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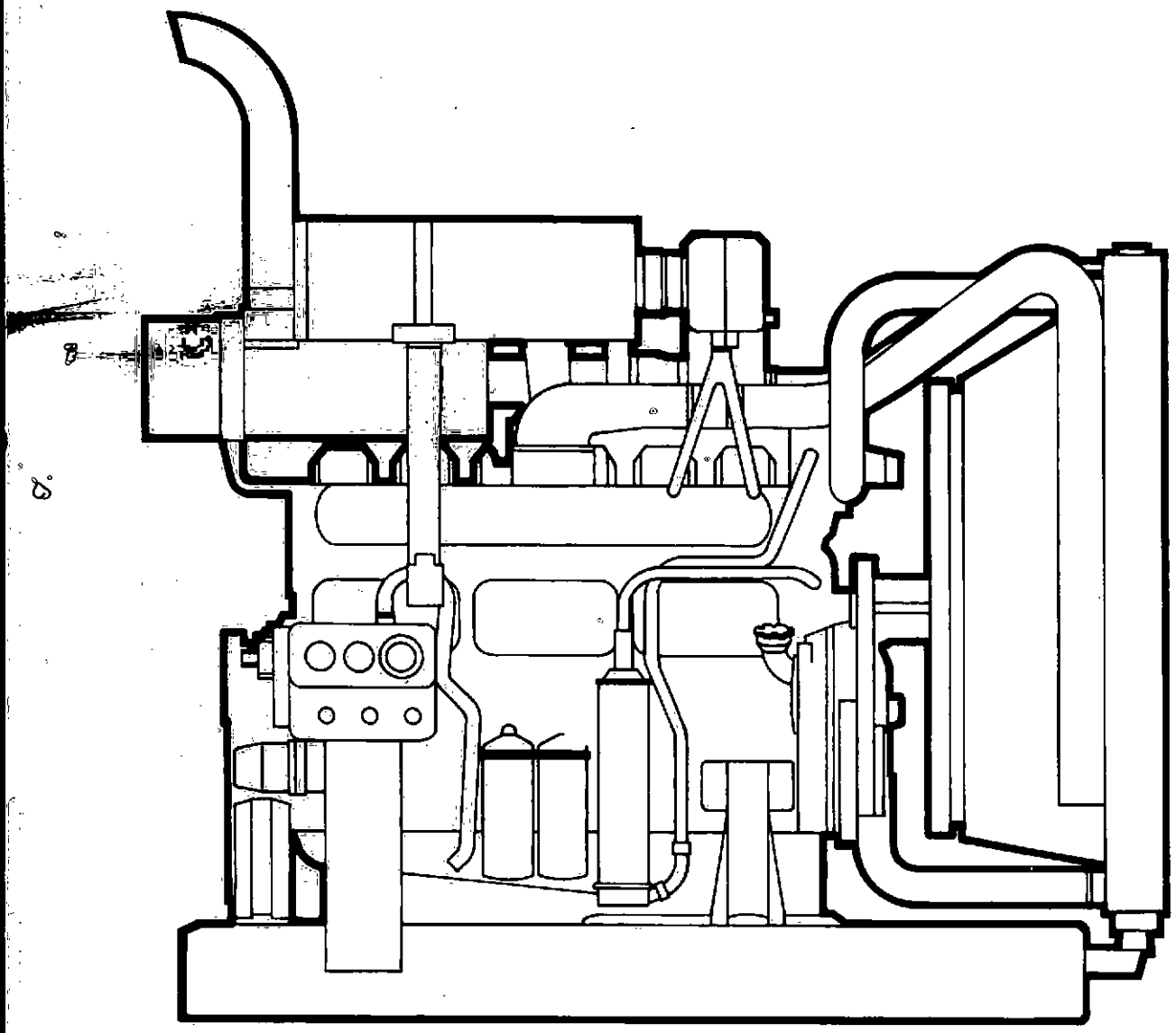
Instruction Book

Generator set and Industrial engines

6–16 litre



VOLVO PENTA

Foreword

Read the user manual before you start the engine! The manual contains the information you need to be able to handle the engine correctly.

A guarantee and service book accompanies each engine, to describe the guarantee which we offer for the product. **The guarantee card which accompanies the product must always be filled in and sent to Volvo Penta at once.** This is important for both you and us.

Volvo Penta has build up a comprehensive service organisation to be able to give your engine the service it needs.

Volvo Penta dealers and service stations are equipped with the necessary special tools and also have well-stocked spare parts stores. Original spare parts are always used of course, for service and repairs.

Make a habit of contacting your Volvo Penta representative for service and repairs. Please include the type designation and serial number of the engine and its equipment each time.

The maintenance instructions in this manual must be observed.

Volvo Penta retains the right to introduce product changes without prior notice, and without assuming any responsibility to introduce corresponding modifications to products which are sold or already manufactured.

Note! The descriptions in this manual are not valid specifications. Each individual engine is equipped in accordance with the contract applicable to that delivery.

AB VOLVO PENTA

Owner

Name: ..... Phone: .....

Address: .....

Nearest Volvo Penta service workshop

Name: ..... Phone: .....

Address: .....

Engine data

Engine type: ..... Serial number .....

Disengageable clutch, type/no. .....

Contents

Safety information

Read this chapter very carefully. It applies to your personal safety. It describes how the safety information in the instruction manual and on the product is presented. It also gives you a summary of the basic safety advice for care and maintenance of the engine.

Incorrect handling can lead to personal injury, product or property damage. Read the instruction manual very carefully before you start the engine or do any care or maintenance work. If there is still something which appears to be unclear, or you are not sure about, please contact your Volvo Penta dealer for assistance.

⚠ This symbol is used in the instruction manual and on the product, to make you aware that this is safety information. Always read such information very carefully

WARNING texts in the instruction are given the following priority:

⚠ **WARNING!** Warns about a risk of personal injury, considerable damage to product or property, or that serious malfunctions could occur if the instructions are not followed.

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

NOTE! Is used to call attention to important information to facilitate work tasks or operation.

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

Safety advice for care and maintenance work

⚠ Daily checks

Make a habit of giving the engine and engine room a visual check before operation **(before starting the engine)** and after operation **(after stopping the engine)**. This will help you to quickly discover if there is any leakage of fuel, coolant, oil or if anything else has happened or is about to happen.

⚠ Preparations

Knowledge

The instruction manual contains advice on doing the most common care and service work in a safe and correct manner. Read them carefully before you start work.

Litreature for more comprehensive work is available from your Volvo Penta dealer.

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

Stop the engine

Stop the engine before the engine hatch/bonnet is opened or removed. Care and maintenance work must be done with the engine stopped, unless otherwise specified.

Make it impossible to start the engine by cutting the current with the main switch, or remove the cable from the + pole on the battery before you start work.

Going close to the engine when it is running is a safety risk. Remember that loose clothing or long hair can catch on rotating components and cause severe personal injury. Volvo Penta recommends that all service work which needs the engine to be running should be given to an authorised Volvo Penta workshop to do.

Lifting the engine

The existing lifting lugs should be used to lift the engine. Always check that the lifting devices are in good condition and that they have sufficient capacity for the lift (the weight of the engine together with any accessories). The engine should be lifted with an adjustable lifting boom for safe handling and to avoid damage to components mounted on top of the engine. All chains and cables should be parallel to each other and as close as possible to a right angle to the top of the engine. If accessories mounted on the engine change its centre of gravity, special lifting devices can be required to get the correct balance and safe handling. Never do any work on an engine which is only hanging from the lifting device. A fork lift truck must be used for all handling of engines mounted on sub-frames.

Before starting

Replace all guards which have been removed, before starting the engine. Check that there are no tools or other objects left behind on the engine.

A turbocharged engine must never be started unless the air filter is installed. The rotating compressor wheel in the turbo can cause severe personal injury. There is also a risk that foreign bodies in the inlet duct could cause damage to machinery.

⚠ Operation

There is no key switch on the instrument panel. This means that the engine room must be lockable to prevent unauthorised persons from starting the engine. Alternatively, a lockable main switch can be used.

In unmanned operation, an automatic stopping device must be installed. The over-speed protection must always be used if there is electronic speed control. Other signals which can be used for automatic stopping are oil pressure, coolant temperature and coolant level.

On engines supplied without guards, all rotating components and hot surfaces must be provided with guards if required for personal safety once the engine has been installed..

Engines must not be operated in environments with surrounding explosive media since none of the electric or mechanical components are spark-proof.

⚠ Hot surfaces and fluids

A hot engine always presents a burn hazard. Be careful with hot surfaces. For example, the exhaust manifold, turbo, sump, turbocharged inlet manifold, starting heater, hot coolant and hot oil in pipes or hoses.

⚠ Carbon monoxide poisoning

Only start the engine in a well ventilated space. When operated in an enclosed space, the exhaust gases and crankcase ventilation gases must be led away from the engine room.

⚠ Fire and explosion

Fuel and lubricants
All fuels, most lubricants and many chemicals are flammable. Read and follow the advice on the packages.

Fuel filters should be changed when the engine is cold to avoid the fire hazard caused by fuel spillage on the exhaust manifold. Always cover the alternator over, if it is located beneath the fuel filter. Spilled fuel can damage the alternator.

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

Never smoke when filling fuel, lubrication oil or when near to a fuel station or in the engine bay.

Non-original spares
Components in the fuel system and electrical systems on Volvo Penta engines are designed and made to minimise the risks of explosion and fire, in accordance with current legal requirements.

The use of non-original spares can cause a fire.

Batteries
Batteries contain and generate explosive gas, especially when charged. This gas is easy to ignite and very 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 jumper cable can cause a spark, which in its turn can be enough to make the battery explode.

Start spray
Engines with air pre-heating (starting heaters): Never use start spray (ki-gas) or similar products as start aids. An explosion can occur in the inlet manifold because of the starting heater. Danger of personal injury.

⚠ Chemicals

Most chemicals, such as glycol, rust preventer, conservation oils, de-greaser etc. are hazardous. Always read and follow 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 when spraying. Always read and follow 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 depot for destruction.

⚠ Fuel filling

There is always a fire and explosion hazard when fuel is filled. Smoking is banned and the engine should be stopped.

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

Only use the fuel recommended in the instruction manual.

Using fuel of lower quality can damage the engine. On a diesel engine, poor fuel can cause the control rod to bind and the engine will over-rev, causing a risk of material damage and personal injury. Poor fuel can also lead to higher maintenance costs.

⚠ Fuel system

Always protect your hands when searching for leaks. Fluids which leak under pressure can force their way into living tissue and cause serious injury. Risk of blood poisoning (septicaemia).

Always cover the alternator over, if it is located beneath the fuel filters. Spilled fuel 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 with the main switch or by removing the cable from the + pole on the battery. Electrical connections to the engine heater, battery charger or other auxiliaries mounted on the engine must be disconnected.

Batteries
Batteries contain strongly corrosive electrolyte. Protect your eyes, skin and clothes when charging batteries or handling them in other ways. Always use protective goggles and gloves.

If you get a splash on your skin, wash with soap and plenty of water. If it splashes in your eyes, rinse immediately with plenty of water and contact a doctor at once

⚠ Cooling system

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

If the filler cap, coolant hoses, tap etc. must be opened or removed anyway when the engine is hot, open the filler cap slowly and carefully, to release the excess pressure before you remove the filler cap entirely and start working. Note that the coolant can still be hot and cause scalding.

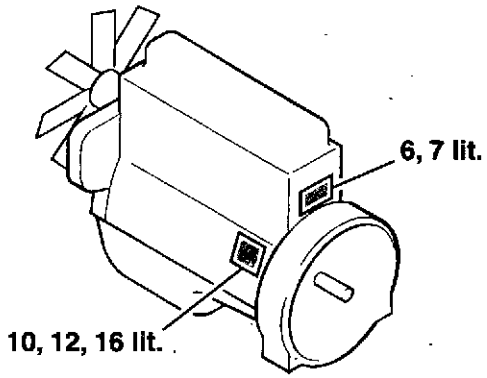
⚠ Lubrication system

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

Introduction

Engine sign

The engines are supplied with two engine signs, one of which is supplied loose to be mounted on a suitable location adjacent to the engine. The other sign is riveted to the engine as follows:



	VOLVO PENTA	
1	ENGINE MODEL	XXXXXXXX
2	SPEC. NO.	XXXXXX
3	SERIAL NO.	XXXXXXXXXX
4	RATED NET POWER without fan kW/hp	XXX/XXX
5	with fan kW/hp	XXX/XXX
6	SPEED AT RATED POWER rpm	XXXX
7	PRELIFT mm/INJ. TIMING	X,X+X,X/XX±X,X°
	MADE IN SWEDEN	3826077

1. Engine designation
2. Product number
3. Serial number
4. Engine power, net (with fan)
5. Engine power, net (without fan)
6. Maximum engine speed
7. Injection timing

Engine designation

When you purchase spare parts and accessories, and in other contacts with Volvo Penta workshops, it is of the greatest importance that you quote the full engine designation.

The following information can be read from the engine designation:

T – Turbocharged
A – Air-to-air intercooler
W – Water-to-air intercooler
D – Diesel engine
10 – Displacement, litre
3 – Generation
0 – Version
V – Engine for stationary and mobile operation
P – Stationarly engine (Power Pac)
G – Gen Set engine
M – Mobile engine
E – Low emission engine

Presentation

The engine programme includes industrial and generator set engines with 6-16 litre displacement.

The engines are in-line 6-cylinder, 4-stroke diesel engines with direct injection. The engines have wet, replacable cylinder liners and have turbochargers. All engines except TD610, TWD610 and TD630 have piston cooling.

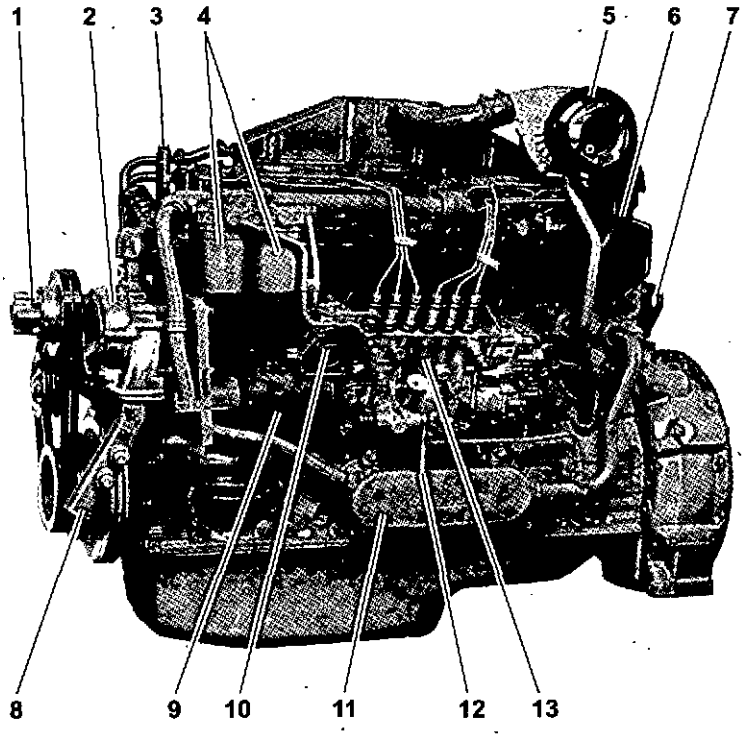
The TAD engines have air-cooled intercoolers and a pusher type fan. The TWD engines have a water-cooled intercooler.

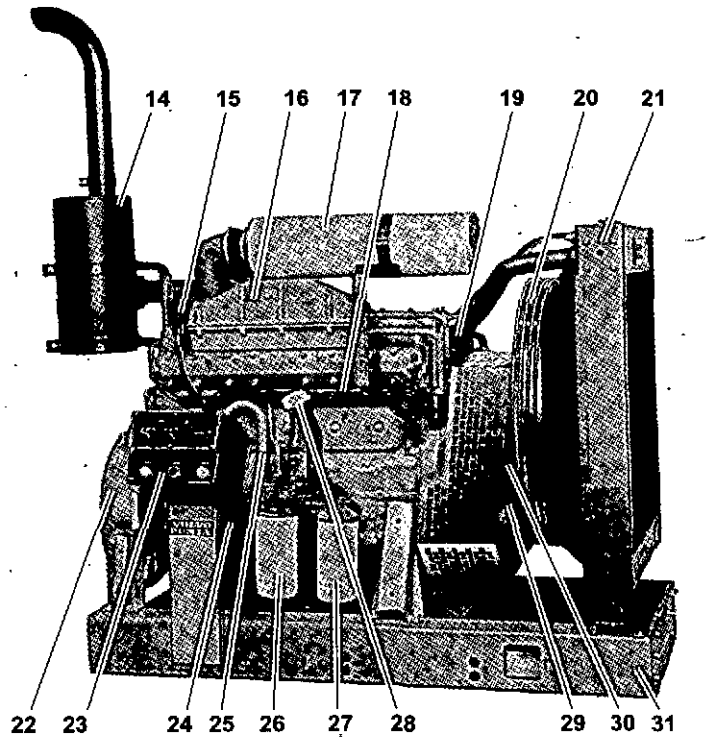
The intercooler lowers the temperature of the inlet air, which gives greater cylinder filling. This permits higher rated power at the same time as the combustion and exhaust temperatures can be maintained at suitable levels. In addition, emissions of oxides of nitrogen are reduced.

The engines have electric starting heaters, to facilitate starting and reduce exhaust emissions when starting in cold weather.

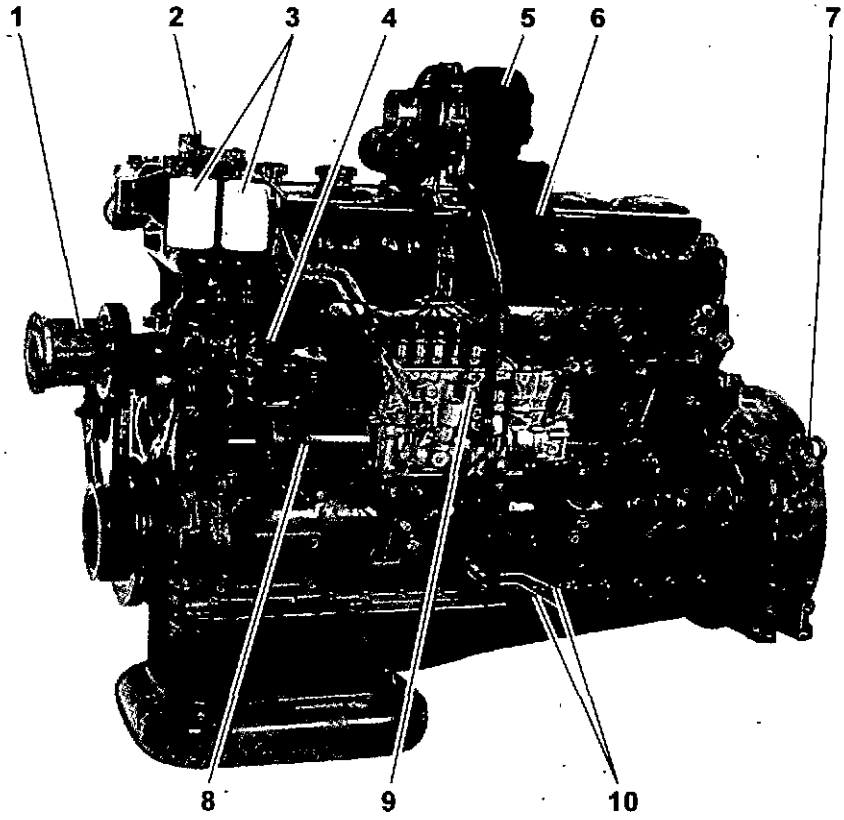
Examples of 6 and 7 litre engines

1. Fan hub
2. Gear driven coolant pump
3. Lifting lug
4. Twin fuel filters
5. Turbocharger
6. Air cooled exhaust manifold
7. Lifting lug
8. Coolant pipe, inlet
9. Pump coupling guard
10. Smoke limiter
11. Oil cooler
12. Fuel pipes for tank connection
13. Injection pump
14. Silencer
15. Rely for inlet manifold heater
16. Inlet manifold heater
17. Air filter
18. Cable bracket
19. Coolant pipe, outlet
20. Fan guard
21. Radiator
22. Flywheel housing
23. Instrument panel
24. Starter motor
25. Pipe for crankcase ventilation
26. Oil filter, full flow
27. Oil filter, by-pass
28. Oil filler cap
29. Vibration damper
30. Belt tensioner, automatic
31. Frame

