# Workshop Manual

## Technical Data

## TWD1210G/P/V, TWD1211G/P/V
## TAD1230G/P/V, TAD1231GE, TAD1232GE

# Safety Precautions

## Introduction

This Workshop Manual contains technical specifications, descriptions and instructions for the repair of the specified Volvo Penta products or product types. Check that you have the correct Workshop Manual for your engine.

**Before starting work on the engine read the "Safety Precautions", "General Information" and "Repair Instructions" sections of this Workshop Manual carefully.**

## Important

In this book and on the product you will find the following special warning symbols.

⚠ **WARNING!** Possible danger of personal injury, extensive damage to property or serious mechanical malfunction if the instructions are not followed.

⚠ **IMPORTANT!** Used to draw your attention to something that can cause damage or malfunctions on a product or damage to property.

**Note!** Used to draw your attention to important information that will facilitate the work or operation in progress.

Below is a summary of the risks involved and safety precautions you should always observe or carry out when operating or servicing the engine.

⚠ Immobilize the engine by turning off the power supply to the engine at the main switch (switches) and lock it (them) in the OFF position before starting work. Set up a warning notice at the engine control point.

⚠ As a general rule all service operations must be carried out with the engine stopped. However, some work, for example certain adjustments require that the engine is running when they are carried out. Approaching an engine which is operating is a safety risk. Loose clothing or long hair can fasten in rotating parts and cause serious personal injury. If working in proximity of an engine which is operating, careless movements or a dropped tool can result in personal injury.

Take care to avoid contact with hot surfaces (exhaust pipes, Turbocharger (TC), air intake pipe, starter element etc.) and hot liquids in lines and hoses on an engine which is running or which has just been stopped. Reinstall all protective parts removed during service operations before starting the engine.

⚠ Check that the warning or information labels on the product are always clearly visible. Replace labels which have been damaged or painted over.

⚠ Never start the engine without installing the air cleaner (ACL) filter. The rotating compressor in the Turbo can cause serious personal injury. Foreign objects entering the intake ducts can also cause mechanical damage.

⚠ Never use start spray products or similar when starting the engine. They may cause an explosion in the inlet manifold. Danger of personal injury.

⚠ Only start the engine in a well-ventilated area. If operating the engine in an enclosed area ensure that there is exhaust ventilation leading out of the engine compartment or workshop area to remove exhaust gases and crankcase ventilation emissions.

⚠ Avoid opening the coolant filler cap when the engine is hot. Steam or hot coolant can spray out as system pressure is lost. Open the filler cap slowly and release the pressure in the system, if the filler cap or a drain cock/venting cock must be opened, or if a plug or engine coolant line must be removed on a hot engine.

It is difficult to anticipate in which direction steam or hot coolant can spray out.

⚠ Hot oil can cause burns. Avoid getting hot oil on the skin. Ensure that the lubrication system is not under pressure before carrying out any work. Never start or operate the engine with the oil filler cap removed, otherwise oil could be ejected.

⚠ Stop the engine before carrying out operations on the engine cooling system.

⚠ Always use protective glasses or goggles when carrying out work where there is a risk of splinters, grinding sparks, acid splashes or where other chemicals are used. The eyes are extremely sensitive, an injury could result in blindness!

⚠ Avoid getting oil on the skin! Repeated exposure to oil or exposure over a long period can result in the skin becoming dry. Irritation, dryness and eczema and other skin problems can then occur. Used oil is more dangerous than fresh oil from a health aspect. Use protective gloves and avoid oil soaked clothes and shop rags. Wash regularly, especially before eating. There are special skin creams which counteract drying out of the skin and make it easier to clean off dirt after work is completed.

⚠ Many chemicals used on the product (for example engine and transmission oils, glycol, gasoline and diesel oil), or chemicals used in the workshop (for example degreasing agents, paint and solvents) are dangerous to health. Read the instructions on the product packaging carefully! Always follow the safety precautions for the product (for example use of protective mask, glasses, gloves etc.). Make sure that other personnel are not exposed to hazardous chemicals, for example in the air. Ensure good ventilation in the work place. Follow the instructions provided when disposing of used or leftover chemicals.

⚠ Excercise extreme care when leak detecting on the fuel system and testing the fuel injector jets. Use eye protection. The jet from a fuel injector nozzle is under extremely high pressure and has great penetrative energy, so the fuel can penetrate deep into the body tissue and cause serious personal injury. Danger of blood poisoning.

⚠ **WARNING!** The delivery pipes must under no circumstances be bent. Damaged pipes should be replaced.

⚠ All fuels and many chemical substances are flammable. Do not allow naked flame or sparks in the vicinity. Fuel, certain thinner products and hydrogen from batteries can be extremely flammable and explosive when mixed with air. Smoking is not to be permitted in the vicinity! Ensure that the work area is well ventilated and take the necessary safety precautions before starting welding or grinding work. Always ensure that there are fire extinguishers at hand when work is being carried out.

⚠ Ensure that rags soaked in oil or fuel and used fuel or oil filters are stored safely. Rags soaked in oil can spontaneously ignite under certain circumstances. Used fuel and oil filters are environmentally dangerous waste and must be deposited at an approved site for destruction together with used lubricating oil, contaminated fuel, paint remnants, solvent, degreasing agents and waste from washing parts.

⚠ Never expose a battery to naked flame or electrical sparks. Never smoke in proximity to the batteries. The batteries give off hydrogen gas during charging which when mixed with air can form an explosive gas – oxyhydrogen. This gas is easily ignited and highly volatile. Incorrect connection of the battery can cause a single spark which is sufficient to cause an explosion with resulting damage. Do not shift the connections when attempting to start the engine (spark risk) and do not lean over any of the batteries.

⚠ Always ensure that the Plus (positive) and Minus (negative) battery leads are correctly installed on the corresponding terminal posts on the batteries. Incorrect installation can result in serious damage to the electrical equipment. Refer to the wiring diagrams.

⚠ Always use protective goggles when charging and handling the batteries. Battery electrolyte contains sulfuric acid which is highly corrosive. Should the battery electrolyte come into contact with unprotected skin wash off immediately using plenty of water and soap. If battery acid comes in contact with the eyes, immediately flush with plenty of water and obtain medical assistance at once.

⚠ Turn the engine off and turn off the power at the main switch(es) before carrying out work on the electrical system.

⚠ Clutch adjustments must be carried out with the engine stopped.

⚠ Use the lifting eyes fitted on the engine when lifting the drive unit. Always check that the lifting equipment used is in good condition and has the load capacity to lift the engine (engine weight including gearbox, if fitted, and any extra equipment installed).

Use an adjustable lifting beam or lifting beam specifically for the engine to raise the engine to ensure safe handling and to avoid damaging engine parts installed on the top of the engine. All chains and cables should run parallel to each other and as perpendicular as possible in relation to the top of the engine.

If extra equipment is installed on the engine which alters its center of gravity a special lifting device is required to obtain the correct balance for safe handling.

Never carry out work on an engine suspended on a hoist without other supporting equipment attached.

⚠ Never work alone when removing heavy engine components, even when using lifting devices such as locking tackle lifts. When using a lifting device two people are usually required to do the work, one to take care of the lifting device and another to ensure that components are lifted clear and not damaged during the lifting operations. Check before starting work if there is enough room to carry out removal work without risking personal injury or damage to the engine or parts.

⚠ **WARNING!** The components in the electrical system and in the fuel system on Volvo Penta products are designed and manufactured to minimize the risk of fire and explosion. The engine must not be run in areas where there are explosive materials.

⚠ Always use the fuels recommended by Volvo Penta. Refer to the Instruction Book. Use of fuels that are of a lower quality can damage the engine. On a diesel engine poor quality fuel can cause the control rod to seize and the engine to overrev with resulting risk of damage to the engine and personal injury. Poor fuel quality can also lead to higher maintenance costs.

⚠ Observe the following rules when cleaning with high-pressure water jets. Never direct the water jet at seals, rubber hoses or electrical components. Never use a high pressure jet when washing the engine.

## About this Workshop Manual

This Workshop Manual contains descriptions and instructions for the repair of the following engines in standard format: TWD1210G, -P, -V, TWD1211G, -P, -V, TAD1231GE and TAD1232GE.

