



OPERATOR'S MANUAL



JCB Tier 4F Engines

TCAE-55

ISSUE A - 07/2014

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Care and Safety

Important Information

T1-042

The Operator Manual

WARNING

You and others can be killed or seriously injured if you operate or maintain the machine without first studying the Operator Manual. You must understand and follow the instructions in the Operator Manual. If you do not understand anything, ask your employer or JCB dealer to explain it.

INT-1-4-2

Do not operate the machine without an Operator Manual, or if there is anything on the machine you do not understand.

Treat the Operator Manual as part of the machine. Keep it clean and in good condition. Replace the Operator Manual immediately if it is lost, damaged or becomes unreadable.

Safety Warnings



This safety alert system identifies important safety messages in this manual. When you see this symbol, be alert, your safety is involved, carefully read the message that follows, and inform other operators.

In this publication and on the machine, there are safety notices. Each notice starts with a signal word. The signal word meanings are given below.

DANGER

Denotes an extreme hazard exists. If proper precautions are not taken, it is highly probable that the operator (or others) could be killed or seriously injured.

INT-1-2-1

WARNING

Denotes a hazard exists. If proper precautions are not taken, the operator (or others) could be killed or seriously injured.

INT-1-2-2

CAUTION

Denotes a reminder of safety practices. Failure to follow these safety practices could result in injury to the operator (or others) and possible damage to the machine.

INT-1-2-3



Safety Yours and Others

All machinery, whether mobile or static can be hazardous. When equipment is correctly operated and properly maintained it can be safe to work with. But when it is carelessly operated or poorly maintained it can become a danger.

Do not work with any equipment until you are sure that it is serviceable, that you know how to control it and be aware of all relevant safety requirements.

If the equipment covered by this manual forms part of a larger product (e.g a vehicle) be sure to observe the safety requirements which relate to the product as a whole, as well as those given in this manual.

On this and the following pages and throughout this manual, you will find safety messages. Please read and understand these safety messages before using and working on the equipment covered in this manual.

Make sure you also read and understand all other safety messages contained in operator manuals and service manuals concerned with the product of which this equipment forms part.

Remember

BE CAREFUL

BE ALERT

BE SAFE

Checklists

Common Rail (Tier 4) Specific

In addition to the general safety notices and general good workshop practices issued in this section and throughout the manual, there are specific points to note when completing maintenance on Tier 4 equipment:

Diesel Fuel Quality

Important: *The potential for engine damage due to the use of incorrect or contaminated fuel is much greater with common rail injection technology than with mechanical injection systems. → [T4i Acceptable and Unacceptable Fuels \(□ 17\)](#).*

Effects of Contamination

Once inside the system, fuel circuit contaminants greatly effect the performance and life of the fuel injection equipment. For example, contaminants in the fuel pump will develop internal wear to cause internal leakage and hence lower discharges. Use of poor quality fuels and poor maintenance could also lead to contaminants entering the fuel injectors. There is a possibility of catastrophic equipment failure if debris should prevent the injectors from fully closing. The main contaminants can be classified as follows: These contaminations can appear during manufacture, assembly and operation.

- Solid Particles - sand, fibres, metallic particles, welding scale, sealing materials and wear particles etc.
- Liquid - usually water and incompatible oils and chemical contaminants.
- Gases - Air, sulphur dioxide etc. which can create corrosive compounds if dissolved in the fluid.

It is critical that the machine is thoroughly cleaned prior to completing any maintenance work. The main filter is rated at 2 micron = 0.002 mm (0.0007874 in).

Listed are a few typical comparisons of micron size:

- Red Blood Cell = 8 microns (0.008 mm, 0.000315 in).
- Human Hair = 70 microns (0.07 mm, 0.00275 in).
- Grain of Salt = 100 microns (0.1 mm, 0.00394 in).
- The smallest particle visible to the naked eye is 40 microns (0.00157 in) approximately.

Common Rail Safety Checklist

The following safety checklist is intended to help remind you of safety procedures and practices relating to a common rail engine.

SAFETY IS YOUR RESPONSIBILITY

- Do make sure the engine and surrounding area has been thoroughly cleaned prior to completing any maintenance tasks. Refer to Section 1, Cleanliness Requirements.
- Do complete all work in accordance with the Service Manual procedures.
- Do disconnect both the battery positive (+) and battery negative (-) cables prior to completing any welding on the machine.
- Do use the recommended grade of fuel (EN590). The fuel injection pump, injector or other parts of the fuel system can be damaged if you use a fuel or fuel additives not recommended by JCB. → [T4i Acceptable and Unacceptable Fuels \(□ 17\)](#).
- Do make sure all the necessary new parts are available before starting any maintenance work.
- Do not 'crack' the injector high pressure fuel lines to bleed the fuel system. The system operates at pressures up to 2000 bar (29400 lbs/in²).
- Do not steam clean the electronic control unit (ECU) or the ECU connectors.
- Do not touch the ECU connector pins, this will eliminate the possibility of damage caused by electrostatic discharge.
- Do not leave any fuel connections 'open' for any extended period of time.
- Do not open any new parts packaging until the part is ready to be fitted. Unnecessary exposure will increase the risk of contamination.
- Do not reuse high pressure fuel pipes. Reusing the pipes will lead to potential fuel leaks.
- Do not attempt to remove and replace the rail pressure sensor or high pressure valve. It is not possible to refit these components without the risk of fuel leaks. If the valve or sensor is diagnosed as faulty then a new common rail assembly must be fitted.

General Safety

The following safety checklist is intended to help remind you of safety procedures and practices.

SAFETY IS YOUR RESPONSIBILITY

You must also refer to local regulations in the country your equipment is being used in. Some of the information may be repeated in the following warnings and cautions pages and in the main text.

- Do not change the application or specification of the engine.
- Install the engine in accordance with recommendations made in the Engine Installation Manual.
- Do not work under a raised vehicle unless properly supported with axle stands or similar equipment.
- Do not lift heavy objects on your own, use lifting equipment or obtain the help of an assistant.
- Do not smoke when adding fuel to the tank or working in the engine bay area.
- Always clean up spilt fluids, dispose of fluids, contaminated material etc. in accordance with local regulations. Do not pollute drains or the ground.
- Use the right tools for the job.
- Always make the equipment safe before completing any maintenance tasks, for instance disconnect the battery so that the engine can not be started.
- Allow engine components to cool before attempting any maintenance tasks, components such as the exhaust can become extremely hot.
- Do not adjust the engine, add fuel or oil whilst it is running unless procedures in this manual instruct you to do so.
- Do not siphon fluids by mouth.
- Operate the engine in well ventilated areas, if using indoors then a purpose designed exhaust fume extraction unit may be needed.
- Keep other people at a safe distance when operating the engine or equipment.
- Do not operate an engine if the safety guard (when applicable) has been removed.
- Vapours from solvents, thinners and adhesives can be highly flammable. In addition to fire risk, they can be toxic and in certain conditions cause unconsciousness, or death if inhaled. Use these items in well ventilated areas.
- Seek medical advice immediately if your skin contacts high pressure fuel.
- Make sure the engine is operated by one person correctly positioned at the controls.
- Do not operate the engine at high speeds with no load applied.
- Make sure you have adequate fire fighting equipment in your workshop, repair area. Contact your local fire prevention officer for advice.
- Turbocharger impeller blades operate at extremely high revolutions and the turbocharger unit becomes very hot. Allow the unit to cool before completing any maintenance. Keep tools and objects away from the impeller when the unit is operating.
- Use only JCB recommended parts. These parts have been designed to give the engine its optimum performance. Using spurious parts may affect the integrity of the engine

WARNING

Care and Alertness

All the time you are working with or on the machine, take care and stay alert. Always be careful. Always be alert for hazards.

INT-1-3-5

WARNING

Clothing

You can be injured if you do not wear the proper clothing. Loose clothing can get caught in the machinery. Wear protective clothing to suit the job. Examples of protective clothing are: a hard hat, safety shoes, safety glasses, a well fitting overall, ear-protectors and industrial gloves. Keep cuffs fastened. Do not wear a necktie or scarf. Keep long hair restrained. Remove rings, watches and personal jewellery.

INT-1-3-6_2

WARNING

Raised Attachments

Raised attachments can fall and injure you. Do not walk or work under raised attachments unless they are safely blocked.

INT-1-3-8

⚠ WARNING**Lifting Equipment**

You can be injured if you use incorrect or faulty lifting equipment. You must identify the weight of the item to be lifted then choose lifting equipment that is strong enough and suitable for the job. Make sure that lifting equipment is in good condition and complies with all local regulations.

INT-1-3-7_2

Introduction

T1-014_2

⚠ WARNING**Safety Labels**

Safety labels on the machine warn you of particular hazards. You can be injured if you do not obey the safety instructions shown.

INT-1-3-11

Safety labels are strategically placed around the machine to remind you of possible hazards.

If you need eye-glasses for reading, make sure you wear them when reading the safety labels. Do not over-stretch or place yourself in dangerous positions to read the safety labels. If you do not understand the hazard shown on the safety label, then refer to **Safety Label Identification**.

Note: The illustration(s) show a typical machine model. Your machine may look different from the model shown.

Keep all safety labels clean and readable. Replace lost or damaged safety labels. Make sure replacement parts include safety labels where necessary. Each safety label has a part number printed on it, use this number to order a new safety label from your JCB distributor.

Operating Safety

⚠ WARNING

The engine has exposed rotating parts. Switch OFF the engine before working in the engine compartment. Do not use the machine with the engine cover open.

5-2-6-5

⚠ WARNING**Exhaust Gases**

Breathing the machine exhaust gases can harm and possibly kill you. Do not operate the machine in closed spaces without making sure there is good ventilation. If possible, fit an exhaust extension. If you begin to feel drowsy, stop the machine at once and get into fresh air.

INT-2-1-10_2

⚠ WARNING

On turbo-charged machines, do not keep the accelerator pedal fully depressed when the engine has started. Do not race the engine until the oil pressure low light has gone out. Racing the engine too soon could damage the turbo-charger due to insufficient lubrication.

16-2-4-1

Maintenance Safety

WARNING

Repairs

If your machine does not function correctly in any way, get it repaired straight away. Neglect of necessary repairs could result in an accident or affect your health. Do not try to do repairs or any other type of maintenance work you do not understand. To avoid injury and/or damage get the work done by a specialist engineer.

GEN-1-5_2

WARNING

Machine Modifications

This machine is manufactured in compliance with legislative and other requirements. It should not be altered in any way which could affect or invalidate any of these requirements. For advice consult your JCB Distributor.

INT-1-3-10_2

WARNING

Petrol

Do not use petrol in this machine. Do not mix petrol with the diesel fuel; in storage tanks the petrol will rise to the top and form flammable vapours.

INT-3-1-6

WARNING

Fuel

Fuel is flammable; keep naked flames away from the fuel system. Stop the engine immediately if a fuel leak is suspected. Do not smoke while refuelling or working on the fuel system. Do not refuel with the engine running. Completely wipe off any spilt fuel which could cause a fire. There could be a fire and injury if you do not follow these precautions.

INT-3-2-2_3

WARNING

Oil

Oil is toxic. If you swallow any oil, do not induce vomiting, seek medical advice. Used engine oil contains harmful contaminants which can cause skin cancer. Do not handle used engine oil more than necessary. Always use barrier cream or wear gloves to prevent skin contact. Wash skin contaminated with oil thoroughly in warm soapy water. Do not use petrol, diesel fuel or paraffin to clean your skin.

INT-3-2-3

WARNING

The cooling system is pressurised when the coolant is hot. When you remove the cap, hot coolant can spray out and burn you. Make sure that the engine is cool before you work on the cooling system.

9-3-3-1_2

WARNING

Always wear safety glasses when dismantling assemblies containing components under pressure from springs. This will protect against eye injury from components accidentally flying out.

GEN-6-2

CAUTION

'O' rings, Seals and Gaskets

Badly fitted, damaged or rotted 'O' rings, seals and gaskets can cause leakages and possible accidents. Renew whenever disturbed unless otherwise instructed. Do not use Trichloroethane or paint thinners near 'O' rings and seals.

INT-3-2-12

WARNING

To avoid burning wear personal protective equipment (PPE) when handling hot components. To protect your eyes, wear personal protective equipment (PPE) when using a brush to clean components.

HYD-1-3_3

⚠ WARNING

Certain seals and gaskets (e.g. crankshaft oil seal) on JCB machines contain fluoroelastomeric materials such as Viton®, Fluorel™ and Technoflon®. Fluoroelastomeric materials subjected to high temperatures can produce highly corrosive hydrofluoric acid. **THIS ACID CAN SEVERELY BURN.**

New fluoroelastomeric components at ambient temperature require no special safety precautions.

Used fluoroelastomeric components whose temperatures have not exceeded 300°C (572°F) require no special safety precautions. If evidence of decomposition (e.g. charring) is found, refer to the next paragraph for safety instructions **DO NOT TOUCH COMPONENT OR SURROUNDING AREA.**

Used fluoroelastomeric components subjected to temperatures greater than 300°C (572°F) (e.g. engine fire) must be treated using the following safety procedure. Make sure that heavy duty gloves and special safety glasses are worn:

- 1 Thoroughly wash contaminated area with 10% calcium hydroxide or other suitable alkali solution, if necessary use wire wool to remove burnt remains.
- 2 Thoroughly wash contaminated area with detergent and water.
- 3 Contain all removed material, gloves etc. used in this operation in sealed plastic bags and dispose of in accordance with Local Authority Regulations.

