lubrication, a synthetic engine oil of recommended viscosity for the relevant temperature should be used. Please refer to the "Maintenance, lubrication system" chapter: Synthetic lubricants are able to manage a wider temperature range than mineral-based lubricants.

Pre-heat the coolant with a separately installed electric engine heater. In extreme cases, a diesel-burning engine heater may be needed. Ask your Volvo Penta dealer for advice.

**⚠ IMPORTANT!** Make sure that the cooling system is filled with a glycol mixture. Please refer to the "Maintenance, cooling system" chapter:

The batteries should be in good condition. Cold weather reduces battery capacity. Increased battery capacity may be necessary.



## Never use start spray

**⚠ WARNING!** Never use start spray or similar products as a starting aid. They may cause an explosion in the inlet manifold. Personal injury could also be caused.

## Starting with auxiliary batteries

**⚠ WARNING!** Batteries (especially auxiliary batteries) contain hydrogen which is highly explosive in contact with air. A spark, which can be formed if the auxiliary batteries are wrongly connected, is enough to make a battery explode and cause damage.

1. Check that the auxiliary batteries are connected (series or parallel) so that the rated voltage corresponds to the engine system voltage.
2. First connect the red (+) jumper cable to the auxiliary battery, then to the flat battery. Then connect the black (-) jumper cable to the auxiliary battery, and lastly to a place which **is some distance away from the flat batteries**, e.g. at the main switch on the negative cable or the negative cable terminal on the starter motor.
3. Start the engine.

**⚠ WARNING!** Do not move the connections when you attempt to start the engine (risk of arcing), and do not stand and lean over one of the batteries.

4. Remove the jumper cables in the reverse order from installation.

**⚠ WARNING!** The ordinary cables to the standard batteries must not be loosened on any condition.

# Operation

Correct operation technique is very important for both fuel economy and engine life. Always let the engine warm up to normal operating temperature before operating at full power. Avoid sudden throttle openings and operation at high engine speeds.

## Checking instruments

Check all instruments directly after starting, and then regularly during operation.

**⚠ IMPORTANT!** On engines which operate continuously, the lubrication oil level must be checked, at least every **24 hours**. Please refer to the “Maintenance, lubrication system” chapter.

## Fault indication

If the EMS 2 system receives abnormal signals from the engine, the control unit generates fault codes and alarms, in the form of lamps and audible warnings. This is done by means of CAN signals to the instrument.

More information about fault codes and fault tracing is found in the “Diagnostic function” chapter.

## Operation at low load

Avoid long-term operation at idle or at low load, since this can lead to increased oil consumption and eventually to oil leakage from the exhaust manifold, since oil will seep past the turbocharger seals and accompany the induction air into the inlet manifold at low turbo boost pressure.

One consequence of this is that carbon builds up on valves, piston crowns, exhaust ports and the exhaust turbine.

At low load, the combustion temperature is so low that full combustion of the fuel can not be ensured, which means that the lubrication oil can be diluted by diesel fuel, and the exhaust manifold will eventually leak oil.

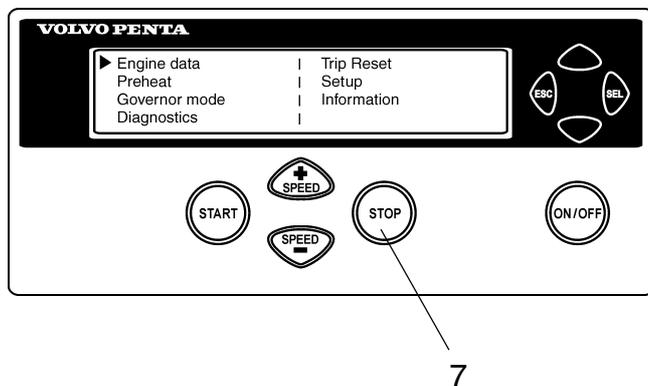
**If the following points are done as a complement to normal maintenance, there will be no risk of malfunctions caused by operation at low load.:**

- Reduce operation at low load to a minimum. If the engine is regularly test run without load once a week, operation duration should be limited to 5 minutes.
- Run the engine at full load for about 4 hours once a year. Carbon deposits in the engine and exhaustpipe can then be burned off.

# Stopping the engine

During longer breaks in operation, the engine must be warmed up at least once every fortnight. This prevents corrosion attack in the engine. If you expect the engine to be unused for two months or more, it must be laid up: Please refer to the chapter entitled "Laying up".

**⚠ IMPORTANT!** If there is a risk of frost, the coolant in the cooling system must have sufficient frost protection. Please refer to the "Maintenance, cooling system" chapter: A poorly charged battery can freeze and burst.



## Before stopping

Let the engine run for a few minutes without loading before stopping it. This permits the temperature inside the engine to even up, "after-boiling" is avoided, at the same time as the turbocharger cools somewhat. This contributes to long service life without malfunctions.

## Stop

- Disengage the clutch (if possible).
- Depress the "STOP" button (7).

## After stopping

- Check the engine and engine bay for leakage.
- Turn off the main switches before any long stoppage.
- Carry out maintenance in accordance with the schedule.

## Extra stop

The extra stop device (AUX STOP) is located on the right side of the engine above the control unit, please refer to "Component location".

**⚠ WARNING!** Working with, or going close to a running engine is a safety risk. Watch out for rotating components and hot surfaces.



# Troubleshooting

A number of symptoms and possible causes of engine malfunctions are described in the table below. Always contact your Volvo Penta dealer if any problems occur which you can not solve by yourself.

 **WARNING!** Read through the safety advice for care and maintenance work in the chapter entitled “Safety-information” before you start work.

## Symptoms and possible causes

 The diagnosis button lamp flashes.	Please refer to the “Diagnostic information” chapter
Engine can not be stopped.	2, 5
Starter motor does not rotate	1, 2, 3, 4, 5, 6, 7, 24
Starter motor rotates slowly	1, 2
Starter motor rotates normally but engine does not start	8, 9, 10, 11,
Engine starts but stops again	8, 9, 10, 11, 13
Engine does not reach correct operating speed at full throttle	9, 10, 11, 12, 13, 21, 25, 26
Engine runs roughly	10, 11
High fuel consumption	12, 13, 15, 25
Black exhaust smoke	12, 13
Blue or white exhaust smoke	15, 22
Too low lubrication oil pressure	16
Excessive coolant temperature	17, 18, 19, 20
Too low coolant temperature	20
No, or poor charge	2, 23

- |   |  |  |
|---|--|--|
| 1. Flat batteries   | 10. Air in the fuel system                                     | 16. Too low oil level                    |
| 2. Poor contact/open circuit in cables  | 11. Water/contamination in fuel                                | 17. Coolant level too low                |
| 3. Main switch turned off   | 12. Faulty unit injector                                       | 18. Air in the coolant system            |
| 4. Main circuit breaker faulty  | 13. Insufficient air supply to engine:<br>– blocked air filter | 19. Faulty circulation pump              |
| 5. Faulty ignition lock   | – air leakage between turbo-charger and engine inlet pipe.     | 20. Defective thermostat                 |
| 6. Faulty main relay  | – fouled compressor section in turbocharger                    | 21. Blocked intercooler                  |
| 7. Faulty starter motor/solenoid  | – faulty turbocharger  | 22. Too high oil level                   |
| 8. Lack of fuel:<br>– fuel taps closed<br>– fuel tank empty/wrong tank connected  | – poor engine bay ventilation                                  | 23. Alternator drive belt slips          |
| 9. Blocked fuel filter/pre-filter (because of contamination, or paraffin fraction separation in fuel at low temperature). | 14. Excessive coolant temperature                              | 24. Water entry into engine              |
|   | 15. Too low coolant temperature                                | 25. High back pressure in exhaust system |
|   |  | 26. Break in “ Pot+ ” cable to pedal     |

# Maintenance schedule

## General

Your Volvo Penta engine and its equipment are designed for high reliability and long life. It is built so as to have minimal environmental impact. If given preventive maintenance, according to the maintenance schedule, and if Volvo Penta original spares are used, these properties are retained and unnecessary malfunctions can be avoided.

## MAINTENANCE SCHEDULE

**⚠ WARNING!** Before you start to do any maintenance work, read the “Maintenance” chapter carefully. This contains instructions for doing work in a safe and correct manner.

**⚠ IMPORTANT!** When both operation and calendar time are specified, do the maintenance job at the interval which is reached first. Maintenance points marked must be done by an authorized Volvo Penta workshop

### Daily, before first start

- Engine and engine bay, general inspection ..... page 28
- Oil level, checking and filling ..... page 32
- Coolant, checking level ..... page 36

### Every 50 hours / at least every 12 months.

- Primary fuel filter. Drain water/contamination ..... page 41

### After the first 150 hours

- Engine oil, changing <sup>1)</sup> ..... page 32

<sup>1)</sup> **NOTE!** An oil change is recommended, change the oil to a grade recommended by Volvo Penta.

### Every 50-600 hours / at least every 12 months.

- Engine oil, changing <sup>1)</sup> ..... page 32
- Oil filter/By-pass filter, change <sup>2)</sup> ..... page 32
- Primary fuel filter, change ..... page 41
- Fuel filter, changing ..... page 41

<sup>1)</sup> Oil change intervals vary, depending on oil grade and sulfur content of the fuel. page 26.

<sup>2)</sup> Change the filters during each oil change.

### Every 400 hours / at least every 12 months.

- Fuel tank (sludge trap), drain. .... not shown
- Drive belts, inspection ..... page 29
- Batteries, checking the electrolyte level ..... page 44

**Every 800 hours / at least every 12 months.**

- Charge air pipe, leakage check ..... page 28
- Primary fuel filter, check ..... not shown

**Every 1000 hours / at least every 6 months.**

- Coolant filter, changing <sup>1)</sup> ..... page 38

<sup>1)</sup> Not at same time as coolant change.

**Every 2000 hours**

- Turbocharger, check ..... not shown
- Valve clearance, inspection/adjustment ..... not shown

**Every 12 months**

- EMS 2-system. Inspection with diagnostic tool (VODIA) ..... please refer to the "VODIA User's Guide"
- Engine, general inspection ..... page 28
- Engine, cleaning/painting ..... not shown
- Air filter, tank breather, change. .... not shown
- Inspection, air compressor, change. .... not shown
- Air filter inserts, check/change ..... page 30

**Every 36 months or every 8000 hours.**

- Drive belts, change ..... page 29-30

**Every 48 months or every 10000 hours.**

- Cooling system, inspection/cleaning ..... page 36, 39
- Coolant, change ..... page 36-39

**Newly renovated engine:****After the first 250 hours**

- Valve clearance, adjustment ..... not shown

# Maintenance

This chapter describes how the specified maintenance points should be done. Read them carefully before starting work. The times when maintenance points need to be attended to are given in the previous chapter: Maintenance schedule

**⚠ WARNING!** Read through the safety advice for care and maintenance work in the “Safety information” chapter before starting work.