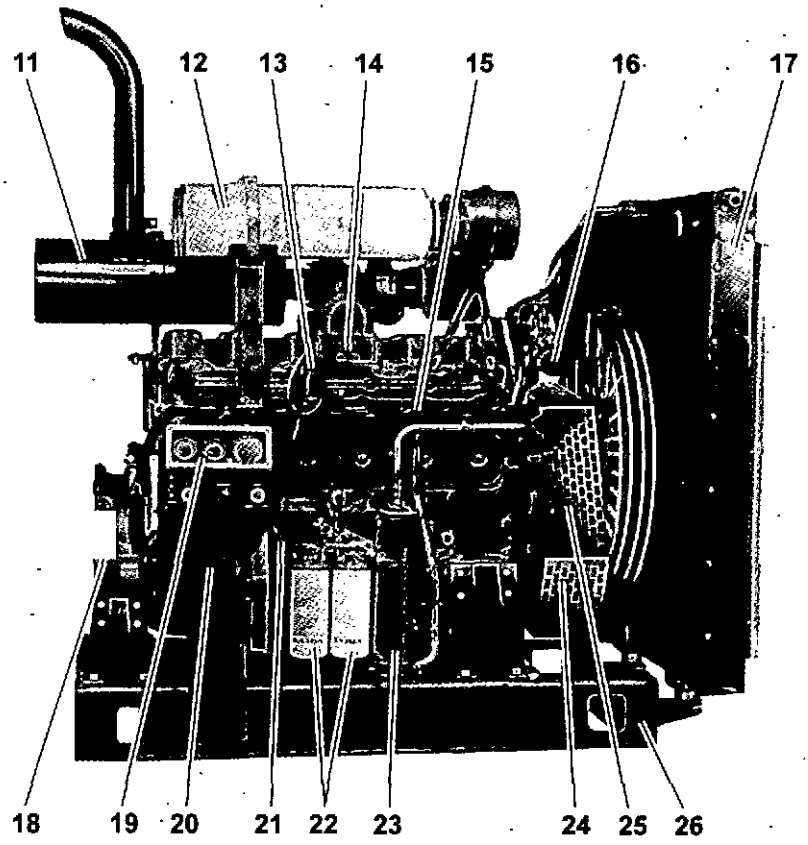




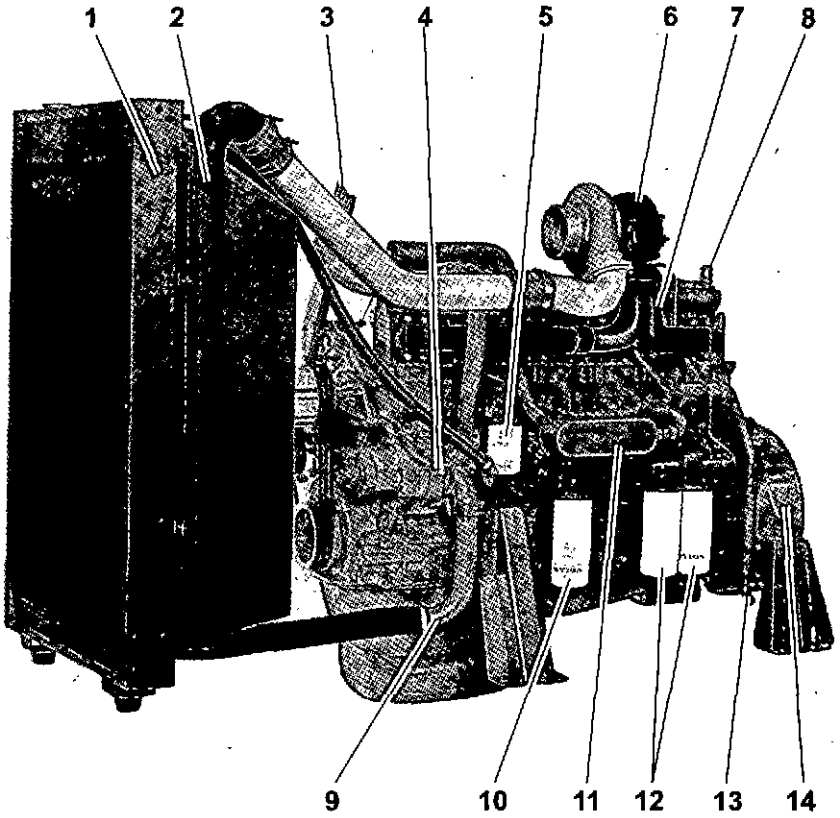
Examples of 10 and 12 litre engines



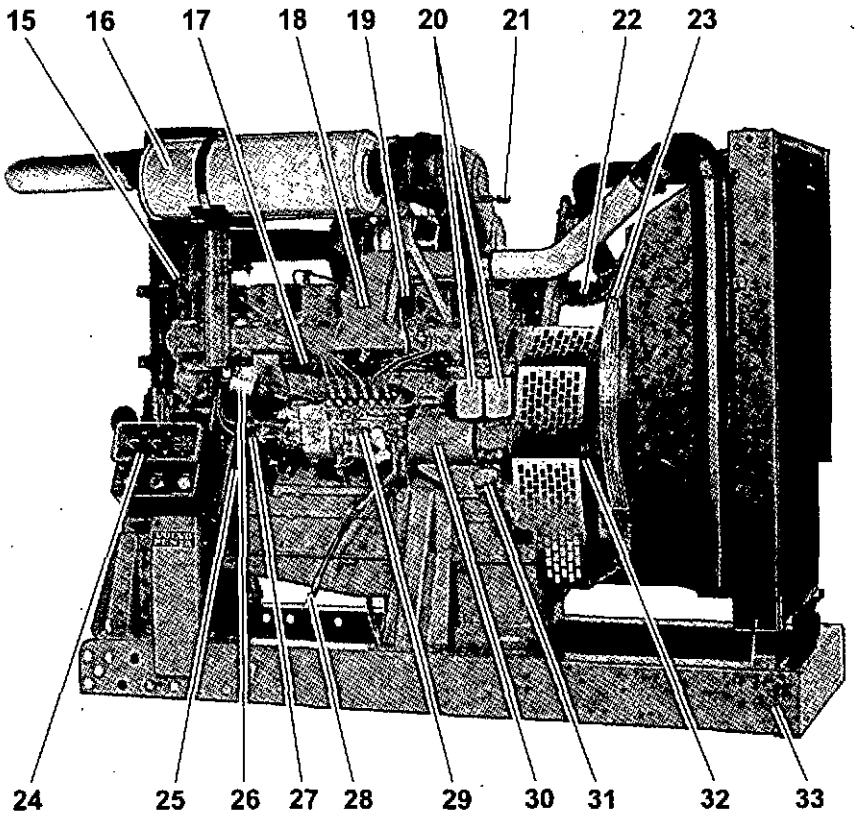
1. Fan hub
2. Lifting lug
3. Twin fuel filters
4. Gear driven circ. pump
5. Turbocharger
6. Air cooled exhaust manifold
7. Lifting lug
8. Pump coupling guard
9. Injection pump
10. Fuel pipes for tank connection
11. Silencer
12. Twin air filters
13. Relay for inlet manifold heater
14. Inlet manifold heater
15. Cable bracket
16. Coolant pipe, outlet
17. Radiator
18. Flywheel housing
19. Instrument panel
20. Starter motor
21. Pipe for crankcase ventilation
22. Twin oil filters, full flow
23. Oil cooler
24. Vibration damper
25. Belt tensioner, (automatic)
26. Frame



Examples of 16 litre engines



1. Radiator
2. Intercooler
3. Bracket for radiator
4. Gear driven coolant pump
5. Coolant filter
6. Turbo charger
7. Air cooled exhaust manifold
8. Lifting lug
9. Coolant pipe, inlet
10. Oil filter, by pass
11. Oil cooler
12. Twin oil filters, full flow
13. Pipe for crankcase ventilation
14. Flywheel housing
15. Silencer
16. Air filter
17. Cable bracket
18. Inlet manifold heater
19. Relay for inlet manifold heater
20. Twin fuel filters
21. Pressure drop indicator for air filter
22. Coolant pipe, outlet
23. Fan guard
24. Instrument panel
25. Start motor
26. Stop solenoid
27. Engine speed control
28. Fuel pipe for tank connection
29. Injection pump
30. Pump coupling guard
31. Oil filler
32. Belt tensioner (automatic)
33. Frame



Fuel, Oil, Coolant

Diesel fuel

It is of the greatest importance for obtaining environmental and reliable operation that the fuel in the recommendation below is used::

Fuel specification
The fuel must meet national and international standards for commercial fuel, such as:

- EN590 (with nationally adapted environmental and cold requirements)
- ASTM-D975-No 1-D, 2-D.
- JIS KK 2204

Sulphur content: In accordance with the legal requirements in each country. If the sulphur content exceeds 0.5 percent by weight, the **oil change intervals** are changed, please refer to page. 29.
Note. Fuel with an extremely low sulphur content (urban diesel in Sweden, City diesel in Finland) can cause a loss of power of about 5% and an increase in fuel consumption of 2-3%.

Lubrication oil, engine

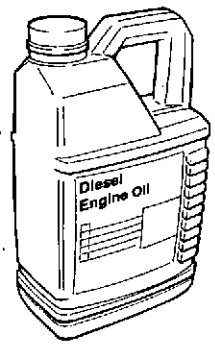
Lubrication oil of grades as in the table below must be used:

Designation	Standard
VDS -2, VDS	Volvo Drain Specification
CCMC D5, D4	CCMC
CD, CE, CF	API
CF-4, CG-4	API

*If long oil change intervals are to be used, a VDS oil must be used. Please refer to the maintenance schedule and "Technical Data".

Operating with an oil of a grade which does not meet the requirements above is a false economy as regards both operating economy and reliability.

Please refer to "Technical Data" on pages 37-55 for oil viscosities and volumes.



Oil for steering servo system, hydraulic pump

(extra equipment)
ATF-oil* must be used for the steering servo system.

* ATF = Automatic Transmission Fluid (oil for automatic transmissions).

Coolant

The coolant has two roles. It both protects the cooling system from freezing and prevents corrosion.

⚠ **IMPORTANT! The following recommendations must be followed to avoid freezing and corrosion damage:**

If there is a risk of frost

Use a mixture of 50% Volvo Penta anti-freeze (glycol) and 50% pure water (as neutral as possible). **This mixture protects the engine from frost damage down to -40° and should be used all year round.**

Note. At least 40% anti-freeze must be used in the system to give acceptable corrosion protection.

Mix the glycol and water in a separate vessel before topping the cooling system up.

Please see the separate instruction on page 18 for topping up the coolant.

⚠ **WARNING! Glycol is hazardous (dangerous to drink).**

Percentage of glycol required to give frost protection down to about:			
-5°C	-28°C	-40°C	-56°C
40%	40%	50%	60%

* The freezing point can be lowered as far as -56°C (60% glycol). **Increasing the glycol mixture above this level impairs frost protection.**

No risk of frost

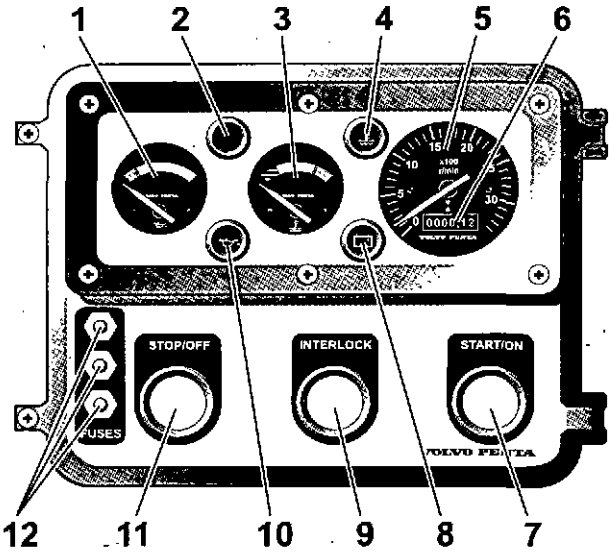
When there is no risk of frost, water mixed with Volvo Penta anti-corrosion agent* (part. no 1141526-2) should be used if a water/glycol mixture is not used all the year round. Mixing ratio 1:30.

Please see the separate instruction on page 18 for topping up the coolant. Run the engine until warm after topping up, to give the additives the best possible effect.

⚠ **WARNING! Anti-corrosion agent is hazardous (dangerous to drink).**

* **Note.** Never mix anti-corrosion agent with anti-freeze (glycol). Foam may be generated which considerably reduces cooling.

Instrumentation

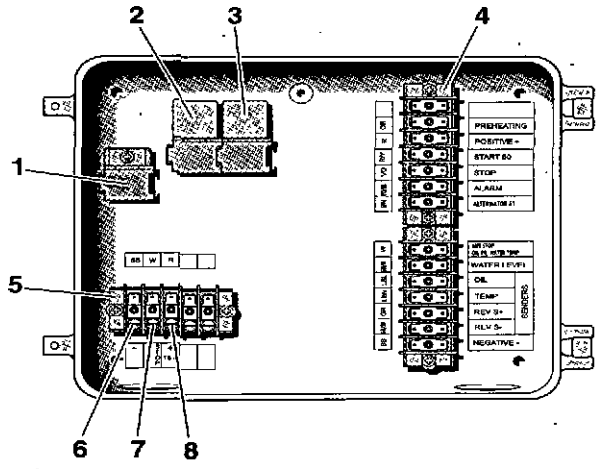


The instruments for monitoring the oil pressure, coolant temperature, engine speed and running hours of the engine, plus the engine start and stop controls, are located on the instrument panel. This is located on a pillar at the rear on the right-hand side of the engine.

1. Oil pressure gauge. Normally in the green field (300-650 kPa).
2. WARNING lamp for low coolant level (extra equipment).
3. Coolant temperature gauge. Normally in the green field (70-95°C).
4. WARNING lamp for high coolant temperature (extra equipment).
5. Tachometer, engine speed gauge. Multiply the value by 100 to get revs per minute.
6. Hours counter. Built into the tachometer housing. Shows engine hours in full and hundredths of hours..
7. Start button (green). **Note.** The start button must **never** be pressed when the engine is running. This could damage the starter motor and the ring gear on the flywheel.
8. Warning lamp which lights up if the charge current from the alternator fails.
9. Interlock button, (black). The automatic stop is disconnected when this button is pressed.
   This button must be kept depressed until the oil pressure reaches its normal level.

   Note. The button also connects the electric starting heater (pre-heating).
10. Warning lamp for low oil pressure (extra equipment).
11. Stop button (red). When the button is pressed, the stop solenoid is engaged. This cuts the fuel supply to the injection pump and the engine stops.

    Note. If the engine has been stopped because the automatic stop has been triggered, the alarm is also silenced when the stop button is pressed.
12. Automatic fuses, two 8 A (16 litre engines have one) and one 16 A. If a automatic fuse has tripped, it can be re-set manually by pressing the button on the automatic fuse.



Instrument pane folded up

Note. The figures in bold type (in brackets) are the component designations on the wiring diagram on pages 18 and 22.

1. Space for coolant level monitor relay (extra equipment) **(9)**
2. *Relay for automatic stop (coolant temperature monitor, oil* pressure monitor, low coolant level monitor, extra equipment) **(10)**
3. Holding current relay (operating current and instruments) **(11)**
4. Terminal for engine cables (12.A)
5. Terminal for automatic stop and extra current outlets (max. 16 A) **(12.B)**
6. Minus (-) for extra current outlets, (black wire)
7. Connections for extra monitors - automatic stop, (white wire)
8. Plus (+) for extra current outlets, (red wire). Max. 16 A

Operation

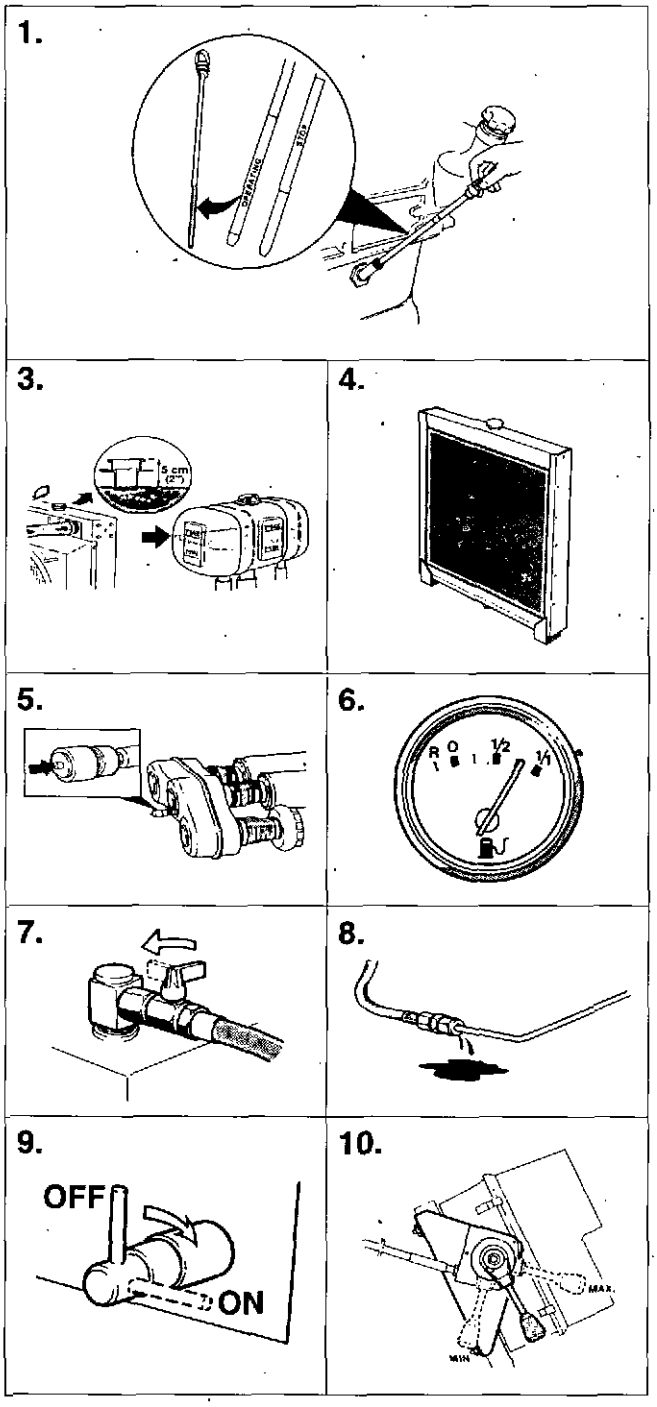
Running in

When the engine is new, it must be run in normal operation. **Do not take out full load for the first ten hours of operation, if possible.** Avoid unnecessary idling with the engine unloaded.

Check the instruments extra carefully during this time to discover any abnormal states in good time.

Also check that no leakage occurs.

NOTE! On a new, or newly renovated engine, check valve clearance after 100-200 hours' operation (1630: 300 hours' operation). Re-tighten all the injectors at the same time (50 Nm/5 kpm).



When a friction clutch is fitted, this should be checked during the first few days. It may need adjustment when the facing have bedded in. Please refer to item 15 of the maintenance schedule on page 31.

Measures before starting

1. Check the engine oil level*. The level should be between the two marks on the dipstick. **The oil level must never fall below the lower mark.**

   *Do not read until at least 3 minutes after stopping.

   Note. On some engines, the oil level can be read during operation (reading on the side marked "OPERATING").

2. Check that the drain tap is closed and that all drain plugs for the cooling system are installed.

   Please refer to pages 16-17 for location of the taps/plugs.

3. Check the coolant level. The level should be about 5 cm (2") below the sealing plane of the filler cap (if there is a separate expansion tank, the level should be between the MAX and MIN levels). Please refer to page 18 for topping up.

   ⚠ **WARNING! Open the filler cap very carefully if the engine is hot. Steam or hot fluid can squirt out.**

4. Check that the radiator core is not dirty or cloged. TAD engines: Check the intercooler as well.

5. Check whether the air filter is blocked. Change the filter when the indicator shows a red field. Reset the indicator after filter replacement by pressing the button.

6. Check the fuel level. Fill up with fuel if necessary. Never allow the engine to stop because of lack of fuel. If this happens, the fuel system must be bled* to permit starting.

   * Please refer to "bleeding the fuel system" on page 21.

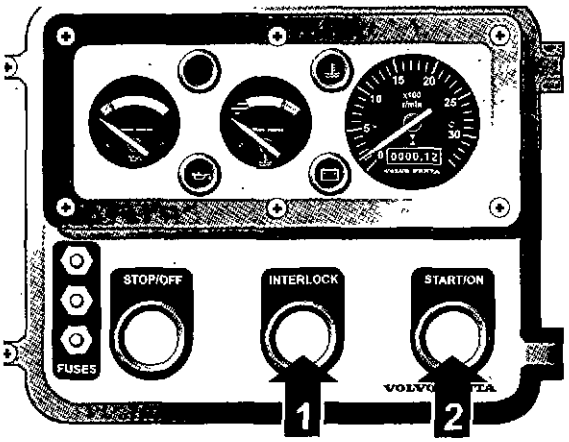
7. Open the fuel taps.

8. Check that there is no leakage of water, fuel or oil.

9. Close the main switches.

10. Disengage the friction clutch if fitted. Make sure that the gear selector is in neutral (mobile equipment) and put the engine speed control to neutral.

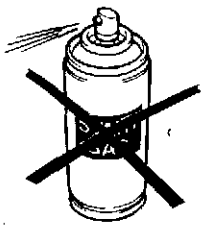
Starting the engine



(Starting procedure can vary, depending on application, such as genset/stand-by etc.).

Engines with alarm separator (extra equipment):
Press the interlock button and check that the warning lamps on the instrument panel light up.

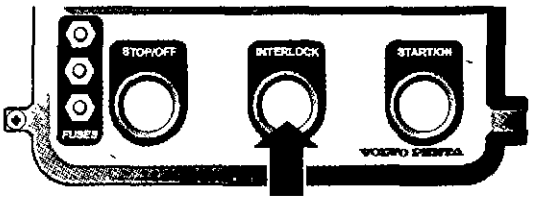
1. ***Cold engine:*** *Press the interlock button (position II on* engines with an ignition lock), and keep it there for about 50 sec. At the same time, the electric inlet *manifold heater is engaged (pre-heating).*



⚠ **WARNING!** Never use start spray (ki gas) or *similar as a start help. An explosion can occur in* the inlet pipe. This could cause personal injury.

Hot engine: Go directly to item 2.

