



User' Handbook

Eagle Tx and Eagle 800



TSD3244

 **Perkins**

EAGLE Tx and

EAGLE 800

**6 cylinder diesel
engines for trucks**

USER'S HANDBOOK

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General information

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General Information

Introduction

The new range of Eagle Truck engines are the latest development from Perkins Engines (Shrewsbury) Limited, a world leader in the design and manufacture of high performance diesel engines.

More than fifty years of diesel production experience, together with the use of the latest technology, have been used in the manufacture of your engine to give you reliable and economic power.

To ensure that you use the correct information for your specific engine type, refer to "Engine identification" on page 1.04.

Danger is indicated in the text by two methods:

Warning! *This indicates that there is a possible danger to the person.*

Caution: *This indicates that there is a possible danger to the engine.*

Note: Is used where the information is important, but there is not a danger.

How to care for your engine

This handbook has been written to assist you to maintain and operate your engine correctly.

To obtain the best performance and the longest life from your engine, you must ensure that the maintenance operations are done at the intervals shown in "Preventive maintenance". If the engine is operated in a very dusty environment or other adverse conditions, certain maintenance intervals will have to be reduced. Renew the filter elements and the lubricating oil regularly to ensure that the inside of your engine remains clean.

Ensure that all adjustments and repairs are done by personnel who have had the correct training. Perkins distributors have this type of personnel available. You can also obtain parts and service from your Perkins distributor. If you do not know the address of your nearest distributor, enquire at one of the Perkins companies listed on page 1.05.

The left and right sides of the engine are as seen from the rear (flywheel) end.

Read the "Safety precautions" and remember them. They are given for your protection and must be applied at all times.

Safety precautions

These safety precautions are important.

Reference must also be made to the local regulations in the country of operation.

- Only use these engines in the type of application for which they have been designed.
- Do not change the specification of the engine.
- Do not smoke when you put fuel in the tank.
- Clean away fuel which has been spilt. Material which has been contaminated by fuel must be moved to a safe place.
- Do not put fuel in the tank while the engine runs (unless it is absolutely necessary).
- Do not clean, add lubricating oil, or adjust the engine while it runs (unless you have had the correct training; even then extreme caution must be used to prevent injury).
- Do not make adjustments that you do not understand.
- Ensure that the engine does not run in a location where it can cause a concentration of toxic emissions.
- Other persons must be kept at a safe distance while the engine or equipment is in operation.
- Do not permit loose clothing or long hair near moving parts.
- Keep away from moving parts during engine operation. **Attention:** Some moving parts cannot be seen clearly while the engine runs.
- Do not operate the engine if a safety guard has been removed.
- Do not remove the filler cap of the cooling system while the engine is hot and while the coolant is under pressure, because dangerous hot coolant can be discharged.
- Do not use salt water or any other coolant which can cause corrosion in the closed coolant circuit.
- Do not allow sparks or fire near the batteries (especially when the batteries are on charge) because the gases from the electrolyte are highly flammable. The battery fluid is dangerous to the skin and especially to the eyes.
- Disconnect the battery terminals before a repair is made to the electrical system.
- Only one person must control the engine.
- Ensure that the engine is operated only from the control panel or from the operator's position.
- If your skin comes into contact with high-pressure fuel, obtain medical assistance immediately.
- Diesel fuel and lubricating oil (especially used lubricating oil) can damage the skin of certain persons. Protect your hands with gloves or a special solution to protect the skin.
- Do not wear clothing which is contaminated by lubricating oil. Do not put material which is contaminated with oil into the pockets.
- Discard used lubricating oil in a safe place to prevent contamination.
- Ensure that the control lever of the transmission drive is in the "out-of-drive" position before the engine is started.
- The combustible material of some components of the engine (for example certain seals) can become extremely dangerous if it is burned. Never allow this burnt material to come into contact with the skin or with the eyes.
- Fit only genuine Perkins parts.

1 GENERAL INFORMATION

Engine identification

The engine is a six cylinder in-line unit and is available as turbocharged or turbocharged/intercooled.

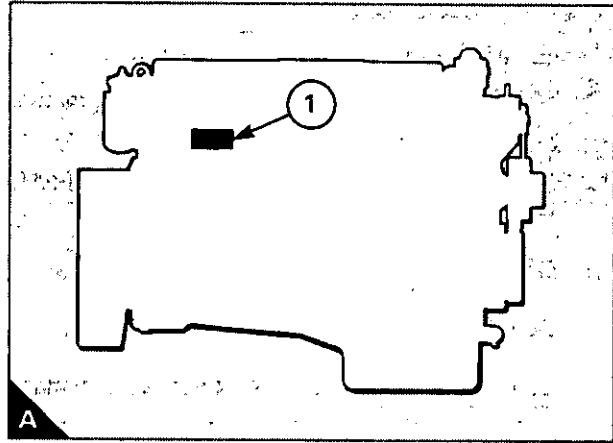
Various engine ratings are available. Details can be obtained from Perkins Engines (Shrewsbury) Limited.

The engine number is stamped on the data plate which is fastened to the right side of the crankcase (A1).

A typical engine number is 8B26116U 73545P which consists of these codes:

8B = Engine family
26116 = Engine number
U = Country of origin
73545 = Build line number
P = Year of manufacture

If you need parts, service or information for your engine, you must give the complete engine number to your Perkins distributor.



Perkins companies**Australia**

Perkins Engines Australia (Pty). Limited,
Suite 2, 364 Main Street,
Morningside 3931, Victoria, Australia.
Telephone: 597 51877 Telex: PERKOIL AA 30816
Fax: 597 58793

France

Moteurs Perkins S.A.
9-11 Avenue Michelet,
93583 Saint Ouen, Cedex, France.
Telephone: (1) 40-10-42-49
Telex: PERKOIL 234924 F
Fax: (1) 40-10-42-45

Germany

Perkins Motoren G.m.b.H.
8752 Kleinostheim, Postfach 1180,
West Germany.
Telephone: 6027 5010 Telex: 4188869 PER D.
Fax: 6027 501124

Italy

Motori Perkins S.p.A.
Via Socrate, 8 Loc, Merlese
22070 Casnate con Bernate (Como), Italy.
Telephone: 031 564625/564633 Telex: 380658 PERKIT I
Fax: 031 249092/564145

Japan

Varity (Japan) K.K.
Reinanzaka Building, 6th floor, 14-2 Akasaka,
1-chome, Minato-ku, Tokyo 107, Japan.
Telephone: 813 3582 7377 Telex: 2424823 PRKOIL.
Cablegrams: Perkoil Tokyo.
Fax: 813 3582 1596.

Singapore

Perkins Engines Asia Pacific,
4 Kian Teck Drive,
Singapore 2262
Telephone: 2656333/2653223
Telex: PERKOIL RS 37729
Fax: 2641188

United Kingdom

Perkins Engines (Shrewsbury) Limited,
Lancaster Road,
Shrewsbury, SY1 3NX, England.
Telephone: 01743 212000
Telex: 35171 PESL G
Fax: 01743 69911

United States of America

Detroit Diesel Corporation
13400 Outer Drive West,
Detroit, Michigan 48239-4001, U.S.A.
Telephone: 313 592 5608.
Telex: 544141 PERKENG LAW
Fax: 404 822 3006

Perkins Engines Latin America Inc.

Suite 620,
999, Ponce de Leon Boulevard,
Coral Gables,
Florida 33134, U.S.A.
Telephone: 305 442 7413.
Telex: 32501 PERKEN G.
Fax: 305 442 7419

In addition to the above companies, there are Perkins distributors in most countries. Perkins Engines Limited, Peterborough or one of the above companies can provide details.

Engine views

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Engine views

Eagle Tx engine

Introduction

Perkins engines are built for specific applications and the views which follow do not necessarily match your engine specification.

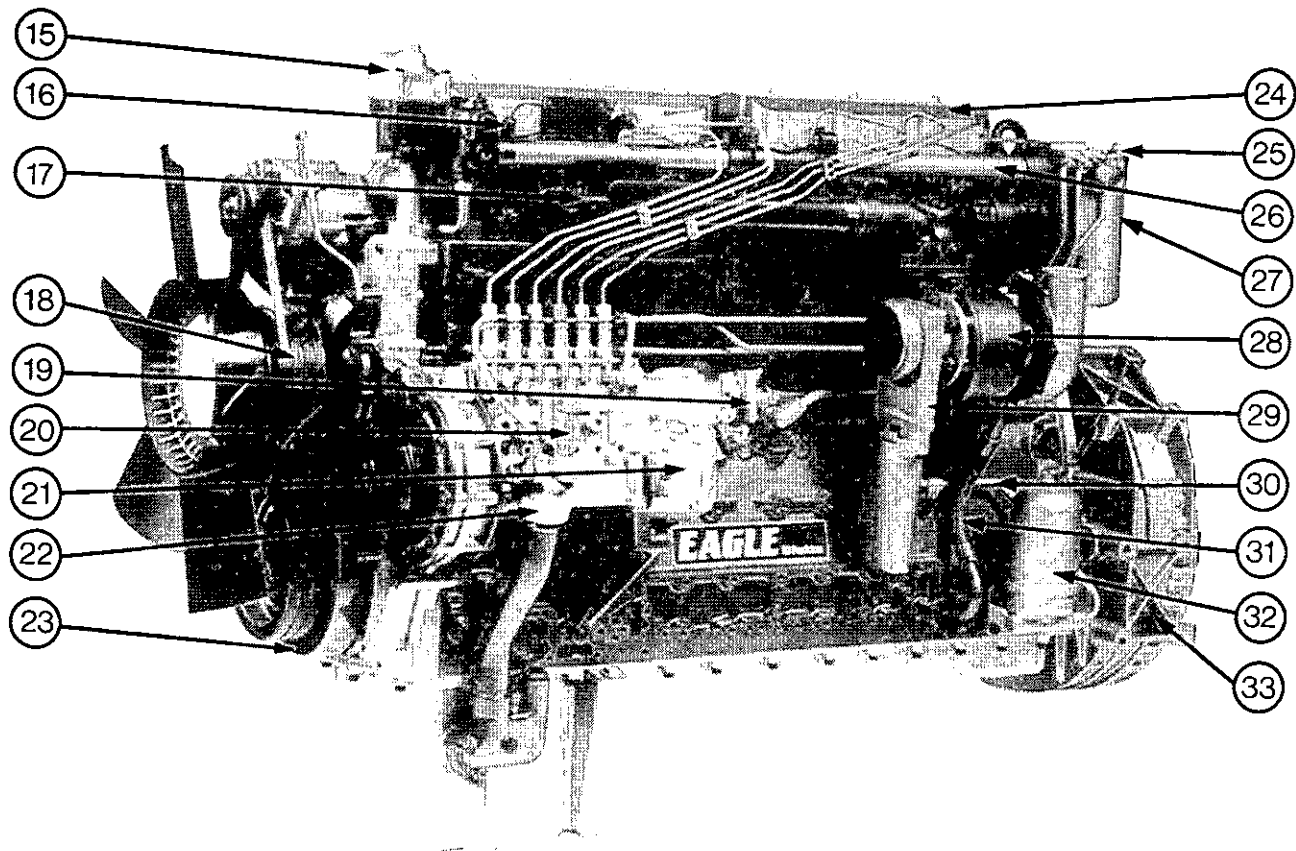
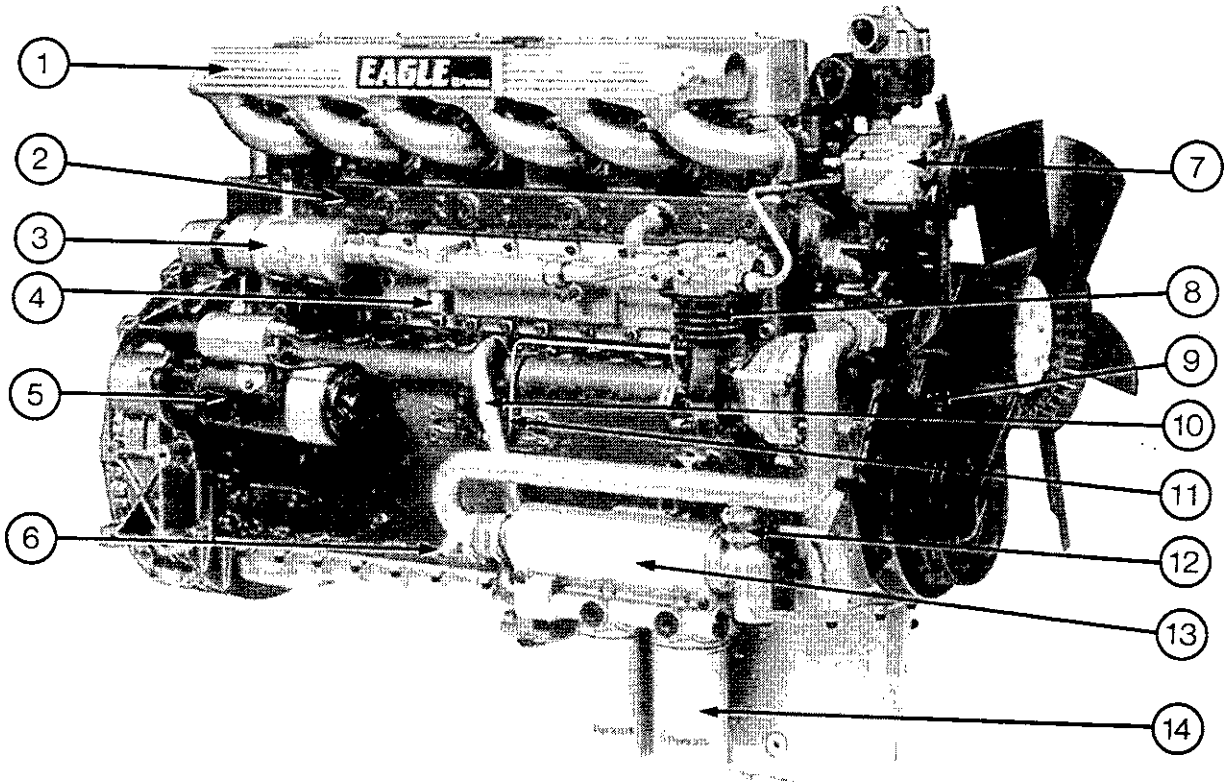
Location of engine parts

Front and right side view of engine

- 1 Inlet manifold
- 2 Data plate
- 3 Air filter for the compressor
- 4 Connection for breather pipe
- 5 Starter motor
- 6 Coolant drain plug
- 7 Alternator
- 8 Air compressor
- 9 Belt tensioner
- 10 Pipe for lubricating oil supply to main gallery
- 11 Oil supply to compressor
- 12 By-pass for the coolant
- 13 Oil cooler
- 14 Canisters of the lubricating oil filter (2)

Front and left side view of engine

- 15 Thermostat
- 16 Fuel injector
- 17 Exhaust manifold
- 18 Coolant pump
- 19 Boost control unit
- 20 Fuel lift pump
- 21 Governor
- 22 Filler cap for lubricating oil
- 23 Crankshaft damper
- 24 Rocker cover
- 25 Connection for spill fuel
- 26 Coolant pipe
- 27 Canister of the fuel filter
- 28 Turbocharger
- 29 Exhaust brake
- 30 Lubricating oil pipe to the turbocharger
- 31 Drain pipe for the lubricating oil from the turbocharger
- 32 By-pass filter for lubricating oil
- 33 Flywheel housing



Engine views

Series 800 engine

Introduction

Perkins engines are built for specific applications and the views which follow do not necessarily match your engine specification.

