



OPERATOR'S MANUAL



ENGINE
JCB Stage-V 448 Elec Engine 4 Cyl

EN - 9841/4050 ISSUE 1 - 03/2020

THIS MANUAL SHOULD ALWAYS STAY WITH THE MACHINE



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This manual contains original instructions, verified by the manufacturer (or their authorized representative).

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Foreword

The Operator's Manual



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

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

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

California Proposition 65

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

Machine Delivery and Installation

Even if you have operated this type of equipment before, it is very important that your new machines operations and functions are explained to you by a JCB Dealer Representative following delivery of your new machine.

Following the installation you will know how to gain maximum productivity and performance from your new product.

Please contact your local JCB dealer if the Installation Form (included in this manual) has not yet been completed with you.

Your local JCB Dealer is



Notes:



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Acronyms Glossary

CCV	Crankcase Ventilation
DEF	Diesel Exhaust Fluid
DOC	Diesel Oxidation Catalyst
DPF	Diesel Particulate Filter
EAT	Exhaust After Treatment
ECM	Engine Control Module
ECU	Electronic Control Unit
FEAD	Front End Accessory Drive
HEST	High Exhaust System Temperature
HPV	High Pressure Valve
IMV	Inlet Metering Valve
ISO	International Organization for Standardization
MIL	Malfunction Indicator Lamp
NO _x	Nitrogen Oxide
PTO	Power Take-Off
RPM	Revolutions Per Minute
SCR	Selective Catalytic Reduction
SCRoF	Selective Catalytic Reduction on Filter
WIF	Water in Fuel

Introduction

About this Manual

Using the Manual

This operator's manual is arranged to give you a good understanding of the engine and its safe operation. It also contains maintenance and technical data.

Read this manual from the front to the back before you use the engine for the first time, even if you have used engines of a similar/same type before as the technical specification, systems and controls of the engine may have changed. Particular attention must be given to all the safety aspects of operating and maintaining the engine.

If there is anything you are not sure about, ask your JCB dealer or employer. Do not guess, you or others could be killed or seriously injured.

The general and specific warnings in this section are repeated throughout the manual. Read all the safety statements regularly, so you do not forget them. Remember that the best operators are the safest operators.

The illustrations in this manual are for guidance only. Where the engines are different, the text and or the illustration will specify.

The manufacturer's policy is one of continuous improvement. The right to change the specification of the 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 manual.

All of the optional equipment included in this manual may not be available in all territories

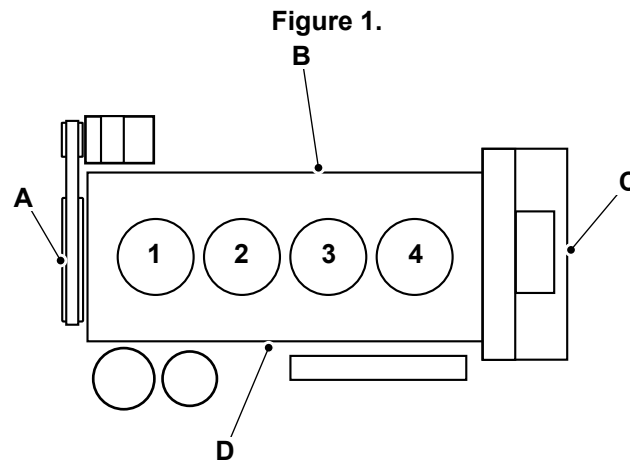
Using the Product

This JCB engine has been supplied for use in third party applications. As JCB will not have any control over the final installation of the engine, the operator may need to seek assistance from the manufacturer / installer of the engine. The content of this operator manual may differ from the actual installation. Please also refer to third party literature in addition to this operator manual.

Left-Hand Side, Right-Hand Side

In this operator manual, the sides of the engine are described as exhaust side or inlet side. There may also be references to the crankshaft pulley end (front) and flywheel end (rear).

Where the engine is installed in third party equipment, consult the installer documentation as the installer may describe the sides as left hand and right hand sides, according to the orientation of the engine in the particular application.



A Front of engine (viewed from crankshaft pulley end)

B Exhaust manifold side of engine

C Rear of engine (Flywheel end of engine)

D Inlet manifold side of engine

Cross References

In this manual, cross references are made by presenting the subject title in blue (electronic copy only). The number of the page upon which the subject begins is indicated within the brackets. For example: [Refer to: Cross References \(Page 2\)](#).

Safety

Safety - Yours and Others

All machinery can be hazardous. When an engine is correctly operated and maintained, it is a safe engine to work with. When it is carelessly operated or poorly maintained it can become a danger to you (the operator) and others.

In this manual and on the engine you will find warning messages, you must read and understand them. They inform you of potential hazards and how to avoid them. If you do not fully understand the warning messages, ask your employer or JCB dealer to explain them.

Safety is not just a matter of responding to the warnings. All the time you are working on or with the machine you must be thinking of what hazards there might be and how to avoid them.

Do not work on the engine until you are sure it is safe to do so, i.e. disconnect the starting battery, place a 'do not start' sign on the controls.

Do not start any work until you are sure that you and those around you will be safe.

If you are not sure of anything, about the engine or the work, ask someone who knows. Do not assume anything.

Remember:

- Be careful
- Be alert
- Be safe.

Safety Warnings

In this manual there are safety notices. Each notice starts with a signal word. The signal word meanings are given below.

The signal word 'DANGER' indicates a hazardous situation which, if not avoided, will result in death or serious injury.

The signal word 'WARNING' indicates a hazardous situation which, if not avoided, could result in death or serious injury.

The signal word 'CAUTION' indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

The signal word 'Notice' indicates a hazardous situation which, if not avoided, could result in engine damage.

The safety alert system symbol (shown) also helps to identify important safety messages in this manual. When you see this symbol your safety is involved, carefully read the message that follows.

Figure 2. The safety alert system symbol



General Safety

Engine Application and Specification

Use the engine only for the application for which it was intended. Do not change the specification of the engine. Do not install unauthorised aftermarket modifications.

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.

Make the Equipment Safe

Always make the engine/equipment safe before completing any maintenance tasks. Isolate or disconnect the battery(s) so the engine cannot be started.

Consult the machine manufacturers documentation before carrying out any work on the engine.

Hot Components

Touching hot surfaces can burn skin. The engine will be hot after the unit has been running. Allow the engine to cool before servicing the unit.

Checks and Adjustments

Do not carry out any engine adjustments or add fuel or fluids when the engine is running unless procedures in this operators manual instruct you to do so.

Consult the machine manufacturers documentation before carrying out any work on the engine.

Siphoning

Do not siphon fluids by mouth.

Exhaust Fumes

Operate the engine/machine in well ventilated areas. If it is to be used indoors, a suitable exhaust extraction system will be required.

Safety Guards/Devices

Never operate the engine if safety guard(s) or device(s) (if applicable) have been removed or de-activated.

Hazardous Atmospheres

This engine is designed for use in normal out door atmospheric conditions. It must not be used in an enclosed area without adequate ventilation. Do not use the engine in a potentially explosive atmosphere, i.e. combustible vapours, gas or dust, without first consulting your JCB dealer.

Vapours and Solvents

Vapours from solvents, thinners and adhesives can be highly flammable. In addition to the fire risk, they can be toxic and in certain conditions cause unconsciousness or death if inhaled. Use these items in well ventilated areas.

Engine Operation

Do not operate the engine at high speeds with no load applied.

Turbocharger

The turbocharger operates at very high temperatures. Allow the turbocharger to cool before completing any maintenance.

Clothing and Personal Protective Equipment (PPE)

Do not wear loose clothing or jewellery that can get caught on controls or moving parts. Wear protective clothing and personal safety equipment issued or called for by the job conditions, local regulations or as specified by your employer.

About the Product

Introduction

General

Before you start using the engine, you must know how the engine operates. Use this part of the manual to identify each control lever, switch, gauge, button and pedal. Do not guess, if there is anything you do not understand, ask your JCB dealer.

Name and Address of the Manufacturer

JCB Power Systems. 1000 Park Avenue, Dove Valley Park, Foston, Derby, DE65 5BX

Product Compliance

Your JCB engine was designed to comply with the laws and regulations applicable at the time of its manufacture for the market in which it was first sold. In many markets laws and regulations exist that require the engine to be operated and maintained according to JCB instructions to maintain compliance to the emissions regulations at the level relevant to the engine when first produced. JCB recommend that the engine compliance also be maintained to ensure safety of the operator and exposed persons. Your engine must not be altered or misused in any way which could affect or invalidate the engine emissions, and any of these requirements. For advice consult your JCB dealer.

For its compliance as a new engine, your JCB and some of its components may bear approval numbers and marking's, and may have been supplied with a declaration of incorporation. These markings and documents are relevant only for the country/region in which the engine was first sold to the extent that the laws and regulations required them.

Re-sales and import/export of engines across territories with different laws and regulations can cause new requirements to become relevant for which the engine was not originally designed or specified. In some cases, pre owned engines irrespective of their age are considered new for the purposes of compliance and may be required to meet the latest requirements which could present an insurmountable barrier to their sale/use.

Despite the presence of any compliance related marking's on the engine and components, you should not assume that compliance in a new market will be possible. In many cases it is the person responsible for import of a pre owned engine into a market that becomes responsible for compliance and who is also considered the manufacturer.

JCB may be unable to support any engine compliance related enquiry for a engine which has been moved out of the legislative country/region where it was first sold, and in particular where a engine specification change or additional certification would have been required in order for the engine to be in compliance.

Description

Intended Use

The JCB Engine can be installed to a variety of construction, agricultural and other machines and 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.

Operation of emergency engines is limited to emergency operations and required maintenance and testing.

Danger Zone

The danger zone is any zone within and/or around the engine in which a person is subject to a risk to their health or safety. The danger zone includes the area in immediate proximity to any hazardous moving parts, areas into which working equipment and attachments can be moved to quickly. During the operation of the engine, keep all persons out of the danger zone. Persons in the danger zone could be injured.

Before you do a maintenance task, make the engine safe.

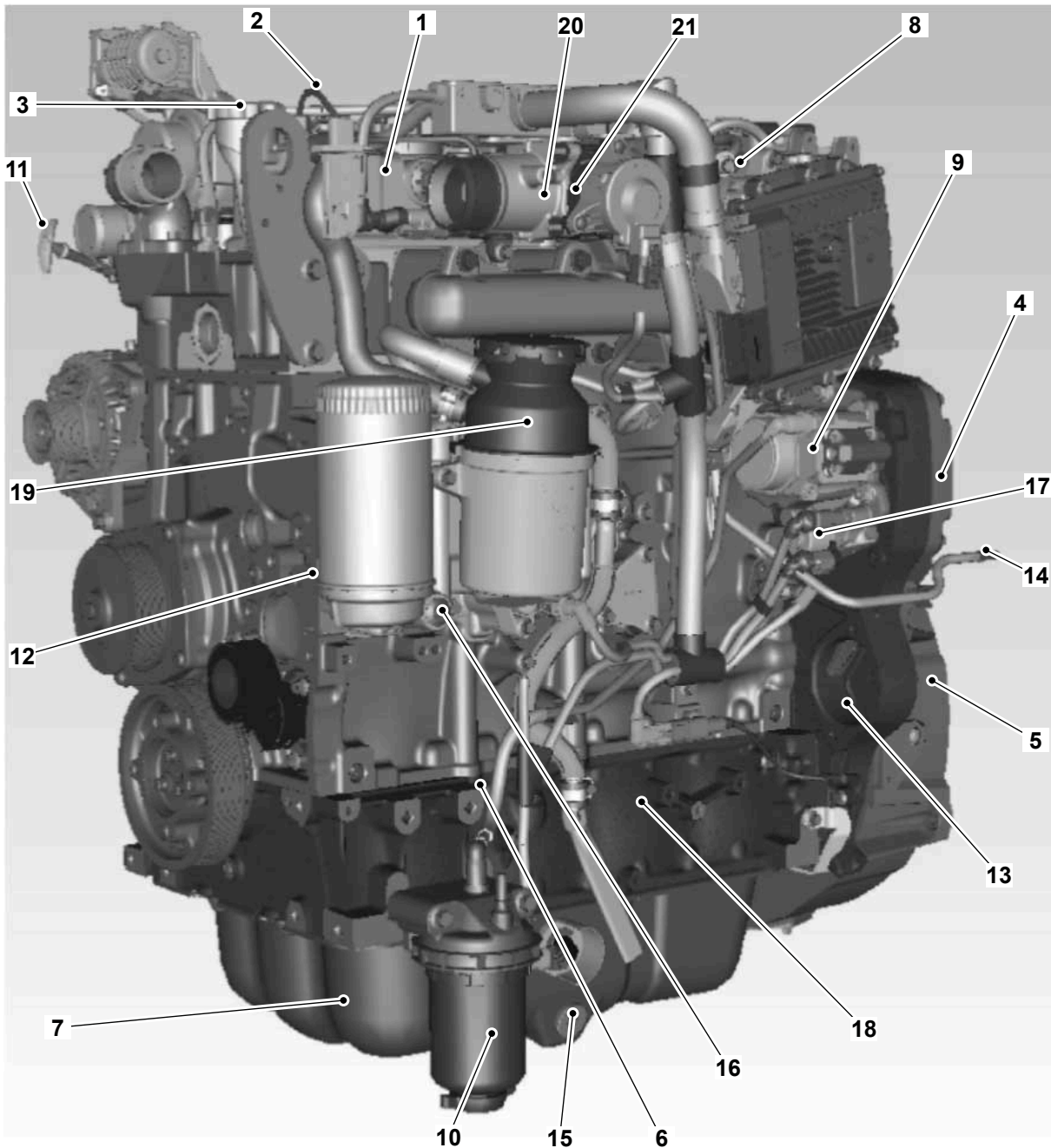
Main Component Locations

Your engine may differ according to its specification from the one shown. The engine shown has capping plugs fitted. If applicable, consult the operator or service manual provided by the installer of this engine.

External

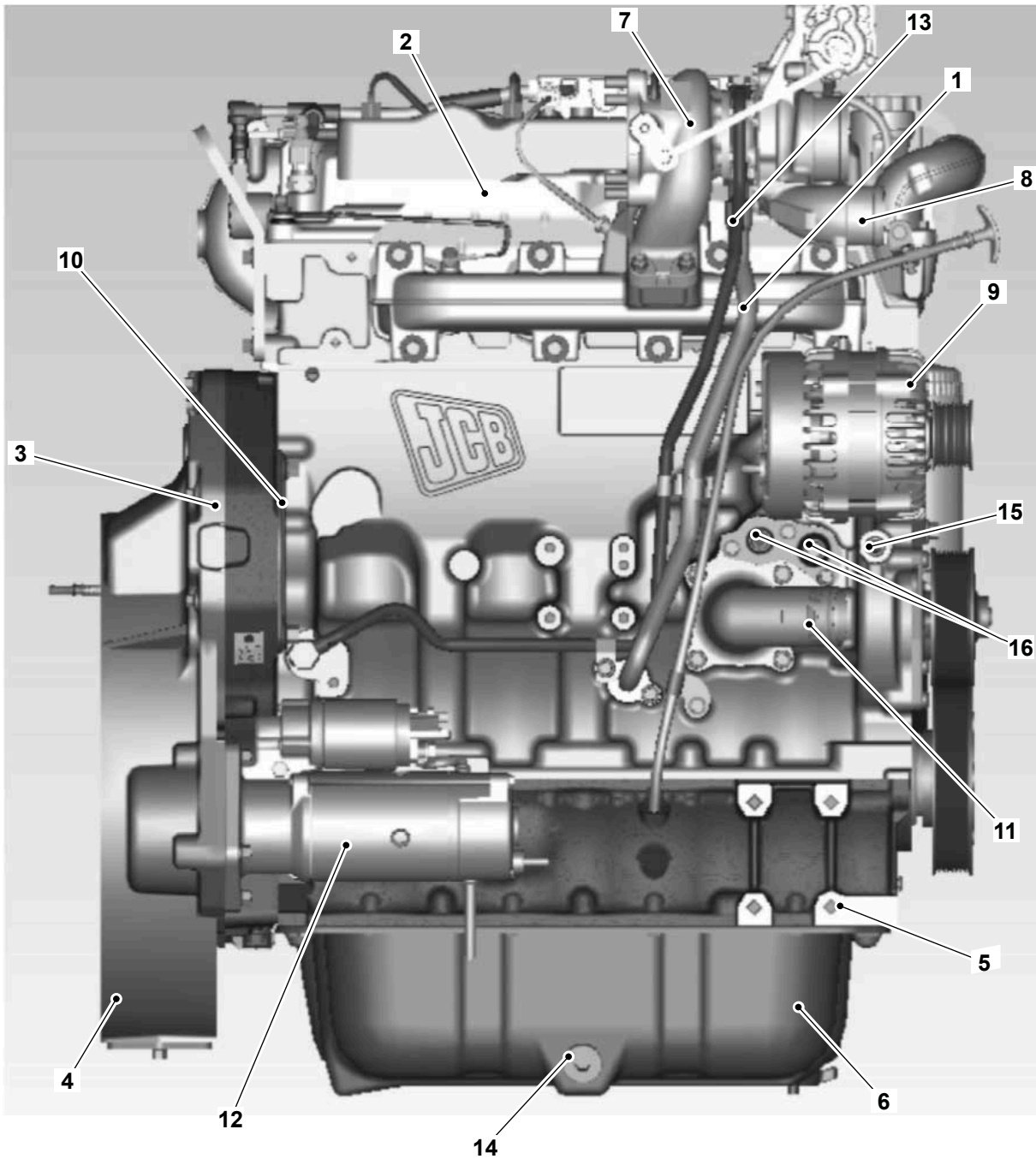
The following identifies the main components of a typical engine assembly visible from the exterior. Some variants may differ in detail.