2. Keep the interlock button depressed. Press the "Start" button (green) at the same time, (not more than 40 sec.).



3. *Release the start button as soon as the engine has* started. The interlock button must be kept depressed for about 5 seconds after starting however (engines with coolant level monitors, extra equipment) or until the oil pressure is stable (other engines). The automatic stop will otherwise be engaged and stop the engine.

Note. In severe cold weather, it may be necessary to *re-engage the pre-heating for a few minutes after* starting by keeping the interlock button depressed.

⚠ **IMPORTANT!** The start button must **never** be pressed when the engine is running. The start motor and ring gear on the flywheel could be damaged.

4. **Do not race the engine after starting!** Run the engine unloaded at about 1300-1500 r/min. for a few *minutes to give all components adequate lubrication.*

Also, do not run the engine at a critical low engine speed. This is particularly important when the engine is connected to equipment with a big moment of inertia.

5. Engage a friction clutch, if fitted, at **no more than 1000-1200 r/min.**

Starting an engine equipped with an electronic governor (GAC)

Before the first start

Check the following before connecting the batteries:

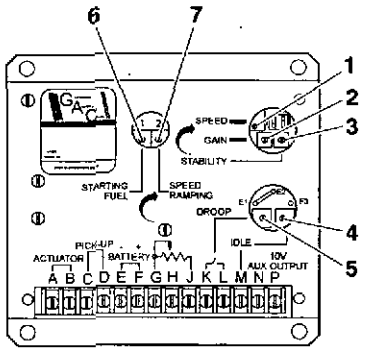
1. That the system voltage is correct (12 V or 24 V).
2. That the control unit connection has the correct polarity at "E" (negative), and at "F" (positive).

NOTE! The control unit has several built-in protection devices. Any short-circuit of the actuator or its cables stops the engine. Once the battery voltage has been cut off and the fault attended to, the control unit will function normally again.

On condition that a quick fuse is used in the battery cable in the wiring diagram (page 25), reversed polarity will not destroy the control unit. Several other incorrect connections can destroy the control unit, however.

3. That the wiring is correct in other respects. See the wiring diagram, page. 25.
4. Set the "GAIN" and "STABILITY" potentiometers on the control unit to their centre positions.
5. Temporarily connect terminals. "G" and "M" on the control unit to get slow idle (app. 600-800 r/min.).

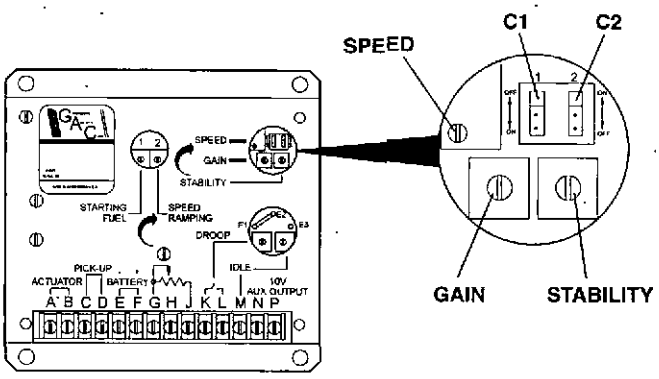
1. Operation speed, setting ("SPEED")
2. Sensitivity, setting ("GAIN")
3. Stability control ("STABILITY")
4. Idle adjustment ("IDLE")
5. High idle control ("DROOP")
6. Starting fuel quantity, adjustment ("STARTING FUEL")
7. Engine speed ramping ("SPEED RAMPING")



Setting the dip switches C1 and C2:

Switch C1 should normally be in the "ON" position. Move the breaker to the "OFF" if hunting occurs.

Switch C2 controls an auxiliary circuit in the control unit which affects sensitivity. Set the breaker to "OFF". If the system suffers high-frequency hunting, set the breaker to "ON". In this position, sensitivity is reduced, which reduces high-frequency hunting in the engine. High frequency hunting in the engine can be caused by a soft or worn flexible coupling between the engine and the generator.



First start

1. Connect the batteries and start the engine. The governor should keep the engine at idle. If desired, the idling speed can be increased by turning the idling potentiometer "IDLE" on the control unit clockwise. Note that this is a **single turn potentiometer**. Turn it carefully, and **not** to its end position.

⚠**WARNING!** Long periods of operation at critical speeds can damage a flexible coupling, engine or generator.

2. Remove the connection between. "G" and "M" on the control unit, once the engine has been checked and been found to function normally. The engine speed should then rise to 1567 r/min., or about 1870 r/min. (with "K" and "L" jumpered for droop), depending on the engine speed ordered.

   On a new control unit which has not been adjusted previously, the "SPEED" potentiometer should be turned approx. 10 turns clockwise from the end position to set the engine speed to 1500 r/min.

3. Do the final adjustment of "GAIN" and "STABILITY" on the control unit as follows:

– Operate the engine without load and turn the sensitivity adjustment "GAIN" **clockwise** until instability occurs. Then turn the adjustment back until stability is obtained again, plus a further 1/8 turn.

– Adjust "STABILITY" in the same way as for sensitivity above. Please refer to the illustration below as well.

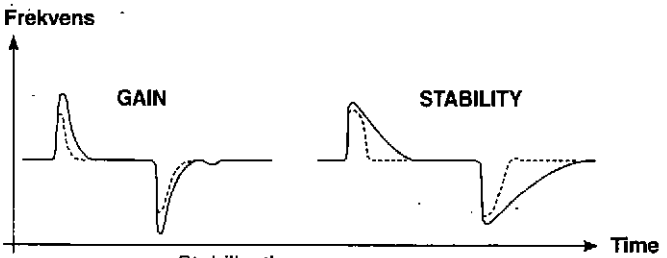
NOTE! When you adjust "GAIN", the set speed might be changed. Adjust this as necessary with the "SPEED" potentiometer.

After these changes, you can apply a load. If necessary, the immediately previous adjustments may have to be repeated. The critical point for these adjustments is normally found with an unloaded cold engine.

NOTE!

Clockwise rotation of the "GAIN" control enhances the reaction of the governor to a change in load. **Turning anti clockwise** gives slower reaction.

Clockwise rotation of "STABILITY" cuts the time needed by the system to return to normal after a load change. **Turning anti clockwise** makes the system react more slowly.



Stabilisation process
Dashed line = optimum setting

Starting the engine in extreme cold

The starting time for a diesel engine increases as the temperature falls. To facilitate, and in some cases, to permit starting, certain preparations have to be made:

Make sure that the cooling system is filled with the correct concentration of glycol (please refer to page 9). Volvo Penta glycol gives acceptable corrosion protection in addition to frost protection.

To facilitate starting, the coolant must be kept warm. It is a good idea to use a separately installed electric engine heater for this. In extreme cases, a diesel-burning engine heater may be required. Please ask your Volvo Penta dealer.

Use "winter fuel" which you know is approved for the relevant temperature. We recommend that a fuel heater should be used at extremely low temperatures.

Use a synthetic engine oil of suitable grade and viscosity (please refer to page. 29), since this can manage a wider temperature range than a mineral based oil.

Also remember that battery capacity falls in cold weather. It may be necessary to increase the battery capacity. Preheating the batteries can reduce the losses..

All Volvo Penta engines have an electric starting heater in the induction manifold. This is to facilitate starting by heating the induction air. The starting heater should be activated for 50 seconds before starting. To reduce the quantity of white smoke, it is a good idea to have the starting *heater activated for 30-50 seconds, immediately after start*ing.

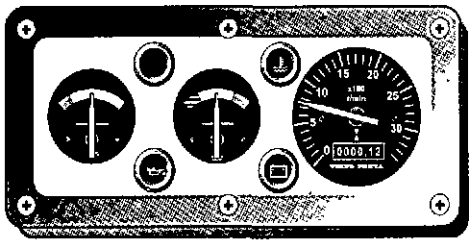
Starting with auxiliary batteries

Please refer to the instruction on page 23 for starting with auxiliary batteries.

During operation

1. Check that the instruments show normal values (needles in the green areas if Volvo Penta instruments are used). The warning lamps must have gone out.

- Oil pressure, normally 300-500 kPa (730: 250-550 kPa, 1030: 400-600 kPa)
- Coolant temperature, normally 75-95°C



Note. *If the oil pressure is too low, the coolant temperature* is too high or the coolant level* is too low, the engine is stopped by the automatic stopping device at the same time as the alarm is sounded.

NOTE! The oil level should be checked every 8 hours on engines in continuous operation.

*The coolant level monitor is extra equipment.

⚠ **WARNING! Never start or run the engine with the oil filler cap removed. Risk of oil ejection.**

2. Mobile applications: Drive by the tachometer. Never overspeed the engine. Be particularly careful when using engine braking downhill.

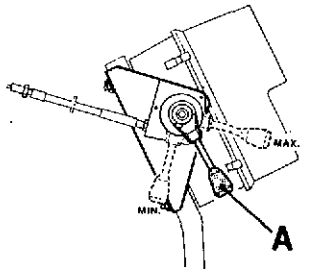
   Use low engine speed under light loading. I.e. no higher engine power output than needed. High engine speeds increase fuel and oil consumption.

⚠ **Never cover the radiator over.** The engine could be damaged by overheating. The thermostat automatically maintains the correct engine temperature in all operating conditions.

Engine speed control (Power Pack)

Engine speed can be adjusted by hand, with a mechanical control on the left-hand side of the instrument panel on the right-hand side of the engine.

Changing engine speed: Move control lever (A) upwards until the desired engine speed is obtained. Please refer to *the illustration.*



Engine speed control
A. Control lever

Operation at low loading

Avoid long-term operation at idling or low loading. These operating conditions can cause increased oil consumption and subsequently, leakage from the exhaust manifold.

One of the reasons for this is that oil passes the turbocharger bearings and goes into the manifold along with the charge air at low loading (low turbo pressure).

A consequence of this is carbon deposits on valves, piston crowns and exhaust turbine.

At low loading, the combustion temperature is so low that full combustion of the fuel can not be ensured. This means that fuel can dilute the lubrication oil and subsequently cause leakage from the exhaust manifold.

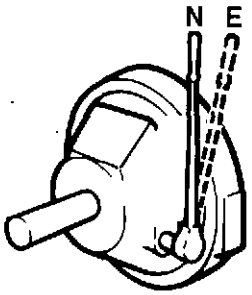
The following measures can be taken to reduce the consequences of running at low loading, as listed above:

1. Reduce running at low load to a minimum. If periodic test operation of the engine is done every week without load, operation duration should be limited to 10 min.
2. Run the engine at full load for about 4 hours once a year. Carbon deposits in the engine and exhaust manifold are then given the chance of burning off.

Note. If these points are done as a complement to normal *periodic maintenance, there is no risk of malfunctions* caused by operation at low loading.

Stopping

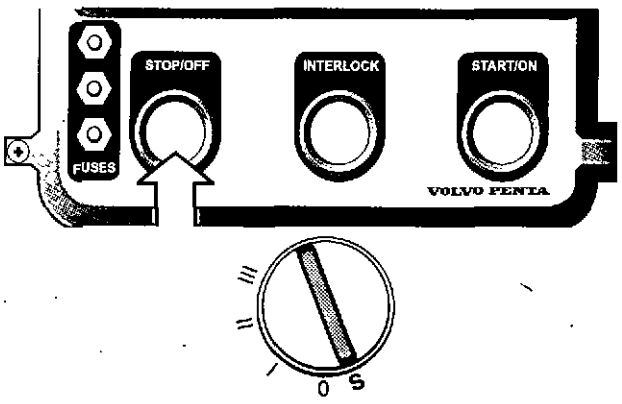
1. **Allow the engine to run for a few minutes without load at about 1300-1500 r/min. before stopping. This is important to even out temperatures inside the engine. Damaging "hot shut-down cooking" is avoided by this means, at the same time as the turbocharger cools off somewhat. This contributes to extended operation life without malfunctions.**



2. De-clutch the engine if possible.

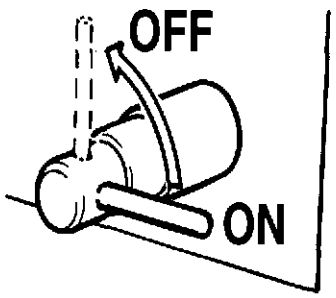
   Disconnecting clutch:

   N = Neutral
   E = Engaged



3. Press the stop button (red) and keep it pressed until the engine stops.

   Engines with ignition switches: Turn the key to the stop position "S". Release the key when the engine has stopped (the key springs back to the 0 position automatically). The key can then be taken out.



4. **Note.** During longer stoppages, the main switch should be disconnected.
   The main switch must never be disconnected when the engine is running. The voltage regulator and alternator could then be damaged.

Cooling system

Cleaning

The coolant should be changed once a year, to avoid any loss of efficiency because of deposits in the cooling system. A further reason for changing is to avoid the risk of corrosion damage since the rust preventing additives become used up as time passes.

The system should be flushed with clean water when the coolant is changed. Continue flushing until the water which comes out is clean.

Coolant, frost protection and rust protection

In areas where there is a risk of frost, a mixture of 50% Volvo Penta anti-freeze (glycol) and 50% pure water **must** be used.

When there is no risk of frost, the glycol can be replaced by Volvo Penta anti corrosion agent. Mixture ratio 1:30.

Please refer to "Coolant" on page 9. **Alcohol must not be used in the cooling system.**

⚠ **WARNING! *The anti corrosion agent is hazardous.* Dangerous to drink. Avoid contact with skin and eyes. Read the instructions on the package.**

⚠ **WARNING! Glycol is hazardous. Dangerous to drink. Avoid contact with skin and eyes. Read the instructions on the package.**

Draining the coolant

Before draining, stop the engine and unscrew the radiator filler cap.

⚠ **WARNING! Open the filler cap very carefully if the engine is hot. Steam or hot fluid can squirt out.**

Then open the drain taps or remove the drain plugs. Unscrew the coolant filter (extra equipment) if installed, and empty it.

Please refer to the "Drain points" heading below and the illustrations, for the location of taps, plugs and filters.

Check that all the coolant really runs out, to avoid frost damage if Volvo Penta anti-freeze has not been used in the system.

Note. There may be deposits inside the tap/plug which will have to be cleared out.

Drain locations (6 - 7 litre engines)

Drain tap (K) :

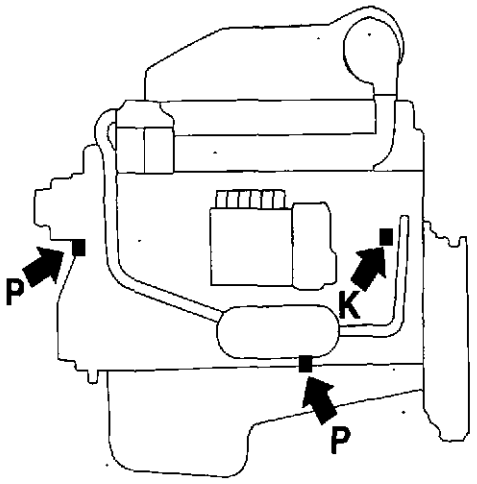
- On left-hand side of cylinder block, rear section

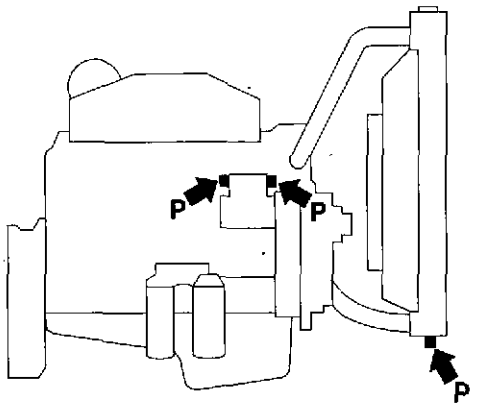
Drain plugs (P) :

- beneath the radiator
- beneath the coolant pump
- beneath the oil cooler
- 2 pcs (front and rear) on the air compressor, if fitted (extra equipment)

Coolant filter (extra equipment):

- individual location





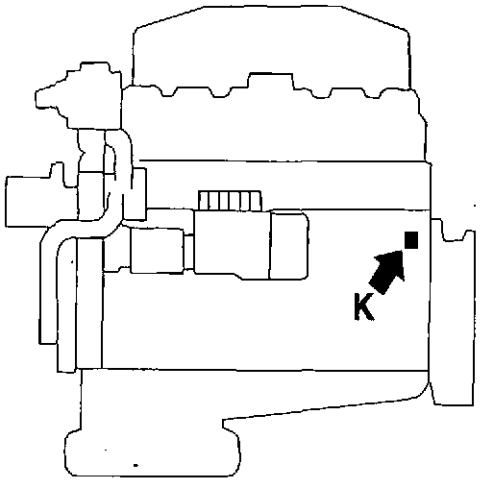
Drain locations (10 - 12 litre engines)

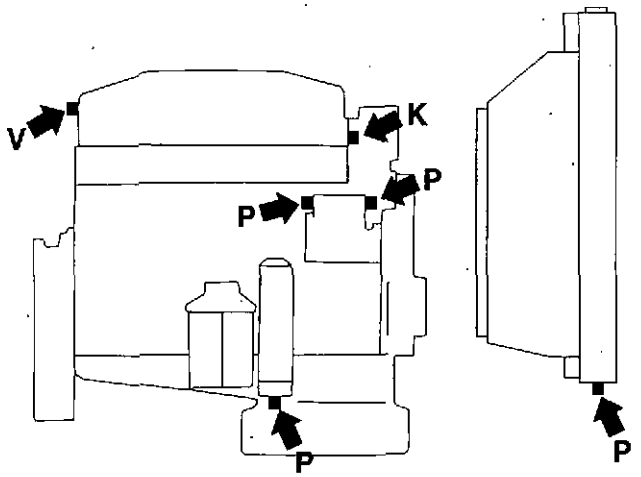
Drain taps (K):
- at rear on left-hand side of the cylinder block
- TWD1010/1210/1211/1230: Intercooler, at front

Drain plugs (P):
- beneath the radiator
- beneath the oil cooler
- 2 pcs (front and rear) on air compressor, if installed (extra equipment)

Coolant filter (extra equipment):
- individual location

Venting tap (V):
- TWD1010/1210/1211/1230: Intercooler, rear





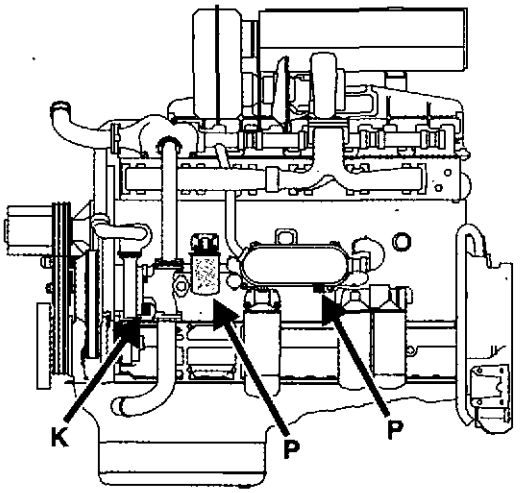
Drain locations (16 litre engines)

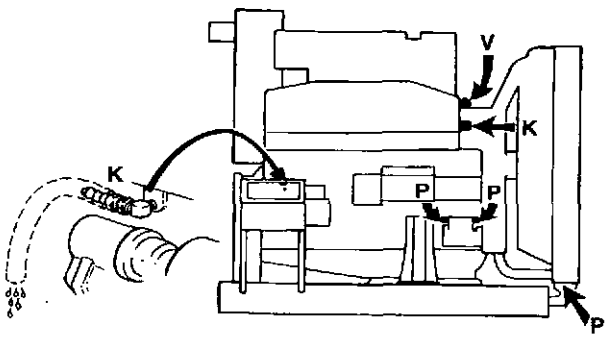
Drain taps (K):
- on cylinder block above start motor
- beneath rear edge of coolant pump
- TWD1630: Intercooler, front end

Drain plugs (P):
- beneath the radiator
- beneath the oil cooler
- 2 pcs (front and rear) on air compressor, if fitted

Coolant filter:
- Behind coolant pump

Venting tap (V):
- TWD1630: Intercooler, at front





Filling the cooling system

⚠ **WARNING! Open the filling cap very carefully if the engine is hot. Steam or hot fluid can squirt out**

Note. *Check that the drain taps are shut and that the drain* plugs are in place before you fill the cooling system.

Fill the system when the engine is not running. TWD1010/1210/1211/1230/1630: Open the venting tap (please refer to the figure on page 17) Do not fill the system so quickly that air bubbles are formed in the system. The air must be able to flow out through the venting tap (TWD1010/1210/1211/1230/1630) or through the filling hole.

If a heater is connected to the engine cooling system, the heater control valve must be opened and the unit vented during filling.

Fill up with coolant to about 5 cm (2") below the sealing plane of the filler cap. Please refer to "Coolant" on page 9 for coolants.

The engine must not be started until the system has been bled and is completely filled.

Start and warm up the engine. TWD1010/1210/1211/1230/1630: Open the venting tap (please refer to the figure on page 17) *a while after starting, to allow any air to escape.* Check the coolant level, top up if necessary.

The system should be topped up with the same kind of mixture as is already in the cooling system.

Inhibiting

Stoppages of up to two months

If the stoppage is expected to last less than two months, it is enough to start the engine and warm it up once every 14 days.

Check/supplement the anti-freeze to avoid damage if there is a risk of frost.

Check the battery charge. A flat battery can easily freeze and burst.