**⚠ WARNING!** Care and maintenance work should be done with the engine stopped unless otherwise specified. Make it impossible to start the engine by removing the ignition key and cutting the system voltage with the main switch. Working with, or going close to a running engine is a safety risk. Watch out for rotating components and hot surfaces.

## Engine, general

### General inspection

Make it a habit to give the engine and engine bay a visual check **before the engine is started and after operation, when the engine has been stopped.** This will help you to discover quickly if anything abnormal has happened, or is about to happen.

Look especially carefully at oil, fuel and coolant leakage, loose screws, worn or poorly tensioned drive belts, loose connections, damaged hoses and electrical cables. This inspection only takes a few minutes and can prevent serious malfunctions and expensive repairs.

**⚠ WARNING!** Deposits of fuel, oils and grease on the engine or in the engine bay are a fire hazard and must be removed as soon as they are discovered.

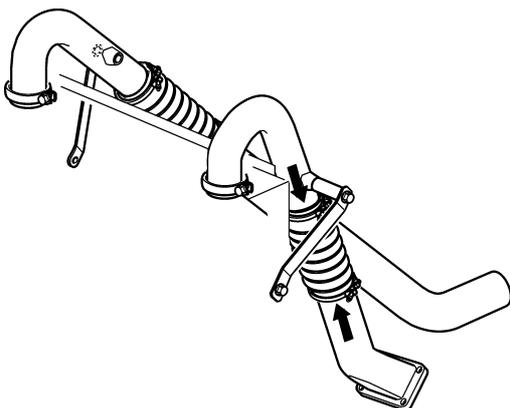
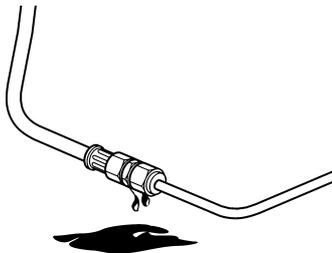
**⚠ IMPORTANT!** If you discover a leakage of oil, fuel or coolant, investigate the cause and fix the fault before you start the engine.

**⚠ IMPORTANT!** Remember the following when washing with a high pressure washer: Never aim the water jet at radiators, intercoolers, seals, rubber hoses or electrical components.

### Charge air pipe, leakage check

Check the charge air pipes, hose connections and the condition of the clamps for cracks or other damage. Change as necessary.

**⚠ IMPORTANT!** Torque the clamps to  $9 \pm 2$  Nm ( $6.6 \pm 1.5$  lbf-fot).



## Drive belt / Alternator belt, inspection

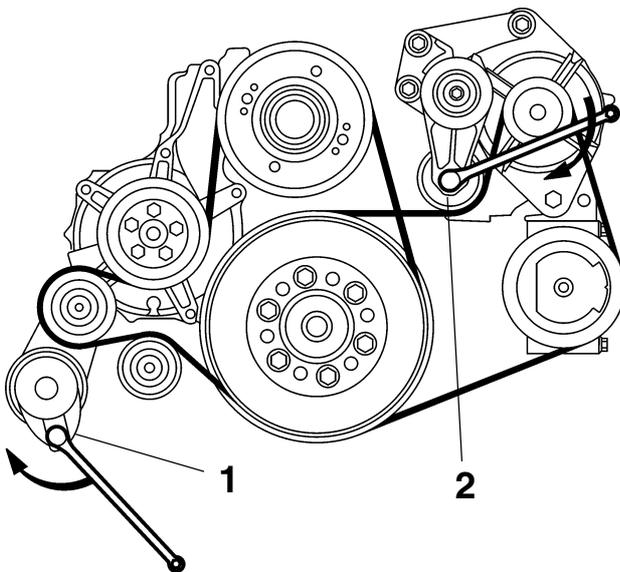
Inspection should be done after operation, when the belts are hot.

It should be possible to press the alternator belts and drive belts down about 3-4 mm (0,118-0,157 ") between the pulleys.

The alternator belts and drive belts have automatic belt tensioners and do not need to be adjusted. Check the condition of the drive belts. Change as necessary, please refer to "Alternator belt, change" and "Drive belt, change".

## Alternator belts, changing

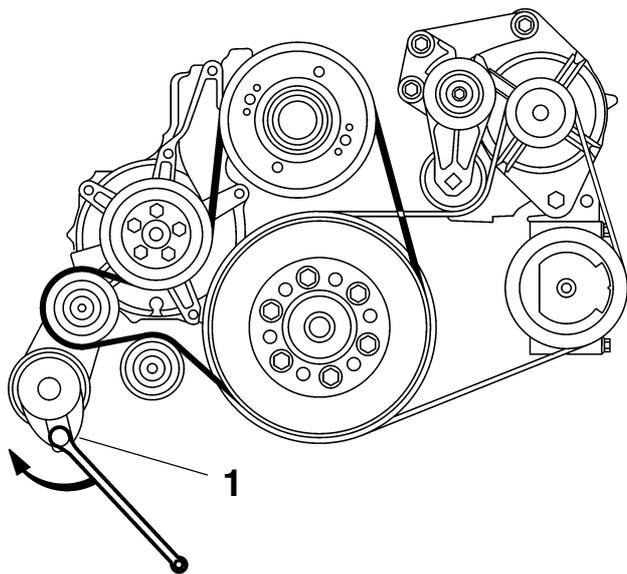
**⚠ IMPORTANT!** Always change a drive belt which appears worn or cracked.



1. Disconnect the main switch(es) and check that the engine is not connected to system voltage.
2. Remove the fan guard and fan ring round the cooling fan.
3. Remove the belt guard.
4. Insert a 1/2" square wrench in the belt tensioner (1). Lift the wrench up and lift the water pump drive belt off.
5. Insert a 1/2" square wrench in the belt tensioner (2). Press the wrench down and remove the alternator belts.
6. Check that the pulleys are clean and undamaged.
7. Press the 1/2" wrench in the belt tensioner (2) down and install the new alternator drive belt.
8. Lift the 1/2" wrench in the belt tensioner (2) and install the new water pump drive belt.
9. Install the belt guards.
10. Install the fan guard and fan ring round the cooling fan.
11. Start the engine and do a function check.

## Drive belt, changing

1. Disconnect the main switch(es) and check that the engine is not connected to system voltage.
2. Remove the fan guard and fan ring round the cooling fan.
3. Remove the belt guard.
4. Insert a 1/2" square wrench in the belt tensioner (1). Lift the wrench and remove the drive belt.
5. Thread the drive belt round the fan and remove it.
6. Check that the pulleys are clean and undamaged.
7. Thread the new drive belt over the fan.
8. Lift the 1/2" wrench and install the new drive belt.
9. Install the belt guards.
10. Install the fan guard and fan ring round the cooling fan.
11. Start the engine and do a function check.



## Air filter Check/change.

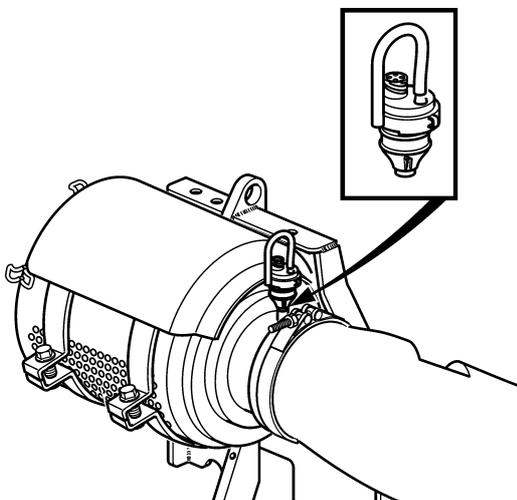
The engine is equipped with electronic air filter indication.

The control unit provides an output signal which is announced as a warning on the instrument panel. The warning indicates a pressure drop in the air filter, which must then be checked and possibly changed.

**NOTE!** Scrap the old filter. No cleaning or re-use is permissible.

**!** **IMPORTANT!** In continuous operation, the filter should be checked every 8 hours.

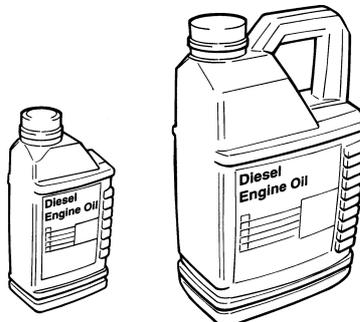
Driving in extremely contaminated environments—such as coal mines or rock crushers requires special air filters.



## Lubrication system

Oil change intervals can vary from **50 to 600 hours**, depending on the grade of lubrication oil and the sulfur content of the fuel. **Note that oil change intervals must never exceed a period of 12 months.**

If you want longer oil change intervals than given in the table below, the condition of the oil must be checked by the oil manufacturers through regular oil testing.



Oilgrade	Sulfur content in fuel, by weight		
	< 0,5 %	0,5 – 1,0 %	> 1,0 % <sup>1)</sup>
	Oil change interval, reached first in operation		
VDS-3 VDS-2 and ACEA: E7 <sup>2)</sup> VDS-2 and ACEA: E5 <sup>2)</sup> VDS-2 and Global DHD-1 <sup>2)</sup> VDS-2 and API: CI-4 <sup>2)</sup> VDS-2 and API: CH-4 <sup>2)</sup>	600 h / 12 months	300 h / 12 months	150 h / 12 months
VDS and ACEA: E3 <sup>2)</sup>	400 h / 12 months	200 h / 12 months	100 h / 12 months
ACEA: E7, E5, E4 API: CI-4, CH-4, CG-4	200 h / 12 months	100 h / 12 months	50 h / 12 months

**NOTE!** Mineral based oil, either fully or semi-synthetic, can be used on condition that it complies with the quality requirements above.

<sup>1)</sup> If the sulfur content is > 1.0% by weight, use oil with TBN > 15

<sup>2)</sup> The engine oil must fulfill **both** requirements. For markets outside Europe, API: CG-4 and CH-4 can be used instead of ACEA: E3.

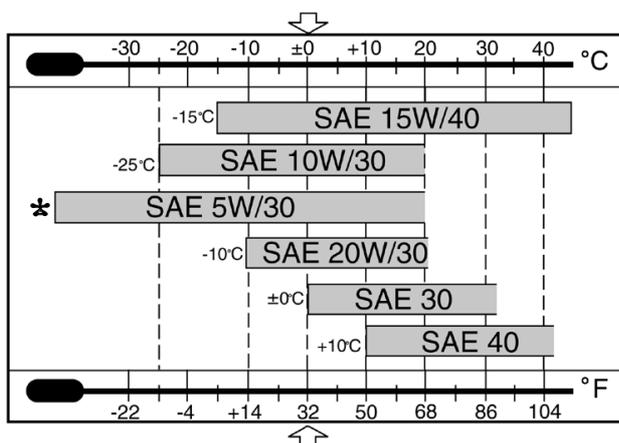
**VDS = Volvo Drain Specification**

**ACEA = Association des Constructeurs Européenne d'Automobiles**

**API = American Petroleum Institute**

**Global DHD = Global Diesel Heavy Duty**

**TBN = Total Base Number**



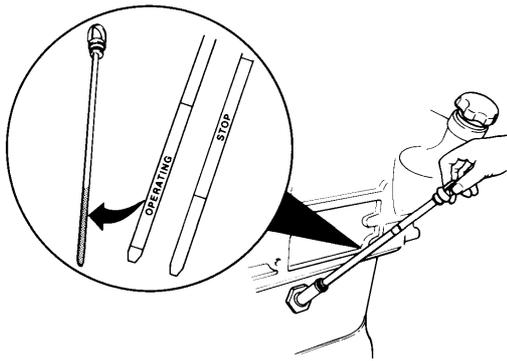
### Viscosity

Select the viscosity from the adjacent table, for the appropriate continuous ambient air temperature.