Figure 3. Left hand Side



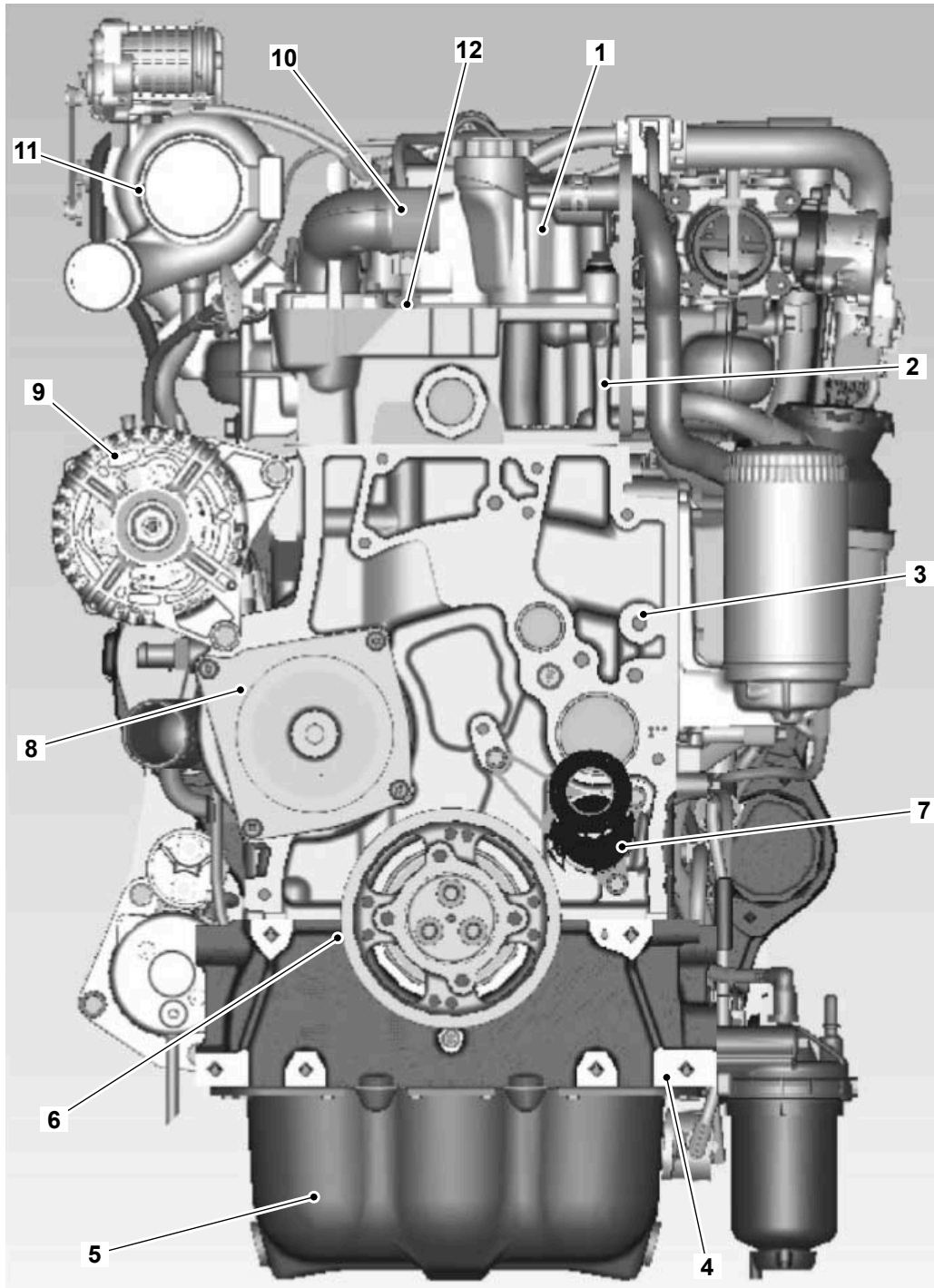
- | | | | |
|----|--|----|---|
| 1 | Rocker cover | 2 | Fuel injectors and high pressure fuel pipes |
| 3 | Lubrication oil filler cap | 4 | Timing gear case |
| 5 | Flywheel housing | 6 | Bedplate |
| 7 | Lubrication oil sump | 8 | Air inlet manifold |
| 9 | High pressure fuel pump | 10 | Fuel filter |
| 11 | Lubrication oil dipstick | 12 | Lubrication oil cooler housing |
| 13 | Low duty PTO (Power Take-Off) (blanking cover if no device is installed) | 14 | Low pressure fuel line (to tank) |
| 15 | Oil drain plug (sump) | 16 | Oil filter housing drain plug |
| 17 | IMV (Inlet Metering Valve) | 18 | ECM (Engine Control Module) |
| 19 | Crankcase ventilation filter assembly | 20 | Electronic air intake throttle |
| 21 | Inlet manifold induction heater (if installed) | | |

Figure 4. Right Hand Side



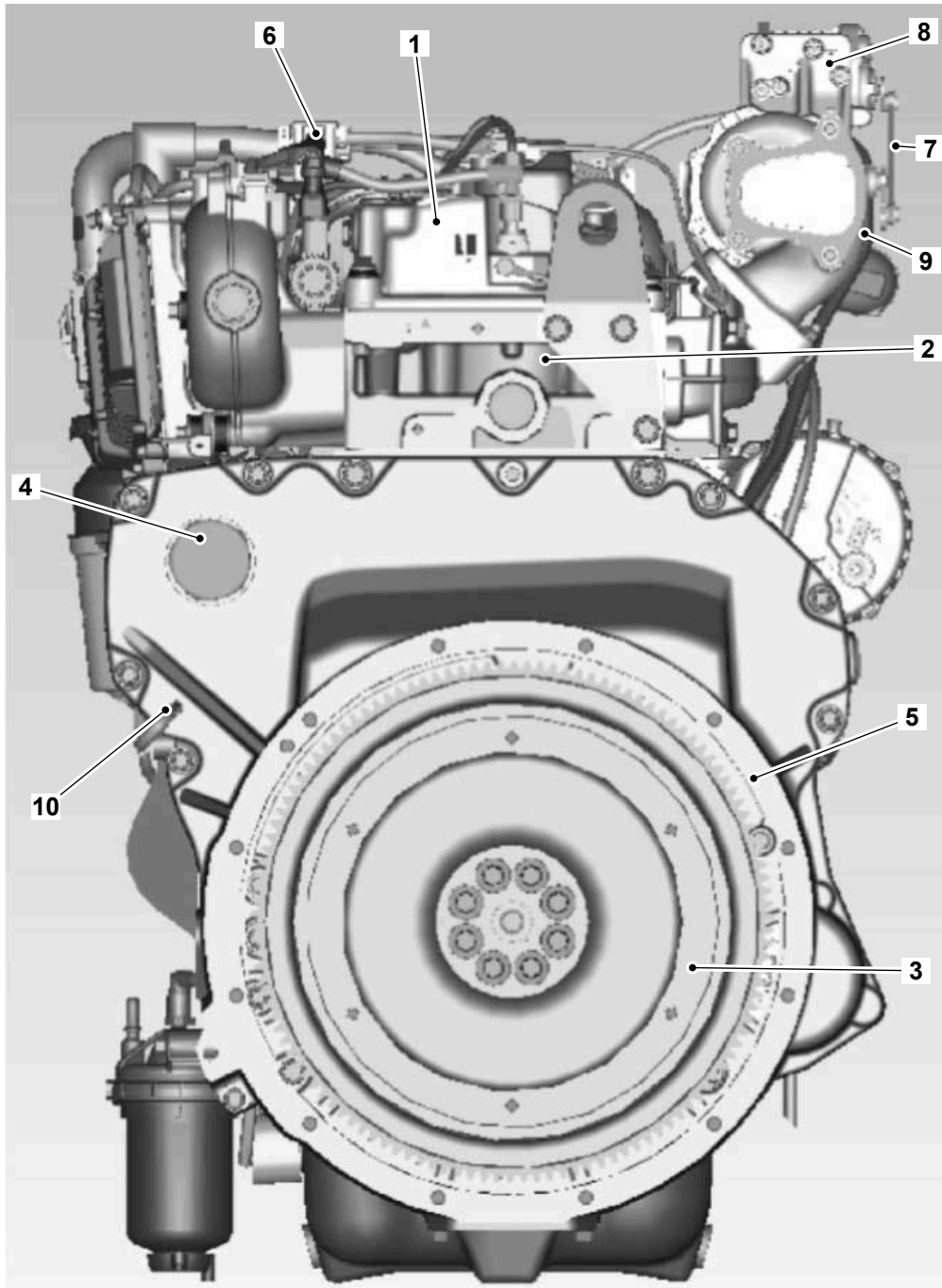
- | | | | |
|----|--|----|---|
| 1 | Turbocharger oil drain line | 2 | Heatshield |
| 3 | Timing gear case | 4 | Flywheel housing |
| 5 | Bedplate | 6 | Lubrication oil sump |
| 7 | Turbocharger | 8 | Turbocharger air outlet |
| 9 | Alternator | 10 | Heavy duty PTO (blanking cover if no device is installed) |
| 11 | Coolant inlet / radiator hose connector | 12 | Starter motor assembly |
| 13 | Turbocharger oil feed line | 14 | Oil drain plug (sump) |
| 15 | SCR (Selective Catalytic Reduction) Water connection | 16 | Heater connections |

Figure 5. Front End



- | | | | |
|----|--|----|--|
| 1 | Rocker cover | 2 | Cylinder head |
| 3 | Crankcase | 4 | Bedplate |
| 5 | Lubrication oil sump | 6 | Crankshaft pulley |
| 7 | FEAD (Front End Accessory Drive) tensioner | 8 | Coolant pump and drive pulley assembly |
| 9 | Alternator and drive pulley assembly | 10 | Coolant thermostat housing/radiator top hose connector |
| 11 | Turbocharger | 12 | Coolant temperature sensor |

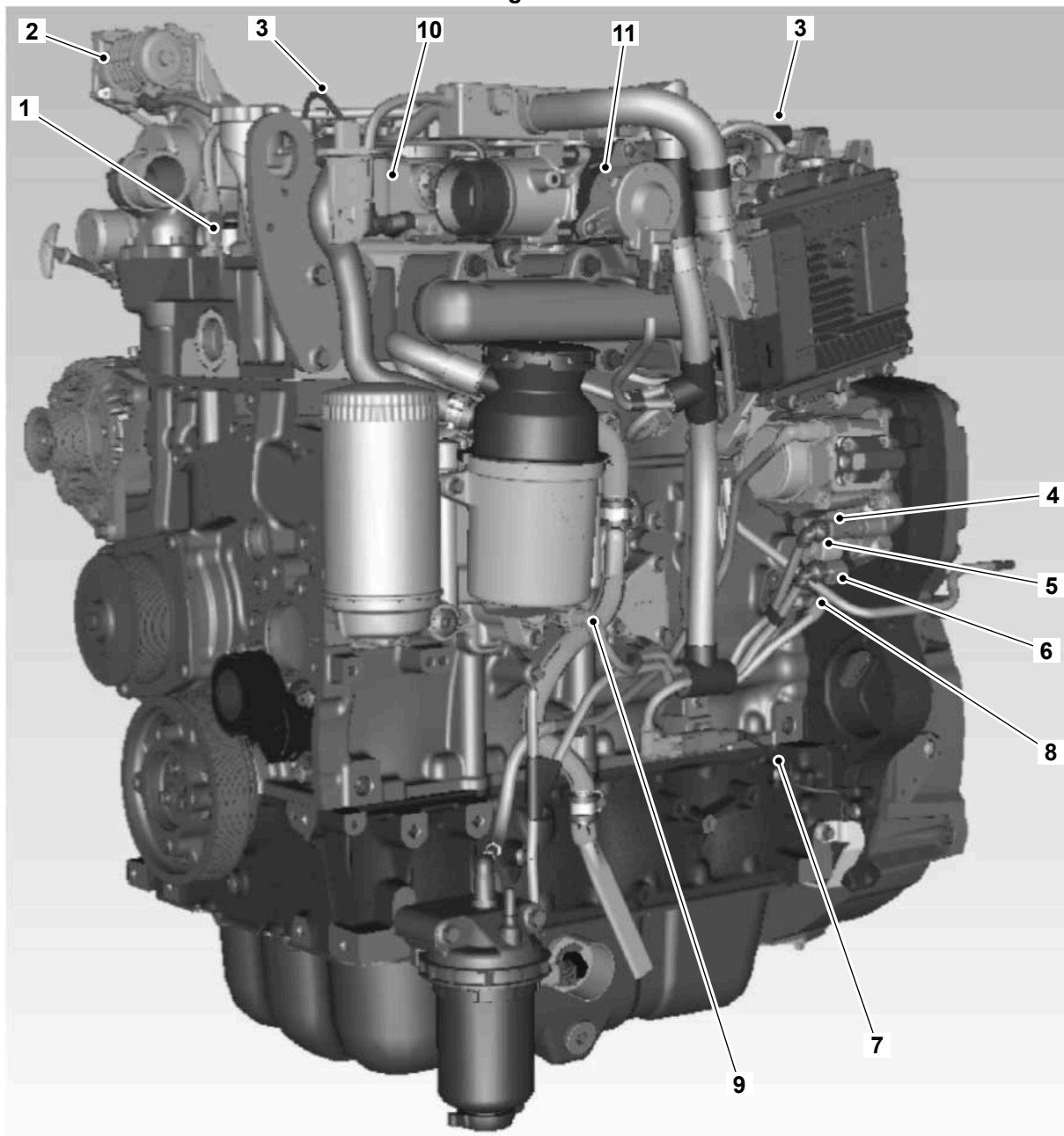
Figure 6. Rear End



- | | | | |
|---|------------------|----|--|
| 1 | Rocker cover | 2 | Cylinder head |
| 3 | Flywheel | 4 | High pressure fuel pump drive gear cover |
| 5 | Flywheel housing | 6 | Engine electrical harness |
| 7 | Linkage | 8 | Actuator |
| 9 | Turbocharger | 10 | Low pressure fuel return line to tank |

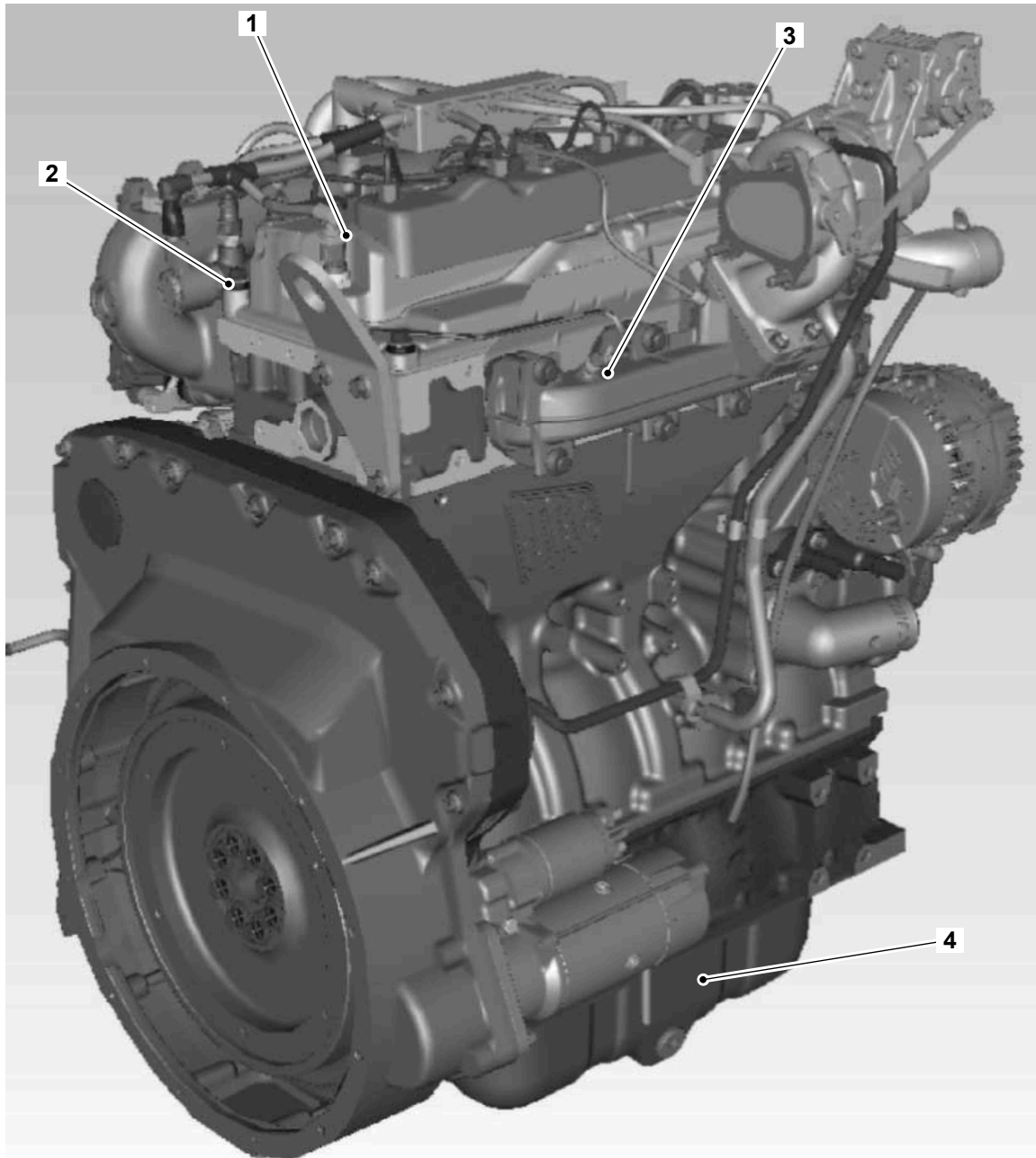
Engine Sensors and Actuators

Figure 7.



- | | | | |
|----|--|----|--|
| 1 | Coolant temperature sensor | 2 | Turbocharger actuator |
| 3 | Temperature manifold air pressure sensor | 4 | Fuel temperature sensor |
| 5 | Fuel inlet metering valve | 6 | Camshaft position sensor |
| 7 | Crankshaft position sensor fly lead (sensor not shown) | 8 | Oil temperature sensor |
| 9 | Oil pressure switch | 10 | Inter cooler outlet temperature sensor |
| 11 | Air inlet throttle | | |

Figure 8.



1 Exhaust manifold pressure sensor

2 Fuel pressure relief valve HPV (High Pressure Valve)

3 Exhaust manifold temperature sensor

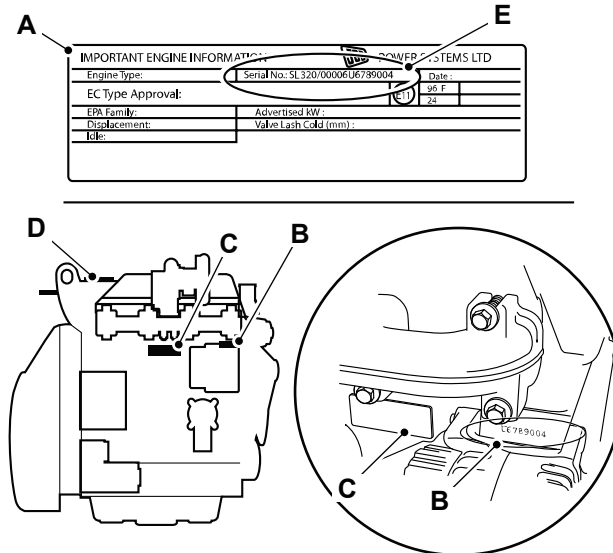
4 Oil level switch (optional not shown)

Product and Component Identification

Engine

The engine data labels are attached to the cylinder block as shown.

