

LISTER - PETTER

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The Alpha Series Industrial Operations Handbook 2

X 90 Series Operators Handbook 29

THE 'ALPHA SERIES' INDUSTRIAL ENGINE OPERATORS HANDBOOK

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INTRODUCTION

The purpose of this handbook is to lay down operating guidelines for the current LPA, LPW, LPWT and LPWS industrial engines.

The specification details given apply to a range of engines and not to any one particular engine, in cases of difficulty the user should consult the local Lister-Petter Distributor or Dealer for further advice and technical assistance.

The information, specifications, illustrations, instructions and statements contained within this publication are given with our best intentions and are believed to be correct at the time of going to press.

Our policy is one of continued development and we reserve the right to amend any technical information with or without prior notice.

Whilst every effort is made to ensure the accuracy of the particulars contained within this publication neither the Manufacturer, Distributor or Dealer shall in any circumstances be held liable for any inaccuracy or the consequences thereof.

The information given is subject to the Company's current Conditions of Tender and Sale, and is for the assistance of users and is based upon results obtained from tests carried out at the place of manufacture. This Company does not guarantee that the same results will be obtained elsewhere under different conditions.

Caring for Your new Engine

This handbook has been supplied with your new engine to help assist you in the correct operation and maintenance of your engine.

To obtain the best performance from your engine you must ensure that all the instructions given in "Section 4 Routine Maintenance" are correctly carried out at the prescribed intervals.

How to Use this Operators Handbook

It is recommended the individual steps contained in the various maintenance or repair operations are followed in the sequence in which they appear.

When a diesel engine is operating or being overhauled there are a number of associated practices which may lead to personal injury or product damage.

Your attention is drawn to the symbols shown and described below which are applied throughout this publication.

CAUTION

This caution symbol draws attention to special instructions or procedures which, if not correctly followed, may result in damage to or destruction of equipment.

WARNING

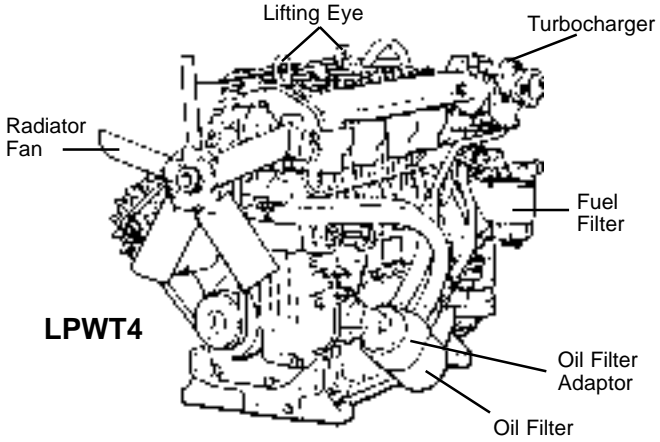
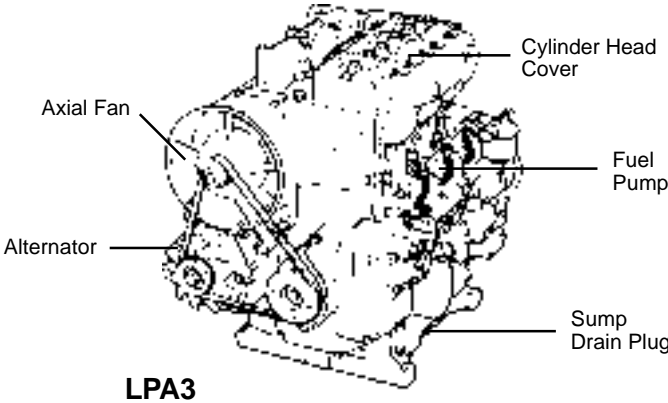
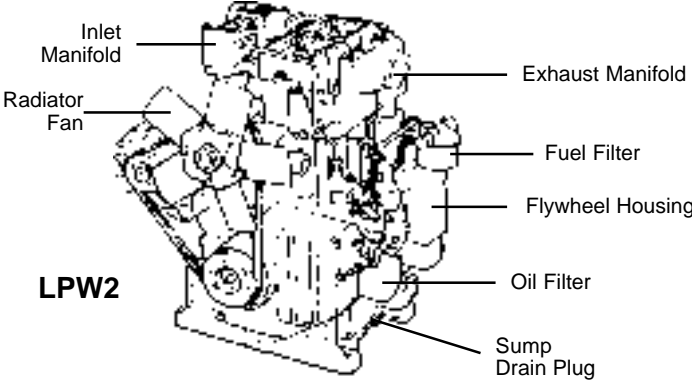
This warning symbol draws attention to special instructions or procedures which, if not strictly observed, may result in personal injury.

WARNING

A WARNING SYMBOL WITH THIS TYPE OF TEXT DRAWS ATTENTION TO SPECIAL INSTRUCTIONS OR PROCEDURES WHICH, IF NOT STRICTLY OBSERVED, MAY RESULT IN SEVERE PERSONAL INJURY, OR LOSS OF LIFE.

Note:

A note is used to draw your attention to additional or important information.



SECTION 1. GENERAL INFORMATION

1.1 Nomenclature

LPA2 and 3 - two and three cylinder, direct injection, naturally aspirated axial fan cooled diesel engines.

LPW2, 3 and 4 - two, three and four cylinder, direct injection, naturally aspirated water cooled diesel engines.

LPWT4 - four cylinder, direct injection, turbocharged water cooled diesel engine.

LPWS2, 3 and 4 - two, three and four cylinder, indirect injection, naturally aspirated water cooled diesel engines. A heater plug is fitted in the combustion pre-chamber.

1.2 Engine Builds

The engines within each range have been assembled to predetermined configurations and where the build number is preceded by a 9 this indicates that the engine is either of a non-standard configuration, or contains non-standard parts or accessories.

It is suggested that reference be made to Lister-Petter to determine the exact engine specification.

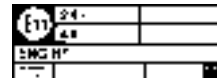
1.3 Engine Serial Number

The engine serial number is stamped on a plate attached to the engine.

1.4 Serial Number Plates



Standard Plate



ECE Emissions Plate



CARB Compliant Plate



EPA Compliant Plate

1.5 Running-in

A gradual running-in of a new engine is not necessary. Extended light load running early in the life of the engine may cause detrimental damage to the cylinder bore allowing lubricating oil to enter the exhaust system.

Maximum load can be applied to the engine as soon as it enters service.

To help assist engine running-in, all engines are despatched with an initial fill lubricating oil which must be changed after 100 hours.

1.6 Ambient Temperature

From the aspect of engine performance, the temperature of the air entering the engine is the only criterion of ambient temperature.

The power developed by the engine, depends on the temperature of the combustion air measured at the air manifold inlet, or the air cleaner, and the temperature of the cooling air as measured at the fan inlet.

The higher of these two temperatures is taken as being "Ambient Temperature" as far as engine ratings are concerned.

The engines are able to run satisfactorily at Ambient temperatures up to 25°C (77°F) without derating. Above this temperature the rated brake horsepower must be reduced in accordance with ISO 3046 Standards.

The maximum permitted ambient temperature is 52°C (125°F).

1 GENERAL INFORMATION

1.7 Safety Precautions

The following safety precautions are of a general nature more specific precautions appear where they are relevant.

1.7.1 General Precautions

- Ensure the engine is securely mounted.
- Ensure that there is a generous supply of cooling and combustion air available.
- Keep the engine and surrounding area clean.
- Keep all safety guards in position.
- Keep the body and clothing clear of all moving or hot parts.
- Never allow any part of the body to come into contact with high pressure fuel oil, for example when testing fuel injection equipment.
- Thoroughly clean any lubricating or fuel oil from the skin as soon as practicable after contact.
- Rectify all fuel, water and oil leaks as soon as practicable and clean any spillages when they occur.

1.7.2 Before Starting Precautions

WARNING

Starting any diesel engine can be dangerous in the hands of inexperienced people. Engine operators must be instructed in the correct procedures before attempting to start any engine.

- Ensure the engine is free to turn without obstruction.
- Check that the water and lubricating oil levels are correct.
- The radiator should be filled to within 13mm-25mm (0.5-1.0in) below the neck of the radiator filler.
- The oil sump must be filled to the 'full' or 'max' mark on the dipstick; do not overfill.
- Check that the fuel supply is adequate and the system is primed.
- Ensure that the battery is connected, fully charged and serviceable.
- Where possible, disengage the driven equipment while starting.

1.7.3 Alternator Precautions

The following points must be strictly observed when an alternator is fitted otherwise serious damage can be done.

- Never remove any electrical cable while the battery is connected in the circuit.
- Only disconnect the battery with the engine stopped and all switches in the OFF position.
- Always ensure that cables are fitted to their correct terminals.
A short circuit or reversal of polarity will ruin diodes and transistors.
- Never connect a battery into the system without checking that the voltage and polarity are correct.
- Never flash any connection to check the current flow.
- Never experiment with any adjustments or repairs to the system.
- The battery and alternator must be disconnected before commencing any electric welding when a pole strap is directly or indirectly connected to the engine.

1.7.4 Starter Battery Precautions

- Do not smoke near the batteries.
- Keep sparks and flames away from the batteries.
- Batteries contain sulphuric acid - if the acid has been splashed on the skin, eyes or clothes flush it away with copious amounts of fresh water and seek medical aid.
- Keep the top of the battery well ventilated during charging.
- **Disconnect the battery negative (earth) lead first and reconnect last.**
- Switch off the battery charger before disconnecting the charger leads.
- Never 'flash' connections to check current flow.
- Never experiment with adjustments or repairs to the system.
- A damaged or unserviceable battery must never be used.

1.7.5 Lifting Precautions

The following points must be considered before attempting to lift the engine.

- Ensure the lifting equipment to be used has the correct capacity to lift the engine.
- Single lifting equipment must only be used when a single lifting eye is fitted.
- When two engine lifting eyes are fitted suitable lifting equipment designed to give two vertical lifts from directly above the engine lifting eyes must be used.
- Check that the engine lifting eyes are not damaged and that they are secure.
- To prevent damage to the cylinder head cover ensure that there is clearance between the lifting equipment hooks and the cover.
- The lifting eyes fitted to the engine are suitable for lifting the engine, and gearbox if fitted, and accessory assemblies originally fitted by Lister-Petter.

WARNING

Engine lifting eyes must not be used to lift the complete plant.

1.7.6 Exhaust Precautions

It is important to ensure that exhaust gases are not sucked in by the air cleaner, or the cooling fan, otherwise premature choking will occur.

WARNING

Unprotected skin and combustible materials must not be allowed to come into contact with the exhaust system.

WARNING

DO NOT BREATHE EXHAUST GASES AS THEY CONTAIN CARBON MONOXIDE, A COLOURLESS, ODOURLESS AND POISONOUS GAS THAT CAN CAUSE UNCONSCIOUSNESS AND DEATH.

1.8 Safety Symbols

This section identifies the ISO 8999 symbols currently used by Lister-Petter.