The Engine Designation and Engine Numbers can be found on the product plate (see page 8). Please always include both the engine designation and the engine number in all correspondance.

The Workshop Manual is produced primarily for the use of Volvo Penta workshops and service technicians. For this reason the manual presupposes a certain basic knowledge and that the user can carry out the mechanical/electrical work described to a general standard of engineering competence.

Volvo Penta products are under a continual process of development and we therefore reserve all rights regarding changes and modifications. All the information in this manual is based on product specifications available at the time the book was published. Any essential changes or modifications introduced into production or updated or revised service methods introduced after the date of publication will be provided in the form of Service Bulletins.

## Spare parts

Spare parts for the electrical and fuel systems are subject to various national safety requirements. Volvo Penta Original Spare Parts meet these specifications. Any type of damage which is the result of using spare parts that are not original Volvo Penta parts for the product in question will not be covered under any warranty or guarantee provided by AB Volvo Penta.

## Certificated engines

Engines certificated to meet national and regional environmental legislation carry with them an undertaking from the manufacturer that both new and existing engines in use meet the enviromental demands of the legislation. The product must correspond to the validated example that was granted certification. In order for Volvo Penta as the manufacturer to take responsibility for engines in use, certain requirements regarding service and spare parts must be met by the user according to the following:

- The Service Intervals and maintenance operations recommended by Volvo Penta must be followed.
- Only Volvo Penta Original Spare Parts intended for the certificated engine may be used.
- Service work on the injection pump and injectors must always be carried out by an authorized Volvo Penta workshop.
- The engine may not be altered or modified in any way, with the exception of accessories and service kits developed by Volvo Penta for that engine.
- No modifications to the exhaust pipes and air supply ducts for the engine room (ventilation ducts) may be undertaken as this may effect exhaust emissions.
- Any seals on the engine may not be broken other than by authorized persons.

⚠ **IMPORTANT!** If replacement parts are required use only Volvo Penta Original Parts.

**Use of replacement parts other than AB Volvo Penta Original Parts will result in AB Volvo Penta being unable to assume any liability that the engine corresponds to the certificated engine variant.**

AB Volvo Penta excludes any liability for all and any type of damage or costs caused by the use of replacement parts that are not Volvo Penta Original Parts for the product in question.

# Repair instructions

The working methods described in the Workshop Manual apply to work carried out in a workshop. The engine has been removed and is installed in an engine fixture. Unless otherwise stated reconditioning work which can be carried out with the engine in place follows the same working method.

Warning symbols used in the Workshop Manual (for full explanation of the symbols refer to the section; "Safety Precautions")

**⚠ WARNING!**

**⚠ IMPORTANT!**

**Note!**

are not in any way comprehensive since it is impossible to predict every circumstance under which service work or repairs may be carried out. AB Volvo Penta can only indicate the risks considered likely to occur as a result of incorrect working methods in a well-equipped workshop using working methods and tools tested by AB Volvo Penta.

All operations described in the Workshop Manual for which there are Volvo Penta Special Tools available assume that these tools are used by the service technician or person carrying out the repair. Volvo Penta Special Tools have been specifically developed to ensure as safe and rational working methods as possible. It is therefore the responsibility of the person or persons using other than Volvo Penta Special Tools or approved Volvo Penta working methods (as described in a Workshop Manual or Service Bulletin), to acquaint themselves of the risk of personal injury or actual mechanical damage or malfunction that can result from failing to use the prescribed tools or working method.

In some cases special safety precautions and user instructions may be required in order to use the tools and chemicals mentioned in the Workshop Manual. Always follow these precautions as there are no specific instructions given in the Workshop Manual.

By following these basic recommendations and using common sense it is possible to avoid most of the risks involved in the work. A clean work place and a clean engine will eliminate many risks of personal injury and engine malfunction.

Above all when working on the fuel system, engine lubrication system, air intake system, Turbocharger unit, bearing seals and seals it is extremely important to observe the highest standards of cleanliness and avoid dirt or foreign objects entering the parts or systems, since this can result in reduced service life or malfunctions.

## Our joint responsibility

Every engine consists of many systems and components that work together. If one component deviates from the technical specifications this can have dramatic consequences on the environmental impact of the engine even if it is otherwise in good running order. It is therefore critical that the stated wear tolerances are observed, that systems which can be adjusted are correctly set up and that only Volvo Penta Original Parts are used on the engine. The stated service intervals in the Maintenance Schedule must be followed.

Some systems, such as the components in the fuel system, require special expertise and special testing equipment for service and maintenance. Some components are factory sealed for environmental and product specific reasons. Under no circumstances attempt to service or repair a sealed component unless the service technician carrying out the work is authorized to do so.

Bear in mind that most chemical products, incorrectly used, are hazardous to the environment. Volvo Penta recommends the use of bio-degradable degreasing agents for all cleaning of engine components unless otherwise stated in the Workshop Manual. Pay special attention to make sure that oils and washing residue are handled correctly for destruction, and do not unintentionally end up in the nature.

## Tightening torques

The correct tightening torques for critical joints which must be tightened using a torque wrench are listed under "Technical Data – Tightening Torques" and stated in the method descriptions in the Workshop Manual. All tightening torques apply to cleaned threads, bolt heads and mating surfaces. Tigthening torques stated are for lightly oiled or dry threads. Where grease, locking or sealing agents are required for screwed joints this is stated in both the operation description and in "Tightening Torques". Where no tightening torque is stated for a joint use the general tightening torques according to the table on the next page. The tightening torques stated are a guide and the joint does not have to be tightened using a torque wrench.

| Dimension | Tightening torque | |
|---|---|---|
| | Nm | lbf.ft. |
| M5 | 6 | 4.4 |
| M6 | 10 | 7.4 |
| M8 | 25 | 18.4 |
| M10 | 50 | 36.9 |
| M12 | 80 | 59.0 |
| M14 | 140 | 103.3 |

## Tightening torque with Protractor tightening

### (angle tightening)

Tightening using both a torque setting and a protractor angle requires that first the recommended torque is applied using a torque wrench and then the recommended angle is added according to the protractor scale. Example: a 90° protractor tightening means that the joint is tightened a further 1/4 turn in one operation after the stated tightening torque has been applied.

## Lock nuts

Do not re-use lock nuts that have been removed during dissassembly operations as these have reduced service life when re-used – use new nuts when assembling or reinstalling. For lock nuts with a plastic insert such as Nylock® the tightening torque stated in the table is reduced if the Nylock® nut has the same head height as a standard hexagonal nut without plastic insert. Reduce the tightening torque by 25% for bolt size 8 mm or larger. Where Nylock® nuts are higher, or of the same height as a standard hexagonal nut, the tightening torques given in the table apply.

## Strength classes

Bolts and nuts are divided up into different classes of strength; the class is indicated by the number on the bolt head. A high number indicates stronger material, for example a bolt marked 10-9 indicates a higher strength than one marked 8-8. It is therefore important that bolts removed during the disassembly of a bolted joint must be reinstalled in their original position when assembling the joint. If a bolt must be replaced check in the spare parts catalogue to make sure the correct bolt is used.

## Sealant

A number of sealants and locking liquids are used on the engines. The agents have varying properties and are used for different types of jointing strengths, operating temperature ranges, resistance to oil and other chemicals and for the different materials and gap sizes in the engines.

To ensure service work is correctly carried out it is important that the correct sealant and locking fluid type is used on the joint where the agents are required.

In the Volvo Penta Workshop Manuals the user will find that each section where these agents are applied in production states which type was used on the engine.

During service operations use the same agent or an alternative from a different manufacturer.

Make sure that mating surfaces are dry and free from oil, grease, paint and anti-corrosion agent before applying sealant or locking fluid. Always follow the manufacturer's instructions for use regarding temperature range, curing time and any other instructions for the product.

Two different basic types of agent are used on the engine and these are:

RTV agent (Room Temperature Vulcanizing). Used for gaskets, sealing gasket joints or coating gaskets. RTV is visible when a part has been disassembled; old RTV must be removed before resealing the joint.

The following RTV agents are mentioned in the Workshop Manual: Loctite® 574, Volvo Penta part No. 840879-1, Permatex® No. 3, Volvo Penta part No. 1161099-5, Permatex® No. 77. Old sealant can be removed using methylated spirits in all cases.