DO NOT BURN FLUOROELASTOMERIC MATERIALS.

INT-3-3-5_4

⚠ CAUTION

Do not allow dirt to enter the fuel system. Before disconnecting any part of the fuel system, thoroughly clean around the connection. When a component has been disconnected, for example a fuel pipe, always fit protective caps and plugs to prevent dirt ingress.

Failure to follow these instructions will lead to dirt entering the fuel system. Dirt in the fuel system will seriously damage the fuel injection equipment and could be expensive to repair.

ENG-1-7

⚠ WARNING

Do not open the high pressure fuel system with the engine running. Engine operation causes high fuel pressure. High pressure fuel spray can cause serious injury or death.

13-3-2-16

***Important:** DO NOT open the high pressure fuel system even when the engine is not running. Contact your JCB Engine Dealer who has the correct tools and training.*

⚠ CAUTION

It is illegal to pollute drains, sewers or the ground. Clean up all spilt fluids and/or lubricants.

Used fluids and/or lubricants, filters and contaminated materials must be disposed of in accordance with local regulations. Use authorised waste disposal sites.

INT-3-2-14



General Information

Introduction

This manual is arranged to give you a good understanding of the engine and its safe operation. It also contains maintenance information and specification data. Read this manual from front to back before using the engine for the first time. Particular attention must be given to all the safety aspects of operating and maintaining the engine.

Read all the safety statements regularly, so you do not forget them. Remember that the best operators are the safest operators.

Keep it clean and in good condition. If there is anything you are not sure about, ask your supplier or employer. Do not guess, you or others could be killed or seriously injured.

The manufacturer's policy is one of continuous improvement. The right to change the specification of engine without notice is reserved. No responsibility will be accepted for discrepancies which may occur between specifications of the engine and the descriptions contained in this publication.

Left Side, Right Side

References to the 'left' side and the 'right' side of the engine are when viewed from the flywheel end of the engine.

Units of Measurement

In this manual, the S.I. system of units is used. For example, liquid capacities are given in litres. The imperial units follow in parenthesis () e.g. 28 litres (6 UK gal).

Machine / Equipment Related Data

The JCB Engine can be fitted to a variety of machines and/or equipment. The scope of this publication is limited to the engine, but references to a typical installation will be made.

When the JCB Engine is used as a power source for pumps, generators, independent power units etc., the operating controls and procedures must be provided by the Original Equipment Manufacturer (OEM). Always refer to Original Equipment Manufacturer (OEM) Operator Manual for safe operating instructions.

Identifying the Engine

Engine Identification Plate

Typical Engine Identification Number

Engine data labels **1A** are located on the cylinder block at position **1C** and rocker cover **1D** (if fitted). The data label contains important engine information and includes the engine identification number **1E**. Injector codes are on a label on the rocker cover **1F**.

A typical engine identification number is explained as follows:

S	H	320/40001	U	00001	12
1	2	3	4	5	6

1 Engine Displacement

S = 4.4 litre series

D = 4.8 litre series

2 A = naturally aspirated (Tier 2)

B = turbocharged (Tier 2)

C = turbocharged and intercooled (Tier 2)

D = turbocharged mechanical fuel injection (mechanical Tier 3)

E = electronic common rail fuel injection (Tier 3)

F = turbocharged and aftercooled (mechanical Tier 3)

H = turbocharged and aftercooled electronic common rail fuel injection (Tier 4i)

3 Engine part number

4 Country of manufacture

U = United Kingdom

5 Engine serial number

6 Year of manufacture

The last three parts of the engine identification number are stamped on the cylinder block at position **1B** as follows:

U 00001 12

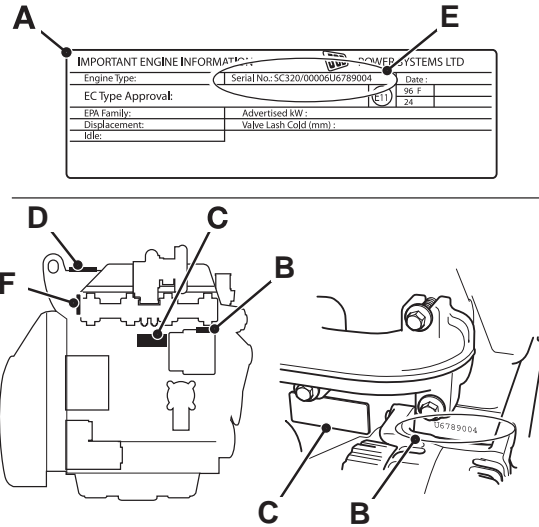


Fig 1. Engine

T062720

Component Labels

In addition to the engine labels, some of the machine engine components will also have a label attached, or a part number etched into the casting, these include:

- the starter motor
- the alternator
- the high pressure fuel pump
- engine bedplate
- engine block
- cylinder head
- turbo charger

In some instances, it may be necessary to quote the information on these labels, for instance if there is a parts query, or a warranty claim. Make a note of these numbers.

Engine Component Identification

JCB Dieselmex Engine T2/T3 Mechanical

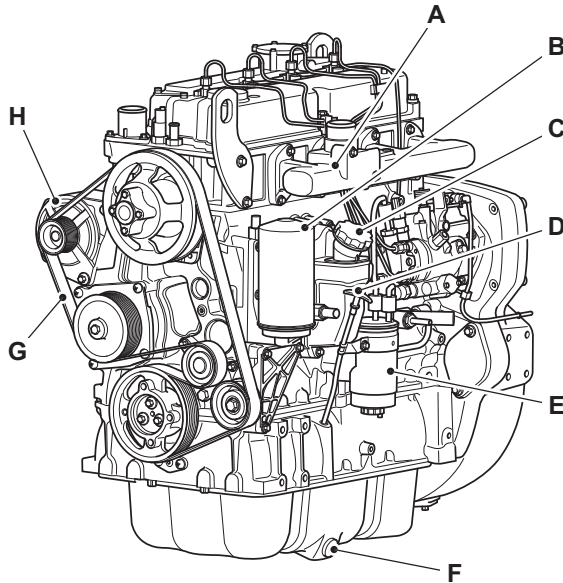


Fig 2.

Item	Description
A	Air Inlet manifold
B	Lubrication oil filter
C	Lubrication oil filler cap
D	Lubrication oil dip stick
E	Fuel filter
F	Oil drain plug (sump)
G	Front end accessory drive belt
H	Alternator and drive pulley assembly

JCB Dieselmex Engine T3 Electrical

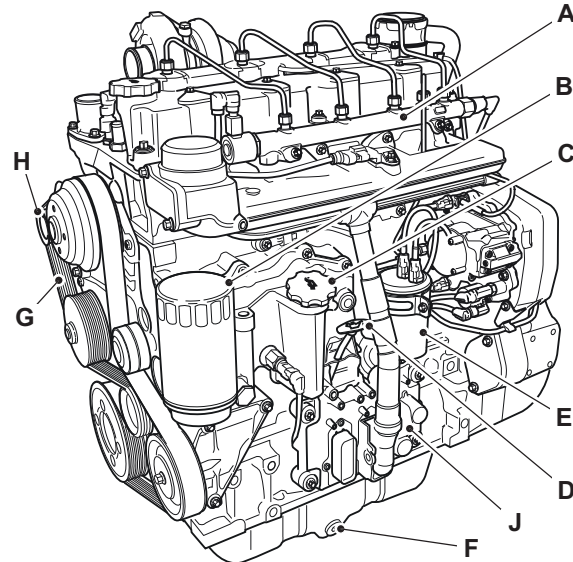


Fig 3.

Item	Description
A	Fuel injection common rail
B	Lubrication oil filter
C	Lubrication oil filler cap
D	Lubrication oil dip stick
E	Fuel filter
F	Oil drain plug (sump)
G	Front end accessory drive belt
H	Alternator and drive pulley assembly
J	Engine electronic control unit (ECU)

JCB Ecomax Engine T4i Electrical

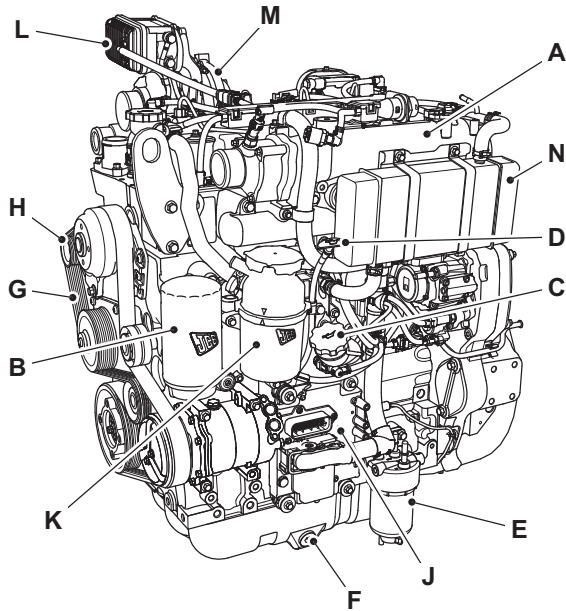


Fig 4.

Item	Description
A	Air Inlet manifold
B	Lubrication oil filter
C	Lubrication oil filler cap
D	Lubrication oil dip stick
E	Fuel filter
F	Oil drain plug (sump)
G	Front end accessory drive belt
H	Alternator and drive pulley assembly
J	Engine electronic control unit (ECU)
K	Crankcase ventilation filter assembly
L	Variable geometry turbocharger actuator
M	Variable geometry turbocharger
N	Exhaust Gas Recirculation Cooler

Operating Procedures

Starting the Engine

Pre-Start Notes

WARNING

On turbo-charged machines, do not keep the accelerator pedal fully depressed when the engine has started. Do not race the engine until the oil pressure low light has gone out. Racing the engine too soon could damage the turbo-charger due to insufficient lubrication.

16-2-4-1

Several factors will influence the starting performance of the engine, these include:

- The ambient temperatures
- The condition of the battery
- The viscosity of the engine oil
- The condition of the starter motor

The engine does not require any cold starting aids for temperatures down to -18°C.

If the engine is operating in temperatures below -18°C, then a pre-heater is available. The heater fits in the inlet manifold as shown, and is linked into the machine's electrical system.

In severe cold climate conditions, a block heater can be installed.

Make sure that all the necessary machine pre-start checks have been completed, these will include:

- engine oil level
- engine coolant level
- battery connections
- fuel tank has sufficient fuel
- fuel pre-filters drained
- the machine is safe and ready to start

Start Procedure

- 1 Make sure that all machine controls are in the 'neutral' position.
- 2 If a pre-heater is fitted, turn the starter key **A** to the pre-heat position **II**. If applicable to your equipment, the warning light on the instrument cluster will extinguish when pre-heat is complete.
- 3 Turn the starter key to the starter engage position **III** and hold it there until the engine starts. Do not operate the starter for more than 20 seconds.

CAUTION

Do not operate the starter motor for more than 20 seconds at one time. Let the starter motor cool for at least 2 minutes.

0124

Note: Operating the starter motor for more than 20 seconds can damage the grid heater and cause severe damage to the engine.

Note: If the engine does not start at the first attempt, return the key to the off (O) position and allow the starter to cool for a few minutes and then repeat steps 2 and 3.

- 4 As soon as the engine starts, release the key which will return to the run position.
- 5 → [Engine Checks After Start-up \(□ 13\)](#).

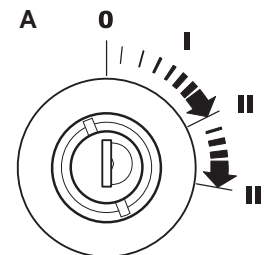


Fig 1.

Engine Checks After Start-up

WARNING

On turbo-charged machines, do not keep the accelerator pedal fully depressed when the engine has started. Do not race the engine until the oil pressure low light has gone out. Racing the engine too soon could damage the turbo-charger due to insufficient lubrication.

16-2-4-1

WARNING

Stop the engine and investigate the cause if any of the following conditions occur:

- 1 The warning lights fail to go off when the engine has been started.
- 2 The alarm is still sounding when the engine has been started.
- 3 The warning lights illuminate and the alarm sounds when the engine is running.

16-2-4-2

Check the following items after the engine has been started.

- 1 Make sure that all the engine instrumentation warning lights have extinguished.
- 2 Do not over accelerate the engine until the Low oil pressure warning light has extinguished.
- 3 If any warning indicator fails to extinguish, or if they illuminate while the engine is running, make the machine safe, stop the engine and investigate the cause.
- 4 Listen for engine noise, any abnormal noise must be investigated to determine the cause.
- 5 Check the exhaust smoke colour, generally after the engine has reached operating temperature, the exhaust colour should be as detailed:

- | | |
|----------------------------|------------|
| - colourless or light blue | - normal |
| - black | - abnormal |
| - white | - abnormal |

- 6 Check for any lubricating oil leakage, particularly around joints and connectors.