Figure 9.



- A** Engine data label - rocker cover
- C** Engine data label - crankcase
- E** Engine identification number
- B** Stamp
- D** Engine data label - rocker cover

The data label includes the engine identification number.

Table 1. Example of the engine identification number

	DP	320/40001	U	00001	04
Digit	1-2	3-10	11	12-16	17-18

Table 2.

Digit 1-2	Engine Type
DP	4.8L turbocharged and aftercooled electronic common rail fuel injection (STV) > 55kW

Table 3. Explanation of the engine identification number

Digit	Explanation
3-10	Engine part number
11	Country of manufacture. U = United Kingdom
12-16	Engine serial number
17-18	Year of manufacture

The country of manufacturer, engine serial number and year of manufacture of the engine are also stamped on the cylinder block. Refer to Figure 9.

Operation Introduction

General

JCB may not have any control over the installation and use of their products, thus it is necessary to read this operation section in conjunction with the manufacturers operators manual through from beginning to end.

The operator must always be aware of events happening in or around the product. Safety must always be the most important factor when you operate the product.

If it applies to the machine / product, make sure you understand any operating controls, gauges and switches, practice using them.

If it applies to the machine / product (subject to the manufacturers approval), drive the product in an open space, clear of people. Get to know the 'feel' of the product and its driving controls.

Do not rush the job of learning, make sure you fully understand everything in all documentation appropriate to the equipment / product. Take your time and work efficiently and safely.

Remember:

- Be careful.
- Be alert.
- Be safe.

Operating Safety

General

Engine Condition

A defective engine can injure you or others. Do not operate a engine which is defective or has missing parts. Make sure the maintenance procedures in this manual are completed before using the engine.

Engine Limits

Operating the engine beyond its design limits can damage the engine, it can also be dangerous. Do not operate the engine outside its limits. Do not try to upgrade the engine performance with unapproved modifications or additional equipment.

Exhaust Gases

Engine exhaust gases can harm and possibly kill you or bystanders if they are inhaled. Do not operate the engine in closed spaces without making sure there is good ventilation. If possible, install an exhaust extractor. If you begin to feel drowsy, stop the engine at once and get into fresh air.

Sparks

Explosions and fire can be caused by sparks from the exhaust or the electrical system. Do not use the engine in closed areas where there is flammable material, vapour or dust.

Hazardous Atmospheres

This engine is designed for use in normal out door atmospheric conditions. It must not be used in an enclosed area without adequate ventilation. Do not use the engine in a potentially explosive atmosphere, i.e. combustible vapours, gas or dust, without first consulting your JCB dealer.

Engine Safety

Stop the engine at once if a fault develops. Abnormal sounds and smells can be signs of trouble. Examine and repair before resuming starting the engine again.

Hot Components

Touching hot surfaces can burn skin. The engine will be hot after the unit has been running. Allow the engine to cool before servicing the unit.

Fires

Do not use water to put out a engine fire, you could spread an oil fire or get a shock from an electrical fire. Use carbon dioxide, dry chemical or foam extinguishers. Contact your nearest fire department as quickly as possible.

High Exhaust System Temperatures

When the engine performs a regeneration the exhaust temperatures will be very high. Before starting the engine conduct a risk assessment to determine if the machine will be safe for the application/environment it will be operating in. Otherwise persons could be injured and property damaged.

Battery Isolator

General

To allow the engine ECU (Electronic Control Unit) to shut down correctly, you must wait 60s before you isolate the battery. The 60s period starts when you turn the ignition off.

Disconnect the Electrics:

1. Turn the ignition key to the off position.
2. Wait for the engine ECU to shutdown correctly.
Duration: 60s
3. Get access to the battery isolator.
4. Operate the battery isolator.

Connect the Electrics:

1. Make sure the ignition is switched off.
2. Operate the battery isolator.

Before Starting the Engine

General

▲ **Notice:** 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.

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

- The ambient temperature
- 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 -12°C (10.4°F).

If the engine is operating in temperatures between -12°C (10.4°F) and -20°C (-4.0°F) then a grid heater is available. The heater is installed in the inlet manifold and is linked into the machine's electrical system.

If the engine is operating in temperatures between -20°C (-4.0°F) and -30°C (-22.0°F) a block heater must 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 of water
- The machine is safe and ready to start

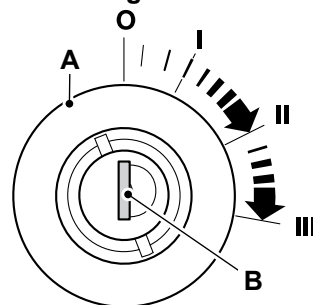
Starting the Engine

General

Start Procedure

- ▲ **Notice:** Do not operate the starter motor for more than 20 s at one time. Let the starter motor cool for at least 2 min.
1. Make sure that all controls (if applicable) are set correctly for starting. Consult the manufacturers operators manual for further information as the actual installation may differ.
 2. If fitted, turn the start key to position (I) to connect the battery to all of the electrical circuits.
 3. For engine coolant temperatures below the figure specified for the use of a grid heater (if installed), the grid heater light will illuminate. Wait for the grid heater light to extinguish.
Temperature: -4°C (24.8°F)
 4. Turn the starter key further to position (II) and hold it there until the engine starts. Do not operate the starter for more than the time specified.
Duration: 20s
 5. There is an intentional delay prior to starting the engine to ensure the engine lubrication system is primed. The delay time is determined by the engine coolant temperature and can be up to:
Duration: 20s
 6. If the engine does not start, return the ignition key to the "0" position, Allow the starter to cool for the time specified:
Duration: 2min
 7. After you start the engine there is an intentional delay at idle during which time the throttle control is overridden to make sure that the lubrication system is primed. This is determined by the engine coolant temperature. The delay time can be up to:
Duration: 28s

Figure 10.



A Ignition switch

B Ignition key

Engine Checks After Start-up

▲ WARNING Fine jets of fluid at high pressure can penetrate the skin. Keep face and hands well clear of pressurised fluid and wear protective glasses. If fluid penetrates your skin, get medical help immediately.

Notice: Stop the engine and investigate the cause if any of the following conditions occur: The warning lights fail to go off when the engine has been started. The alarm is still sounding when the engine has been started. The warning lights illuminate and the alarm sounds when the engine is running.

Notice: 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.

Check the following items after the engine has been started.

1. Consult the machine manufacturers operators manual for further information.
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. Refer to Table 4.
6. Check for any lubricating oil leakage, particularly around joints and connectors.
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.
8. 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.
9. Check the coolant system for signs of leakage, particularly around the radiator and hose connections.

Table 4.

Exhaust smoke colour	Condition
Colourless or light blue	Normal
Black	Abnormal
White	Abnormal

Engine Running-in Procedure

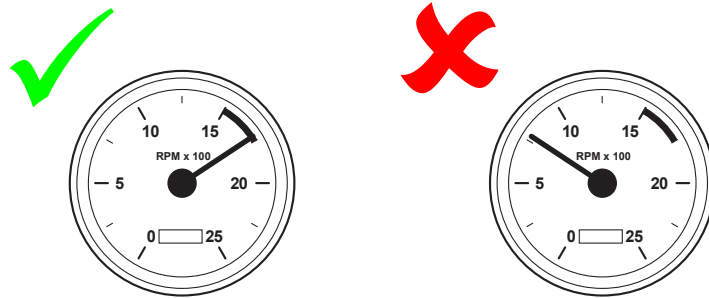
New engines do not require a running-in period. The engine should be used in a normal work cycle immediately.

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).

The recommended grade of engine oil must be used. [Refer to: Fluids, Lubricants and Capacities \(Page 72\).](#)

Figure 11.



Warming Up

Warming up requirements will depend on the type of installation. Consult the machine manufacturers instructions.

Stopping and Parking

General

Stopping the Engine

- ▲ **Notice:** Allow turbocharged engines to run at approximately 1000 rpm and reduced load or idle for 2 –3 min before shut down. This will allow the turbocharger to cool. Failure to follow this procedure could result in turbocharger damage.
1. Make sure that all machine controls are in the correct position for stopping the engine. Consult the machine manufacturers operators handbook
 2. Turn the ignition key (or other control) to the off (0) position.

Lifting the Product

General

For the various engine weights. Refer to: [Technical Data \(Page 71\)](#).

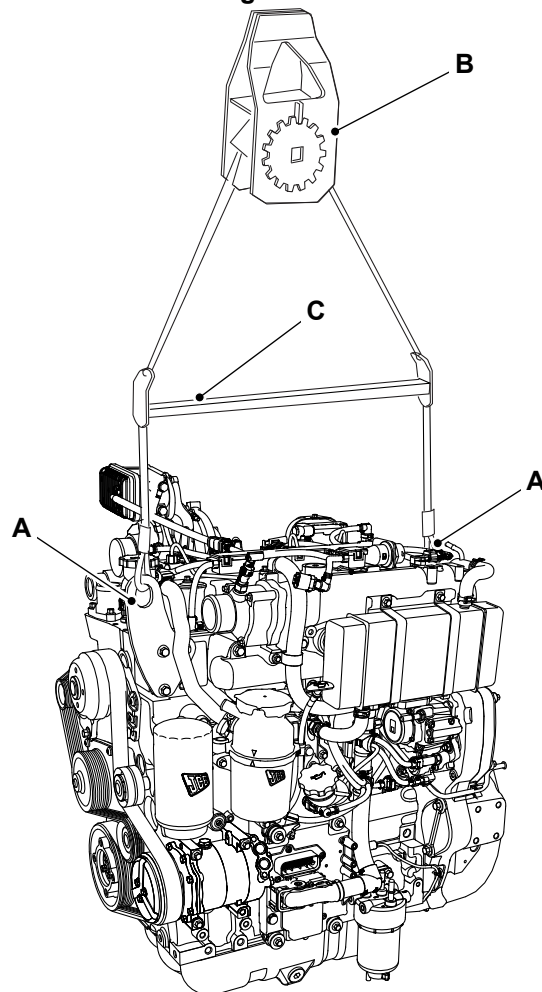
The lifting equipment used must be an approved type and capable of lifting the engine safely. The recommended lifting equipment is shown in figure. Use spreader bar when lifting the engine. Refer to Figure 12.

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 for signs of damage. The brackets must be correctly torqued to the engine block, the correct torque figure for the bracket retaining bolts is 43–51N·m. Refer to Figure 12.

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

Figure 12.



A Lifting brackets
C Spreader bar

B Lifting equipment

Operating Environment

General

Operating in Dusty or Sandy Areas

Consult the machine manufacturers documentation before considering the following:

1. Air cleaner. Frequently check, clean or replace the elements regardless of the inspection interval.
2. Make sure all engine or ancillary openings are correctly secured to prevent the ingress of sand and dust.
3. Make sure that debris do not accumulate around the engine.

Operating in Coastal Regions

Consult the machine manufacturers documentation before considering the following:

1. Make sure the engine and its systems are not subjected to salt water.

Operating in Areas With Wet or Soft Ground

Consult the machine manufacturers documentation before considering the following:

1. Moisture or mud will cause paint, wiring and metallic parts to deteriorate. Keep the engine as dry as possible.
2. Make sure that debris do not accumulate around the engine.

Operating in Low Temperatures

▲ Notice: Do not connect two batteries in series to give 24 V for starting as this can cause damage to the electrical circuits.

1. Consult the machine manufacturers operators manual.
2. Use the correct viscosity engine lubricating oil.
[Refer to: Fluids, Lubricants and Capacities \(Page 72\).](#)
3. If available, use a low temperature diesel fuel.
4. Use the correct coolant mixture.
5. Keep the battery at full charge.
6. Fill the fuel tank and DEF (Diesel Exhaust Fluid) tank at the end of each work period, this will help to prevent condensation forming on the tank walls.
7. If appropriate to the application, protect the machine when its not in use.
8. If appropriate to the application, park the machine inside a building or cover it with a tarpaulin.
9. If appropriate to the installation, before the engine is started, remove any snow from the engine compartment or snow could get into the air filter.

In temperatures below 0°C (32.0°F) special care must be taken in addition to the above.

The DEF system tank and pipes are protected from freezing by an automatic heating system. This does not require any control by the operator.

1. Consult the machine manufacturers operators manual.
2. Drain the water collected in the fuel system to prevent it freezing.
3. Additional low temperature fuel and lubricants and batteries may be required. Contact your local JCB engine dealer for advice.

4. If appropriate to the installation, install a cold weather starting aid. In very low temperatures (less than the value shown) additional starting aids may be needed. For example are fuel, oil and coolant heaters. Ask your JCB dealer for advice.

Temperature: -18°C (-0.4°F)

Operating in High Temperatures

1. Use the correct viscosity engine lubricating oil.
2. Use the correct coolant mixture.
3. Check the coolant system regularly, keep the coolant at the correct level. Make sure there are no leaks.
4. Keep the cooling pack and engine clean, regularly remove dirt and debris from the cooling pack and the engine.
5. Check the fan belt regularly.
6. Check the air vents. Make sure that the air vents to and from the engine compartment are not blocked.
7. Check the engine pre-cleaner regularly (if installed).
8. Check the battery electrolyte level.

Refuelling

General

▲ **CAUTION** Spilt fuel may cause skidding and therefore accidents. Clean any spilt fuel immediately.

Do not use fuel to clean the machine.

When filling with fuel, choose a well aired and ventilated area.

Notice: A combination of water and sulphur will have a corrosive chemical effect on fuel injection equipment. Use of high sulphur fuels will poison the SCR catalyst and must not be used.

Notice: Consult your fuel supplier or JCB dealer about the suitability of any fuel you are unsure of.

Filling the Tank

▲ **Notice:** 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.

Notice: No warranty liability whatsoever will be accepted for failure of the emissions control system where the failure is attributed to contamination of the diesel exhaust fluid (DEF).

Notice: No warranty liability whatsoever will be accepted for failure of the emissions control system where the failure is attributed to contamination of the diesel fuel.

Notice: No warranty liability whatsoever will be accepted for failure of the emissions control system where the failure is attributed to the quality and grade of the diesel exhaust fluid (DEF) used.

[Refer to: Fuel \(Page 73\)](#). If you use the incorrect type of fuel or fuel which is contaminated, then damage to the fuel injection system can occur.

Fill the fuel tank and DEF (Diesel Exhaust Fluid) tank (if applicable) at the end of each work period, this will help to prevent condensation forming on the tank walls.

Always replenish the DEF tank at the same as you refill the diesel tank. It is recommended that the DEF tank is not continually run down to the minimum, as this may drag contamination into the system and reduces the likelihood of an engine de-rate due to DEF level.

DEF has a totally separate tank of its own. You can recognise your DEF tank by its blue cap or an AdBlue® label.

If the engine cuts out and the low fuel level lamp was on do not attempt to restart the engine without first refilling the fuel tank. Otherwise the fuel injection equipment could be damaged.

Filling the Diesel Tank

▲ **Notice:** Make sure that you use the fuel filler and not the DEF filler. Even small amounts of fuel in the DEF tank may damage the system. If there is any possibility that the DEF system has been contaminated with fuel, the engine must not be started before cleaning the system. Contact your JCB dealer.

1. If the machine has a protective flap, you must move the flap to get access to the filler cap.
2. Remove all unwanted material around the diesel fuel cap.
3. Remove the diesel fuel tank cap.
4. Add the fuel through the filler neck as necessary.
5. Install the diesel fuel tank cap.
6. Lock the diesel fuel tank cap to prevent theft and tampering.

Filling the Diesel Exhaust Fluid Tank

▲ **Notice:** Make sure that you use the DEF filler and not the fuel filler. Even small amounts of DEF in the fuel tank may damage the system. If there is any possibility that the fuel system has been contaminated with DEF, the engine must not be started before cleaning the system. Contact your JCB dealer.

1. Remove all unwanted material around the DEF cap.
2. Remove the DEF cap.
3. Add the DEF through the filler neck as necessary.
4. Install the DEF cap.
5. Lock the DEF cap to prevent theft and tampering.

Preservation and Storage Cleaning

General

▲ **WARNING** When using cleaning agents, solvents or other chemicals, you must adhere to the manufacturer's instructions and safety precautions.

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

Notice: Cleaning metal parts with incorrect solvents can cause corrosion. Use only recommended cleaning agents and solvents.

Clean the product with water and/or steam. Do not let mud, debris etc. to collect on the product.

Before you do any service procedures that require components to be removed:

- The cleaning must be done 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 the surrounding product must be cleaned.
- When cleaning is complete, move the product away from the wash area or alternatively, remove the material washed from the product.

When you remove components, be aware of exposure to dirt and debris. Cover any open ports and remove the deposits before proceeding.

Refer to the individual clean procedures throughout the Maintenance section. [Refer to: Maintenance Schedules \(Page 39\)](#).

Detergents

Do not use a full strength detergent. Always dilute the detergents as per the manufacturer's recommendations, or damage to the paint finish can occur.

Always obey the local regulations regarding the disposal of debris created from cleaning the product.

Pressure Washing and Steam Cleaning

▲ **CAUTION** When using a steam cleaner, wear safety glasses or a face shield as well as protective clothing. Steam can cause personal injury.

Notice: The engine and other components could be damaged by high pressure washing systems. Special precautions must be taken if the machine is to be washed using a high pressure system.

Make sure that the alternator, starter motor and any other electrical components are shielded and not directly cleaned by the high pressure cleaning system. Do not aim the water jet directly at bearings, oil seals or the engine air induction system.

Use a low pressure washer and brush to remove dried mud or dirt.

Use a steam cleaner to remove soft dirt and oil.

When cleaning around decals:

- Ensure the water pressure is kept below 138bar (2,000.0psi).
- Keep water temperature below 80°C (175.9°F).
- Use a spray nozzle with a 40° wide angle spray pattern.
- Keep the nozzle at least 300mm away from and perpendicular (at 90° degrees) to the decal.

The machine must always be greased (if appropriate) after pressure washing or steam cleaning.

Preparation

1. Make the machine safe.
2. Stop the engine and let it cool for at least one hour. Do not try to clean any part of the engine while it is running.
3. Make sure that all of the electrical connectors are correctly coupled. If the connectors are open, attach the correct caps or seal with water proof tape.

Storage

General

If the machine will not be used for an extended period (greater than two months), you must store the machine correctly. If you prepare the machine carefully and apply on-going care you can prevent deterioration and damage to the machine while it is in storage.

It is recommended the engine is operated and reaches operating temperature at least every three months.

Storage Area

The machine can be stored in a temperature range of: -40°C (-39.9°F) to 30°C (86.0°F)

If the machine uses DEF (Diesel Exhaust Fluid) and is to be stored with DEF (or other fluids present), check the relevant fluid storage requirements as they may affect the applicable storage temperature range. [Refer to: During Storage \(Page 32\)](#).