Anaerobic agents. These agents cure in an absence of air. They are used when two solid parts, for example cast components, are installed face-to-face without a gasket. They are also commonly used to secure plugs, threads in stud bolts, cocks, oil pressure switches and so on. The cured material is glass-like and it is therefore colored to make it visible. Cured anaerobic agents are extremely resistant to solvents and the old agent cannot be removed. When reinstalling the part is carefully degreased and then new sealant is applied.

The following anaerobic agents are mentioned in the Workshop Manual: Loctite® 572 (white), Loctite® 241 (blue).

**Note:** Loctite® is the registered trademark of Loctite Corparation, Permatex® the registered trademark of the Permatex Corporation.

# Safety rules for fluorocarbon rubber

Fluorocarbon rubber is a common material in seal rings for shafts, and in O-rings, for example.

When fluorocarbon rubber is subjected to high temperatures (above 300°C/572°F), **hydrofluoric acid** can be formed, which is highly corrosive. Skin contact can give severe chemical burns. Splashes in your eyes can give severe chemical burns. If you breathe in the fumes, your lungs can be permanently damaged.

⚠ **WARNING!** Be very careful when working on engines which have been exposed to high temperatures, e.g. overheating during a seizure or fire. Seals must never be cut with an oxy-acetylene torch, or be burned up afterwards in an uncontrolled manner.

- Always use gloves made of chloroprene rubber (gloves for handling chemicals) and protective goggles.
- Handle the removed seal in the same way as corrosive acid. All residue, including ash, can be highly corrosive. Never use compressed air to blow anything clean.
- Put the remains in a plastic box which is sealed and provided with a warning label. Wash the gloves under running water before removing them.

The following seals are probably made from fluorocarbon rubber:

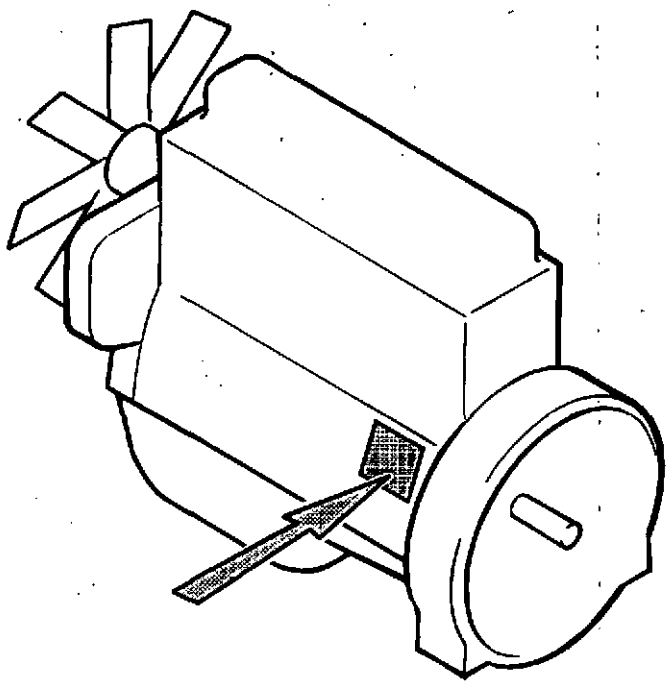
- Seal rings for the crankshaft, camshaft, intermediate shafts.
- O-rings irrespective of where they are installed. O-rings for cylinder liner sealing are almost always made from fluorocarbon rubber.

**Note that seals which have not been subjected to high temperature can be handled normally.**

# Location of identification plates

Each engine is supplied with two identical identification plates, of which one is mounted on the cylinder block, see fig.

The other identification plate should be mounted in a suitable location adjacent to the engine.



| VOLVO PENTA | |
|---|---|
| ENGINE MODEL | XXXXXXX |
| SPEC. NO. | XXXXX |
| SERIAL NO. | XXXXXXXXX |
| RATED NET POWER without fan kW/hp | XXX/XXX |
| with fan kW/hp | XXX/XXX |
| SPEED AT RATED POWER rpm | XXXX |
| PRELIFT mm/INJ. TIMING | X,X+X,X/XX±X,X° |
| MADE IN SWEDEN | 3826077 |

951211-2

T – Turbocharged
A – Air-to-air charge air cooler
W – Water-to-air charge air cooler
D – Diesel engine
12 – Displacement, liters
3 – Generation
0 – Version
P – Stationary engine (Power Pac)
G – Gen Set engine
V – Engine for stationary and mobile operation
M – Engine for mobile operation
E – Low emission engine

# Technical Data

## General

| | |
|---|---|
| **Designation** | **TWD1210G/P/V, TWD1211G/P/V, TAD1230G/P/V, TAD1231GE, TAD1232GE** |
| In line four stroke diesel engine with direct injection. Turbocharged and air-to-air intercooled (TAD). Turbocharged and water-to-air intercooled (TWD). | |
| Numbers of cylinders | 6 |
| Displacement, total | 11.98 litres (731 in³) |
| Firing order | 1–5–3–6–2–4 |
| Rotation direction, viewed towards the front | Clockwise |
| Bore | 130.175 mm (5.125") |
| Stroke | 150 mm (5.91") |
| *Compression ratio,* | |
| TAD1230G/P/V, TAD1231GE, TAD1232GE | 14.0:1 |
| TWD1210G | 13.9:1 |
| TWD1210P/V | 13.3:1 |
| TWD1211G/P/V | 13.3:1 |
| Compression pressure, starter speed | 2400 kPa (348 psi) |
| Dry weight, engine only, | |
| TAD1230G, TAD1231GE, TAD1232GE | 1250 kg (2756 lbs) |
| TAD1230P/V | 1215 kg (2679 lbs) |
| TWD1211P/V, TWD1210P/V | 1105 kg (2437 lbs) |
| TWD1211G, TWD1210G | 1140 kg (2514 lbs) |
| Idling speed, low (approx.), | |
| TAD1230G, TAD1231GE, TAD1232GE | 1300 rpm |
| TAD1230P/V | 600 rpm |
| TWD1211P/V, TWD1210P/V | 600 rpm |
| TWD1211G, TWD1210G | 1300 rpm |

## Performance

| | |
|---|---|
| Max output | See applicable engine diagram |
| Max torque | See applicable engine diagram |

## Electrical system

| | |
|---|---|
| Voltage and type | 24V, *insulated from earth* |
| Alternator, | |
| output | 60 Amp |
| voltage | 28V |
| rating | 1700W |
| make | Valeo |
| Starter motor battery capacity, | |
| maximum | 2 x 143 Ah |
| *minimum at >+5°C* | *2 x 110 Ah* |
| Battery electrolyte density at +25°C (77°F), | |
| fully charged | 1.28 g/cm³ (1.24 g/cm³)* |
| battery needs recharging at | 1.24 g/cm³ (1.20 g/cm³)* |
| Starter motor, | |
| type | Bosch 6,6 kWh/24V |
| Starting heater | 24V |

* **Note:** Refers to batteries with tropic acid.