\* Refers to synthetic or semi-synthetic oils.

### Oil change volume

Please refer to the "Technical Data" chapter.



## Oil level, checking and filling

The oil level must be inside the marked area on the dipstick and must be checked daily before the first start.

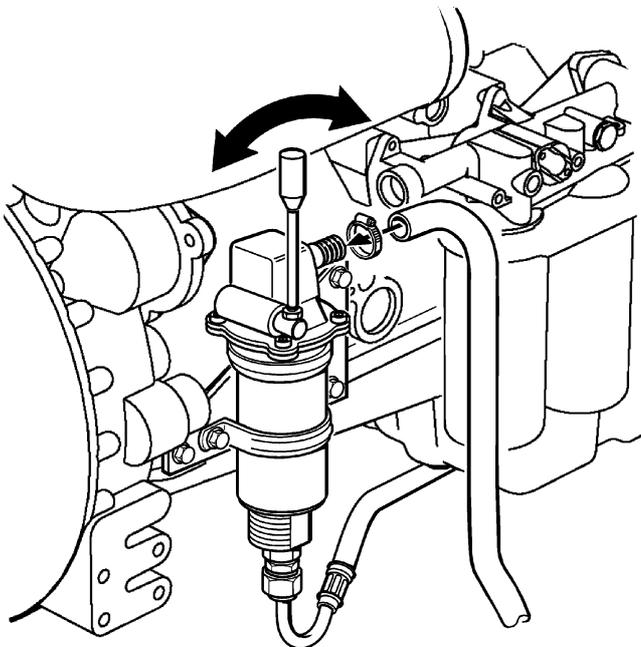
**NOTE!** The oil level can be read both when the engine is stationary (the STOP side of the dipstick) and with the engine running (the OPERATING side of the dipstick).

Top up with oil via the filler opening on the left side of the engine.

Check that the correct level has been achieved. If the engine is stationary, wait for a few minutes to allow the oil to run down into the oil pan.

**⚠ IMPORTANT!** Do not fill up above the maximum oil level. Only use a recommended grade of oil. (please refer to previous page).

**NOTE!** The oil level sensor only measures the oil level at the time when the ignition is turned on. In other words, not continually during operation.



## Engine oil, changing

**⚠ WARNING!** Hot oil and hot surfaces can cause burns.

**NOTE!** Topping up must be done when the engine is warm.

1. Connect the drain hose to the oil drain pump and check that no leakage can occur.
2. Pump the oil out (or remove the bottom drain plug and drain the engine oil).

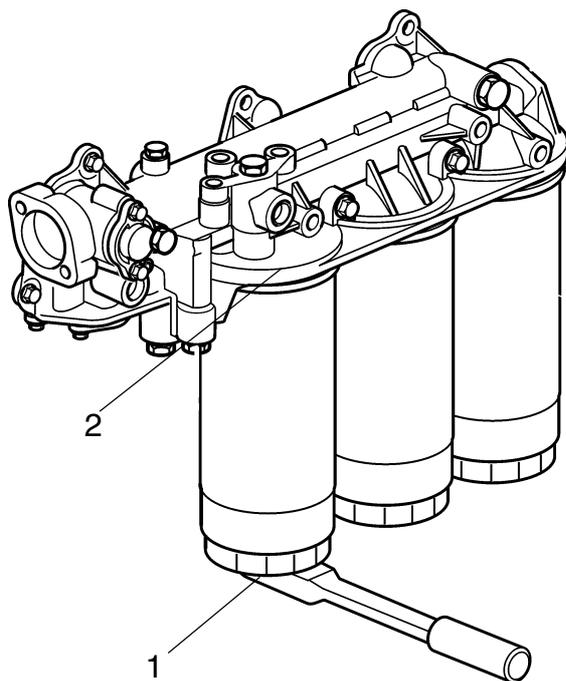
**Collect all the old oil and old filters, and hand them to a re-cycling station for destruction.**

3. Remove the drain hose (or install the bottom drain plug).
4. Fill up with engine oil.

Change volume, please refer to the "Technical Data" chapter.

## Oil filter/By-pass filter, change

**⚠ WARNING!** Hot oil and hot surfaces can cause burns.



1. Clean the oil filter bracket (2).
2. Remove all oil filters with a suitable oil filter remover (1).
3. Clean the mating surface of the oil filter bracket. Make sure that no pieces of old oil seal are left behind. Carefully clean round the inside of the protective rim (2) on the oil filter bracket.
4. Put a thin layer of engine oil on the seal rings of the new fuel filters.
5. Install the new oil filters. Tighten the two full-flow filters (on the right of the illustration)  $\frac{1}{2}$  -  $\frac{3}{4}$  turns after they just touch. Tighten the bypass filter  $\frac{3}{4}$  - 1 turn after it just touches.
6. Top up with engine oil, start the engine and let it run for 20-30 seconds.
7. Shut the engine off, check the oil level and top up engine oil as necessary.
8. Check sealing round the oil filters.

## Cooling system

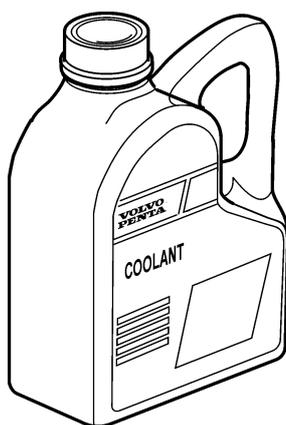
The cooling system ensures that the engine operates at the correct temperature. It is a closed circuit system and must always be filled with a mixture of at least 40 % concentrated coolant and 60 % water to protect against internal corrosion, cavitation and damage caused by freezing.

We recommend that you use “**Volvo Penta Coolant, Ready Mixed**”, alternatively “**Volvo Penta Coolant**” (concentrated) mixed with **pure** water according to spec, see “Coolant. Mixture”. Only coolant of this quality is suited too and approved by Volvo Penta.

The coolant should contain ethylene glycol of a good quality with a suitable chemical consistency for an adequate protection of the engine. Using anti-corrosion additive exclusively is not permitted in Volvo Penta’s engines. Never use water by itself as coolant.

**⚠ IMPORTANT!** Coolant, with a suitable consistency, must be used all year round. This applies even if there is never any risk for frost, to ensure that the engine has an adequate protection against corrosion. Future warranty claims on the engine and additional equipment may be rejected if an unsuitable coolant has been used or if the instructions concerning coolant mixing have not been followed.

**NOTE:** The anti-corrosive agents become less effective after a time, which means that the coolant must be replaced, see “Service schematic”. The cooling system should be flushed out at the same time as the coolant is replaced, see “Cooling system. Flushing”.



“**Volvo Penta Coolant**” is a concentrated coolant that is to be mixed with water. It has been developed to function optimally with Volvo Penta’s engines and provides excellent protection against corrosion, cavitation and frost damage.

“**Volvo Penta Coolant, Ready Mixed**” is a ready-mixed coolant, 40% “Volvo Penta Coolant” and 60% water. This concentration protects the engine against corrosion, cavitation damage and freezing conditions down to -28 °C (18°F).



## Coolant. Mixture

**⚠ WARNING!** All glycol is hazardous and harmful to the environment. Do not consume!  
Glycol is flammable.

**⚠ IMPORTANT!** Ethylene glycol must not be mixed with other types of glycol.

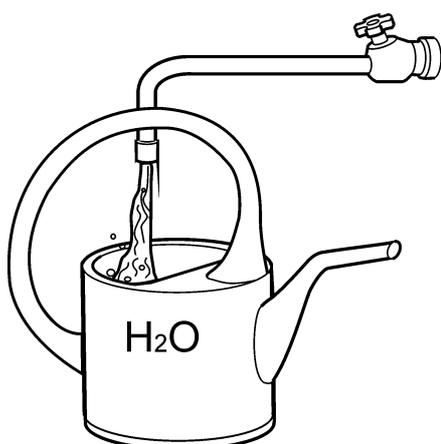
**Mix:**

**40 % “Volvo Penta Coolant” (conc. coolant)  
60 % water**

This mixture protects the engine against internal corrosion, cavitation and frost damage down to  $-28\text{ }^{\circ}\text{C}$  ( $18\text{ }^{\circ}\text{F}$ ). (Using 60 % glycol lowers the freezing point to  $-54\text{ }^{\circ}\text{C}$  ( $65\text{ }^{\circ}\text{F}$ )). Never mix more than 60 % concentrate (Volvo Penta Coolant) in the cooling liquid, this will give reduced cooling effect and increase the risk of overheating, and will give reduced freezing protection.

**⚠ IMPORTANT!** Coolant must be mixed with **pure** water, use **distilled - de-ionized water**. The water must fulfill the requirements specified by Volvo Penta, see “Water quality”.

**⚠ IMPORTANT!** It is extremely important that the correct concentration of coolant is added to the system. Mix in a separate, clean vessel before adding into the cooling system. Ensure that the liquids mix properly.



## Water quality

### ASTM D4985:

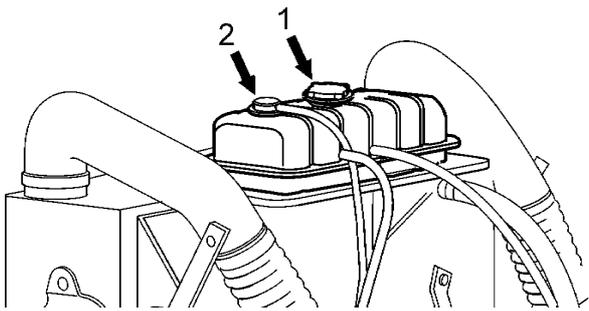
Total solid particles .....	< 340 ppm
Total hardness: .....	< 9.5° dH
Chloride .....	< 40 ppm
Sulfate .....	< 100 ppm
pH value .....	5,5–9
Silica (acc. ASTM D859) .....	< 20 mg SiO <sub>2</sub> /l
Iron (acc. ASTM D1068) .....	< 0.10 ppm
Manganese (acc. ASTM D858) .....	< 0.05 ppm
Conductivity (acc. ASTM D1125) .....	< 500 μS/cm
Organic content, COD <sub>Mn</sub> (acc. ISO8467) ....	< 15 mg KMnO <sub>4</sub> /l

## Coolant, inspection

**⚠ WARNING!** Do not open the filler cap (1) when the engine is warm, except in emergencies. Steam or hot fluid could spray out.