When possible, you must keep the machine in a dry building or shelter.

If only an outdoor storage area is available, look for a storage area with good drainage.

Prepare the Machine for Storage

1. Clean the machine to remove all unwanted material and corrosive products.
2. Dry the machine to remove solvents and moisture.
3. Touch-up any damaged paint. Treat exposed parts with anti-rust agent. Apply grease to unpainted surfaces.
4. Apply grease to the moving parts.
5. Examine the machine for worn or damaged parts. Replace if necessary.
6. Fill the diesel fuel and DEF tanks to prevent a build up of condensation in the tank.
7. Examine the coolant condition. Replace if necessary.
8. Examine all fluid levels. Top up if necessary.
9. Inflate the tyres to the correct pressure (if applicable).

Put into Storage

Engines should be stored in the 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, refer to hot test description.

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

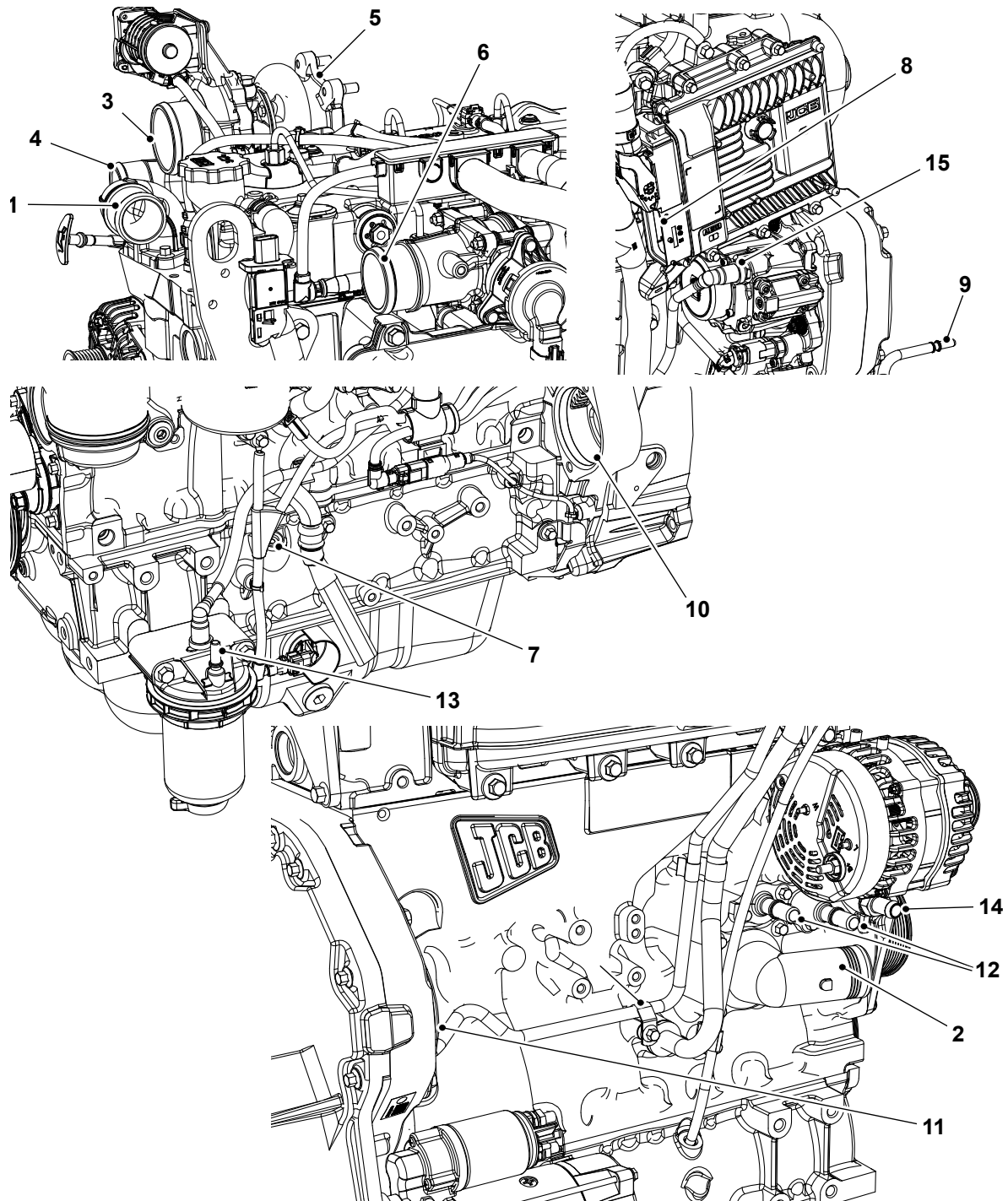
If an engine is to be placed into storage, all external signs of surface coating damage or corrosion should be cleaned and re-coated. Electrical connectors and components should be coated with a protective spray.

Capping Engine Openings

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

Some engine configurations may differ in detail to the illustrations shown. Make sure you identify and cap all openings. Including but not limited to:

Figure 13. Typical engine



- | | | | |
|----|---|----|--|
| 1 | Top hose cap | 2 | Bottom hose cap |
| 3 | Turbocharger intake cap | 4 | Turbocharger compressor outlet cap |
| 5 | Turbocharger exhaust outlet cap | 6 | Inlet manifold cap |
| 7 | Dipstick plug | 8 | ECM (Engine Control Module) machine harness connector cap |
| 9 | Fuel spill back line cap | 10 | Low duty PTO (Power Take-Off) (if installed) cap |
| 11 | Heavy duty PTO (if installed) cap | 12 | Cab heater feed and return spigots |
| 13 | Low pressure fuel filter inlet spigot (engines with fuel filter attached) | 14 | SCR (Selective Catalytic Reduction) coolant feed spigot (if installed) |

- 15** Fuel pump low pressure inlet spigot (engines with no fuel filter attached)

12 Month Revalidation Procedure

1. Pre-inspection:
 - 1.1. Inspect packaging for signs of damage.
 - 1.2. Inspect the caps for signs of damage.
 - 1.3. Inspect openings for signs of water or dirt ingress.
 - 1.4. Inspect the engine for signs of external corrosion.
 - 1.5. Inspect the engine for signs of fluid leaks.
2. From storage:
 - 2.1. Remove the air intake caps.
 - 2.2. Make sure the engine oil level is correct.
 - 2.3. Using a suitable power supply at the correct voltage, crank the engine over.
 - 2.4. During cranking, check that the oil pressure switch opens using a multimeter. The switch is closed when there is no or low oil pressure and opens when oil pressure reaches a set point. After three separate 20 second cranking periods, If the oil pressure switch does not open (indicating no, or low oil pressure), contact your JCB engine dealer.
 - 2.5. Recap all engine openings.
 - 2.6. Coat any exposed bare metal with a suitable product.
 - 2.7. Electrical connectors and components should be coated with a protective spray if exposed.
 - 2.8. Cover in weatherproof packaging.
 - 2.9. Place in storage, under cover on level ground or shelving.
 - 2.10. Record details of work as required.
 - 2.11. Do not expose to extremes of temperature or humidity.

Notice: Do not operate the starter motor for more than 20 s at one time. Let the starter motor cool for at least 2 min.

Table 5. Oil Pressure Switch Set Points

Oil pressure switch closed	>0.6bar (8.7psi)
Oil pressure switch open	<0.6bar (8.7psi)

OEM Commissioning Check on Engine Installation After More Than 12 Months

1. Flush the coolant system with proprietary flushing solution.
2. Refill the coolant system with 50/50 mix of long life antifreeze mixture.
3. Hot test engine according to the hot test profile. Refer to Table 6.
4. Drain engine oil and replace engine oil filter.
5. Refill with the correct oil and inhibit the cooling system using the correct product.
6. Record details of work as required.

Hot Test Description

▲ WARNING When using cleaning agents, solvents or other chemicals, you must adhere to the manufacturer's instructions and safety precautions.

All engines despatched from JCB will have been subjected to a hot test (checking items such as oil pressure, engines speeds, torque values etc.) and therefore the interior surfaces will have been coated with engine oil.

All coolant galleries are coated with CRODAFLUID PA75 corrosion inhibitor.

Stored engines will require re-inhibiting every 12 months, this will include hot testing the engine using a dynamometer. The hot test profile is:

Table 6. Hot Test Profile

Stage	Description	Mode	Speed (rpm)	Torque (Nm)	Time (secs)	Comment
1	Start up	Speed/Torque	1000	5	20	Engine start
2	Warm up 1	Speed/Torque	1000	120	40	Warm up and general leak check
3	Warm up 2	Speed/Torque	peak torque speed	50% peak torque	70	Warm up with 50% load
4	Peak torque	Speed/Torque	peak torque speed	85% peak torque	105	Peak torque check
5	Peak power	Speed/Torque	peak power speed	85% torque at peak power speed	55	Peak power check
6	High idle	Speed/Torque	Wide open throttle	20	10	High idle speed check
7	Cool down	Speed/Torque	1500	10	40	Cool down
8	Low idle	Speed/Torque	Low idle	5	20	Oil pressure at idle check

During Storage

Effects of Storage on the DEF System

If the engine has been shutdown correctly and there are no faults with the DEF system, the DEF system and engine can remain in a deactivated state under the following conditions:

Table 7. Storage - DEF system

Storage Period	Storage Actions
Up to 9 months	Fill DEF tank to maximum level with fresh DEF. Do not disconnect any electrical or hydraulic connections. Make sure the ambient temperature is between -40–30°C (-39.9–86.0°F)
Longer than 9 months	Carry out recommissioning process

Take out of Storage

Recommissioning Process

Table 8. Recommissioning Process

Recommissioning Process	Refill DEF tank with fresh fluid
	Change the main filter of the supply module
	Start the engine to enable the dosing system
	If a failure is detected, shut down the engine
	Wait until the main relay of the dosing system is deactivated (depending on application this is usually 30–45s). Start the engine again
	If a failure occurs again, consult JCB service.



Stored engines will also require re-inhibiting with CRODAFLUID PA75 every 12 months, including hot testing on a dynamometer.



Notes:

Maintenance Introduction

General

Your engine has been designed and built to give maximum performance, economy and ease of use under a wide variety of operating conditions. Prior to delivery, your engine was inspected both at the factory and by your dealer to make sure that it reaches you in optimum condition. To maintain this condition and trouble free operation it is important that the routine services and maintenance, as specified in this manual, are done at the recommended specified intervals and it is recommended that this is done by an approved JCB dealer using genuine JCB parts. Servicing/repairs carried out by unauthorised personnel or the use of non-genuine inferior quality parts could limit engine warranty.

After completing any routine servicing, maintenance or repairs you must complete the functional checks according to the maintenance schedule.

This section of the manual gives full details of the service requirements necessary to maintain your JCB engine at peak efficiency.

It can be seen from the service schedules on the following pages that many essential service checks must only be done by a JCB trained specialist competent person. JCB dealer service engineers have been trained by JCB to do such specialist tasks, and are equipped with the necessary special tools and test equipment to do such tasks, thoroughly, safely, accurately and efficiently.

JCB regularly updates its dealers to advise them of any engine developments, changes in specifications and procedures. Therefore only a JCB dealer is fully able which makes them best placed to maintain and service your engine.

A service record sheet or book is provided at the back of this publication which will enable you to plan your service requirements and keep a service history record. It must be dated, signed and stamped by your dealer each time your engine is serviced.

Remember, if your engine has been correctly maintained, not only will it give you improved reliability but its resale value will be greatly enhanced.

Obtaining Spare Parts

If you use non-genuine JCB parts or consumables, then you can compromise the health and safety of the operator and cause engine failure.

A parts book for your engine is available from your JCB dealer. The parts book will help you identify parts and order them from your JCB dealer.

Your dealer will need to know the exact model, build and serial number of your engine. [Refer to: Product and Component Identification \(Page 13\)](#).

The data plate also shows the serial numbers of the engine, transmission and axle(s), where applicable. Remember, if any of these units have been changed, the serial number on the data plate may be wrong. Check on the unit itself.

Maintenance Safety

General

Engine Modifications

This engine is manufactured in compliance with prevailing legislative requirements. It must not be altered in any way which could affect or invalidate its compliance. For advice consult your JCB dealer.

Repairs

If your engine 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.

'O' rings, Seals and Gaskets

Badly installed, 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.

Hot Components

Touching hot surfaces can burn skin. The engine will be hot after the unit has been running. Allow the engine to cool before servicing the unit.

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.

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.

Fires

Do not use water to put out a engine fire, you could spread an oil fire or get a shock from an electrical fire. Use carbon dioxide, dry chemical or foam extinguishers. Contact your nearest fire department as quickly as possible.

Fluids and Lubricants

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.

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 personal protective equipment. Hold a piece of cardboard close to suspected leaks and then examine the cardboard for signs of fluid. If fluid penetrates your skin, get medical help immediately.

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.

Hygiene

Lubricants are not a health risk when used correctly 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 must 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.

CAUTION Damaged or spent batteries and any residue from fires or spillage must be put in a suitable closed receptacle and must be disposed of in accordance with local environmental waste regulations.

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

The collection and disposal of used oil must 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:

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

First Aid - Oil

Eyes

In the case of eye contact, flush with water for 15min. 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 with sand or a locally approved brand of absorbent granules. Scrape up and remove to a chemical disposal area.

Fires

▲ WARNING Do not use water to put out an oil fire. This will only spread it because oil floats on water.
Extinguish oil and lubricant fires with carbon dioxide, dry chemical or foam.

First Aid - Electrolyte

Eyes

In the case of eye contact, flush with water for 15min. always get medical attention.

Swallowing

Do not induce vomiting. Drink large quantities of water or milk. Then drink milk of magnesia, beaten egg or vegetable oil. Get medical help.

Skin

Flush with water, remove affected clothing. Cover burns with a sterile dressing then get medical help.

Maintenance

▲ Notice: Using incorrect fluid could damage the system. See Fluids, Capacities and Lubricants for the correct fluid. The fluid can harm your skin. Wear rubber gloves. Cover cuts or grazes.

CAUTION The temperature of the hydraulic oil will be high soon after stopping the machine. Wait until it cools before beginning maintenance.

First Aid - DEF

If large quantities of DEF have been swallowed a doctor should be called immediately. Do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Avoid prolonged or repeated skin contact. After contact with skin wash thoroughly with plenty of soap and water. If irritation develops seek medical advice. Avoid contact with eyes, skin and clothing. Wear chemical resistant gloves, overalls and safety goggles complying with an approved standard. If in contact with eyes, rinse immediately with plenty of clean water. If irritation occurs seek medical attention.

Always wash hands and arms thoroughly after handling before eating, drinking, smoking or using the lavatory. DEF is corrosive to some metals such as copper and its alloys. Make sure DEF does not come in to contact with electrical connections.

Use only recommended storage and dispensing systems. DEF solution is very polluting to surface water and groundwater. DEF may not be removed by oil separators so it is important to isolate drainage from the dispensing area to prevent pollution in the event of a spill. Keep container closed in a segregated, approved and labelled area. Store below 30°C (86.0°F).

Maintenance Schedules

General

▲ WARNING Maintenance must be done only by suitably qualified and competent persons.

Before doing any maintenance make sure the machine is safe, it must be correctly parked on solid, level ground.

To prevent anyone starting the engine, remove the ignition key. Disconnect the battery (by means of the battery isolator if installed) when you are not using electrical power. If you do not take these precautions you could be killed or injured.

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

To ensure the correct functioning of the engine and emissions control system all operation and maintenance must be conducted in accordance with the instructions in this manual. Incorrect operation, maintenance or repair of the engine and emissions control system may lead to reduced product life, loss of performance or malfunctions. It is the engine owner's responsibility to ensure maintenance is conducted properly in accordance with the requirements in this manual.

Apart from the daily tasks, the schedules are based on the engine running hours. Keep a regular check on the hourmeter readings to correctly gauge the service intervals. When there is no hourmeter installed, use the calendar equivalents to determine the service intervals.

Do not use a engine which is due for a service. Make sure any defects found during the regular maintenance checks are corrected immediately.

More frequent checks of engine components than the engine manufacturer recommends do not invalidate emissions warranty.

How to Use the Maintenance Schedules

The schedules show the service tasks which must be done and their intervals.

The services must be done at either the hourly interval or the calendar equivalent, whichever occurs first.

The intervals given in the schedules must not be exceeded. If the engine is operated under severe conditions (high temperature, dust, water, etc.) shorten the intervals.

Table 9.

○	Service task can be completed by a competent operator. Details of how to complete the service task are given in the Operator's Manual.
□	We recommend that a Service Engineer completes the service task. Details of how to complete the service task are given in the Service Manual.

Maintenance Intervals

General

Table 10.

Interval (h)	Calendar Equivalent
10	Daily
50	Weekly
500	6 months
1000	Yearly
2000	2 Years
8000	8 Years

Pre-start Cold Checks, Service Points and Fluid Levels

The following maintenance procedure refers to the JCB engine only. It does not apply to the machine or equipment in which it is installed. Consult the manufacturers operation manual for further information.

Table 11. All Applications Except Generator Set Applications.

Pre-start Cold Checks Service Points and Fluid Levels	Operation	10h	50h	500h	1,000h	1,500h	2,000h	8,000h
ENGINE								
Oil level	Check	○	○	□	□	□	□	□
Coolant Quality/ level	Check	○	○	□	□	□	□	□
Coolant or Oil Leaks	Check	○	○	□	□	□	□	□
Water Sedimenters/separators (primary and secondary)	Check for Contamination and Drain		○	□	□	□	□	□
Fuel Filters (primary and secondary)	Change			□	□	□	□	□
Oil and Filter ⁽¹⁾	Change			□	□	□	□	□
All Hoses - Condition	Check			□	□	□	□	□
Radiator ⁽²⁾	Clean/check			□	□	□	□	□
FEAD (Front End Accessory Drive) Belt Condition/tension	Check			□	□	□	□	□
Air Cleaner Outer Element ⁽²⁾	Change				□		□	□
DEF (Diesel Exhaust Fluid) Dosing Module Filter ⁽⁴⁾	Change				□		□	□
CCV (Crankcase Ventilation) Filter	Change						□	□
Air Cleaner Inner Element	Change						□	□
Valve Clearances ⁽³⁾	Check and Adjust						□	□
Oil Filler and Dipstick O-rings	Change						□	□
Cooling system	Drain and Fill						□	□
FEAD Belt	Change							□
Injectors ⁽³⁾	Change							□
Injector(s) Leak-Off Rail ⁽³⁾	Change							□
High Pressure Fuel Lines ⁽³⁾	Change							□
SCRoF (Selective Catalytic Reduction on Filter) ⁽⁵⁾	Clean							□

(1) If operating under arduous conditions, do an engine oil flush (use the normal recommended engine oil) every 250h. Change the engine oil and filter every 250h.