# Engine

## Cylinder heads

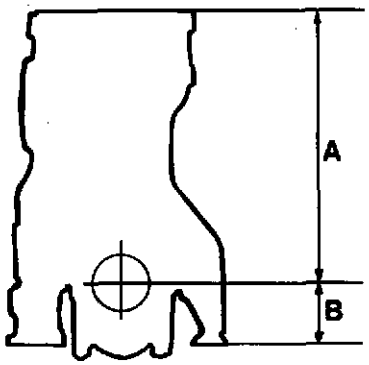
| | |
|---|---|
| Type | One per cylinder |
| Length | 187.9 mm (7.398") |
| Width | 253 mm (9.961") |
| Height, min | 124.65 mm (4.9075") |

## Cylinder head bolts

| | |
|---|---|
| Number/cylinder head | 8 |
| Thread size | 9/16" – 12 UNC |
| Length | 190 mm (7.48") |

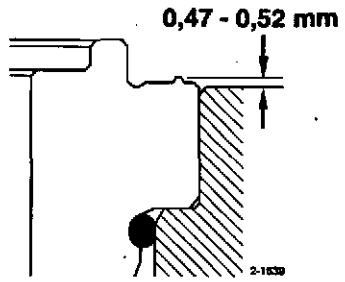
## Cylinder block

| | |
|---|---|
| Length | 1054 mm (41.50") |
| Height, upper block face – crankshaft centre (A), min | 463.8 mm (18.26") |
| Height, lower block face – crankshaft centre (B) | 120 mm (4.72") |




## Cylinder liners

| | |
|---|---|
| Type | Wet, replaceable |
| Height, total | 313.5 mm (12.34") |
| Stepped edge height above block face | 0.47–0.52 mm (0.019–0.020") |
| Upper sealing ring | 1 |
| Lower sealing ring | 3 |




## Pistons

| | |
|---|---|
| Height above block face | Max 0.55 mm (0.022") |
| Number of ring grooves | 3 |
| Front marking | Arrow pointing forwards |

## Piston rings

**Compression rings**

| | |
|---|---|
| Number | 2 |
| Piston ring gap measured in ring opening | |
| 1st ring | 0.40–0.65 mm (0.016–0.026") |
| 2nd ring | 0.35–0.55 mm (0.014–0.022") |

**Oil scraper ring**

| | |
|---|---|
| Number | 1 |
| Piston ring gap measured in ring opening | 0.4–0.8 mm (0.016–0.031") |

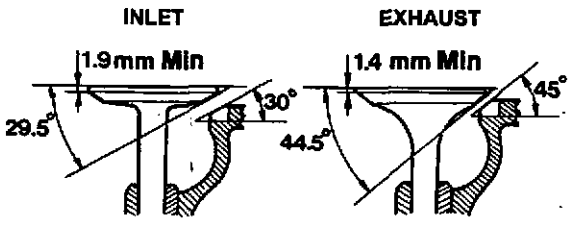
## Gudgeon pins

| | |
|---|---|
| Clearance, gudgeon pin – connecting rod bushing | 0.018–0.026 mm (0.0007–0.0010") |
| Gudgeon pin diameter, standard | 54.998–55.004 mm (2.1653–2.1655") |
| Gudgeon pin hole diameter in piston | 55.000–55.008 mm (2.1654–2.1657) |

# Valve mechanism

## Valves

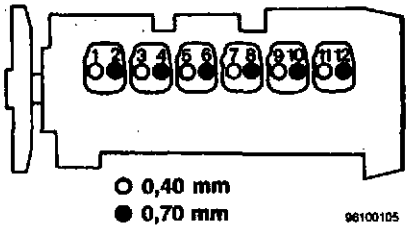
| | | |
|---|---|---|
| Disc diameter, | | |
| Inlet | | 54 mm (2.13") |
| Exhaust | | 50 mm (1.97") |
| Stem diameter, | | |
| Inlet | min | 10.91 mm (0.4295") |
| Exhaust | min | 10.90 mm (0.4291") |
| Valve seat angle, | | |
| Inlet | | 29.5° min |
| Exhaust | | 44.5° min |
| Seat angle in cylinder head, | | |
| Inlet | | 30° |
| Exhaust | | 45° |
| Valve disc edge, | | |
| Inlet | min. | 1.9 mm (0.016") |
| Exhaust | min. | 1.4 mm (0.028") |



Valve clearance, cold engine or at operating temperature,

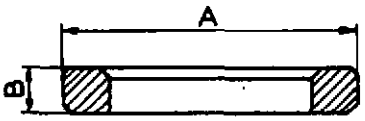
| | |
|---|---|
| Inlet | 0.40 mm (0.016") |
| Exhaust | 0.70 mm (0.028") |

The valves can be adjusted according to the two-position method.
When 1st cylinder piston is at T.D.C. after compression, adjust valves 1, 2, 3, 6, 7 and 10.
When 6th cylinder piston is at T.D.C. after compression, adjust valves 4, 5, 8, 9, 11 and 12.



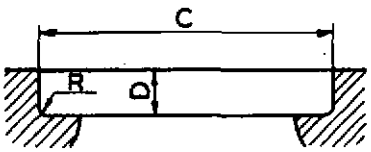

## Valve seats

| | |
|---|---|
| Outer diameter (**meas. A**), standard, | |
| Inlet | 59.1 mm (2.327") |
| Exhaust | 56.6 mm (2.228") |
| Oversize, | |
| Inlet | 59.3 mm (2.335") |
| Exhaust | 56.8 mm (2.226") |
| Height (**meas. B**), | |
| Inlet | 6.8 mm (0.268") |
| Exhaust | 9.5 mm (0.374") |




## Valve seat location

| | |
|---|---|
| Diameter (**meas. C**), standard, | |
| Inlet | 59.000–59.030 mm (2.3228–2.3240") |
| Exhaust | 56.500–56.530mm (2.2244–2.2256") |
| Diameter (**meas. C**). oversize, | |
| Inlet | 59.200–59.230 mm (2.3307–2.3319") |
| Exhaust | 56.700–56.730 mm (2.2323–2.2335") |
| Depth (**meas. D**), | |
| Inlet | 8.8–8.9 mm (0.346–0.350") |
| Exhaust | 10.8–10.9 mm (0.425–0.429") |
| Seat bottom radius (**meas. R**), | |
| Inlet/ Exhaust | 0.5–0.8 mm (0.020–0.031") |
| Measurement between valve disc and cylinder head face, | |
| Inlet/Exhaust | 0.2–1.2 mm (0.008–0.047") |




## Valve guides

| | |
|---|---|
| Inner diameter (spare part), | |
| Inlet/Exhaust | 11.032–11.059 mm (0.4343–0.4354") |
| Length, | |
| Inlet | 82 mm (3.23") |
| Exhaust | 66 mm (2.60") |
| Height above cylinder head spring face, | |
| Inlet/Exhaust | 19.7 mm (0.78") |

## Valve springs

| | |
|---|---|
| **Outer valve spring** | |
| Length, unloaded | 73.1 mm (2.88") |
| With load of 343–383 N (77.2–86.2 lbf) | 54 mm (2.13") |
| **Inner valve spring** | |
| Length, unloaded | 67.1 mm (2.64") |
| With load of 137–157 N (30.8–35.3 lbf) | 48 mm (1.89") |

## Camshaft

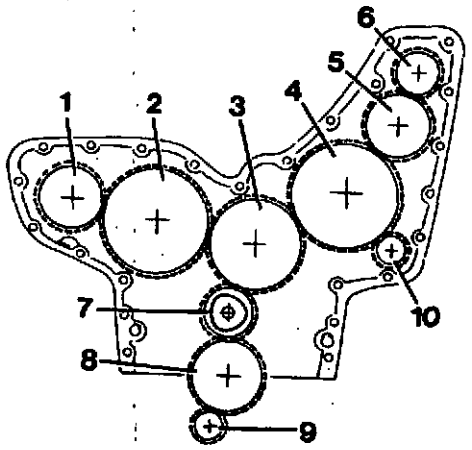
| | |
|---|---|
| Diameter, front bearing journal | 68,985–69,015 mm (2.7160–2.7171") |
| 2nd bearing journal | 66,610–66,640 mm (2.6224–2.6236") |
| 3rd bearing journal | 64,222–64,252 mm (2.5284–2.5296") |
| 4th bearing journal | 63,435–63,465 mm (2.4974–2.4986") |
| 5th bearing journal | 61,047–61,077 mm (2.4034–2.4046") |
| 6th bearing journal | 60,260–60,290 mm (2.3724–2.3736") |
| 7th bearing journal | 56,285–56,315 mm (2.2159–2.2171") |
| Axial clearance | 0,05–0,18 mm (0.0020–0.0071" |
| Radial clearance | 0,03–0,08 mm (0.0012–0.0031") |
| Check of camshaft setting (cold engine and valve clearance = 0), Inlet valve for No. 1 cylinder must with flywheel position 10° A.T.D.C. have opened | 4.5 ±0.3 mm (0.177 ±0.012") |
| Lift height camshaft (new), | |
| Inlet | 8.6 mm (0.339") |
| Exhaust | 9.2 mm (0.362") |
| Liftheight camshaft (min), | |
| Inlet | 8.4 mm (0.331") |
| Exhaust | 9.0 mm (0.334") |
| Max valve lift, Inlet | 13.3 mm (0.524") |
| Exhaust | 14.2 mm (0.560") |
| Min valve lift, Inlet | 13.0 mm (0.512") |
| Exhaust | 13.9 mm (0.547") |