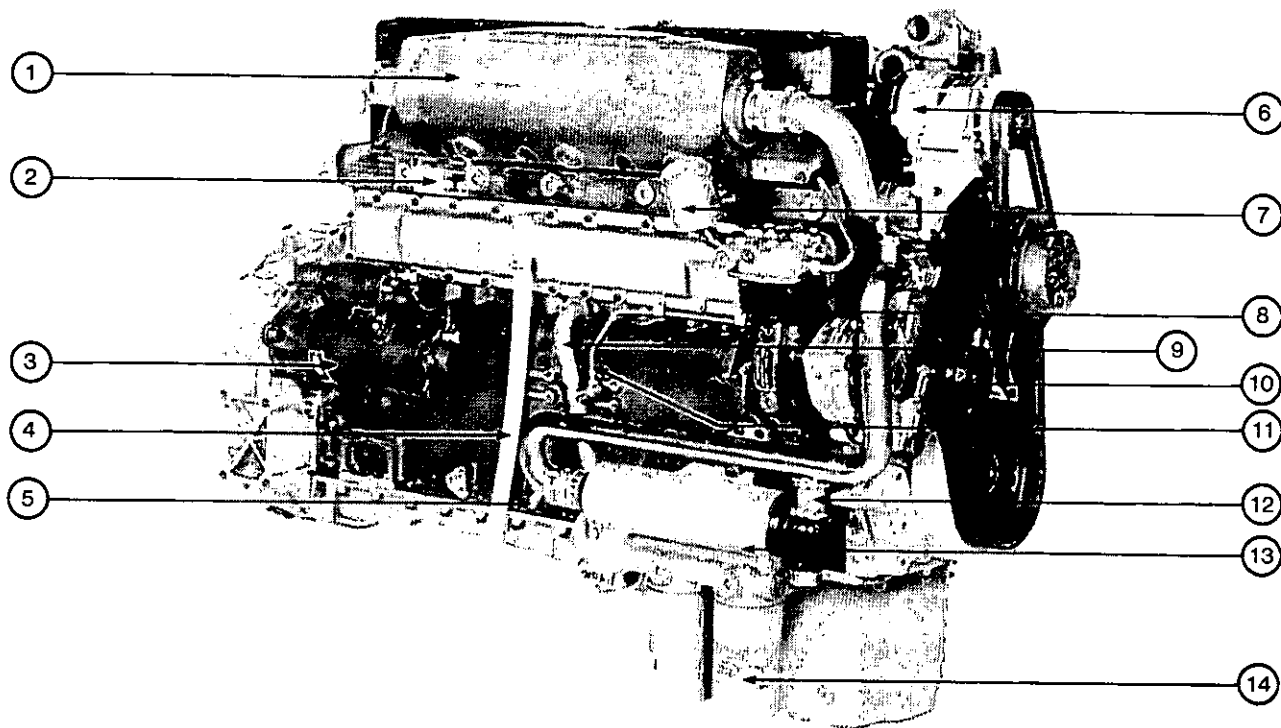
Location of engine parts

Front and right side view of engine

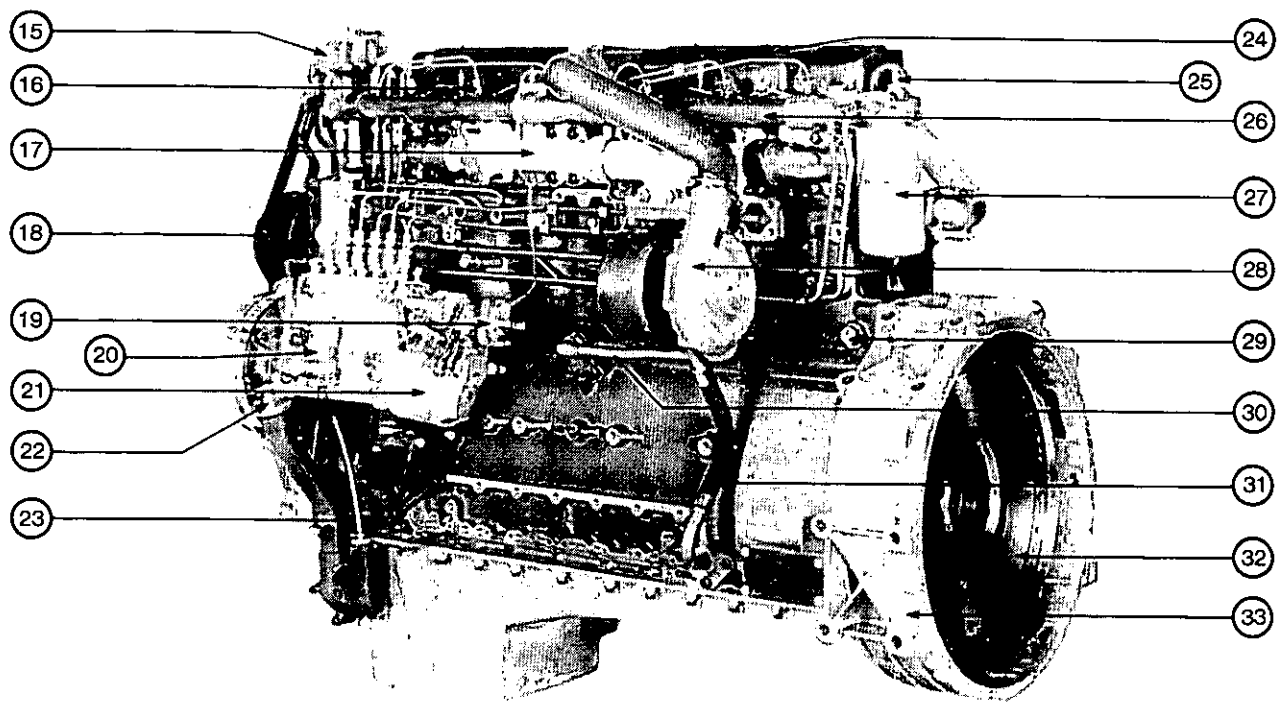
- 1 Air charge cooler
- 2 Data plate
- 3 Starter motor
- 4 Breather pipe
- 5 Drain plug for the coolant
- 6 Alternator
- 7 Air filter for the compressor
- 8 Air compressor
- 9 Pipe for lubricating oil supply to main gallery
- 10 Belt tensioner
- 11 Oil supply to compressor
- 12 By-pass for the coolant
- 13 Oil cooler
- 14 Canisters of the lubricating oil filter (2)

Front and left side view of engine

- 15 Thermostat
- 16 Fuel injector
- 17 Exhaust manifold
- 18 Alternator drive belts
- 19 Boost control unit
- 20 Fuel lift pump
- 21 Governor
- 22 Filler cap for lubricating oil
- 23 Dipstick tube and dipstick
- 24 Rocker cover
- 25 Connection for spill fuel
- 26 Coolant pipe
- 27 Canister of the fuel filter
- 28 Turbocharger
- 29 Drain plug for the coolant
- 30 Lubricating oil pipe to the turbocharger
- 31 Drain pipe for the lubricating oil from the turbocharger
- 32 Flywheel
- 33 Flywheel housing



Front and right side view



Rear and left side view

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Operation instructions

How to prepare a new or an overhauled engine

Every new engine supplied by Perkins Engines (Shrewsbury) Limited is run-in before it leaves the factory.

- 1 Check that all protection covers and blanking plugs have been removed.
- 2 Fit all components that were removed for storage or for transport.
- 3 Ensure that the drain plugs for the coolant and for the lubricating oil are securely fitted.
- 4 Where necessary, connect the remote control linkages, the pressure gauge pipes, the air inlet pipes and the wiring loom.
- 5 Connect the fuel pipes.
- 6 Connect the exhaust pipes.
- 7 Fill the fuel tank(s) with the correct grade of fuel (see page 5.02).
- 8 Fill the cooling system with the approved coolant mixture (see page 5.02).
- 9 Fill the sump to the H mark on the dipstick with the correct grade of lubricating oil (see page 5.02).
- 10 Remove the plug from the right side of the fuel injection pump and fill the fuel injection pump and the governor with engine lubricating oil, of the correct grade (see page 5.02), until the level of the oil reaches the hole for the plug. Fit the plug and tighten securely.
- 11 Add oil to the turbocharger, or to the two turbochargers if relevant, as follows: Clean the area around the blanking plug at the top of the turbocharger bearing housing. Remove the plug and insert 0,2 litre ($\frac{1}{5}$ pint) of engine lubricating oil of the correct grade. Fit the plug.
- 12 Eliminate air from the fuel system (see page 4.15).
- 13 Lubricate all of the control linkages and check the linkages for free movement.
- 14 Ensure that the stop control is in the STOP position and that the accelerator is in the IDLE position. Press the start button for 10 seconds and wait for 10 seconds, then press it for 20 seconds and wait for 20 seconds. Oil pressure MUST be indicated on the gauge.

Normal start procedures

Service checks before a new or an overhauled engine, or an engine which has been in storage, is started

If an engine has been in storage for a period of more than one month or if the fuel injection pump has been removed, lubricating oil must be added to the fuel injection pump, to the governor of the fuel injection pump and to the turbocharger(s). The procedure is described on this page, paragraphs 10 and 11. Use clean engine oil of the same grade and specification as that already in the system.

Service checks each day before the first engine start

- 1 Check that the level of the coolant is just at the bottom of the filler extension in the radiator or as specified in the vehicle manual. Fill, if necessary, to the required level with the approved coolant mixture. Find the reason for large losses of coolant.
- 2 Check the engine oil level. With the engine stopped the oil level must be at the H mark on the dipstick. If necessary, add oil of the same grade and specification as that already in the system. Do NOT add more oil than is necessary.
- 3 Check the level in the fuel tank. Open the valve for the fuel, if one is fitted.

How to start the engine

Perform the daily service checks then proceed as follows:

Move the stop control lever to the RUN position.

- 1 Move the accelerator to the maximum speed position.
- 2 Press the start switch and release it when the engine starts.
- 3 Move the speed control lever to the idle position.

How to start the engine in low ambient temperatures

In addition to the use of cold starting aids as given below, efficient starts in low temperatures require the use of a suitable engine lubricating oil of the correct viscosity and also a good battery.

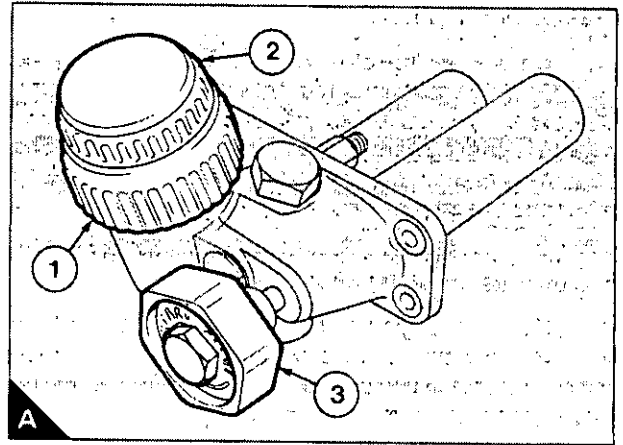
If a cold engine is started in a temperature of 10°C, it will increase speed immediately to the maximum engine speed. At -30°C (-22°F), 20 minutes may elapse before the engine speed increases from the minimum of 450 rev/min at which the engine will continue to run, to the maximum engine speed.

Variable speed engines have an automatic excess fuel device which is fitted within the fuel injection pump and operates when the lever for the speed control is moved to the position for maximum speed. The excess fuel device works as a starting aid when ambient temperatures are below 0°C.

Engines which drive generators are fitted with manual excess fuel levers.

'Start Pilot' Systems

- 1 **ER System.** Remove the cap (A1) of the capsule chamber and pull the plunger (A2) fully out. Insert a fluid capsule into the chamber, fit the cap and push the plunger fully in to make a hole in the capsule.



- 2 After a short delay, when the capsule is empty, repeat the operation with two or three additional capsules according to the adverse ambient temperature. Then operate the pump (A3) for three double strokes while the start switch is operated.

3 OPERATION INSTRUCTIONS

'Fleetguard' System.

The system consists of an expendable screw-on type canister which contains 710 cc of ether under pressure. The ether is supplied to the engine by a remotely operated priming valve. Each operation of the priming valve causes the atomisation and injection of 6 cc of the ether into the inlet manifold.

- 1 Move the accelerator away from the IDLE position and operate the start switch.
- 2 When the engine turns, pull the control knob to operate the priming valve for two seconds and then release it. This action causes ether to be discharged for three seconds into the inlet manifold.
- 3 According to the adverse ambient temperature, repeat the operation of the priming valve until the engine starts and runs. Release the start switch but continue to repeat the operation of the priming valve until the engine speed increases. Then return accelerator to the IDLE position.
- 4 Do not turn continuously the engine at cranking speed for more than 20 seconds. If the engine does not start, there must be an interval of 20 seconds before operations 1 to 3 are repeated.

How to run the engine

The precautions that follow will help to ensure a long and fault-free life for the engine:

- 1 Do not operate the engine at high speeds and loads until the coolant has reached a minimum temperature of 78°C (172°F).
- 2 Do not allow the engine to run at idle speed, or without load, for prolonged periods.
- 3 Do not exceed the maximum rated speed of the engine.
- 4 Never allow an engine to continue to run if the oil pressure is below 207 kN/m² (30 lbf/in²) at the rated speed.
- 5 Fill the fuel tank(s) at the end of each day to prevent condensation and to allow sediment to fall to the bottom of the tank.