WARNING

Fluid Under Pressure

Fine jets of fluid at high pressure can penetrate the skin. Keep face and hands well clear of fluid under pressure and wear protective glasses and gloves. Hold a piece of cardboard close to suspected leaks and then inspect the cardboard for signs of fluid. If fluid penetrates your skin, get medical help immediately.

INT-3-1-10_3

WARNING

Fuel

Fuel is flammable; keep naked flames away from the fuel system. Stop the engine immediately if a fuel leak is suspected. Do not smoke while refuelling or working on the fuel system. Do not refuel with the engine running. Completely wipe off any spilt fuel which could cause a fire. There could be a fire and injury if you do not follow these precautions.

INT-3-2-2_3

- 7 Check the fuel circuit for leakage, including fuel lines, fuel filter(s) and high pressure pump. Stop the engine immediately if a fuel leak is suspected.

Important: DO NOT attempt to tighten high pressure fuel line connections. DO NOT attempt to repair high pressure fuel lines. If the fuel lines are damaged or leaking they must be replaced by a qualified engineer.

- 8 Check the coolant system for signs of leakage, particularly around the radiator and hose connections.

Engine Running-in Procedure

New engines DO NOT require a running-in period. The engine/machine should be used in a normal work cycle immediately.

Glazing of the piston cylinder bores, resulting in excessive oil consumption, could occur if engine duty is too light from new.

Under no circumstances should the engine be allowed to idle for extended periods; (e.g. warming up without load).

The recommended grade of engine oil must be used. [⇒ Engine Lubricating Oil \(78 \).](#)

Superior grade oils may be more appropriate for heavy duty applications (such as sustained high loads and operation at elevated temperatures).

Stopping the Engine

- 1 Make sure that all machine controls are in the 'neutral' position.

 CAUTION

Allow turbocharged engines to run at approximately 1000 rpm and reduced load for 2 to 3 minutes before shut down. This will allow the turbocharger to cool. Failure to follow this procedure could result in turbocharger damage.

ENG-1-6

- 2 Turn the starter key to the OFF (O) position, as shown at A.

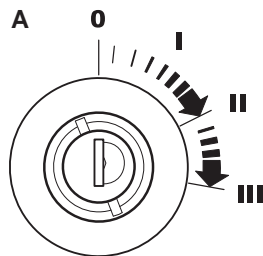


Fig 2.

Lubricants and Capacities

Engine Lubricating Oil

New engines DO NOT require a running-in period. The engine/machine should be used in a normal work cycle immediately, glazing of the piston cylinder bores, resulting in excessive oil consumption, could occur if the engine is gently run-in. Under no circumstances should the engine be allowed to idle for extended periods; (e.g. warming up without load).

A minimum API CH-4 grade oil must be used. Superior grade oils may be more appropriate for heavy duty applications (such as sustained high loads and operation at elevated temperatures).

The choice of lubricant viscosity should be made based on the lowest ambient temperature at which the machine will be started and the maximum ambient temperature at which it will operate.

The following table provides guidance as to the temperature range that can be accommodated by standard oil viscosities and can be used to select an appropriate grade. → [Table 1.](#) (□ 15).

Important: When selecting the oil viscosity grade make sure the oil conforms with or exceeds the recommended specification. → [Recommended Oils](#) (□ 15).

Table 1.

Oil Viscosity	Minimum Temperature °C (°F)	Maximum Temperature °C (°F)
SAE 0W30	- 40 (-40)	+ 30 (86)
SAE 0W20	- 40 (-40)	+ 10 (50)
SAE 5W20	- 30 (-22)	+ 10 (50)
SAE 5W40	- 30 (-22)	+ 40 (104)
SAE 10W30	- 20 (-4)	+ 40 (104)
SAE 15W40	- 15 (-5)	+ 50 (122)

Recommended Oils

Table 2. With no exhaust after treatment

Engine Oil	Specification
JCB Extreme Performance	ACEA E5/B3/A3, API CH-4/SJ

Table 3. With after treatment

Engine Oil	Specification
JCB Ultimate Performance	CJ-4

Engine Oil Capacity

Choose the grade of oil to suit the temperature range as detailed. → [Table 1.](#) (□ 15). The engine oil capacity, including filter and clean sump is 11.5 litres MIN and 14 litres MAX mark on the dipstick.

Table 4. JCB Dieselmax T2/T3 Mechanical

Item	Capacity litres (UK Gal)	
	Minimum	Maximum
Engine	12 (2.6)	15 (3.3)

Table 5. Dieselmax T3 Electronic

Item	Capacity litres (UK Gal)	
	Minimum	Maximum
Engine	11.5 (2.5)	14 (3.0)

Table 6. Ecomax T4i Electronic

Item	Capacity litres (UK Gal)	
	Minimum	Maximum
Engine	11.5 (2.5)	14 (3.0)

Coolant Mixtures

Coolant Mixtures

T3-009_3

Check the strength of the coolant mixture at least once a year, preferably at the start of the cold period.

Replace the coolant mixture according to the intervals shown in the machine's Service Schedule.

WARNING

Antifreeze can be harmful. Obey the manufacturer's instructions when handling full strength or diluted antifreeze.

7-3-4-4_1

You must dilute full strength antifreeze with clean water before use. Use clean water of no more than a moderate hardness (pH value 8.5). If this cannot be obtained, use de-ionized water. For further information advice on water hardness, contact your local water authority.

The correct concentration of antifreeze protects the engine against frost damage in winter and provides year round protection against corrosion.

The protection provided by JCB High Performance Antifreeze and Inhibitor is shown below.

50% Concentration (Standard)

Protects against damage down to -40 °C (-39 °F)

60% Concentration (Extreme Conditions Only)

Protects against damage down to -56 °C (-68 °F)

Important: Do not exceed a 60% concentration, as the freezing protection provided reduces beyond this point.

If you use any other brand of antifreeze:

- Ensure that the antifreeze complies with International Specification ASTM D6210.
- Always read and understand the manufacturer's instructions.
- Ensure that a corrosion inhibitor is included. Serious damage to the cooling system can occur if corrosion inhibitors are not used.
- Ensure that the antifreeze is ethylene glycol based and does not use Organic Acid Technology (OAT).

Coolant

It is recommended that JCB HP Antifreeze is used, however where this is not available an ethylene glycol based antifreeze / inhibitor to ASTM D6210 may be used.

The JCB Ecomax engine only coolant volume is 8 (TBC) litres.

Engine Coolant	JCB High Performance Antifreeze ⁽¹⁾ and Inhibitor/Water and Summer Coolant/Water.
Minimum	50%
Maximum	60%
Specification	ASTM D6210 ⁽²⁾

- (1) If an alternative anti-freeze is used, refer to the manufacturer's instructions and ensure that a corrosion inhibitor is included. DO NOT use solutions of more than 60% or less than 50% or damage to the cooling system will occur.
- (2) Do not use anti-freeze that does not conform to this standard.

The strength of the anti-freeze solution must be checked at least once a year, preferably at the beginning of the cold period. It is an advantage to leave the anti-freeze in all the year round as it gives continued protection against corrosion.

Always renew the anti-freeze every two years or in accordance with the vehicle service documentation, which ever comes first. A 50% anti-freeze mixture must be used even if frost protection is not needed. This gives protection against corrosion and raises the coolant's boiling point.

Important: The coolant must contain the correct corrosion inhibitor. Serious damage to the cooling system can occur if corrosion inhibitor is not used.

T4i Fuel

T4i Acceptable and Unacceptable Fuels

Important: *No warranty liability whatsoever will be accepted for failure of fuel injection equipment where the failure is attributed to the quality and grade of the fuel used.*

Fuel Groups

The major world fuels standards are divided into four categories. Those that are fully accepted as suitable fuels, those that are acceptable from a warranty point of view, but may have undesirable affects on the expected life of the engine performance changes from original specification, those that will lead to reduce the expected life, and lastly those that are viewed as unacceptable for use. (Note: fuels shown on the same line as each other are considered equivalents).

The lists below are not exhaustive of all diesel fuel standards encountered in the marketplace. If comment is required on the suitability of fuel standards not on the list, requests with, if possible, specification details showing at least the key characteristics described above should be forwarded to JCB Service for assessment and comment.



Fuel Specification T4i

Group 1	Advice	Service Comments
EN590 Diesel fuel types - Auto/C0/C1/C2/C3/C4	The following fuel grades are preferred and may be used with no restrictions or conditions:	For fuel with unspecified parameters, EN590 values apply. Fuel grades within each standard must be appropriate to the ambient temperature. Appropriate level of fuel cleanliness at the FIE inlet after filtration has to be ensured by the customer
BS2869:2006 Class A2		
ASTM D975-08a Grade 2, US DF2 (military equivalent)		
JIS K2204:2007 Grades 1, 2 and 3 and Special Grade 3		
Group 2		
Group 1 fuels with HFFR WSD in the range 460-520 µm	The following fuels are not preferred and may be used but may lead to reduced FIE life and / or loss of performance:	
ASTM D975-91 Class 1-1DA		
B20 Biodiesels can cause serious problems for engines. JCB Ecomax Tier 4i /Stage 3B engines have been developed to run with biodiesels up to 20% mix (B20), but NOT with higher biodiesel proportion. The biodiesel content of this mix must be to ASTM D6751, DIN 51606, or ISO 14214 standards. Using a B20 blend of biodiesel requires caution and additional servicing of the engine is required. ⁽¹⁾		The Ecomax dealer, or JCB Power Systems Applications department, should be consulted for further guidance. Biodiesel is very problematic to store; fuel in storage has to be very carefully managed to ensure that it does not deteriorate during this period. No warranty liability will be accepted for failure of fuel injection equipment where the failure is attributed to the quality and grade of the fuel used.
Group 3		
AVTUR FS11 (NATO F34, JP8, MIL T83133, DEF STAN 91-87, DERD 2463)	The following fuels are not preferred and may be used only with appropriate additives and will lead to reduced FIE life and / or loss of performance:	
AVCAT FS11 (NATO F44, JP5, MIL T5624, DERD 2452, AVTOR)		
JET A1 (NATO F35, DEF STAN 91-91, DERD 2494)		
AVCAT (NATO F43, JP5 without additives)		
JET A (ASTM D1655)		
ASTM D3699 Kerosene		
JP7 (MIL T38219 XF63)		
NATO F63		
Group 4 - Unacceptable		
Unmodified Vegetable Oils and Biodiesels over 20% concentration		

(1) See your JCB Dealer for advice on service requirements.

Additives

The additives listed below are advertised as being suitable for bringing the lubricity levels of kerosene/low sulphur fuels up to those of diesel fuels.

Note: *These products are given as examples only. The information is derived from the manufacturers data. The products are not recommended or endorsed by JCB. Contact your JCB dealer for further advice.*

- Elf 2S 1750. Dosage 1000-1500 ppm (0.1 - 0.15%), specifically for Indian Superior Kerosene (SKO) but may be applicable to other fuels.
- Lubrizol 539N. Dosage (on Swedish low sulphur fuel) 250 ppm.
- Paradyne 7505 (from Infineum). Dosage 500 ppm (0.05%).

Service Requirements for use of B20 Biodiesel

- The engine oil must be a grade CH4 as minimum specification.
- Do not leave unused B20 biodiesel in the fuel tank for extended periods (top up each day).
- Make sure that 1 in 5 fuel tank fills use standard diesel to EN590 specification, this will help to prevent 'gumming'.
- Make sure regular oil sampling is completed (look for excessive unburnt fuel content, water or wear particles).
- Change the engine oil and filter more frequently (as a minimum half the recommended intervals), or as indicated by oil sampling.
- Change the fuel filters more frequently (as a minimum half the recommended intervals), or if there are engine performance related issues.
- Make sure the fuel is stored correctly, care must be taken to make sure no water enters the machine fuel tank (or the storage tank). Water will encourage micro-bacterial growth.
- Make sure that the fuel pre-filter is drained DAILY (not every week as currently advised).
- Use heater kits in low ambient temperature territories.
- The biodiesel must meet the following standards: ASTM D6751, DIN 51606, ISO 14214

Note: *If necessary use a test kit to confirm the fuel specification. Testing kits are available (not from JCB currently), use the internet as a source for the kits.*

Note: *If performance related issues are to be reported to JCB Service, and the engine has been run on biodiesel, then the fuel system must be filled with standard diesel (at least 2 x tank fills) to EN590 specification and relevant stall speeds recorded prior to making the report.*

Warranty

JCB have shown a commitment to support the environment by approving the use of biodiesel blended fuels.

Using a B20 blend of biodiesel requires caution and additional servicing of the engine is required. → [Service Requirements for use of B20 Biodiesel \(19\)](#)

Failure to follow the additional recommended service requirements may lead to a warranty claim being declined.

Failures resulting from the incorrect use of biodiesels or other fuel additives are not defects of the JCB Ecomax engine workmanship and therefore will not be supported by JCB Warranty.

T4i Usage and Effects of Fuels

Note: The information that follows does not indicate types of fuel that are acceptable or unacceptable. ⇒ [T4i Acceptable and Unacceptable Fuels \(□ 17\)](#).