Read the Handbook



Stop control (no Engine)



Diesel fuel fill



Engine oil fill



Engine oil level



Engine oil pressure



Anti clockwise

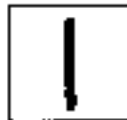


Clockwise

Rotation



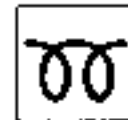
Lifting eye (engine only)



On



Off



Pre-heat



Rotational speed control



Linear speed control



Tachometer



Elapsed hours



Battery charging



Engine cranking



General hot surface warning



Electrical hazards



Engine coolant pressure



Engine coolant fill



Engine coolant level



Engine coolant temperature

1.9 Technical Data

	LPA	LPW/LPWT	LPWS
Rotation	Anti-clockwise when looking on the flywheel		
Type of injection	Direct	Direct	Indirect
Firing order	2 Cylinder 3 Cylinder 4 Cylinder	1-2 1-2-3 -	1-2 1-2-3 1-3-4-2
Electrical system	12v negative earth		
Starter battery charging	12v engine mounted alternator		
Oil pressure	at idle	0.7bar (10.2lbf in ²)	1.0bar (14.5lbf in ²)
	3000r/min. (See Note)	2.0bar (29.0lbf in ²)	2.0bar (29.0lbf in ²) LPWT4 -2.5bar 36.3lbf in ²)
Engine mounted fuel tank	12litre; 1.5gal; 1.8US gal		
Oil sump capacity	Refer to 'Section 4 Routine Maintenance'		
Coolant capacity	Refer to 'Section 4 Routine Maintenance'		

Note:

Oil pressure at 3000r/min is with the oil at 110°C (230°F).

1.10 Guards

Special accessories may require special guards which must be supplied and fitted by the purchaser.

1.11 Engine Controls

 **WARNING**

After prolonged running, metal parts of the stop control may become hot; it is advisable to use suitable hand protection when stopping the engine.

Remote or engine mounted variable, two speed and stop controls are available for all engines.

1.12 Cooling

LPA cooling is by axial fan using a V-ribbed belt with the cooling air being directed around the cylinders by cowling and baffle plates.

LPW, LPWT and LPWS cooling is by a remote or engine mounted radiator with water circulation being assisted by a centrifugal belt driven pump using a V-ribbed belt.

1 GENERAL INFORMATION

1.13 Coolant Concentrate

A 40% concentration must be maintained under all operating conditions.

The specification of the coolant concentrate should comply with one of the following:-

BS6580 : 1985

MIL-A-11755D

MIL-A-46153/B

To determine the amount of coolant concentrate to be added it will be necessary to calculate the total coolant capacity by adding together the engine and radiator or heat exchanger and expansion tank and associated pipework capacities.

WARNING

Coolant concentrate must not be allowed to come into contact with the skin; adhere to the manufacturers instructions and precautions.

1.14 Associated Publications

Master Parts Manual:

- LPA P027-08040

- LPW/LPWT/LPWS P027-08041

Workshop Manual P027-08240

Technical Information P027-08247

Arrangement Drawings P027-08037

Various wall charts and technical/sales leaflets are available.

Please contact Lister-Petter for details.

1.15 Data on CD ROM

The Master Parts Manuals, Technical Bulletins issued since June 1988 and parts information is available on CD ROM.

Please contact Lister-Petter for details.

1.16 Training

Comprehensive training in the correct operation, service and overhaul procedures of engines is available at the Lister-Petter International Product Training Centre.

Please contact Lister-Petter for details.

1.17 If Problems Occur

If problems occur with your engine, or any of the Lister-Petter approved accessories fitted to it, your local Lister-Petter Distributor should be consulted.

There are Lister-Petter Distributors in most countries of the world and details for these can be obtained from any one of the Lister-Petter companies listed on the back cover, or from <http://www.lister-petter.co.uk>.

1.18 The Importance of Using Genuine Parts

Parts that have not been approved by the Lister-Petter organisation cannot be relied upon for correct material, dimensions or finish.

This Company cannot therefore, be responsible for any damage arising from the use of such parts and the guarantee may be invalidated.

When purchasing parts or giving instructions for repairs users should, in their own interests, always specify Genuine Lister-Petter Parts.

SECTION 2. STARTING AND STOPPING

2.1 Preliminary Instructions

WARNING

Starting any diesel engine can be dangerous in the hands of inexperienced people.

Before attempting to start any engine the operator should read "1.7 Safety Precautions" and be conversant with the use of the engine controls and the correct starting procedures.

The following information is of a general nature and should be read in conjunction with, or substituted by, the equipment manufacturers instructions.

CAUTION

ETHER BASED COLD START AIDS MUST NOT BE USED UNDER ANY CIRCUMSTANCES.

WARNING

DO NOT BREATHE EXHAUST GASES AS THEY CONTAIN CARBON MONOXIDE, A COLOURLESS, ODOURLESS AND POISONOUS GAS THAT CAN CAUSE UNCONSCIOUSNESS AND DEATH.

CAUTION

On LPWT4 engines serious damage to the turbocharger bearing can result if for any reason the turbocharger housing is not full of oil.

It is recommended that these engines run on 'no load' after starting for 30 seconds, to ensure an adequate oil supply to the turbocharger, and 30 seconds before stopping to allow the heat from the bearing to dissipate.

2.3 Start/Stop Control

The basic engine has a plastic knob fitted to the control and other variants for automatic or remote operation are available.

Engines not fitted with a fuel control solenoid have a spring clip to hold the engine control in the stop position.

2.2 Cold Start Aid

To provide additional heating of the combustion air during starting a 345W heater plug may be fitted to the inlet manifold on LPA and LPW engines.

A 696W plug is fitted on the LPWT4 and LPWS engines are fitted with a 12V glow plug for each cylinder as standard.



Figure 2.2.1 Heater Plugs

A - Manifold Heater Plug
B - LPWS Glow plug

2 STARTING AND STOPPING

2.4 Starting - LPA and LPW

CAUTION

These instructions do not apply to LPWT4 engines; refer to "2.5 Starting - LPWS and LPWT4".

If an oil pressure switch bypass button is fitted it must be depressed during engine cranking and until the engine attains full speed.

If the engine fails to start within 30 seconds, release the key and attempt to restart after allowing sufficient time for all moving parts to stop.

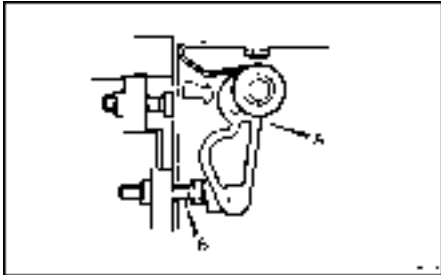


Figure 2.4.1 Starting

1. Move the engine control lever (A) clockwise until it is against the stop screw (B).
2. On variable speed engines move the speed control to the fast position.

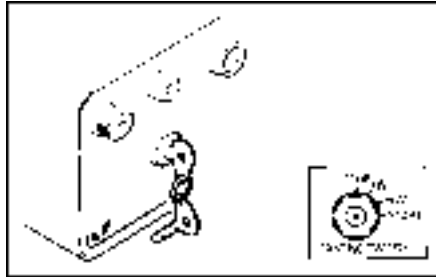


Figure 2.4.2 Key Start

3. Turn the key clockwise to the 'START' position and release it immediately the engine starts.
4. Reduce the engine speed as necessary.

2.5 Starting - LPWS and LPWT4

If an oil pressure switch bypass button is fitted it must be depressed during engine cranking and until the engine attains full speed.

If the engine fails to start within 30 seconds, release the key and attempt to restart after allowing sufficient time for all moving parts to stop.

1. Move the engine control lever (A) clockwise until it is against the stop screw (B).

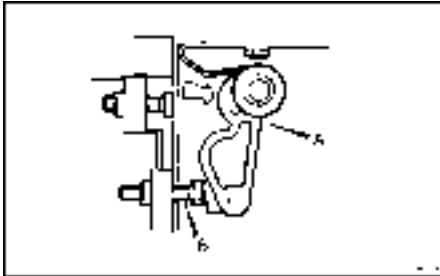


Figure 2.5.1 Starting

2. On variable speed engines move the speed control to the fast position.

3. For ambient starting temperatures above -10°C (14°F) turn the key clockwise and hold it in the 'HEAT' position for 10 to 15 seconds before turning it to the 'START' position to energise the starter.



Figure 2.5.2 Key Start

4. For ambient starting temperatures below -10°C (14°F) turn the key clockwise to the 'HEAT' position for 15 to 20 seconds before turning the key to the 'START' position to energise the starter.

Immediately the engine starts the key must be moved anti-clockwise to the 'HEAT' position until the engine has attained full speed.

5. Reduce the engine speed as necessary.

2 STARTING AND STOPPING

2.6 Stopping - all engines

1. If possible remove the load from the engine.
2. If a variable speed control is fitted reduce the engine speed.
3. On engines fitted with a fuel control solenoid turn the key to the 'STOP' position.



Figure 2.6.1 Key Start

4. On engines not fitted with a fuel control solenoid move the engine control lever anti-clockwise into the stop position and turn the key to the 'STOP' position.

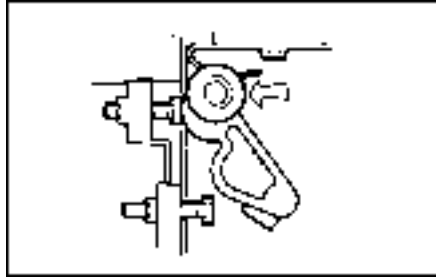


Figure 2.6.2 Stopping

CAUTION

Turning the key to the 'STOP' position alone will not stop the engine unless a fuel control solenoid is fitted.

SECTION 3. OIL AND FUEL SPECIFICATIONS

3.1 Fuel Specification

The engine must only be used with diesel fuel oil which conforms to one of the following:

- a. BS 2869:1988 Class A2.
- b. BS EN590:1995 Class A1.
- c. USA Specification ASTM D-975-77 Grades No.1-D and 2-D.
- d. BSMA 100 Class M1 for marine use.

The fuel must be a distillate, and not a residual oil or blend. Vaporising oils are not suitable as fuels for these diesel engines.

The user is cautioned that although the engines may operate on fuels outside the above specifications, such operation may well result in excessive wear and damage.

CAUTION

The fuel injection equipment is manufactured to very accurate limits and the smallest particle of dirt will destroy its efficiency.

Fuel, free from water and contaminants is of the utmost importance.

3.2 Low Temperature Fuels

Special winter fuels are often available for use at ambient temperatures below 0°C (32°F).

These fuels have a lower viscosity and limit the formation of wax at low ambient temperatures.

CAUTION

Wax formation can rapidly reduce the flow of fuel through the fuel filter element.

3.3 Oil Specification

This section does not apply to LPWG engines; refer to the 'LPWG Operators Handbook', P027-08197.

To help assist engine running-in, all engines are despatched with an initial fill lubricating oil which must be changed after 100 hours.

All subsequent oil changes must be as specified in "4.10 Oil and Filter Changes".

CAUTION

Some of the following classifications may not be available in your country. In cases of difficulty, it is suggested contact be made with a reputable oil supplier or any Lister-Petter Distributor.

1. The temperatures mentioned in the tables are the ambient temperatures at the time when the engine is started. However, if monograde oils are used and running ambient temperatures are significantly higher than starting temperatures, a higher viscosity oil should be selected subject to satisfactory starting performance. Multigrade oils may be used to overcome the problem.