(2) If operating in dusty adverse working environments, do these jobs more frequently.

(3) These jobs must be done by a qualified engineer.

(4) Change DEF filter more regularly under arduous conditions.

(5) Or when indicated by service light.



Maintenance Positions

General

Consult the machine manufacturers operators manual



Service Points

General

Consult the machine manufacturers operators manual

Access Apertures

General

Consult the machine manufacturers operators manual

Engine

General

Clean

▲ Notice: 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.

Notice: 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 engine air intake, alternator, starter motor and any other electrical components are shielded and not directly cleaned by the high pressure cleaning system.

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 engine must be cleaned.

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 soft bristle brush to soak off caked mud or dirt.
7. Apply an approved cleaning and degreasing 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 ECU (Electronic Control Unit), alternator or fuel injectors. Do not place the jet nozzle closer than the distance specified to any part of the engine or aftertreatment system.
Length/Dimension/Distance: 600mm
9. When the pressure washing is complete move the engine away from the wash area, or alternatively, clean away the material washed from the engine.
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

Additional cleaning must be carried out prior to working on the high pressure fuel system.

Check (Condition)

Start the engine and check for:

- Excessive smoke
- Excessive vibration
- Excessive noise
- Overheating
- Performance
- Unusual smells.

Oil

Check (Leaks)

Before you start the machine, do a check for oil leaks:

1. Make the machine safe.
2. Get access to the engine compartment (if applicable)
3. Check the engine and the area below for oil leaks.
4. Close the engine cover (if applicable).
5. If necessary, contact your JCB dealer.

Check (Level)

▲ WARNING Never check the oil level or add oil with the engine running. Be careful of hot lubricating oil. Danger of scalding.

Notice: Do not exceed the maximum level of engine oil in the sump. If the maximum is exceeded, the excess must be drained to the correct level. An excess of engine oil could cause the engine speed to increase rapidly without control.

1. Make the product safe.
[Refer to: Maintenance Positions \(Page 41\).](#)
2. Wait for the oil to drain back into the engine sump before you take a reading. If not, a false low reading may be recorded which can cause the engine to be overfilled.
3. Get access to the engine compartment (if applicable).
[Refer to: Access Apertures \(Page 43\).](#)
4. Remove and clean the dipstick.
[Refer to: Service Points \(Page 42\).](#)
5. Replace the dipstick.
6. Remove the dipstick.
7. Check the oil level. The oil should be between the two marks on the dipstick.
8. If necessary, add more oil:
 - 8.1. Remove the filler cap.
[Refer to: Service Points \(Page 42\).](#)
 - 8.2. Add the recommended oil slowly through the filler point
[Refer to: Fluids, Lubricants and Capacities \(Page 72\).](#)
 - 8.3. Replace the dipstick.
 - 8.4. Remove the dipstick.
 - 8.5. Check the oil level, if necessary add more oil.
 - 8.6. Replace the dipstick
 - 8.7. Replace the filler cap.
9. Close and secure the engine cover (if applicable).

Replace

Special Tools

Description	Part No.	Qty.
Oil Filter Removal Tool	320/B4374	1
Data Link Adaptor (DLA) Kit	892/01174	1

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

CAUTION! Oil will gush from the hole when the drain plug is removed. Keep to one side when you remove the plug.

1. Place a container of suitable size beneath the drain plug.
2. Remove the oil sump drain plug and 'O' ring. Let the oil drain out, then clean and install the drain plug with a new 'O' ring. Tighten the plug to the correct torque value.
3. Loosen and remove the filter housing drain plug. Let the oil fully drain. Install the plug. Tighten the plug to the correct torque value.
4. Unscrew the filter canister, use special tool if necessary.
[Special Tool: Oil Filter Removal Tool \(Qty.: 1\)](#)
5. Clean the seal face of the filter head.
6. Smear the seal on the new filter canister with clean engine oil.
7. Screw in the new filter canister and tighten it to the correct torque value.
 - 7.1. The filter canister can also be tightened by hand. Screw the filter until it contacts the filter housing and then tighten it an additional 3/4 of a turn.
8. Through one of the filler points, fill the engine with the recommended oil to the MAX mark on the dipstick. Wipe off any spilt oil, install the filler cap and make sure it is secure.
9. If the engine has a dead crank feature, carry out the following procedure.
 - 9.1. Turn the ignition key to the on position.
 - 9.2. Turn the ignition key to the off position.
 - 9.3. Repeat steps 9.1 and 9.2 5 times.
 - 9.4. Wait for the ECU (Electronic Control Unit) to shutdown.
Duration: 30s
 - 9.5. Turn the ignition key to the start position. The engine will crank for an extended time period before starting.
Duration: 10s
10. If the engine does not have a dead crank feature, carry out the following procedure.
 - 10.1. Connect a laptop to the engine with a data link adaptor and open Servicemaster.
[Special Tool: Data Link Adaptor \(DLA\) Kit \(Qty.: 1\)](#)
 - 10.2. Perform the IMV (Inlet Metering Valve) Override test.
 - 10.3. The IMV Override test will allow the engine to be cranked for a set time period without starting allowing sufficient time to prime the oil pressure.
Duration: 10s
11. Operate the engine at idle, make sure that the oil pressure low warning light is extinguished immediately after the engine starts. If it does not extinguish, stop the engine and investigate the cause.

12. Check for oil leakage. When the oil has cooled, check the oil level again, and if necessary top up with clean engine oil.

Figure 14.

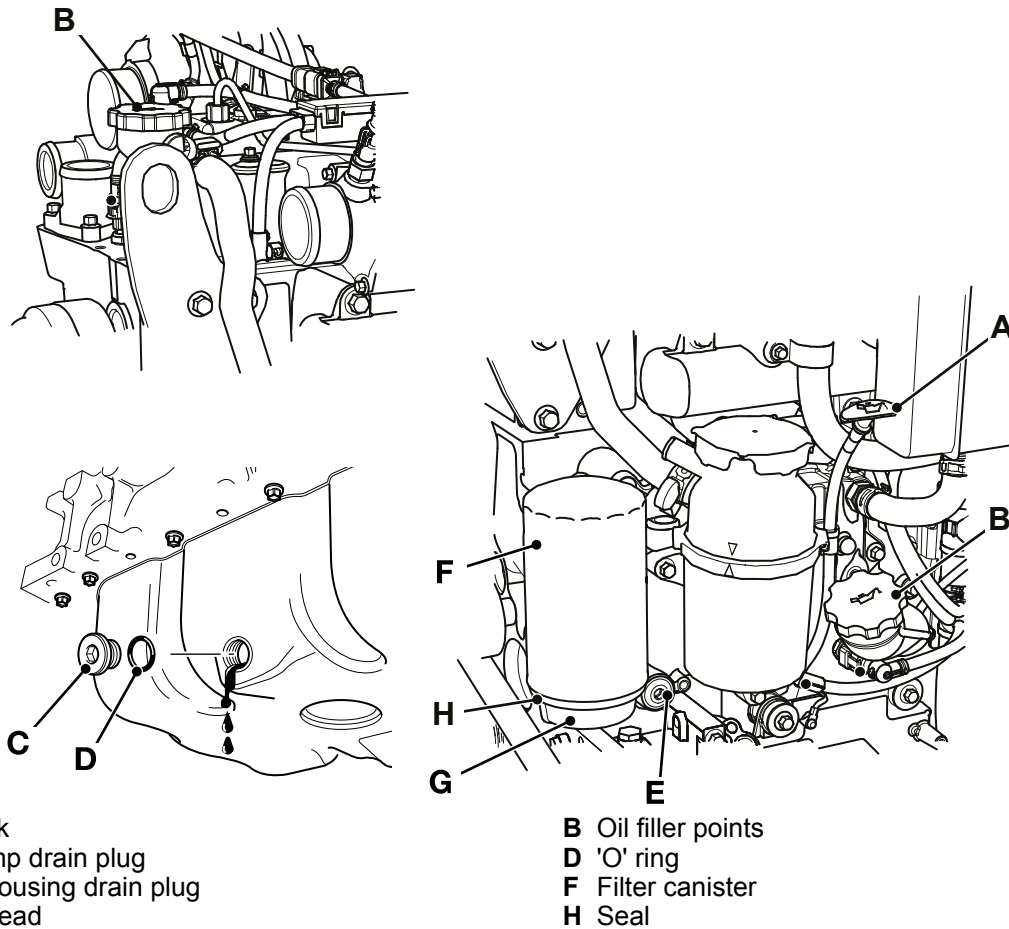


Table 12. Torque Values

Item	Description	Nm
C	Oil sump drain plug	40
E	Filter housing drain plug	40
F	Oil filter canister	15

Front End Accessory Drive (FEAD) Belt

Check (Condition)

▲ **Notice:** A drive belt that is loose can cause damage to itself and/or other engine parts.

1. Make the product safe.
[Refer to: Stopping and Parking \(Page 21\).](#)
2. Open the engine compartment cover (if applicable).
[Refer to: Access Apertures \(Page 43\).](#)
3. Get access to the drive belt.
4. Check the drive belt tension, if necessary contact your JCB dealer for any service requirements.

5. Renew the belt if it has cracks or if it is frayed or has pieces of material missing. Contact your JCB dealer for any service requirements.
6. Close and latch the engine compartment cover (if applicable).

Emissions Control System

General

▲ Notice: Make sure that genuine Diesel Exhaust Fluid is used (DIN 70070 or ISO 22241 certified). Do not dilute DEF or mix it with other substances, it may damage the catalyst.

Notice: When filling the Diesel Exhaust Fluid tank, make sure that you use the DEF filler and not the fuel filler. Even small amounts of DEF in the fuel tank may damage the system. If there is any possibility that fuel has been contaminated with DEF, the engine must not be started before emptying and cleaning the fuel tank.

Notice: Supplementary admixtures or additives are not allowed. Do not dilute Diesel Exhaust Fluid or mix it with other substances as it may damage the catalyst. If the DEF quality sensor detects a problem, it will cause the engine to run at reduced power.

Notice: Be careful when handling Diesel Exhaust Fluid. It is aggressive to some materials and corrosive to some metals. DEF becomes crystalline when in contact with air. In case of a spillage, rinse with plenty of water and dry with a clean cloth.

To meet Stage V emission standards, the engine uses EAT (Exhaust After Treatment) comprising SCR (Selective Catalytic Reduction) technology and a DOC (Diesel Oxidation Catalyst). In SCR technology, a liquid called DEF (Diesel Exhaust Fluid) is injected into the exhaust gases to convert nitrogen oxides into nitrogen, water and carbon dioxide. The DOC is used to facilitate passive and assisted passive regeneration of soot, and NO_x (Nitrogen Oxide) conversion. It also assists shielding the SCR_oF (Selective Catalytic Reduction on Filter) from engine out poisons.

DEF is specified in standards DIN 70070 and ISO 22241. Most commonly known trademarks of DEF are:

- AdBlue
- Air1
- Greenox

The SCR system consists of a SCR_oF, ECM (Engine Control Module) and injection system. These are connected together by a CANbus.

The ECM is mounted on the engine. It controls the normal functions of the engine as well as the SCR system.

The injection system comprises the following main components:

- DEF supply module: The DEF supply module pumps DEF from the DEF tank to the dosing module. The DEF is pumped through heated supply lines and the supply module maintains the pressure of the DEF at the required pressure..
- Dosing module. The DEF dosing module is an electrically operated solenoid valve installed in the exhaust pipe between the DOC and SCR catalyst. When the dosing module is operated, a fine spray of DEF is sent into the exhaust system. The amount dosed is calculated to ensure optimal NO_x reduction.

The DEF consumption depends upon the duty cycle of the engine, typically this is around 7-9% of the fuel consumption. The DEF tank and pipes are heated so that the system works in low temperatures. If DEF freezes, it is automatically defrosted when the engine is started. The freezing point of DEF (32.5% urea concentration) is -11°C (12.2°F). The only maintenance required in normal use is the DEF filter change for the supply module.

The SCR is equipped with on-board diagnostic systems which will warn the operator or limit the usage of the machine if any problems occur in the system; for example leakages or blocking of lines.

Be careful when handling DEF. It is aggressive to some materials and corrosive to some metals. DEF becomes crystalline when in contact with air. In case of a spillage, rinse with plenty of water and dry with a clean cloth.

Air Filter

General

Check (Condition)

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.

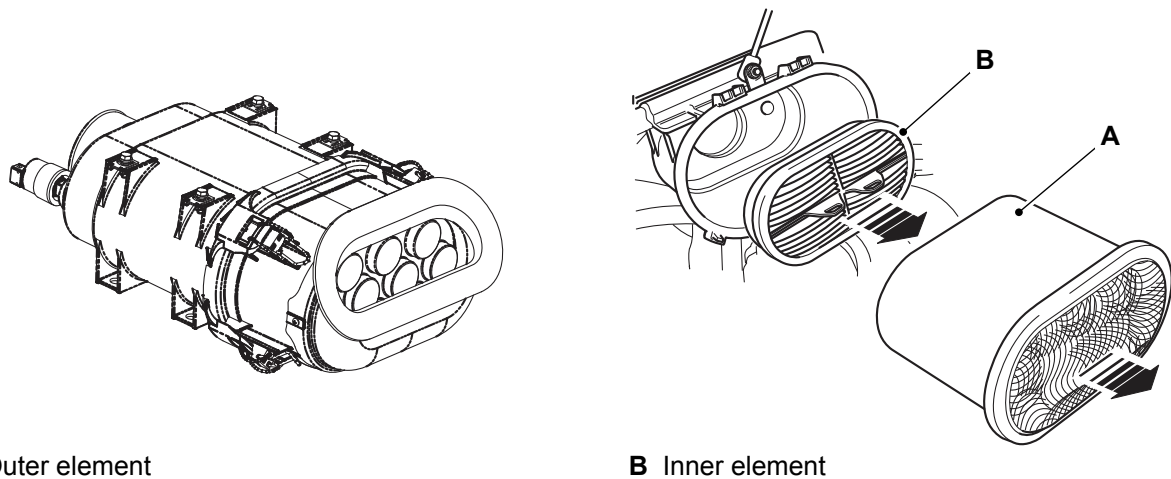
Inspect hoses and fittings for splits and poor clamping which may allow unfiltered air to enter the engine

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

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

A typical air filter installation with outer and inner element is shown. Refer to Figure 15.

Figure 15.



A Outer element

B Inner element

Fuel System

General

Bleed

Consult the manufacturers operator or service manual.

Check (Leaks)

1. Make the machine safe.
2. Get access to the engine compartment (if applicable).
3. Check the engine compartment (if applicable), fuel lines and the area below for leaks.
4. If necessary, contact your JCB dealer.

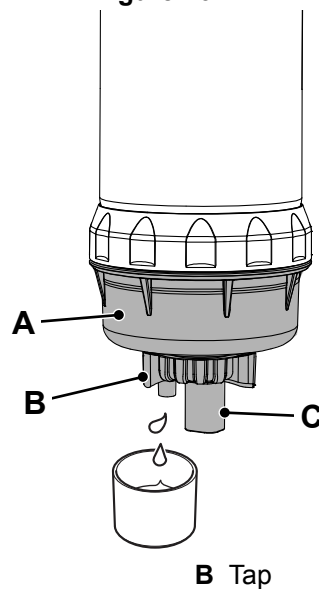
Primary Fuel Filter

Drain

Draining the Water Separator

1. Make the machine safe.
2. Get access to the filter.
3. Disconnect the WIF (Water in Fuel) connector.
4. If there is water but no sediment, open the tap to drain the water. If there is any sediment in the bowl replace the fuel filter element.
5. Tighten the drain tap when all the water is drained.
6. Reconnect the WIF connector.

Figure 16.



A Water separator bowl
C WIF connector

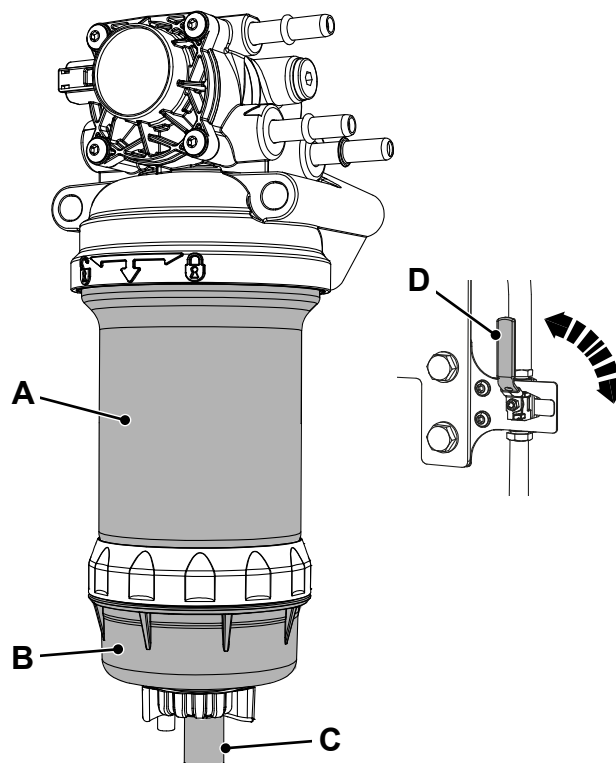
B Tap

Replace

Remove

1. Make the machine safe.
2. Get access to the filter.
3. Set the fuel shut-off valve to isolate the fuel supply.
4. Drain the water separator bowl.
5. Disconnect the WIF (Water in Fuel) connector.
6. Unscrew the water separator bowl to remove. Any fuel and water mix drained must be disposed of in accordance with local regulations. Do not reuse the drained fuel.
7. Unscrew the filter element to remove.

Figure 17.



A Filter element
C WIF connector

B Water separator bowl
D Fuel shut-off valve

Install

1. The installation procedure is the opposite of the removal procedure. Additionally do the following steps.
2. Install a new filter element and screw in by hand until a click is felt/heard.
3. Make sure that the WIF electrical connector is correctly installed.
4. Set the fuel shut-off valve to connect the fuel supply.

Secondary Fuel Filter

Replace

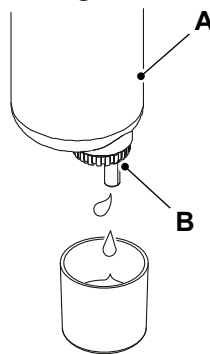
Special Tools

Description	Part No.	Qty.
Spanner - HP Fuel Filter	334/G5933	1
Fuel Filter Removal Tool (4 cyl)	892/01383	1

Before Removal

1. Make sure that the engine is safe to work on. If the engine has been running, let it cool before you start the service work.
2. Get access to the filter.
 - 2.1. On some machines the filter is located on the engine. Other machines have remotely located filters. There may be more than one filter. Refer to the relevant service point information for details.
3. Thoroughly clean the outside of the filter housing and around the filter head.
4. On machines with a fuel shut-off valve, set the valve to isolate the fuel supply.
5. Loosen the drain tap and allow the water / fuel to drain into a suitable container.