Acceptable Fuels

1 Ultra Low Sulphur Diesel (EN590)

Available throughout the UK, Europe and North America since March 1999. This fuel has a maximum sulphur content of 0.001% (0.0015% in North America) by weight and a further reduction in the natural lubricity and aromatic content than experienced with low sulphur diesel. Major oil producers will add lubrication improvers and also maintain the total aromatic content to an acceptable level.

2 B20 Biodiesel -7-20%

Biodiesel refers to pure fuel before it is blended with diesel fuel ⇒ [Service Requirements for use of B20 Biodiesel \(□ 19\)](#). When biodiesel is blended with diesel fuel it is referred to as B5, B20 etc., where the number indicates the percentage of biodiesel in the fuel, for example B5 contains 5% biodiesel.

Biodiesel has different characteristics than mineral based fuels, this could lead to seals swelling, fuel system corrosion and seal damage.

Biodiesels will 'cloud' at higher temperatures than mineral based fuels. To explain Cloud Point - the lowest temperature at which fluid can flow and performs its functions is referred to as Pour Point. Just prior to reaching its Pour Point the diesel fluid becomes 'cloudy' due to crystallization of waxy constituents - this is known as Cloud Point. Using diesel at temperature below its cloud point can result in filter clogging. To prevent this happening pre-heating will be required.

Using B20 biodiesel can result in unburnt fuels accumulating in the engine oil, ultimately this can affect the engine oil efficiency and lead to engine damage (with standard diesel any unburnt fuel evaporates off the lubricating oil).

The natural properties of biodiesel make it a good medium for micro bacterial growth, these microbes can cause fuel system corrosion and early fuel filter

blocking. Biodiesels must be stored to exclude water absorption and oxidation. It will be necessary to consult and seek advice from your fuel supplier, the effectiveness of conventional antibacterial additives when used in biodiesel is still being investigated in the fuel industry. A high percentage biodiesel mixture (>20%) can lead to fuel gelling and filter blocking in low temperature operation, it may also effect the power and performance of the engine.

To minimise the risk of engine damage when using a B20 mix, there are additional service requirements. ⇒ [Service Requirements for use of B20 Biodiesel \(□ 19\)](#)

If the recommended actions are not taken there may be the following consequences:- low temperature filter clogging- injectors lacquering / sticking- deterioration of seals and rubber hoses- corrosion of metal parts in the fuel system- engine performance problems. These risks will be increased if the fuel has been poorly stored, that is deteriorated through oxidation and / or water absorption.

Unacceptable Fuels

3 B100 - Chemically Modified Vegetable Oils (FAME/VOME)

These fuels have been derived from a wide range of vegetable oils and animal fats, resulting in better stability, viscosity and cetane number than those produced from unmodified vegetable oils, but it is recognised that there are potential problems associated with the finished fuel characteristics. These oils are less stable than mineral oil derived fuels when stored and they will readily degrade producing fatty acids, methanol and water, none of which are desirable in the FIE. These effects are known to be accelerated when the fuel is stored in the presence of air and water together.

An extract 'common statement' from the FIE manufactures specifies that, The fuel injection equipment manufacturers can accept no liability whatsoever for failure attributable to operating their products with fuels for which the products were not designed, and no warranties or representations are made as to the possible effects of running these products with such fuels.

The three most common Fame types are RME - Rapeseed methyl ester (preferred crop in Europe),

SME - Soyabean methyl ester (preferred crop in USA). Less common FAME's can be derived from animal fats (e.g. modified beef extracts) and reclaimed cooking oils.

4 Unmodified Vegetable Oils

Burned in diesel engines neat or used as an extender to mineral derived fuel. When these are subjected to heat in the fuel injection system they form sticky deposits that can be found inside the fuel pump and a hard lacquer in the injectors where exposure to even higher temperatures takes place.

T4i Effects of Fuel Contaminates

The effect of dirt, water and other contaminants in diesel can be disastrous for injection equipment:

- Dirt - A severely damaging contaminant. Finely machined and mated surfaces such as delivery valves and distributor rotors are susceptible to the abrasive nature of dirt particles - increased wear will almost inevitably lead to greater leakage, uneven running and poor fuel delivery.
- Water - water can enter fuel through poor storage or careless handling, and will almost inevitably condense in fuel tanks. The smallest amounts of water can result in effects that are just as disastrous to the fuel injection pump as dirt, causing rapid wear, corrosion and in severe cases, even seizure. It is vitally important that water is prevented from reaching the fuel injection equipment. The filter/water trap must be drained regularly.
- Wax - wax is precipitated from diesel when the ambient temperature falls below that of the fuel's cloud point, causing a restriction in fuel flow resulting in rough engine running. Special winter fuels may be available for engine operation at temperatures below 0°C (32°F). These fuels have a lower viscosity and limit wax formation.

Chemical Contamination

It should be noted that exposure of fuel to surfaces containing Copper (Cu), Zinc (Zn) or Lead (Pb) can adversely affect fuel quality and should be minimized.

T2/T3 Fuel

Acceptable and Unacceptable Fuels

Important: No warranty liability whatsoever will be accepted for failure of fuel injection equipment where the failure is attributed to the quality and grade of the fuel used.

Fuel Specification	Applicable Engines	Service Requirements
EN590 Diesel fuel types - Auto/C0/C1/C2/C3/C4	All Dieselmex engines.	Obey the usual routine maintenance schedules and procedures
BS2869 Class A2		
ASTM D975-91 Class 2, US DF1, US DF2, US DFA		
JIS K2204 (1992) Grades 1, 2, 3 and Special Grade 3		
ASTM D975-91 Class 1DA	All Dieselmex engines. Engines operated with these fuels may have a reduced service life	Obey the usual routine maintenance schedules and procedures. Fuel additives are recommended for use with low sulphur fuels ⇒ Additives (□ 19)
MIL T38219 XF63		
NATO F63		
French EN590 (RME5) with 5% maximum		
AVTURFSII, NATO F34, JP8, MIL T83133, DERD 2463, DEF STAN 91-87	All Dieselmex engines. Engines operated with these fuels will have a reduced service life	Obey the usual routine maintenance schedules and procedures. Fuel additives MUST be used ⇒ Additives (□ 19)
AVCAT FSII, NATO F44, JP5, MIL T5624, DERD 2452, AVTOR		
NATO F35, JET A1, DEF STAN 91-91, DERD 2494, JP7		
AVCAT, NATO F43 (obsolete), JP5 without additives		
JET A (ASTM D1655)		
ASTM D3699 Kerosene		
B20 Biodiesel - RME content blended with mineral derived diesel (20% maximum) - ASTM D6751, DIN 51606, ISO 14214	Dieselmex engines manufactured from 2007 on ONLY⁽¹⁾	YOU MUST obey special routine maintenance schedules and procedures. ⇒ Service Requirements for use of B20 Biodiesel (□ 19)
AVTAG (obsolete)	These fuels are NOT ACCEPTABLE with or without additives. Engines MUST NOT be operated with these fuels	
AVTAG FSII (obsolete), NATO F40, JP4, DERD 2454		
JET B (ASTM D1655)		
BS MA100		
JIS K2203 No.2		
Unmodified vegetable oils		

(1) The year of manufacture is part of the engine serial number. Refer to Identifying the Engine.

Additives

The additives listed below are advertised as being suitable for bringing the lubricity levels of kerosene/low sulphur fuels up to those of diesel fuels. They must be used as specified by your fuel supplier who will understand the concentration level necessary.

- Elf 2S 1750. Dosage 1000-1500 ppm (0.1 - 0.15%), specifically for Indian Superior Kerosene (SKO) but may be applicable to other fuels.
- Lubrizol 539N. Dosage (on Swedish low sulphur fuel) 250 ppm.
- Paradyne 7505 (from Infineum). Dosage 500 ppm (0.05%).

Note: These products are given as examples only. The information is derived from the manufacturers data. The products are not recommended or endorsed by JCB.

Service Requirements for use of B20 Biodiesel

- The engine oil must be a grade CH4 as minimum specification.
- Do not leave unused B20 biodiesel in the fuel tank for extended periods (top up each day).
- Make sure that 1 in 5 fuel tank fills use standard diesel to EN590 specification, this will help to prevent 'gumming'.
- Make sure regular oil sampling is completed (look for excessive unburnt fuel content, water or wear particles).
- Change the engine oil and filter more frequently (as a minimum half the recommended intervals), or as indicated by oil sampling.
- Change the fuel filters more frequently (as a minimum half the recommended intervals), or if there are engine performance related issues.
- Make sure the fuel is stored correctly, care must be taken to make sure no water enters the machine fuel tank (or the storage tank). Water will encourage micro-bacterial growth.
- Make sure that the fuel pre-filter is drained DAILY (not every week as currently advised).
- Only JCB ENGINES built after Jan. 2007 are applicable (i.e. engines with 07 on the end of their

serial number and factory filled with CH4 oil) - this is not approved with other manufacturers.

- Use heater kits in low ambient temperature territories.
- The biodiesel must meet the following standards: ASTM D6751, DIN 51606, ISO 14214

Note: If necessary use a test kit to confirm the fuel specification. Testing kits are available (not from JCB currently), use the internet as a source for the kits.

Note: If performance related issues are to be reported to JCB Service, and the engine has been run on biodiesel, then the fuel system must be filled with standard diesel (at least 2 x tank fills) to EN590 specification and relevant stall speeds recorded prior to making the report.

Warranty

JCB have shown a commitment to support the environment by approving the use of biodiesel blended fuels.

Using a B20 blend of biodiesel requires caution and additional servicing of the engine is required. → [Service Requirements for use of B20 Biodiesel \(19\)](#)

Failure to follow the additional recommended service requirements may lead to a warranty claim being declined.

Failures resulting from the incorrect use of biodiesels or other fuel additives are not defects of the JCB Dieselmex engine workmanship and therefore will not be supported by JCB Warranty.

T2/T3 Fuel Types

Note: The information that follows does not indicate types of fuel that are acceptable or unacceptable. ⇒ [T4i Acceptable and Unacceptable Fuels \(□ 17\)](#).

Any fuel purchased for operation of the JCB Dieselmox engine must be purchased from reputable oil producers/outlets and stored in accordance with the manufacturers recommendations. ⇒ [T4i Effects of Fuel Contaminates \(□ 21\)](#)

- 1 Diesel - mineral derived, hydrocarbon fuels to European standard EN590 or equivalent.
- 2 Low Sulphur Diesel - mineral derived, hydrocarbon fuels to EN590 or equivalent. This fuel has totally replaced automotive (road use) diesel in the European Union since October 1996 and has sulphur limited to a maximum of 0.05% by weight.
- 3 Ultra Low Sulphur Diesel - Reformulated mineral derived, hydrocarbon fuels to EN590 or equivalent. Now widely available in the UK, mainland Europe and some parts of the USA. Sulphur limited to a maximum of 0.005% by weight or lower. ⇒ [T2/T3 Sulphur Content \(□ 26\)](#)
- 4 Vegetable Oil -unmodified. Certain pure vegetable oils (sunflower oil, rapeseed oil etc.)
- 5 Biodiesel - chemically modified vegetable oil. By chemically modifying vegetable oils, methyl esters of that oil are produced. These are collectively known as "Fatty Acid Methyl Esters" (FAME) or "Vegetable Oil Methyl Esters" (VOME).

Note: Refer also to additional information. ⇒ [T4i Usage and Effects of Fuels \(□ 20\)](#).

T2/T3 Usage and Effects of Fuels

Note: The information that follows does not indicate types of fuel that are acceptable or unacceptable. ⇒ [T4i Acceptable and Unacceptable Fuels \(□ 17\)](#).

1 Low Sulphur Diesel

In its basic form because of the process of reducing sulphur by removal of sulphur containing compounds (which contribute to mechanical lubrication) an increase in the wear rate of the fuel injection equipment could occur. In view of this, the major fuel producers add suitable lubricity improvers to enable the FIE to run satisfactorily, with no acceleration in wear rate. They must ensure that the lubricity improvers do not themselves create residual deposits that could block the fuel system e.g. filter, injectors etc.

In addition to the lubrication effect there can also be a further reduction in the aromatic content of the fuel which can lead to shrinking/cracking of traditionally nitrile rubber seals throughout the fuel injection equipment that has previously been exposed to higher sulphur level fuels. The major fuel producers tend to maintain the total aromatic content to an acceptable level (15% by volume).

2 Ultra Low Sulphur Diesel

Also known as 'city diesel'. Available throughout the UK and some parts of Europe since March 1999. This fuel has a maximum sulphur content of 0.005% by weight and a further reduction in the natural lubricity and aromatic content than experienced with low sulphur diesel. Major oil producers will add lubrication improvers and also maintain the total aromatic content to an acceptable level.

3 Unmodified Vegetable Oils

Burned in diesel engines neat or used as an extender to mineral derived fuel. When these are subjected to heat in the fuel injection system they form sticky deposits that can be found inside the fuel pump and a hard lacquer in the injectors where exposure to even higher temperatures takes place.

4 Chemically Modified Vegetable Oils (FAME/VOME)

These fuels have been derived from a wide range of vegetable oils and animal fats, resulting in better

stability, viscosity and cetane number than those produced from unmodified vegetable oils, but it is recognised that there are potential problems associated with the finished fuel characteristics. These oils are less stable than mineral oil derived fuels when stored and they will readily degrade producing fatty acids, methanol and water, none of which are desirable in the FIE. These effects are known to be accelerated when the fuel is stored in the presence of air and water together.