2. Where it is not practical to continually change oils to suit varying ambient temperatures a suitable multigrade oil is recommended to ensure adequate starting performance at the lowest temperature likely to be encountered.

3. All engines other than LPWT and LPWS must be run on heavy duty lubricating oils that at least meet the requirements of one of the following:

API CC	MIL-L-46152B
DEF2101D	MIL-L-2104B

Straight mineral oils are not suitable, neither are oils of less detergency than specified.

Note:

Higher specification oils meeting API CD, API CE and API CF-4 are more commonly available than API CC. The

3 OIL AND FUEL SPECIFICATIONS

use of these oils in new engines is acceptable for topping up the 'first fill' and following the first 100 hours when running-in has been completed.

These oils are particularly suited to engines running at a high load factor, or in conjunction with high ambient temperatures. They must also be used where the sulphur content of the fuel exceeds 0.5%.

4. API CD, Series 3 or MIL-L-2104C/D oils must be used in all LPWS and LPWT engines.

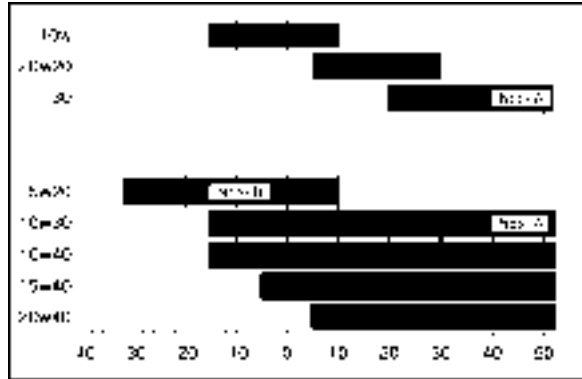
CAUTION

API CD, API CE, API CF-4 or MIL-L-2104C/D/E oils can inhibit the running-in process in new or reconditioned engines and are not suitable for engines running on low duty cycles.

5. For engines in long running installations Lister-Petter should be consulted.

3.4 Oil Viscosity

The following chart shows the correct oil viscosities at various °C ambient temperature ranges for cold start to maximum running. Before selecting a viscosity grade refer to the Notes below the chart.



$$^{\circ}\text{F} = (1.8 \times ^{\circ}\text{C}) + 32.$$

A - Intermittent running.

B - Synthetic oils only.

Notes:

1. SAE 5W-20 oils are recommended on the basis that they are fully synthetic, and are technically suitable for use up to 25°C (77°F). Non synthetic oils at very low temperatures will suffer from wax crystallisation.

Monograde SAE 5W is not normally available as a synthetic oil and therefore is not quoted.

2. In order to maintain the cold starting characteristics of any recommended grade, it is essential that oil changes are made within the Lister-Petter recommendations. An oil change is

recommended immediately if the engine fails to reach its normal cold start cranking speed due to excessive oil viscosity.

Fuel dilution of the lubricating oil will adversely affect cold starting and oil consumption.

3. SAE 30 and 10W-30 oils may be used at up to 52°C (126°F) but oil consumption may be affected.

10W-40, 15W-40 and 20W-40 multigrades are recommended for continuous full load operation at this temperature.

4. Monograde SAE 40 oils are not recommended.

SECTION 4. ROUTINE MAINTENANCE

4.1 Preliminary Instructions

CAUTION

This handbook is designed for the operator, detailed maintenance procedures are given in the Workshop Manual; part number P027-08240.

This section is designed primarily for use by trained technicians but it does contain sufficient information, illustrations and detail to allow the operator to perform basic maintenance work.

This work can only be carried out if the necessary hand and service tools are available. When the user has insufficient tools, experience or ability to carry out adjustments, maintenance and repairs this work should not be attempted.

Where accurate measurements or torque values are required they can only be made using calibrated instruments.

Under no circumstances should makeshift tools or equipment be used as their use may adversely affect safe working procedures and engine operation.

These recommendations and instructions cover several engine models therefore they are of a general nature.

- The engine should receive regular attention during the first 50 hours of its life from new and after a major overhaul.
- Long periods of light or 'no load' running early in the engine's life may lead to cylinder bore glazing and high oil consumption.
- The instructions given in the Maintenance Schedule are based on average operating conditions and cover the minimum requirements to keep an engine running at peak performance with trouble free operation.
- Under very dusty conditions, air cleaners, lubricating oil and fuel filters will require more frequent attention
- It is essential to ensure that nuts and bolts are tightened to the torques specified in the Workshop Manual.

4.1.1 Fuel Injector

WARNING

ON NO ACCOUNT ALLOW ANY UNPROTECTED SKIN TO COME INTO CONTACT WITH THE INJECTOR SPRAY AS THE FUEL MAY ENTER THE BLOOD STREAM WITH FATAL RESULTS.

4.1.2 Before Commencing Work

- Before carrying out any maintenance work on an engine it is advisable to remove the battery.
- The battery and alternator must be disconnected before commencing any electric welding when a pole strap is directly or indirectly connected to the engine.
- Before commencing any maintenance work it will be necessary to identify the type of engine to enable the correct maintenance procedures to be carried out.

The type and Build of the engine is stamped on the serial number plate.

4.2 Waste Disposal

WARNING

Extreme care must be taken to ensure that waste fuel, oil, filter elements, acid coolant concentrate, where applicable, paint, solvents or other toxic wastes are disposed of in accordance with local regulations to prevent contamination

4 ROUTINE MAINTENANCE

4.3 Oil Seals

WARNING

SOME ENGINES MAY BE FITTED WITH SEALS OR 'O' RINGS MANUFACTURED FROM 'VITON' OR A SIMILAR MATERIAL. WHEN EXPOSED TO ABNORMALLY HIGH TEMPERATURES, IN EXCESS OF 400°C (752°F), AN EXTREMELY CORROSIVE ACID IS PRODUCED WHICH CANNOT BE REMOVED FROM THE SKIN. IF SIGNS OF DECOMPOSITION ARE EVIDENT, OR IF IN DOUBT, ALWAYS WEAR DISPOSABLE HEAVY DUTY GLOVES.

4.4 Precautions for Filters and Elements

- Particular attention is drawn to the instructions given later in this section for replacing filters.
 - Used liquid filters and elements contain some of the filtered liquid and should be handled and disposed of with care.
 - After handling new or used elements the users hands should be thoroughly washed, particularly before eating.
-

WARNING

Fuel and new or used lubricating oil may cause skin irritation.

4.5 Initial Attention

To help assist engine running-in, all engines are despatched with an initial fill lubricating oil **which must be changed after 100 hours.**

All subsequent oil changes must be as specified in "4.10 Oil and Filter Changes".

It is recommended that the following receive attention after the engine has run 50 hours and again after 250 hours.

- Check for leaks to the coolant, oil and fuel systems.
- Check the lubricating oil level and top up if necessary.
- On water cooled engines, check the radiator coolant level and top up if necessary. It is essential to maintain a 40% concentration at all times.
- Check the drive belt tension.

Following the initial attention, the normal routine maintenance must be carried out as given in "4.21 Maintenance Schedule".

4.6 Drive Belt Tension

The drive belt must be replaced every 2000 hours, irrespective of its condition.

It is important that the tension of the drive belt is checked:

1. After the first 50 hours.
2. Every 250 hours.
3. After an overhaul when the existing, or a new belt is fitted.

4.6.1 Drive Belt Tension

When a new belt is correctly fitted and tensioned a force (F) of 31.0-33.5N (7.0-7.5lbf) is required to deflect it a distance (d) of 3.5mm (0.14in).

On subsequent checking and adjustment a force (F) of 22.0-24.0N (5.0-5.4lbf) is required to deflect it a distance (d) of 3.5mm (0.14in).

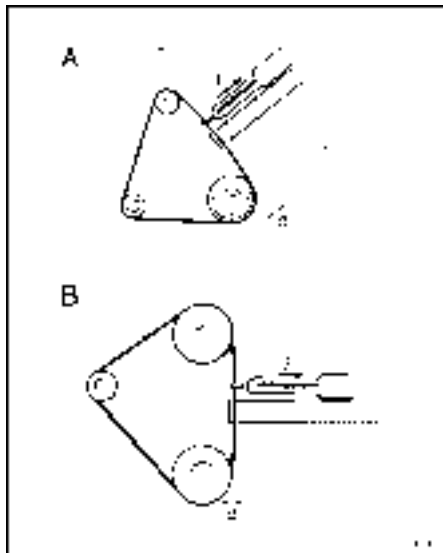


Figure 4.6.1 Checking Belt Tension:
A - LPA
B - LPW/LPWT/LPWS

4.7 Draining the Cooling System

WARNING

The cooling system is pressurised and extreme care must be taken when removing the radiator cap if the engine is hot.

1. Place a suitable container under the radiator bottom hose if the coolant is to be retained.
2. Slacken the clips of the hose and slide the hose off.
3. Remove the radiator filler cap.
4. Allow sufficient time for the system to drain.

4.8 Flushing the Cooling System

1. With the bottom hose removed flush the radiator through the filler with clean fresh water, preferably using a hose pipe, until clean water emerges.
2. With the top and bottom hoses removed from the engine, flush the engine through the top hose with clean fresh water, preferably using a hose pipe, until clean water emerges.
3. Replace the hoses.

4 ROUTINE MAINTENANCE

4.9 Filling the Cooling System

CAUTION

Under some circumstances an airlock can occur when filling the system causing a false level indication.

1. Ensure the hoses have been replaced.
2. Refill the system with clean fresh water and coolant concentrate to a 40% concentration while bleeding air from the system at a suitable point. The radiator should be filled to within 13.0mm-25.0mm (0.5-1.0in) below the neck of the radiator filler.
3. Run the engine for a short time and check the coolant level.

4.9.1 Engine Block Coolant Capacity

	LPW2 LPWS2	LPW3 LPWS3	LPW4 LPWT4 LPWS4
litres	2.1	2.5	3.0
pints	3.7	4.4	5.3
US qts	2.2	2.64	3.16

4.9.2 Radiator Coolant Capacity

There are a number of radiator options available for LPW, LPWT and LPWS engines including some which may not have been originally fitted by Lister-Petter.

For these reasons it is advisable to ascertain the radiator capacity which must then be added to that given in "4.9.1 Engine Block Coolant Capacity" before determining the amount of coolant concentrate to be added to maintain a 40% concentration.

The capacity of hoses on remote radiator applications must also be taken into consideration.

4.10 Oil and Filter Changes

Change the lubricating oil and filter for the first time after 100 hours and then as specified below.

All Builds Except 28, 51, 57, 58, 59

Ambient Temperature	Periods in Hours	
	LPA, LPW LPWT	LPWS
Up to 35°C	250	100
Above 35°C (see Note)	125	75

Builds 28, 51, 57, 58, 59

Up to 35°C	500	250
Above 35°C (see Note)	250	150

35°C = 95°F

Note:

The oil and filter change periods, given in hours, apply when engines are operating regularly at temperatures exceeding 35°C (95°F) at high speeds and duty factors.

4.11 Changing the Oil Filter

The full flow filter is a spin-on cartridge type located on the crankcase door.

Only approved filters should be used as these have high temperature joints, adequate filter paper characteristics and a rigid case.