Longer than two months' stoppage

1. Warm the engine up to normal operating temperature.
2. Stop the engine and drain or pump out all the oil from the sump.
3. **Max. 8 months' stoppage:** Change the oil filter and fill up with Volvo Penta oil in the engine to the normal level. Warm the engine up after the oil change.
4. **More than 8 months' stoppage:** Fill up with conservation oil to the lower level on the dipstick. Conservation oil is sold by the oil companies.
5. Connect the fuel lines (supply and return pipes) to a fuel can containing a mixture of 1/3 conservation oil and 2/3 diesel fuel. Some oil companies have a ready mixed oil for this purpose.

   Bleed the fuel system. Please refer to "bleeding the fuel system" on page 21. Start the engine and run it at a fast idle until about 2 litres of the mixture have been used up. Stop the engine and drain or pump out the conservation oil from the sump. Connect the ordinary fuel hoses.
6. Check that the coolant has sufficient anti-freeze, top up if necessary. As an alternative, the cooling system can be drained.
7. Check that the batteries are kept well charged. A flat battery can freeze and burst.

   Batteries always have a natural discharge rate which increases with rising temperature. Batteries in storage should therefore be kept at the lowest possible temperature. They should be kept clean and dry, and normally should be charged every two months. They can also be trickle charged at 1 mA per Ah capacity.

   Preferably take the batteries out and hand them in for trickle charging as specified by the manufacturer.

   Please refer to item 2 under heading "Important notes about the electrical system" on page 23.
8. Improve the external rust protection by brushing with rust protection oil. The surfaces should be clean and dry before treatment.

   ⚠ **NOTE! Some conservation oils are flammable. Some of them are also hazardous to breathe. Ensure good ventilation. Use a breathing mask when spraying.**
9. Put a note on the engine, containing the date, type of conservation and the conservation oil used.
10. Cover up the engine air inlet, exhaust opening and engine if necessary.

Bringing out of storage

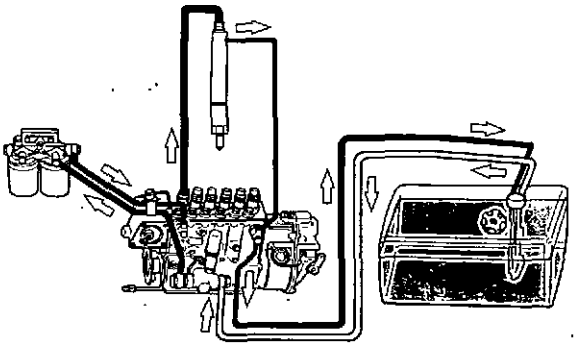
1. Remove any covers on the engine, air inlet and exhaust pipe.
2. Wash off external conservation preparations with white spirit.
3. Shut the drain taps and install any drain plugs.

   Fill the cooling system if the coolant has been drained. Please refer to "Filling the cooling system" above. Please refer to page 9 for coolants.
4. *Fill the engine up with lubrication oil of the correct grade.* Install a new oil filter if it was not changed during the oil change when the engine was conserved
5. Check the batteries as in the instruction on page 23. Please refer to item 6 in the maintenance schedule on page 30. Connect the battery cables.
6. *Install a new fuel filter and vent the fuel system.* Please refer to "bleeding the fuel system" on page 21.
7. Start the engine and heat it up at a fast idle before loading the engine.
8. Check that there are no leaks of oil, fuel or coolant.

Fuel system

General

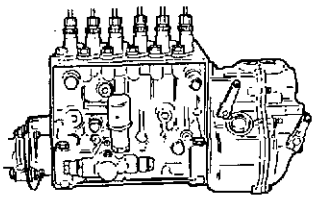
The following main components are included in the fuel system: fuel tank with level sensor, feed pump, two fuel filters, injection pump, injectors and pipes.



Injection pump

The injection pump is driven by the timing gear train in the engine.

Pump settings are measured by a dial gauge, as the lift from a base circle at a specified crankshaft angle.



Smoke limiter

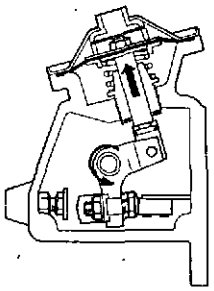
The task of the smoke limiter is to limit the fuel supply when the turbocharger supplies low manifold pressure.

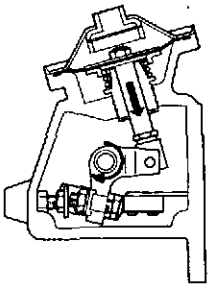
The diaphragm in the smoke limiter is influenced by the pressure in the inlet manifold, via a pipe. The movements of the diaphragm affect an angle lever via a system of linkages

The lower end of the angle arm influences the movement of the fuel rack.

At low manifold pressure, the angle lever influences the fuel rack to reduce the maximum fuel quantity.

At high manifold pressure, the angle lever takes up a position which allows the fuel rack to give a greater maximum quantity.



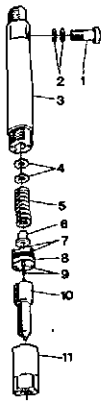


Injectors

The function of the injectors is to:

- Finely divide the fuel to give reliable ignition and combustion.
- Direct the jets of fuel in the combustion chamber, together with the air turbulence, to give the optimum mixture of fuel and air.

The opening pressure of the injectors is determined by spring pre-loading.



Governors

Mechanical governor

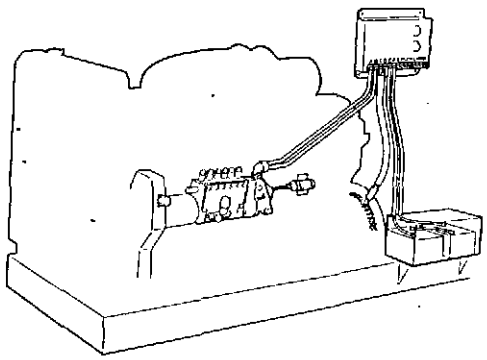
A mechanical regulator depends on a centrifugal weight which rotates at ½ engine speed. The engine speed is governed over the entire engine speed range, from low to high idle (as with variable engine speed).

Electronic governor (GAC)

The electronic governor system is a control unit which governs the engine speed. Its functions are:

- to maintain engine speed at the set idling speed
- maintain engine operating speed to the pre-set value, irrespective of varying load changes.

The engine speed is governed by the control unit, which "senses" the difference between the set engine speed and the true engine speed. The difference in values is converted to a signal which is supplied to an actuator, which adjusts the fuel rack in the injection pump to increase or reduce fuel supply.

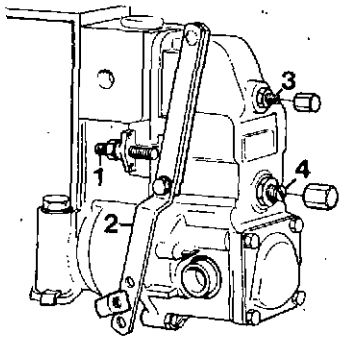


Engine speed, setting

RSV governor

(The engine must be at normal operating temperature!)

Check that the accelerator linkage functions normally, i.e. that the fuel supply arm in the injector pump meets the low idling stop when the accelerator control is moved to the idling position, and is pressed against the maximum stop when the control is moved to the maximum position. Adjust the control if necessary. Check that the air filter is not blocked.



1. Stop screw for maximum speed (sealed)
2. Fuel supply arm
3. Adjustment screw for low idle
4. Adjustment screw for idling stabilistation

Low idle

1
Let the engine idle and check the engine speed. Refer to "Technical data" for engine speed

2
Adjust the engine speed if necessary, by removing the domed nut and unscrewing the adjustment screw (3).

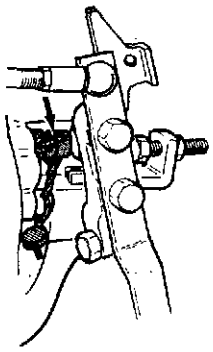
If engine speed oscillates, adjust idling damping as follows:

1
Remove the domed nut (4) and undo the lock nut. Turn the damping screw carefully clockwise until oscillation stops.

2
Check that the high idling speed has not been changed. If it has, the damping screw has been screwed in too far.

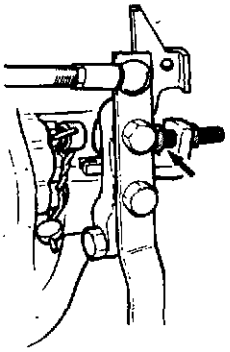
3
Lock the adjustment screw and install the domed nut when adjustment is completed.

RQV, RQ governors



1
The engine must be at normal operating temperature. Check that the accelerator control fully pulls the fuel supply arm in the injection pump back to the stop position for low idling.

2
Move the accelerator control to the maximum position and check that the fuel supply lever reaches the stop screw for high idle. Adjust if necessary.



Low idling

3
Let the engine idle and check the engine speed. Refer to "Technical data" for engine speed

4
Adjust the engine speed as necessary with the low idle screw.

Bleeding the fuel system

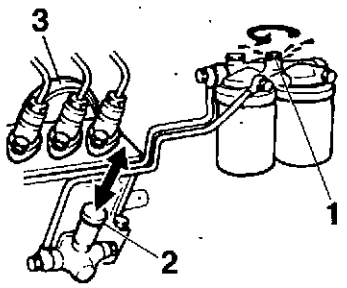
Bleeding of :

- Engines equipped with **stop solenoid**
- Engines equipped with **fuel shut-off valve supplied energized to stop (E.T.S)**

should be done as follows:

Make sure that the engine is ready to operate. Open vent screw (1). Press the hand pump (2) and pump until air-free fuel flows out. Shut the screw whilst fuel is flowing out. Then pump a futher 15-20 strokes. Check that no leakage occurs.

NOTE! If the engine is equipped with a fuel shut-off valve, you frequently have to vent the injection pump as well. This is done by undoing the pressure equalisation chamber on the injection pump (3) (27 mm narrow, open spanner). Pump the hand pump (2) until air-free fuel flows out.

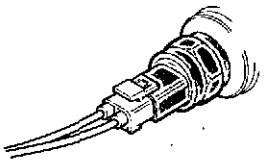


Bleeding of :

- Engines equipped with **fuel shut-off valve supplied energized to run (E.T.R)**

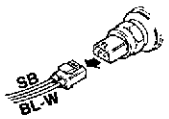
should be done as follows:

Is there an "automatic stop for low oil pressure" with Volvo Penta's design of oil pressure monitor? When the engine is stopped, this monitor is closed ("Nc"-Normally closed). It is located on the right-hand side of the engine. It is installed on Genset and Stationary engines



Yes

Undo the connector on the oil pressure switch
SB= black BL-W= blue-white



Does the engine have a Volvo Penta instrument panel (Genset or Stationary engine series) ?

Yes

Genset and Stationary engines with Volvo Penta instrument panel

1. If there is a coolant level alarm - check the level. If the level is low, the alarm stops the engine.
2. Press the start button (green) briefly. The instruments are now activated and the charge warning lamp is lit. If there is a coolant level alarm: Press the interlock button (black) for 4 sec.
3. Bleed the fuel system as usual (see above)
4. Press the stop button (red)
5. Reinstate the connector
6. The engine is now able to be used.

No

No

Is there and "automatic stop for low oil pressure" with a third party oil pressure switch which is open when the engine is stationary? ("No" = Normally open)

Yes

Short circuit the oil pressure switch connector with a jumper.

No

Volvo Penta ignition lock or third party ignition lock

1. Turn the key switch to operate/ignition Pos. 1 (15+) on Volvo Penta switches
2. The solenoid valve is now activated for operation (not stop position)
3. Bleed the fuel system as usual (see above)
4. The engine is now able to be used

Lubrication system

The lubrication pump presses oil through the oil cooler and the two full-flow oil filters before it is lead out to all the lubrication points in the engine, via galleries and pipes.

The lubrication system includes four (1630/1631: five) valves:

1. A by-pass valve for the oil filters opens to ensure lubrication if the filters are blocked.
2. A by-pass opens if the pressure drop across the oil cooler is too high, for example during a cold start. When the valve opens, the oil is led past the oil cooler to reach the lubrication points in the engine faster.
3. A reduction valve opens when the oil pressure is too high and sends any excess oil back to the sump.
4. The piston cooling valve opens when engine speed has increased to just above idling speed, and the oil pressure has increased. This allows oil to flow to the piston cooling nozzles via a drilling in the engine block.
5. Only applies to 1630/1631. The safety valve opens when the pressure in the system is too high and leads oil to the suction side of the pump via a duct in the pump housing.

   Six nozzles are connected to the piston cooling gallery, one for each piston. Oil is sprayed from these nozzles to the underside of the piston crowns.

Oil filter

The oil filter is a full-flow filter, which means that oil passes the filter before it is directed to the oil ducts in the engine. The 6 and 7 litre engines have a single filter, the other engines have twin filters.

6, 7 and 16 litre engines have a by-pass filter in addition to the full flow filter (does not apply to the 6 litre engine with tubular oil cooler). Since only a small portion of the oil passes the by-pass filter, the flow rate is relatively low. This means, in its turn, that the filter can separate very small particles from the oil.

Oil cooler

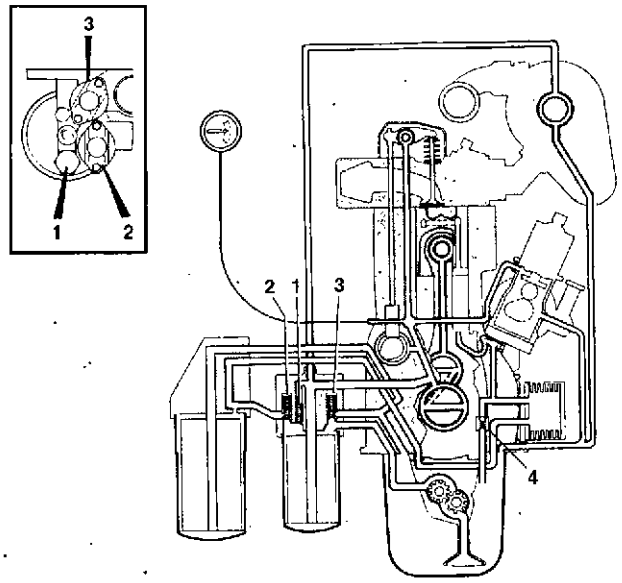
All engines except the TD 630 ME have a tubular oil cooler or flat plate oil cooler as standard equipment.

The oil cooler ensures that the temperature of the lubricating oil is kept at a relatively low value, which reduces wear and maintains the good properties of the oil.

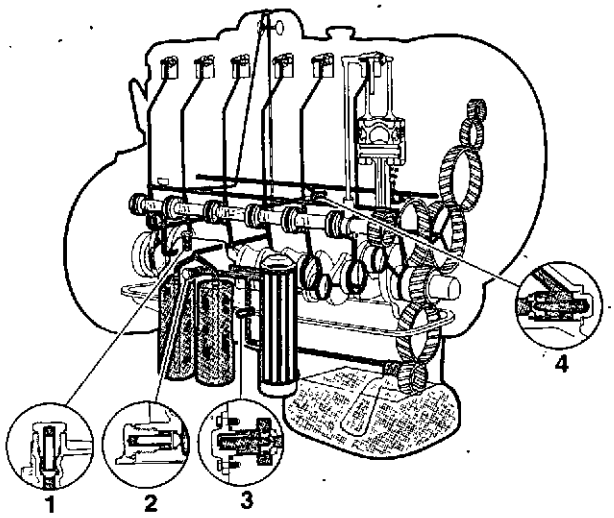
Piston cooling

The pistons are oil cooled to reduce the risk of carbon deposits during heavy loading. Piston cooling also increases the service life of the pistons, piston rings, cylinder linings and reduces oil consumption.

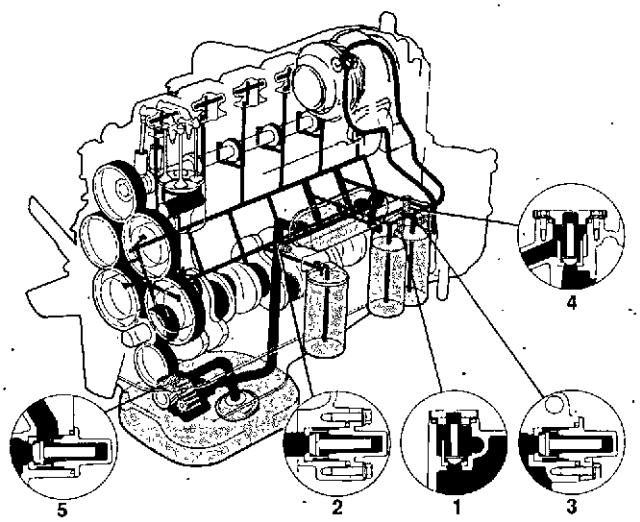
All engines except T(W)D 610 and TD 630 are equipped with piston cooling.



6-7 litre engines



10-12 litre engines



16 litre engines

Electrical system

Important notes about the electrical system

⚠ **Stop the engine and cut the current with the main switches before doing work on the electrical system.**

Main switch

Never break the circuit between the alternator and the batteries when the engine is running. In other words, the main switch must never be disconnected before the engine has stopped. If the circuit is broken while the engine is running, the voltage regulator can be destroyed and the alternator damaged.

Batteries

Never mix up the positive and negative poles of the battery when you install it. Wrong connection can cause serious damage to the electrical equipment. Compare with the wiring diagram. The battery poles must be carefully cleaned and the cable terminals must always be tight and greased with Vaseline to avoid open circuits.

Avoid quick charging the battery. If you have to quick charge the battery, remove the battery cables first.

NOTE! Observe applicable safety rules during battery charging. During charging, the cell plugs must be unscrewed but left in place in the plug holes. Ventilate well, especially if the batteries are charged in an enclosed space. Always cut the charge current **before** removing the battery charger clamps.

⚠ **WARNING!** The battery locker must never be exposed to open flames or sparks. Never smoke near batteries. When charged, batteries give off hydrogen, which forms an explosive mixture when mixed with air. This gas is very easy to ignite and very explosive.

Always use protective goggles when charging or handling batteries. Battery electrolyte contains strongly corrosive sulphuric acid. If it comes into contact with skin, rinse at once with a large amount of water and contact a doctor at once.

Checking batteries and terminals

The service life of batteries mainly depends on how they are looked after. Keep batteries clean and dry. Contamination on batteries can cause stray currents and discharge the batteries, especially in damp weather.

Clean the battery poles and terminals with a suitable wire brush. Poor contact can cause unnecessary voltage loss. Tighten the battery terminals well and spray the battery terminals and connections with rust preventer or coat them with Vaseline.

Check that the batteries are securely fastened.

Also check that all other electrical connections are free of oxide and that there are no loose connections. Spray these connections with water-repellent spray as necessary (Volvo Penta universal oil).

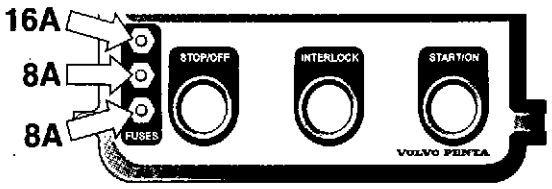
Fuses

The engines have three (1630: two) automatic fuses* located in the instrument panel. The fuses break the current on overload.

The fuses are re-set by pressing the button on each fuse.

Note. If a fuse trips frequently, there is a fault which will have to be attended to..

* 2 pcs (1630: 1 pc) 8 A for engine and instrument panel and 1 pc 16 A for extra equipment.



Automatic fuses

Starting with auxiliary batteries

⚠ **WARNING!**

Batteries (especially help batteries) contain flammable gas which is highly explosive. A spark, which could be formed if the batteries are wrongly connected, is enough to make the battery explode and cause damage.

1. Check that the batteries are connected (series or parallel) so that their rated voltage coincides with the engine system voltage.
2. First connect the red jumper cable (+) to the help battery and then to the flat battery. Then connect the black jumper cable (-) to the help battery, and lastly to a place **some distance away from the flat batteries**, e.g. by the negative side of the main switch or the negative connection of the start motor.
3. Start the engine. **NOTE! Do not move the connections during the start attempt (arcing) and do not stand leaning over any of the batteries.**
4. Remove the cables in the exact opposite order to installation. **NOTE! The ordinary cables for the standard battery must not be loosened under any circumstances.**

Electric welding

Remove the positive and negative cables from the batteries. Then remove all cables leading to the alternator.

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

After you have finished welding: Always re-connect the alternator cables **before** putting the battery cables back.

Stop solenoid

The stop solenoid is located behind the injection pump. When the stop solenoid is activated, the fuel rack in the injection pump is pulled to the "0" position and the engine stops since the fuel supply is cut.

The stop solenoid is constructed with a pull winding which pulls the plunger to the end stop, after which a latching winding takes over. A built-in time relay cuts out the pull winding after about 1 second.

NOTE! If the plunger does not stop in the end position, this is probably because the stop solenoid is wrongly adjusted. The plunger does not bottom since the control arm makes contact with its stop heel on the injection pump.

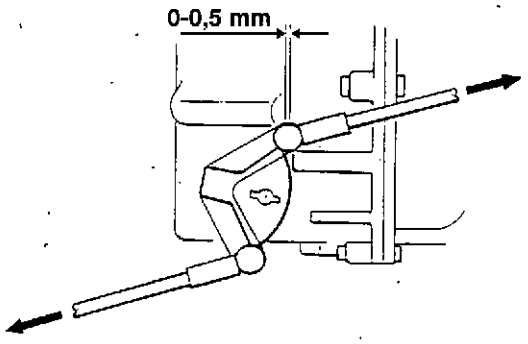
Adjustment

1. Release the screws which hold the stop solenoid, until the solenoid can be moved sideways.

2. Switch on the current and send an operation signal to the solenoid. Check that the solenoid stops at its end position.

Energized to run (E.T.R.)