Figure 18.

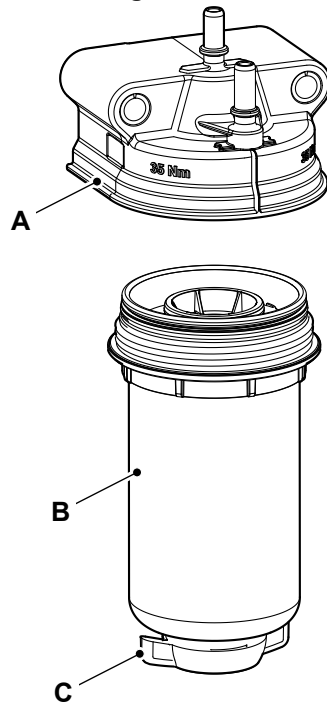


A Fuel filter element

B Drain tap

Remove

Figure 19.



A Filter head
C Drain tap

B Filter element

1. Use the applicable service tool to unscrew the filter element from the filter head (anticlockwise).
[Special Tool: Fuel Filter Removal Tool \(4 cyl\) \(Qty.: 1\)](#)
[Special Tool: Spanner - HP Fuel Filter \(Qty.: 1\)](#)

Install

1. Lubricate the element seals with clean fuel and install a new filter element.
 - 1.1. Make sure that the filter flange touches the filter head.
 - 1.2. Use the applicable service tool to tighten to the correct torque value.
 Torque: 35N·m
[Special Tool: Fuel Filter Removal Tool \(4 cyl\) \(Qty.: 1\)](#)
[Special Tool: Spanner - HP Fuel Filter \(Qty.: 1\)](#)
2. Open the fuel shut-off valve (if applicable).
3. Bleed the fuel system.

Cooling System

General

Check (Leaks)

Before you start the engine, inspect the system for leaks:

1. Make the machine safe.
2. Get access to the cooling pack.
3. Check the cooling system for leaks.
4. If necessary, contact your JCB dealer.

Coolant

Check (Condition)

Refer to: [Coolant \(Page 78\)](#).

Check (Level)

1. Make the machine safe.
[Refer to: Maintenance Positions \(Page 41\)](#).
2. Let the engine cool.
3. Get access to the radiator filler cap and expansion bottle.
[Refer to: Service Points \(Page 42\)](#).

CAUTION! 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.

4. Check the level of coolant in the radiator and in the expansion bottle. If necessary, top-up the system:
 - 4.1. Carefully remove the filler cap.
 - 4.2. If necessary top-up the coolant to the neck of the expansion tube.
 - 4.3. If necessary top-up the coolant in the expansion bottle so that it is half full.
 - 4.4. Install the filler cap, make sure that it is tight.

Cooling Pack

Clean

1. Make the machine safe.
[Refer to: Maintenance Positions \(Page 41\)](#).
2. Let the engine cool.
3. Get access to the cooling pack.
[Refer to: Access Apertures \(Page 43\)](#).
4. If necessary, use a soft bristle brush or compressed air to remove all debris from the cooling pack.

Check (Condition)

1. Make the machine safe.

[Refer to: Maintenance Positions \(Page 41\).](#)

2. Let the engine cool.
3. Get access to the cooling pack.
[Refer to: Access Apertures \(Page 43\).](#)
4. Check the condition of the hoses, radiator and fan for:
 - 4.1. Condition.
 - 4.2. Damage.
 - 4.3. Security.
5. Replace the system hoses/radiator if necessary.

Electrical System

Fuses

Replace

For details of fuse locations and ratings, please consult the machine manufacturers Operators Manual.

Relays

Replace

For information about the locations and types of relays fitted, please consult the machine manufacturers Operators Manual.

Fault-Finding

General

Introduction

Also refer to DEF (Diesel Exhaust Fluid) level warnings and emission system faults. [Refer to: Engine \(Page 87\)](#).

Also refer to the manufacturers operators manual.

The fault finding tables are each dedicated to a particular fault category. The tables are designed to identify possible causes of faults by performing checks on the engine. Having identified a cause of a fault, a possible remedy is given.

Due to the time and effort involved in removing, dismantling, assembling and replacing an engine, it is recommended that fault finding procedures are carried out until a fault can be identified with a good degree of certainty.

There are many reasons why an engine may malfunction. Time and effort will be saved by following basic troubleshooting steps:

- Do not make assumptions
- If possible, talk to the operator for a description of the fault. Also, check if any recent maintenance or repair has been completed on the engine.
- Start simple: for instance, many starting and running faults may be attributed to low fuel or low DEF level. Make sure you check the fuel and DEF specifications and levels before proceeding. [Refer to: Engine \(Page 87\)](#).
- Systematically work through each of the possible causes.
- Confirm your diagnosis before dismantling and assembling.
- Follow the recommended repair procedures in this manual.

Fault Codes

The engine electronic control systems record some system faults which can be accessed using the correct equipment. Contact your JCB engine dealer who will have the correct equipment.

Reduced Torque Mode

If an engine or emissions system fault is detected, the ECU may put the engine into a reduced torque mode which will restrict the power output. [Refer to: Engine \(Page 87\)](#).

Limp Home Mode

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

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.

Fault Finding Tables

Table 13.

A Charts
Engine - Will Not Start or Difficult to Start (No Exhaust Smoke) Refer to Table 17.
Engine - Will Not Start or Difficult to Start (Exhaust Smoke) Refer to Table 18.
Engine - Will Not Crank or Cranks Slowly Refer to Table 19.
Engine - Starts then Stops Refer to Table 20.
Engine - Poor Running Refer to Table 21.
Engine - Poor Running at Idle Refer to Table 22.
Engine - Noise Excessive Refer to Table 23.
Engine - Compression Knocks Refer to Table 24.
Engine - Reduced Power Output Refer to Table 25.
Engine - Will Not Reach Maximum RPM Refer to Table 26.
Engine - RPM (Revolutions Per Minute) Surges Refer to Table 27.
Engine - Vibration Excessive Refer to Table 28.
Engine - Exhaust Smoke Excessive (Black Smoke) Refer to Table 29.
Engine - Exhaust Smoke Excessive (White/Blue Smoke) Refer to Table 30.
Engine - Will Not Shut Off Refer to Table 31.

Table 14.

B Charts
Fuel - Consumption Excessive Refer to Table 32.
Fuel/Oil - Leaking from Exhaust Manifold Refer to Table 33.

Table 15.

C Charts
Lubricating Oil - Consumption Excessive Refer to Table 34.
Lubricating Oil - Contaminated Refer to Table 35.
Lubricating Oil - Pressure Low Refer to Table 36.
Lubricating Oil - Pressure High Refer to Table 37.

Table 16.

D Charts
Coolant - Loss Refer to Table 38.
Coolant - Over Temperature Refer to Table 39.
Coolant - Under Temperature Refer to Table 40.
Coolant - Contaminated Refer to Table 41.

WARNING! Fine jets of fluid at high pressure can penetrate the skin. Keep face and hands well clear of pressurised fluid and wear protective glasses. If fluid penetrates your skin, get medical help immediately.

A Charts-Engine

Table 17. Engine - Will Not Start or Difficult to Start (No Exhaust Smoke)

Cause	Remedy
Refer to: Starting the Engine (Page 18).	
No fuel in supply tank.	Check the level in the fuel tank, use sight gauge or dipstick. Replenish as required.
Starter switch or starter electrical system failure.	Check the operation of the starter switch. Check the correct electrical wires for open or short circuits.
Improper starting procedure.	Verify proper starting procedure. Refer to: Starting the Engine (Page 18).
Fuel Filter blocked with water or other contamination.	Drain fuel/water separator or replace fuel filter.

Cause	Remedy
Defective fuel lift pump (fuel supply inadequate).	Check that the lift pump operates and delivers fuel to the high pressure fuel pump. Check the correct electrical wires for open or short circuits.
Fuel is aerated.	Check the fuel system for loose connections and possible air ingress points. Rectify and bleed the fuel system. Check the primary fuel filter does not have a continuous air bleed.
Check fuel inlet restriction.	Maximum inlet restriction to fuel lift pump must not exceed 0.133bar (1.9psi). Check for kinked or trapped fuel lines. Check for blockage at fuel tank pick-up
Air intake or exhaust system blocked.	Visually check the air intake and exhaust system for blockage or obstruction - remove as required. Check the air filter elements for signs of blocking - replace as required.
Fuel drain return line blocked, not connected properly.	Verify that the fuel return line is not obstructed and connected to the top of the fuel tank.
One or more fuel injector worn or malfunctioning.	Check the electronic fault codes. Check the electrical connections at the injectors (specialist task - contact your JCB dealer).
ECU (Electronic Control Unit) or electrical sensor fault.	Check the electronic fault codes. Check the electrical connections at the ECU and sensors.
Worn or malfunctioning high pressure fuel pump.	Check the electronic fault codes Do all the necessary fault finding checks before removal of the high pressure fuel pump.
Injectors Contaminated	Check the injectors. Use the Servicemaster test procedure in Servicemaster tools actuator test. Test and replace as required (specialist task - contact your JCB dealer).

Table 18. Engine-Will Not Start or Difficult to Start (Exhaust Smoke)

Cause	Remedy
Check fuel in tank	Refer to: Fuel (Page 73).
Starting procedure incorrect.	Verify proper starting procedure. Refer to: Starting the Engine (Page 18).
Air intake system blocked or restricted.	Visually check the air intake for blockage or obstruction - remove as required. Check the air filter elements for signs of blocking - replace as required.
Fuel is aerated.	Check the fuel system for loose connections and possible air ingress points. Rectify and bleed the fuel system.
Fuel lift pump not operating correctly (fuel supply inadequate).	Check that the lift pump operates and delivers fuel to the high pressure fuel pump. Check the correct electrical wires for open or short circuits.
Fuel is contaminated or incorrect grade diesel fuel used.	Stop the engine. Replace the fuel filters. Operate the engine with a temporary supply of the correct grade of clean fuel. Refer to: Fuel (Page 73). Monitor the engine performance. Dirty fuel will cause damage to the high pressure fuel pump and injectors. Drain tank.
Fuel filter(s) blocked, fuel supply restricted.	Check/replace the fuel filter(s). Check fuel lines for restriction.
Fuel drain return line blocked, not connected properly.	Verify that the fuel return line is not obstructed and connected to the top of the fuel tank.
Check fuel inlet restriction.	Maximum inlet restriction to fuel lift pump must not exceed 0.133bar (1.9psi).

Cause	Remedy
One or more fuel injector worn or malfunctioning.	Check the electronic fault codes. Check the electrical connections at the injectors (specialist task - contact your JCB dealer).
Inlet and exhaust valve clearances set incorrectly.	Set the valve clearances to the recommended clearances.
Engine compression low in one or more cylinders.	Check the engine compression.
Cranking speed too slow.	Refer to Table 19. for possible low cranking speed faults.
ECU or electrical sensor fault.	Check the electronic fault codes. Check the electrical connections at the ECU and sensors.
Worn or malfunctioning high pressure fuel pump.	Check the electronic fault codes. Contact your JCB Engine Dealer.

Table 19. Engine-Will Not Crank or Cranks Slowly

Cause ⁽¹⁾	Remedy
Starting electrical circuit connections loose or corroded.	Clean and tighten connections.
Battery charge low.	Check battery voltage, charge the battery or replace as required. Make sure that the alternator is functioning correctly and charging the battery.
No electrical connection to starter solenoid.	Check voltage to solenoid.
Crankshaft rotation restricted.	Use special tool 892/01147 (crankshaft turning tool) to manual turn the engine and check for any severe rotational resistance.
Solenoid or starter motor fault.	Replace starter motor.
Starter motor operating but not cranking.	Remove the starter motor and check for broken teeth on the ring gear or broken starter motor spring.

(1) See "Starting the engine" section.

Table 20. Engine-Starts then Stops

Cause	Remedy
No fuel in supply tank.	Check the level in the fuel tank, use sight gauge or dipstick. Replenish as required.
Engine starting under load.	Check for added loading from malfunctioning accessories or driven units, brakes dragging and other changes in vehicle loading. Disengage the hydraulic controls.
Air intake or exhaust system blocked.	Visually check the air intake and exhaust system for blockage or obstruction - remove as required. Check the air filter elements for signs of blocking - replace as required.
Fuel is aerated.	Check the fuel system for loose connections and possible air ingress points. Rectify and bleed the fuel system.
Check fuel inlet restriction.	Maximum inlet restriction to fuel lift pump must not exceed 0.133bar (1.9psi). Check for kinked or trapped fuel lines. Check for blockage at fuel tank pick-up
Fuel lift pump not operating correctly (fuel supply inadequate).	Check that the lift pump is operating and delivering fuel to the injection pump.
Fuel is waxing due to extremely cold weather.	Verify by inspecting the fuel filter. Clean the system and use acclimatised fuel. Refer to: Fuel (Page 73) .

Cause	Remedy
Fuel is contaminated or incorrect grade diesel fuel used.	Stop the engine. Replace the fuel filters. Operate the engine with a temporary supply of the correct grade of clean fuel. Refer to: Fuel (Page 73) . Dirty fuel will cause damage to the high pressure fuel pump and injectors.
Fuel filter(s) blocked, fuel supply restricted.	Check/replace the fuel filter(s). Check fuel lines for restriction.
Fuel drain return line blocked, not connected properly.	Verify that the fuel return line is not obstructed and connected to the top of the fuel tank.
ECU or Electrical sensor fault.	Check the electronic fault codes.

Table 21. Engine-Poor Running

Cause	Remedy
Condition only occurs at idle	Refer to Table 22. for possible poor running at idle faults.
Engine is cold, coolant temperature sensor fault.	Check the electrical connection at the coolant sensor. Check the correct electrical wires for open or short circuits. Check the electronic fault codes. If engine will not reach operating temperature,
Fuel injection lines leaking.	Replace defective high pressure fuel lines. Do not repair defective fuel lines. If there is a fuel leak stop the engine and contact your JCB Engine Dealer.
Fuel is aerated.	Check the fuel system for loose connections and possible air ingress points. Rectify and bleed the fuel system.
Fuel lift pump not operating correctly (fuel supply inadequate).	Check that the lift pump operates and delivers fuel to the high pressure fuel pump. Check the correct electrical wires for open or short circuits.
Fuel filter(s) blocked, fuel supply restricted.	Check/replace the fuel filter(s). Check fuel lines for restriction.
Fuel is contaminated or incorrect grade diesel fuel used.	Stop the engine. Replace the fuel filters. Operate the engine with a temporary supply of the correct grade of clean fuel. Refer to: Fuel (Page 73) . Monitor the engine performance. Dirty fuel will cause damage to the high pressure fuel pump and injectors.
Inlet and exhaust valve clearances set incorrectly.	Set the valve clearances to the recommended clearances.
Engine compression low in one or more cylinders.	Check the engine compression.
ECU or electrical sensor fault.	Check the electronic fault codes. Check the electrical connections at the ECU and sensors.
Worn or malfunctioning high pressure fuel pump.	Check the electronic fault codes. Contact your JCB Engine Dealer.
Camshaft or tappets damaged.	Contact your JCB Engine Dealer.

Table 22. Engine-Poor Running at Idle

Cause	Remedy
Coolant temperature sensor fault.	Check the electrical connection at the coolant sensor. Check the correct electrical wires for open or short circuits. Check the electronic fault codes. Test the coolant sensor. Refer to Test Procedures, Section 6. If engine will not reach operating temperature, Refer to Table 40.
Engine mounts over-tightened, damaged or loose.	Verify condition of mounts. Refer to the machine's service manual for correct adjustment procedure.

Cause	Remedy
Fuel injection lines leaking.	Replace defective high pressure fuel lines. Do not repair defective fuel lines. If there is a fuel leak stop the engine and contact your JCB Engine Dealer.
Fuel is aerated.	Check the low pressure fuel system for loose connections and possible air ingress points. Rectify and bleed the fuel system.
Fuel lift pump not operating correctly (fuel supply inadequate).	Check that the lift pump operates and delivers fuel to the high pressure fuel pump. Check the correct electrical wires for open or short circuits.
Fuel filter(s) blocked, fuel supply restricted.	Check/replace the fuel filter(s). Check fuel lines for restriction.
Fuel is contaminated or incorrect grade diesel fuel used.	Stop the engine. Replace the fuel filters. Operate the engine with a temporary supply of the correct grade of clean fuel. Refer to: Fuel (Page 73) . Dirty fuel will cause damage to the high pressure fuel pump and injectors.
Inlet and exhaust valve clearances set incorrectly.	Set the valve clearances to the recommended clearances.
Engine compression low in one or more cylinders.	Check the engine compression.
One or more fuel injector worn or malfunctioning.	Check the electronic fault codes. Check the electrical connections at the injectors (specialist task - contact your JCB dealer).
ECU or electrical sensor fault.	Check the electronic fault codes. Check the electrical connections at the ECU and sensors.
Worn or malfunctioning high pressure fuel pump.	Check the electronic fault codes. Contact your JCB Engine Dealer.

Table 23. Engine-Noise Excessive

Cause	Remedy
Drive belt squeal, insufficient tension or abnormally high loading.	Check the tensioner and inspect the drive belt for loading, deterioration, Make sure water pump, tensioner pulley, fan alternator turn freely. Check for paint/oil or other material on pulleys. Check the tension of accessory drive belts.
Coolant temperature sensor fault.	Check the electrical connection at the coolant sensor. Check the correct electrical wires for open or short circuits. Check the electronic fault codes . If engine will not reach operating temperature, Refer to Table 40.
Intake air or exhaust leaks.	Refer to Table 29. and Refer to Table 30.
ECU or electrical sensor fault.	Check the electronic fault codes. Check the electrical connections at the ECU and sensors.
Fuel is contaminated or incorrect grade diesel fuel used.	Stop the engine. Replace the fuel filters. Operate the engine with a temporary supply of the correct grade of clean fuel. Refer to: Fuel (Page 73) . for recommended diesel fuels. Monitor the engine performance. Dirty fuel will cause damage to the high pressure fuel pump and injectors.
Inlet and exhaust valve clearances set incorrectly.	Set the valve clearances to the recommended clearances. Make sure the push rods are not bent or the rocker levers are not severely worn.
Turbocharger noise.	Contact your JCB Engine Dealer.
Inlet and exhaust valve springs broken.	Contact your JCB Engine Dealer.
Worn crank/connecting rod bearings (knocking under load).	Contact your JCB Engine Dealer.