**NOTE!** Only open filler cap (1). Do not open filler cap (2).

The coolant level must be higher than the MIN marking. Check the coolant level daily before starting. Top up with coolant as necessary, please refer to Coolant, filling.



## Cooling system, filling

**⚠ WARNING!** Do not open the filler cap (1) when the engine is warm, except in emergencies. Steam or hot fluid could spray out.

**NOTE!** Do not open filler cap (2).

### Filling a completely empty system

1. Open filler cap (1).
2. Check that all drain points are closed.

**NOTE!** Only use the coolant recommended by Volvo Penta.

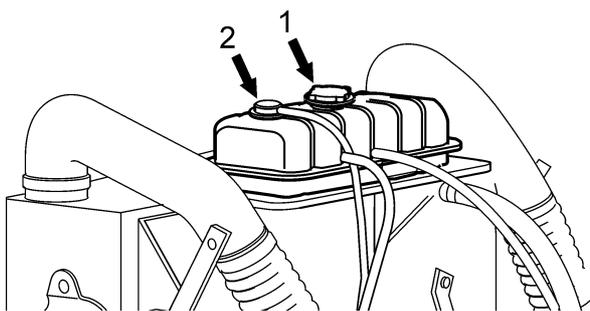
3. Mix the correct amount of coolant in advance, to ensure that the cooling system is completely filled.
4. Fill up with coolant, so that the level ends up between the MIN and MAX markings. **Do not start the engine until the system is vented and completely filled.**

Filling should be done with the engine stationary. Fill up slowly, to allow the air to flow out.

5. Start the engine when the cooling system has been completely filled and vented. Open any venting taps some while after starting, to allow shut-in air to escape.

If a heating unit is connected to the engine cooling system, the heat control valve should be opened and the installation vented during filling.

6. Stop the engine after about an hour and check the coolant level. Top up as necessary.

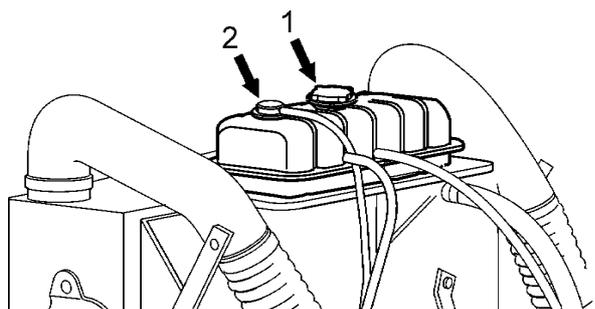


## Coolant. Draining.

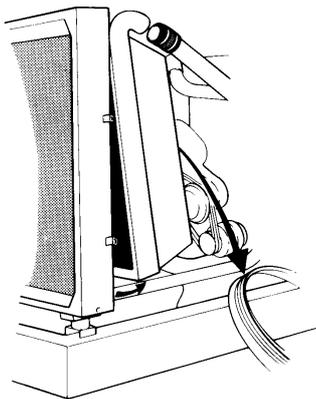
The engine must be stopped before draining, and the filler cap unscrewed.

**⚠ WARNING!** Do not open the filler cap (1) when the engine is warm, except in emergencies. Steam or hot fluid could spray out.

**NOTE!** Do not open filler cap (2). On engines which are to be laid up or put in storage, the engine cooling system should not be drained. The coolant contains corrosion-inhibiting additives.



1. Remove the filler cap (1).
2. Open all drain points. Drain the coolant from the radiator and engine block, using the drain hose. The drain nipples are situated under the radiator on the right side of the engine block.
3. Check that all coolant drains out. Deposits may be found inside the drain plug/tap, and need to be cleared away. There is otherwise a risk that coolant could remain and cause frost damage. Check whether the installation has any further taps or plugs at the lowest points of the cooling water pipes.
4. Shut any taps and check that the spring-loaded covers on the nipples close completely. Install the rubber plugs.

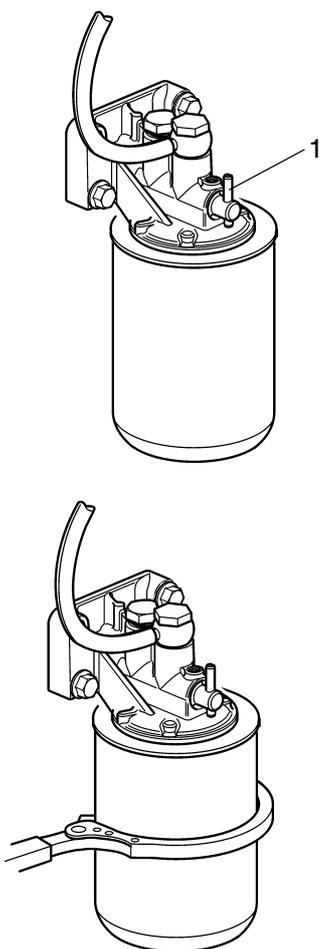


## Intercooler. External cleaning

Remove guards as necessary, to access the radiator.

Clean with water and a mild detergent. Use a soft brush. Be careful to ensure that the radiator matrix is not damaged. Re-install the components.

**⚠ IMPORTANT!** Do not use a high pressure power washer.



## Coolant filter, changing

1. Turn the tap (1) 90° to stop the flow through the coolant filter.
2. Remove the coolant filter with a suitable extractor. Make sure that no residue from the old seal remains in the housing.
3. Put a thin layer of engine oil on the new coolant filter seal. Screw the coolant filter on by hand until the seal comes into contact with the mating surface of the filter bracket. Then tighten the coolant filter a further 1/2 turn.
4. Turn the tap (1) 90° to release the flow through the coolant filter again.
5. Start the engine and do a leakage check.
6. Switch the engine off and check the coolant level. Please refer to "Coolant level, check".

## Cooling system, cleaning

Cooling performance is reduced by deposits in the radiator and cooling galleries. The cooling system should be cleaned out when the coolant is changed.

 **IMPORTANT!** Cleaning must not be done if there is any risk of the cooling system freezing, since the cleaning solution does not have any frost prevention ability.

1. Empty the cooling system. Please refer to “Cooling system, draining”.
2. Put a hose into the filling hole in the expansion tank and flush with **pure** water, which complies with Volvo Penta specifications, please refer to the “Water Quality” chapter, until the water which runs out is completely clear.
3. If there should still be some contamination left after flushing for a long time, cleaning can be done with coolant. Otherwise, continue as in item 8 below.
4. Fill the cooling system with 15-20% mixture of concentrated coolant. Only use Volvo Penta recommended concentrated coolant, mixed with **pure** water.
5. Drain the coolant after 1-2 days of operation.

**NOTE!** To prevent suspended material from settling back in the system, emptying should be done rapidly, within the space of 10 minutes, when the engine has not been standing still for a long time. Remove the filler cap and possibly the lower radiator hose to increase the speed of emptying.

6. Flush the system at once, very carefully, with **pure** hot water to stop dirt from settling on the inner surfaces again. Flush until the water that runs out is completely clean. Make sure that any heater controls are set to full heating during emptying.
7. If contamination should still be left after a long period of flushing, you can do a clean-out with Volvo Penta radiator cleaner, followed by finishing-off with Volvo Penta neutralizer. Carefully follow the instructions on the package. Otherwise, continue as in item 8 below.
8. When the cooling system is completely free from contamination, close the drain taps and plugs.
9. Fill up with Volvo Penta recommended coolant, following the instructions in the chapters entitled “Coolant, mixing” and “Coolant, filling”.

 **IMPORTANT!** It is extremely important that the correct concentration and volume of coolant is put in the system. Mix in a separate clean vessel before filling the cooling system. Make sure that the liquids mix.

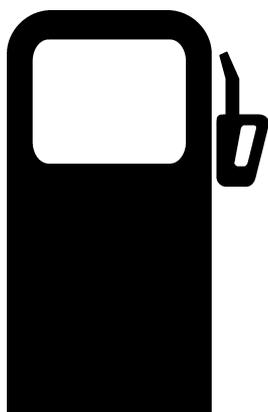
## Fuel system

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Only use the grades of fuel recommended in the fuel specification below. Always observe the greatest cleanliness during re-fueling and work on the fuel system.

All work on the injection system of the engine must be done by an authorized workshop.

**⚠ WARNING!** Fire hazard. Work on the fuel system must be done with the engine cold. Fuel spills on hot surfaces or electrical components can cause fires. Store fuel-soaked rags in a fire-proof manner.



### Fuel specification

The fuel must at least comply with national and international standards for commercially supplied fuels, such as:

**EN590** (with nationally adapted environmental and cold- requirements)

**ASTM D 975 No 1 - D and 2 - D**

**JIS KK 2204**

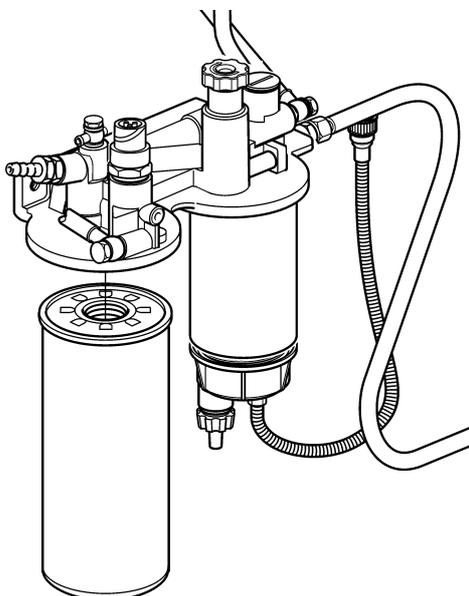
**Sulfur content:** Complying with legal requirements in each country. If the sulfur content exceeds 0.5 percent by weight, the **oil change intervals** must be changed. Please refer to the “Lubrication system” heading.

Extremely low sulfur content fuel (urban diesel in Sweden and city diesel in Finland) can cause a loss of up to 5% of power and an increase in fuel consumption of about 2–3 %.

## Fuel filters, replacing

**NOTE!** Do not fill the new fuel filter with fuel before assembly. There is a risk that contamination could get into the system and cause malfunctions or damage.

**⚠ WARNING!** The fuel filter must be changed when the engine is cold, to avoid the risk of fire due to spilled fuel on hot surfaces.