Other filters may have the same external dimensions and thread as the genuine one but may fail in service.

Before changing the filter read "4.4 Precautions for Filters and Elements".

1. Use a band type gripping tool to remove the filter from the engine.
2. Lightly grease or oil the face of the rubber joint on the new filter.
3. Screw the new filter onto the crankcase filter adaptor, or filter mounting bracket, facing until the rubber joint just makes contact with the crankcase facing of mounting bracket facing.
4. Screw the filter on a further quarter to half of a turn.
5. Start the engine and run it for a few minutes to circulate the oil.
6. Stop the engine and allow time for the oil to drain down and check the level on the dipstick.
7. Add more oil if necessary.

4.12 Draining the Oil Sump

Before draining the oil read "4.4 Precautions for Filters and Elements".

Oil drain plugs are located on the oil filter side and the gear end of the crankcase.

If the engine has been run immediately before draining the warm oil will drain quicker.

1. Remove the oil filler cap.
2. Remove the oil sump drain plug and allow the oil to run into a suitable retainer.
3. Clean the drain plug threads and coat them with Hylomar PL32/M, Loctite 572 or Hylogrip 760.
4. Replace the plug and tighten it.

4.13 Refilling the Oil Sump

1. Ensure the new oil meets the correct specification as given in Section 3.
2. Fill the sump through the oil filler (A) to the upper mark on the dipstick.

CAUTION

Do not overfill with oil. If a cylinder head oil filler is fitted the oil must only be poured into the filler at a rate which enables it to drain into the crankcase. If the oil is poured in too quick it can flood the crankcase breather holes and escape into the inlet manifold and cylinders.

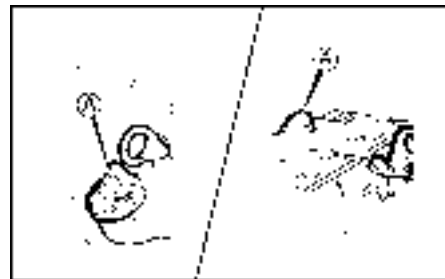


Figure 4.13.1 Oil Filler

3. Start the engine and run it for a few minutes to circulate the oil.
4. Stop the engine and allow time for the oil to drain down and check the level on the dipstick.
5. Add more oil if necessary.

4 ROUTINE MAINTENANCE

4.13.1 Oil Sump Capacity - excluding the filter

All Builds except 28, 51, 52, 57, 58, 59

	LPA2 LPW2 LPWS2	LPA3 LPW3 LPWS3	LPW4 LPWT4 LPWS4
litres	3.00	3.75	5.50
pints	5.28	6.60	9.68
US qts	3.17	3.96	5.81

Builds 28, 51, 52, 57, 58, 59

litres	5.85	8.25	11.5
pints	10.29	14.52	20.23
US qts	6.18	8.72	12.12

4.13.2 Capacity Between Dipstick Marks

All Builds except 28, 51, 52, 57, 58, 59

	LPA2 LPW2 LPWS2	LPA3 LPW3 LPWS3	LPW4 LPWT4 LPWS4
litres	0.9	0.95	1.2
pints	1.58	1.67	2.11
US qts	0.95	1.00	1.27

Builds 28, 51, 52, 57, 58, 59

litres	1.50	1.75	2.20
pints	2.64	3.08	3.87
US qts	1.59	1.85	2.32

4.14 Priming the Fuel System

1. Ensure there is sufficient fuel.
2. Release the bleed screws (A) on the filter and re-tighten when no further air bubbles are expelled.

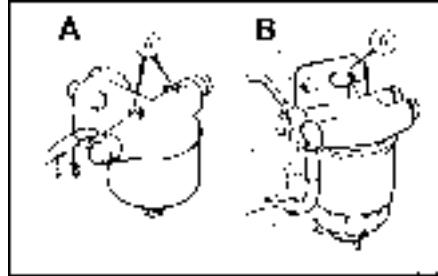


Figure 4.14.1 Priming the Fuel Filter

3. On variable speed engines move the speed control control to the fast position
4. Move the engine stop/run control from the stop to the run position.
5. Operate the fuel lift pump by hand.

4.15 Cartridge Agglomerator

Water is drained from the agglomerator by unscrewing the drain tap (C) sufficiently to allow the water to drain.

Before changing the agglomerator read "4.4 Precautions for Filters and Elements".

1. Using a suitable strap wrench unscrew the cartridge (A) from the head (B).
2. Screw a new cartridge onto the head and hand tighten it.



Figure 4.15.1 Cartridge Agglomerator

4.16 Changing the Fuel Filter

The element should be renewed every 500 hours, or more frequently if for any reason the fuel is known to be dirty.

Before changing the filter read "4.4 Precautions for Filters and Elements".

1. Isolate the fuel supply or drain the tank.
2. Unscrew the centre bolt (A) of the filter assembly.
3. Discard the old element (B) and fit a replacement.

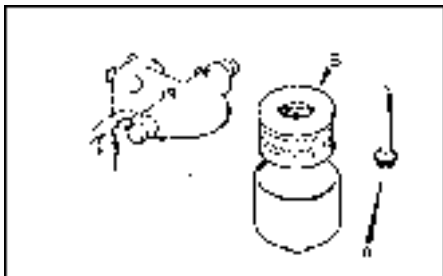


Figure 4.16.1 Fuel Filter

4. Fill the fuel tank and prime the system.
5. Run the engine and check to see that no fuel is leaking from the filter.

4.17 Air Cleaner

Care must be taken to ensure that the air cleaner draws air in at a temperature not exceeding:-

12°C (54°F) above outside ambient in temperate climates.

6°C (43°F) above outside ambient in tropical climates.

4.17.1 Light Duty Air Cleaner

The snout is normally fitted lying horizontal and pointing towards the gear end although the cleaner itself can be rotated through 360°.

1. Release the three cover clips (A).
2. Lift off the cover (B).
3. Lift out the element (C).

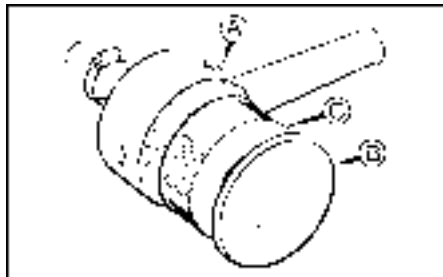


Figure 4.17.1 Light Duty Air Cleaner

4. Fit a new element.
5. Replace the cover and clips.

4.17.2 Cyclonic Air Cleaner

A cyclonic air cleaner can be remote or engine mounted over the flywheel housing, both are connected to the engine by a moulded rubber hose secured by jubilee clips.

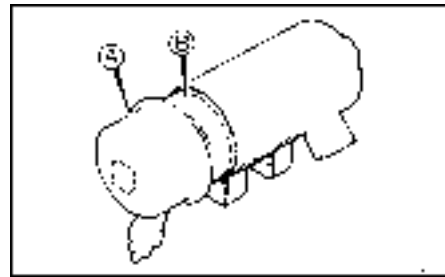


Figure 4.17.2 Cyclonic Type Air Cleaner

1. Regularly remove the dust cap (A) and empty all the dust.
2. Access to the paper element (B) is gained by undoing the cruciform headed screw in the centre of the main body of the filter.
3. Remove the element.
4. The element can be cleaned by directing a low pressure compressed air nozzle up and down the pleats from inside the element.
5. Inspect the element for damage by placing a suitable light source inside it. If the element is found to have any holes it must be replaced.

4 ROUTINE MAINTENANCE

4.18 Valve Clearance

These engines are fitted with hydraulic tappets and therefore no adjustment is necessary.

4.19 Checking the Battery

1. Wear protective gloves and goggles.
2. Clean the top of the battery filler plug area.
3. Remove the filler plugs and check that the electrolyte level is 6.0-9.0mm (0.25-0.37in) above the tops of the separators.
4. If necessary top up with distilled water. In cold weather distilled water should only be added immediately before running the engine.
5. Replace and tighten the filler plugs.
6. Check that the terminal connections are tight; petroleum jelly will help to protect them from corrosion.

WARNING

BATTERIES CONTAIN SULPHURIC ACID WHICH CAN CAUSE SEVERE BURNS AND PRODUCE EXPLOSIVE GASSES. IF THE ACID HAS BEEN SPLASHED ON THE SKIN, EYES OR CLOTHES FLUSH WITH COPIOUS AMOUNTS OF FRESH WATER AND SEEK IMMEDIATE MEDICAL AID.

4.20 Laying-up Procedure

The following routine should be carried out when it is known that the engine will not be required for some months.

If the following procedure is not carried out the engine should be run on full load for approximately 45 minutes once a month.

CAUTION

As a direct result of combustion the lubricating oil may contain harmful acids and therefore it should not be left in the sump if it is known that the engine will not be used for extended periods.

- a. Replace the fuel in the tank with a small supply of suitable inhibition fluid.
- b. Drain the lubricating oil from the sump and refill with new oil.
- c. Run the engine for a period to circulate the oil through the system and to ensure the inhibition fluid is passed through the fuel pumps and injectors.

- d. Stop the engine, drain the cooling system and drain the lubricating oil from the sump.

The crankshaft should NOT be turned until the engine is again required for service.

The inhibition fluid should be left in the fuel system.

- e. Seal all openings on the engine with tape.
- f. Remove the batteries and store them fully charged after coating the terminals with petroleum jelly.
- g. Grease all external bright metal parts and the speed control linkage.
- h. Tie labels on the engine clearly stating what steps have been taken to inhibit the engine during storage.
- e. Seal all openings on the engine with tape.
- f. Remove the batteries and store them fully charged after coating the terminals with petroleum jelly.
- g. Grease all external bright metal parts and the speed control linkage.
- h. Tie labels on the engine clearly stating what steps have been taken to inhibit the engine during storage.

4.21 Maintenance Schedule

Also refer to "4.10 Oil and Oil Filter Change Periods".

Daily
Check the coolant level.
Check the supply and level of fuel.
Check the level and condition of the lubricating oil.
Clean the air cleaner if the engine is operating in very dusty conditions.

Every 125 Hours
The above and the following items.
Clean the air cleaner if the engine is operating in moderately dusty conditions.
Check for fuel, coolant and oil leaks.
Check the serviceability of the battery.

Every 250 Hours
The above and the following items.
Check the condition and tension of the radiator drive belt.
Check the radiator fins for contamination or blockage.
Clean the fuel injector nozzles if the exhaust is dirty.
Renew the fuel filter element if the fuel is not perfectly clean.

Every 500 Hours
The above and the following items.
Renew the fuel filter element.
Renew the air cleaner element.
Check the air induction system for leaks, damage and restrictions.

Every 1000 Hours
The above and the following items.
Check all external nuts, bolts and unions for tightness.
Ensure that all guards are firmly attached and not damaged.
Replace the fuel lift pump diaphragm; see Note:

Every 2000 Hours
The above and the following items.
Decarbonise, if performance has deteriorated, renewing all joints and seals as necessary.
Drain and clean the engine mounted fuel tank, if fitted.
Check the engine and speed controls for free movement.
Clean and check, or replace, the fuel injector nozzles.
Check the radiator fins and radiator fan blades for damage.
Replace the fan drive belt.
Check the lubricating oil pressure.
Renew the air cleaner element.