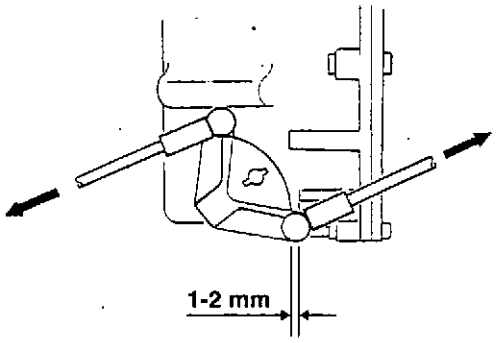
3.



Adjust the stop solenoid. When the solenoid has bottomed, the clearance between the control arm and its upper stop (full load stop) should be 0 - 0.5 mm (0 - 0.020"). Preferably adjust this with a feeler gauge. A small amount of clearance reduces the risk of oscillation. The solenoid must bottom first, however, to eliminate unwanted stoppages. This means that the control arm should just touch the upper stop, but must not press against the stop under any circumstances.

Energized to stop (E.T.S.)

3.



Adjust the stop solenoid. When the solenoid has bottomed, the clearance between the control arm and its stop heel should be 1-2 mm (0.040 - 0.080")

Common

4. Tighten the solenoid screws whilst it is carrying current and has bottomed.

Turn the current off. Check adjustment by applying current again. Re-adjust the pull rod if necessary.

NOTE! Since the stroke of the solenoid is limited to 25 mm (1"), either the solenoid or the lever will limit movement in the end position.

Fuel shut-off valve

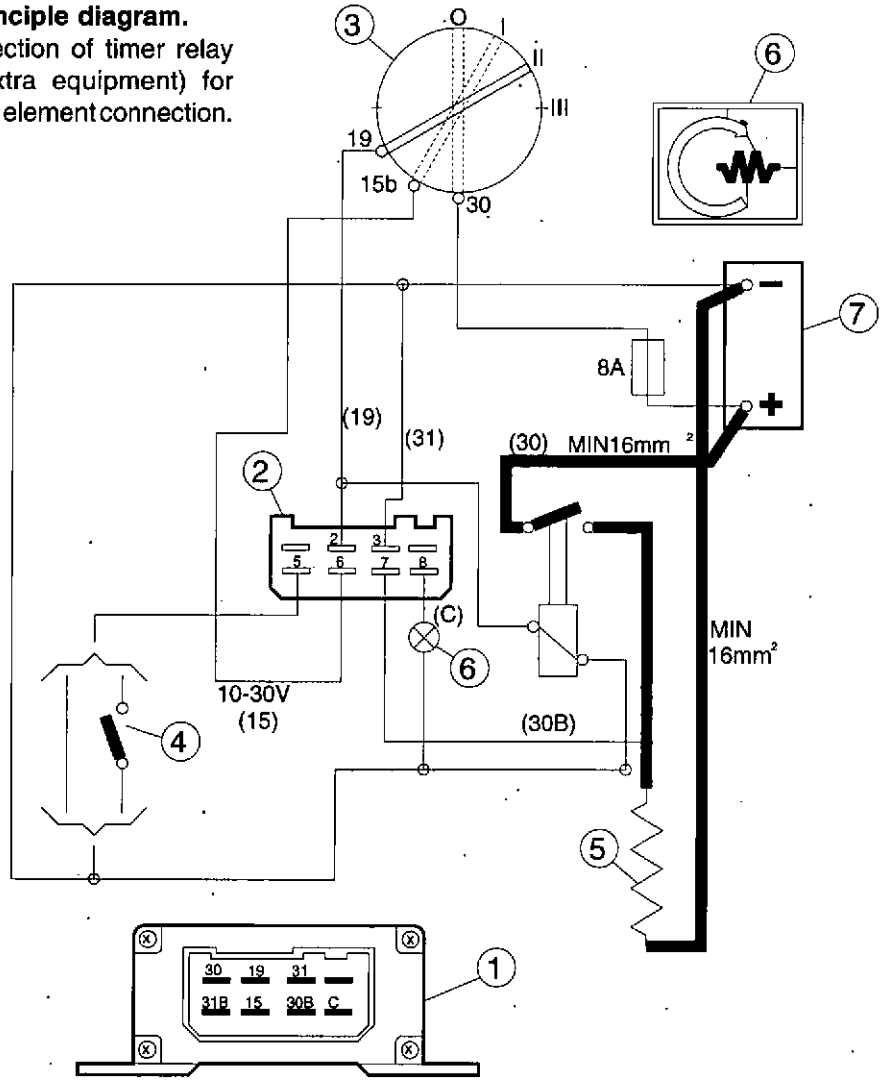
Most engines can be fitted with a fuel shut-off valve instead of the stop solenoid

The fuel valve controls the direction of fuel flow to and from the feed pump.

When the fuel shut-off valve is activated, the flow is reversed so that a vacuum is built up in the fuel chamber of the injection pump. This prevents the pump elements from being filled with fuel and the engine stops.

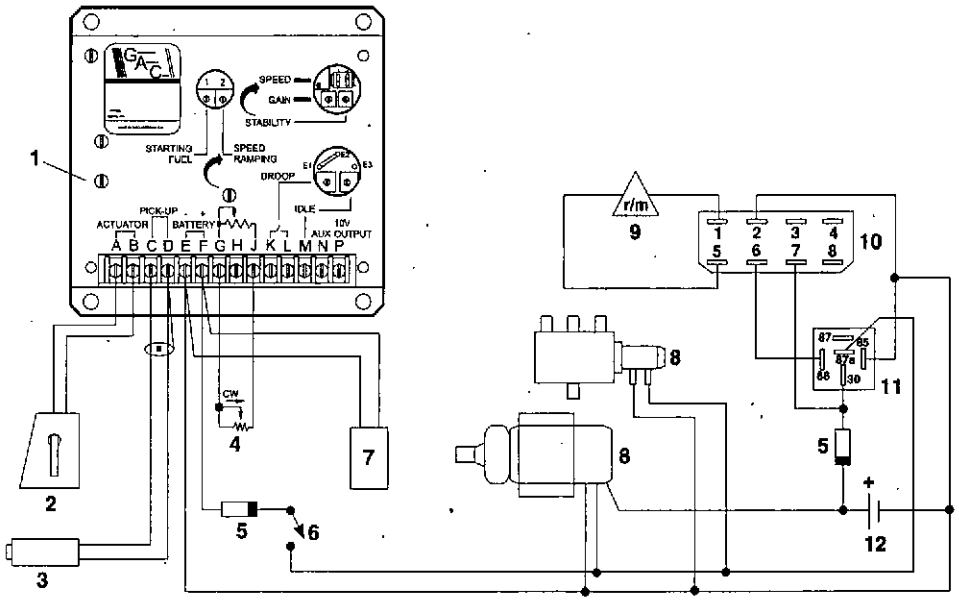
NOTE! Bleeding the fuel system on engines equipped with a fuel shut-off valve supplied **energized to run (E.T.R.)** requires a special procedure. Please refer to page 21.

1. Principle diagram.
Connection of timer relay kit (extra equipment) for starter element connection.



1. Timer relay
2. Connector. 8 pol.
3. Key switch
4. Temperature switch (extra equipment)
5. Starting element
6. Indication lamp (connected starter element)
7. Battery

2. Principle diagram.
Engine with electronic speed governor (GAC)

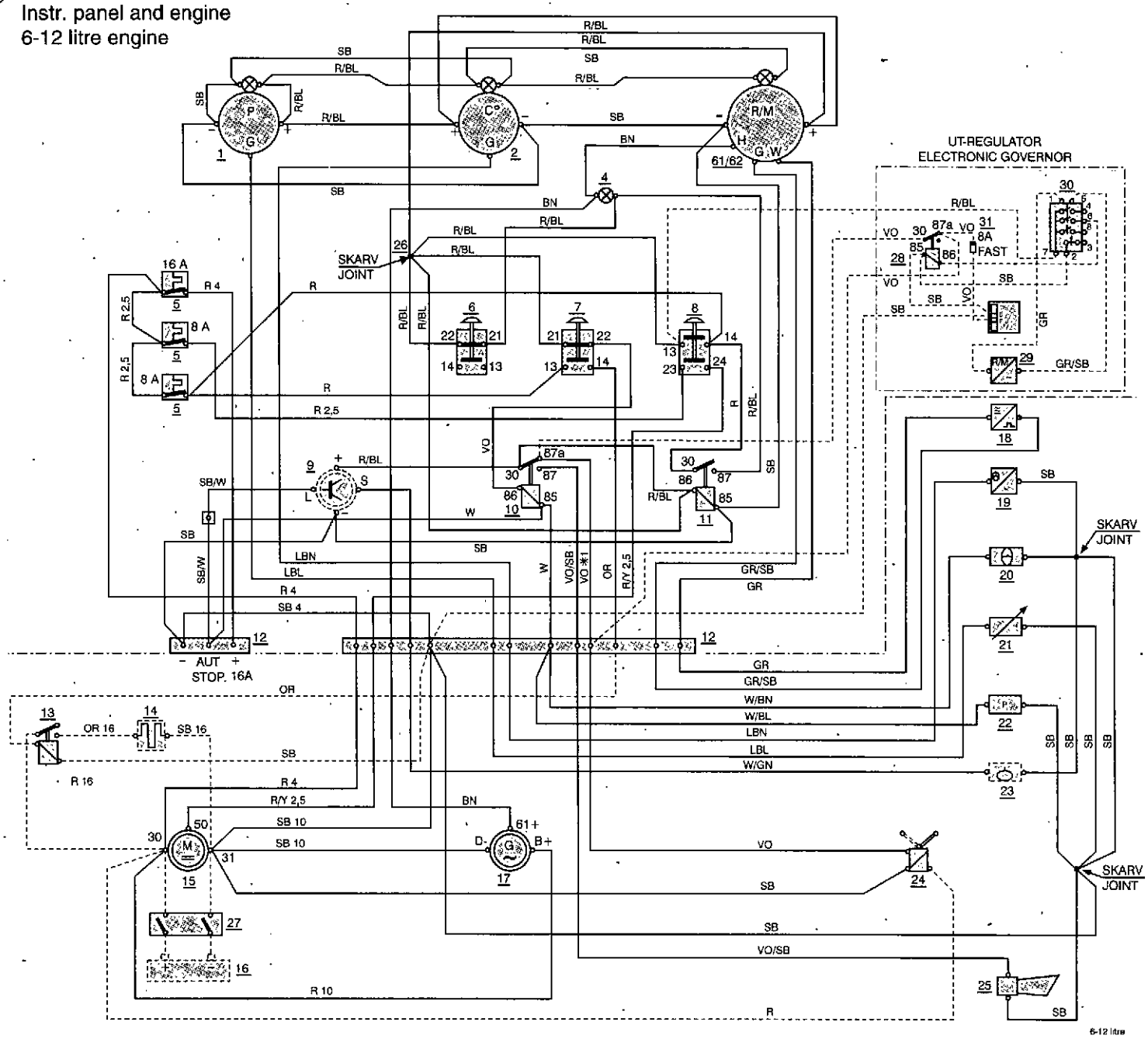


Stop solenoid / fuel shut-off valve connected live during operation

1. Control unit
2. Actuator
3. Speed sensor (Pickup)
4. Multi-turn potentiometer
5. Fuse (quick blow)
6. Main switch
7. Transient protection
8. Stop solenoid/ fuel valve
9. Sensor for engine overspeed protection
10. Overspeed relay
11. Relay
12. Battery

3. Principle diagram

Instr. panel and engine
6-12 litre engine



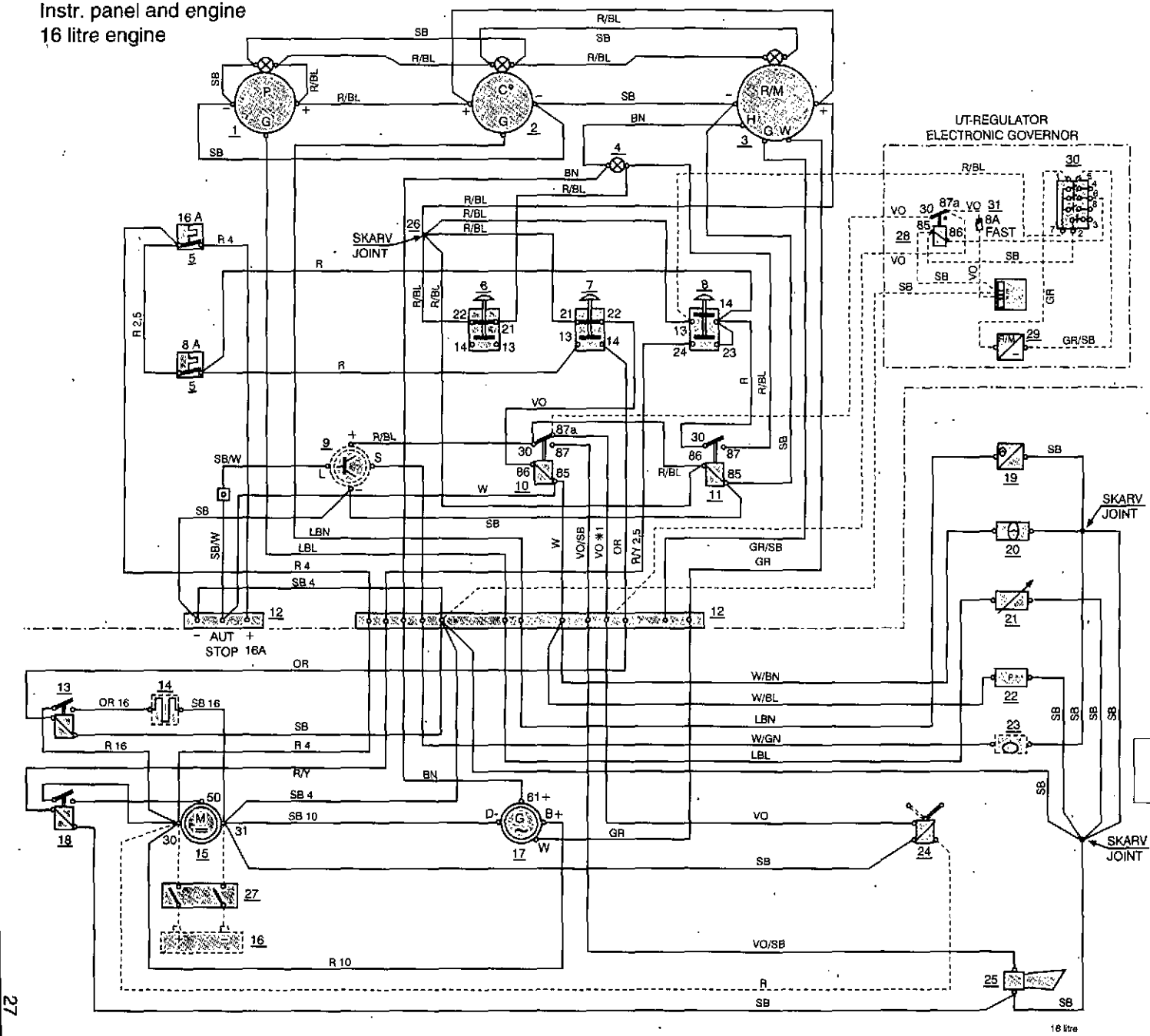
Position list for principle diagrams 3 and 4

1. Oil pressure gauge
2. Coolant temperature gauge
3. Tachometer with built-in hours counter
4. Warning lamp, charge
5. Automatic fuses (manual reset)
6. Stop button
7. Interlock button
8. Start button
9. Relay for coolant level switch (extra equipment)
10. Relay for coolant temperature switch, oil pressure switch
11. Holding current relay (control current and instruments)
12. Terminal (extra current outlet, fused for 16A, outlet for automatic stop, closes on error).
13. Relay for starter element
14. Starter element
15. Starter motor
16. Batteries
17. Alternator
18. Engine speed sensor
19. Coolant temperature sender
20. Coolant temperature monitor (normally open)
21. Oil pressure sender
22. Oil pressure switch (normally open)
23. Level switch, coolant (extra equipment)
24. Stop solenoid (energized to run)
25. Horn
26. Joint
27. Main switch
28. Engine speed sensor
29. Relay
30. Overspeed protection
31. Fuse

*1 Removed when GAC governor is installed

4. Principle diagram

Instr. panel and engine
16 litre engine



Cable areas in mm² (Specified after colour code in wiring diagram).
1,5 mm² is used unless otherwise noted.

Cable colour

BL	=	Blue	OR	=	Orange
LBL	=	Light blue	VO	=	Violet
BN	=	Brown	R	=	Red
LBN	=	Light brown	SB	=	Black
GN	=	Green	W	=	White
GR	=	Grey	Y	=	Yellow

Battery cable area related to battery location.

Distance from start motor - batteries:

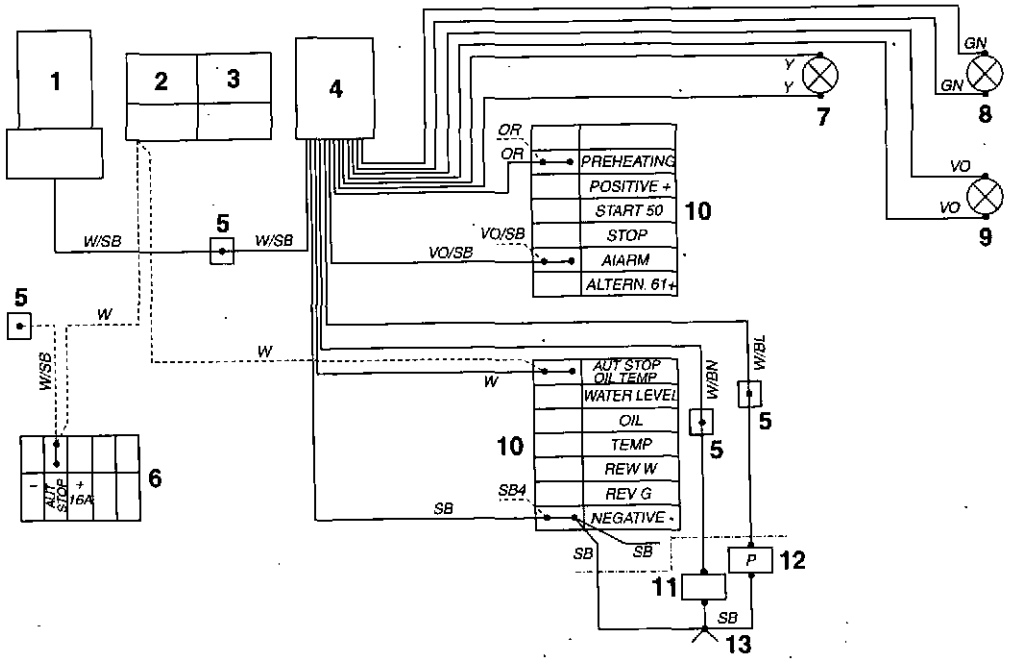
max. 2 m, area = 70 mm²
max. 4 m, area = 120 mm²

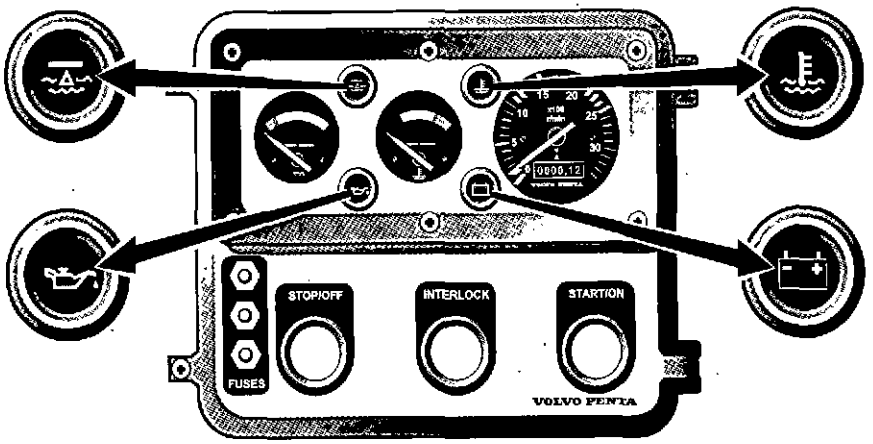
Relationship mm²/AWG*

* American Wiring Gauge

mm²	1,0	1,5	2,5	10	16
AWG	16 (17)	15 (16)	13	7	5

5. Principle diagram.
Connection of alarm separator (extra equipment)
to instrument panel





1. Relay for coolant level switch (extra equipment)
2. Relay for coolant temperature switch, oil pressure switch
3. Holding current relay (control current and instruments)
4. Alarm separator
5. Joining piece
6. Terminal (extra current outlet, fused for 16A. Outlet for automatic stop, closes on fault).
7. Warning lamp, high coolant temperature (extra equipment)
8. Warning lamp, low coolant level (extra equipment)
9. Warning lamp, low oil pressure (extra equipment)
10. Terminal for engine cables
11. Coolant temperature switch (normally open)
12. Oil pressure switch (normally open)
13. Joint

Dashed lines are existing cables

Maintenance

It is very important for reliable operation and long service life that the engine and its auxiliaries receive maintenance in accordance with the maintenance schedule. This gives advice about when and how maintenance should be done. Always use an authorised Volvo Penta workshop for the jobs you are not entirely sure about doing yourself.