## Camshaft bearings

| | |
|---|---|
| Diameter, | |
| front bearing | 69.050–69.075 mm (2.7185–2.7195") |
| 2nd bearing | 66.675–66.700 mm (2.6250–2.6260") |
| 3rd bearing | 64.287–64.312 mm (2.5310–2.5320") |
| 4th bearing | 63.500–63.525 mm (2.5000–2.5010") |
| 5th bearing | 61.112–61.137 mm (2.4060–2.4070") |
| 6th bearing | 60.325–60.350 mm (2.3750–2.3760") |
| 7th bearing | 56.350–56.375 mm (2.2185–2.2195") |

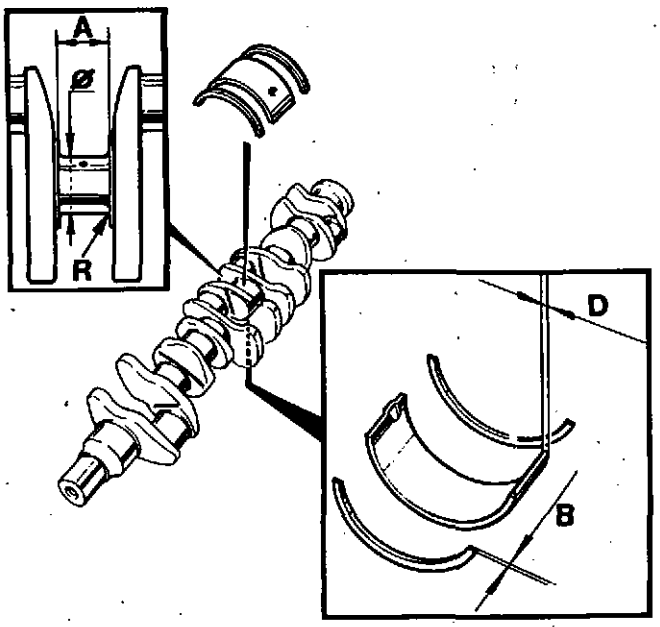
## Timing gears

| | |
|---|---|
| Number of teeth, | |
| crankshaft gear | 30 |
| intermediate gear for oil pump | 48 |
| drive gear for oil pump | 21 |
| intermediate gear | 53 |
| camshaft gear | 60 |
| drive gear for injection pump | 60 |
| intermediate gear for coolant pump | 31 |
| drive gear for coolant pump | 19 |
| drive gear for compressor | 33 |
| drive gear for servo pump | 19 |
| Backlash | 0.03–0.17 mm (0.001–0.007") |
| Axle journal for intermediate gear, diameter | 92.084–92.106 mm (3.6253–3.6262") |
| Bushing for intermediate gear, diameter, max | 92.131–92.166 mm (3.6272–3.6286") |
| Radial clearance for intermediate gear | 0.03 – 0.09 mm (0.001–0.004") |
| Axial clearance for intermediate gear | 0.05 – 0.15 mm (0.002–0.006") |




1. Drive gear for compressor (optional)
2. Camshaft gear
3. Intermediate gear
4. Drive gear for injection pump
5. Intermediate gear for coolant pump
6. Drive gear for coolant pump
7. Crankshaft gear
8. Intermediate gear for oil pump
9. Drive gear for oil pump
10. Drive gear for servopump

# Crank mechanism




## Crankshaft

| | |
|---|---|
| Length | 1218 mm (48.0") |
| Crankshaft, axial clearance | 0.06–0.27 mm (0.002–0.012") |
| Main bearing, radial clearance | 0.07–0.14 mm (0.003–0.006") |

The crankshaft is nitrocarburized.
**Note:** A nitrocarburized crankshaft may be ground down to **maximum** 2nd undersize. If ground more, it must be re-nitrocarburized.

## Main bearing journals

| | | |
|---|---|---|
| Diameter (Ø), standard | | 107.915–107.937 mm (4.2486–4.2495") |
| undersize | 0.25 mm (0.010") | 107.661–107.683 mm (4.2386–4.2395") |
| | 0.50 mm (0.020") | 107.407–107.429 mm (4.2286–4.2295") |
| | 0.75 mm (0.030") | 107.153–107.175 mm (4.2186–4.2195") |
| | 1.00 mm (0.040") | 106.899–106.921 mm (4.2086–4.2095") |
| | 1.25 mm (0.050") | 106.645–106.667 mm (4.1986–4.1995") |
| Main bearing journals, out-of-round | max | 0.004 mm (0.0002") |
| wear, out-of-round | max | 0.08 mm (0.003") |
| taper | max | 0.05 mm (0.002") |

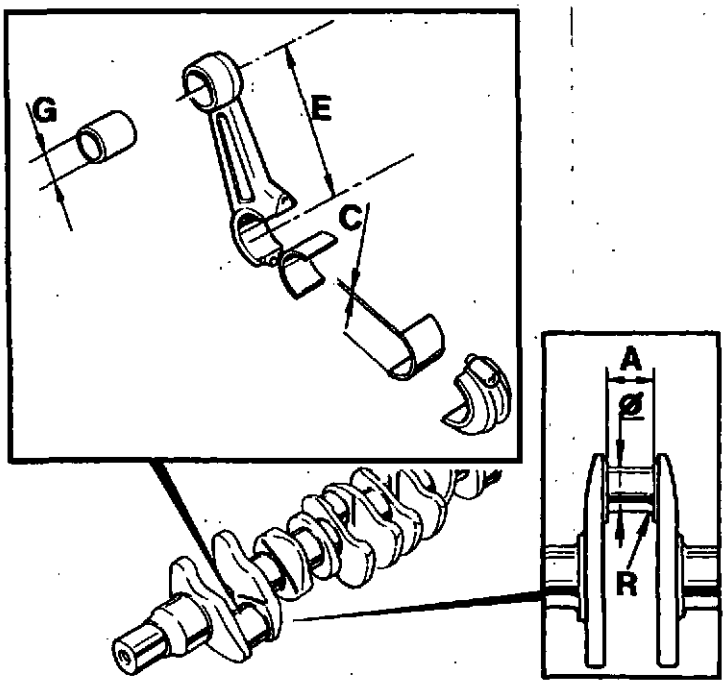
| | |
|---|---|
| Width, axial bearing pin (A), standard | 45.975–46.025 mm (1.8100–1.8120") |
| Oversize, | |
| 0.2 mm (axial bearing 0.1 mm) | 46.175–46.225 mm (1.8179–1.8199") |
| 0.4 mm (axial bearing 0.2 mm) | 46.375–46.425 mm (1.8258–1.8278") |
| 0.6 mm (axial bearing 0.3 mm) | 46.575–46.625 mm |
| Fillet radius (R) | 4.35–4.60 mm. (0.1713–1.1811") |

## Thrust washers (axial bearing)

| | |
|---|---|
| Width (B), standard | 3.140–3.210 mm (0.1236–0.1264") |
| oversize 0.1 mm (0.004") | 3.240–3.310 mm (0.1276–0.1303") |
| 0.2 mm (0.008") | 3.340–3.410 mm (0.1315–0.1343") |
| 0.3 mm (0.012") | 3.440–3.510 mm (0.1354–0.1382") |

## Main bearing shells

| | | |
|---|---|---|
| Thickness (D), standard | | 2.510 mm (0.0988") |
| oversize | 0.25mm(0.010") | 2.637 mm (0.1038") |
| | 0.50 mm(0.020") | 2.764 mm (0.1088") |
| | 0.75 mm(0.030") | 2.891 mm (0.1138") |
| | 1.00 mm(0.040") | 3.018 mm (0.1188") |
| | 1.25 mm(0.050") | 3.145 mm (0.1238") |