Every 6000 Hours
The previous items and give the engine a major overhaul, if necessary.

Every Year - LPW and LPWS
Drain, flush and refill the cooling system adding new coolant concentrate to a 40% concentration.

Every Year - All Engines
Drain and replace the lubricating oil and filter, irrespective of their condition, if the engine has run for less than 250 hours in the preceding twelve months.

Every Two Years
Replace the coolant hoses irrespective of their condition.

Note:
It is recommended that the fuel lift pump diaphragm is inspected at more frequent intervals if it is known the fuel is contaminated. It should also be inspected at regular intervals on engines in low duty cycle applications; for example, stand-by generating sets.

4 ROUTINE MAINTENANCE

4.22 Fault Finding

This section is intended as a guide only.

In cases of difficulty, refer to the Workshop Manual, part number P027-08240, or consult any Lister-Petter Distributor or Dealer.

Difficult Starting

Unsuitable lubricating oil (too heavy).

Incorrect fuel.

No fuel in the tank.

Choked fuel filter.

Air lock in the fuel system.

Discharged battery.

Poor battery connections.

Excessive Carbon Deposits

Choked air filter.

Choked exhaust system.

Unsuitable fuel oil.

Unsuitable lubricating oil.

Continuous idling.

Exhaust Smoke

White smoke - generally as a result of water entering the cylinder.

Faint blue smoke - generally the result of light load.

Heavy blue smoke - caused by lubricating oil passing the piston rings due to:
Stuck, worn or broken rings.
Worn cylinder bore.
Overfull oil sump.

Black smoke due to incomplete combustion can be caused by:
Overload.
Choked air filter.
Inlet temperature too high.
Unsuitable fuel, or water in it.

Engine Stops

Lack of fuel.

Air or water in the fuel system.

Choked air or fuel filter.

Overload.

Overheating.

Loss of compression.

Loss of electrical supply to the fuel injector pump solenoid.

Automatic shutdown, if protective devices are fitted.

Loss of Power

Loss of compression.

Choked air filter.

Choked exhaust system.

Fuel injector dirty.

Choked fuel filter.

Worn engine.

Overheating

Radiator fan belt too slack.

Overload.

Lubricating oil level too low.

Radiator fan inlet obstructed.

Recirculation of exhaust gasses or cooling air.

Radiator cooling fins blocked.

Low level of coolant.

Cooling system obstructed.

SECTION 5. INDEX

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X90

Operators

Handbook

THE X90 SERIES OPERATORS HANDBOOK

HANDBOOK CONTENTS

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The purpose of this handbook is to lay down operating guidelines for the current X90 Series of engines.

The specification details given apply to a range of engines and not to any one particular engine, in cases of difficulty the user should consult the local Lister-Petter Distributor or Dealer for further advice and technical assistance.

The information, specifications, illustrations, instructions and statements contained within this publication are given with our best intentions and are believed to be correct at the time of going to press.

Our policy is one of continued development and we reserve the right to amend any technical information with or without prior notice.

Whilst every effort is made to ensure the accuracy of the particulars contained within this publication neither the Manufacturer, Distributor or Dealer shall in any circumstances be held liable for any inaccuracy or the consequences thereof.

The information given is subject to the Company's current Conditions of Tender and Sale, and is for the assistance of users and is based upon results obtained from tests carried out at the place of manufacture. This Company does not guarantee that the same results will be obtained elsewhere under different conditions.

How to Use this Operators Handbook

It is recommended the individual steps contained in the various maintenance or repair operations are followed in the sequence in which they appear.

When an engine is operating or being overhauled there are a number of associated practices which may lead to personal injury or product damage.

Your attention is drawn to the symbols shown and described below which are applied throughout this publication.

CAUTION

This caution symbol draws attention to special instructions or procedures which, if not correctly followed, may result in damage to or destruction of equipment.

WARNING

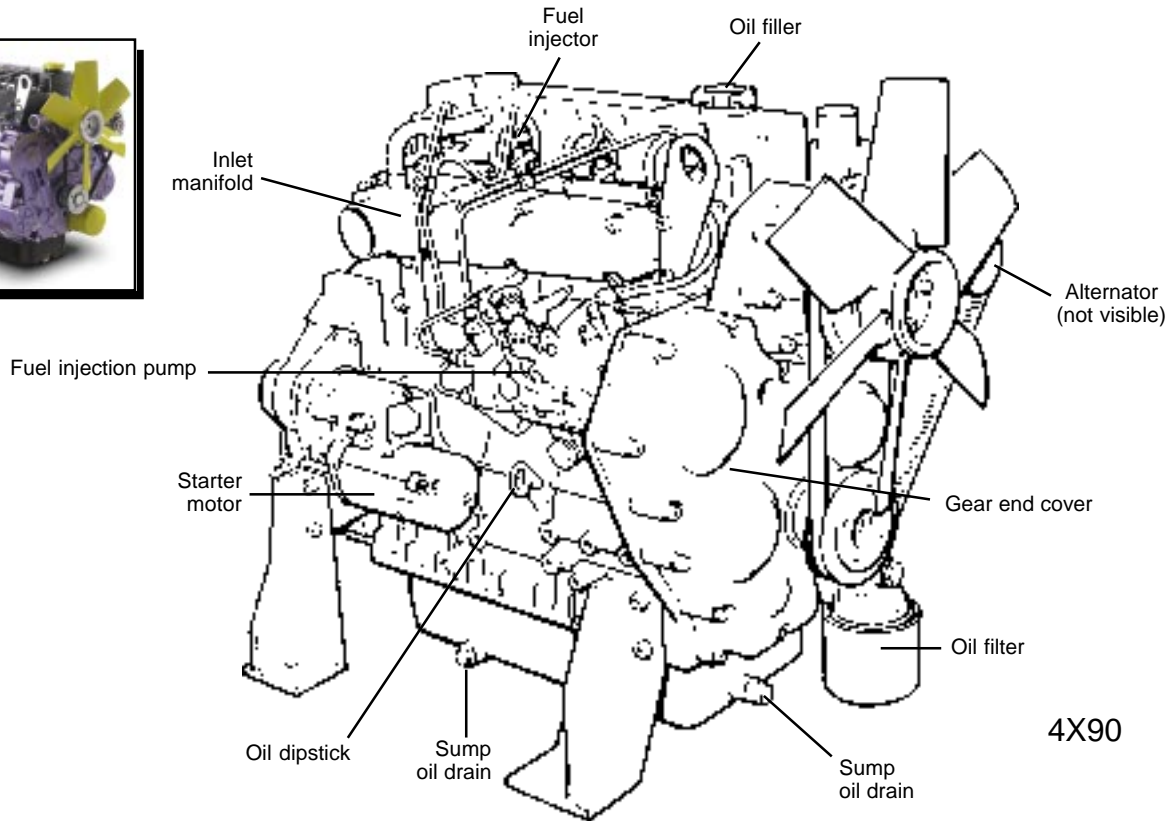
This warning symbol draws attention to special instructions or procedures which, if not strictly observed, may result in personal injury.

WARNING

A WARNING SYMBOL WITH THIS TYPE OF TEXT DRAWS ATTENTION TO SPECIAL INSTRUCTIONS OR PROCEDURES WHICH, IF NOT STRICTLY OBSERVED, MAY RESULT IN SEVERE PERSONAL INJURY, OR LOSS OF LIFE.

Note:

A note is used to draw your attention to additional or important information.



1. GENERAL INFORMATION

The following safety precautions are of a general nature, more specific precautions appear where they are relevant.

1.1 Safety Precautions

The following safety precautions are of a general nature, more specific precautions appear where they are relevant.

1.1.1 General Precautions

- Ensure the engine is securely mounted.
- Ensure that there is a generous supply of cooling and combustion air available.
- Keep the engine and surrounding area clean.
- Keep all safety guards in position.
- Keep the body and clothing clear of all moving or hot parts.
- Never allow any part of the body to come into contact with high pressure fuel oil, for example when testing fuel injection equipment.
- Thoroughly clean any lubricating or fuel oil from the skin as soon as practicable after contact.
- Rectify all fuel, water and oil leaks as soon as practicable and clean any spillages when they occur.

1.1.2 Before Starting Precautions

WARNING

Starting any diesel engine can be dangerous in the hands of inexperienced people. Engine operators must be instructed in the correct procedures before attempting to start any engine.

- Ensure the engine is free to turn without obstruction.
- Check that the water and lubricating oil levels are correct.
- The radiator should be filled to within 13mm-25mm (0.5-1.0in) below the neck of the radiator filler.
- The oil sump must be filled to the 'full' mark on the dipstick; do not overfill.
- Check that the fuel supply is adequate and the system is primed.
- Ensure that the battery is connected, fully charged and serviceable.
- Where possible, disengage the driven equipment while starting.

1.1.3 Alternator Precautions

The following points must be strictly observed when an alternator is fitted otherwise serious damage can be done.

- Never remove any electrical cable while the battery is connected in the circuit.
- Only disconnect the battery with the engine stopped and all switches in the OFF position.
- Always ensure that cables are fitted to their correct terminals.
A short circuit or reversal of polarity will ruin diodes and transistors.
- Never connect a battery into the system without checking that the voltage and polarity are correct.
- Never flash any connection to check the current flow.
- Never experiment with any adjustments or repairs to the system.
- The battery and alternator must be disconnected before commencing any electric welding when a pole strap is directly or indirectly connected to the engine.

1 GENERAL INFORMATION

1.1.4 Starter Battery Precautions

- Do not smoke near the batteries.
- Keep sparks and flames away from the batteries.
- Batteries contain sulphuric acid - if the acid has been splashed on the skin, eyes or clothes flush it away with copious amounts of fresh water and seek medical aid.
- Keep the top of the battery well ventilated during charging.
- **Disconnect the battery negative (earth) lead first and reconnect last.**
- Switch off the battery charger before disconnecting the charger leads.
- Never 'flash' connections to check current flow.
- Never experiment with adjustments or repairs to the system.
- A damaged or unserviceable battery must never be used.

1.1.5 Lifting Precautions

The following points must be considered before attempting to lift the engine.

- Ensure the lifting equipment to be used has the correct capacity to lift the engine.
- Two engine lifting eyes are fitted to X90 engines.

Suitable lifting equipment designed to give two vertical lifts from directly above the engine lifting eyes must be used.

- Check that the engine lifting eyes are not damaged and that they are secure.
- To prevent damage to the cylinder head cover ensure that there is clearance between the lifting equipment hooks and the cover.
- The lifting eyes fitted to the engine are suitable for lifting the engine and accessory assemblies originally fitted by Lister-Petter.

WARNING

Engine lifting eyes must not be used to lift the complete plant.