Oil change intervals

Oil change intervals can vary from **600 to 50 hours** depending on oil grade and the sulphur content of the fuel. **Note that oil change intervals must never stretch over a longer period than 12 months.**

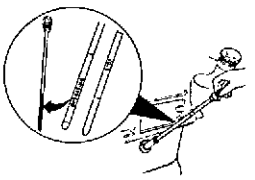
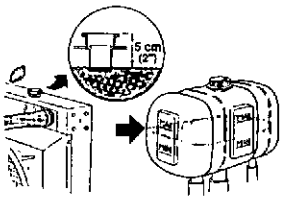
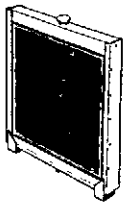
Note. If longer oil changes are required than those noted in the table below, the status of the oil must be checked by the oil manufacturer by doing regular oil analyses.

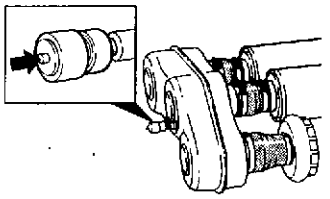
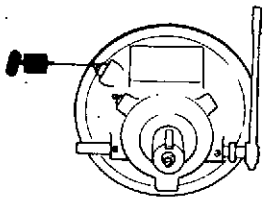
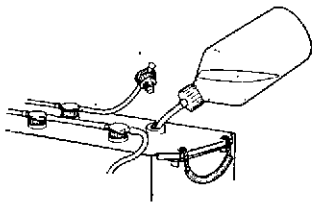
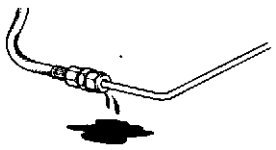
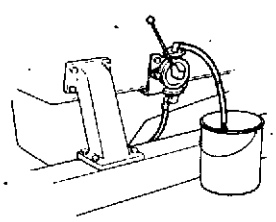
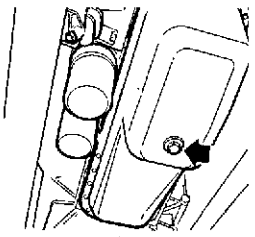
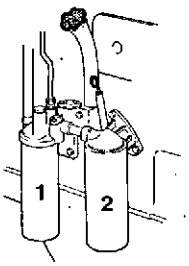
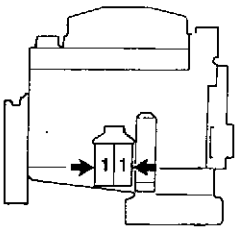
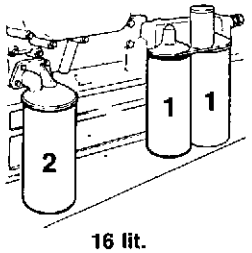
Oil grade	Fuel sulphur content by weight		
	up to 0,5 %	0,5 – 1,0 %	more than 1,0 %
	Oil change interval: First reached during operation		
VDS -2	12 months or **600** hours.	12 months or **300** hours.	12 months or **150** hours.
VDS	12 months or **400** hours.	12 months or **200** hours.	12 months or **100** hours.*
ACEA E3–96, E2–96 **API CD, CE, CF** **CF-4, CG-4**	12 month. or **200** hours.	12 month. or **100** hours.	12 month. or **50** hours.*

*Use oils grades with TBN 14 - 20 .

VDS = Volvo Drain Specification

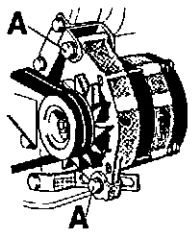
NOTE! If 6 and 7 litre engines are equipped with low-profile sumps, the oil change interval should be halved.
Mineral-based or fully synthetic oils can be used, on condition that they meet the above specifications

Hours	Action	
Daily before starting.	1. **Check the oil level in the engine.** Make sure that the level is between the MIN and MAX levels. On some engines, the level can be checked while the engine is running. You can then read the oil level with the dipstick on the side marked "OPERATING". **NOTE!** In continuous operation, the oil level should be checked every 8 hours. 2. **Check the coolant level.** The level should be 5 cm (2") below the sealing plane of the filler cap. On engines with a separate expansion tank, the level should be between the MIN and MAX markings. 3. **Check that the outsides of the radiator and intercooler (TAD) are not blocked.** Please refer to cleaning under item 13.	1.  2.  3. 

Hours	Action	
Daily before starting	**4. Check blockage in the air filter.** Check that the filters are not blocked. Change the filters when the indicator stays in the red field once the engine has been stopped. Re-set the indicator after a filter change by pressing in the red button. **NOTE!** Do not touch the filters until the indicator displays the red field. Scrap the old filters. No cleaning or re-use may be done. **NOTE!** In continuous operation, the filters should be checked every 8 hours. **Note!** For use in extremely dirty conditions (e.g. coal mines, stone crushers), a special air filter is required (not sold by Volvo Penta).	4. 
Every 50 hours	**5. Lubricate the clutch release bearing if there is a disconnection clutch** (applies to more than 15-20 declutchings per day. Otherwise, every 400 hours). Apply grease sparingly so that no grease is forced out. Use lithium-based grease, such as Mobilux EP2, Statoil Uniway EP2N, Texaco Multifac EP2, Q8 Rembrandt EP2.	5. 
	6. Check the batteries Battery level about 10 mm (3/8") above the cell plates. ⚠ **Warning!** Always use protective goggles when handling batteries. Batteries contain explosive gas and highly corrosive sulphuric acid. An open flame or spark near to the batteries can cause an explosion.	6. 
	7. Check that there is no leakage of coolant, oil or fuel.	7. 
Every 50 hours to every 600 hours. **(also see table on previous page)**	**8. Change the engine oil*** Drain the oil when the engine is hot. ⚠ **Warning!** Hot oil can cause burns.	8.  
	9. Change the oil filter (1) and by-pass filter (2). Remove the filters with special tools. Fill the new filters with engine oil, lubricate the gaskets and screw the filters on by hand. Then turn a further 3/4 turn once the gasket has made contact. Start and check that there is no oil leakage. Stop the engine and check the oil level. * Oil change intervals vary because of oil grade and the sulphur content of the fuel. Please refer to the table on the previous page.	9.  6, 7 lit.  10, 12 lit.  16 lit.

Hours	Action
Every 400 hours	**12. Check/tension the vee belts** Undo screws (A) before you tension the alternator drive belts. It should be possible to press the belts down 10 mm (3/8") between the pulleys. Worn belts which work in pairs must be changed together. The fan belts have an automatic belt tensioner. **13. Check that the radiator and intercooler (TAD) are not blocked externally** Undo the intercooler if very dirty. Remove the belt guard. Remove the charge air hoses from the intercooler. Undo the intercooler from the radiator and fold it backwards/upwards. Clean with water and a mild detergent. Be careful not to damage the radiator fins. Note. You must not use a high-pressure washer. Re-install the components. **14. Lubricate the friction clutch (if fitted)** Lubricate the inner support bearing (where there is a grease nipple), the main bearing, release bearing and the moving components of the release mechanism. Grease sparingly (20-30 g for the main bearing) Please refer to item 5 for grades. Put a few drops of oil on the inner link arms. **15. Check/adjust the friction clutch** ⚠ **Warning! Do this adjustment when the engine is stationary.** The engagement force at the end of the lever should be 34-41 kp (twin plate clutch) or 36-45 kp (triple plate clutch) at the point of engagement. Adjustment: Remove the inspection hatch. Undo the catch (A) and turn the red adjuster (B) clockwise. Lock the catch. The clutch disks must not slip after adjustment!
Every 800 hours	**16. Drain the sludge trap in the fuel tank when possible.** **17. Change the fuel filters** Remove the filters with special tools. Lubricate the gaskets and screw the new filters on by hand. Then give another 1/2 turn once the gaskets have made contact. Cleanliness! No dirt must get into the fuel system. Bleed the system, please refer to page 21. ⚠ The fuel filter should be changed when the engine is cold, to avoid the fire risk caused by spilled fuel on the exhaust manifold. **18. Check that the oil pipes to and from the turbocharger do not leak.** **19. Check that the air hoses and connections do not leak.** Check all air hoses for damage. Change if necessary. Re-tighten all clamps.

12.



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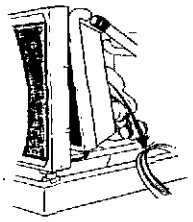

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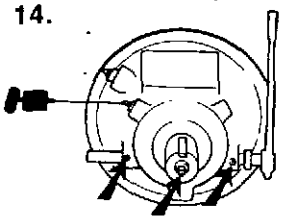

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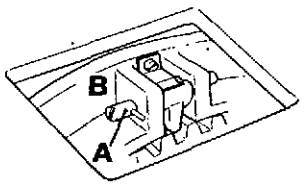

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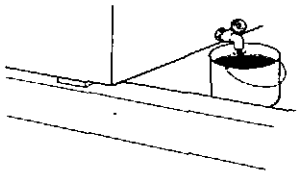

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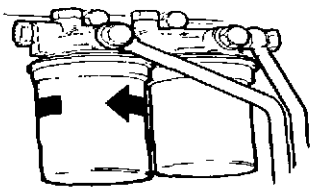

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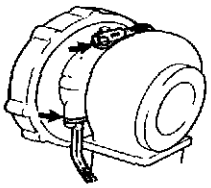

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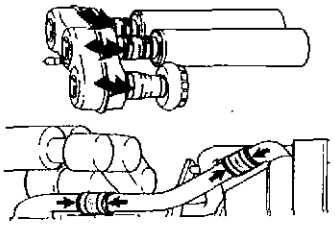
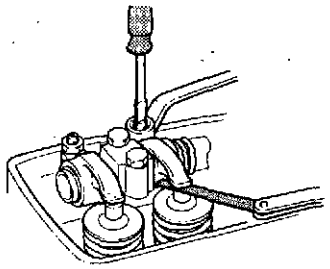


Hours	Action
Every 1200 hours	**20. Get an authorised workshop to check the valve clearance** Do the check with the engine stopped.
Every 2400 hours or as necessary	**21. Get an authorised workshop to check the injectors** Replace by adjusted injectors if necessary. Hand in the old injectors to an authorised workshop. Tightening torque: Injectors 50 Nm, supply pipes 15-20 Nm. **22. Get an authorised workshop to check the condition of the turbocharger and do a general check of the engine and its equipment.**
Every 6 months	**23. Change the coolant filter*** Shut the tap (position "A"). Remove the filter with special tools. Install a new filter (in the same way as for the oil filters, item 9). Open the tap (position "B") * But **not** when you change the coolant
Every 12 months	**24. Change the air filter on the air compressor, if fitted** Undo the hose clamp, remove the filter and scrap it. Install a new filter and tighten the clamp. **25. Clean the cooling system/change the coolant** (only engines **without** a coolant filter) Check that no leakage occurs. High coolant temperature can be caused by low coolant level, a faulty thermostat, faulty radiator fan, or blockage of the intercooler/ radiator or other sections of the cooling system. Please refer to page 9 for coolants.
Every 24 months	**26. Clean the cooling system/change the coolant** (only engines **with** a coolant filter) Check that no leakage occurs. High coolant temperature can be caused by low coolant level, a faulty thermostat, faulty radiator fan, or blockage of the intercooler/ radiator or other sections of the cooling system. Please refer to page 9 for coolants.

20.



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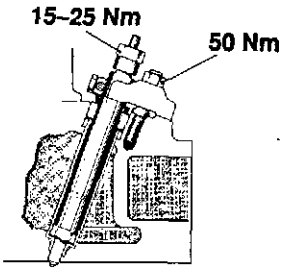

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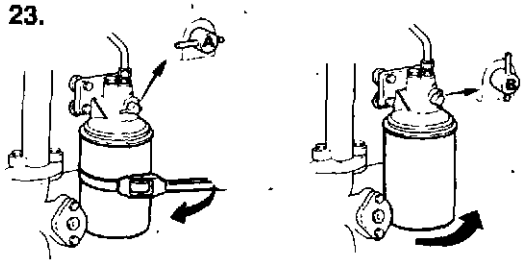

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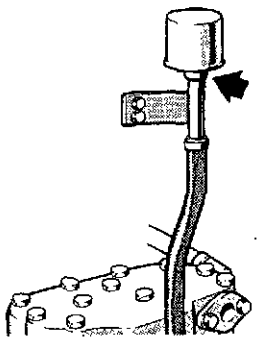


Trouble-shooting

1. Engine does not start

Starter motor does not turn engine over

CAUSE	REMEDY
• Flat batteries	Charge the batteries (help batteries can be connected as in the instruction on page 23)
• Main switches disconnected	Turn the main switches on
• One of the automatic fuses in the instrument panel has tripped	Re-set the fuse by pressing the button
• Poor contact/open circuit, electric wiring	Check for faulty contact/open circuits. Check that the contacts are not oxidised. Clean as necessary and spray connections with moisture-repellent spray. Please refer to the wiring diagram on pages 26-27.
• Faulty key switch/start button	Change key switch/start relay
• Faulty start relay	Change start relay
• Faulty starter motor/solenoid (control solenoid)	Contact authorised workshop personnel.
• Water entry in the combustion chambers	Contact authorised workshop personnel. Do not make any further starting attempts if you suspect water entry.

Starter motor rotates slowly

CAUSE	REMEDY
• Flat batteries	Charge the batteries (help batteries can be connected as in the instruction on page 23)
• Poor contact/open circuit in electric wiring	Check for faulty contact/open circuits. Check that the contacts are not oxidised. Clean as necessary and spray connections with moisture-repellent spray.

Starter motor rotates normally but the engine does not start

CAUSE	REMEDY
• Air in the fuel system	Bleed the fuel system as in the instructions on page 21.
• Fuel shortage	
- Fuel taps shut	Open the fuel taps
- fuel tank empty	Fill up with fuel
- blocked fuel filter (caused by contamination or paraffin deposits in the fuel at low temperature)	Install new fuel filters (pre-filter and/or fine filter). Bleed the fuel system as in the instructions on page 21.
• Stop solenoid incorrectly connected / binding	Check that the stop solenoid is in the operating position.
• Insufficient pre-heating	
- incorrect starting procedure	Do a new start attempt as in the instruction manual.
- starting heater is not connected	Check that none of the automatic fuses have tripped. Re-set the automatic fuses by pressing the button.
	Check the electric wiring and the interlock button,start relay and high-current relay. Check with the personnel at an authorised workshop to see if the starting heater needs to be changed.
• Blocked air inlet	Check the air supply to the engine room.

2. Engine starts but stops again/ uneven running

CAUSE	REMEDY
• Air in the fuel system	Bleed the fuel system as in the instructions on page 21
• Lack of fuel	
- fuel taps shut	Open the fuel taps
- fuel tank empty	Fill up with fuel
- blocked fuel filter (caused by contamination or paraffin deposits in the fuel at low temperature)	Install new fuel filters (pre-filter and/or fine filter). Bleed the fuel system as in the instructions on page 21.
• Stop solenoid incorrectly connected / binding	Check that the stop solenoid is in the operating position.
• Insufficient pre-heating	
- incorrect starting procedure	Do a new start attempt as in the instruction manual.
- starting heater is not connected	Check that none of the automatic fuses have tripped. Re-set the automatic fuses by pressing the button.
	Check the electric wiring and the interlock button, start relay and high-current relay. Check with the personnel at an authorised workshop to see if the starting heater needs to be changed.

• Not enough air supply to engine	
- blocked air filter	Install a new air filter, check the engine room ventilation
• Faulty injectors	Check / change injectors

3. Too high coolant temperature

CAUSE	REMEDY
• Too low coolant level in engine (air in the system)	Top up the coolant in the engine and bleed the system as advised on page 18
• Faulty thermostat	Install a new thermostat
• Blocked radiator and / or intercooler (TAD)	Clean as advised in the schedule on page. 31 item. 13
• Faulty circulation pump	Contact authorised workshop personnel.
• Faulty temperature gauge / temperature sensor	Check / change temperature gauge / temperature sensor
• Faulty injection timing	Check / change the injection timing. Contact authorised workshop personnel

4. Too low coolant temperature

CAUSE	REMEDY
• Faulty thermostat	Fit a new thermostat

5. Engine does not reach correct speed at wide open throttle

CAUSE	REMEDY
• Engine overloaded	Reduce load if possible
• Not enough fuel supply	
- Blocked fuel filter (caused by contamination or paraffin deposits in the fuel at low temperatures)	Install a new fuel filter (pre-filter and/or fine filter). Bleed the system as in the instructions on page 21
• Water in the fuel	Clean the fuel tank. Drain any water in the pre-filter
• Not enough air supply to the engine	
- blocked air filter	Install a new air filter
- air leakage between turbo and engine inlet manifold	Check the rubber hose between the turbo and the connection pipe, and other connections. Re-tighten all hose clamps.
- faulty turbocharger	Contact authorised workshop personnel
- poor engine room ventilation	Check that the engine room ventilation ducts are not blocked.
• Accelerator linkage incorrectly adjusted	Adjust the accelerator linkage.

• *High back pressure in exhaust system*	*Check that there are no restrictions in the exhaust pipe.*
• Incorrect adjustment of injection pump	Contact authorised workshop personnel.
• Fault in smoke limiter	
- smoke limiter binds	Contact authorised workshop personnel.
- Pressure pipe between inlet manifold and smoke limiter leaks	Install a new pressure pipe.
- faulty diaphragm in smoke limiter	Contact authorised workshop personnel.
- incorrect setting	Contact authorised workshop personnel.
• Stop control position	Check that the stop control is in full operating position

6. Engine does not stop

CAUSE	REMEDY
• One of the automatic fuses in the instrument panel has tripped	Reset the fuse by pressing the button.
• Poor contact / open circuit in electric wiring (loose connections, oxidation)	Attend to any open circuits / loose connections. Check that the connections are not oxidised. Clean as necessary and spray with water-repellent spray. Please refer to the wiring diagram on pages 26-27.
• Faulty stop button	Change stop button
• Faulty stop solenoid / fuel shut-off valve	Contact authorised workshop personnel.

Technical data

Genset Engines

General

	TD610G	TWD610G	TD710G
Type designation			
No. of cylinders	6	6	6
Displacement	5.48 litre	5.48 litre	6.73 litre
Low idling, app.	1300 ± 50 r/min	1300 ± 50 r/min	1300 ± 50 r/min
Valve clearance mm, engine cold or hot			
inlet	0.40 mm	0.40 mm	0.40 mm
outlet	0.55 mm	0.55 mm	0.55 mm
Weight, only engine (dry) app.	655 kg	655 kg	785 kg

Fuel system

Injection pump, setting	23° BTDC	16° BTDC	20° BTDC
prelift	2.95 (±0.05) mm	2.95 (±0.05) mm	2.65 (±0.05) mm
Injectors, opening pressure	25.0 MPa	25.0 (+0.8) MPa	25.0 (+0.8) MPa
setting pressure (new spring)	25.5 (+0.8) MPa	25.5 (+0.8) MPa	25.5 (+0.8) MPa
No. of holes/hole diameter	4 pcs/0.38 mm	4 pcs/0.34 mm	4 pcs/0.38 mm

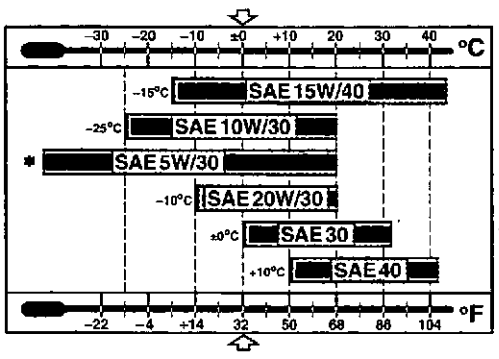
Cooling system

Cooling system volume incl. VP standard radiator etc.	36 litre	37 litre	39 litre
Thermostats, quantity	1 pc	1 pc	1 pc
starts to open at	75°C	75°C	75°C
fully open at	88°C	88°C	88°C

Lubrication system

Oil pressure, hot engine at operating speed	300-500 kPa	300-500 kPa	300-500 kPa
at idle	min 150 kPa	min 150 kPa	min 150 kPa
Oil change volume, app.:			
without oil filter	20 litre	20 litre	24 litre
with oil filter	22 litre	22 litre	29 litre
volume difference, min-max	6 litre	6 litre	7 litre
Oil grade	Please refer to "Maintenance"		

Viscosity at various ambient temperatures
(Temperature values refer to steady ambient temperatures)



* Refers to synthetic or semi-synthetic oils
NOTE! **Only** SAE 5W/30 may be used

Electrical system

System voltage	24 V
Alternator, voltage/max current rating	28 V/60 A
power app.	1700 W
Battery capacity, 2 in series 12 V	max 143 Ah
Battery electrolyte density at 25°	
fully charged battery	1.28 g/cm³ (1.24 g/cm³)*
re-charge battery at	1.24 g/cm³ (1.20 g/cm³)*

***Note.** Applies to batteries with tropical acid

General

	TWD710G	TAD730G	TD1010G
Type designation			
No. of cylinders	6	6	6
Displacement	6.73 litre	6.73 litre	9.60 litre
Low idling, app.	1300 ± 50 r/min	1300 ± 50 r/min	1300 ± 50 r/min
Valve clearance mm, engine cold or hot			
inlet	0.40 mm	0.40 mm	0.40 mm
outlet	0.55 mm	0.55 mm	0.70 mm
Weight, only engine (dry) app.	795 kg	901 kg	990 kg

Fuel system

Injection pump, setting, 1500 r/min	17° BTDC (10°)*	11° BTDC	24° BTDC
1800 r/min			
prelift	2.65 (±0.05) mm	3.55 (±0.05) mm	2.65 (±0.05) mm
Injectors, opening pressure	25.0 (+0.8) MPa	30.0 (+0.8) MPa	25.5 MPa
setting pressure (new spring)	25.5 (+0.8) MPa	30.5 (+0.8) MPa	26.0 MPa
No. of holes/hole diameter	4 pcs/0.38 mm	5 pcs/0.32 mm	4 pcs/0.38 mm