How to stop the engine

- 1 Operate the engine for 3 minutes at idle speed with no load to allow the turbocharger to reduce speed and temperature.
- 2 Move the switches for the engine protection devices to their OFF positions.
- 3 Move the stop control to the STOP position and release it after the engine is stopped.

Running-in after a repair

Every new or reconditioned engine which is supplied by Perkins Engines has been given a period of running-in before it leaves the Factory and it requires no special process when it is put into service.

When a 'Short engine' or a 'Long engine' has been installed, or when a partial overhaul has needed new cylinder liners and new piston rings, the Operator is advised that the procedure, given below, should be applied before the engine is run at full load.

- 1 Run the engine **without** a load until the normal temperature is reached.
- 2 During a period of three to four hours, increase **gradually** the load on the engine until the final conditions of the full load are reached.

Preventive maintenance

4

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Preventive maintenance

Preventive maintenance periods

These preventive maintenance periods apply to average conditions of operation. Check the periods given by the manufacturer of the equipment in which the engine is installed. If necessary, use the shorter periods. When the operation of the engine must conform to the local regulations, these periods and procedures may need to be adapted to ensure correct operation of the engine.

The service intervals can be reduced for operation in adverse conditions. The intervals must not be extended unless Perkins Engines (Shrewsbury) Limited have approved the changes as indicated in the Perkins Warranty.

Note: When the engine is used for short distance operation with frequent starts and stops, the hours of operation are more important than the distance.

It is good preventive maintenance to check for leakage and loose fasteners at each service. These maintenance periods apply only to engines that are operated with fuel and lubricating oil which conform to the specifications given in this handbook.

EAGLE Tx engines

The service periods which follow are for the renewal of engine lubricating oil and canisters of the oil filter.

1 LONG DRAIN – Vehicles which operate for more than 80 000km/50 000 miles per annum.

Service period – 40 000km/25 000 miles.

Engines which use 'long drain' SAE 15W/40 viscosity oil to one of the API specifications which follow: API-CE, CE/SF or CE/SG together with CCMC-D5 for temperatures above -15°C (5°F).

Long drain oils of SAE 10W/30 viscosity which conform to the above requirements are acceptable within an ambient temperature range of -20°C to 30°C (-4°F to 86°F), or SAE 15W/30 within -15°C to 30°C (5°F to 86°F).

Engine test requirements

The oil selected from the above specifications must have a maximum bore polish rating from a recent Ford Tornado test run to CEC L-27-T-79 procedure which does not exceed the reference oil RL47.

2 NORMAL DRAIN – Vehicles which operate for less than 80 000km/50 000 miles per annum and/or where a 'long drain' oil is NOT being used.

Service period – 20 000km/12 500 miles.

Engines which use high quality SAE 15W/40 viscosity oil to one of the API specifications which follow: API-CE, CE/SF, CE/SG, CD, CD/SE or CD/SF together with CCMC-D5 or CCMC-D4 for temperatures above -15°C (5°F).

High quality oils of SAE 10W/30 viscosity which conform to the above requirements are acceptable within an ambient temperature range of -20°C to 30°C (-4°F to 86°F), or SAE 15W/30 within -15°C to 30°C (5°F to 86°F).

Engine test requirements

The oil selected from the above specifications must have a maximum bore polish rating from a recent Ford Tornado test run to CEC L-27-T-79 procedure which does exceed the reference oil RL47.

Schedule

The preventive maintenance operations must be applied at the interval (kilometres, miles, days, weeks or months) which occurs first.

- A - Every 500km/300 miles or daily
- B - At pre-delivery inspection or 1600km/1000 miles
- C - Every 20000km/12500 miles or every 12 weeks (see page 4.02 for Tx options)
- D - Every 160000km/100000 miles or every 12 months
- E - Every 800000km/500000 miles

A	B	C	D	E	Operation
●		●			Clean the air cleaner or empty the dust bowl of the air filter – extremely dusty conditions – normal conditions
		●			Clean or renew the air filter element
●	●				Check the pressure of the lubricating oil at the gauge, if fitted
●					Check the level of the lubricating oil
●					Check the amount of coolant
●					Drain all water/sediment from the primary fuel filter, if fitted
	●	●			Check the condition and the tension of all drive belts
		●			Renew the lubricating oil (see page 4.02 for optional servicing periods)
		●			Renew the canisters of the lubricating oil filter (see page 4.02 for optional servicing periods)
		●			Renew the rotor of the lubricating oil by-pass filter
		●			Renew the canister of the main fuel filter
			●		Check the specific gravity and the pH value of the coolant
			●		Renew the compressor air filter, if fitted
			●		Loosen and tighten the bolts and the nuts of the cylinder heads to the correct torque only in accordance with the instructions given in this Section.
			●		Ensure that the fuel injectors are checked and corrected or renewed, if necessary*
			●		Ensure that the tappet clearances are checked and adjusted, if necessary*
			●		Ensure that the alternator, turbocharger/s, starter motor and the coolant pump are checked*
			●		Engine overhaul

* By a person who has had the correct training.

4 PREVENTIVE MAINTENANCE

How to check the coolant level

Remove the filler cap from the radiator and check that the level of the coolant mixture just touches the bottom of the filler tube inside the radiator or as specified in the vehicle manual. If necessary, add coolant until the level of the coolant reaches the filler tube. Fit the filler cap.

For radiators which have a short filler tube: check that the level of the coolant mixture is 76mm (3 in) below the top of the filler tube of the radiator. If necessary, add coolant until the level is correct. Fit the filler cap.

Caution: *If coolant is added to the system during the service, it must consist of the same original mixture as used to fill the system.*

Warning! *On a hot engine release the filler cap carefully as the system will be under pressure.*

How to check the lubricating oil level

Check the amount of lubricating oil in the sump by the use of the dipstick, at the periods given in the service schedule.

Stop the engine and check that the oil level is at the H mark on the dipstick. If necessary, put more oil into the sump. The oil must be of the same grade and specification as the oil which is already in the system. Do NOT overfill.

How to check the drive belts

Check all drive belts and renew a belt if it is worn or damaged. Where more than one belt is used between two pulleys, all of the belts must be renewed together.

Check the belt tension at the centre of the longest free length (A1).

The correct deflection of the belt at this point should be 12 mm (0.5 in) when the pressures given below are applied.

Fan belts

254 mm (10.0 in) between the centres of the pulleys:

6,3 to 7,25 kgf (14 to 16 lbf)

321 mm (12.625 in) between the centres of the pulleys:

5,0 to 6,0 kgf (11 to 13 lbf).

Alternator belt

All engines:

6,5 to 7,5 kgf (14.5 to 16.5 lbf).

How to adjust the drive belts

(a) Drive belts for the coolant pump

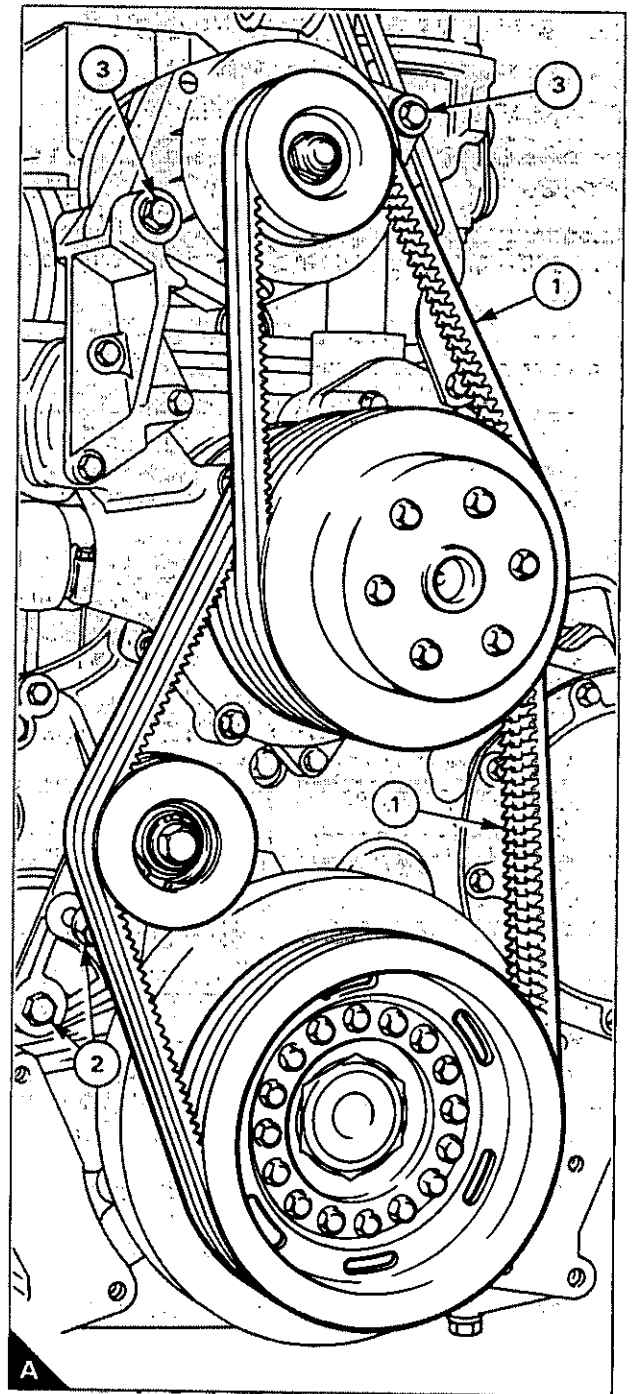
Loosen the two bolts (A2) which retain the belt tensioner and slide the belt tensioner until the correct tension is obtained. Tighten the two bolts.

(b) Drive belt for the alternator

Loosen the two bolts (A3) and move the alternator on the pivot bolt to tighten the belt to the correct tension. Tighten the two bolts.

Check again the belts to ensure that the tensions are still correct. Maximum belt life will be obtained only if the belts are kept at the correct tensions.

Where more than one belt is used between two pulleys, check/adjust the tension on the tightest belt.



4 PREVENTIVE MAINTENANCE

How to renew the engine lubricating oil

Ensure that the engine is on level ground

- 1 Operate the engine until it is warm.
- 2 Stop the engine, remove the sump drain plug (A1 or B1) and drain the lubricating oil into a suitable container.

Attention: A thread insert is fitted to certain sumps. Inspect the thread to find which type is fitted to your engine.

- 3 Fit the drain plug and a new sealing washer and, according to the type of thread, proceed as follows:

Sump with a thread insert (A): This plug has a $\frac{7}{8}$ UNS thread. Use a spanner - size $1\frac{1}{8}$ AF - to tighten the drain plug (A1) to a torque of 115 Nm (85 lbf ft). Retain the drain plug with locking wire where this facility is provided.

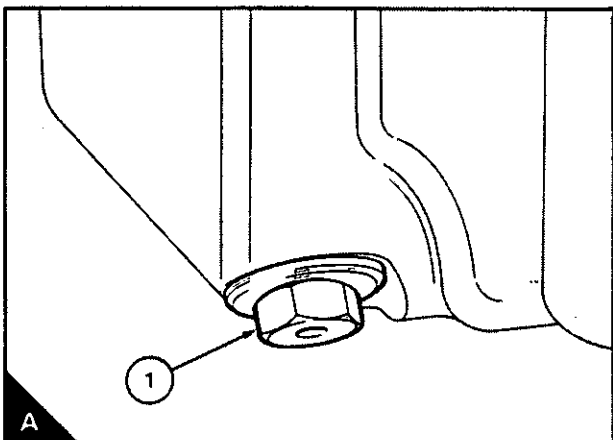
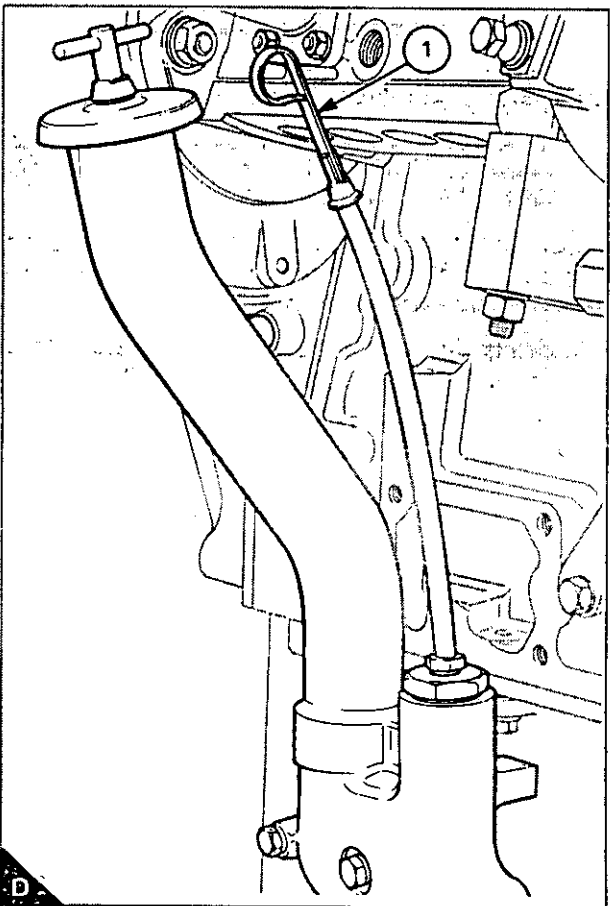
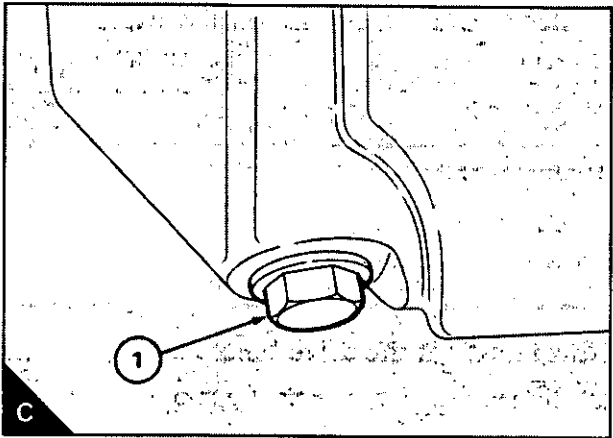
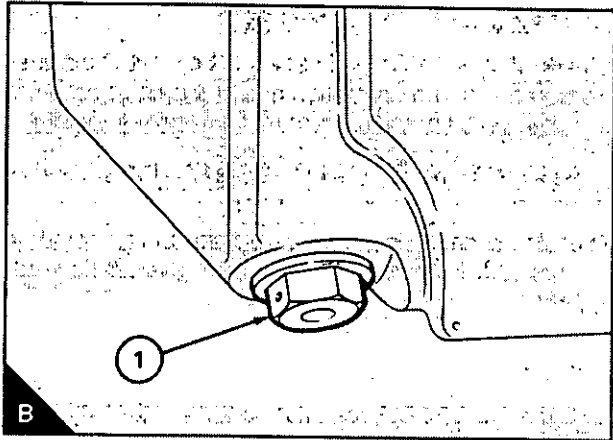
Sump without a thread insert (B): This plug has a $\frac{5}{8}$ BSP thread. Use a spanner - size $\frac{13}{16}$ AF - to tighten the drain plug (B1) to a torque of 47,5 Nm (35 lbf ft). Retain the drain plug with locking wire where this facility is provided.