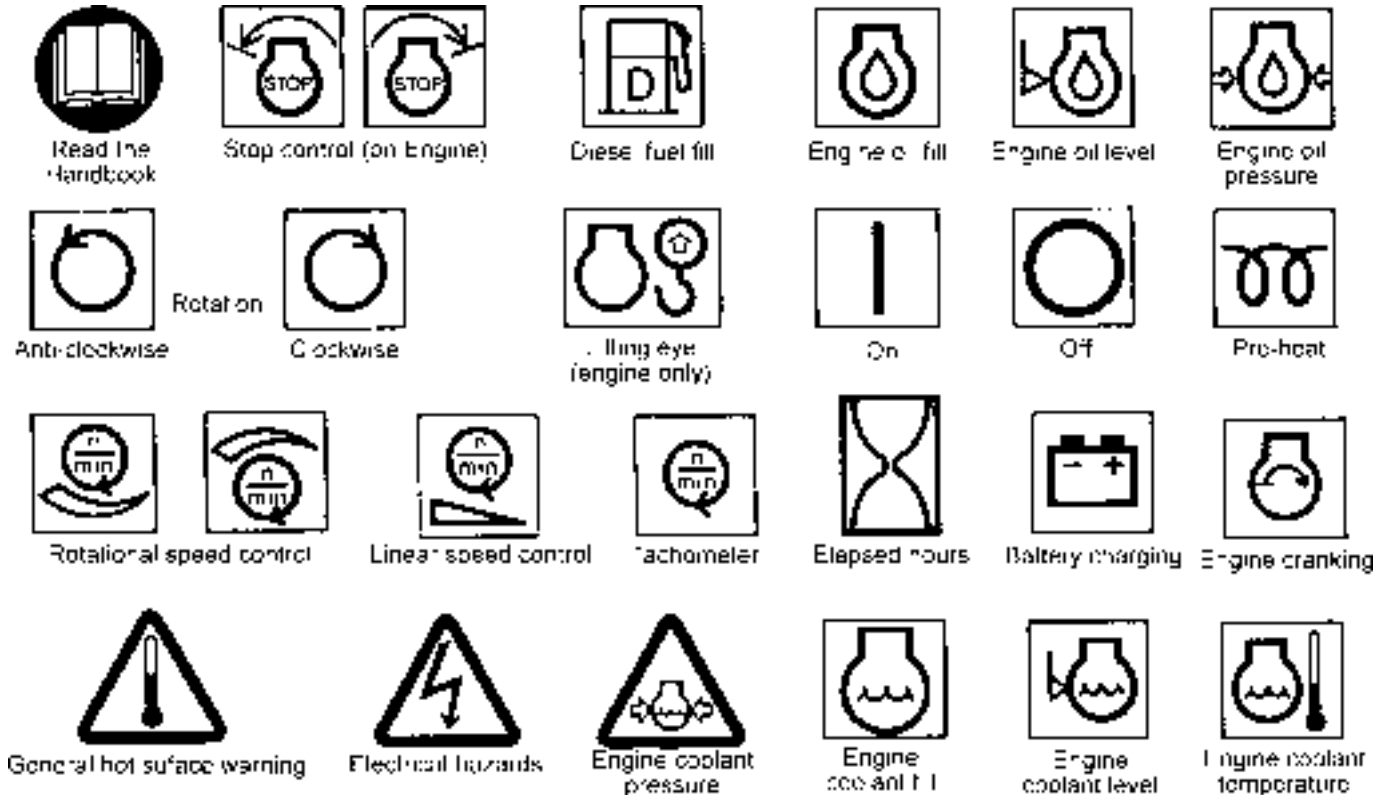
1.1.6 Waste Disposal Precautions

WARNING

Extreme care must be taken to ensure that waste oil, fuel, filter elements, coolant concentrate, battery electrolyte, solvents or other toxic wastes are disposed of in accordance with local regulations to prevent contamination.

1.2 Safety Symbols

This section identifies the ISO 8999 symbols currently used by Lister-Petter.



1 GENERAL INFORMATION

1.3 Technical Data

		4X90
Rotation		Anti-clockwise when looking on the flywheel
Type of injection		Direct
Firing order		1 - 3 - 4 - 2 see Note ¹
Electrical system		12v negative earth
Starter battery charging		12v engine mounted alternator
Oil pressure	at idle	2.0bar (29.0lbf in ²)
	3000r/min	4.5bar (65.3lbf in ²) See Note ²
Oil sump capacity	litres	6.5
	pints	11.4
	US quarts	6.9
Oil capacity between dipstick marks	litres	1.0
	pints	1.7
	US quart	1.0
Engine block coolant capacity	litres	1.135
	pints	2.0
	US quart	1.2

Notes:

1. Number 1 cylinder is at the gear end.
2. Oil pressure at 3000r/min is with the oil at 110°C (230°F).

1.4 The Engine Serial Number

The engine serial number is stamped on a plate attached to the engine.

It is necessary to identify the type of engine to enable the correct maintenance procedures, as described later in this publication, to be carried out.

An example number is shown below.

01 001234 4X90 V3000 A

01 Year code (01 = 2001)
001234 Unique engine number
4X90 Engine series
V3000 Type
A Variant Code

1.5 Nomenclature

4X90 - four cylinder, direct injection, naturally aspirated water cooled diesel engine.

1.6 The Engine Variant

The engine will have been assembled to a predetermined configuration.

1.7 Valve Clearance

These engines are fitted with hydraulic tappets and therefore no adjustment is necessary.

1.8 Ambient Temperature

From the aspect of engine performance, the temperature of the air entering the engine is the only criterion of ambient temperature.

The power developed by the engine, depends on the temperature of the combustion air measured at the air manifold inlet, or the air cleaner, and the temperature of the cooling air as measured at the fan inlet.

The higher of these two temperatures is taken as being "Ambient Temperature" as far as engine ratings are concerned.

The engines are able to run satisfactorily at Ambient temperatures up to 25°C (77°F) without derating. Above this temperature the rated brake horsepower must be reduced in accordance with ISO 3046, BS 5514 or DIN 6271 Standards. The maximum permitted ambient temperature is 52°C (125°F).

1.9 The Cooling System

Cooling is by a radiator with water circulation being assisted by an engine mounted, centrifugal, belt driven water pump using a single belt.

1.10 The Coolant Concentrate

A 50% concentration must be maintained under all operating conditions.

The specification of the coolant concentrate should comply with one of the following:

BS6580 : 1985
MIL-A-11755D
MIL-A-46153/B

To determine the amount of coolant concentrate to be added it will be necessary to calculate the total coolant capacity by adding together the engine, radiator and associated pipework capacities.

WARNING

Coolant concentrate must not be allowed to come into contact with the skin; adhere to the manufacturers instructions and precautions.

1 GENERAL INFORMATION

1.11 Associated Publications

Master Parts Manual: P027-08045
Workshop Manual P027-08218

1.12 Data on CD ROM

The Master Parts Manual is available on CD ROM.

Please contact Lister-Petter for details.

1.13 Training

Comprehensive training in the correct operation, service and overhaul procedures of engines is available at the Lister-Petter International Product Training Centre.

Please contact Lister-Petter for details.

1.14 If Problems Occur

If problems occur with your engine, or any of the Lister-Petter approved accessories fitted to it, your local Lister-Petter Distributor should be consulted.

There are Lister-Petter Distributors in most countries of the world and details for these can be obtained from any one of the Lister-Petter companies listed on the back cover, or from <http://www.lister-petter.co.uk>.

1.15 The Importance of Using Genuine Parts

Parts that have not been approved by the Lister-Petter organisation cannot be relied upon for correct material, dimensions or finish.

This Company cannot therefore, be responsible for any damage arising from the use of such parts and the guarantee may be invalidated.

When purchasing parts or giving instructions for repairs users should, in their own interests, always specify Genuine Lister-Petter Parts.

2. FUEL AND OIL SPECIFICATIONS

2.1 The Fuel Specification

The engine must only be used with diesel fuel oil which conforms to one of the following:-

- a. BS 2869:1988 Class A2.
- b. BS EN590:1995 Class A1.
- c. USA Specification ASTM D-975-77 Grades No.1-D and 2-D.
- d. BSMA 100 Class M1 for marine use.

The fuel must be a distillate, and not a residual oil or blend.

Vaporising oils are not suitable as fuels for Lister-Petter engines.

The user is cautioned that although the engines may operate on fuels outside the above specifications, such operation may well result in excessive wear and damage.

CAUTION

The fuel injection equipment is manufactured to very accurate limits and the smallest particle of dirt will destroy its efficiency. Fuel free from water and contaminants is of the utmost importance.

2.2 The Oil Specification

To help assist engine running-in, all engines are despatched with an initial fill lubricating oil which must be changed, with the filter, after the first 100 hours.

All subsequent oil changes must be as specified in "4.15 Interim Routine Maintenance".

1. The temperatures mentioned in the tables are the ambient temperatures at the time when the engine is started. However, if monograde oils are used and running ambient temperatures are significantly higher than starting temperatures, a higher viscosity oil should be selected subject to satisfactory starting performance. Multigrade oils may be used to overcome the problem.
2. Where it is not practical to continually change oils to suit varying ambient temperatures a suitable multigrade oil is recommended to ensure adequate starting performance at the lowest temperature likely to be encountered.
3. X90 Series engines must be run on heavy duty lubricating oils. Straight mineral oils are not suitable, neither are oils of less detergency than specified.

4. API CD, Series 3 or MIL-L-2104C/D oils must be used in X90 naturally aspirated engines.

CAUTION

API CD, API CE, API CF-4 or MIL-L-2104C/D/E oils can inhibit the running-in process in new or reconditioned engines and are not suitable for engines running on low duty cycles.

5. For engines in long running installations Lister-Petter should be consulted.

2 FUEL AND OIL SPECIFICATIONS

2.3 The Oil Viscosity

The following chart shows the recommended oil viscosity ranges for various °C ambient temperatures for cold start to maximum running.

Before selecting a viscosity grade refer to the 'Notes'.



Notes:

$$^{\circ}\text{F} = (1.8 \times ^{\circ}\text{C}) + 32.$$

A. Intermittent running.

B. Synthetic oils only.

1. SAE 5W-20 oils are recommended on the basis that they are fully synthetic, and are technically suitable for use up to 25°C (77°F). Non synthetic oils at very low temperatures will suffer from wax crystallisation.

Monograde SAE 5W is not normally available as a synthetic oil and therefore is not quoted.

2. *In order to maintain the cold starting characteristics of any recommended grade it is essential that oil changes are made within the Lister-Petter recommendations.*

An oil change is recommended immediately if the engine fails to reach its normal cold start cranking speed due to excessive oil viscosity.

Fuel dilution of the lubricating oil will adversely affect cold starting and oil consumption.

3. SAE 30 and 10W-30 oils may be used at up to 52°C (126°F) but oil consumption may be affected.

10W-40, 15W-40 and 20W-40 multigrades are recommended for continuous full load operation at this temperature.

4. Monograde SAE 40 oils are not recommended.

b. Oil and Filter Change Periods

3.1 Preliminary Instructions

The following information is of a general nature and should be read in conjunction with, or substituted by, the equipment manufacturers instructions.

WARNING

Starting any diesel engine can be dangerous in the hands of inexperienced people.

Before attempting to start any engine the operator should read "1.1 Safety Precautions" and be conversant with the use of the engine controls and the correct starting procedures.

CAUTION

ETHER BASED COLD START AIDS MUST NOT BE USED UNDER ANY CIRCUMSTANCES.

WARNING

DO NOT BREATHE EXHAUST GASES AS THEY CONTAIN CARBON MONOXIDE, A COLOURLESS, ODOURLESS AND POISONOUS GAS THAT CAN CAUSE UNCONSCIOUSNESS AND DEATH.