An extract 'common statement' from the FIE manufactures specifies that "The fuel injection equipment manufacturers can accept no liability whatsoever for failure attributable to operating their products with fuels for which the products were not designed, and no warranties or representations are made as to the possible effects of running these products with such fuels".

The three most common FAME types are RME - Rapeseed methyl ester (preferred crop in Europe), SME - Soyabean methyl ester (preferred crop in USA). Less common FAME's can be derived from animal fats (e.g. modified beef extracts) and reclaimed cooking oils.

5 B20 Biodiesel

Biodiesel refers to pure fuel before it is blended with diesel fuel ⇒ [B100 - Chemically Modified Vegetable Oils \(FAME/VOME\) \(□ 20\)](#). When biodiesel is blended with diesel fuel it is referred to as B5, B20 etc., where the number indicates the percentage of biodiesel in the fuel, for example B5 contains 5% biodiesel.

Biodiesel has different characteristics than mineral based fuels in that it is able to mix with water and therefore will have a high water retention capacity - this could lead to seals swelling, fuel system corrosion and seal damage.

Biodiesels will 'cloud' at higher temperatures than mineral based fuels. To explain Cloud Point - the lowest temperature at which fluid can flow and performs its functions is referred to as Pour Point. Just prior to reaching its Pour Point the diesel fluid becomes 'cloudy' due to crystallization of waxy constituents - this is known as Cloud Point. Using diesel at temperature below its cloud point can result

in filter clogging. To prevent this happening pre-heating will be required.

Using B20 biodiesel can result in unburnt fuels accumulating in the engine oil, ultimately this can affect the engine oil efficiency and lead to engine damage (with standard diesel any unburnt fuel evaporates off the lubricating oil). Biodiesels must be stored to exclude water absorption and oxidation.

The natural properties of biodiesel make it a good medium for micro bacterial growth, these microbes can cause fuel system corrosion and early fuel filter blocking. It will be necessary to consult and seek advice from your fuel supplier, the effectiveness of conventional antibacterial additives when used in biodiesel is still being investigated in the fuel industry. A high percentage biodiesel mixture (>20%) can lead to fuel gelling and filter blocking in low temperature operation, it may also effect the power and performance of the engine.

To minimise the risk of engine damage when using a B20 mix, there are additional service requirements. [⇒ Service Requirements for use of B20 Biodiesel \(□ 19\)](#)

If the recommended actions are not taken there may be the following consequences:- low temperature filter clogging- injectors lacquering / sticking- deterioration of seals and rubber hoses- corrosion of metal parts in the fuel system- engine performance problems. These risks will be increased if the fuel has been poorly stored, that is deteriorated through oxidation and / or water absorption.

T2/T3 Sulphur Content

High sulphur content can cause engine wear. (High sulphur fuel is not normally found in North America, Europe or Australia.) If you have to use high sulphur fuel you must change the engine oil more frequently. [⇒ Table 7. Sulphur Content \(□ 26\).](#)

Low sulphur fuels must have the appropriate fuel lubricity additives, these lubricity improvers must not create residual deposits that block the fuel system, e.g. injectors, filters etc. Contact your fuel Supplier.

CAUTION

A combination of water and sulphur will have a corrosive chemical effect on fuel injection equipment. It is essential that water is eradicated from the fuel system when high sulphur fuels are used.

ENG-3-2

Table 7. Sulphur Content

Percentage of sulphur in the fuel (%)	Oil Change Interval
Less than 0.5	Normal
0.5 to 1.0	0.75 of normal
More than 1.0	0.50 of normal

T2/T3 Effects of Fuel Contaminates

The effect of dirt, water and other contaminants in diesel can be disastrous for injection equipment:

- Dirt - A severely damaging contaminant. Finely machined and mated surfaces such as delivery valves and distributor rotors are susceptible to the abrasive nature of dirt particles - increased wear will almost inevitably lead to greater leakage, uneven running and poor fuel delivery.
- Water - water can enter fuel through poor storage or careless handling, and will almost inevitably condense in fuel tanks. The smallest amounts of water can result in effects that are just as disastrous to the fuel injection pump as dirt, causing rapid wear, corrosion and in severe cases, even seizure. It is vitally important that water is prevented from reaching the fuel injection equipment. The filter/water trap must be drained regularly.
- Wax - Wax is precipitated from diesel when the ambient temperature falls below that of the fuel's cloud point, causing a restriction in fuel flow resulting in rough engine running. Special winter fuels may be available for engine operation at temperatures below 0°C (32°F). These fuels have a lower viscosity and limit wax formation.

Routine Maintenance

Introduction

The following Routine Maintenance section refers to the engine only.

General references will be made to the machine

WARNING

Machinery utilizing the engine must be correctly parked and prepared, for example safety strut fitted, prior to completing maintenance tasks on the engine.

Maintenance must be completed by suitably qualified personnel.

You or others could be killed or seriously injured if the machine is not correctly prepared and maintained.

ENG-1-5

When the engine is installed in a machine, it will be necessary to make sure that the machine is correctly parked and prepared to safely complete the routine maintenance tasks. Refer to the machine's documentation.

To obtain the best performance from your engine, make sure that the service tasks are completed at the recommended period - see Service Schedules.

If the machine/engine is working in adverse conditions, then the service intervals should be reduced, examples of adverse conditions are:

- operating in a very dusty environment
- operating continuously at high engine load
- operating in an environment with lots of chaff
- operating in an extremely hot or cold environment
- operating continuously on slopes
- operating continuously at high altitude
- operating in an environment with high humidity
- operating with a low quality fuel. ⇒ [T4i Acceptable and Unacceptable Fuels \(17\)](#).

All maintenance procedures must be completed by suitably qualified personnel.

Cleaning the Engine

WARNING

Clean the engine before you start engine maintenance. Obey the correct procedures. Contamination of the fuel system will cause damage and possible failure of the engine.

ENG-8-5_2

Before carrying out any service procedures that require components to be removed, the engine must be properly cleaned.

Cleaning must be carried out either in the area of components to be removed or, in the case of major work, or work on the fuel system, the whole engine and surrounding machine must be cleaned.

Important: *Stop the engine and allow it to cool for at least one hour. DO NOT attempt to clean any part of the engine while it is running.*

- 1 Make sure that the electrical system is isolated.
- 2 Make sure that all electrical connectors are correctly coupled. If connectors are open fit the correct caps or seal with water proof tape.
- 3 Cover the alternator with a plastic bag to prevent water ingress.
- 4 Seal the engine air intake, exhaust and breather system.
- 5 Make sure that the oil filler caps and dipstick are correctly installed.
- 6 Use a low pressure water jet and brush to soak off caked mud or dirt.

CAUTION

The engine or certain components could be damaged by high pressure washing systems; special precautions must be taken if the engine is to be washed using a high pressure system.

Ensure that the alternator, starter motor and any other electrical components are shielded and not directly cleaned by the high pressure cleaning system.

ENG-3-3

- 7 Apply an approved cleaning and de-greasing agent with a brush. Obey the manufacturers instructions.

- 8 Use a pressure washer to remove the soft dirt and oil.

Important: *DO NOT aim the water jet directly at oil seals or electrical and electronic components such as the engine electronic control unit (ECU), alternator or fuel injectors.*

Important: *DO NOT place the jet nozzle closer than 600mm (24 in) to any part of the engine.*

- 9 When the pressure washing is complete move the machine away from the wash area, or alternatively, clean away the material washed from the machine.

- 10 Before working on specific areas of the engine use a compressed air jet to dry off any moisture. When the area is dry use a soft clean brush to remove any sand or grit particles that remain.

- 11 When removing components be aware of any dirt or debris that may be exposed. Cover any open ports and clean away the deposits before proceeding.

Lubricants - Health and Safety

It is most important that you read and understand this information and the publications referred to. Make sure all your colleagues who are concerned with lubricants read it too.

Hygiene

JCB lubricants are not a health risk when used properly for their intended purposes.

However, excessive or prolonged skin contact can remove the natural fats from your skin, causing dryness and irritation.

Low viscosity oils are more likely to do this, so take special care when handling used oils, which might be diluted with fuel contamination.

Whenever you are handling oil products you should maintain good standards of care and personal and plant hygiene. For details of these precautions we advise you to read the relevant publications issued by your local health authority, plus the following.

Storage

Always keep lubricants out of the reach of children.

Never store lubricants in open or unlabelled containers.

Waste Disposal

CAUTION

It is illegal to pollute drains, sewers or the ground. Clean up all spilt fluids and/or lubricants.

Used fluids and/or lubricants, filters and contaminated materials must be disposed of in accordance with local regulations. Use authorised waste disposal sites.

INT-3-2-14

All waste products should be disposed of in accordance with all the relevant regulations.

The collection and disposal of used oil should be in accordance with any local regulations. Never pour used engine oil into sewers, drains or on the ground.

Handling

New Oil

There are no special precautions needed for the handling or use of new oil, beside the normal care and hygiene practices.

Used Oil

Used engine crankcase lubricants contain harmful contaminants.

Here are precautions to protect your health when handling used engine oil:

- 1 Avoid prolonged, excessive or repeated skin contact with used oil.
- 2 Apply a barrier cream to the skin before handling used oil.
- 3 Note the following when removing engine oil from skin:
 - a Wash your skin thoroughly with soap and water.
 - b Using a nail brush will help.
 - c Use special hand cleansers to help clean dirty hands.
 - d Never use petrol, diesel fuel, or paraffin for washing.
- 4 Avoid skin contact with oil soaked clothing.
- 5 Don't keep oily rags in pockets.
- 6 Wash dirty clothing before re-use.
- 7 Throw away oil-soaked shoes.



First Aid - Oil

Eyes

In the case of eye contact, flush with water for 15 minutes. If irritation persists, get medical attention.

Swallowing

If oil is swallowed do not induce vomiting. Get medical advice.

Skin

In the case of excessive skin contact, wash with soap and water.

Spillage

Absorb on sand or a locally approved brand of absorbent granules. Scrape up and remove to a chemical disposal area.

Fires

Extinguish with carbon dioxide, dry chemical or foam. Firefighters should use self-contained breathing apparatus.

Service Schedules

A badly maintained engine is a danger to the operator and the people working around him. Make sure that the regular maintenance and lubrication jobs listed in the service schedules are done to keep the engine in a safe and efficient working condition.

WARNING

Machinery utilizing the engine must be correctly parked and prepared, for example safety strut fitted, prior to completing maintenance tasks on the engine.

Maintenance must be completed by suitably qualified personnel.

You or others could be killed or seriously injured if the machine is not correctly prepared and maintained.

ENG-1-5

Apart from the daily jobs, the schedules are based on machine running hours. Keep a regular check on the hourmeter readings to correctly gauge service intervals. Do not use a machine which is due for a service. Make sure any defects found during the regular maintenance checks are rectified immediately.

Calendar equivalents:

10 Hours = Daily 50 Hours = Weekly 500 Hours = Six Months 1000 Hours = Yearly 2000 Hours = 2 Years 8000 Hours = 8 Years

The tick boxes indicate the frequency, for example, 'Oil and Filter Change' is indicated every 500 hours. The first change would therefore be at 500 hours, then the next change at 1000 hours, then 1500 hours etc.



Table 1. All Electronic T3/ T4i Applications Except Generator Set Applications.

Pre-start Cold Checks Service Points and Fluid Levels	Operation	10 Hr	50 Hr	500 Hr	1000 Hr	1500 Hr	2000 Hr	8000 Hr
ENGINE								
Oil level	- Check	<input type="checkbox"/>						
Coolant Quality/ level	- Check	<input type="checkbox"/>						
Coolant or Oil Leaks	- Check	<input type="checkbox"/>						
Water Sedimenter	- Check for Contamination and Drain		<input type="checkbox"/>					
Fuel Filter (machine mounted)	- Change			<input type="checkbox"/>				
Oil and Filter ^{(1) (2)}	- Change			<input type="checkbox"/>				
All Hoses - Condition	- Check			<input type="checkbox"/>				
Radiator ⁽³⁾	- Clean			<input type="checkbox"/>				
Front End Accessory Drive (FEAD) Belt Condition	- Check			<input type="checkbox"/>				
Fuel Filter (engine mounted)	- Change				<input type="checkbox"/>			
Air Cleaner Outer Element ⁽³⁾	- Change				<input type="checkbox"/>			
Crankcase Ventilation Filter ⁽⁴⁾	- Change				<input type="checkbox"/>			
Crankcase Ventilation Filter	- Change					<input type="checkbox"/>		
Air Cleaner Inner Element	- Change						<input type="checkbox"/>	
Valve Clearances ⁽⁵⁾	- Check and Adjust						<input type="checkbox"/>	
Oil Filler and Dipstick O-rings	- Change						<input type="checkbox"/>	
Cooling system	- Drain and Fill						<input type="checkbox"/>	
Front End Accessory Drive (FEAD) Belt	- Change							<input type="checkbox"/>
Injectors ⁽⁵⁾	- Change							<input type="checkbox"/>
Injector(s) Leak-Off Rail ⁽⁵⁾	- Change							<input type="checkbox"/>
High Pressure Fuel Lines ⁽⁵⁾	- Change							<input type="checkbox"/>

- (1) If operating under arduous conditions (Arduous conditions are utilisation over 70% continuous load factor), change the engine oil and filter every 250 hours.
- (2) When the engine is operated with 20% biodiesel change the engine oil and filter every 250 hours. Refer to Technical Data, Fuel System Data, for more information about operating the engine with biodiesel.
- (3) If operating in dusty adverse working environments, do these jobs more frequently.
- (4) Tier 3 Only
- (5) These jobs must be done by a qualified engineer.