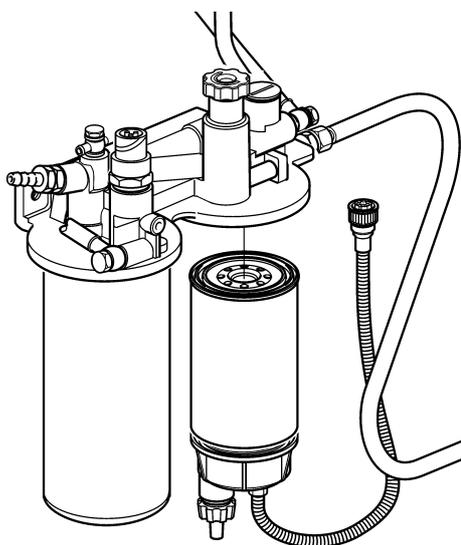


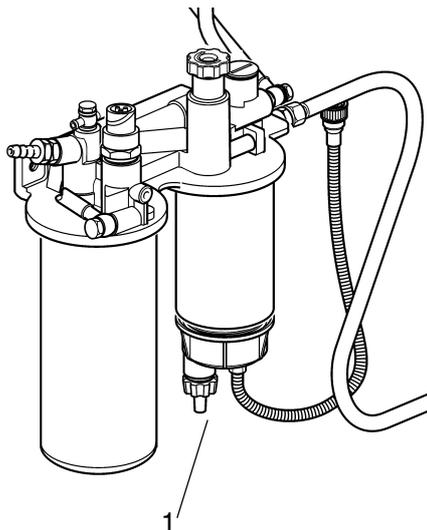
1. Clean round the fuel filter.
2. Remove the filter with a suitable filter remover. Collect any spilled fuel in a collection vessel.
3. Clean the filter mating surface on the filter bracket.
4. Lubricate the seal with diesel fuel and install the new fuel filter. Tighten the fuel filter in accordance with the instructions on the fuel filter.
5. If necessary, vent the fuel system, please refer to "Fuel System, Venting".

**NOTE!** If a water trap is installed: change the filter in it at the same time as the fuel filter, and clean the water trap in the plastic bowl under the filter with a soft rag.

## Primary fuel filter, change

1. Undo the cable from the water trap sensor.
2. Remove the water trap filter from the filter bracket. Collect any spilled fuel in a collection vessel.
3. Remove the lower part of the water trap from the filter.
4. Clean the lower part of the water trap with a soft rag. Check that the drain hole in the lower part is not blocked.
5. Install a new seal on the lower part and lubricate the seal with diesel fuel. Re-install the lower part of the filter.
6. Lubricate the seal with diesel fuel. Screw the filter onto the filter bracket by hand until the rubber seal just touches the mating surface. Then tighten a further half turn, no more.
7. Connect the cable to the water trap sensor.
8. If necessary, vent the fuel system, please refer to "Fuel System, Venting".





## Draining condensate, fuel system

**NOTE!** Put a collection vessel under the fuel filter to collect the condensate and fuel.

1. Open the drain nipple (1) in the base of the primary fuel filter.
2. Tighten the drain tap (1) when fuel without water starts to run out.

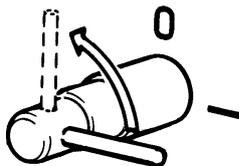
## Venting the fuel system

The system does not need to be vented unless it has been run completely dry. Venting is then done with the hand pump on the fuel filter bracket.

## Electrical system

The engine is equipped with a 2-pole electrical system and an alternator. System voltage is 24V.

**⚠ WARNING!** Before any work is done on the electrical system, the engine must be stopped and the current cut by switching off the main switch(es). All connections to equipment such as battery chargers or other auxiliary equipment must be broken.



### Main switch

The main switches must never be disconnected before the engine has been stopped. If the circuit between the alternator and the battery is disconnected when the engine is running, the alternator and electronics can be damaged. The charging circuits must never be re-connected with the engine running, for the same reason.

**⚠ IMPORTANT!** Never disconnect the current with the main switch(es) when the engine is running.

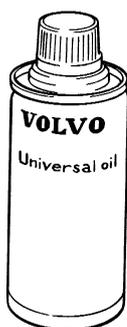
### Circuit breaker

The engine is equipped with a 10 A circuit breaker which cuts the current if overloaded.

The circuit breaker is located on the left-hand side of the engine, please refer to Component Location.

**Note.** The engine stops if **the fuse** trips.

If the circuit breaker trips frequently, an authorized Volvo Penta workshop should be contacted to investigate the cause of the overload.



### Electrical connections

Check that electrical connections are dry, free from oxide and that they are securely tightened. Spray these connections as necessary with water-repellent spray (Volvo Penta universal oil).

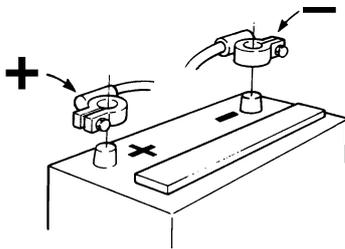
## Battery. Maintenance



**⚠ WARNING!** Fire and explosion hazard. Batteries must never be exposed to open flames or sparks.

**⚠ WARNING!** Never confuse the positive and negative poles on the batteries. Risk of arcing and explosion.

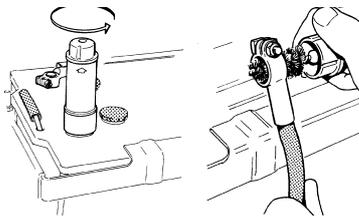
**⚠ WARNING!** Battery electrolyte is highly corrosive. Always protect your eyes, skin and clothes when handling batteries. Always use protective goggles and gloves. If acid comes into contact with your skin, wash at once with soap and a lot of water. If you get battery acid in your eyes, flush your eyes with a lot of water, and get medical assistance at once.



### Connection and disconnection

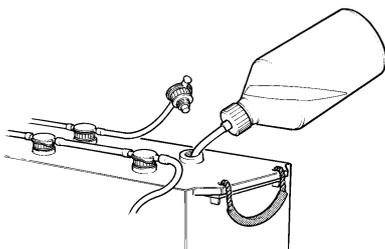
When you connect batteries, first connect the + cable (red) to the + pole on the battery. Then connect the – cable (black) to the – pole on the battery

When you disconnect batteries, connect the – cable (black) first, then the + cable (red).



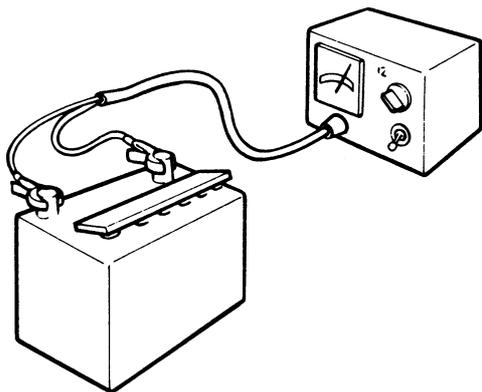
### Cleaning

Keep the batteries dry and clean. Contamination and oxide on the batteries and battery poles can cause stray currents, voltage drop and discharge, especially in wet weather. Clean oxidation from the battery poles and terminals, using a brass brush. Tighten the terminals securely and grease them with terminal grease or Vaseline.



### Filling

The electrolyte level should be 5–10 mm above the cell plates in the battery. Fill up with **distilled water** if necessary: After filling, the battery should be charged for at least 30 minutes by running the engine at idle. **NOTE!** Some maintenance-free batteries have special instructions, which must be observed.



## Batteries, charging

**⚠ WARNING!** Explosion risk! Hydrogen is given off when batteries are charged. This forms an explosive mixture with air. A short circuit, open flame or spark could cause a violent explosion. Ventilate well.

**⚠ WARNING!** Battery electrolyte is highly corrosive. Protect your eyes, skin and clothes. Always use protective goggles and gloves. If acid comes into contact with your skin, wash at once with soap and a lot of water. If you get battery acid in your eyes, flush at once with a lot of cold water, and get medical assistance at once.

Charge batteries if they have become discharged. If the engine is not used for a longer period of time, the batteries should be fully charged, then possibly trickle charged (please refer to the battery manufacturer's recommendations). Batteries are damaged by being left discharged, and can also freeze and burst easier in cold weather.

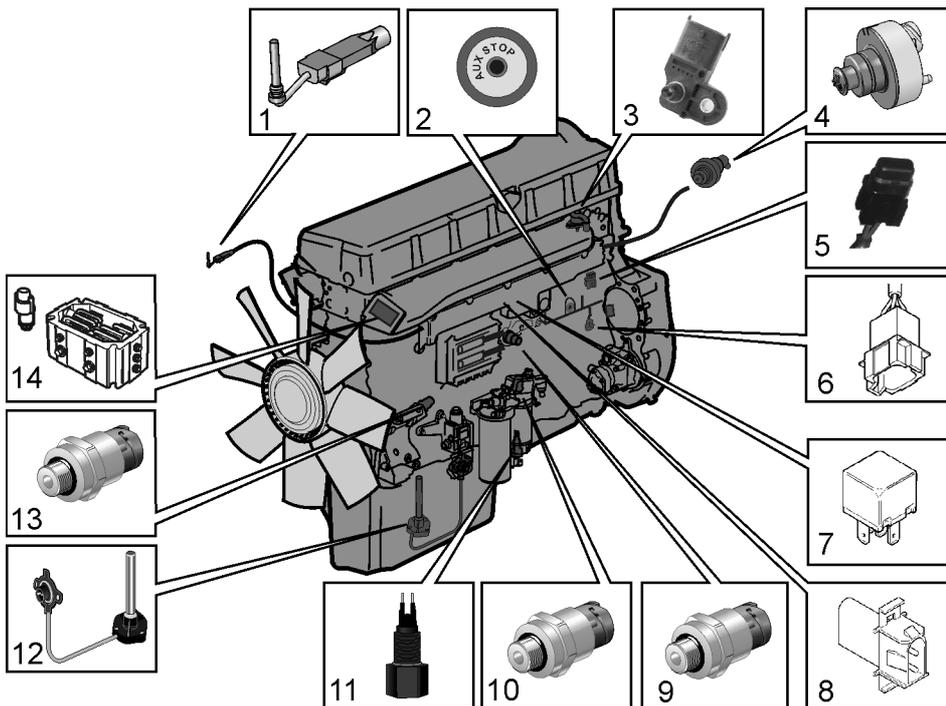
**⚠ IMPORTANT!** Observe the instruction manual for the battery charger carefully. To avoid the risk of electrochemical corrosion when an external charger is connected, the battery cables should be removed from the batteries before the charger is connected.

During charging, unscrew the cell plugs but leave them in the plug holes. Ventilate well, especially if the batteries are charged in an enclosed space.

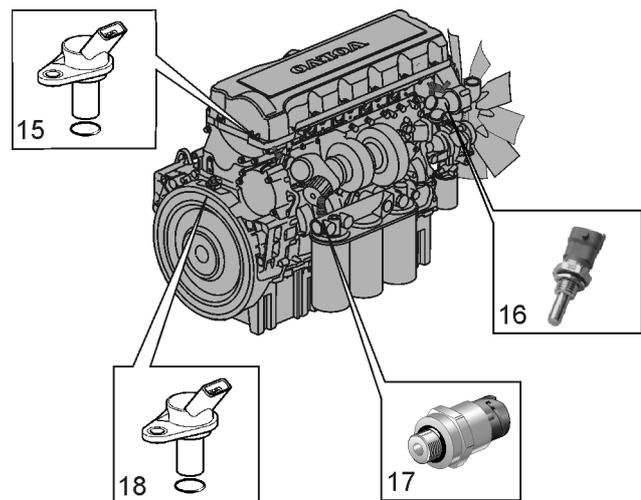
**⚠ WARNING!** Always cut the charge current **before** the battery charger clamps are undone. Never confuse the positive (+) and negative (-) poles on the batteries. This can cause serious arcing and can cause an explosion.