* TA-luft rating

Cooling system

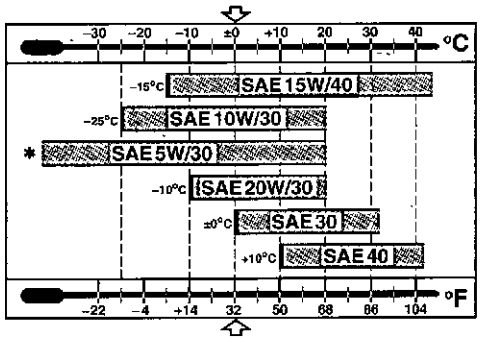
Cooling system volume incl. VP standard radiator etc.	42 litre	37 litre	42 litre
Thermostats, quantity	1 pc	1 pc	1 pc
starts to open at	*75°C*	*75°C*	*75°C*
fully open at	88°C	88°C	88°C

Lubrication system

Oil pressure, hot engine at operating speed	300-500 kPa	300-500 kPa	300-500 kPa
at idle	min 150 kPa	min 150 kPa	min 150 kPa
Oil change volume, app.:			
without oil filter	24 litre	24 litre	21 litre
with oil filter	29 litre	29 litre	25 litre
volume difference, min-max	7 litre	8 litre	9 litre

Oil grade ..... Please refer to "Maintenance"

Viscosity at various ambient temperatures .....
(Temperature values refer to steady ambient temperatures)



* Refers to synthetic or semi-synthetic oils
NOTE! **Only** SAE 5W/30 may be used

Electrical system

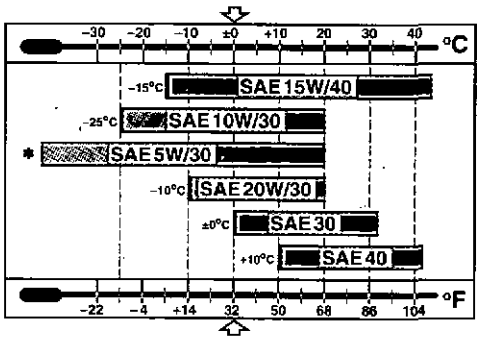
System voltage	24V	24V	24V
Alternator, voltage/max current rating	28V/60A	28V/60A	28V/60A
power app.	1700W	1700W	1700W
Battery capacity, 2 in series12V	max 143Ah	143Ah	143Ah
Battery electrolyte density at 25°			
fully charged battery		1.28g/cm³ (1.24g/cm³)*	
re-charge battery at		1.24g/cm³ (1.20g/cm³)*	

***Note.** Applies to batteries with tropical acid

TWD1010G	TAD1030GE	TD1210G	TWD1210G
6	6	6	6
9.60 litre	9.60 litre	11.98 litre	11.98 litre
1300 ± 50 r/min	1300 ± 50 r/min	1300 ± 50 r/min	1300 ± 50 r/min
0.40 mm	0.40 mm	0.40 mm	0.40 mm
0.70 mm	0.70 mm	0.70 mm	0.70 mm
901kg	1107 kg	1110 kg	1140 kg
22° BTDC	12° BTDC 15° BTDC	24° BTDC	20° BTDC (17°)*
2.65 (±0.05) mm	3.45 (±0.05) mm	2.65 (±0.05) mm	3.55(±0.05) mm
25.5 MPa	27.5 MPa	26.5 MPa	27.0 (+0.8) MPa
26.0 MPa	28.0 MPa	27.0 MPa	27.5 (+0.8) MPa
4 pcs/0.38 mm	5 pcs/0.30 mm	5 pcs/0.36 mm	5 pcs/0.38 mm
46 litre	38 litre	49 litre	52 litre
1 pc	1 pc	1 pc	1 pc
75°C	82°C	75°C	75°C
88°C	95°C	88°C	88°C
300-500 kPa	300-500 kPa	300-500 kPa	300-500 kPa
min 150 kPa	min 150 kPa	min 150 kPa	min 150 kPa
21 litre	32 litre	34 litre	34 litre
25 litre	36 litre	38 litre	38 litre
9 litre	10 litre	9 litre	9 litre

Please refer to "Maintenance"

*Refers to synthetic or semi-synthetic oils
NOTE! **Only** SAE 5W/30 may be used



24 V	24 V	24 V	24 V
28 V/60 A	28 V/ 60 A	28 V/60 A	28 V/60 A
1700 W	1700 W	1700 W	1700 W
max. 143 Ah	max. 143 Ah	max. 152 Ah	max. 152 Ah

1.28 g/cm3 (1.24 g/cm3) *
1.24 g/cm3 (1.20 g/cm3) *
***Note.** Applies to batteries with tropical acid

General

	TWD1211G	TAD1230G	TAD1231/32GE
Type designation	6	6	6
No. of cylinders	11.98 litre	11.98 litre	11.98 litre
Displacement	1300 ± 50 r/min	1300 ± 50 r/min	1300 ± 50 r/min
Low idling, app.			
Valve clearance mm, engine cold or hot			
inlet	0.40 mm	0.40 mm	0.40 mm
outlet	0.70 mm	0.70 mm	0.70 mm
Weight, only engine (dry) app.	1140 kg	1250 kg	1250 kg

Fuel system

Injection pump, setting, 1500 r/min	22° BTDC	14.5° BTDC	12° BTDC
1800 r/min	22° BTDC	14.5° BTDC	15° BTDC
prelift	3.55 (±0.05) mm	4.05 (±0.05) mm	4.05 (±0.05) mm
Injectors, opening pressure	27.0 MPa	25.5 MPa	25.5 MPa
setting pressure (new spring)	27.5 (+0.8) MPa	26.0 (+0.2) MPa	26.0 (+0.2) MPa
No. of holes/hole diameter	5 pcs/0.38 mm	5 pcs/0.38 mm	6 pcs/0.34 mm

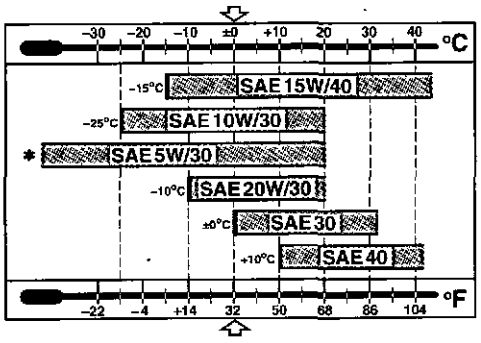
Cooling system

Cooling system volume incl: VP standard radiator etc	59 litre	48 litre	48 litre
Thermostats, quantity	1 pc	1 pc	1 pc
starts to open at	75°C	82°C	82°C
fully open at	88°C	95°C	95°C

Lubrication system

Oil pressure, hot engine at operating speed	300-500 kPa	300-500 kPa	300-500 kPa
at idle	min 150 kPa	min 150 kPa	min 150 kPa
Oil change volume, app.:			
without oil filter	34 litre	34 litre	34 litre
with oil filter	38 litre	38 litre	38 litre
volume difference, min-max	9 litre	9 litre	9 litre
Oil grade	Please refer to "Maintenance"		

Viscosity at various ambient temperatures
(Temperature values refer to steady ambient temperatures)



* Refers to synthetic or semi-synthetic oils
NOTE! **Only** SAE 5W/30 may be used

Electrical system

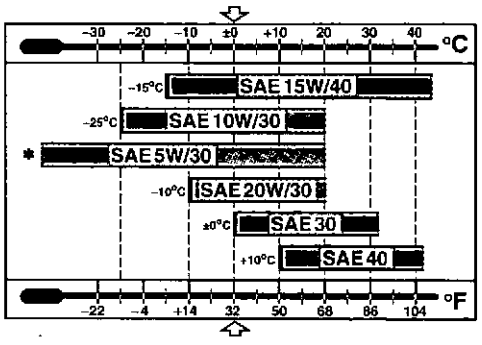
System voltage	24 V
Alternator, voltage/max current	28 V/60 A
power app.	1700 W
Battery capacity, 2 in series 12V	max. 152 Ah
Battery electrolyte density at 25°C	
fully charged battery	1.28 g/cm³ (1.24 g/cm³) *
re-charge battery at	1.24 g/cm³ (1.20 g/cm³) *

***Note.** Applies to batteries with tropical acid

TWD1630G	TWD1630GE	TAD1630GE	TAD1631GE
6	6	6	6
16.12 litre	16.12 litre	16.12 litre	16.12 litre
1300 ± 50 r/min	1300 ± 50 r/min	1300 ± 50 r/min	1300 ± 50 r/min
0.30 mm	0.30 mm	0.30 mm	0.30 mm
0.60 mm	0.60 mm	0.60 mm	0.60 mm
1428 kg	1428 kg	1538 kg	1538 kg
21° BTDC	18° BTDC	18° BTDC	17° BTDC
25° BTDC	20° BTDC	21° BTDC	21° BTDC
3.65 (±0.05) mm	3.65 (±0.05) mm	4.55 (±0.05) mm	4.55 (±0.05) mm
26.0 MPa	26.0 MPa	26.0 MPa	28.5 MPa
26.5 (+0.2) MPa	26.5 (+0.2) MPa	26.5 (+0.2) MPa	29.0 (+0.2) MPa
7 pcs/0.31 mm	7 pcs/0.31 mm	7 pcs/0.31 mm	7 pcs/0.35 mm
67 litre	67 litre	60 litre	64 litre
2 pcs	2 pcs	2 pcs	2 pcs
75°C	75°C	82°C	82°C
88°C	88°C	95°C	95°C
300-500 kPa	300-500 kPa	300-500 kPa	300-500 kPa
min 150 kPa	min 150 kPa	min 150 kPa	min 150 kPa
57 litre	57 litre	57 litre	57 litre
64 litre	64 litre	64 litre	64 litre
17 litre	17 litre	17 litre	17 litre

Please refer to "Maintenance".

*Refers to synthetic or semi-synthetic oils
NOTE! **Only** SAE 5W/30 may be used



24 V	24 V	24 V	24 V
28 V/ 60 A	28 V/ 60 A	28 V/ 60 A	28 V/ 60 A
1700 W	1700 W	1700 W	1700 W
max. 176 Ah	max. 176 Ah	max. 176 Ah	max.176Ah

1.28 g/cm3 (1.24 g/cm3) *
1.24 g/cm3 (1.20 g/cm3) *
* **Note.** Applies to batteries with tropical acid

Technical data

Industrial Engines

General

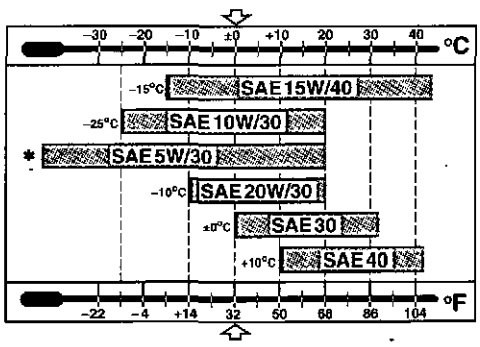
	TD610V	TWD610V	TD630VE
Type designation			
No. of cylinders	6	6	6
Displacement	5,48 litre	5,48 litre	5,48 litre
Low idling, app.	640 ± 25 r/min	600 ± 25 r/min	700 ± 25 r/min
Valve clearance mm, engine cold or hot			
inlet	0,40 mm	0,40 mm	0,40 mm
outlet	0,55 mm	0,55 mm	0,55 mm
Weight, only engine (dry) app.	655 kg	665 kg	655 kg

Lubrication system

Oil pressure, hot engine at operating speed	300-500 kPa	300-500 kPa	300-500 kPa
	min 120 kPa	min 150 kPa	min 120 kPa
Oil change volume, app.:			
Standard sump,			
without oil filter	20 litre	20 litre	20 litre
with oil filter	24 litre	22 litre	24 litre
volume difference, min-max	6 litre	6 litre	6 litre
Shallow sump (10°),			
without sump	12 litre	-	12 litre
with sump	16 litre		16 litre
volume difference,min-max	5 litre	-	5 litre
Shallow sump for large inclinations,			
without oil filter	15 litre	-	15 litre
med oljrfilter	19 litre	-	19 litre
volume difference, min-max	3 litre	-	3 litre
Deep sump for large inclinations,			
without oil filter	18 litre	-	18 litre
with oil filter	22 litre	-	22 litre
volume difference, min-max	6 litre	-	6 litre
Vehicle-type sump,			
without oil filter	-	-	-
with oil filter	-	-	-
volume difference, min-max	-	-	-
Laminated sump (sound damping),			
without oil filter	-	-	20 litre
with oil filter	-	-	24 litre
volume difference, min-max	-	-	6 litre

Oil grade ..... Please refer to "Maintenance"

Viscosity at various ambient temperatures .....
(Temperature values refer to steady ambient temperatures)



* Refers to synthetic or semi-synthetic oils.
NOTE! **Only** SAE 5W/30 may be used .....

	TD610V	TWD610V	TD630VE
Fuel system			
Injection pump, setting	25° (±0.5) BTDC	16° (±0.5) BTDC	12°(±0.5) BTDC
prelift	2.95 (±0.05) mm	2.95 (±0.05) mm	2.95 (±0.05) mm
Injectors, opening pressure	25.0 MPa	25.0 (+0.8) MPa	25.0 MPa
setting pressure (new spring)	25.5 (+0.8) MPa	25.5 (+0.8) MPa	26.0 (+0.8) MPa
No. of holes/hole diameter	4 pcs/0.32 mm	4 pcs/0.34 mm	6 pcs/0.228 mm
Cooling system			
Cooling system volume incl. VP standard radiator etc	22 litre	31 litre	22 litre
Thermostats,quantity	1 pc	1 pc	1 pc
starts to open at	75°C	75°C	75°C
fully open at	88°C	88°C	88°C
Electrical system			
System voltage	24 V	24V	24 V
Alternator,(alt.1)			
voltage / max current rating	28 V / 55 A	-	28 V / 55 A
power app.	1550 W	-	1550 W
Alternator (alt 2),			
voltage / max current rating	28 V / 60 A	28 V / 60 A	28 V / 60 A
power app.	1700 W	1700 W	1700 W
Alternator (alt 3)			
voltage / max current rating	28 V / 80A	-	28 V / 80 A
power app.	2240 W	-	2240 W
System voltage	12 V	12 V	12 V
Alternator,(alt.1)			
voltage / max current rating	14 V / 60 A	-	14 V / 60 A
power app.	840 W	-	840 W
Alternator (alt 2),			
voltage / max current rating	14 V / 90 A	14 V / 90 A	14 V / 90 A
power app.	1260 W	1260 W	1260 W
Battery capacity,			
for 24 V Electrical system			
2 pcs series connected 12 V	max. 135 Ah	max 135 Ah	max. 135 Ah
for 12 V Electrical system			
2 pcs paralell connected	max. 110 Ah	max. 110 Ah	max. 110 Ah
Battery electrolyte density at 25°			
fully charged battery		1.28g/cm³ (1.24g/cm³)*	
re-charge battery at		1.24g/cm³ (1.20g/cm³)*	

***Note.** Applies to batteries with tropical acid

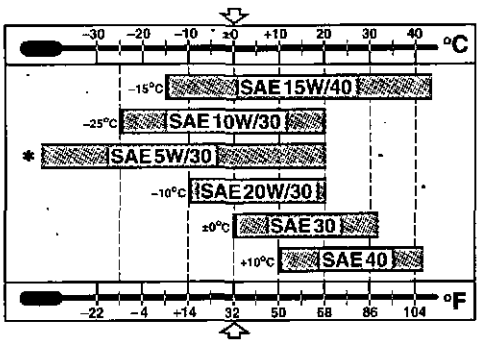
General

	TWD630VE	TD71A	TID71A
Type designation			
No. of cylinders	6	6	6
Displacement	5,48 litre	6,73 litre	6,73 litre
Low idling, app.	725 ± 25 r/min	600 ± 25 r/min	600 ± 25 r/min
Valve clearance mm, engine cold or hot			
inlet	0,40 mm	0,40 mm	0,40 mm
outlet	0,55 mm	0,55 mm	0,55 mm
Weight, only engine (dry) app.	665 kg	760 kg	770 kg

Lubrication system

Oil pressure, hot engine at operating speed	300-500 kPa	300-500 kPa	300-500 kPa
at idle	min 120 kPa	min 150 kPa	min 150 kPa
Oil change volume, app.:			
Standard sump,			
without oil filter	20 litre	24 litre	24 litre
with oil filter	24 litre	29 litre	29 litre
volume difference, min-max	6 litre	8 litre	8 litre
Shallow sump (10°),			
without sump	12 litre	14 litre	14 litre
with sump	16 litre	19 litre	19 litre
volume difference,min-max	5 litre	7 litre	7 litre
Shallow sump for large inclinations,			
without oil filter	15 litre	19 litre	19 litre
with oil filter	19 litre	24 litre	24 litre
volume difference, min-max	3 litre	3 litre	3 litre
Deep sump for large inclinations,			
without oil filter	18 litre	-	-
with oil filter	22 litre	-	-
volume difference, min-max	6 litre	-	-
Vehicle-type sump,			
without oil filter	-	22 litre	22 litre
with oil filter	-	27 litre	27 litre
volume difference, min-max	-	7 litre	7 litre
Laminated sump (sound damping),			
without oil filter	20 litre	-	-
with oil filter	24 litre	-	-
volume difference, min-max	6 litre	-	-
Oil grade	Please refer to "Maintenance"		

Viscosity at various ambient temperatures
(Temperature values refer to steady ambient temperatures)



* Refers to synthetic or semi-synthetic oils
NOTE! **Only** SAE 5W/30 may be used

Fuel system

	TWD630VE	TD71A	TID71A
Injection pump, setting	13.5° (±0.5) BTDC	20° (±0.5) BTDC	18°(±0.5)BTDC
prelift	2.45 (±0.05) mm	3.05 (±0.05) mm	3.05 (±0.05) mm
Injectors, opening pressure	25.0 MPa	25.0 MPa	25.0 MPa
setting pressure (new spring)	26.0 (+0.8) MPa	25.5 (+0.8) MPa	25.5 (+0.8) MPa
No. of holes/hole diameter	6st/0.226 mm	4st 0.34 mm	4st 0.38 mm

Cooling system

Cooling system volume incl. VP standard radiator etc.	22 litre	25 litre	26 litre
Thermostats, quantity	1 pc	1 pc	1 pc
starts to open at	75°C	75°C	75°C
fully open at	88°C	88°C	88°C

Electrical system

System voltage	24 V	24V	24 V
Alternator, (alt.1)			
voltage / max current rating	28 V / 55 A	28 V / 55 A	28 V / 55 A
power app.	1550 W	1550 W	1550 W
Alternator (alt 2),			
voltage / max current rating	28 V / 60 A	28 V / 60 A	28 V / 60 A
power app.	1700 W	1700 W	1700 W
Alternator (alt 3)			
voltage / max current rating	28 V / 80 A	28 V / 80 A	28 V / 80 A
power app.	2240 W	2240 W	2240 W
System voltage	12 V	12 V	12 V
Alternator, (alt.1)			
voltage / max current rating	14 V / 60 A	-	-
power app.	840 W	-	-
Alternator (alt 2),			
voltage / max current rating	-	14 V / 90 A	14 V / 90 A
power app.	-	1260 W	1260 W
Battery capacity,			
vid 24 V Electrical system			
2 pcs series connected12 V	max. 135 Ah	max 135Ah	max. 135 Ah
vid 12 V Electrical system			
2 pcs paralell connected	max. 110 Ah	max. 110 Ah	max. 110 Ah
Battery electrolyte density at 25°:			
fully charged battery		1.28 g/cm³ (1.24 g/cm³)*	
re-charge battery at		1.24 g/cm³ (1.20 g/cm³)*	

***Note.** Applies to batteries with tropical acid

General

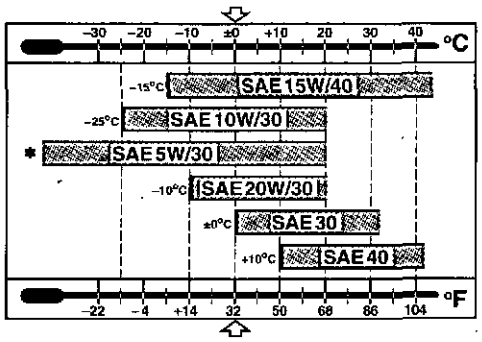
	TWD710V	TD730VE	TWD731VE
Type designation			
No. of cylinders	6	6	6
Displacement	6.73 litre	6.73 litre	6.73 litre
Low idling, app.	600 ± 25 r/min	650 ± 25 r/min	650 ± 25 r/min
Valve clearance mm, engine cold or hot			
inlet	0.40 mm	0.40 mm	0.40 mm
outlet	0.55 mm	0.55 mm	0.55 mm
Weight, only engine (dry) app.	770 kg	760 kg	770 kg

Lubrication system

Oil pressure, hot engine at operating speed	300-500 kPa	250-550 kPa	250-550 kPa
at idle	min 150 kPa	min 150 kPa	min 150 kPa
Oil change volume, app.:			
Standard sump,			
without oil filter	22 litre	24 litre	24 litre
with oil filter	27 litre	29 litre	29 litre
volume difference, min-max	7 litre	8 litre	8 litre
Shallow sump (10°),			
without sump	-	14 litre	14 litre
with sump	-	19 litre	19 litre
volume difference,min-max	-	7 litre	7 litre
Shallow sump for large inclinations,			
without oil filter	-	19 litre	19 litre
with oil filter	-	24 litre	24 litre
volume difference, min-max	-	3 litre	3 litre
Deep sump for large inclinations,			
without oil filter	-	-	-
with oil filter		-	-
volume difference, min-max		-	-
Vehicle-type sump,			
without oil filter	-	22 litre	22 litre
with oil filter	-	27 litre	27 litre
volume difference, min-max	-	7 litre	7 litre
Laminated sump (sound damping),			
without oil filter	-	22 litre	22 litre
with oil filter	-	27 litre	27 litre
volume difference, min-max	-	7 litre	7 litre

Oil grade ..... Please refer to "Maintenance"

Viscosity at various ambient temperatures .....
(Temperature values refer to steady ambient temperatures)



* Refers to synthetic or semi-synthetic oils
NOTE! **Only** SAE 5W/30 may be used .....