Table 2. All Mechanical T2/ T3 Applications Except Generator Set Applications

Pre-start Cold Checks, Service Points and Fluid Levels	Operation	10 Hr	50 Hr	500 Hr	1000 Hr	2000 Hr	6000 Hr
ENGINE							
Oil level	- Check	<input type="checkbox"/>	<input type="checkbox"/>				
Coolant Quality/ level	- Check	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Coolant or Oil Leaks	- Check	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fuel Filter and Water Sedimenter	- Check for Contamination and Drain		<input type="checkbox"/>	<input type="checkbox"/>			
Oil and Filter ^{(1) (2)(3)}	- Change			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fuel Pre-filter ⁽⁴⁾	- Change			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Main Fuel Filter	- Change				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
All Hoses - Condition	- Check			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Radiator ⁽⁵⁾	- Clean			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Front End Accessory Drive (FEAD) Belt Condition	- Check			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Air Cleaner Outer Element ⁽⁵⁾	- Change				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Air Cleaner Inner Element	- Change					<input type="checkbox"/>	<input type="checkbox"/>
Valve Clearances	- Check and Adjust					<input type="checkbox"/>	<input type="checkbox"/>
Breather Gauze	- Clean					<input type="checkbox"/>	<input type="checkbox"/>
Oil Filler and Dipstick O-rings	- Change					<input type="checkbox"/>	<input type="checkbox"/>
Low Idle Speed	- Check and Adjust					<input type="checkbox"/>	<input type="checkbox"/>
Cooling system	- Drain and Fill					<input type="checkbox"/>	<input type="checkbox"/>
Rocker Cover Seal and Injector Seals	- Change					<input type="checkbox"/>	<input type="checkbox"/>
Front End Accessory Drive (FEAD) Belt	- Change						<input type="checkbox"/>
Injectors	- Change						<input type="checkbox"/>
Injector(s) Leak-Off Rail	- Change						<input type="checkbox"/>
High Pressure Fuel Lines	- Inspect						<input type="checkbox"/>

- (1) If operating under arduous conditions (Arduous conditions are utilisation over 70% continuous load factor), change the engine oil and filter every 250 hours.
- (2) The oil service interval will be affected if there is a high sulphur content in the fuel. Refer to Fluids, Lubricants and Capacities, Fuel, for more information.
- (3) If Dieselmex engines are operated with B20 Biodiesel change the oil and filter every 250 hours. A minimum specification of CH4 oil must be used. Only Dieselmex engines manufactured from 2007 are suitable for operation with B20 Biodiesel. Other service requirements apply, refer to Fluids, Lubricants and Capacities, Fuel.
- (4) Specific to JCB Fuel Pre-filter.
- (5) If operating in dusty adverse working environments, more frequently.



Table 3. T2/ T3 Mechanical Generator Set Applications Only

Pre-start Cold Checks, Service Points and Fluid Levels	Operation	10 Hr	50 Hr	500 Hr	1000 Hr	2000 Hr	6000 Hr
ENGINE							
Oil level	- Check	<input type="checkbox"/>	<input type="checkbox"/>				
Coolant Quality/ level	- Check	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Coolant or Oil Leaks	- Check	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fuel Filter and Water Sedimenter	- Check for Contamination and Drain		<input type="checkbox"/>	<input type="checkbox"/>			
Oil and Filter ⁽¹⁾ ⁽²⁾ ⁽³⁾ ⁽⁴⁾	- Change			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fuel Pre-filter ⁽⁵⁾	- Change			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Main Fuel Filter	- Change			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
All Hoses	- Check Condition			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Radiator ⁽⁶⁾	- Clean			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Front End Accessory Drive (FEAD) Belt	- Check Condition			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Air Cleaner Outer Element ⁽⁵⁾	- Change				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Air Cleaner Inner Element	- Change					<input type="checkbox"/>	
Valve Clearances - 4.8	- Check and Adjust				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Valve Clearances - 4.4	- Check and Adjust					<input type="checkbox"/>	<input type="checkbox"/>
Breather Gauze	- Clean					<input type="checkbox"/>	<input type="checkbox"/>
Oil Filler and Dipstick O-rings	- Change					<input type="checkbox"/>	<input type="checkbox"/>
Low Idle Speed	- Check and Adjust					<input type="checkbox"/>	<input type="checkbox"/>
Cooling system	- Drain and Fill					<input type="checkbox"/>	<input type="checkbox"/>
Rocker Cover Seal and Injector Seals	- Change					<input type="checkbox"/>	<input type="checkbox"/>
Front End Accessory Drive (FEAD) Belt ⁽⁷⁾	- Change						<input type="checkbox"/>
Injectors	- Change						<input type="checkbox"/>
Injector(s) Leak-Off Rail	- Change						<input type="checkbox"/>
High Pressure Fuel Lines	- Inspect						<input type="checkbox"/>

- (1) If operating under arduous conditions (Arduous conditions are utilisation over 70% continuous load factor), change the engine oil and filter every 250 hours.
- (2) The oil service interval will be affected if there is a high sulphur content in the fuel. Refer to Technical Data, Fuel System Data, for more information.
- (3) If Dieselmex engines are operated with B20 Biodiesel change the oil and filter every 250 hours. A minimum specification of CH4 oil must be used. Only Dieselmex engines manufactured from 2007 are suitable for operation with B20 Biodiesel. Other service requirements apply, refer to Fluids, Lubricants and Capacities, Fuel.
- (4) Oil filter and change at 250 hours for T/C with intercooling.
- (5) Specific to JCB Fuel Pre-filter.
- (6) If operating in dusty adverse working environments, more frequently.
- (7) For G-Drive applications, change the Front End Accessory Drive (FEAD) belt every 4000 hours

Engine Oil and Filter

CAUTION

It is illegal to pollute drains, sewers or the ground. Clean up all spilt fluids and/or lubricants.

Used fluids and/or lubricants, filters and contaminated materials must be disposed of in accordance with local regulations. Use authorised waste disposal sites.

INT-3-2-14

WARNING

Oil

Oil is toxic. If you swallow any oil, do not induce vomiting, seek medical advice. Used engine oil contains harmful contaminants which can cause skin cancer. Do not handle used engine oil more than necessary. Always use barrier cream or wear gloves to prevent skin contact. Wash skin contaminated with oil thoroughly in warm soapy water. Do not use petrol, diesel fuel or paraffin to clean your skin.

INT-3-2-3

Checking the Oil Level

Engine oil and oil filter change must be completed in accordance with the service schedules. Failure to change the oil and filter at the recommended interval could cause serious engine failure.

- 1 Park and make the machine safe in accordance with the machine handbook instructions.
- 2 Check that the oil level is between the two marks on the dipstick.
- 3 If necessary, add recommended oil through one of the the filler points.

Changing the Oil and Filter

Drain the oil when the engine is warm as contaminants held in suspension will then be drained with the oil.

- 1 Place a container of suitable size beneath the drain plug **1-C**.

CAUTION

Oil will gush from the hole when the drain plug is removed. Hot oil and engine components can burn you. Keep to one side when you remove the plug.

13-3-1-15

- 2 Remove drain plug **1-C** and its 'O' ring **1-D**. Let the oil drain out, then clean and refit the drain plug with a new 'O' ring. Torque tighten the plug to 40 - 60 Nm (30 - 44 lbf ft).
- 3 Loosen and remove filter housing drain plug **1-E**. Let the oil fully drain. Refit the plug. Torque tighten the plug to 40 - 60 Nm (30 - 44 lbf ft).
- 4 Unscrew the filter canister **1-F**, using a chain wrench if necessary.
- 5 Clean the seal face of the filter head **1-G**.
- 6 Smear the seal **1-H** on the new filter canister with clean engine oil.
- 7 Screw in the new filter canister - hand tight only.

CAUTION

It is illegal to pollute drains, sewers or the ground. Clean up all spilt fluids and/or lubricants.

Used fluids and/or lubricants, filters and contaminated materials must be disposed of in accordance with local regulations. Use authorised waste disposal sites.

INT-3-2-14

- 8 Through one of the filler points **1-B**, fill the engine with the recommended oil to the MAX mark on the dipstick **1-A**. Wipe off any spilt oil, refit the filler cap and make sure it is secure.

- 9 Operate the engine until the oil pressure low warning light has extinguished. Check for oil leakage. When

the oil has cooled, check the oil level again, and if necessary top up with clean engine oil.

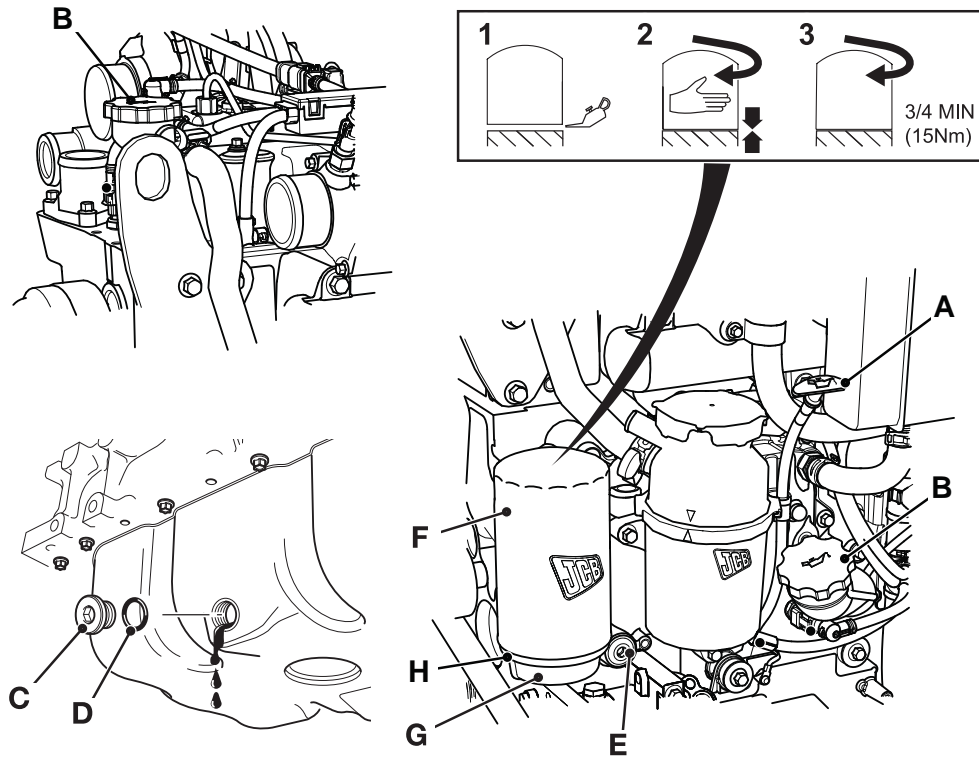


Fig 1.

T063690

Engine Cooling System

Coolant Mixtures

The protection provided by JCB Four Seasons Anti-freeze and Summer Coolant is shown below. If any other anti-freeze is used, refer to the manufacturer's instructions and ensure that a corrosion inhibitor is included.

DO NOT use solutions of more than 50% or damage to the engine may occur.

Solution	Maintains circulation down to:	Protects against damage down to:
50%	-33°C (-27°F)	-45°C (-49°F)

The strength of the anti-freeze solution must be checked at least once a year, preferably at the beginning of the cold period.

It is an advantage to leave the anti-freeze in all the year round as it gives continued protection against corrosion. Always renew the anti-freeze every two years.

A 50% anti-freeze mixture must be used even if frost protection is not needed. This gives protection against corrosion and raises the coolant's boiling point.

WARNING

Antifreeze can be harmful. Obey the manufacturer's instructions when handling full strength or diluted antifreeze.

7-3-4-4_1

Checking the Coolant Level

The procedures below describes a typical coolant package installation.

WARNING

The cooling system is pressurised when the coolant is hot. When you remove the cap, hot coolant can spray out and burn you. Make sure that the engine is cool before you work on the cooling system.

9-3-3-1_2

- 1 Park and make the machine safe in accordance with the machine handbook instructions.

- 2 Check the level of coolant in the expansion bottle. If necessary remove the filler cap and top up to the level indicated.
- 3 Refit the filler cap and make sure it is tight.
- 4 Run the engine for a while to raise the coolant to working temperature and pressure. Stop the engine and check for leaks.

Changing the Coolant

The procedures below describes a typical coolant package installation.

WARNING

The cooling system is pressurised when the coolant is hot. When you remove the cap, hot coolant can spray out and burn you. Make sure that the engine is cool before you work on the cooling system.