Sump without a thread insert (C): This plug has a $\frac{3}{4}$ BSP thread. Use a spanner - size $\frac{15}{16}$ AF - to tighten the drain plug (C1) to a torque of 61 Nm (45 lbf ft).

- 4 Renew both of the oil filter canisters as instructed on page 4.07.

5 Clean the area around the oil filler cap and remove the cap. Fill the sump to the H mark on the dipstick (D1) with clean new lubricating oil of an approved grade as given on page 5.02. Do NOT overfill.

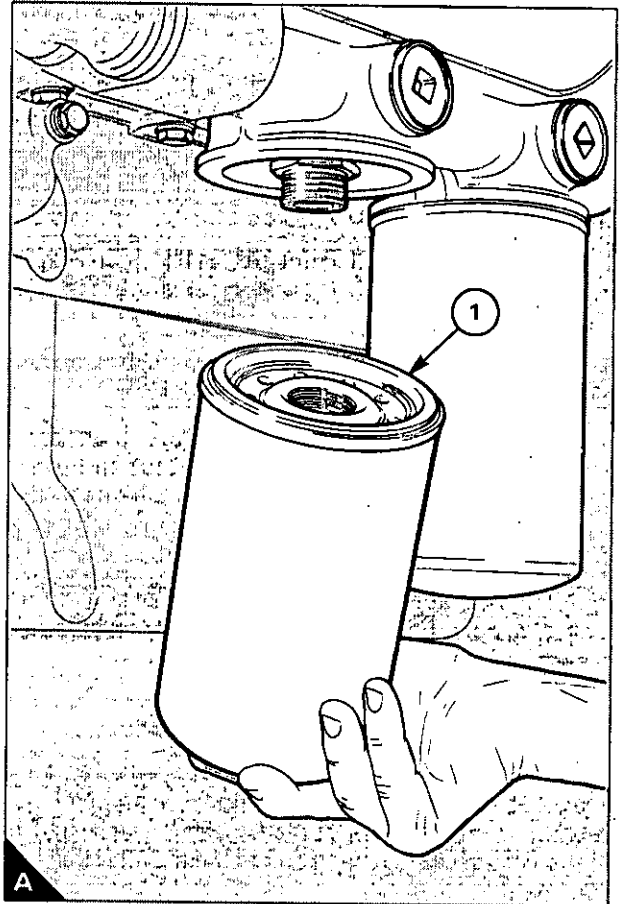
6 Operate the engine and check for leakage from the filter canisters. When the engine has cooled, check the oil level on the dipstick and put more oil into the sump, if necessary.



How to renew the canisters of the oil filter

Two screw-on type canisters are fitted to the filter head, which is integral with the casing of the heat exchanger and is fitted to the right side of the engine at the front.

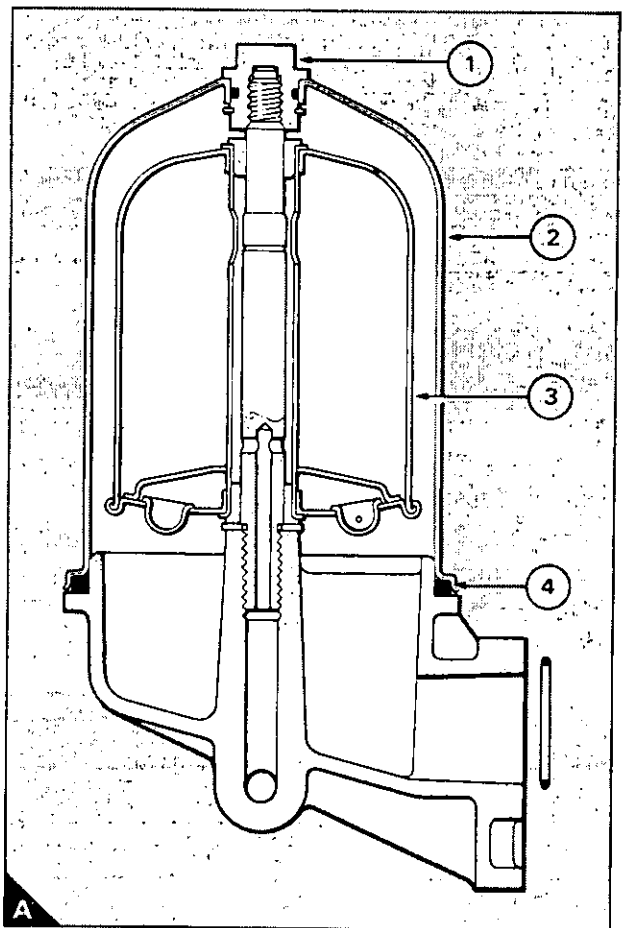
- 1 Put a tray under the canisters and use a strap wrench GA 5074 to remove each canister.
- 2 Check that the sealing rings (A1) are correctly fitted to the new canisters and clean the contact faces of the filter head.
- 3 Fill the two new canisters with new engine lubricating oil of the correct grade and lubricate the top of each canister seal with the same oil.
- 4 To install the new canisters use this procedure: Tighten the canisters on their adaptors until the sealing rings are in contact with the face of the filter head, then turn the canisters a further $1 \frac{1}{4}$ of a turn, by hand. Do NOT overtighten.



How to renew the rotor of the by-pass filter for the lubricating oil

Some engines are also fitted with a by-pass filter for the lubricating oil. The rotor of the by-pass filter must be renewed at the periods given in the relevant schedule.

- 1 Clean the area around the by-pass filter. Remove the filter bowl (B2), remove and discard the rotor (B3).
- 2 Remove the seal (B4) from the filter bowl and clean all the components, especially the recess for the seal in the filter bowl and the contact face for the seal on the housing.
- 3 Fit a new seal to the recess in the filter bowl and lubricate the face of the seal with clean engine lubricating oil.
- 4 Fit a new rotor to the spindle and ensure that it can rotate freely. Fit the filter bowl and tighten the nut (B1) to a torque of 20 Nm (15 lbf ft).
- 5 When the engine is operated, check for leakage from the by-pass filter.



4 PREVENTIVE MAINTENANCE

How to renew the canister of the main fuel filter

The main fuel filter is at the rear of the engine and is a unit with a single canister.

- 1 Clean the area around the filter and remove the fuel filter canister. If necessary, use a strap wrench GA 5074. Discard the canister.
- 2 Check that the sealing ring (A1) is fitted correctly to the new canister and clean the contact face of the filter head.
- 3 Lubricate the top of the canister seal with clean fuel oil and renew the sealing ring on the adaptor.
- 4 To install the new canister use this procedure: Tighten the canister on its adaptor, until the sealing ring is in contact with the face of the filter head, then turn the canister a further $1 \frac{1}{4}$ of a turn, by hand, or to a torque of 20 Nm (15 lbf ft). Do NOT overtighten.

After the fuel filter canister has been renewed, turn on the fuel supply. Eliminate air from the low pressure fuel system as given on page 4.15.

How to drain the primary fuel filter

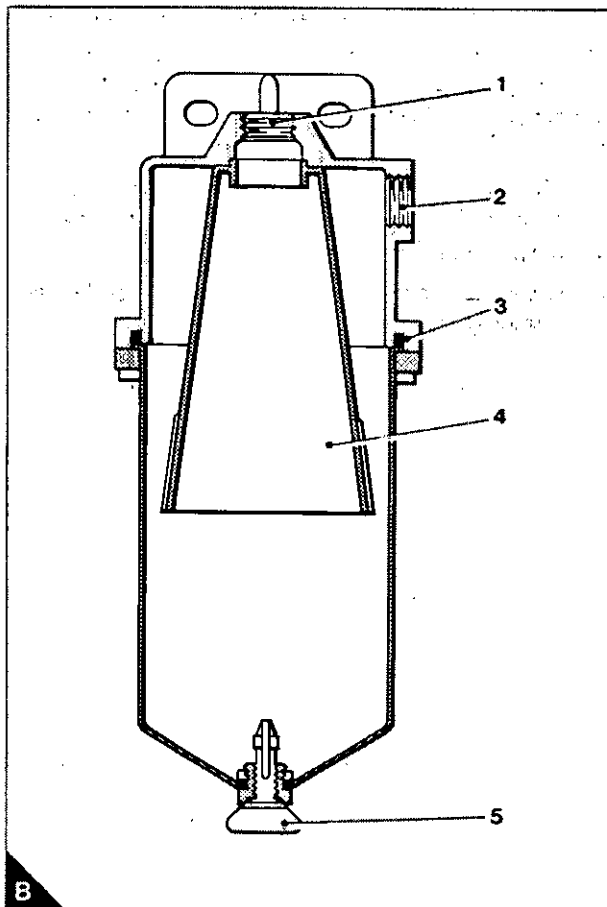
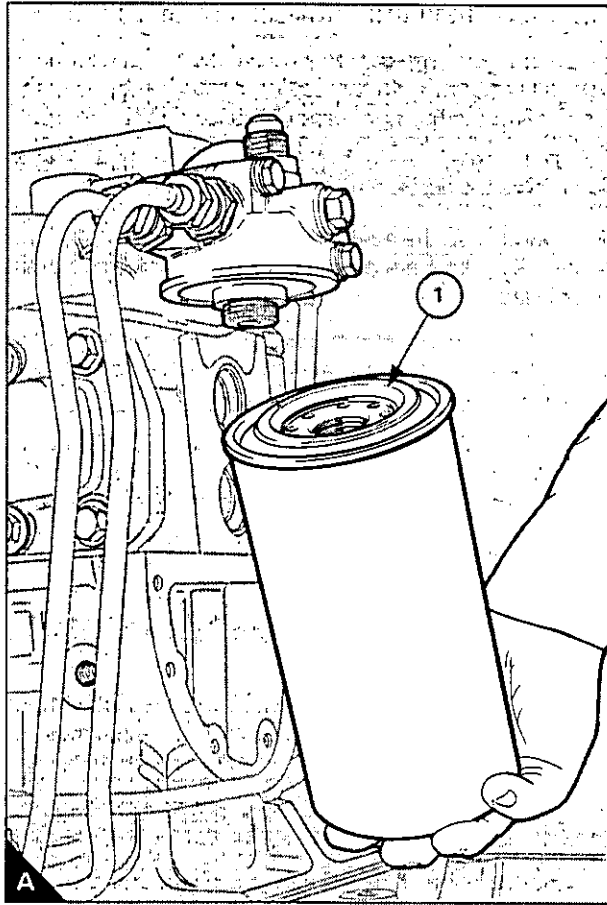
The primary fuel filter (B) is fitted between the fuel tank and the lift pump and works on the principle of centrifugal separation. The fuel is obtained from the tank by the suction of the lift pump and enters the filter through the port (B2).

The fuel rotates around the tapered tube (B4) to cause all sediment and water to move toward the outer wall of the filter, and then to fall to the bottom of the sediment bowl. The fuel flows out through the port (B1) to the fuel lift pump.

- 1 Remove the drain plug (B5) from the base of the filter bowl and allow all water and sediment to drain from the unit.
- 2 Fit the drain plug and tighten it securely.

How to clean the primary fuel filter

- 1 Remove the three bolts and remove the sediment bowl.
- 2 Clean all of the components with paraffin and dry them with compressed air.
- 3 Fit the sediment bowl to the filter head, together with a new sealing ring (B3). Align the clamp ring and fasten it with the three bolts.



How to check the specific gravity of the coolant

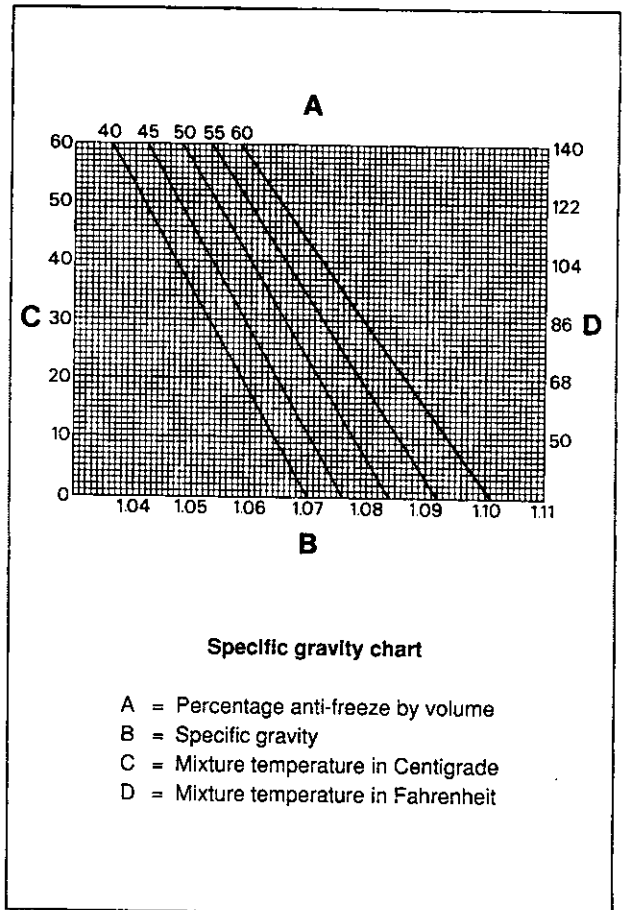
Drain some coolant from the cooling system after the engine has been stopped and before the formation of sediment. Proceed as follows:

- 1 Mixtures which contain inhibited ethylene glycol:
 - (a) Put a hydrometer, and a reliable thermometer, into the anti-freeze mixture and check the readings on both instruments.
 - (b) Compare the readings obtained with the chart and adjust the strength of the mixture as necessary.
- 2 For mixtures which contain inhibited propylene glycol:
 - (a) Open the cover of the refractometer, check that the clear panel is clean and use a small syringe to apply a few drops of the coolant mixture to the clear panel.
 - (b) Spread the coolant over the full area of the clear panel and close the cover. Hold the refractometer horizontal with the clear panel up and inspect the sample through the viewer.
 - (c) Compare the reading with the chart in the instructions; adjust the strength of the mixture as necessary.