For so-called **quick charging**, there are special rules. Quick charging can shorten battery life, and should therefore be avoided.

## Component location



1. Coolant level sensor (in the expansion tank)
2. Extra stop
3. Charge pressure / charge temperature sensor
4. Air filter pressure and temperature sensor
5. Main circuit breaker 10 A
6. Connector interface (8-pin connector)
7. Main relay
8. Diagnostic connector (2-pin connector)
9. Oil pressure sensor
10. Fuel pressure sensor
11. Sensor, water in fuel
12. Oil level and oil temperature sensor (installed inside the oil pan)
13. Crankcase pressure sensor
14. Air pre-heater with pre-heating relay
15. Camshaft position sensor
16. Coolant temperature sensor
17. Piston cooling pressure sensor
18. Flywheel position and speed sensor

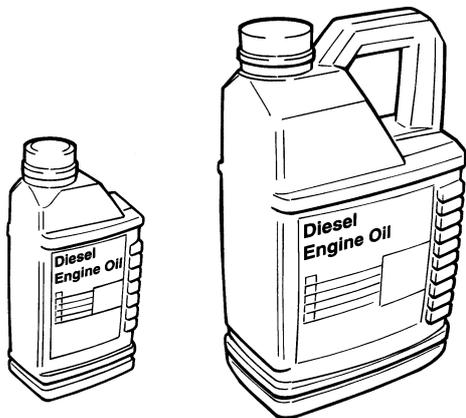


# Laying up

The engine and other equipment must be laid up to prevent damage if they are not used for two months or more. It is important that this is done in the correct manner, and nothing is forgotten. For this reason, we have compiled a check list of the most important points.

Before the engine is taken out of service for a long period of time, an authorized Volvo Penta workshop should check it over. Have any faults and deficiencies attended to, so that the equipment is in order, ready for the next start.

- ⚠ WARNING!** Before you start to do any maintenance work, read the “Maintenance” chapter carefully. This contains instructions for doing work in a safe and correct manner.
- ⚠ WARNING!** Some conservation oils are flammable. Some are also dangerous to breathe. Ensure good ventilation. Use a protective mask for spraying.
- ⚠ IMPORTANT!** Remember the following when washing with a high pressure washer: Never aim the water jet at seals, rubber hoses or electrical components.



## Conservation

- **For up to 8 month's stoppage:**  
Change the oil and oil filter on the engine, then warm it up afterwards.
- **More than 8 month's stoppage:**  
Conserve the lubrication and fuel systems with conservation oil. **Please refer to the instruction on the next page.**
- Check that the coolant offers sufficient frost protection. Top up as necessary. Alternatively, you can drain the coolant (also drain the coolant filter).
- Drain any water and contamination from the fuel filters and fuel tank. Fill the fuel tank completely, to avoid condensation.
- Disconnect the battery cables, clean and charge the batteries. Trickle charge the batteries while the equipment is laid up. **A poorly charged battery can freeze and burst.**
- Clean the outside of the engine. Do not use a high pressure washer for engine cleaning. Touch up paint damage with Volvo Penta original paint.
- Spray the components of the electrical system with water-repellent spray.
- Check and rust-proof any control cables.
- Put a note on the engine with the date, type of conservation and the conservation oil used.
- Cover over the air filter, exhaust pipe and engine if necessary.

## Removing conservation preparations

- Remove any covers from the engine, air filter and exhaust pipe.
- Put the correct grade of oil into the engine, if necessary. Install a new oil filter if the filter was not changed during conservation.
- Install new fuel filters and vent the fuel system.
- Check the drive belt(s).
- Check the condition of all rubber hoses, and re-tighten the hose clamps.
- Close the drain taps and install any drain plugs.
- Check the coolant level. Top up as necessary.
- Connect the fully charged batteries.
- Start the engine and warm it up at fast idle with no loading.
- Check that no oil, fuel or coolant leakage occurs.

### Conservation of the lubrication and fuel systems for more than 8 months' stoppage:

- Drain the engine oil and fill up with **conservation oil\*** to just over the MIN marking on the dipstick.
- Connect the fuel suction and return hoses to a 1/3 full jerrican containing **conservation oil\*** and 2/3 diesel fuel.
- Vent the fuel system.
- Start the engine and run at a fast idle until about 2 liters (1 US quart) of the fluid in the jerrican have been used. Stop the engine and connect the ordinary fuel pipes.
- Drain the engine's conservation oil.
- Follow the other instructions on the previous page.

\* Conservation oils are sold by oil companies.

# Diagnostic function

The diagnostic function monitors and checks that the EMS 2 system functions normally.

The diagnostic function has the following tasks:

- Detecting and locating disturbances
- Reporting detection of disturbances
- Providing guidance when troubleshooting

## Message regarding disturbance

If the diagnostic function discovers a malfunction in the EMS 2 system, this is reported by means of fault codes/fault cause on the instruments.

Both inactive (rectified) and active (un-mended) faults are stored in the control unit.

Please refer to the "Operation" heading for reading fault codes.

All fault codes are found in the fault code list, with information about the reason, reaction and measures to be taken. Please refer to the "Fault codes" chapter.

**NOTE!** All instruments are optional

### Active faults

#### DCU (Display Control Unit) / DU (Display Unit)

- "text" !! ENGINE WARNING !!" is shown on the display.

**NOTE!** It's possible to choose which language the information will be presented in.

#### CIU (Control Interface Unit)

- the diagnostic lamp starts to flash.
- "Easy-link" instrument (requires a CIU)
  - warning lamp on the alarm panel lights up
  - after the diagnostic button has been pressed, the fault code is shown as text on the tachometer display.

#### DU (Display Unit)

- Either "WARNING!" or "ALARM STOP" (a buzzer sounds) will be shown on the display, depending on the severity of the fault.

**NOTE!** You can choose the language used for the information presented on the.

- Fault codes can also be read by means of the **VODIA** tool. Please refer to the "VODIA User's Guide" for advice on use.

At the same time, the fault is stored in the control unit memory. When the fault has been attended to and the ignition is switched off and on again, the fault disappears as active.

### Inactive faults

- DCU - the fault is indicated as passive
- CIU - the diagnostic lamp goes out
- DU - the fault message disappears (inactive faults can not be read)
- "Easy Link" - the warning lamp on the alarm panel turns off

## Effect on engine

Engines are affected differently, depending on the severity of the fault discovered by the diagnostic function.

A fault message in the form of a fault code is always generated when a malfunction is discovered by the diagnostic function.

Engines are affected differently, depending on the severity of the fault.

- The engine is not affected
- Engine idles
- Engine torque is restricted to a certain amount
- Engine is stopped

## Operation

When a malfunction has occurred and the diagnostic system has generated one or more fault codes, these are read out differently, depending on the equipment used. Please refer to "Fault codes".

### If the system indicates that a fault code has been set:

1. Cut engine speed to idle, or shut the engine off.
2. **For DCU/DU**  
Read the fault code set from the display, please refer to "Reading fault cause via the DCU" or "Reading fault cause via DU".  
**For CIU**  
Press the diagnostic button and read the fault code that has been set, by observing the flashing of the diagnostic lamp. Please refer to "Reading fault codes via the diagnostic lamp, CIU"
3. Look up the fault code/cause in the "Fault Code" chapter and take the recommended measures.

## Reading fault cause via the DCU (Display Control Unit)

When a fault code is set, the following text is shown on the display:

"!! ENGINE WARNING !!"

alternated with

"Press SEL for information".

**NOTE!** You can choose the language used for the information presented on the.

### Read the fault code as follows:

1. Press the SEL button (to come to the error list).  
The fault list shows:
  - Operation hours
  - Fault cause
  - Active/inactive
2. Look up the fault code in the "Fault Code" chapter and take the recommended measures.
3. Press the ESC button to leave the fault list.

**NOTE!** To enter the fault list when no fault code has been set, press the SEL button and select "Diagnostics" from the menu.

## Reading fault cause via the DU (Display Unit)

Depending on the severity of the faults, one of the following messages will appear on the display: "**WARNING!**" or "**ALARM STOP**" (a buzzer sounds).

1. Press any button to come to the fault list.  
The fault list shows:
  - Operation hours
  - Fault cause
2. Look up the fault code in the "Fault Code" chapter and take the recommended measures.
3. Press **ACK** to confirm the fault code. The display background will change color (the buzzer stops sounding).
4. Press **EXIT** to leave the fault list.

## Reading fault codes via the diagnostic lamp on the instrument panel, CIU

When the system has discovered a malfunction, the diagnostic lamp starts to flash. If the diagnostic button is depressed and then released, a fault code is flashed out.

The fault code consists of two groups of flashes, separated by a pause of two seconds. A fault code is obtained by counting the number of flashes in each group.

**Example:** ✨ ✨ pause ✨ ✨ ✨ ✨ = Fault code 2.4

The fault code is stored and can be read as long as the malfunction remains. You can find information about cause, reaction and actions in the "Fault Code" chapter.

### Read the fault code as follows:

1. Press the diagnostic button.
2. Release the diagnostic button and make a note of the fault that is flashed out.
3. Repeat items 1-2. A new fault code is flashed out if more are stored. Repeat until the first fault code is repeated.
4. Look up the fault code in the "Fault Code" chapter and take the recommended measures.

**NOTE!** When the first fault code is repeated, all fault codes have been read out.

If the diagnostic button is pressed after the fault has been mended and the fault codes have been erased, code 1.1 "No fault" will be displayed.

## Reading fault codes via "Easy Link" instrument (only with CIU)

When the system has discovered a malfunction, the diagnostic lamp starts to flash and the fault code will show in the display of the tachometer.

1. Press the diagnostic button, the fault code will show in the display of the tachometer.
2. Look up the fault code in the "Fault Code" chapter and take the recommended measures.
3. When the fault has been attended to, the fault code disappears from the display and the diagnostic lamp goes out.

## Erasing fault codes

Fault codes must be erased by means of the VODIA tool.

# Fault codes

**⚠ WARNING!** Read through the safety advice for care and maintenance work in the "Safety information" chapter before you start work.

**NOTE!** Reading the fault codes below, such as **Code 2.1, PID 97** means that **2.1** is the flashing code indicated by the diagnostic lamp. **PID 97** is read with the VODIA diagnostic tool. With the use of DCU or DU the fault message will be shown as text in the display.