9-3-3-1_2

- 1 Park and make the machine safe in accordance with the machine handbook instructions. Stop the engine and let it cool down.
- 2 Carefully loosen cap just enough to let any pressure escape. Remove the cap when all pressure is released.
- 3 Disconnect the bottom radiator hose at and allow the coolant to drain.
- 4 Flush the system by pouring clean water into filler port .
- 5 Reconnect the radiator hose.
- 6 Fill the expansion bottle, using the necessary anti-freeze solution, to the level indicated.
- 7 Check for leaks.
- 8 Run the engine for a while to raise the coolant to working temperature and pressure. Stop the engine and check for leaks. Check the level in the expansion bottle and top up if necessary.

Front End Accessory Drive (FEAD) Belt

A spring loaded tensioning unit **2-A** ensures that the front end accessory drive belt (FEAD) **2-B** is kept at the correct tension.

WARNING

Make sure the engine cannot be started. Disconnect the battery before doing this job.

2-3-3-5

WARNING

Turning the Engine

Do not try to turn the engine by pulling the fan or fan belt. This could cause injury or premature component failure.

0094

Front End Accessory Belt (FEAD) Inspection

At the recommended service interval, visually inspect the belt for damage.

- 1 Park and make the machine safe in accordance with the machine handbook instructions. Stop the engine and let it cool down.
- 2 Renew the belt if it has cracks or if it is frayed or has pieces of material missing (as shown at **2-C**).

If the belt does need replacing follow the procedures described below:

Front End Accessory Belt (FEAD) Replacement

- 1 Park and make the machine safe in accordance with the machine handbook instructions. Stop the engine and let it cool down.
- 2 Use a 16mm socket located on the hexagon spigot nut **2-D**, carefully rotate the tensioner against spring force in the direction shown. Do not use excessive force or the tensioner will be damaged.
- 3 Keep holding the tensioner against the spring force and lift the belt off the drive tensioner pulley.
- 4 Slowly release the spring force by rotating the tensioner unit in the opposite direction.

- 5 Before fitting the new belt, check that the tensioner roller and the fan pulley rotate smoothly and that there is no play in the bearings.
- 6 Fit the new belt using a reversal of the above procedures.

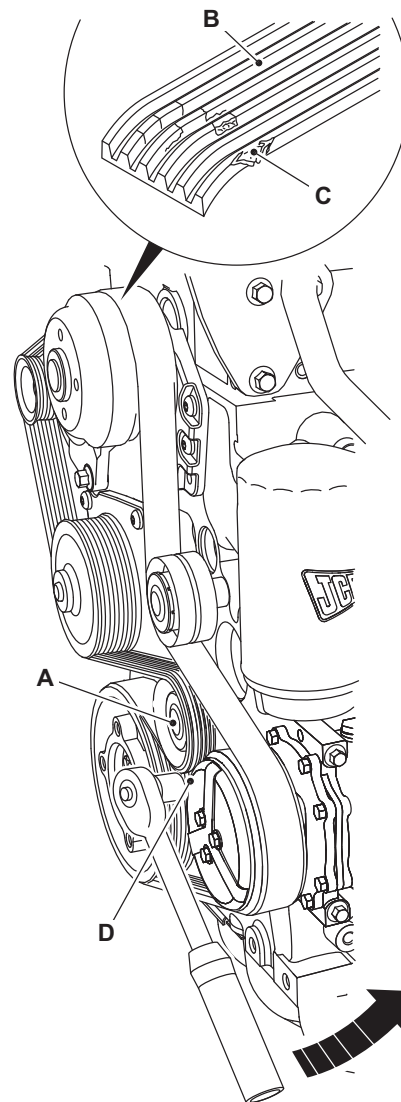


Fig 2.

T063720

Engine Fuel System

Fuel

Important: USE THE CORRECT FUEL. The potential for engine damage due to the use of incorrect or contaminated fuel is much greater with common rail injection technology than with mechanical injection systems.

For information about fuel types and cleanliness requirements refer to **Section 1, Technical Data, Fuel, Acceptable and Unacceptable Fuels and Cleanliness Requirements.**

WARNING

Fuel

Fuel is flammable; keep naked flames away from the fuel system. Stop the engine immediately if a fuel leak is suspected. Do not smoke while refuelling or working on the fuel system. Do not refuel with the engine running. Completely wipe off any spilt fuel which could cause a fire. There could be a fire and injury if you do not follow these precautions.

INT-3-2-2_3

WARNING

Petrol

Do not use petrol in this machine. Do not mix petrol with the diesel fuel; in storage tanks the petrol will rise to the top and form flammable vapours.

INT-3-1-6

CAUTION

Consult your fuel supplier or JCB distributor about the suitability of any fuel you are unsure of.

GEN-9-2

Draining the Water Separator and Fuel Filter

Note: The engine fuel filter **3-A** is fitted as standard. Refer to the machine handbook for information relating to the location of the pre-filter and water separator **4A**.

CAUTION

It is illegal to pollute drains, sewers or the ground. Clean up all spilt fluids and/or lubricants.

Used fluids and/or lubricants, filters and contaminated materials must be disposed of in accordance with local regulations. Use authorised waste disposal sites.

INT-3-2-14

- 1 Park and make the machine safe in accordance with the machine handbook instructions.
- 2 Drain off any water in the element **3A** by turning tap **3B**.
- 3 Drain off any water in the water separator bowl **4A** by turning tap **4B**. DO NOT disconnect the water in fuel electrical connector **4C**.
- 4 If there is sediment in the bowl after draining, support the bowl and release the locking ring **4D**.
- 5 Wash the bowl in clean fuel.
- 6 Refit the bowl, secure in position with locking ring **4D**.
- 7 Make sure that the water in fuel electrical connector **4C** is correctly fitted.

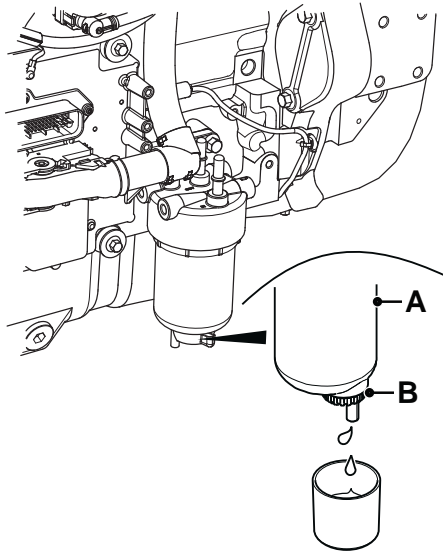


Fig 3.

T063700

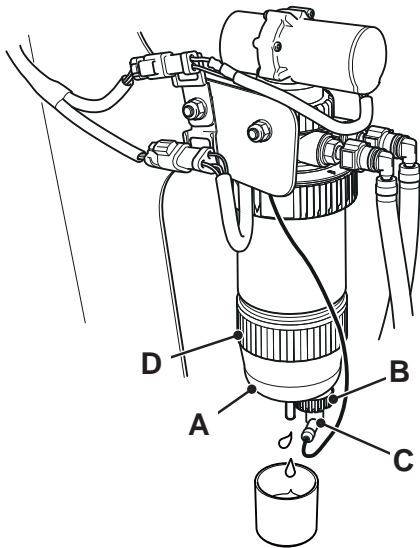


Fig 4.

C048590-C1

Changing the Filter Element

- 1 Park and make the machine safe in accordance with the machine handbook instructions.

CAUTION

Do not allow dirt to enter the fuel system. Before disconnecting any part of the fuel system, thoroughly clean around the connection. When a component has been disconnected, for example a fuel pipe, always fit protective caps and plugs to prevent dirt ingress.

Failure to follow these instructions will lead to dirt entering the fuel system. Dirt in the fuel system will seriously damage the fuel injection equipment and could be expensive to repair.

ENG-1-7

- 2 Thoroughly clean the outside of the filter housing and around the filter head.
- 3 Loosen the drain tap **5B** and allow the water/fuel to drain into a suitable container.
- 4 Unscrew the filter element (anti-clockwise. Use the dedicated tool **C**).
- 5 Lightly oil the element seals and install a new filter element **8A**. Make sure that the filter flange touches the filter head. Use the dedicated tool **C**. Tighten to a torque of 30 N m.
- 6 Bleed the fuel system. [⇒ Bleeding the Fuel System \(□ 43\)](#)

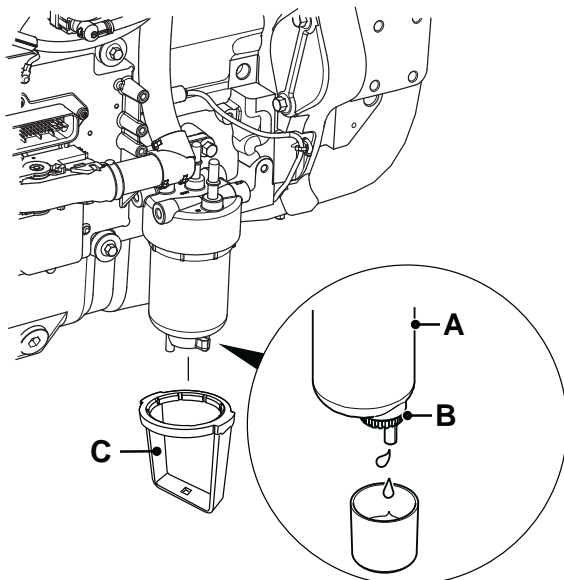


Fig 5.

T063700-2

Changing the Water Separator Pre- Filter

Note: Refer to the machine handbook for information relating to the location of the pre-filter and water separator.

- 1 Park and make the machine safe in accordance with the machine handbook instructions.

CAUTION

Do not allow dirt to enter the fuel system. Before disconnecting any part of the fuel system, thoroughly clean around the connection. When a component has been disconnected, for example a fuel pipe, always fit protective caps and plugs to prevent dirt ingress.

Failure to follow these instructions will lead to dirt entering the fuel system. Dirt in the fuel system will seriously damage the fuel injection equipment and could be expensive to repair.

ENG-1-7

- 2 Drain and remove the water separator bowl **6C**. [⇒ Draining the Water Separator and Fuel Filter \(□ 40\)](#).
- 3 To remove the filter element **6A**, release locking ring **6B** and discard element.
- 4 Fit new element and secure in position with locking ring **6B**.
- 5 Refit water separator bowl **6C**.
- 6 Make sure that the water in fuel electrical connector **6D** is correctly fitted.

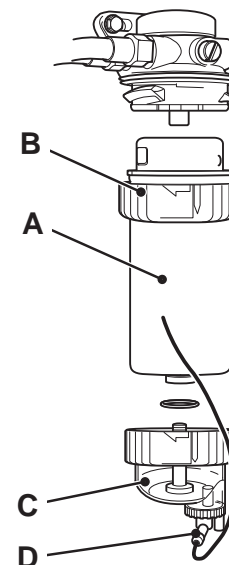


Fig 6.

T068740

Bleeding the Fuel System

CAUTION

Running the engine with air in the system could damage the fuel injection pump. After maintenance, the system must be bled to remove any air.

2-3-3-11

The entry of air into the fuel system can cause problems such as difficult engine starting and unstable engine running.

Air can enter the system if the following occurs:

- A fuel system component has been disconnected. For example, a fuel filter renewal.
- A leak in the low pressure side of the fuel system during engine operation, or the low pressure pipes have been disconnected. Refer to **System Descriptions** for a more detailed description of the fuel circuit.
- The fuel tank is allowed to drain during normal operation.

The engine installation features an electrically operated fuel lift pump **7A**. The system is designed to bleed automatically when the lift pump is operated. Make sure that as much air is removed from the fuel as possible BEFORE starting the engine. Bleed the system as follows:

WARNING

Do not open the high pressure fuel system with the engine running. Engine operation causes high fuel pressure. High pressure fuel spray can cause serious injury or death.

13-3-2-16

Important: DO NOT attempt to bleed the high pressure fuel system by loosening high pressure pipe connections even when the engine is not running. To bleed the fuel system follow the correct procedure.

- 1 Turn on the machine starter switch to start the fuel lift pump **7A**. DO NOT start the engine. Allow the pump to run for 30 seconds.
- 2 Turn off the machine starter switch to stop the fuel lift pump **7A**. Wait 10 seconds and then turn the starter switch to start the pump. DO NOT start the engine. Allow the pump to run for 30 seconds.

- 3 Repeat step 2 twice more before starting the engine.
- 4 Start the engine and make sure it runs smoothly.

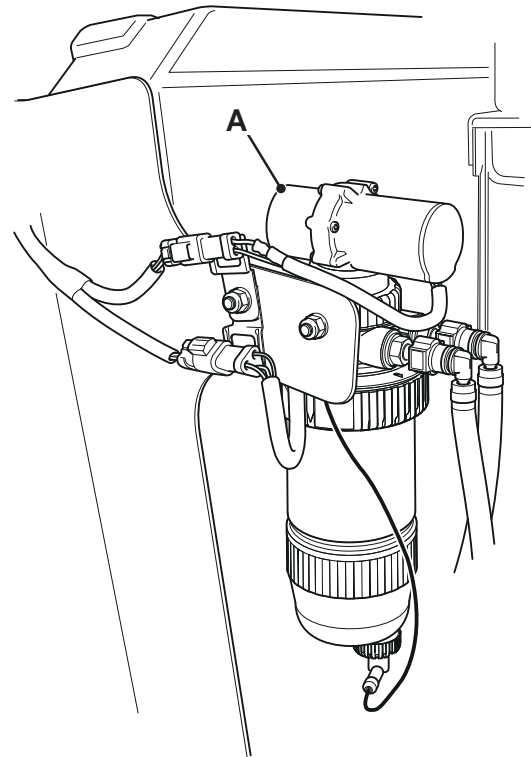


Fig 7.