Attention: The clear panel must be thoroughly cleaned before use. If some of the fluid which was tested before remains on the clear panel, the reading of the sample will be affected.

Protection against frost is as follows:

Anti-freeze/water (% by volume)	Protection down to (°C)
50/50	-35
60/40	-40



How to check the pH value of the coolant

The pH value of the coolant must not be less than pH7 or more than pH9.5. The pH value can be found by the use of a pH meter or test papers, which are available from pharmaceutical manufacturers.

If these limits are exceeded the pH value may be adjusted by the addition of corrosion inhibitor to the same specification as that already in use. If this is not possible, the system must be drained, flushed and filled with new coolant.

4 PREVENTIVE MAINTENANCE

Fuel injector fault

A fuel injector fault can cause an engine misfire.

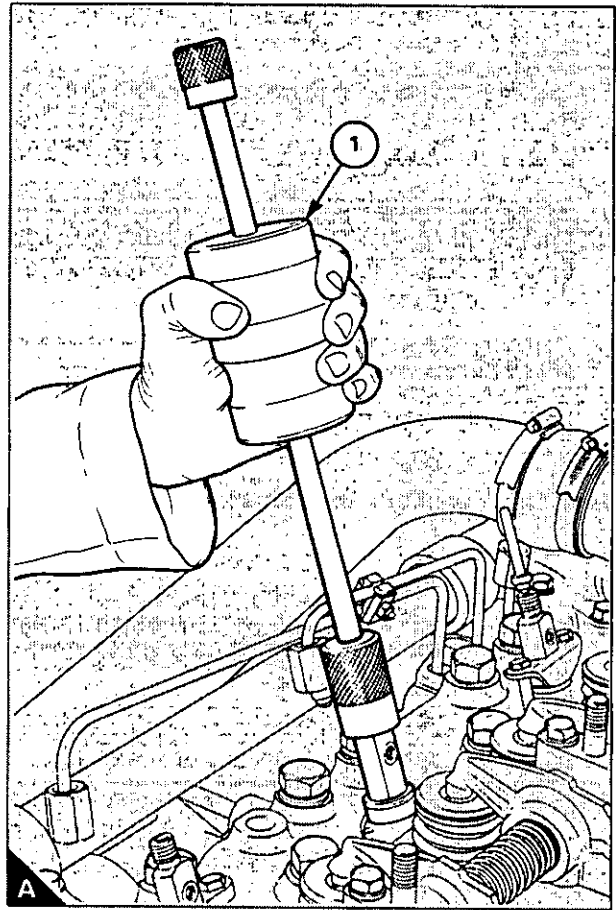
To find which injector is defective, operate the engine at a fast idle speed. Loosen and tighten the union nut of each of the high-pressure fuel pipes at the fuel injection pump. When the union nut of the defective injector pipe is loosened, it has little or no effect on the engine speed.

Warning!

- Ensure that the fuel does not spray onto your skin.
- Ensure that the fan guards are fitted.

How to remove a fuel injector

- 1 Clean the area around the fuel injector.
- 2 Disconnect and remove the leak-off pipe from the fuel injector.
- 3 Disconnect and remove the high pressure pipe. If necessary, release the pipe clip. Do NOT bend the pipe.
- 4 Remove the bolts and the clamp which retains the fuel injector and withdraw the fuel injector. Remove and discard the copper sealing washer and the rubber seal, and temporarily seal the top of the fuel injector sleeve to prevent the entry of dirt or debris.
- 5 To remove a tight fuel injector, use the slide hammer, GA 5100 (A1) and the relevant adaptor GA 5100-12.



Fuel injector sleeves

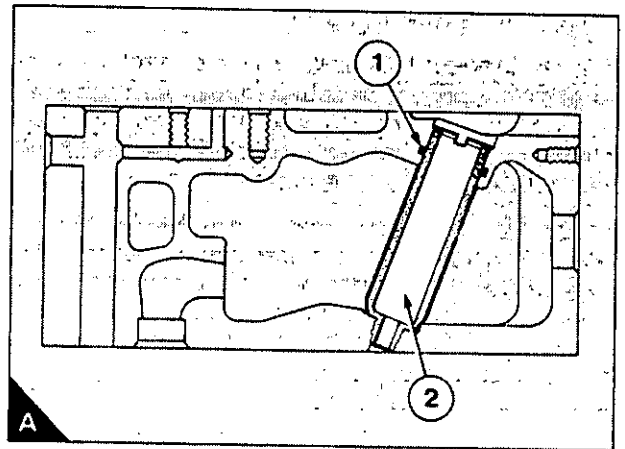
Steel fuel injector sleeves are fitted through the coolant galleries of each cylinder head and are retained by a thread at the bottom of the cylinder head. The thread is sealed with 'Hylomar Universal' sealing compound. The top of the fuel injector sleeve is sealed by an 'O' ring (A1) which is fitted to a groove in the cylinder head.

How to correct a fuel injector sleeve

Before the fuel injectors are renewed, the faces of the seats in the fuel injector sleeves should be cleaned by the method given below.

1 To retain carbon and metal particles, grease must be applied to both of the cutters of the tool in the cleaning kit GA 5165 before it is used. Insert the tool into the fuel injector sleeve and remove the carbon deposits from the faces of the seats. **DO NOT REMOVE METAL FROM THE FACES OF THE SEATS.**

2 When a fuel injector is removed, if the copper sealing washer remains in the fuel injector sleeve, it can be removed with the tool which is used to clean the fuel injector sleeve.



4 PREVENTIVE MAINTENANCE

How to fit a fuel injector

The seal between the nozzle of the fuel injector and the fuel injector sleeve is made by a copper sealing washer. The washer must be renewed at the recommended intervals given in the schedules for the preventive maintenance of the fuel injectors.

To prevent the entry of dirt between the fuel injector and the fuel injector sleeve, a rubber seal is fitted onto the body of the fuel injector over a counterbore in the cylinder head. An aluminium distance piece is then fitted above the rubber seal. When the clamp for the fuel injector is tightened, the rubber seal is pressed into the counterbore. The rubber seal should be renewed at the recommended intervals given in the schedules for the preventive maintenance of the fuel injectors.

1 Ensure that the fuel injector sleeve is clean and is free from carbon deposits.

2 Fit a new rubber seal (A1) onto the body of the fuel injector and a new copper sealing washer (A2) to the nozzle. Fit the aluminium distance piece above the rubber seal.

3 Apply evenly anti-seize compound ('Morris K72' or equivalent) to the body of the fuel injector between the arrows (B1). Do NOT allow the anti-seize compound to contaminate the copper washer or the nozzle of the fuel injector (B2).

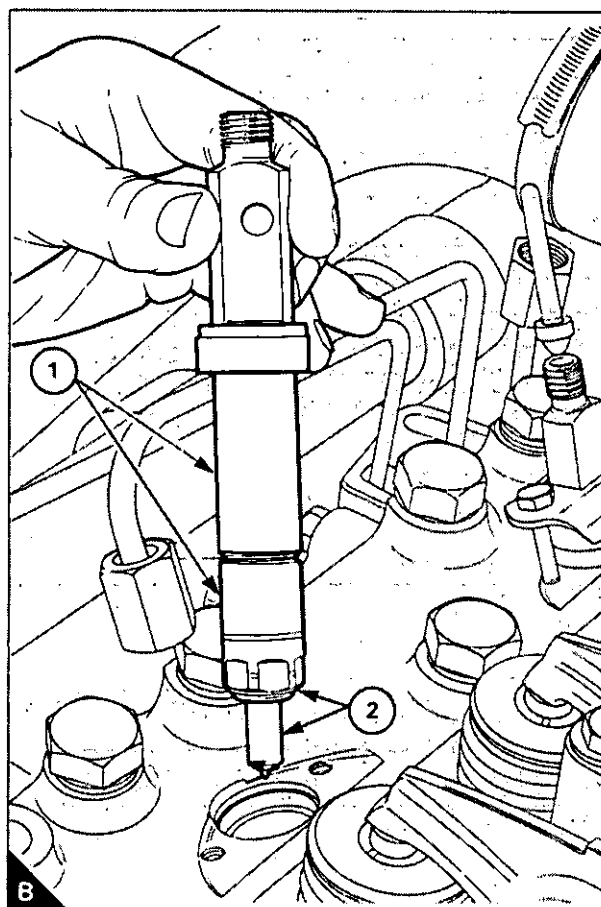
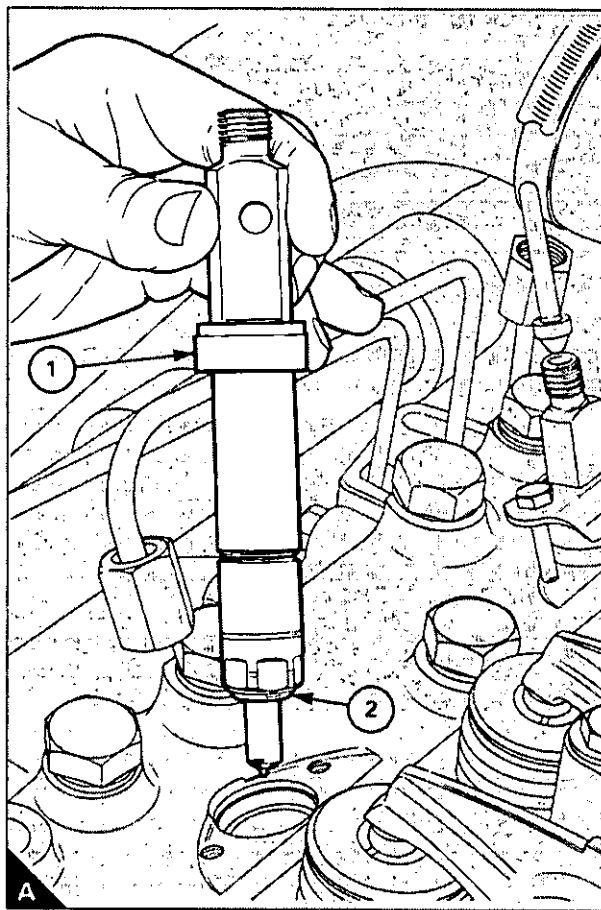
4 Fit the fuel injector into the fuel injector sleeve. Apply an even layer of anti-seize compound of 1mm thickness to the threads of the retaining bolts. Retain the fuel injector with the clamp and the bolts. Tighten evenly the bolts to a torque of 11Nm (8 lbf ft).

5 Fit the high-pressure fuel pipe. Ensure that there is no tension on the connections and that the connections do not turn when the nut is tightened.

6 Fit and tighten all clamps which may have been removed.

7 Fit the leak-off pipe, complete with new washers, and eliminate air from the fuel system as given on page 4.13.

8 Run the engine and check for leakage.



How to eliminate air from the fuel system

If air enters the fuel system, it must be eliminated before the engine can be started.

The pressure from the fuel injection pump may become insufficient to operate the valves of the fuel injectors and the engine may stop, misfire or fail to start.

Air can enter the system if:

- The fuel tank is drained during normal operation.
- The low-pressure fuel pipes are disconnected.
- There is a leakage in the fuel system during the operation of the engine.
- The fuel filter canister has been removed.

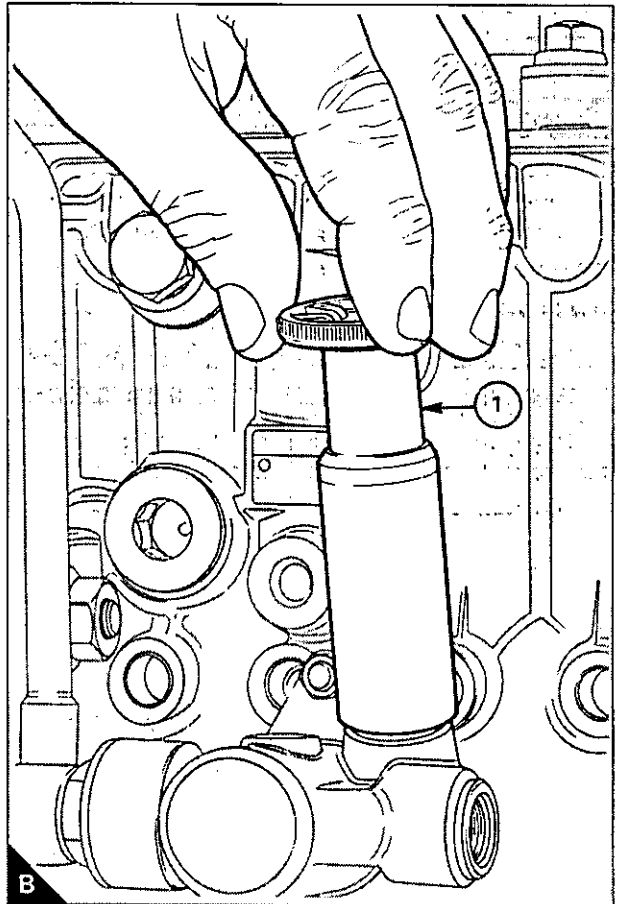
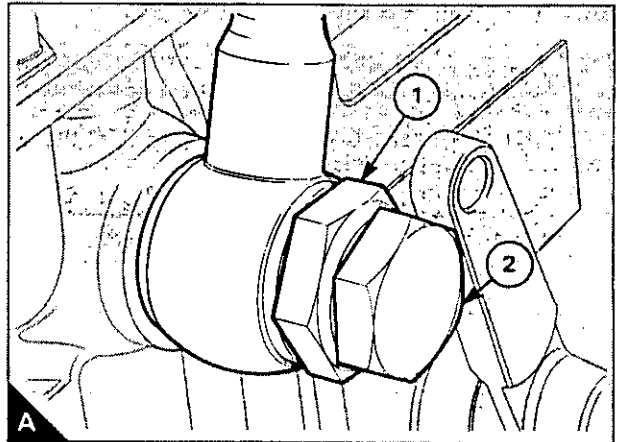
To eliminate air from the system, use the procedure which follows:

Low pressure system

1 Use a 19 mm spanner to loosen the banjo connection bolt (A1) at the low-pressure relief valve by one or two turns. Do NOT loosen the bolt (A2) which retains the spring and the plunger of the relief valve.