## Connecting rod bearing journals

| | | |
|---|---|---|
| Diameter (Ø), standard | | 92.028–92.043 mm (3.6231–3.6237") |
| | undersize 0.25 mm (0.010") | 91.778–91.793 mm (3.6133–3.6139") |
| | 0.50 mm (0.020") | 91.528–91.543 mm (3.6133–3.6040") |
| | 0.75 mm (0.030") | 91.278–91.293 mm (3.5933–3.5942") |
| | 1.00 mm (0.040") | 91.028–91.043 mm (3.5838–3.5844") |
| | 1.25 mm (0.050") | 90.778–90.793 mm (3.5739–3.5745") |
| Width (A), axial bearing journal | | 54.90–55.00 mm (2.1614–2.1654") |
| Fillet radius (R) | | 4.35–4.60 mm (0.1713–0.1811") |
| Connecting rod bearing journals | | |
| out-of-round | max | 0.004 mm (0.0002") |
| wear, out-of-round | max | 0.08 mm (0.0031") |
| taper | max | 0.05 mm (0.002") |

## Connecting rod bearing shells

| | |
|---|---|
| Thickness (C), standard | 2.357 mm (0.0928") |
| undersize 0.25 mm(0.010") | 2.482 mm (0.0977") |
| 0.50 mm(0.020") | 2.607 mm (0.1026") |
| 0.75 mm(0.030") | 2.732 mm (0.1076") |
| 1.00 mm(0.040") | 2.857 mm (0.1125") |
| 1.25 mm(0.050") | 2.982 mm (0.1174") |

## Connecting rods

| | |
|---|---|
| Length, centre – centre (E) | 275 mm (10.8268") |
| Marking: | |
| Connecting rod resp. cap | 1 to 6 |
| "FRONT" on rod turned | Forwards |
| Connecting rod bushing bore (G) | 55.022–55.026 mm (2.0473–2.0483") |
| Axial clearance, connecting rod – crankshaft | 0.15–0.35 mm (0.006–0.0138") |
| Connecting rod bearing, radial clearance | 0.08–0.12 mm (0.003–0.005") |

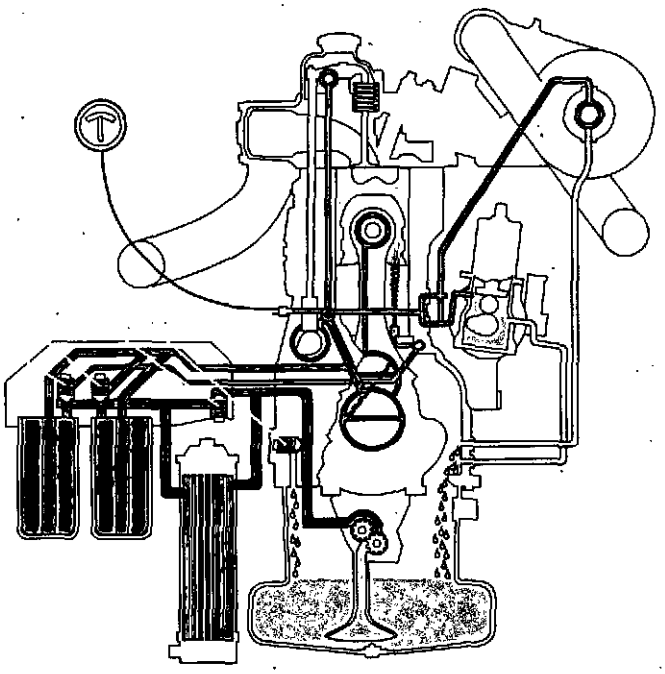
## Flywheel, installed

| | |
|---|---|
| Max permitted axial throw measuring radius 150 mm (5.91") | 0.15 mm (0.006") |
| Ring gear on flywheel | 156 teeth |

## Flywheel casing, installed

| | |
|---|---|
| Max permitted axial throw for rear contact surface | 0.20 mm (0.008") |
| Max permitted radial throw for inner edge guide | 0.25 mm (0.010") |

# Lubrication system

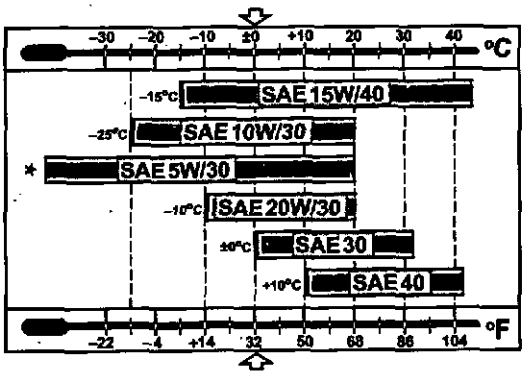


## Lubrication system, general

| | |
|---|---|
| Oil system capacity, | |
| incl. filter | 38 litres (10.04 US gals) |
| excl. filter | 34 litres (8.98 US gals) |
| Difference in volume between MIN – MAX | 9 litres (2.38 US gals) |
| Oil pressure, | |
| rated speed | 300–500 kPa (43.5–72.5 psi) |
| idling speed (min) | 150 kPa (21.75 psi) |
| Oil temperature, | |
| *normal* | 105°C (221°F) |
| max | 120°C (248°F) |
| Oil filter, micron size | 0.040 mm (0.0016") |

**Viscosity is selected as per table below**

The temperatures refer to stable ambient temperature



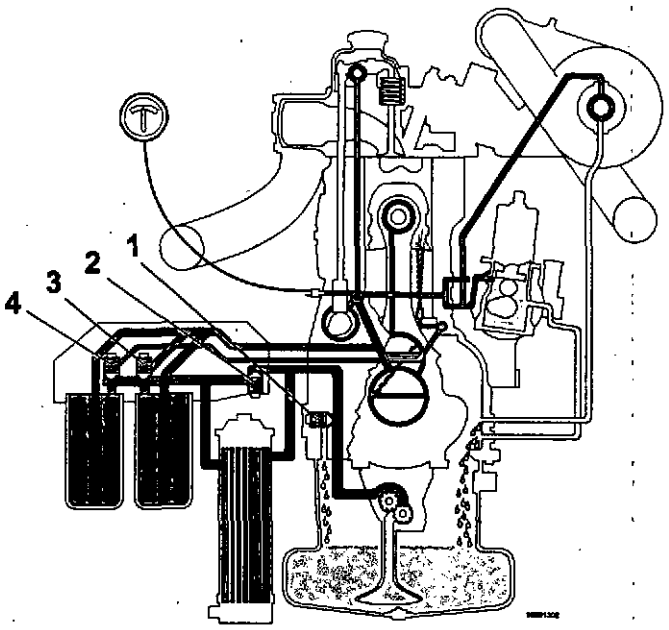

## Lubricanting oil, engine

| *Oil grade* | *Standard* |
|---|---|
| VDS -2, VDS | Volvo Drain Specification |
| CCMC D5, D4 | CCMC |
| CD, CE, CF | API |
| CF-4, CG-4 | API |

* Concerns synthetic or semi-synthetic oil
**Note: Only** SAE 5W/30 may be used

## Lube oil pump

| | |
|---|---|
| Type | Gear driven |
| Diameter, | |
| bearing sleeve, intermediate gear | 92.084–92.106 mm (3.6253–3.6262") |
| intermediate gear, bushing | 92.131–92.166 mm (0.6272–3.6286") |
| Axial clearance, | |
| drive gear | 0.15 mm (0.006") |
| intermediate gear | 0.15 mm (0.006") |




## Oil valves

| | |
|---|---|
| 1. Reduction valve, | |
| marking | Yellow |
| 2. By-pass valve, oil cooler, | |
| Type | Pressure spring |
| Spring length, | |
| off-load | 46.0 mm (1.8") |
| loaded 22.5–24.5 N (5.06–5.51 lbf) | 39.0 mm (1.5") |
| 3. Overflow valve, filter, | |
| Type | Pressure spring |
| Spring length | |
| off-load | 68.8 mm (2.71") |
| loaded 18 ±1 N (4.05 ± 0.23 lbf) | 40.0 mm (1.6") |
| 4. Piston cooling valve, | |
| marking | – |

# Fuel system

## Fuel specifications

The fuel must be approved according to national and international standards for commercial fuels, for example:

**EN 590** (With environmental and sub-zero temperature specifications according to national requirements)

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

**JIS KK 2204**

**Sulphur content:** According to current legislation, in respective country.

**Note.** Fuels with extremely low sulfur contents ("Urban diesel" in Sweden and "City diesel" in Finland) can cause a drop in power output of 5% and an increase in fuel consumption of 2–3%.