Air Intake System

Engine performance and durability will be severely affected if the quality of the air intake is poor.

A dirty and blocked air cleaner element will reduce the amount of air entering the combustion chamber which can cause engine mis-firing, black smoke and low output power.

A dirty and blocked air filter can also lead to abrasion of the cylinder bores and valves (referred to as 'dusting'). This will cause excessive oil consumption, black smoke, low output power and a reduced engine life.

Refer to the machine's operator handbook for the air filter element removal and replacement procedures.

Inspect hoses and fittings for splits and poor clamping which may allow unfiltered air to enter the engine.

In hostile environments, change the air filter elements more frequently.

In some applications, an air filter pre-cleaner can be fitted.

A typical air filter installation is shown, is the outer element 8-A and is the inner element 8-B.

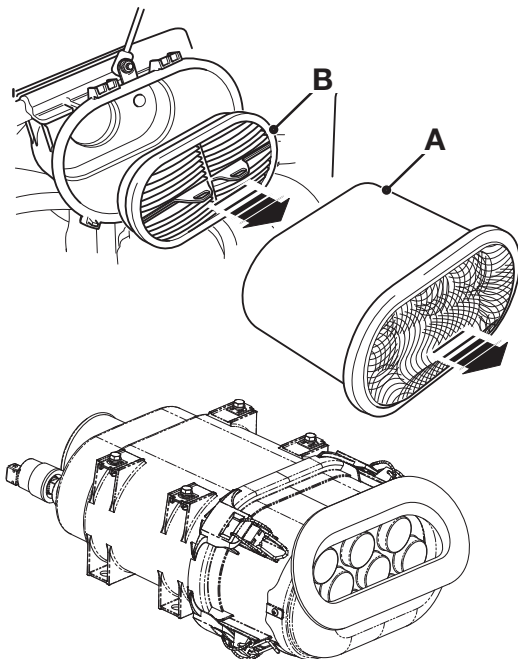


Fig 8.

T064070

Engine Crankcase Ventilation

Changing the Filter Element

The filter element must be changed at the recommended interval - → [Service Schedules \(□ 32\)](#).

- 1 Park and make the machine safe in accordance with the machine handbook instructions.
- 2 Rotate the filter cover **9A** anti clockwise and remove.
- 3 Lift out the filter element **9B** and discard it.
- 4 Clean the inside of the filter housing **9C**. Remove all oil and sludge contamination.
- 5 Make sure that the oil drain in the bottom of the filter housing is not blocked with sludge.
- 6 Fit a new filter element **9B**.

Important: Install the correct type of filter element.

- 7 Align the arrows on both parts to install the filter cover **9C**

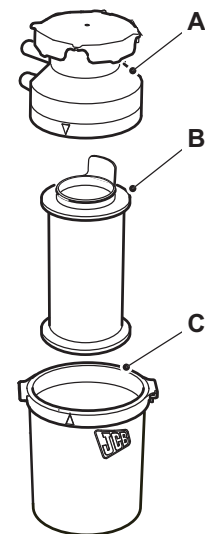
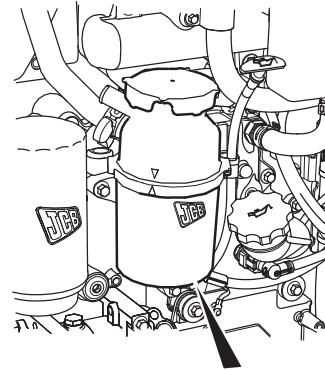


Fig 9.

T063710

Lifting Information

Refer to the **Technical Data** section for the various engine weights.

The lifting equipment used must be an approved type and capable of lifting the engine safely. The recommended lifting equipment is shown at **10-B**. Use spreader bar **10-C** when lifting the engine.

Never attempt to manually lift heavy components such as the cylinder head, crankshaft etc. on your own. Always use lifting equipment, or obtain the help of an assistant.

Inspect the lifting brackets **10-A** for signs of damage. The brackets must be correctly torqued to the engine block, the correct torque figure for the bracket retaining bolts is 43-51Nm.

Make sure the lifting equipment does not damage any of the engine dressing and the rocker cover.

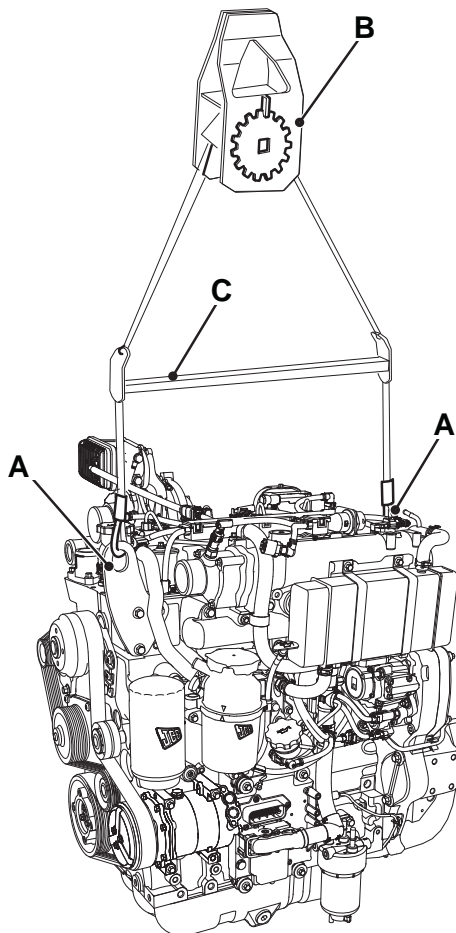


Fig 10.

T062740

Fault Finding

Introduction

Reduced Torque Mode

If an engine fault is detected the ECU may put the engine into a reduced torque mode which will restrict the power output.

Limp Home Mode

The engine control ECU can enter a limp home mode if serious engine faults are detected. The limp home mode limits the engine speed. The engine will not respond to foot or hand throttles.

Engine Shutdown

If the engine detects a major fault it may shut the engine down to protect the operator or the engine.

Component Replacement

Each engine ECU has different software and each fuel injector has a different calibration. DO NOT attempt to correct faults by replacement with new parts, or parts from a different engine unless you have the correct electronic tools and training.

If a fuel injector or engine ECU is possibly defective, contact your JCB Engine Dealer who has the correct electronic diagnostic and service tools.



Storage and Preservation

Storage

Engines should be stored in original shipping packaging. Damaged or disturbed packaging should be made weatherproof immediately.

If an engine is shipped 'with oil', it should be stored in the correct (upright) position.

If an engine is shipped 'dry of oil', after 6 months it should be filled with oil to the correct level and 're-inhibited'.

All floor stock engines should be stored under cover in dry conditions and not subjected to extreme variations in temperature or humidity.

Preservation

Capping Engine Openings

All openings on the engine must be suitably capped to prevent ingress of water and contamination by foreign particles.

Technical Data

Basic Engine Data (444) Electronic

Engine Variants: Tier 3	
- SE	Turbocharged with Intercooler
Emission compliance	US-EPA Tier 3, EU Stage IIIA
Engine Variants: Tier 4i	
- SH	Turbocharged with Intercooler
Emission compliance	US-EPA Tier 4i, EU Stage IIIB
Rated speed	2200 rpm
Weight (Dry) ⁽¹⁾ :	
- SE	457 kg (1007 lb)
- SH	496 kg (1091 lb)
Number of cylinders	4
Nominal bore size	103 mm (4.055 in)
Stroke	132 mm (5.16 in)
Cylinder arrangement	In line
Combustion Cycle	4-stroke
Firing order	1-3-4-2
Displacement	4.40 litres
Compression ratio	
- SE	17.1 : 1
- SH	16.9: 1
Engine Compression	see Note ⁽²⁾
Direction of rotation (viewed from front {crankshaft pulley} end)	Clockwise
Valves	4 per cylinder
Valve clearances measured at the pushrod end of the rockers (measured cold): -SE	
- Inlet	0.24 to 0.29 mm (0.009 to 0.011 in)
- Exhaust	0.44 to 0.49 mm (0.017 to 0.019 in)
Valve clearances measured at the pushrod end of the rockers (measured cold): -SH	
- Inlet	0.15 to 0.20 mm (0.006 to 0.008 in)
- Exhaust	0.43 to 0.50 mm (0.017 to 0.020 in)
Lubricating oil pressure ⁽³⁾	1.6 - 6.5 bar (23 - 91lb in ²)
Combustion system	Common rail direct Injection
High pressure fuel pump	High pressure with electronically controlled fuel metering

(1) Dry weight. No cooling fan drive.

(2) Compression variance between each cylinder should be no greater than 3.5 bar (50 lb in²)

(3) Dependent on engine temperature and speed.

Basic Engine Data (444) Engine Mechanical

Engine Variants (Tier 2/Stage 2):	
- SA	Naturally Aspirated
- SB	Turbocharged
- SC	Turbocharged with Intercooler
Engine Variants (Tier 3):	
- SD	Naturally Aspirated
- SF	Turbocharged with Intercooler
Rated speed	
Vehicle applications	2200 rpm
Generator set application - 50 Hz	1500 rpm
Generator set application - 60 Hz	1800 rpm
Weight (Dry):	
- SA	472 kg (1040 lb)
- SB	477 kg (1052 lb)
- SC, SD, SF	477 kg (1052 lb)
Number of cylinders	4
Nominal bore size	103 mm (4.055 in)
Stroke	132 mm (5.16 in)
Cylinder arrangement	In line
Combustion Cycle	4-stroke
Firing order	1-3-4-2
Displacement	4.40 litres
Compression ratio	
- SA	18.6 : 1
- SB	18.3 : 1
- SC	17.5 : 1
- SD	17.2 : 1
- SE	17.1 : 1
- SF	17.2 : 1
Engine Compression	see Note ⁽¹⁾
Direction of rotation (viewed from front {crankshaft pulley} end)	Clockwise
Valves	4 per cylinder
Valve tip clearances (measured cold):	
- Inlet	0.19 to 0.27 mm (0.007 to 0.011 in)
- Exhaust	0.56 to 0.64 mm (0.022 to 0.025in)
Lubricating oil pressure ⁽²⁾	>4.6 bar (67lb in ²)
Combustion system	Direct Injection
Fuel injection pump	Rotary Mechanical

(1) Compression variance between each cylinder should be no greater than 3.5 bar (50 lb in²)

(2) Engine at normal operating temperature and maximum revs.

Basic Engine Data - 448 Engine

Engine Variants (Tier 2/Stage 2):	
- DA	Naturally Aspirated
- DB	Turbocharged
- DC	Turbocharged with Intercooler
Engine Variants (Tier 3):	
- DD	Naturally Aspirated
- DF	Turbocharged with Intercooler
Rated speed	
Vehicle applications	2200 rpm
Generator set application - 50 Hz	1500 rpm
Generator set application - 60 Hz	1800 rpm
Weight (Dry):	
- DA	472 kg (1040 lb)
- DB	477 kg (1052 lb)
- DC, DD, DF	477 kg (1052 lb)
Number of cylinders	4
Nominal bore size	106 mm (4.173 in)
Stroke	135 mm (5.315 in)
Cylinder arrangement	In line
Combustion Cycle	4-stroke
Firing order	1-3-4-2
Displacement	4.80 litres
Compression ratio	
- DA	18.6 : 1
- DC	18.1 : 1
Engine Compression	see Note ⁽¹⁾
Direction of rotation (viewed from front {crankshaft pulley} end)	Clockwise
Valves	4 per cylinder
Valve tip clearances (measured cold):	
- Inlet	0.19 to 0.27 mm (0.007 to 0.011 in)
- Exhaust	0.56 to 0.64 mm (0.022 to 0.025in)
Lubricating oil pressure ⁽²⁾	>4.6 bar (67lb in ²)
Combustion system	Direct Injection
Fuel injection pump	Rotary Mechanical

(1) Compression variance between each cylinder should be no greater than 3.5 bar (50 lb in²)

(2) Engine at normal operating temperature and maximum revs.



JCB Service

Warranty

All JCB Engines are retailed through our specialist JCB Engine Dealers - these can be located at www.jcbpowersystems.com.

In the unlikely event that your engine should develop a problem, you should contact your JCB Engine Dealer.

Your JCB Engine Dealer will also have a full copy of the warranty terms and conditions associated with your JCB Ecomax engine. Any queries relating to warranty must be directed to the JCB Engine Dealer.

The engine must be maintained in accordance with the regular maintenance requirements detailed in this manual. Only suitably trained personnel should carry out the regular servicing.

Only Genuine JCB parts, or parts of equivalent quality should be used.

If supplied with the engine, the Registration Card must be completed and forwarded to your JCB Engine Dealer.