2 Operate the priming pump (B1) of the fuel lift pump. When fuel, free from air, flows from the banjo connection, continue to operate the priming pump and tighten the banjo connection bolt.

Clean away fuel which has been spilled.



4 PREVENTIVE MAINTENANCE

How to check the tappet clearances

Check and adjust the tappet clearances in the sequence which follows, while the injectors are removed for service.

The tappet clearances are measured between the rocker levers and the tips of the valves (A).

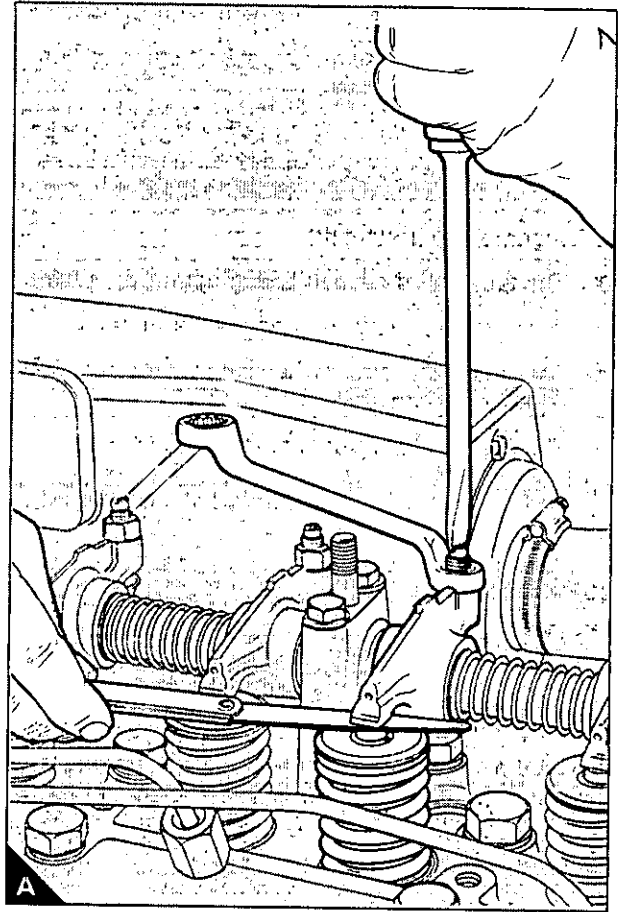
Valves set on cylinder No.	Check tappets on cylinder No.
6	1
3	4
5	2
1	6
4	3
2	5

- 1 Remove the rocker covers.
- 2 Turn the crankshaft in the normal direction of rotation until the inlet valve of number 6 cylinder has just opened and the exhaust valve of the same cylinder has not closed completely. The valves of number 6 cylinder are then 'set'.
- 3 Check the clearances of the valves of number 1 cylinder and adjust them, if it is necessary (A). When the clearance has been set, tighten the lock nut.

Tappet clearances (cold)

Inlet	0,25mm (0.010in)
Exhaust	0,50mm (0.020in)

- 4 Continue to turn the engine and adjust the remainder of the tappets in the sequence given above.
- 5 Refit rocker covers.



Alternator

The alternator which is fitted on the 2000 Series engine is a Butec type A3024 with an integral regulator. It is belt driven.

The three phase alternator is of the rotating field and stationary armature type. The rectifier consists of six silicon diodes. These are retained by the two heat sinks in the assembly of the rectifier, which is in the housing at the slip ring end.

Excitation of the field is done by three auxiliary diodes which are assembled in the centre of the rectifier.

The output is controlled by an integral regulator and the maximum rated output (hot) is 32 amps at 28 volts.

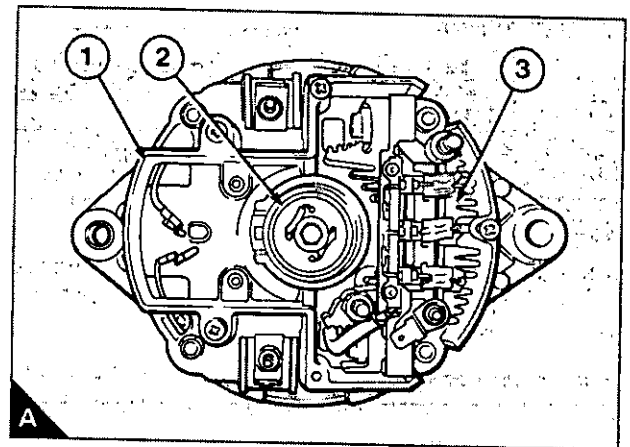
A centrifugal fan causes a flow of cool air through the alternator and the fins of the heat sinks.

How to maintain the alternator

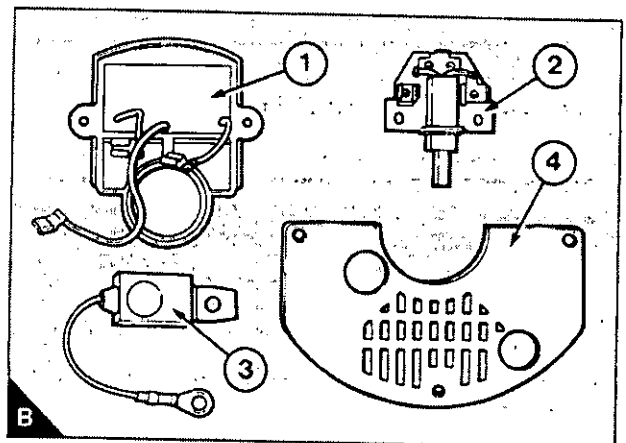
Clean the outside of the alternator and ensure that the ventilation holes are clean, at the periods given in the service schedule. Contamination near to the diodes can cause sparks and must be removed with an approved cleaning fluid. A recommended fluid is Electronic Cleaning Fluid, Grade 8-23, available in aerosol containers or in larger quantities from Applied Chemicals Limited, Uxbridge, Middlesex.

The alternator must be checked and corrected, if necessary, by a person who has had the correct training, at the recommended intervals given in the schedules for the preventive maintenance of the alternator. Proceed as follows:

- 1 Check the condition and the tension of the drive belt, and adjust or renew as necessary.
- 2 Disconnect the two wires of the regulator (B1) from the terminals on the holder (B2) of the carbon brushes. Make a note of the correct position of each wire for their subsequent assembly. Remove the two screws which retain the regulator and lift away the regulator.
- 3 Remove the screws which retain the holder of the carbon brushes, disconnect the wires and lift out the assembly of the holder.
- 4 Check the carbon brushes for damage and ensure that they are suitable for use. The minimum possible protrusion of the carbon brushes from the holder must be 10,0 mm (0.394 in). Renew the carbon brushes if the protrusion is less than 10 mm.
- 5 Remove the four screws which retain the housing of the carbon brushes, withdraw the housing and inspect the assembly of the slip rings.



A 1 Carbon brush housing
2 Slip ring assembly
3 Rectifier assembly



B 1 Regulator
2 Brush box assembly
3 Capacitor
4 Plastic cover

6 Clean the components and remove all of the dirt. Use a soft clean rag which is damp with gasoline or white spirit. Slip rings which are worn or rough must be renewed.

7 It is recommended that the Manufacturer's Instruction Publication is used as a reference when new components are to be fitted.

4 PREVENTIVE MAINTENANCE

Starter motor

The Butec LMS1 starter motor is an electrically operated 24 volt unit with a solenoid switch fitted on the outside of the yoke. The drive gear engages with a starter ring which is a component of the flywheel assembly.

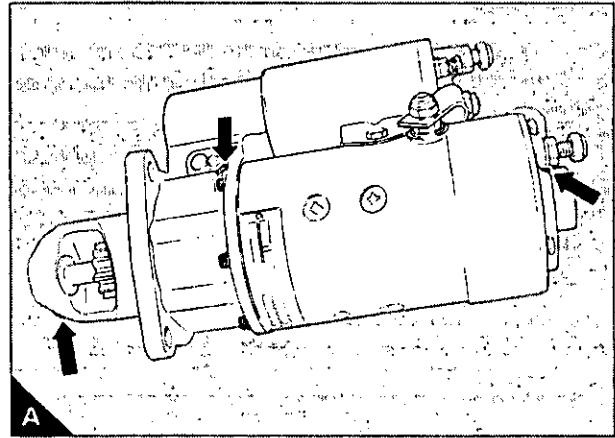
How to maintain the starter motor

Attention: Before the starter motor is removed from the engine or other work is done to it, disconnect the cables from the battery terminals.

At intervals, inspect the starter cables for damage and ensure that the nuts of the terminals and the bolts which hold the starter motor are tight.

The starter motor must be checked and corrected, if necessary, by a person who has had the correct training, at the recommended intervals given in the service schedules. Remove the starter motor and proceed as follows:

- 1 Clean the outside of the starter motor and remove the commutator cover. Use dry compressed air to remove dust from the area of the carbon brushes.
- 2 Inspect the commutator for wear and damage. A polished dark copper finish indicates that the condition is acceptable. Signs of wear or damage indicate that a new or reconditioned commutator is necessary.
- 3 Ensure that the carbon brushes slide freely in their holder and check that the load of the springs is 1,42 to 1,68 kgf (50 to 59 ozf). An excessively lower load indicates that the carbon brushes are worn. The minimum acceptable length is 15,9 mm (0.625 in).
- 4 If new carbon brushes are necessary, the shape of the contact faces must conform to the radius of the commutator. Keep away the wires of the carbon brushes from other components.
- 5 Spread a thin application of glycerine on the gasket of the cover for the carbon brushes and fit the ends of the cover across one of the ribbed sections of the yoke. Tighten the two screws which retain the cover to 1,13 to 1,70 Nm (10 to 15 lbf in).
- 6 Remove the screws from the three points shown by arrows (A) and put three or four drops of SAE 5W/20 engine lubricating oil on the lubricator wicks. Fit the screws to the three points.



A new unit, or an exchange unit, should also be lubricated by the same procedure before it is fitted.

- 7 Clean the splines of the pinion assembly and lubricate them with a thin application of graphite grease. Check that the pinion moves freely.
- 8 Ensure that the starter motor is assembled correctly to the engine and retain it securely with the three bolts. Check that the terminals are clean.
- 9 Fit the lugs of the relevant cables to the two terminals. Ensure that the polarity of the cables is correct and fit the locking washers and the lock nuts, or the stiffnuts if relevant.
- 10 Hold a 19 mm (0.75 in) A/F spanner on the inner lock nuts to ensure that they do not move while the outer nuts are tightened to 34 Nm to 41 Nm (25 to 30 lbf ft) with a suitable torque wrench.

How to drain the coolant system

Drain and flush the coolant system every 12 months or less. It is recommended that the coolant system is drained as soon as possible after the engine has been stopped and before the formation of sediment. Proceed as follows:

- 1 Ensure that the engine is level.
- 2 Remove carefully the filler cap of the radiator, especially if the engine is hot.

Warning! Use care during the removal of the filler cap as the coolant system will be under pressure.

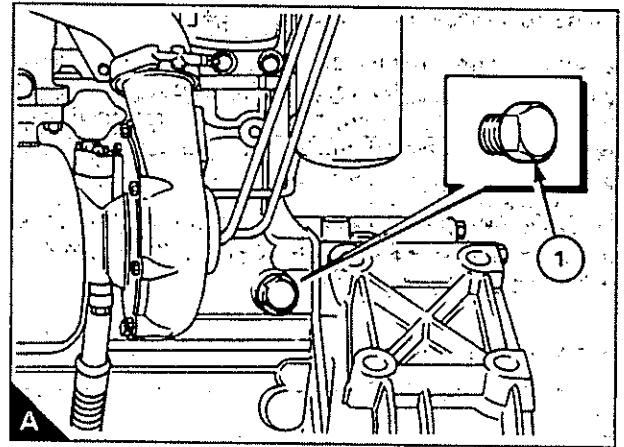
- 3 Remove the coolant drain plug (A1) from the rear of the left side of the engine. Ensure that the drain holes are not restricted.
- 4 To drain the radiator, refer to the Manufacturer's Instruction Publication.
- 5 Flush the system with clean water.
- 6 Fit the engine drain plug and all items which were removed in accordance with the Manufacturer's Instruction Publication.
- 7 Fit a 'coolant drained' label if the coolant system is not to be filled immediately.

How to clean the coolant system

The coolant system must be drained and flushed through with clean water until it flows clear from all of the drain outlets.

If the system has become contaminated, it must be cleaned. Use clean water with 1% of Symperonic 'N'. This is equivalent to 10 ml/litre or 45 ml/UK gallon.

- 1 Fill the system with clean water, at the same time add the necessary amount of Symperonic 'N' at the filler cap.
- 2 Operate the engine until the coolant reaches the normal temperature of operation, then operate the engine at maximum rated speed for 10 minutes. See 'Note' at the end of this section.
- 3 Stop the engine and drain immediately the coolant from all of the drain outlets.
- 4 Allow the engine to cool, then fill the system with clean water. Allow a minimum of 5 litres (1 UK gallon) to drain from the system before the drain outlets are closed.
- 5 Operate the engine as in operation 2, but maintain maximum speed for 5 minutes only.



- 6 Repeat operations 3, 4 and 5.
- 7 Drain the system completely and close the drain outlets. Fill the system with the correct coolant mixture.

Note: In very cold ambient conditions, the thermostat may not open to allow full circulation of the cleaning fluid. If this occurs the engine must be operated on load. The thermostat is open when the pipe between the thermostat housing and the radiator is hot. If the pipe is cool, the thermostat valve is closed.

How to fill the coolant system

Fill the system slowly, with the approved coolant mixture, until the coolant is just in contact with the bottom of the filler tube inside the radiator or as specified in the vehicle manual. For radiators which have a short filler tube: check that the level of the coolant mixture is 76mm (3 in) below the top of the filler tube of the radiator. Operate the engine until the coolant reaches the normal temperature of operation. Stop the engine, check the coolant level and, if necessary, add extra coolant. Fit the filler cap.

Warning! Use care during the removal of the filler cap as the coolant system will be under pressure.

4 PREVENTIVE MAINTENANCE

How to check the turbocharger

Disconnect and remove the pipes from between the air filters and the turbocharger, at the periods given in the service schedule. Turn, rapidly, the rotor assembly, check for freedom of movement and for sounds of interference.

Deposits must not be removed from the turbine wheel nor the compressor wheel, or the balance of the assembly will be adversely affected.