**NOTE!** Please refer to "Wiring schedule CIU and DCU" for references to the sleeves in the electrical connectors on the engine control unit.

## Code 1.1 No faults

There are no active faults.

## Code 2.1, PID / SPN 97. Water in fuel

### Cause:

- Water in fuel.

### Reaction:

- None.

### Remedy:

- Empty the primary fuel filter.

## Code 2.2, PID / SPN 111. Coolant level

### Cause:

- Low coolant level.

### Reaction:

- Warning indication.
- Engine control module reduces engine power (unless the protection has been shut off with the VODIA diagnostic tool).

### Remedy:

- Check the coolant level.
- Check coolant level monitor function.

## Code 2.3, PID / SPN 111. Coolant level sensor

### Cause:

- Short circuit to positive (+).
- Fault in sensor.

### Reaction:

- None.

### Remedy:

- Check that the coolant level sensor cable is not damaged.
- Check coolant level sensor function.

## Code 2.4. SID21 / SPN 637 Flywheel speed sensor

### Cause:

- No signal.
- Abnormal frequency.
- "Intermittent" signal from the sensor.
- Fault in sensor.

### Reaction:

- Engine is very difficult to start and runs roughly when it starts.

### Remedy:

- Check that the sensor connector is correctly installed.
- Check that the engine speed sensor cable is not damaged.
- Check that the engine speed sensor is correctly installed in the flywheelhousing.
- Check engine speed sensor function.

## Code 2.5. SID22 / SPN 636 Camshaft drive speed sensor

### Cause:

- No signal.
- Abnormal frequency.
- Fault in sensor.

### Reaction:

- Engine takes longer to start than normal. Engine runs normally when running.

### Remedy:

- Check that the engine speed sensor connector is correctly installed.
- Check that the engine speed sensor cable is not damaged.
- Check that the engine speed sensor is correctly installed in the upper timing gear cover.
- Check engine speed sensor function.

**Code 2.6, PID / SPN 190. Engine speed****Cause:**

- Engine speed too high.

**Reaction:**

- None.

**Remedy:**

- After the engine has stopped, look for the reason for the high speed.

**Code 2.8, PPID 132 / SPN 608  
Speed potentiometer connected to CIU****Cause:**

- Shorted to plus (+) or minus (-).
- Fault in sensor.

**Reaction:**

- Engine goes to idle.

If you release the accelerator first, and then press it down again, the engine can be forced to run using the idle contact.

**Remedy:**

- Check that the potentiometer has been connected correctly.
- Check that the cable harness to the potentiometer has not been damaged.
- Check the potentiometer function.

**Code 2.9. PID / SPN 97  
Indicator for water in fuel****Cause:**

- Short circuit
- Open circuit.
- Fault in indicator.

**Reaction:**

- None.

**Remedy:**

- Check the indicator cables for breaks and short circuits.
- Check indicator function. Change indicator as necessary

**Code 3.1, PID / SPN 100. Oil pressure sensor****Cause:**

- Short circuit to positive (+) or earth (ground) (-).
- Open circuit.

**Reaction:**

- None.

**Remedy:**

- Check that the oil pressure sensor cable is not damaged.
- Check that the oil pressure sensor is correctly connected.

**Code 3.2. PID / SPN 105  
Charge air temperature sensor****Cause:**

- Short circuit to positive (+) or earth (ground) (-).
- Open circuit.

**Reaction:**

- None.

**Remedy:**

- Check that the charge air temperature sensor connector is correctly installed.
- Check that the charge air temperature sensor cable is not damaged.
- Check that the charge air temperature sensor is correctly installed.
- Check charge air temperature sensor function.

**Code 3.3. PID / SPN 110  
Coolant temperature sensor****Cause:**

- Short circuit to positive (+) or earth (ground) (-).
- Open circuit.

**Reaction:**

- Preheating is also activated when the engine is hot.

**Remedy:**

- Check that the coolant temperature sensor connector is correctly installed.
- Check that the coolant temperature sensor cable is not damaged.
- Check that the coolant temperature sensor is correctly installed.
- Check coolant temperature sensor function.

**Code 3.6, PID / SPN 94. Fuel pressure sensor**

**Cause:**

- Short circuit to positive (+) or earth (ground) (-).
- Open circuit.

**Reaction:**

- None.

**Remedy:**

- Check that the fuel pressure sensor connector is correctly installed.
- Check that the fuel pressure sensor cable is not damaged.
- Check that the fuel pressure sensor is correctly installed.
- Check fuel pressure sensor function.

**Code 3.7, PID / SPN 175. Oil temperature sensor**

**Cause:**

- Shorted to plus (+) or minus (-).
- Break.

**Reaction:**

- None.

**Remedy:**

- Check that the cable harness to the oil temperature sensor has not been damaged.
- Check that the oil temperature sensor has been connected correctly.

**Code 3.8, PID / SPN 94. Fuel pressure**

**Cause:**

- Low supply pressure.

**Reaction:**

- None.

**Remedy:**

- Check if it is possible to build up pressure with the hand pump.
- Check the fuel filter.
- Check the fuel pre-filter.

**Code 3.9, PID / SPN 158. Battery voltage, EMS**

**Cause:**

- Faulty alternator.
- Faulty battery, battery cables.

**Reaction:**

- None.

**Remedy:**

- Check the supply voltage from the control unit.

**Code 4.6. PPID 3 / SID 39 / SPN 677  
Start output / Start motor relay**

**Cause:**

- Shorted to plus (+) or minus (-).
- Activated for too long.

**Reaction:**

- The engine cannot be started.
- The engine starts immediately when ignition is turned on.

**Remedy:**

- Check that connections to the ignition key have not been damaged.
- Check that the cable harness to the ignition key has not been damaged.

**Code 4.8, PPID 6/ SPN 520195. Stop input EMS**

**Cause:**

- Short circuit to negative (-).
- Open circuit.

**Reaction:**

- Engine can only be stopped with the auxiliary stop.

**Remedy:**

- Check that the starter switch connections are not damaged.

**Code 5.2, PPID 4 / SPN 520194. Starter input CIU**

**Cause:**

- Shorted to minus (-).
- Activated for too long.

**Reaction:**

- The engine cannot be started.
- The engine starts immediately when ignition is turned on.

**Remedy:**

- Check that connections to the ignition key have not been damaged.
- Check that the cable harness to the ignition key has not been damaged.

**Code 5.3, PPID 6/ SPN 970. Stop input CIU****Cause:**

- Short circuit to negative (-).
- Open circuit.
- Activated for too long time.

**Reaction:**

- Engine can only be stopped with the auxiliary stop (AUX STOP) on engine.
- Engine stops. A fault code is displayed for 40 seconds and the engine can not be started during this time. When a fault code is active, the engine can be started but not stopped.

**Remedy:**

- Check that the starter switch connections are not damaged.
- Check that the ignition switch cable is not damaged.

**Code 5.4, PID 45/ SPN 626. Preheating relay****Cause:**

- Short circuit to positive (+) or earth (ground) (-).
- Open circuit.

**Reaction:**

- Preheating can not be activated.
- Preheating is constantly connected.

**Remedy:**

- Check that the relay input cable is not damaged.
- Check relay function.

**Code 5.6, PID/SPN 107. Air filter sensor****Cause:**

- Shorted to plus (+) or minus (-).
- Break.

**Reaction:**

- None

**Remedy:**

- Check that the air filter sensor contact is correctly installed.
- Check that the cable harness to air filter sensor has not been damaged.
- Check the air filter sensor functionality.

**Code 5.7. PID / SPN 98, Oil level****Cause:**

- Oil level is too low.

**Reaction:**

- Warning indication.

**Remedy:**

- Check the oil level.

**Code 5.8, PID / SPN 175. Oil temperature****Cause:**

- Oil temperature is too high

**Reaction:**

- Warning indication.
- The engine control module limits engine output (unless protection has been turned off with the diagnosis tool VODIA).

**Remedy:**

- Check the oil level.
- Check the oil temperature.
- Check the oil temperature sensor function.

**Code 5.9, PID / SPN 98. Oil level sensor****Cause:**

- Shorted to plus (+) or minus (-).
- Break.

**Reaction:**

- None.

**Remedy:**

- Check that the cable harness to the oil level sensor has not been damaged.
- Check the oil level sensor function.

**Code 6.1, PID / SPN 110. Coolant temperature****Cause:**

- Coolant temperature is too high.

**Reaction:**

- Engine control module reduces engine power (unless the protection has been shut off with the VODIA diagnostic tool).

**Remedy:**

- Check the coolant level.
- Check the intercooler (cleanliness).
- Check if there is air in the cooling system.
- Check the pressure cap on the expansion tank.
- Check coolant temperature sensor function.
- Check thermostat function.

**Code 6.2, PID / SPN 105. Charge air temperature**

**Cause:**

- Charge air temperature is too high.

**Reaction:**

- Engine control module reduces engine power (unless the protection has been shut off with the VODIA diagnostic tool).

**Remedy:**

- Check the coolant level.
- Check the intercooler (cleanliness).
- Check charge air temperature sensor function.
- Check the function of the thermostat.

**Code 6.4. PPID 231 / SPN 639. Data link (CAN). CIU**

**Cause:**

- Faulty data link (CAN), CIU.

**Reaction:**

- Instruments and warning lamps stop working.

**Remedy:**

- Check that the 8-pin connector is not damaged.
- Check that the cables between the CIU and the engine management unit are not damaged.

**Code 6.5. PPID 231 / SPN 639. Data link (CAN), EMS 2**

**Cause:**

- Internal fault in control module.

**Reaction:**

- Engine not operating: engine can not be started.  
Engine operating: engine idles and can only be stopped with the auxiliary stop (AUX-stop).

**Remedy:**

- Check that the 8-pin connector is not damaged.
- Check that the cables between the CIU and the engine management unit are not damaged.
- Check that sleeves 11 and 12 in the connector on the CIU are not damaged.

**Code 6.6, PID / SPN 100, Oil pressure**

**Cause:**

- Oil pressure is too low.

**Reaction:**

- Engine control module reduces engine power (unless the protection has been shut off with the VODIA diagnostic tool).

**Remedy:**

- Check oil level.
- Check that the air filters are not blocked.
- Check system pressure valves and safety valves in the oil system.
- Check oil pressure sensor function.

**Code 6.7, PPID 8 / SPN 520192, Piston cooling pressure**

**Cause:**

- Piston cooling pressure is too low.

**Reaction:**

- Engine stopped. The fault code is de-activated at engine speeds below 1000 rpm.

**Remedy:**

- Check that the oil pressure in the engine exceeds 175 kPa (25.4 psi).

**Code 6.8, PPID 8 / SPN 520192, Piston cooling pressure sensor**

**Cause:**

- Shorted to plus (+) or minus (-).
- Break.

**Reaction:**

- None.

**Remedy:**

- Check that the piston cooling pressure sensor contact is correctly installed.
- Check that the cable harness to the piston cooling pressure sensor has not been damaged.
- Check the piston cooling pressure sensor functionality.