Fuel system

	TWD710V	TD730VE	TWD731VE
Injection pump, setting	17° (±0.5) BTDC	8° (±0.5) BTDC	12°(±0.5) BTDC
prelift	2.65 (±0.05) mm	3.35 (±0.05) mm	3.45 (±0.05) mm
Injectors, opening pressure	25.0 (+0.8) MPa	25.5 MPa	25.0. MPa
setting pressure (new spring)	25.5 (+0.8) MPa	26.0 (+0.8) MPa	26.0 (+0.8) MPa
No. of holes/hole diameter	4 pcs/0.38 mm	7 pcs/0.235 mm	6 pcs/0.258 mm

Cooling system

Cooling system volume incl. VP standard radiator etc.	34 litre	25 litre	26 litre
Thermostats, quantity	1 pc	1 pc	1 pc
starts to open at	75°C	75°C	75°C
fully open at	88°C	88°C	88°C

Electrical system

System voltage	24 V	24V	24 V
Alternator,(alt.1)			
voltage / max current rating	-	28 V / 55 A	28 V / 55 A
power app.	-	1550 W	1550 W
Alternator (alt 2),			
voltage / max current rating	28 V / 60 A	28 V / 60 A	28 V / 60 A
power app.	1700 W	1700 W	1700 W
Alternator (alt 3)			
voltage / max current rating	-	28 V / 80 A	28 V / 80 A
power app.	-	2240 W	2240 W
System voltage	12 V	12 V	-
Alternator, (alt.1)			
voltage / max current rating	-	-	-
power app.	-	-	-
Alternator (alt 2),			
voltage / max current rating	14 V / 90 A	14 V / 90 A	-
power app.	1260 W	1260 W	-
Battery capacity,			
vid 24 V Electrical system			
2 pcs series connected12 V	max. 135 Ah	max 135 Ah	max. 135 Ah
vid 12 V Electrical system			
2 pcs paralell connected	max. 110 Ah	max. 110 Ah	-
Battery electrolyte density at 25°			
fully charged battery		1.28 g/cm³ (1.24 g/cm³)*	
re-charge battery at		1.24 g/cm³ (1.20 g/cm³)*	

***Note.** Applies to batteries with tropical acid

General

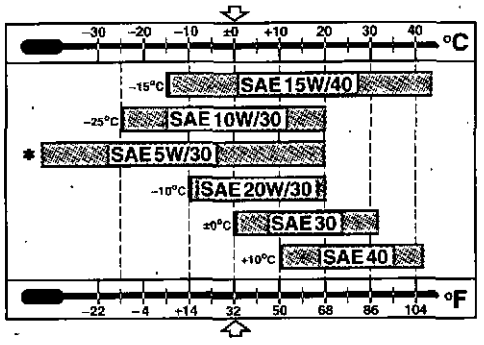
	TAD730V	TD100G	TD1030VE
Type designation			
No. of cylinders	6	6	6
Displacement	6.73 litre	9.60 litre	9.60 litre
Low idling, app.	600 ±25 r/min	550 ± 50 r/min	600 ±25 r/min
Valve clearance mm, engine cold or hot			
inlet	0.40 mm	0.40 mm	0.40 mm
outlet	0.55 mm	0.70 mm	0.70 mm
Weight, only engine (dry) app.	876 kg	945 kg	945 kg

Lubrication system

Oil pressure, hot engine at operating speed	300-500 kPa	300-500 kPa	400-600 kPa
at idle	min 150 kPa	min 150 kPa	min 150 kPa
Oil change volume, app.:			
Standard sump,			
without oil filter	22 litre	21 litre	32 litre
with oil filter	27 litre	25 litre	36 litre
volume difference, min-max	7 litre	9 litre	10 litre
Shallow sump (10°),			
without sump	-	-	-
with sump	-		-
volume difference,min-max	-	-	-
Shallow sump for large inclinations,			
without oil filter	-	-	-
with oil filter	-	-	-
volume difference, min-max	-	-	-
Deep sump for large inclinations,			
without oil filter	-	27 litre	27 litre
with oil filter	-	31 litre	31 litre
volume difference, min-max	-	9 litre	11 litre
Vehicle-type sump,			
without oil filter	-	-	-
with oil filter	-	-	-
volume difference, min-max	-	-	-
Laminated sump (sound damping),			
without oil filter	-	-	32 litre
with oil filter	-	-	36 litre
volume difference, min-max	-	-	10 litre

Oil grade ..... Please refer to "Maintenance"

Viscosity at various ambient temperatures .....
(Temperature values refer to steady ambient temperatures)



* Refers to synthetic or semi-synthetic oils
NOTE! **Only** SAE 5W/30 may be used .....

Fuel system

	TAD730V	TD100G	TD1030VE
Injection pump, setting	11° (±0.5) BTDC	20° (±0.5) BTDC	11°(±0.5) BTDC
prelift	3.65 (±0.05) mm	3.55 (±0.05) mm	3.45 (±0.05) mm
Injectors, opening pressure	30.0 (+0.8) MPa	26.0 MPa	25.0 MPa
setting pressure (new spring)	30.5 (+0.8) MPa	25.5 (+0.8) MPa	26.0 (+0.8) MPa
No. of holes/hole diameter	5 pcs/0.35 mm	4 pcs/0.38 mm	7 pcs/0.27 mm

Cooling system

Cooling system volume incl. VP standard radiator etc.	37 litre	27 litre	30 litre
Thermostats, quantity	1 pc	1 pc	1 pc
starts to open at	75°C	82°C	82°C
fully open at	88°C	95°C	95°C

Electrical system

System voltage	24 V	24V	24 V
Alternator, (alt.1)			
voltage / max current rating	-	28 V / 55 A	28 V / 55 A
power app.	-	1550 W	1550 W
Alternator (alt 2),			
voltage / max current rating	28 V / 60 A	28 V / 60 A	28 V / 60 A
power app.	1700 W	1700 W	1700 W
Alternator (alt 3)			
voltage / max current rating	-	28 V / 80 A	28 V / 80 A
power app.	-	2240 W	2240 W
System voltage	-	-	-
Alternator (alt.1),			
voltage / max current rating	-	-	-
power app.	-	-	-
Alternator (alt 2),			
voltage / max current rating	-	-	-
power app.	-	-	-
Alternator (alt 3),			
voltage / max current rating	-	-	-
power app.	-	-	-
Battery capacity,			
vid 24 V Electrical system			
2 pcs series connected12 V	max. 135 Ah	max 143 Ah	max. 143 Ah
vid 12 V Electrical system			
2 pcs paralell connected	max. 110 Ah	max. 110 Ah	max. 110 Ah
Battery electrolyte density at 25°			
fully charged battery		1.28 g/cm³ (1.24 g/cm³)*	
re-charge battery at		1.24 g/cm³ (1.20 g/cm³)*	

***Note.** Applies to batteries with tropical acid

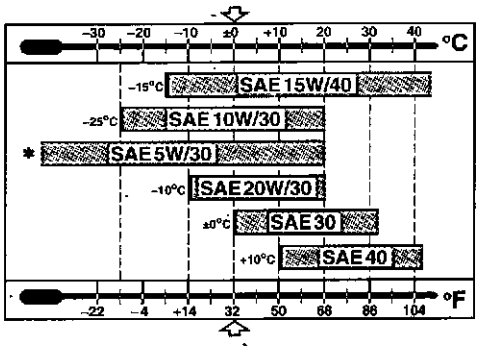
General

	TWD1031VE	TAD1030V	TD121G
Type designation			
No. of cylinders	6	6	6
Displacement	9.60 litre	9.60 litre	11.98 litre
Low idling, app.	675 ±25 r/min	600 ±25 r/min	600 ±50 r/min
Valve clearance mm, engine cold or hot			
inlet	0.40 mm	0.40 mm	0.40 mm
outlet	0.70 mm	0.70 mm	0.70 mm
Weight, only engine (dry) app.	975 kg	1062 kg	1075 kg

Lubrication system

Oil pressure, hot engine at operating speed	400-600 kPa	300-500 kPa	300-500 kPa
at idle	min 150 kPa	min 150 kPa	min 150 kPa
Oil change volume, app.:			
Standard sump,			
without oil filter	32 litre	30 litre	34 litre
with oil filter	36 litre	34 litre	38 litre
volume difference, min-max	10 litre	8 litre	9 litre
Shallow sump (10°),			
without sump	-	-	-
with sump	-	-	-
volume difference,min-max	-	-	-
Shallow sump for large inclinations,			
without oil filter	-	-	-
with oil filter	-	-	-
volume difference, min-max	-	-	-
Deep sump for large inclinations,			
without oil filter	27 litre	-	30 litre
with oil filter	31 litre	-	34 litre
volume difference, min-max	11 litre	-	12 litre
Vehicle-type sump,			
without oil filter	-	-	-
with oil filter	-	-	-
volume difference, min-max	-	-	-
Laminated sump (sound damping),			
without oil filter	32 litre	-	-
with oil filter	36 litre	-	-
volume difference, min-max	10 litre	-	-
Oil grade	Please refer to "Maintenance"		

Viscosity at various ambient temperatures
(Temperature values refer to steady ambient lufttemperatur



* Refers to synthetic or semi-synthetic oils
NOTE! **Only** SAE 5W/30 may be used

Fuel system

	TWD1031VE	TAD1030V	TD121G
Injection pump, setting	10° (±0,5) BTDC	15° (±0,5) BTDC	26°(±0,5) BTDC *
prelift	4,15 (±0,05) mm	3,45 (±0,05) mm	2,45 (±0,05) mm
Injectors, opening pressure	25,0 MPa	27,5 (+0,8) MPa	27,0 MPa
setting pressure (new spring)	26,0 (+0,8) MPa	28,0 (+0,8) MPa	27,5 (+0,8) MPa
No. of holes/hole diameter	6 pcs/0,25 mm	5 pcs/0,30 mm	5 pcs/0,36 mm

* 24° for engines with H2D turbo

Cooling system

Cooling system volume incl. VP standard radiator etc	30 litre	38 litre	34litre
Thermostats, quantity	1 pc	1 pc	1 pc
starts to open at	75°C	82°C	82°C
fully open at	88°C	95°C	95°C

Electrical system

System voltage	24 V	24V	24 V
Alternator, (alt.1)			
voltage / max current rating	28 V / 55 A	-	28 V / 55 A
power app.	1550 W	-	1550 W
Alternator (alt 2),			
voltage / max current rating	28 V / 60 A	28 V / 60 A	28 V / 60 A
power app.	1700 W	1700 W	1700 W
Alternator (alt 3),			
voltage / max current rating	28 V / 80A	-	28 V / 80 A
power app.	2240 W	-	2240 W
System voltage	-	-	-
Alternator (alt.1),			
voltage / max current rating	-	-	-
power app.	-	-	-
Alternator (alt 2),			
voltage / max current rating	-	-	-
power app.	-	-	-
Alternator (alt 3),			
voltage / max current rating	-	-	-
power app.	-	-	-
Battery capacity,			
for 24 V Electrical system			
2 pcs series connected12 V	max. 143 Ah	max 143 Ah	max. 143 Ah
for 12 V Electrical system			
2 pcs paralell connected	-	-	-
Battery electrolyte density at 25°			
fully charged battery		1.28 g/cm³ (1.24 g/cm³)*	
re-charge battery at		1.24 g/cm³ (1.20 g/cm³)*	

***Note.** Applies to batteries with tropical acid

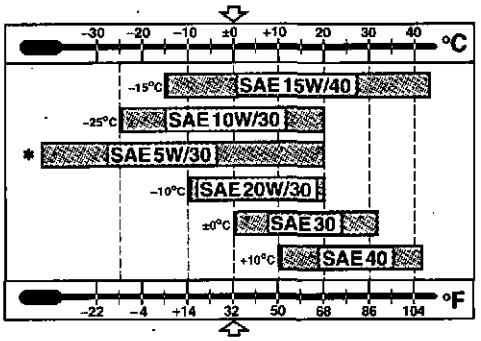
General

	TWD1210V	TWD1211V	TWD1230VE
Type designation			
No. of cylinders	6	6	6
Displacement	11.98 litre	11.98 litre	11.98 litre
Low idling, app.	600 ± 25 r/min	600 ± 25 r/min	600 ± 25 r/min
Valve clearance mm, engine cold or hot			
inlet	0.40 mm	0.40 mm	0.40 mm
outlet	0.70 mm	0.70 mm	0.70 mm
Weight, only engine (dry) app.	1105 kg	1105 kg	1105 kg

Lubrication system

Oil pressure, hot engine at operating speed	300-500 kPa	300-500 kPa	300-500 kPa
at idle	min 150 kPa	min 150 kPa	min 150 kPa
Oil change volume, app.:			
Standard sump,			
without oil filter	34 litre	34 litre	34 litre
with oil filter	38 litre	38 litre	38 litre
volume difference, min-max	9 litre	9 litre	9 litre
Shallow sump (10°),			
without sump	-	-	-
with sump	-		-
volume difference, min-max	-	-	-
Shallow sump for large inclinations,			
without oil filter	-	-	30 litre
with oil filter	-	-	34 litre
volume difference, min-max	-	-	12 litre
Deep sump for large inclinations,			
without oil filter	-	-	30 litre
with oil filter	-	-	34 litre
volume difference, min-max	-	-	12 litre
Vehicle-type sump,			
without oil filter	-	-	-
with oil filter	-	-	-
volume difference, min-max	-	-	-
Laminated sump (sound damping),			
without oil filter	-	-	34 litre
with oil filter	-	-	38 litre
volume difference, min-max	-	-	12 litre
Oil grade	Please refer to "Maintenance"		

Viscosity at various ambient temperatures
(Temperature values refer to steady ambient temperatures)



* Refers to synthetic or semi-synthetic oils
NOTE! **Only** SAE 5W/30 may be used

Fuel system

	TWD1210V	TWD1211V	TWD1230VE
Injection pump, setting	20° (±0.5) BTDC	18° (±0.5) BTDC	12° (±0.5) BTDC
prelift	3.55 (±0.05) mm	3.55 (±0.05) mm	4.15 (±0.05) mm
Injectors, opening pressure	27.0 (+0.8) MPa	27.0 (+0.8) MPa	25.0 MPa
setting pressure (new spring)	27.5 (+0.8) MPa	27.5 (+0.8) MPa	26.0 (+0.8) MPa
No. of holes/hole diameter	5 pcs/0.38 mm	5 pcs/0.38 mm	6 pcs/0.28 mm

Cooling system

Cooling system volume incl. VP standard radiator etc	49 litre	55 litre	37 litre
Thermostats, quantity	1 pc	1 pc	1 pc
starts to open at	75°C	82°C	82°C
fully open at	88°C	95°C	95°C

Electrical system

System voltage	24 V	24 V	24 V
Alternator, (alt.1)			
voltage / max current rating	-	-	28 V / 55 A
power app.	-	-	1550 W
Alternator (alt 2),			
voltage / max current rating	28 V / 60 A	28 V / 60 A	28 V / 60 A
power app.	1700 W	1700 W	1700 W
Alternator (alt 3)			
voltage / max current rating	-	-	28 V / 80 A
power app.	-	-	2240 W
System voltage	-	-	-
Alternator,(alt.1)			
voltage / max current rating	-	-	-
power app.	-	-	-
Alternator (alt 2),			
voltage / max current rating	-	-	-
power app.	-	-	-
Alternator (alt 3),			
voltage / max current rating	-	-	-
power app.	-	-	-
Battery capacity,			
vid 24 V Electrical system			
2 pcs series connected12 V	max. 143 Ah	max 143 Ah	max. 143 Ah
vid 12 V Electrical system			
2 pcs paralell connected	-	-	-
Battery electrolyte density at 25°			
fully charged battery		1.28 g/cm³ (1.24 g/cm³)*	
re-charge battery at		1.24 g/cm³ (1.20 g/cm³)*	

***Note.** Applies to batteries with tropical acid

General

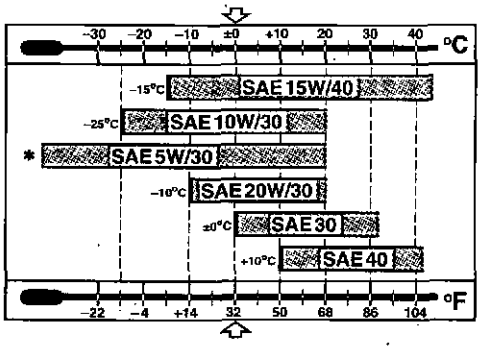
	TAD1230V	TWD1630V	TAD1630V
Type designation			
No. of cylinders	6	6	6
Displacement	11.98 litre	16.12 litre	16.12 litre
Low idling, app.	600 ± 25 r/min	500 ± 25 r/min	500 ± 25 r/min
Valve clearance mm, engine cold or hot			
inlet	0.40 mm	0.30 mm	0.30 mm
outlet	0.70 mm	0.60 mm	0.60 mm
Weight, only engine (dry) app.	1215kg	1409 kg	1515 kg

Lubrication system

Oil pressure, hot engine at operating speed	300-500 kPa	300-500 kPa	300-500 kPa
at idle	min 150 kPa	min 150 kPa	min 150 kPa
Oil change volume, app.:			
Standard sump,			
without oil filter	34 litre	57 litre	57 litre
with oil filter	38 litre	64 litre	64 litre
volume difference, min-max	9 litre	17 litre	17 litre
Shallow sump (10°),			
without sump	-	-	-
with sump	-		-
volume difference, min-max	-	-	-
Shallow sump for large inclinations,			
without oil filter	-	-	-
med oljrfilter	-	-	-
volume difference, min-max	-	-	-
Deep sump for large inclinations,			
without oil filter	-	-	-
with oil filter	-	-	-
volume difference, min-max	-	-	-
Vehicle-type sump,			
without oil filter	-	-	-
with oil filter	-	-	-
volume difference, min-max	-	-	-
Laminated sump (sound damping),			
without oil filter	-	-	-
with oil filter	-	-	-
volume difference, min-max	-	-	-

Oil grade ..... Please refer to "Maintenance"

Viscosity at various ambient temperatures .....
(Temperature values refer to steady ambient temperatures)



* Refers to synthetic or semi-synthetic oils
NOTE! **Only** SAE 5W/30 may be used .....

Fuel system

	TAD1230V	TWD1630V	TAD1630V
Injection pump, setting	14.5° (±0.5) BTDC	25° (±0.5) BTDC	21° (±0.5) BTDC
prelift	4.05 (±0.05) mm	3.45 (±0.05) mm	4.55 (±0.05) mm
Injectors, opening pressure	25.5 (+0.8) MPa	26.0 MPa	26.0 MPa
setting pressure (new spring)	26.0 (+0.8) MPa	26.5 (+0.2) MPa	26.5 (+0.2) MPa
No. of holes/hole diameter	5 pcs/0.38 mm	7 pcs/0.31 mm	7 pcs/0.31 mm

Cooling system

Cooling system volume incl. VP standard radiator etc	48 litre	67 litre	60 litre
Thermostats, quantity	1 st	2 pcs	2 pcs
marking	Red	Blue	Red
starts to open at	82°C	75°C	82°C
fully open at	95°C	88°C	95°C

Electrical system

System voltage	24 V	24V	24 V
Alternator, (alt.1)			
voltage / max current rating	-	-	-
power app.	-	-	-
Alternator (alt 2),			
voltage / max current rating	28 V / 60 A	28 V / 60 A	28 V / 60 A
power app.	1700 W	1700 W	1700 W
Alternator (alt 3),			
voltage / max current rating	-	-	-
power app.	-	-	-
System voltage	-	-	-
Alternator (alt.1),			
voltage / max current rating	-	-	-
power app.	-	-	-
Alternator (alt 2),			
voltage / max current rating	-	-	-
power app.	-	-	-
Alternator (alt 3),			
voltage / max current rating	-	-	-
power app.	-	-	-
Battery capacity,			
vid 24 V Electrical system			
2 pcs series connected12 V	max. 143 Ah	max 176 Ah	max. 176 Ah
vid 12 V Electrical system			
2 pcs paralell connected	-	-	-
Battery electrolyte density at 25°			
fully charged battery		1.28 g/cm³ (1.24 g/cm³)*	
re-charge battery at		1.24 g/cm³ (1.20 g/cm³)*	

***Note.** Applies to batteries with tropical acid

Friction clutches (extra equipment)

Type designation	**AP S11A2**
Type	Single plate clutch
Ratio	1:1
Size	292 mm (11 1/2")
Weight, approx	66 kg

Type designation	**AP D11A2**
Type	Twin plate clutch
Ratio	1:1
Size	292 mm (11 1/2")
Weight, approx	83 kg

Type designation	**AP T14A1**
Type	Triple plate clutch
Ratio	1:1
Size	355 mm (14")
Weight, approx	209 kg

Notes