How to tighten the bolts of the cylinder head

- 1 Remove the rocker covers and the rocker assembly.
- 2 Clean the nuts and the heads of the bolts which retain the cylinder heads.
- 3 Make a temporary mark on each nut and the head of each bolt, and also on the cylinder heads. Ensure that the marks are aligned.

Caution: Do NOT loosen more than one nut or bolt at a time.

- 4 Work on one bolt or nut at a time, use the sequence shown (A) and proceed as follows:

Bolts and nuts shown in white circles (A):

- a) Remove each bolt, lubricate lightly the threads and the face under the head of the bolt. Fit the bolt.
- b) Tighten to 204 Nm (150 lbf ft) or until the marks align (whichever is the tighter).

Bolts shown in black circles (A):

- a) Remove each bolt, lubricate lightly the threads and the face under the head of the bolt. Fit the bolt.
- b) Tighten the bolt to 237 Nm (175 lbf ft) or until the marks align (whichever is the tighter).

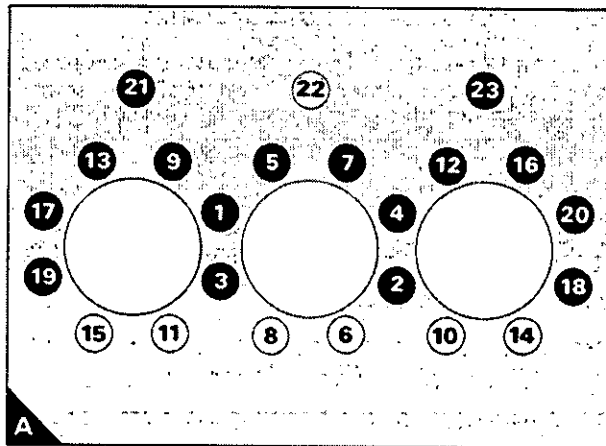
- 5 Fit the rocker gear, tighten the bolts evenly and gradually to a torque of 40 Nm (30 lbf ft).

- 6 Check the tappet clearances and, if necessary, adjust them to the correct dimension.

Tappet clearances (cold):

Inlet 0,25mm (0.010in)
Exhaust 0,50mm (0.020in)

- 7 Put approximately 0,6 litre (1 pint) of clean engine lubricating oil over the rocker assemblies and fit the rocker covers.



Engine fluids

5

Diesel fuel	...	...	...	...	...	...	5.02
Coolant	...	...	...	...	...	...	5.02
Coolant mixture	...	...	...	...	...	...	5.02
Corrosion inhibitor	...	...	...	...	...	...	5.02
Water quality	...	...	...	...	...	...	5.02
Lubricating oil	...	...	...	...	...	...	5.02
Engine oils							
Europe	...	...	...	...	...	...	5.03
Remainder of the world	...	...	...	...	...	...	5.04

Engine fluids

Diesel fuel

Diesel fuel must conform to the specifications below:

BS EN 590:1993 - (0.2% sulphur maximum - 49 minimum cetane number). Fuel oils for automotive use, or BS 2869: Part 2 1988 Class 2 - 0.5% sulphur maximum - 45 minimum cetane number). Fuel oils for non-marine use.

ASTM Diesel fuel Classification: D.975 No. 1-D or ASTM Diesel Fuel Classification: D.975 No. 2-D.

The use of fuels that do not conform to the above standards can cause damage and/or reduced engine life and could affect the warranty. Further details can be obtained from Perkins Engines (Shrewsbury) Limited.

Coolant

Coolant mixture

The coolant approved for use in all diesel engines manufactured by PE(S)L is a mixture of 50% inhibited ethylene glycol, or inhibited propylene glycol, and 50% clean soft water.

Mixtures which contain methanol are **NOT** approved.

The corrosion inhibitor in the anti-freeze or coolant concentrate, must be based on sodium nitrite, sodium benzoate, sodium borate, sodium metasilicate and benzotriazole.

Neither amines nor phosphates to be used. If operators are in doubt, they should consult their source of supply.

In addition, all products which are used should conform to BS 6580-1992.

For marine engines and engines which use aluminium water-cooled exhaust manifolds, only 'DOW 007/400F' is approved.

Corrosion inhibitor

If anti-freeze is not available and is not required then clean soft water, with 1% of PE(S)L corrosion inhibitor, may be used. This ratio is equivalent to 0,5 litres of corrosion inhibitor to 50 litres (11 UK gallons) of water.

The corrosion inhibitor is available from PE(S)L, part number OE 45350 (1 litre).

The use of this product should be controlled in accordance with the manufacturer's instructions.

Water quality

Soft water means de-ionised water, distilled water, rain water, or water from a mains supply which has a maximum combined chloride and sulphate level of 150 mg/litre and a maximum total hardness of 250 mg/litre.

i) If soft water is not used, the cooling system may be affected by the formation of hard deposits which can cause the engine to overheat. This is especially important for engines which are topped up frequently.

ii) The use of products which are not approved for the cooling system may cause serious problems. Coolant mixtures with insufficient corrosion inhibitor can cause erosion and/or corrosion of the cooling system components.

Lubricating oil

1 Viscosity - PE(S)L recommend the use of SAE 15W/40 for all engines that work in ambient temperatures above -15°C (5°F). Below -15°C (5°F) and down to -25°C (-13°F) the use of a 10W/30 oil is recommended. For engines which operate in arctic conditions, below -25°C (-13°F), contact the PE(S)L Service Department.

2 Performance specification - For heavy duty operation, or extended drain (Eagle TX only), super high performance oils (SHPD) must be used. These oils exceed the requirements of CCMC-D5 and API-CE and are listed in the 'preferred' columns of the table shown.

For normal operation, oils which exceed the requirements of CCMC-D4 and API-CE may be used. These oils are listed in the 'acceptable' columns of the tables shown.

In countries where oils which conform to API-CE are not yet available, an oil which conforms to API-CD/MIL-L-2104D can be used.

It is recommended that the operator uses oils shown in the 'preferred' columns as these give the greatest protection.

Below is a list of oils recommended by Perkins Engines (Shrewsbury) Limited. The operator must ensure that the oil used conforms to the above requirements.

Europe

Manufacturer of lubricating oil	Preferred multi-grade oils which conform to CCMC D5, API-CE	Acceptable multi-grade oils which conform to CCMC D4, API-CE
AGIP	Sigma Turbo 15W/40	Super Diesel 15W/40
BP	Vanellus C3 Extra 15W/40 Vanellus FE 10W/30 Vanellus HT 10W/40	Vanellus C3 15W/40 Vanellus C3 10W/30
CALTEX	ONLY MARKETED IN MIDDLE EAST, SOUTH AND EAST AFRICA AND AUSTRALASIA	
CASTROL	Turbomax 15W/40	Rx Super Plus 15W/40
CENTURY	Centurion 15W/40	Hypafleet 15W/40
CHEVRON	Delo SHP 15W/40	
DALTONS	Turbolene D Plus 15W/40	Turbolene D 15W/40 Ashford 15W/40
ELF	Performance Trophy 15W/40	Performance Super 15W/40
ESSO	Super Diesel Oil TD 15W/40	Essolube XD-3+ 15W/40
GULF	Superfleet Special 15W/40	Superfleet 15W/40 Super Diesel Multi-grade 15W/40
KUWAIT	Q8T 700 15W/40	Q8T 800 Q8T 400
MILLERS	Truckmaster XHPD 15W/40 Magnafleet SHPD 15W/40 Truckmaster XFE 10W/30	Maxifleet MP 15W/40 Multifleet 15W/40 Suprex 15W/40
MOBIL	Delvac XHP 15W/40	Delvac Super 15W/40 Delvac 1300 Super 15W/40
MORRIS	XHD Plus 15W/40 XHD FE 10W/30	XHD 15W/40 Duplex CDX 15W/40
NICKERSON	Caroylak SHPD 15W/40	Caroylak HDC/X 15W/40
PETROFINA	Fina Kappa LDO 15W/40	Fina Kappa TD 15W/40
SHELL	Myrina TX 10W/30 Myrina M 15W/40	Rimula X 15W/40
SUN	Sunoco Super HPD 15W/40	
TEXACO	URSA Super TD 15W/40	URSA Super LA 15W/40 URSA Super LA 10W/30 URSA Super FE 15W/40
VEEDOL	Turbostar 15W/40	Dieselstar Plus 15W/40 NOT AVAILABLE IN THE UK

5 ENGINE FLUIDS

Remainder of the world

Manufacturer of lubricating oil	Mono-grade oils for continuously operated industrial engines	Preferred multi-grade oils which conform to CCMC D5, API-CE	Acceptable multi-grade oils which conform to API-CE/CD MIL-L-2104D
AGIP		Sigma Turbo 15W/40	Super Diesel 15W/40
BP	Vanellus C3 30 Vanellus C3 40	Vanellus C3 Extra 15W/40 Vanellus FE 10W/30	Vanellus C3 15W/40
CALTEX	RPM Delo 400 SAE 30 (Advanced) RPM Delo 400 SAE 40 (Advanced)	RPM Delo 450 15W/40	RPM Delo 400 15W/40 (Advanced)
CASTROL	RX Super 30 RX Super 40	Turbomax 15W/40	RX Super Plus 15W/40
CENTURY	Centlube Superb 30 Centlube Superb 40	Centurion 15W/40	Hypafleet 15W/40 Superby 15W/40
MIDDLE EAST, FAR EAST AND AUSTRALIA			
CHEVRON	Delo 1000 Marine SAE 30 or 40	Delo SHP 15W/40	
DALTONS	Ashford 30 and 40	Turbolene D Plus 15W/40 AVAILABLE MIDDLE EAST ONLY	Ashford 15W/40
ELF	Disola MT 30 and 40 Disola M 30 and 40		Disola W 15W/40
ESSO	Essolube XD-3 30 Essolube XD-3 40	Super Diesel Oil TD 15W/40	Essolube XD-3+ 15W/40 Essolube XD-3 15W/40
KUWAIT	Q8T 400 30 Q8T 400 40	Q8T 700	Q8T 800 Q8T 400
MILLERS	Maxifleet MP 30 and 40 Turbo M30 and 40	AVAILABLE ONLY BY SPECIAL ORDER	
MOBIL	Delvac 1430 Delvac 1330	Delvac XHP 15W/40	Delvac Super 15W/40 Delvac 1300 Super 15W/40
MORRIS	XHD 30 or 40 HD 30 or 40	XHD Plus 15W/40	XHD 15W/40 Duplex CDX 15W/40
AVAILABLE MIDDLE EAST AND BY SPECIAL ORDER ONLY			
PETROFINA	Fina Kappa TD 30 and 40	Fina Kappa LDO 15W/40	Fina Kappa TD 15W/40
SHELL	Rimula X 30 Rimula X 40	Myrina M 15W/40	Rimula X 15W/40 Rotella T 15W/40
SUN	Sunoco Super HPO SAE 40		
TEXACO	URSA Super LA 30 and 40 URSA Super Plus 30 URSA Super Plus 40		URSA Premium 15W/40 URSA Super Plus 15W/40
VEEDOL	Dieselstar 30 Dieselstar 40	Turbostar 15W/40	Dieselstar Plus 15W/40 Dieselstar 15W/40 Ultistar 25W/40

Warranty

The engine must be operated with the approved fuel, lubricant and coolant, and maintained in accordance with the service schedule or the warranty can become invalid.

Fault diagnosis

6

Problems and possible causes	...	...	...	...	6.02
Code list of possible causes	...	...	...	...	6.03

Fault diagnosis

Problem	Possible causes	
	Checks by the user	Checks by service personnel
The starter motor turns the engine too slowly	1, 2, 3, 4	
The engine will not start	5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 17	34, 35, 36, 37, 38, 42, 43, 44
The engine is difficult to start	5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 19	34, 36, 37, 38, 40, 42, 43, 44
Not enough power	8, 9, 10, 11, 12, 13, 16, 17, 18, 19, 20, 21	34, 36, 37, 38, 39, 42, 43, 44, 61, 63
Misfire	8, 9, 10, 12, 13, 15, 20, 22	34, 36, 37, 38, 39, 40, 41, 43
High fuel consumption	11, 13, 15, 17, 18, 19, 21, 22	34, 36, 37, 38, 39, 40, 42, 43, 44, 63
Black exhaust smoke	11, 13, 15, 17, 19, 21, 22	34, 36, 37, 38, 39, 40, 42, 43, 44, 61, 63
Blue or white exhaust smoke	4, 15, 21, 23	36, 37, 38, 39, 42, 44, 45, 52, 58, 62
The pressure of the lubricating oil is too low	4, 24, 25, 26	46, 47, 48, 50, 51, 59
The engine knocks	9, 13, 15, 17, 20, 22, 23	36, 37, 40, 42, 44, 46, 52, 53, 60
The engine runs erratically	7, 8, 9, 10, 11, 12, 13, 15, 16, 18, 20, 22, 23	34, 38, 40, 41, 44, 52, 60
Vibration	13, 18, 20, 27, 28	34, 38, 39, 40, 41, 44, 52, 54
The pressure of the lubricating oil is too high	4, 25	49
The engine temperature is too high	11, 13, 15, 19, 27, 29, 30, 32	34, 36, 37, 39, 52, 55, 56, 57
Crankcase pressure	31, 33	39, 42, 44, 45, 52
Bad compression	11, 22	37, 39, 40, 42, 43, 44, 45, 53, 60
The engine starts and stops	10, 11, 12	6, 7, 8, 9, 10, 12, 16, 34, 35