Cause	Remedy
Excessive camshaft bearing wear.	Contact your JCB Engine Dealer.
Worn or damaged pistons and/or piston rings.	Contact your JCB Engine Dealer.
One or more fuel injector worn or malfunctioning.	Check the electronic fault codes. Check the electrical connections at the injectors (specialist task - contact your JCB dealer).
Gear train noise.	Contact your JCB Engine Dealer.
Loss of Pilot injection on one or more cylinders.	Use service master to disable pilot injections to identify audibly if they are still present.

Table 24. Engine-Compression Knocks

Cause	Remedy
Fuel is aerated.	Check the low pressure fuel system for loose connections and possible air ingress points. Rectify and bleed the fuel system.
Fuel is contaminated or incorrect grade diesel fuel used.	Stop the engine. Replace the fuel filters. Operate the engine with a temporary supply of the correct grade of clean fuel. Refer to: Fuel (Page 73) . Monitor the engine performance. Dirty fuel will cause damage to the high pressure fuel pump and injectors.
ECU or electrical sensor fault.	Check the electronic fault codes. Check the electrical connections at the ECU and sensors.
Inlet and exhaust valve springs broken.	Contact your JCB Engine Dealer.
One or more fuel injector worn or malfunctioning.	Check the electronic fault codes. Check the electrical connections at the injectors (specialist task - contact your JCB dealer).
Coolant operating temperature incorrect.	Refer to Table 39. and Refer to Table 40.

Table 25. Engine-Reduced Power Output

Cause	Remedy
Refer to: Engine (Page 87) .	
Low DEF in supply tank	Check the level in the DEF tank. Replenish as required.
No fuel in supply tank.	Check the level in the fuel tank, use sight gauge or dipstick. Replenish as required.
Oil level incorrect.	Check oil level. Refer to: Check (Level) (Page 45) .
Engine overload.	Check for added loading from malfunctioning accessories or driven units, brakes dragging and other changes in vehicle loading. Disengage the hydraulic controls.
Throttle position sensor (TPS) system defective.	Check the throttle assembly. Check the electronic fault codes.
Fuel is contaminated or incorrect grade diesel fuel used.	Stop the engine. Replace the fuel filters. Operate the engine with a temporary supply of the correct grade of clean fuel. Refer to: Fuel (Page 73) . Monitor the engine performance. Dirty fuel will cause damage to the high pressure fuel pump and injectors.
Turbocharger boost control pipe leaking or damaged, or wastegate diaphragm ruptured.	Inspect and tighten fittings, repair pipes. Contact your JCB Engine Dealer.
Fuel injection lines leaking.	Inspect and correct as required leaks in the high pressure lines, fittings injector sealing washers, or delivery valves.
Fuel filter(s) blocked, fuel supply restricted.	Check/replace the fuel filter(s). Check fuel lines for restriction. Check for kinked or trapped fuel lines. Check for blockage at fuel tank pick-up

Cause	Remedy
Fuel is aerated.	Check the fuel system for loose connections and possible air ingress points. Rectify and bleed the fuel system.
Fuel lift pump not operating correctly (fuel supply inadequate).	Check that the lift pump operates and delivers fuel to the high pressure fuel pump. Check the correct electrical wires for open or short circuits.
Air intake or exhaust system blocked.	Visually check the air intake and exhaust system for blockage or obstruction - remove as required. Check the air filter elements for signs of blocking - replace as required.
One or more fuel injector worn or malfunctioning.	Check the electronic fault codes. Check the electrical connections at the injectors (specialist task - contact your JCB dealer).
Exhaust leak at the manifold or turbocharger (if applicable).	Check/correct leaks in the manifold or turbocharger gaskets. Look for a cracked manifold.
Extra injector sealing washer installed under injector.	Remove extra injector sealing washer (specialist task - contact your JCB dealer).
Inlet and exhaust valve clearances set incorrectly.	Set the valve clearances to the recommended clearances.
Worn or malfunctioning high pressure fuel pump.	Check the electronic fault codes. Contact your JCB Engine Dealer.
Engine compression low in one or more cylinders.	Contact your JCB Engine Dealer.
Engine in reduced torque or limp home mode	Investigate the fault using Service master.
ECU or electrical engine fault	Check the electronic fault codes.

Table 26. Engine-Will Not Reach Maximum RPM

Cause	Remedy
Refer to: Engine (Page 87).	
Tachometer faulty.	Verify engine speed with hand tachometer. Correct as required.
Engine overloaded.	Verify high idle speed without load. Investigate operation to be sure correct gear is being used.
Throttle position sensor (TPS) system defective.	Check the throttle assembly. Check the electronic fault codes.
Fuel is aerated.	Check the low pressure fuel system for loose connections and possible air ingress points. Rectify and bleed the fuel system.
Fuel lift pump not operating correctly (fuel supply inadequate).	Check that the lift pump operates and delivers fuel to the high pressure fuel pump. Check the correct electrical wires for open or short circuits.
Fuel is contaminated or incorrect grade diesel fuel used.	Stop the engine. Replace the fuel filters. Operate the engine with a temporary supply of the correct grade of clean fuel. Refer to: Fuel (Page 73) . Monitor the engine performance. WARNING: Dirty fuel will cause damage to the high pressure fuel pump and injectors.
Fuel filter(s) blocked, fuel supply restricted.	Check/replace the fuel filter(s). Check fuel lines for restriction. Check for kinked or trapped fuel lines. Check for blockage at fuel tank pick-up
Turbocharger wastegate actuator diaphragm ruptured.	Repair or replace turbocharger.

Cause	Remedy
One or more fuel injector worn or malfunctioning.	Check the electronic fault codes. Check the electrical connections at the injectors (specialist task - contact your JCB dealer).
Worn or malfunctioning high pressure fuel pump.	Check the electronic fault codes. Contact your JCB Engine Dealer.

Table 27. Engine-RPM Surges

Cause	Remedy
Fuel level low.	Check/fill fuel tank.
Throttle position sensor (TPS) system defective.	Check the throttle assembly. Check the electronic fault codes.
Fuel injection lines leaking.	Replace defective high pressure fuel lines. Do not repair defective fuel lines. If there is a fuel leak stop the engine and contact your JCB Engine Dealer.
Fuel tank cap vent/breather blocked.	Inspect and rectify as required - replace cap if necessary.
Fuel is aerated.	Check the low pressure fuel system for loose connections and possible air ingress points. Rectify and bleed the fuel system.
ECU or electrical sensor fault.	Check the electronic fault codes. Check the electrical connections at the ECU and sensors.
One or more fuel injector worn or malfunctioning.	Check the electronic fault codes. Check the electrical connections at the injectors (specialist task - contact your JCB dealer).
Worn or malfunctioning high pressure fuel pump.	Check the electronic fault codes Contact your JCB Engine Dealer.

Table 28. Engine-Vibration Excessive

Cause	Remedy
Engine not running smoothly/misfiring.	Refer to Table 22.
Oil level over-full.	Check oil level, refer to Engine Oil, Section 3.
Fan damaged or accessories faulty.	Check/replace the vibrating component. Refer to the machine's service manual for correct installation and torque figures.
Fan hub faulty.	Inspect/replace the fan hub. Refer to the machine's service manual for correct installation and torque figures.
Engine mounts loose or broken.	Check/replace engine mounts. Refer to the machine's service manual for correct installation and torque figures.
Inlet and exhaust valve clearances set incorrectly.	Set the valve clearances to the recommended clearances.
Engine compression low in one or more cylinders.	Contact your JCB Engine Dealer.
Alternator bearing worn or damaged.	Check/replace the alternator.
Flywheel housing misaligned.	Contact your JCB Engine Dealer.
ECU or electrical sensor fault.	Check the electronic fault codes. Check the electrical connections at the ECU and sensors.
Drive line components worn or unbalanced.	Check and inspect drive line components such as propshafts. Refer to the machine's service manual for correct installation and torque figures.

Table 29. Engine-Exhaust Smoke Excessive (Black Smoke)

Cause	Remedy
Engine being lugged down.	Use appropriate gear for task.
Air intake or exhaust system blocked.	Visually check the air intake and exhaust system for blockage or obstruction - remove as required. Check the air filter elements for signs of blocking - replace as required.
Air leak between the turbocharger and the intake manifold (Turbocharged machines only).	Check/correct leaks in the air crossover tube, hoses, or manifold cover.
Intercooler faulty.	Check for blocked cooler matrix.
Exhaust leak at the Manifold or Turbocharger (Turbocharged machines only).	Check/correct leaks in the manifold or turbocharger gaskets. Look for a cracked manifold.
Turbocharger wastegate faulty.	Repair or replace wastegate.
Turbocharger malfunction.	Replace Turbocharger.
ECU or electrical sensor fault.	Check the electronic fault codes. Check the electrical connections at the ECU and sensors.
One or more fuel injector worn or malfunctioning.	Check the electronic fault codes. Check the electrical connections at the injectors (specialist task - contact your JCB dealer).
Engine compression low in one or more cylinders. Smokes under load at all speeds, but mainly low to mid speed range.	Contact your JCB Engine Dealer.

Table 30. Engine-Exhaust Smoke Excessive (White/Blue Smoke)

Cause	Remedy
Improper starting procedure.	Verify proper starting procedure. Refer to: Starting the Engine (Page 18) .
Fuel is contaminated or incorrect grade diesel fuel used.	Stop the engine. Replace the fuel filters. Operate the engine with a temporary supply of the correct grade of clean fuel. Refer to: Fuel (Page 73) . Monitor the engine performance. Dirty fuel will cause damage to the high pressure fuel pump and injectors.
Oil level incorrect.	Check oil level. Refer to: Check (Level) (Page 45) .
Diesel or hydraulic oil in sump.	Check oil consistency. If oil contamination is suspected check equipment such as PTO pump for hydraulic oil leaks pass the seal into the engine. Drain, flush and fill with clean oil.
Coolant temperature too low (over-cooling) - light blue or white high speed/light load.	Refer to Table 40.
ECU or electrical sensor fault.	Check the electronic fault codes. Check the electrical connections at the ECU and sensors.
One or more engine injector worn or malfunctioning. - white/ blue smoke at operating temperature.	Check the electronic fault codes. Check the electrical connections at the injectors (specialist task - contact your JCB dealer).
Coolant leaking into combustion chamber.	Refer to Table 38.
Leaking valve stem seals - evident after long idle period and then acceleration.	Contact your JCB Engine Dealer.
One or more fuel injector worn or malfunctioning.	Check the electronic fault codes. Check the electrical connections at the injectors (specialist task - contact your JCB dealer).
Piston rings not sealing - evident with persistent blue smoke at all speeds/load.	Contact your JCB Engine Dealer.

Table 31. Engine-Will Not Shut Off

Cause	Remedy
Stop switch or stop switch electrical system failure.	Check the operation of the stop switch. Check the correct electrical wires for open or short circuits.

B Charts - Fuel

Table 32. Fuel-Consumption Excessive

Cause	Remedy
Additional load on engine.	Check/repair accessories and vehicle components. Refer to the equipment manufacturer's procedures.
Operator technique.	Review operation for correct gear shifts, deceleration and idling.
Fuel leaks.	Check for external leaks at the fuel tank, fuel lines, filters and lift pump. Do not repair defective fuel lines. If there is a fuel leak stop the engine and contact your JCB Engine Dealer.
Intake air or exhaust leaks.	Refer to Table 29. and Refer to Table 30.
Engine compression low in one or more cylinders.	Check the engine compression. Refer to Engine Compression Check, Section 6.
ECU or electrical sensor fault.	Check the electronic fault codes. Check the electrical connections at the ECU and sensors.
One or more engine injector worn or malfunctioning.	Check the electronic fault codes. Check the electrical connections at the injectors (specialist task - contact your JCB dealer).
Inlet and exhaust valve clearances set incorrectly.	Set the valve clearances to the recommended clearances.

Table 33. Fuel/Oil-Leaking from Exhaust Manifold

Cause	Remedy
Operating for extended periods under light or no load conditions.	Review operation for correct gear shifts, deceleration and idling.
Intake air or exhaust leaks.	Refer to Table 29. and Refer to Table 30.
Turbocharger lubricating oil drain line obstructed.	Check/clean line.
Exhaust leak at the Manifold or Turbocharger	Check/correct leaks in the manifold or turbocharger gaskets. Look for a cracked manifold.
Valve guide seals are leaking.	Contact your JCB Engine Dealer.
ECU or electrical sensor fault.	Check the electronic fault codes. Check the electrical connections at the ECU and sensors.
One or more engine injector worn or malfunctioning.	Check the electronic fault codes. Check the electrical connections at the injectors (specialist task - contact your JCB dealer).

C Charts - Lubricating Oil

Table 34. Lubricating Oil-Consumption Excessive

Cause	Remedy
Oil leaks.	Inspect the engine for visible signs of leaks. Pay particular attentions to seals, gaskets oil cooler and external connections.
Oil level over-full.	Check oil level. Refer to: Check (Level) (Page 45).

Cause	Remedy
Incorrect lubricating oil (specification of viscosity).	Make sure the correct lubricating oil is being used. Refer to: General (Page 72) . Check for reduced viscosity from dilution with fuel. Fuel dilution in lubricating oil can originate from a defective high pressure fuel pump driveshaft seal. Review/reduce the lubricating oil change intervals.
Crank case ventilation (CCV) system blocked).	Check the breather tube area for signs of lubricating oil loss. Check and if necessary replace the CCV filter.
Lubricating oil cooler leak.	Check for lubricating oil in the coolant.
Turbocharger leaking lubricating oil to the air intake or exhaust (if fitted).	Inspect the air crossover tube for evidence of lubricating oil transfer.
Valve guide seals are leaking.	Contact your JCB Engine Dealer.
Piston rings not sealing - lubricating oil being consumed by the engine (blue smoke from exhaust).	Contact your JCB Engine Dealer.
Worn cylinder bores - lubricating oil being consumed by the engine (blue smoke from exhaust).	Contact your JCB Engine Dealer.
Glazed cylinder bores.	Contact your JCB Engine Dealer.

Table 35. Lubricating Oil-Contaminated

Cause	Remedy
Coolant in the lubricating oil, internal engine component leaks.	Refer to Table 38.
Lubricating oil sludge excessive.	Change oil and filter. Refer to: Oil (Page 45) . Review oil and filter change period. If operating in arduous applications, change more frequently. Refer to: Maintenance Schedules (Page 39) . Make sure the correct lubricating oil is being used. Refer to: General (Page 72) .
Fuel in the lubricating oil, engine operating too cold.	Review the operation for excessive idling resulting in the engine running below normal temperature.
ECU or electrical sensor fault.	Check the electronic fault codes. Check the electrical connections at the ECU and sensors.
One or more engine injector worn or malfunctioning.	Check the electronic fault codes. Check the electrical connections at the injectors (specialist task - contact your JCB dealer). Have oil sample analysed. Repair engine as required.

Table 36. Lubricating Oil-Pressure Low

Cause	Remedy
Oil level incorrect.	Check oil level. Refer to: Check (Level) (Page 45) .
Incorrect lubricating oil (specification of viscosity).	Make sure the correct lubricating oil is being used. Refer to: General (Page 72) . Check for reduced viscosity from dilution with fuel. Fuel dilution in lubricating oil can originate from a defective high pressure fuel pump driveshaft seal. Review oil and filter change period. If operating in arduous applications, change more frequently. Refer to: Maintenance Schedules (Page 39) .
Pressure switch or gauge fault.	Verify the pressure switch is functioning correctly. Refer to Test Procedures, Section 6.
Lubricating oil filter blocked.	Change lubricating oil filter. Review oil and filter change period. If operating in arduous applications, change more frequently. Refer to: Oil (Page 45) .
Lubricating oil filter drain down valve not fitted (refer to System Description, Section 4).	Change lubricating oil filter. refer to Engine Oil and Filter, Section 3.

Cause	Remedy
Suction pump pressure relief valve stuck open.	Contact your JCB Engine Dealer.
Oil pump pressure relief valve stuck open.	Contact your JCB Engine Dealer.
Lubricating oil pump worn.	Contact your JCB Engine Dealer.

Table 37. Lubricating Oil-Pressure High

Cause	Remedy
Incorrect lubricating oil (specification of viscosity).	Make sure the correct lubricating oil is being used. Refer to: General (Page 72) . Review oil and filter change period. If operating in arduous applications, change more frequently. Refer to: Maintenance Schedules (Page 39) .
Pressure switch or gauge fault.	Verify the pressure switch is functioning correctly. Refer to Test Procedures, Section 6.
Engine running too cold.	Refer to Table 40.
Oil pump pressure relief valve stuck closed.	Contact your JCB Engine Dealer.

D Charts - Coolant

Table 38. Coolant-Loss

Cause	Remedy
Incorrect coolant level.	Check the level.
Coolant leaking from engine radiator or cab heater.	Visually inspect the radiator heater, hoses and connection to locate the leak. If oil is present in the coolant, check for a transmission or engine oil cooler leak
External engine coolant leak.	Visually inspect the engine and components for seal, gasket hose connection leaks. Make sure all hose clips are in good condition and torqued to the recommended figure.
Overheating or compression gases leaking, resulting in loss through the radiator overflow.	Refer to Table 39.
If equipped, transmission cooler leak.	Check for mixing of coolant and transmission fluid.
If the engine is coolant aftercooled, aftercooler leak.	Check/replace the aftercooler. Look for coolant in the intake manifold and in the oil.
Lubricating oil cooler leak.	Check/replace the oil cooler. Look for coolant in the oil.
Cylinder head gasket leak.	Contact your JCB Engine Dealer.
Cylinder head cracked or porous.	Contact your JCB Engine Dealer.
Cylinder block coolant passages leaking.	Contact your JCB Engine Dealer.

Table 39. Coolant-Over Temperature

Cause	Remedy
Incorrect coolant level (low).	Check the level. Refer to: Check (Level) (Page 54) . Ensure low level is not as a result of a coolant leak. Refer to Table 38.
External radiator matrix blocked with dirt or chaff.	Clean exterior or radiator matrix.
Air flow to the radiator inadequate or restricted.	Check/repair fan shroud, anti-recirculation sealing, shutters, fan sensors, fan speeds as required. Refer to the machine manufacturer's documentation for detailed information.
Coolant pump or fan drive belts loose.	Check/correct belt tension.
Radiator hose collapsed, restricted or leaking.	Check/replace hose.
Oil level over-full.	Check oil level. Refer to: Check (Level) (Page 45) .
Cooling system pressure cap incorrect or faulty.	Replace cap with the correct rating for the system.