## Feed pump

| | |
|---|---|
| Type | FP/KG 24 P307 |
| Feed pump pressure | 100–150 kPa (14.5–21.75 psi) |
| Feed pump max suction height | 2.0 m (78.7") |

## Injection pump

| | |
|---|---|
| Pump type, | |
| TAD1230G, TAD1231GE, TAD1232GE | Bosch PE6P 130A 300 RS 7274 |
| TAD1230P/V | Bosch PE6P 130A 320 RS 7282 |
| TWD1211G/P/V, TWD1210G | Bosch PE6P 120A 320 RS 3206-1 |
| TWD1210P/V | Bosch PE6P 120A 320 RS 3206-1 |
| Governor type, | |
| TAD1230G, TAD1231GE, TAD1232GE | electronic/GAC |
| TAD1230P/V | mechanical Bosch RQV 300–900 PA1059 |
| TWD1211G | mechanical RQ 750 PA783-1 |
| TWD1210G | mechanical RQ 750 PA783-2 |
| TWD1211P/V, TWD1210P/V | mechanical RSV 250–900 P4A550 |
| Pump element diameter, | |
| TAD1230G/P/V, TAD1231GE, TAD1232GE | 13 mm (0.512") |
| TWD1211G/P/V. TWD1210G/P/V | 12 mm (0.472") |
| Setting, | |
| TAD1230G/P/V | 14.5° ±0.5° B.T.D.C. |
| TAD1231GE, TAD1232GE, 1500/1800 rpm | 12°/15° ±0.5° B.T.D.C. |
| TWD1211G | 22.0° ±0.5° B.T.D.C. |
| TWD1211P/V | 18.0° ±0.5° B.T.D.C. |
| TWD1210G | 20.0° ±0.5° B.T.D.C. |
| TWD1210P/V | 22.0° ±0.5° B.T.D.C. |
| Lift from basic circle (stroke position), | |
| TAD1230G, TAD1231GE, TAD1232GE | 4.05 (±0.05) mm (0.1594 ± 0.002") |
| TAD1230P/V | 4.05 (±0.05) mm (0.1594 ± 0.002") |
| TWD1211G/P/V, TWD1210G/P/V | 3.55 (±0.05) mm (0.1398 ± 0.002") |

## Injectors

| | |
|---|---|
| Designation, nozzle holder, TAD1230G/P/V, TAD1231GE, TAD1232GE | KBEL 117 P73 |
| nozzle holder, TWD1211G/P/V, TWD1210G/P/V | KBEL 117 P74 |
| nozzle, TAD1230G/P/V | DLLA 150 P407 |
| nozzle, TAD1231GE, TAD1232GE | DLLA 150 P711 |
| nozzle, TWD1211G/P/V, TWD1210G/P/V | DLLA 150 P119 |
| Marking, complete injector, | |
| TAD1230G/P/V | 677 |
| TWD1211G/P/V, TWD1210G/P/V | 808 |
| TAD1231GE, TAD1232GE | 552 |
| Opening pressure, | |
| TAD1230G/P/V, TAD1231GE, TAD1232GE | 25.5 MPa (3698 psi) |
| TWD1211G/P/V, TWD1210G/P/V | 27.0 MPa (3915 psi) |
| Adjustment pressure, new spring, | |
| TAD1230G/P/V, TAD1231GE, TAD1232GE | 26.0 (+0.8) MPa (3770 +116 psi) |
| TWD1211G/P/V, TWD1210G/P/V | 27.5 (+0.8) MPa (3988 +116 psi) |
| Bore, | |
| TAD1230G/P/V, TWD1210G/P/V, TWD1211G/P/V | 5 x 0.38 mm (5 x 0.0150") |
| TAD1231GE, TAD1232GE | 6 x 0,34 mm (6 x 0,0134") |

## Cooling system

| | |
|---|---|
| Type | Pressurized, closed circuit |
| Pressure valve opens at | 70 kPa (10.2 psi) |
| Recommended coolant, | |
| Volvo Penta ethylen glycol or Volvo Penta anticorriosion additive together with clean fresh water | |
| Coolant capacity, TAD1230G/P/V, TAD1231GE, TAD1232GE, | |
| engine | 23 litres (6.1 US gals) |
| engine incl. standard radiator with hoses | 48 litres (12.7 US gals) |
| Coolant capacity, TWD1211G/P/V, | |
| engine | 26 litres (6.9 US gals) |
| engine incl. standard radiator with hoses | 55 litres (14.5 US gals) |
| Coolant capacity, TWD11210G/P/V, | |
| engine | 26 litres (6.9 US gals) |
| engine incl,. standard radiator with hoses | 49 litres (12.9 US gals) |
| Thermostat, TAD1230G/P/V, TAD1231GE, TAD1232GE, TWD1211P/V, | |
| marked | Red |
| starts to open | 82°C (180°F) |
| fully open | 95°C (230°F) |
| Thermostat, TWD1211G, TWD1210G/P/V, | |
| marked | Blue |
| starts to open | 75°C (168°F) |
| fully open | 88°C (190°F) |

## Intake and exhaust system

### Turbocharger

| | |
|---|---|
| Designation, | |
| TAD1230G/P/V, TAD1231GE, TAD1232GE | Holset H3B |
| TWD1210G, TWD1211P/V | K.K.K. K33 4067 MNA/24,22 |
| TWD1210P/V, TWD1211G | K.K.K. K33 4067 MNA/30,22 |
| Lube system | Pressure lubrication |

### Boost pressure,

### TAD1230G, TAD1231GE, TAD1232GE

| | 1500 rpm | 1800 rpm |
|---|---|---|
| Prime power, kPa (psi) | 170 (24.6) | 200 (29.0) |
| Stand by power, kPa (psi) | 220 (31.9) | 225 (32.6) |

### TWD1211G

| | 1500 rpm | 1800 rpm |
|---|---|---|
| Prime power, kPa (psi) | 150 (21.7) | 160 (23.2) |
| Stand by power, kPa (psi) | 190 (27.5) | 200 (29.0) |

### TWD1210G

| | 1500 rpm | 1800 rpm |
|---|---|---|
| Prime power, kPa (psi) | 150 (21.7) | 170 (24.6) |
| Stand by power, kPa (psi) | 200 (29.0) | 210 (30.4) |

### TAD1230P/V

| | 1400 rpm | 1500 rpm | 1600 rpm | 1800 rpm |
|---|---|---|---|---|
| Continuous power, kPa (psi) | 170 (24.6) | 180 (26.1) | 195 (28.3) | 205 (29.7) |

### TWD1211P/V

| | 1400 rpm | 1500 rpm | 1600 rpm | 1800 rpm |
|---|---|---|---|---|
| Continuous power, kPa (psi) | 147 (21.3) | 159 (23.1) | 168 (24.4) | 182 (26.4) |

### TWD1210P/V

| | 1400 rpm | 1500 rpm | 1800 rpm | 2000 rpm |
|---|---|---|---|---|
| Continuous power, kPa (psi) | 117 (17.0) | 124 (18.0) | 153 (22.2) | 168 (24.4) |

## Exhaust system

| | TAD1230G/1231GE, TAD1232GE | | TAD1230P/V | |
|---|---|---|---|---|
| | 1500 rpm | 1800 rpm | 1500 rpm | 1800 rpm |
| Exhaust gas temperature after turbine °C (°F), | | | | |
| prime power without fan | 480 (895) | 460 (860) | | |
| stand by power without fan | 505 (940) | 500 (930) | | |
| continuous power | 550 (1022) | 511 (952) | | |
| Max allowable back-pressure in exhaust line kPa (in. w.c.) | 5.0 (20.1) | 7.0 (28.1) | 8.3 (33.3) | 12.0 (48.2) |

| | TWD1211G | | TWD1210G | |
|---|---|---|---|---|
| | 1500 rpm | 1800 rpm | 1500 rpm | 1800 rpm |
| Exhaust gas temperature after turbine °C (°F), | | | | |
| prime power without fan | 575 (1065) | 535 (995) | 515 (955) | 480 (895) |
| stand by power without fan | 595 (1100) | 565 (1050) | 545 (1010) | 515 (955) |
| Max allowable back-pressure in exhaust line (kPa/in. w.c.) | 5.0 (20.1) | 7.0 (28.1) | 5.0 (20.1) | 7.0 (28.1) |