Code list of possible causes

- | | |
|---|--|
| <ul style="list-style-type: none"> 1 The battery capacity is low. 2 A bad electrical connection. 3 A fault in the starter motor. 4 The wrong grade of lubricating oil. 5 The starter motor turns the engine too slowly. 6 The fuel tank is empty. 7 A fault in the stop control. 8 A restriction in a fuel pipe. 9 A fault in the fuel lift pump. 10 A dirty element of the fuel filter. 11 A restriction in the air filter or the induction system. 12 There is air in the fuel system. 13 A fault in the fuel injectors, or the fuel injectors are of the wrong type. 14 The cold start system is not used correctly. 15 A fault in the cold start system. 16 A restriction in the vent of the fuel tank. 17 The wrong type or grade of fuel has been used. 18 A restriction in the movement of the engine speed control. 19 A restriction in the exhaust pipe. 20 The engine temperature is too high. 21 The engine temperature is too low. 22 The tappet clearances are incorrect. 23 Too much oil, or oil of a wrong specification is used in a wet type air cleaner. 24 Not enough lubricating oil in the sump. 25 A defective gauge. 26 A dirty element of the lubricating oil filter. 27 The fan is damaged. 28 A fault in the mountings of the engine or the flywheel housing. 29 Too much lubricating oil in the sump. 30 A restriction in the air passages or in the water passages of the radiator. 31 A restriction in the breather. 32 There is insufficient coolant in the system. 33 A fault in the exhauster, or there is a leakage in the vacuum pipe. | <ul style="list-style-type: none"> 34 A fault in the fuel injection pump. 35 A broken drive on the fuel injection pump. 36 The timing of the fuel injection pump is incorrect. 37 The valve timing is incorrect. 38 There is bad compression. 39 The cylinder head gasket leaks. 40 The valves are not free. 41 Wrong high-pressure pipes. 42 The cylinder bores are worn. 43 A leakage between the valves and the seats. 44 The piston rings are not free, or they are worn or damaged. 45 The valve stems and/or the guides are worn. 46 The crankshaft bearings are worn or damaged. 47 The lubricating oil pump is worn. 48 The relief valve does not close. 49 The relief valve does not open. 50 The spring of the relief valve is broken. 51 A fault in the suction pipe of the lubricating oil pump. 52 A piston is damaged. 53 The piston height is incorrect. 54 The flywheel housing, or the flywheel, is not aligned correctly. 55 A fault in the thermostat or the thermostat is of a wrong type. 56 A restriction in the coolant passages. 57 A fault in the water pump. 58 There is damage to the oil seals (if they are fitted) of the valve stems. 59 A restriction in the sump strainer. 60 A valve spring is broken. 61 The impeller of the turbocharger is damaged or is dirty. 62 Leakage of lubricating oil from the oil seal of the turbocharger. 63 The induction system leaks (turbocharged engines). |
|---|--|

Engine preservation

7

Storage	7.02
Short period storage	7.02
Long period storage	7.02
Removal from storage	7.03
Approved products for engine preservation	7.03

Engine preservation

Storage

When the engine is not in use, temporarily or for a longer period, it must be protected from corrosion. The amount and the type of treatment to prevent corrosion during storage is according to the length of the period of storage. When necessary, there must also be protection from frost.

All new and reconditioned engines which leave the Factory have been inhibited to Perkins Engines standards. An engine may be in storage, under a cover and in dry conditions, for a maximum period of 12 months from the date it left the Factory, without the need for it to be inhibited again.

After a period of 12 months of storage, the engine must be inspected thoroughly and must be again inhibited.

Short period storage

Up to seven days:

No treatment is necessary.

Up to three months:

Each week, operate the engine until the normal temperature of operation is reached. If the engine cannot be operated, turn the crankshaft by hand, in the normal direction of rotation (anti-clockwise as seen on the flywheel), a minimum of three revolutions.

Long period storage

If it is necessary to put an engine into storage for a period of between three and twelve months, use this procedure:

- 1 Remove the thermostat from its housing and carefully clean it. Apply a silicone grease, such as MS4, to the valve stems of the thermostat and operate the valves by hand to ensure that the grease enters the glands. Fit the thermostat to its housing.
- 2 Operate the engine until the normal temperature of operation is reached. Stop the engine and drain immediately the lubricating oil from the sump and from the canisters of the oil filter (see 'Attention' on this page).
- 3 Fill the canisters of the oil filter with PX4 corrosion inhibitor and fit the canisters to the filter head (see 4.09).
- 4 Fill the sump, to the normal oil level, with PX4 corrosion inhibitor and, once again, run the engine until the normal temperature of operation is reached.
- 5 Stop the engine, disconnect the fuel supply pipe and connect the pipe to a supply of PX4 corrosion inhibitor. Start the engine, while it is still hot, and operate the engine, with no load, for ten minutes. Stop the engine.
- 6 Disconnect the supply of PX4 corrosion inhibitor from the fuel system and seal the end of the pipe. Drain the fuel filters.

Note: The canisters of the oil filters and the fuel filters are designed so that when fitted upside down, the lubricating oil or fuel does not drain from the canister, when the engine is stopped.

To drain a canister, hold the canister over a suitable container, insert a small tool into one of the inlet openings and carefully press open the rubber, non-return seal. During this operation, do not damage the rubber seal or the element of the filter.

Fasten a label, at a position where it will be seen, to indicate that the fuel system has been disconnected.

7 Remove the fuel injectors and put them in a container of PX4 corrosion inhibitor.

8 Set the fuel control lever to the **NO FUEL** position, remove the rocker covers and disconnect the air filter(s).

9 Turn the engine by the use of the starter and, at the same time, spray PX4 corrosion inhibitor into the manifolds until an emission of vapour is seen from each opening for the fuel injectors. Connect the air inlet pipes. Connect the air filter(s).

10 Spray 40 cc of PX4 corrosion inhibitor into each cylinder, through the openings for the fuel injectors. Fit the fuel injectors.

Caution: The engine must NOT be turned after this operation and a label must be fitted to this effect.

11 Spray PX4 corrosion inhibitor around the valves and around the rocker assemblies. Refit the rocker covers.

12 Drain the PX4 corrosion inhibitor from the sump of the engine and from the oil filter canisters. Fit a **NO OIL** label to the oil filler cap.

13 Drain the cooling system and fill with the recommended coolant mixture (see page 5.02).

Caution: The mixture must NOT contain less than 50% inhibited ethylene glycol or propylene glycol, and may contain up to 90% by volume.

14 Wait for 15 minutes, then drain completely the coolant mixture. Fit a **NO COOLANT** label to the filler cap of the radiator.

15 Disconnect the exhaust pipe at the turbocharger outlet, or at the junction of the manifolds if the engine has a normal aspiration system. Inject two grammes of VPI 260 powder and fit a blanking plug. Do NOT connect the exhaust pipe.

16 Inject two grammes of VPI 260 powder into the turbocharger, if relevant.

17 Disconnect the air ducts between the air filter(s) and the turbocharger and inject two grammes of VPI 260 powder into the air ducts.

18 Inject two grammes of VPI 260 powder into each paper element type air filter. Other types of air cleaners may be sprayed inside with PX4 corrosion inhibitor. Fit the air ducts.

19 Spray Crodafluid PM47 onto areas of the engine and auxiliary equipment which are not protected by paint. Ensure that the fuel control linkage is sprayed with Crodafluid PM47.

Caution: Do NOT spray PM47 into the vent holes of the alternator.

20 Cover, completely, the alternator and the starter motor in mouldable wax wrapping and seal with adhesive tape.

21 Seal the air filter inlets, the crankcase breather and all other openings with mouldable wax wrapping and adhesive tape.

22 Remove all drive belts, apply French chalk to the belts and put them in a sealed plastic bag. Fasten the bag to the engine.

23 Fasten to the engine a label which indicates:

(a) That the exhaust system has been sealed.

(b) The dates when the corrosion inhibitors were applied to the engine and when the corrosion inhibitors must be applied again.

If the engine is to remain in storage for more than one year, the above procedure must be repeated at the end of each period of twelve months.

Removal from storage

To prepare the engine for use, after it has been in storage, refer to Section 3 - Operation instructions. The information given applies to new engines and to those engines which have been removed from storage.

Approved products for engine preservation

Component	Product	Manufacturer
Thermostat	MS4 silicone grease	Ambersil Limited Whitney Road Basingstoke Hampshire
Lubrication system	PX4 corrosion inhibitor	Croda Chemicals Limited Churchill Road Doncaster Yorkshire
Fuel system	PX4 corrosion inhibitor	Croda Chemicals Limited
Valves and rocker assemblies	PX4 corrosion inhibitor	Croda Chemicals Limited
Cooling system	Inhibited ethylene glycol or inhibited propylene glycol	Various
Induction/exhaust systems	PX4 corrosion inhibitor	Croda Chemicals Limited
	VPI 260 powder	Shell Chemicals Limited Stanlow Terminal Ellesmere Port Cheshire
Engine and auxiliaries - outer casing	Crodafluid PM47	Croda Chemicals Limited
	Mouldable wax wrapping	Carrs Paper Limited Shirley Solihull West Midlands

Parts and service

8

Introduction	8.02
Service literature	8.02
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Parts and service

Introduction

If problems occur with your engine or with the components fitted to it, your Perkins distributor can make the necessary repairs. Your Perkins distributor will ensure that only the correct parts are fitted and that the work is done correctly.

Certain components can be supplied by your Perkins distributor through the Perkins POWER EXCHANGE System. These will enable you to reduce the cost of certain repairs.

Service literature

Workshop manuals and other service publications are available from your Perkins distributor at a nominal cost.

Training

A four day course on the service and the overhaul of the Eagle range of engines is available at the Factory. For details, apply to: The Customer Training Centre, Perkins Engines (Shrewsbury) Limited, Shrewsbury, Shropshire.

Service Bulletins

Service procedures and engine design are checked continuously at Perkins Engines. As a result of this development work, it may become necessary to alter the information in manuals and other service publications. Between revisions of the literature, all relevant personnel are provided with full details of changes as they occur. The information is produced as a Service Bulletin; these are supplied to distributors for distribution as necessary.

Changes to engine design and service procedures are published as Service Bulletins for addition to any relevant Manuals.

Engine data

9

General	9.02
Cooling system	9.02
Fuel system	9.03
Lubrication system	9.03
Induction/exhaust system	9.03
Electrical equipment	9.03
Auxiliary equipment	9.03

Engine data

Eagle Tx and Eagle 800 Diesel Engine

General

Number of cylinders.....	6
Cylinder arrangement.....	In-line
Cycle.....	Four stroke
Induction system	
Tx (all versions)	turbocharged and air-to-air charge cooled
800 (up to 224 kW/300 bhp)	turbocharged
800 (over 224 kW/300 bhp)	turbocharged and air-to-coolant charge cooled
Combustion system	Direct injection
Nominal bore	130,17mm (5.125 in)
Stroke	152,4mm (6.00 in)
Compression ratio	15.9 : 1
(except Tx 300 and Tx 325)	17.1 : 1
Cubic capacity	12,17 litre (742.64 in ³)
Firing order	1, 4, 2, 6, 3, 5
No. 1 cylinder is at the front (fan end)	
Cylinder numbering	From front (fan end) to rear (flywheel end)
Tappet clearances (cold)	
Inlet	0,25mm (0.010 in)
Exhaust	0,50mm (0.020 in)
Direction of rotation	Anti-clockwise, view on flywheel
Injection timing	As stamped on engine data plate
Dry weight of engine (approx.)	
Tx	1065 kg (2348 lb)
800 (up to 224 kW/300 bhp)	1065 kg (2348 lb)
800 (over 224 kW/300 bhp)	1090 kg (2403 lb)

Cooling system

Capacity of coolant system (does not include radiator)	20,4 litre (4.5 UK gallons)
Coolant system pressure	Maximum 70 kN/m ² (10 lbf/in ²) to suit installation
Temperature (normal)	
At sea level	78 to 95°C (172 to 203°F)
Thermostat	Triple-element wax capsule type with radiator by-pass

Fuel system

Type..... Low pressure supply to fuel injection pump with through flow to tank

Fuel injection pump**Tx engines**

300 to 325 bhp Bosch S3000 with 12mm lower-helix elements and snubber valves. Boost control device fitted to 325 bhp engines only. Automatic selection of excess fuel and retarded timing for starting. The engine is retarded -6°

350 to 400 bhp Bosch S7100 with 12mm lower-helix elements and snubber valves. Boost control device fitted. Automatic selection of excess fuel and retarded timing for starting. The engine is retarded -6°

Series 800 engines

300 to 325 bhp Bosch S3000 with 12mm lower-helix elements (snubber valves - 300 bhp only). Boost control device fitted to 300 bhp engines only. Automatic selection of excess fuel and retarded timing for starting. The engine is retarded -3°

350 to 400 bhp Bosch S7100 with 12mm lower-helix elements and snubber valves. Boost control device fitted. Automatic selection of excess fuel and retarded timing for starting. The engine is retarded -3°

Governor Bosch RQV

Lift pump..... Bosch - single acting
Bosch - double acting

Fuel supply pressure..... 103 to 207 kN/m² (15 to 30 lbf/in²)

Fuel injectors Bosch low spring type, opening pressure
240 atmospheres

Main fuel filter..... Single screw-on type canister

Lubrication system

Type..... Wet sump

Lubricating oil pressure

Normal load conditions 350 to 480 kN/m² (50 to 70 lbf/in²)

Minimum at rated speed *207 kN/m² (30 lbf/in²)

Capacity of lubricating oil 25 litres (5.5 UK gallons) to maximum mark on dipstick
System total 29,5 litres (6.5 UK gallons)

Pressure relief valve..... Spring loaded plunger in body of oil pump

Oil-to-coolant heat exchanger..... Single unit, tube stack type with partial by-pass for coolant

Filters..... Two screw-on type canisters with integral by-pass valves

Induction/exhaust system

Aspiration..... Pressure charged by a Holset H2C or H2D turbocharger

Cold start aids..... Optional: Start Pilot or Fleetguard

Electrical equipment

Alternator..... CAV or Butec - with belt drive

Starter motor..... CAV S130L or Butec LMS1A (24 volt)

Stop control..... SEM MD5 (24 volt)

Auxiliary equipment

Air compressor (if fitted)..... WABCO single cylinder, flange mounted

* Important for the protection of turbocharger bearings

Perkins Power Sales and Service Limited
Lancaster Road,
Shrewsbury, Shropshire SY1 3NX, England
Telephone: STD Code 01743/212000 Telex: 35171

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CALIFORNIA
Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

Asia

Perkins Engines (Asia Pacific) Pte Ltd
7 Tractor Road
Singapore 627968
Telephone +65 6828 7469
Fax +65 6828 7414

Europe, Middle East and Africa

Perkins Engines Company Limited
Peterborough PE1 5NA
United Kingdom
Telephone +44 (0)1733 583000
Fax +44 (0)1733 582240

North America

Perkins Engines Inc
N4 AC 6160
PO Box 610
Mossville, IL 61552-0610, USA
1-888-PERK-ENG
Telephone +1 309 578 7364
Fax +1 309 578 7329

Latin America

Perkins Motores do Brasil Ltda
Rua Alexandre Dumas, 1711 Ed. Birman 11, 9º andar
Chácara Santo Antonio
São Paulo / SP - Brasil
Cep: 04717-004
Telephone +55 11 2109 2038
Fax +55 11 2109 2089



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www.perkins.com