**Code 6.9, PID / SPN 158, Battery voltage, CIU****Cause:**

- Short circuit to negative (-).
- Faulty alternator.
- Faulty battery, battery cables.

**Reaction:**

- Problems in engine starting.

**Remedy:**

- Check the supply voltage from the control unit.
- Check the battery.
- Check the alternator.
- Check the 8-pin contact.

**Code 7.1. SID 1 / SPN 651  
Injector, cylinder #1****Cause:**

- Electrical fault.
- Faulty compression or injector.

**Reaction:**

- Engine runs on 5 cylinders.
- Abnormal sound.
- Reduced performance.

**Remedy:**

- Check that the injector cables are not damaged.
- Check that the injector connections are not damaged.
- Check fuel supply pressure.
- Check the valve clearance.
- Do a compression test and check cylinder #1.

**Code 7.2. SID 2 / SPN 652  
Injector, cylinder #2****Cause:**

- Electrical fault.
- Faulty compression or injector.

**Reaction:**

- Engine runs on 5 cylinders.
- Abnormal sound.
- Reduced performance.

**Remedy:**

- Check that the injector cables are not damaged.
- Check that the injector connections are not damaged.
- Check fuel supply pressure.
- Check the valve clearance.
- Do a compression test and check cylinder #2.

**Code 7.3. SID 3 / SPN 653  
Injector, cylinder #3****Cause:**

- Electrical fault.
- Faulty compression or injector.

**Reaction:**

- Engine runs on 5 cylinders.
- Abnormal sound.
- Reduced performance.

**Remedy:**

- Check that the injector cables are not damaged.
- Check that the injector connections are not damaged.
- Check fuel supply pressure.
- Check the valve clearance.
- Do a compression test and check cylinder #3.

**Code 7.4. SID 4 / SPN 654  
Injector, cylinder #4**

**Cause:**

- Electrical fault.
- Faulty compression or injector.

**Reaction:**

- Engine runs on 5 cylinders.
- Abnormal sound.
- Reduced performance.

**Remedy:**

- Check that the injector cables are not damaged.
- Check that the injector connections are not damaged.
- Check fuel supply pressure.
- Check the valve clearance.
- Do a compression test and check cylinder #4.

**Code 7.5. SID 5 / SPN 655  
Injector, cylinder #5**

**Cause:**

- Electrical fault.
- Faulty compression or injector.

**Reaction:**

- Engine runs on 5 cylinders.
- Abnormal sound.
- Reduced performance.

**Remedy:**

- Check that the injector cables are not damaged.
- Check that the injector connections are not damaged.
- Check fuel supply pressure.
- Check the valve clearance.
- Do a compression test and check cylinder #5.

**Code 7.6. SID 6 / SPN 656  
Injector, cylinder #6**

**Cause:**

- Electrical fault.
- Faulty compression or injector.

**Reaction:**

- Engine runs on 5 cylinders.
- Abnormal sound.
- Reduced performance.

**Remedy:**

- Check that the injector cables are not damaged.
- Check that the injector connections are not damaged.
- Check fuel supply pressure.
- Check the valve clearance.
- Do a compression test and check cylinder #6.

**Code 7.7. PID / SPN 153  
Crankcase ventilation pressure**

**Cause:**

- Crankcase ventilation pressure too high.

**Reaction:**

- The engine is shut down (if the protection has not been shut off by the parameter tool).

**Remedy:**

- Check whether the crankcase ventilation is blocked.
- Check whether cylinder liner, piston or piston rings are worn or damaged.

**Code 7.8. PID / SPN 153  
Crankcase ventilation pressure sensor**

**Cause:**

- Shorted to plus (+) or minus (-).
- Break.

**Reaction:**

- None.

**Remedy:**

- Check that the crankcase ventilation pressure sensor contact is correctly installed.
- Check that the cable harness to the crankcase ventilation pressure sensor has not been damaged.
- Check crankcase ventilation pressure sensor function.

**Code 7.9, PID / SPN 172**  
**Air temperature sensor, inlet**
**Cause:**

- Shorted to plus (+) or minus (-).
- Break.

**Reaction:**

- None.

**Remedy:**

- Check that the air temperature sensor contact is correctly installed.
- Check that the cable harness to the air temperature sensor has not been damaged.
- Check the air temperature sensor functionality.
- Check the preheating relay.

**Code 9.2. SID250 / SPN 608**  
**Faulty data link (J1587)**
**Cause:**

- Faulty data link.

**Reaction:**

- None.

**Remedy:**

- Check that the 8-pin connector is not damaged.
- Check that the cables between the CIU/DCU and the engine management unit are not damaged.

**Code 9.3. SID 232 / SPN 620**  
**Power supply to sensor**
**Cause:**

- Shortcut.
- Fault in sensor.

**Reaction:**

- Faulty values in oil pressure and charge air pressure sensors.
- Fault code for oil pressure- and charge air pressure sensor.
- Low engine output.
- The instrument shows zero oil pressure and boost pressure.

**Remedy:**

- Check that the cable harness to oil pressure and charge air pressure sensor has not been damaged.
- Check oil pressure and charge air pressure sensors.

**Code 9.8, SID 253 / SPN 630**  
**Data set memory EEPROM, CIU**
**Cause:**

- Internal fault in control module
- Programming faulty.

**Reaction:**

- Engine does not start.

**Remedy:**

- Re-program the control module. If the fault remains, change the control module.

**Code 9.8. PPID 254 / SPN 629**  
**Fault in control unit, CIU**
**Cause:**

- Faulty EEPROM, CIU.
- Faulty flash memory, CIU.
- Fault in control module, CIU

**Reaction:**

- CIU returns to factory setting.
- Engine goes to idle.
- Engine can not be started.

**Remedy:**

- Re- program the unit
- Change CIU unit.

**Code 9.9, SID 240 / SPN 639. Memory fault**
**Cause:**

- Memory fault in engine management system.

**Reaction:**

- Engine might not start.

**Remedy:**

- Re-program the unit.

**Code 9.9, SID 253 / SPN 630**  
**Data set memory EEPROM, EMS**

**Cause:**

- Internal fault in control module
- Programming faulty.

**Reaction:**

- Engine does not start.

**Remedy:**

- Re-program the control module. If the fault remains, change the control module.

**Code 9.9, SID 254 / SPN 629**  
**Control module EMS**

**Cause:**

- Internal fault in control module.

**Reaction:**

- Engine misfires.
- Engine does not start.

**Remedy:**

- Change engine control unit.

# Technical data

## General

Designation	TAD1640GE	TAD1641GE	TAD1642GE	TAD1641VE	TAD1642VE
Power, Prime/Stand-by	See sales literature				
Torque, Prime/Stand-by	See sales literature				
No. of cylinders	6	6	6	6	6
Bore	144	144	144	144	144
Stroke, mm	165	165	165	165	165
Cylinder volume, dm <sup>3</sup>	16,12	16,12	16,12	16,12	16,12
Weight, dry (kg)	1440	1440	1480	1480	1480
Weight, wet (kg)	1510	1510	1550	1550	1550
Injection sequence	1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4
Compression-ratio	17.5:1	16.5:1	16.5:1	17.5:1	17.5:1
Low idle, rpm	900	900	900	600	600
High idle, rpm	1500/1800	1500/1800	1500/1800	1800-2000	1800-2000

## Lubrication system

### Oil

Change volume, including filter change ..... 48 liter (12.6 US gallon)

### Oil pressure, hot engine

at operating speed ..... 300-650 kPa (44-94 psi)

at idle, min ..... 270 kPa (39 psi)

Oil grade ..... Please refer to the specification under "Maintenance".

Viscosity ..... Please refer to the specification under "Maintenance".

### Oil filter

Full flow filter ..... 2

By-passfilter ..... 1

### Oil pump

Type ..... Gear driven

## Fuel system

### Feed pump

Matartryck vid 600 r/min .....	min 100 kPa (14.5 psi)
Supply pressure at 1200 rpm .....	min 300 kPa (43.5 psi)
Supply pressure at full load .....	min 300 kPa (43.5 psi)

### By - pass valve

Opening pressure .....	400-550 kPa (58-80 psi)
------------------------	-------------------------

## Fuel specification

The fuel must comply with national and international standards for commercially supplied fuels, such as:

**EN 590** (with nationally adapted environmental and cold requirements)

**ASTM D 975 No 1 - D and 2 - D.**

**JIS KK 2204**

**Sulfur content:** Complying with legal requirements in each country.

Low density fuel (urban diesel in Sweden and city diesel in Finland) can cause a loss of up to 5% of power and an increase in fuel consumption of about 2-3%.

## Cooling system

Type .....	Pressurized, sealed
Pressure cap, max. opening pressure .....	75 kPa (11 psi)
Volume (engine) .....	20 liter (21.1 US quart)
Volume (engine + radiator and hoses) .....	60 liter (15.8 US gallon)

## Thermostat

Quantity .....	1 pcs.
Opening temperature .....	86° C (187° F)

## Electrical system

System voltage .....	24V
Alternator	
voltage/max. current density .....	28V / 80A
power app. ....	2200W
Alternative generating equipment (optional): .....	
voltage/max. current density .....	28V/110A
power app. ....	2800W
Battery capacity .....	2 pcs. series connected 12V, max. 225 Ah
Battery electrolyte specific gravity at +25°C:	
fully charged battery .....	1,28 g/cm <sup>3</sup> (1,24 g/cm <sup>3</sup> )*
re-charge battery at .....	1,20 g/cm <sup>3</sup> (1,20 g/cm <sup>3</sup> )*

\* **NOTE!** Applies to batteries with tropical acid.

# Notes

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# Notes

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ENG

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**Julkaisunumero: 7746107**

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*Ota huomioon, että tarjous on voimassa 1 vuoden ajan moottorin luovutuspäivämäärästä, sen jälkeen vain tuotteen saatavuuden perusteella.*

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*Notar que a oferta é válida por um período de 12 meses a partir da data de entrega do motor. Depois desse período, a oferta é válida consoante a disponibilidade.*

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**Ναι,**

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Αριθμός έκδοσης: 7746110

Όνομα

Διεύθυνση

Χώρα

*Παρακαλούμε σημειώστε ότι αυτή η προσφορά ισχύει για 12 μήνες από την ημερομηνία παράδοσης της μηχανής. Μετά θα είναι θέμα διαθεσιμότητας.*

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Номер издания: 7746112

Имя

Адрес

Страна

*К Вашему сведению, это предложение действительно в течение 12 месяцев от даты поставки двигателя; в дальнейшем оно зависит от наличия.*

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manual/coupon](http://www.volvopenta.com/manual/coupon)

**Ja graag,**

Ik wil kosteloos een instructieboek in het Nederlands ontvangen.

**Publicatienummer: 7746108**

Naam

Adres

Land

*Denk eraan dat de aanbieding geldt tot 12 maanden na levering van de motor, daarna nog slechts indien beschikbaar.*

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