3.2 Starting the Engine

If an oil pressure switch bypass button is fitted it must be depressed during engine cranking and until the engine attains full speed.

The engine is fitted with a fuel pump solenoid which is automatically energised by the start key during the starting procedure, and while the engine is running with the key in the 'ON' position.

If the engine fails to start within 30 seconds, release the key and attempt to restart after allowing sufficient time for all moving parts to stop.

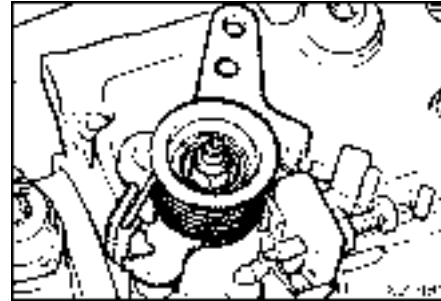


Figure 3.2.1 Engine Control Lever

1. On variable speed engines move the speed control to the fast position.
- 2a. For ambient starting temperatures **above** -10°C (14°F) turn the key clockwise and hold it in the 'HEAT' position for 10 to 15 seconds before turning it to the 'START' position to energise the starter.

3 STARTING AND STOPPING

- 2b. For ambient starting temperatures **below** -10°C (14°F), turn the key clockwise to the 'HEAT' position for 15 to 20 seconds before turning the key to the 'START' position to energise the starter.

Immediately the engine starts, the key must be moved anti-clockwise and held in the 'HEAT' position until the engine has attained full speed.

When the engine is up to speed, release the key to allow it to return to the 'ON' position.

3. On variable speed engines, reduce the engine speed as necessary.

3.3 Stopping the Engine

1. If possible, remove the load from the engine.
2. If a variable speed control is fitted, reduce the engine speed.
3. Turn the key to the 'STOP' position.

This will de-energise the fuel pump solenoid and the engine will come to rest.

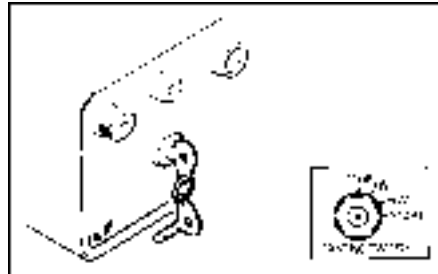


Figure 3.3.1 Key Start

4. ROUTINE MAINTENANCE

4.1 Preliminary Instructions

WARNING

Routine maintenance must be performed by qualified persons who are conversant with the hazards of oil, fuel, electricity and machinery.

This section is designed primarily for use by trained technicians but it does contain sufficient information, illustrations and detail to allow the operator to perform basic maintenance work.

This work can only be carried out if the necessary hand and service tools are available. When the user has insufficient tools, experience or ability to carry out adjustments, maintenance and repairs this work should not be attempted.

Where accurate measurements or torque values are required they can only be made using calibrated instruments.

Under no circumstances should makeshift tools or equipment be used as their use may adversely affect safe working procedures and engine operation.

These recommendations and instructions cover several engine models therefore they are of a general nature.

The engine may include optional equipment not specifically covered in this book.

- Long periods of light or 'no load' running early in the engine's life may lead to cylinder bore glazing and high oil consumption.
- The instructions given in "4.16 Maintenance Schedule" are based on average operating conditions and cover the minimum requirements to keep an engine running at peak performance with trouble free operation.
- Under very dusty conditions, air cleaners, lubricating oil and fuel filters will require more frequent attention
- Decarbonising may be required more often if the engine has been running on light loads for long periods.
- Before carrying out any maintenance work on an engine it is advisable to remove the battery.

The battery and alternator must be disconnected before commencing any electric welding when a pole strap is directly or indirectly connected to the engine.

- It is essential to ensure that nuts and bolts are tightened to the torques specified in the Workshop Manual.
- When re-assembling an engine lubricate all moving parts with engine oil.
- Renew nuts and bolts that have been taken from high stress locations. In particular nuts and/or bolts from the connecting rods should be renewed.
- The fuel injector can only be checked and set off the engine using suitable specialist test equipment.

Note:

It is highly recommended by Lister-Petter that details of the maintenance work carried out on the engine during the first 6000 hours, except the daily checks, is recorded in "6. Maintenance Record".

4 ROUTINE MAINTENANCE

WARNING

ON NO ACCOUNT ALLOW ANY UNPROTECTED SKIN TO COME INTO CONTACT WITH THE INJECTOR SPRAY AS THE FUEL MAY ENTER THE BLOOD STREAM WITH FATAL RESULTS.

WARNING

SOME ENGINES MAY BE FITTED WITH SEALS OR 'O' RINGS MANUFACTURED FROM 'VITON' OR A SIMILAR MATERIAL. WHEN EXPOSED TO ABNORMALLY HIGH TEMPERATURES, IN EXCESS OF 400°C (752°F), AN EXTREMELY CORROSIVE ACID IS PRODUCED WHICH CANNOT BE REMOVED FROM THE SKIN. IF SIGNS OF DECOMPOSITION ARE EVIDENT, OR IF IN DOUBT, ALWAYS WEAR DISPOSABLE HEAVY DUTY GLOVES.

4.2 Precautions for Filters and Elements

- Used liquid filters and elements contain some of the filtered liquid and should be handled and disposed of with care.
 - After handling new or used elements the users hands should be thoroughly washed, particularly before eating.
-

WARNING

Fuel and new or used lubricating oil may cause skin irritation

WARNING

The materials used in the manufacture and treatment of some filters and elements may cause irritation or discomfort if they come into contact with the eyes or mouth and they may give off toxic gasses if they are burnt.

4.3 Waste Contamination

WARNING

Extreme care must be taken to ensure that waste oil, fuel, filter elements, coolant concentrate, battery electrolyte, solvents or other toxic wastes are disposed of in accordance with local regulations to prevent contamination.

4.4 Drive Belt Tension

It is important that the tension of the drive belt is checked after:

- a. After the first 50 hours running.
- b. After an overhaul.
- c. After a new belt has been fitted.
- d. As specified in "4.16 Maintenance Schedule".

When a new belt is correctly fitted and tensioned a force of 12N (2.7lbf) is required to deflect it a distance of 4.5mm (0.18in).

On subsequent checking and adjustment a force of 10N (2.2lbf) is required to deflect it a distance of 4.5mm (0.18in).

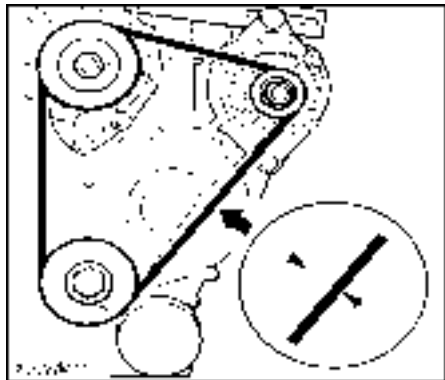


Figure 3.4.2 Checking Belt Tension

4.5 Draining the Cooling System

WARNING

The cooling system is pressurised and extreme care must be taken when removing the radiator filler cap if the engine is hot.

A drain plug is fitted just behind, and below, the rearmost water gallery core plug when looking at the right hand side of the block from the flywheel end.

1. If a drain plug is fitted to the radiator, place a suitable container under both it and the cylinder block drain plug.

If a radiator drain plug is not fitted, place a suitable container under the radiator bottom hose, slacken the clips of the hose and slide the hose off

2. Open the drain plug/s.
3. Remove the radiator filler cap.
4. Allow sufficient time for the system to drain.

4.6 Flushing the Cooling System

a. Radiator

1. With the top and bottom hose, or drain plug, removed from the radiator flush the radiator through the filler with clean fresh water, preferably using a hose pipe, until clean water emerges from the bottom.
2. Replace the hoses and drain plug.

b. Cylinder Block

1. With the cylinder block drain plug and the top hose from the radiator removed, flush the engine block with clean fresh water, preferably using a hose pipe, until clean water emerges from the drain plug.
2. Replace the hose and drain plug.

4.7 Filling the Cooling System

The coolant capacity is given in "1.3 Technical Data".

CAUTION

Under some circumstances an airlock can occur when filling the system causing a false level indication.

1. Ensure all the hoses and drain plugs, have been replaced.
2. Refill the system with clean fresh water, and coolant concentrate to a 40% concentration, while bleeding air from the system at a suitable point.
The radiator should be filled to within 13.0mm-25.0mm (0.5-1.0in) below the neck of the radiator filler.
3. Run the engine for a short time and check the coolant level.

4 ROUTINE MAINTENANCE

4.8 Changing the Oil Filter

The full flow filter is a spin-on cartridge type located on the gear end cover.

Only approved filters should be used as these have high temperature joints, adequate filter paper characteristics and a rigid case.

Other filters may have the same external dimensions and thread as the genuine one, but may fail in service.

The oil filter should be changed as specified in "4.15 Maintenance Schedule".

Before changing the filter read "4.2 Precautions for Filters and Elements".

1. Use a band type gripping tool to remove the filter (A) from the engine.

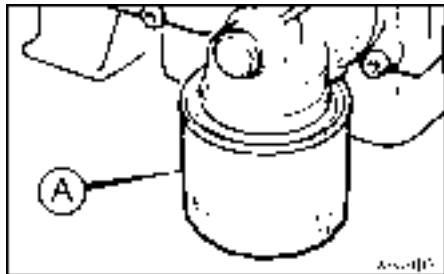


Figure 4.8.1 Oil Filter

2. Lightly grease or oil the face of the rubber joint on the new filter.
3. Screw the new filter onto the gear end cover filter adaptor until the rubber joint just makes contact with the crankcase facing.
4. Screw the filter on a further quarter to half of a turn.
5. Start the engine and run it for a few minutes to circulate the oil.
6. Stop the engine and allow time for the oil to drain down and check the level on the dipstick.
7. Add more oil if necessary. The capacity between dipstick marks is given in "1.3 Technical Data".

4.9 Draining the Oil Sump

The sump is fitted with two drain plugs. One is located on one side of the sump and the other will be either at the gear end, or flywheel end of the sump.

If the engine has been run immediately before draining, the warm oil will drain quicker.

The oil should be changed as specified in "4.15 Oil and Filter Change Periods".

Before draining the oil read "4.2 Precautions for Filters and Elements".

1. Remove the oil filler cap.
2. Remove the most convenient drain plug and allow the oil to run into a suitable container.

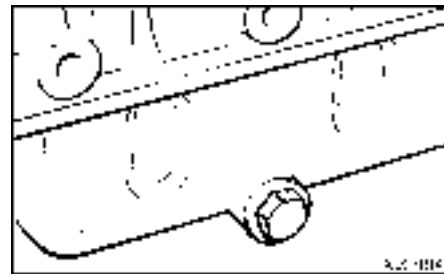


Figure 4.9.1 Oil Drain Plug

3. Clean the drain plug threads, fit a new copper washer, replace the plug and tighten it.

4.10 Filling the Oil Sump

CAUTION

Do not overfill with oil. The oil must only be poured into the filler at a rate which enables it to drain into the crankcase.