| | TWD1211P/V | | | |
|---|---|---|---|---|
| | 1200 rpm | 1500 rpm | 1600 rpm | 1800 rpm |
| Exhaust gas temperature after turbine °C (°F), | | | | |
| continuous power | 630 (1165) | 565 (1050) | 550 (1020) | 540 (1005) |
| Max allowable back-pressure in exhaust line (kPa/in. w.c.) | 3.9 (15.6) | 4.9 (19.6) | 5.4 (21.6) | 6.9 (27.6) |

| | TWD1210P/V | | | |
|---|---|---|---|---|
| | 1200 rpm | 1500 rpm | 1800 rpm | 2000 rpm |
| Exhaust gas temperature after turbine °C (°F), | | | | |
| continuous power | 660 (1165) | 600 (1050) | 555 (1020) | 520 (1005) |
| Max allowable back-pressure in exhaust line (kPa/in. w.c.) | 4.3 (17.3) | 6.8 (27.3) | 9.7 (39.0) | 12.0 (48.2) |

| | TAD1230G, TAD1231GE, TAD1232GE | |
|---|---|---|
| | 1500 rpm | 1800 rpm |
| Max combustion pressure MPa (psi), | | |
| prime power | 14.8 (2050) | 13.8 (2001) |

| | TAD1230P/V | |
|---|---|---|
| | 1500 rpm | 1800 rpm |
| Max combustion pressure MPa (psi), | | |
| continuous power | 14.1 (2045) | 13.0 (1885) |

| | TWD1211G | |
|---|---|---|
| | 1500 rpm | 1800 rpm |
| Max combustion pressure MPa (psi), | | |
| prime power | 12.7 (1840) | 12.1 (1750) |

| | TWD1210G | |
|---|---|---|
| | 1500 rpm | 1800 rpm |
| Max combustion pressure MPa (psi), prime power | 12.5 (1810) | 12.3 (1780) |

| | TWD1211P/V | | |
|---|---|---|---|
| | 1200 rpm | 1500 rpm | 1800 rpm |
| Max combustion pressure MPa (psi), continuous power | 13.0 (1885) | 13.6 (1970) | 13.2 (1915) |

| | TWD1210P/V | | |
|---|---|---|---|
| | 1500 rpm | 1800 rpm | 2000 rpm |
| Max combustion pressure MPa (psi), continuous power | 11.7 (1696) | 11.6 (1682) | 11.7 (1696) |

# Wear tolerances

## Cylinder heads

| | |
|---|---|
| Height, min | 124.65 mm (94.91") |

## Cylinder liners

Cylinder liner (pistons and piston rings) should be replaced with wear of 0.40 – 0.45 mm (0.0157 – 0.0177") or if oil consumption is abnormally high.

## Crankshaft

| | |
|---|---|
| Max permitted out-of-round on main and connecting rod bearing journals | 0.08 mm (0.003") |
| Max permitted taper on main and connecting rod bearing journals | 0.05 mm (0.002") |
| Max axial clearance on crankshaft | 0.40 mm (0.016") |

## Connecting rods

| | |
|---|---|
| Straightness, max deviation on 100 mm (3.94") measuring lenght | 0.05 mm (0.002") |
| Warp, max deviation on 100 mm (3.94") measuring lenght | 0.10 mm (0.004") |

## Valves

| | |
|---|---|
| Valve stem, max permitted wear | 0.07 mm (0.003") |
| Max permitted clearance between valve stem and valve guides, | |
| Inlet | 0.2 mm (0.008") |
| Exhaust | 0.3 mm (0.012") |
| Valve disc edge should be min., | |
| Inlet | 1.9 mm (0.075") |
| Exhaust | 1.4 mm (0.055") |
| Valve seat may be ground down so far that distance from valve disc (new valve) to cylinder head face is max., | |
| Inlet/Exhaust | 1.5 mm (0.059")* |

* With greater values, the seats must be replaced.

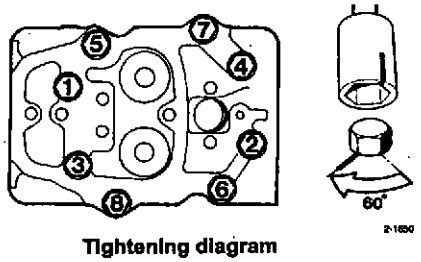
## Camshaft

| | |
|---|---|
| Max permitted out-of-round (with new bearings) | 0.05 mm (0.002") |
| Bearings, max permitted wear | 0.05 mm (0.002") |
| Lift height, min., | |
| Inlet | 8.4 mm (0.33") |
| Exhaust | 9.0 mm (0.35") |
| Valve tappet, max permitted radial clearance | 0.08 mm (0.003") |

# Tightening torques

| | Nm | (lbf.ft) |
|---|---|---|
| Cylinder heads [1] | | |
| Main bearings | 340 ±25 | (250 ±1.8) |
| Connecting rod bearings [2] | | |
| Axial bearing, camshaft | 40 ±4 | (29.5) |
| Timing gear cover | 40 ±4 | (29.5) |
| Timing gear casing | 40 ±4 | (29.5) |
| Gear, camshaft | 60 | (44.3 ±0.5) |
| Gear, injection pump drive (TAD) | 33 ±4 | (24.4 ±0.4) |
| Gear, injection pump drive (TWD) | 70 ±7 | (51.7 ±5) |
| Intermediate gear journal | 60 | (44.3 ±0.5) |
| Intermediate gear, coolant pump | 120 | (88.6) |
| Bearing bracket rocker arm shaft | 40 ±4 | (29.5) |
| Drain plug, oil sump | 60 ±15 | (44.3 ±0.5) |
| Bracket, oil pump | 40 ±4 | (29.5) |
| Intermediate gear, oil pump | 17 ±2 | (12.5 ±0.2) |
| Flywheel | 175 ±5 | (129.2) |
| Crankshaft pulley | 60 ±6 | (44.3 ±0.5) |
| Flywheel casing | 140 ±15 | (103 ±11) |
| Centre bolt, crankshaft | 550 | (406) |
| Delivery valve holder, injection pump | 85 ±5 | (62.7 ±3.7) |
| Nut for retainers, injectors | 50 ±5 | (36.9 ±0.5) |
| Clamp bolt, injection pump (TAD) | 90 ±9 | (66.4 ±6.6) |
| Clamp bolt, injection pump (TWD) | 60 ±5 | (44.3 ±0.6) |
| Injection pump coupling (TAD) | 62 ±5 | (45.8 ±3.7) |
| Injection pump coupling (TWD) | 30 ±2 | (22.1 ±1.5) |
| Valve covers | 10 | (7.4) |
| Cleaning plugs in cylinder block and cylinder heads | 60 ±10 | (44.3 ±0.6) |
| Oil sump, | | |
| gaskets with a string of silicone | 16 ±2 | (11.8 ±1.5) |
| other gaskets | 24 ±3 | (17.7 ±2.2) |
| (tighten in a specified order, see figure below) [3] | | |

[1] Tighten the cylinder head bolts in 4 stages.
- First tightening **50 Nm (37 lbf.ft)**.
- Second tightening **150 Nm (111 lbf.ft)**.
- Third tightening **190 Nm (140 lbf.ft)**.
- Final tightening, angle tightening **60°**.

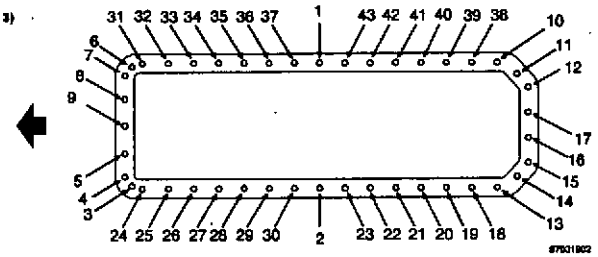



**Tightening diagram**

[2] Tigthen the connecting rod bolts in 3 stages.
- First tightening **40 Nm (30 lbf.ft)**.
- Second tightening **75 Nm (55 lbf.ft)**.
- Final tightening (angle tightening) **90°**.

Where the bolts cannot be accessed to angle tighten, tighten to a torque of 260 Nm (188 lbf.ft).

[3]




**Tightening diagram, oil sump**

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