1. Ensure the drain plug is fitted.
2. Fill the sump through the oil filler (A) on the top of the valve rocker cover to the upper mark on the dipstick. The oil capacity is given in "1.3 Technical Data".

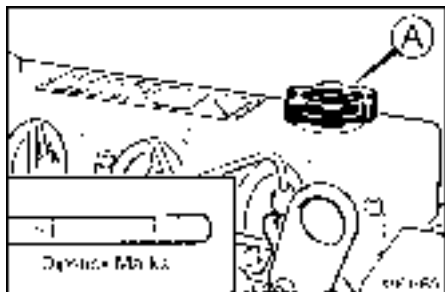


Figure 4.10.1 Oil Filler

3. Start the engine and run it for a few minutes to circulate the oil.
4. Stop the engine and allow time for the oil to drain down and check the level on the dipstick.
5. Add more oil if necessary.

4.11 The Fuel Filter

The fuel filter is fitted on the opposite side of the engine to the fuel injector pump.

Water can be drained from the filter by gently unscrewing (B) a few turns.

The fuel filter should be changed as specified in "4.16 Maintenance Schedule".

Before changing the fuel filter read "4.2 Precautions for Filters and Elements".

1. Loosen the bleed screws (A) and (B) to drain the fuel.
2. Unscrew the cartridge retainer (B) sufficiently for the element cartridge to be removed from the filter head.

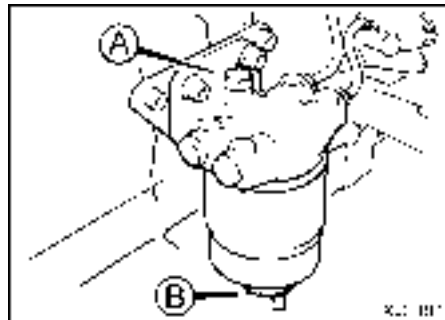


Figure 4.11.1 Fuel Filter

3. Push a new cartridge securely onto the head and tighten the retainer.
4. Prime the fuel system.

5. Start the engine and run it for a few minutes to check for leaks.

4.12 Priming the Fuel Filter

The fuel system is self-bleed but should priming be necessary, follow the instructions below.

CAUTION

Care must be taken to contain any spilled fuel while carrying out this procedure.

1. Ensure there is sufficient fuel.
2. Release the bleed screw (A) on the head of the fuel filter.
3. Tighten the bleed screw when no further air bubbles are expelled.



Figure 4.12.1 Priming the Fuel Filter

4 ROUTINE MAINTENANCE

4.13 The Cyclonic Air Cleaner

The air cleaner should be cleaned daily under very dusty operating conditions and as specified in "4.16 Maintenance Schedule".

1. Release the cover clips (A) and remove the end cap (B).

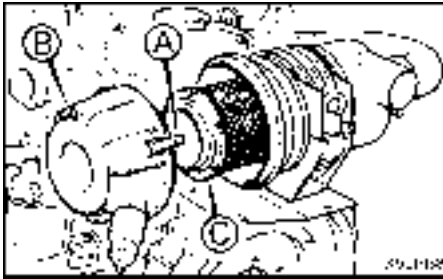


Figure 4.13.1 Cyclonic Type Air Cleaner

2. Empty all the dust from the end cap.
3. Remove the element (C).
4. The element can be cleaned by directing a low pressure compressed air nozzle up and down the pleats from inside the element.
5. Inspect the element for damage by placing a suitable light source inside it. If the element is found to have any holes it must be replaced.
6. Replace the element and end cover.

4.14 Checking the Battery

1. Check that the terminal connections are tight; petroleum jelly will help to protect them from corrosion.

The following instructions do not apply to 'no maintenance' or 'sealed' batteries.

2. Wear protective gloves and goggles.
3. Clean the top of the battery filler plug area.
4. Remove the filler plugs and check that the electrolyte level is 6.0-9.0mm (0.25-0.37in) above the tops of the separators.
5. If necessary top up with distilled water. In cold weather distilled water should only be added immediately before running the engine.
6. Replace and tighten the filler plugs.

WARNING

BATTERIES CONTAIN SULPHURIC ACID WHICH CAN CAUSE SEVERE BURNS AND PRODUCE EXPLOSIVE GASSES. IF THE ACID HAS BEEN SPLASHED ON THE SKIN, EYES OR CLOTHES FLUSH WITH COPIOUS AMOUNTS OF FRESH WATER AND SEEK IMMEDIATE MEDICAL AID.

4.15 Interim Routine Maintenance

The details in this section are to be carried out in addition to those given in "4.16 Maintenance Schedule".

Note:

It is highly recommended by Lister-Petter that details of the maintenance work carried out on the engine during the first 6000 hours, except the daily checks, is recorded in "6. Maintenance Record".

a. Daily Checks

1. Check the coolant, lubricating oil and fuel levels.
2. Check for coolant, lubricating oil and fuel leaks.
3. Clean the air cleaner under very dusty operating conditions.
4. Examine the cooling fan for damage.
5. Ensure all guards are firmly attached and not damaged.

b. Oil and Filter Change Periods

To help assist engine running-in, X90 engines are despatched with an initial fill lubricating oil.

This oil, and the oil filter, must be changed after the first 100 hours, with all subsequent oil and filter changes being made as specified in the table below.

The oil capacity is given in "1.3 Technical Data".

Before attempting to change the lubricating oil or filter:

1. Read "4.2 Precautions for Filters and Elements".
2. Ensure the new oil is of the correct type and viscosity as given in "2. Fuel and Oil Specifications".

Ambient Temperature	Hours
Up to 35°C	500
Above 35°C (see Note)	250

35°C = 95°F

Note:

The oil and filter change periods, given in hours, apply when engines are operating regularly at temperatures exceeding 35°C (95°F), at high speeds and duty factors.

c. After Every 2 Years

1. Check the coolant hoses and replace them if they are swollen or perished.
2. Drain, flush and refill the coolant system, adding new coolant concentrate to a 50% concentration. The coolant capacity is given in "1.3 Technical Data".

4 ROUTINE MAINTENANCE

4.16 Maintenance Schedule

Also refer to "4.15 Interim Maintenance" and "Note 1" below.

	Maintenance Schedule Hours											
	500	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000
Drain the lubricating oil and refill the sump with new oil of the correct type and viscosity.												
Replace the fuel and lubricating oil filters.												
Check the cooling system drive belt and adjust the belt tension if necessary.	•	•	•	•	•	•	•	•	•	•	•	•
Renew the air cleaner element and ensure the connections are airtight.												
Check the battery condition.												
Replace the lift pump diaphragm - see Note ² .	-	•	-	•	-	•	-	•	-	•	-	•
Replace the fuel injectors - see Note ³ .	-	-	-	-	-	•	-	-	-	-	-	•
Check the compression. Decarbonise and overhaul, if it is required.	-	-	-	-	-	-	-	-	-	-	-	•
Replace the cooling system drive belt.	-	-	-	-	-	-	-	-	-	-	-	•

Note 1:

It is highly recommended by Lister-Petter that details of the maintenance work carried out on the engine during the first 6000 hours, except the daily checks, is recorded in "6. Maintenance Record".

Note 2:

It is recommended that the fuel lift pump diaphragm is inspected at more frequent intervals if it is known the fuel is contaminated. It should also be inspected at regular intervals on engines in low duty cycle applications; for example, stand-by generating sets.

Note 3:

The injectors are only changed at 3000 hours on constant speed engines running at 3000r/min.

4.17 Fault Finding

This section is intended as a guide only. If in difficulty refer to the Workshop Manual or consult any Lister-Petter Distributor or Dealer.

Difficult Starting
Unsuitable lubricating oil (too heavy).
Incorrect fuel.
No fuel in the tank.
Choked fuel filter.
Air lock in the fuel system.
Discharged battery.
Fuel pump solenoid not energised.
Poor battery connections.

Excessive Carbon Deposits
Choked air filter.
Choked exhaust system.
Unsuitable fuel oil.
Unsuitable lubricating oil.
Continuous idling.

White Exhaust Smoke
Water entering the cylinder.
Faulty crankcase temperature switch - refer to Lister-Petter
Faulty fuel pump - refer to Lister-Petter

Light Blue Exhaust Smoke
Generally as a result of light load.

Heavy Blue Exhaust Smoke
Lubricating oil passing the piston rings due to: Stuck, worn or broken rings. Worn cylinder bore. Overfull oil sump.

Black Exhaust Smoke
Overload.
Choked air filter.
Inlet temperature too high.
Unsuitable fuel, or water in it.

Engine Stops
Lack of fuel.
Air or water in the fuel system.
Choked air or fuel filter.
Overload.
Overheating.
Loss of compression.
Loss of electrical supply to the fuel pump solenoid.
Automatic shutdown, if protective devices are fitted.

Loss of Power
Loss of compression.
Choked air filter.
Choked exhaust system.
Fuel injector dirty.
Choked fuel filter.
Worn engine.

Overheating
Radiator fan belt too slack.
Overload.
Lubricating oil level too low.
Radiator fan inlet obstructed.
Recirculation of exhaust gasses or cooling air.
Radiator cooling fins blocked.
Low level of coolant.
Cooling system obstructed.

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6. MAINTENANCE RECORD

It is highly recommended by Lister-Petter that details of the maintenance work carried out on the engine during the first 6000 hours, except the daily checks, is recorded in this section.

Details of the scheduled work to be carried out are given in "4.15 Interim Maintenance" and "4.16 Maintenance Schedule".

This record may need to be produced in the event of a warranty claim.

I certify that I have carried out the initial 100 hour oil change as detailed in Section 4		
Signature	Name	Date
Company Name and Address		

I certify that I have carried out the first 250 hour oil change as detailed in Section 4		
Signature	Name	Date
Company Name and Address		

6 MAINTENANCE RECORD

I certify that I have carried out the first 500 hour service as detailed in Section 4		
Signature	Name	Date
Company Name and Address		

I certify that I have carried out the first 1500 hour service as detailed in Section 4		
Signature	Name	Date
Company Name and Address		

I certify that I have carried out the first 1000 hour service as detailed in Section 4		
Signature	Name	Date
Company Name and Address		

I certify that I have carried out the first 2000 hour service as detailed in Section 4		
Signature	Name	Date
Company Name and Address		

I certify that I have carried out the first 2500 hour service as detailed in Section 4		
Signature	Name	Date
Company Name and Address		

I certify that I have carried out the first 3500 hour service as detailed in Section 4		
Signature	Name	Date
Company Name and Address		

I certify that I have carried out the first 3000 hour service as detailed in Section 4		
Signature	Name	Date
Company Name and Address		

I certify that I have carried out the first 4000 hour service as detailed in Section 4		
Signature	Name	Date
Company Name and Address		

6 MAINTENANCE RECORD

I certify that I have carried out the first 4500 hour service as detailed in Section 4		
Signature	Name	Date
Company Name and Address		

I certify that I have carried out the first 5500 hour service as detailed in Section 4		
Signature	Name	Date
Company Name and Address		

I certify that I have carried out the first 5000 hour service as detailed in Section 4		
Signature	Name	Date
Company Name and Address		

I certify that I have carried out the first 6000 hour service as detailed in Section 4		
Signature	Name	Date
Company Name and Address		

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