Cause	Remedy
Over concentration of anti-freeze.	Remove part of the coolant from cooling system and replace with water. Refer to: Coolant (Page 78) .
Temperature sensor gauge faulty.	Check the electronic fault codes. Verify that the gauge and temperature sensor are accurate.
Thermostat faulty, incorrect or missing.	Check/replace the thermostat.
Air or combustion gases in the cooling system.	Make sure the fill rate is not exceeded and the correct vented thermostat is installed. If aeration continued, check for a compression leak through the head gasket.
Coolant pump faulty.	Check/replace the coolant pump.
Vent line from engine and/or radiator blocked or incorrectly routed (sudden overheating).	Check routing and operation of vent line.
Leak between the top tank and the auxiliary tank (sudden overheating).	Check for coolant leakage between radiator auxiliary tank and radiator top tank.
Cooling passages in radiator, cylinder head, head gasket or block blocked.	Flush the system and fill with clean coolant.
ECU or electrical sensor fault.	Check the electronic fault codes. Check the electrical connections at the ECU and sensors.
One or more engine injector worn or malfunctioning.	Check the electronic fault codes. Check the electrical connections at the injectors (specialist task - contact your JCB dealer).

Table 40. Coolant-Under Temperature

Cause	Remedy
Air flow across the radiator excessive.	Check/repair fan shroud, anti-recirculation sealing, shutters, fan sensors, fan speeds as required. Refer to the machine manufacturer's documentation for detailed information.
Temperature sensor gauge faulty.	Check the electronic fault codes. Verify that the gauge and temperature sensor are accurate.
Thermostat faulty, (open - not sealing).	Check/replace the thermostat.
Coolant not flowing by temperature sensor	Check/clean coolant passages.

(1) A total coolant loss may result in the gauge showing low temperature initially. In which case, check the level, refer to *Engine Cooling System, Section 3*.

Table 41. Coolant-Contaminated

Cause	Remedy
Coolant rusty, operation without correct mixture of antifreeze and water.	Drain and flush the cooling system. Fill with correct mixture of antifreeze and water. Review the coolant change interval. Refer to the Operation and Maintenance Manual.
Engine oil cooler, or cooler housing allowing cross contamination of coolant with engine oil.	Remove the oil cooler assembly and check relevant sealing elements for damage.
Transmission lubricating oil cooler leaking (if applicable).	Check/replace lubricating oil cooler. Refer to equipment manufacturer's procedures.
Lubricating oil leaks from lubricating oil cooler, head gasket, head and cylinder block.	Refer to Table 38.

Technical Data

Performance Dimensions

General

Table 42.

Description	DPEngine
Engine Variants	Turbocharged with intercooler and exhaust after treatment system
Emission compliance	EU Stage V
Rated speed	2200 rpm
Weight (Dry)	(Dry weight-No cooling fan drive) 496kg
Number of cylinders	4
Nominal bore size	106mm
Stroke	135mm
Cylinder arrangement	In line
Combustion Cycle	4-stroke
Firing order	1-3-4-2
Displacement	4.765L
Compression ratio	16.7: 1
Engine Compression	Compression variance between each cylinder should be no greater than 3.5bar (50.7psi)
Direction of rotation (viewed from front {crankshaft pulley} end)	Clockwise
Valves	4 per cylinder
Valve clearances measured at the tappet end of the rockers (measured cold)	
- Inlet	0.15–0.21mm
- Exhaust	0.43–0.49mm
Lubricating oil pressure (Dependent on engine temperature and speed)	1.6–6.5bar (23.2–94.2psi)
Fuel filter type	Screw-on canister (with drain facility)
Oil pressure relief valve setting	6bar (87.0psi)
Oil pressure switch setting	0.6bar (8.7psi) falling
Oil pump ⁽¹⁾	Integral unit with relief valve
Combustion system	Common rail direct Injection
High pressure fuel pump	High pressure with electronically controlled fuel metering

(1) The oil pump is a non-serviceable part

Fluids, Lubricants and Capacities

General

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 CJ-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 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. Refer to Table 43.

When selecting the oil viscosity grade make sure the oil conforms with or exceeds the recommended specification. Refer to Table 44.

Table 43.

Oil Viscosity	Minimum Temperature °C (°F)	Maximum Temperature °C (°F)
SAE 5W30	-30°C (-22.0°F)	30°C (86.0°F)
SAE 5W40	-30°C (-22.0°F)	46°C (114.7°F)
SAE 10W30	-15°C (5.0°F)	46°C (114.7°F)

Recommended Oils

Table 44. With exhaust after treatment

Engine Oil	Specification
JCB 5W30 (Part 4001/3100)	CJ-4
JCB 5W40 (Part 4001/3400)	CJ-4
JCB 10W30 (Part 4001/3000)	CJ-4
JCB 10W30 (Part 4001/3700)	CK-4
JCB 5W40 (Part 4001/3800)	CK-4

Engine Oil Capacity

Choose the grade of oil to suit the temperature range as detailed. Refer to Table 43.

The engine oil capacity, including filter and clean sump is 11.5L MIN and 14L MAX mark on the dipstick. Refer to Table 45.

Always check the oil is filled to the maximum mark on the dipstick.

Table 45.

Item	Capacity L	
	Minimum	Maximum
Engine	11.5L	14L
Engine - remote oil filter		21L

DEF System

When cleaning the DEF (Diesel Exhaust Fluid) filter 'O' rings use only deionised/demineralised water or DEF

Fuel

This engine has been certified for Stage V emissions for use within the EU member states and for any countries that have the same Stage V certification requirement for emissions.

The Stage V engine has been certified on the standard market fuel for the EU (EN590 and non-road gas oil). For requirements of this standard market fuel: Refer to Table 46.

In addition to this the following alternative market fuels have also been certified to be Stage V compliant on this engine:

- EN15940 paraffinic diesel meeting the requirements. Refer to Table 47.
- EN16734 diesel with 10% FAME meeting the requirements. Refer to Table 48.
- EN16709 diesel with 20% FAME meeting the requirements. Refer to Table 49.

Fuels that do not meet the requirements stated in this document cannot be used in EU member states or any countries that have adopted the same Stage V certification requirements for emissions.

Please note that EU member states may have additional restrictions on fuel parameters stated in this document.

Table 46. Standard market fuel (EN590 diesel or non-road gas oil)

Property	Test method	Minimum	Maximum
Cetane number	EN ISO 5165	45	-
Density at 15°C (59.0°F)	EN ISO 12185	820kg/m ³	865kg/m ³
Polycyclic aromatic hydrocarbons	EN 12916	-	8% concentration by mass
Sulphur content	EN ISO 20846 EN ISO 20884	-	10mg/kg
Flash point	EN ISO 2719	55°C (130.9°F)	-
Carbon residue (on 10% distillation residue)	EN ISO 10370	-	0.3% concentration by mass
Ash content	EN ISO 6245	-	0.01% concentration by mass
Water content	EN ISO 12937	-	200mg/kg
Total contamination	EN ISO 12662	-	24mg/kg
Copper strip corrosion (3h at 50°C (121.9°F))	EN ISO 2160	Class 1 rating	Class 1 rating
FAME content	EN 14078	0% concentration by volume	7% concentration by volume
Oxidation stability			
< 2% concentration by volume FAME	EN ISO 12205	-	25g/m ³
> 2% concentration by volume FAME	EN 15751	20h	-
Lubricity, corrected wear scar diameter (wsd 1.4) at 60°C (139.9°F)	EN ISO 12156-1	-	460µm
Viscosity at 40°C (103.9°F)	EN ISO 3104	2mm ² /s	5mm ² /s
Distillation			
% concentration by volume recovered at 250°C (481.6°F)	EN ISO 3405		65% concentration by volume
% concentration by volume recovered at 350°C (661.5°F)	EN ISO 3924	85% concentration by volume	
95% concentration by volume recovered at			360°C (679.5°F)
Manganese content	EN 16576	-	2mg/l

Table 47. EN15940 paraffinic diesel

Property	Test method	Minimum	Maximum
Cetane number	EN ISO 15195	70	-
Density at 15°C (59.0°F)	EN ISO 12185	765kg/m ³	800kg/m ³
Total aromatic hydrocarbons	EN 12916	-	1.1% concentration by mass
Sulphur content	EN ISO 20846	-	5mg/kg
Flash point	EN ISO 2719	55°C (130.9°F)	-
Carbon residue (on 10% distillation residue)	EN ISO 10370	-	0.3% concentration by mass
Ash content	EN ISO 6245	-	0.01% concentration by mass
Water content	EN ISO 12937	-	200mg/kg
Total contamination	EN ISO 12662	-	24mg/kg
Copper strip corrosion (3h at 50°C (121.9°F))	EN ISO 2160	Class 1 rating	Class 1 rating
FAME content	EN 14078	0% concentration by volume	7% concentration by volume
Oxidation stability			
< 2% concentration by volume FAME	EN ISO 12205	-	25g/m ³
> 2% concentration by volume FAME	EN 15751	20h	-
Lubricity, corrected wear scar diameter (wsd 1.4) at 60°C (139.9°F)	EN ISO 12156-1	-	460µm
Viscosity at 40°C (103.9°F)	EN ISO 3104	2mm ² /s	4.5mm ² /s
Distillation			
% concentration by volume recovered at 250°C (481.6°F)	EN ISO 3405		65% concentration by volume
% concentration by volume recovered at 350°C (661.5°F)	EN ISO 3924	85% concentration by volume	
95% concentration by volume recovered at			360°C (679.5°F)
Manganese content	EN 16576	-	2mg/l

Table 48. EN16734 diesel with 10% FAME

Property	Test method	Minimum	Maximum
Cetane number	EN ISO 5165	51	-
Density at 15°C (59.0°F)	EN ISO 3675	820kg/m ³	845kg/m ³
Polycyclic aromatic hydrocarbons	EN 12916	-	8% concentration by mass
Sulphur content	EN ISO 20846 EN ISO 20884	-	10mg/kg
Flash point	EN ISO 2719	55°C (130.9°F)	-
Carbon residue (on 10% distillation residue)	EN ISO 10370	-	0.3% concentration by mass
Ash content	EN ISO 6245	-	0.01% concentration by mass
Water content	EN ISO 12937	-	200mg/kg
Total contamination	EN ISO 12662	-	24mg/kg
Copper strip corrosion (3h at 50°C (121.9°F))	EN ISO 2160	Class 1 rating	Class 1 rating
FAME content	EN 14078	0% concentration by volume	10% concentration by volume
Oxidation stability			
< 2% concentration by volume FAME	EN ISO 12205	-	25g/m ³
> 2% concentration by volume FAME	EN 15751	20h	-

Property	Test method	Minimum	Maximum
Lubricity, corrected wear scar diameter (wsd 1.4) at 60°C (139.9°F)	EN ISO 12156-1	-	460µm
Viscosity at 40°C (103.9°F)	EN ISO 3104	2mm ² /s	4.5mm ² /s
Distillation			
% concentration by volume recovered at 250°C (481.6°F)	EN ISO 3405		65% concentration by volume
% concentration by volume recovered at 350°C (661.5°F)	EN ISO 3924	85% concentration by volume	
95% concentration by volume recovered at			360°C (679.5°F)
Manganese content	EN 16576	-	2mg/l

Table 49. EN16709 diesel with 20% FAME

Property	Test method	Minimum	Maximum
Cetane number	EN ISO 5165	51	-
Density at 15°C (59.0°F)	EN ISO 12185	820kg/m ³	860kg/m ³
Polycyclic aromatic hydrocarbons	EN 12916	-	8% concentration by mass
Sulphur content	EN ISO 20846	-	10mg/kg
Flash point	EN ISO 2719	55°C (130.9°F)	-
Carbon residue (on 10% distillation residue)	EN ISO 10370	-	0.3% concentration by mass
Ash content	EN ISO 6245	-	0.01% concentration by mass
Water content	EN ISO 12937	-	260mg/kg
Total contamination	EN ISO 12662	-	24mg/kg
Copper strip corrosion (3h at 50°C (121.9°F))	EN ISO 2160	Class 1 rating	Class 1 rating
FAME content	EN 14078	14% concentration by volume	20% concentration by volume
Oxidation stability	EN 15751	20h	-
Lubricity, corrected wear scar diameter (wsd 1.4) at 60°C (139.9°F)	EN ISO 12156-1	-	460µm
Viscosity at 40°C (103.9°F)	EN ISO 3104	2mm ² /s	4.62mm ² /s
Distillation			
% concentration by volume recovered at 250°C (481.6°F)	EN ISO 3405		65% concentration by volume
% concentration by volume recovered at 350°C (661.5°F)	EN ISO 3924	85% concentration by volume	
95% concentration by volume recovered at			
Manganese content	EN 16576	-	2mg/l

Additives

Diesel fuels are blended by fuel companies and subjected to test to ensure fuel and aftertreatment systems are not impacted. The use of further additive products is unacceptable.

Unacceptable Fuels

Diesel with FAME content > 20%

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 manufacturers 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".

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.

Sulphur Content

▲ **Notice:** A combination of water and Sulphur will have a corrosive chemical effect on fuel injection equipment. Use of high Sulphur fuels will poison the Selective Catalytic Reduction (SCR) catalyst (if fitted) and must not be used. Ultra Low Sulphur Diesel (ULSD) should always be used. Ultra Low Sulphur Diesel (ULSD) has a Sulphur content of less than 10 ppm (US 15ppm).

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 (32.0°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 minimised.

Diesel Exhaust Fluid (DEF)

▲ **Notice:** No warranty liability whatsoever will be accepted for failure of the emissions control system where the failure is attributed to the quality and grade of the diesel exhaust fluid (DEF) used.

Notice: No warranty liability whatsoever will be accepted for failure of the emissions control system where the failure is attributed to contamination of the diesel exhaust fluid (DEF).

This engine has exhaust gas treatment using selective catalytic reduction technology. In SCR (Selective Catalytic Reduction) technology, a liquid called diesel exhaust fluid is injected into the exhaust gasses. DEF (Diesel Exhaust Fluid) is used within SCR systems on diesel engines to reduce harmful exhaust gas emissions known as NOx. When the DEF is injected into the exhaust stream it turns into ammonia and water, this ammonia

enters the catalyst and reacts with the NOx molecules to form nitrogen and water. Naturally occurring and harmless, they are then released into the atmosphere.

The DEF consumption depends on the duty cycle of the engine.

DEF is a highly purified, colourless liquid containing demineralized water 67.5% and Urea 32.5%. DEF is specified under ISO 22241 and is marketed under various names such as AdBlue®, ARLA 32 or AUS 32.

Make sure that genuine DEF is used. Do not dilute DEF or mix it with other substances, it may damage the catalyst.

The DEF tanks and pipes are heated if there is any danger of freezing, the freezing point of DEF at 32.5% is -11°C (12.2°F). The DEF storage tank on the machine will be heated from the engine cooling system automatically.

If a problem is detected within the DEF system for any problem including contamination, engine power will be reduced.

Storage

Always use polyethylene, polypropylene, stainless steel or plastic containers for storing DEF, as DEF can be corrosive to most metals (eg steel, copper, and aluminium). This applies to any funnels, jugs, pipes, pumps and other handling equipment

Avoid decanting wherever possible to prevent contamination from dirt or trace amounts of metals that can occur when metal containers are used. Even the use of apparently clean items such as jugs or funnels may introduce damaging contaminants if they have ever been used for other purposes.

Always ensure any caps on DEF storage containers are screwed tight to prevent evaporation and crystallisation.

DEF can be stored for up to 12 months in a sealed container, and must be kept between -6°C (21°F) and 25°C (77°F) in a shaded area out of direct sunlight and ultraviolet radiation.

Spillages

A small DEF spill can be diluted with water. It is best to mop up the spillage and avoid flushing it down a drain or waterway

In case of a large spill, try to prevent the spillage from entering drains or waterways. Contain the spill with sand, earth or your spill kit and dispose of it properly

The surface on which you spill DEF may become slippery. Make sure that you clean up the spill as quickly as possible to prevent slips and falls.

If a spill occurs on the machine, wash away with water as white crystals will form and these will eventually become corrosive to paintwork and, in turn, metal work

DEF should never be spilled onto electrical connectors as it will destroy terminals quickly. It can also travel easily by capillary action between the insulation and copper wires in harnesses.

Preventing Contamination of the DEF tank

In order to prevent damage to the SCR system, DEF used must be compliant to the ISO 22241-1 standard. ISO 22241-1 DEF is available from all JCB dealers

Every machine equipped with a JCB SCR system is fitted with a quality sensor in the DEF tank to help prevent problems caused by cross contamination with other fluids

DEF needs to be kept free from dirt and other particle contaminants at all times to prevent damage to the SCR system. There is a mesh strainer fitted in the JCB DEF filler.

DEF needs to be kept free from liquid contaminants such as diesel, oil, antifreeze, screenwash and other fluids at all times. Even one drop of diesel or oil can pollute 20L of DEF.

If diesel is poured into the DEF tank this can damage the after treatment system, do not start the engine, please contact your local JCB dealer immediately so they can correctly flush the system to avoid an expensive repair.

A range of special tools and fluid analysis services are available at your local JCB dealer to check DEF quality via simple hydrocarbon test paper strips, or a more comprehensive laboratory service. Digital and optical concentration measuring devices are also available.

If any cross contamination is detected JCB will not be liable for any further diagnosis or repairs to the SCR system.

Preventing Cross Contamination of Diesel Fuel and DEF

The opening for your DEF tank is narrower than the opening for a diesel tank, so you should not be able to put diesel in the wrong tank (as the nozzle does not fit)

The DEF cap on every JCB machine is blue and clearly marked with AdBlue®, DEF and the ISO (International Organization for Standardization) symbol in white lettering . There are warning decals next to the DEF filling point

The diesel cap is also clearly marked with lettering.

Every JCB DEF cap is lockable with a special key with a blue key fob, which can be given to a site supervisor or other person of responsibility.

There is a special magnet fitted in the DEF filler neck which will allow some DEF electric dispensing pumps to start if it has the matching ISO feature, as all forecourt dispensing systems have, thus preventing DEF being dispensed if nozzle is not in the DEF tank.

If contamination occurs do not start the engine. Please contact your local JCB dealer immediately so they can correctly flush the system to avoid an expensive repair.

Coolant

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

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.

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.

Table 50.

Concentration	Level of protection
50% (Standard)	Protects against damage down to -40°C (-40°F)
60% (Extreme Conditions Only)	Protects against damage down to -56°C (-69°F)

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

If you use any other brand of antifreeze:



- Make sure that the antifreeze complies with International Specification ASTM D6210.
- Always read and understand the manufacturer's instructions.
- Make sure that a corrosion inhibitor is included. Serious damage to the cooling system can occur if corrosion inhibitors are not used.
- Make sure that the antifreeze is ethylene glycol based and does not use Organic Acid Technology (OAT).
- Care should be taken to not mix coolant types. Mixing coolant will have a detrimental effect on the performance of the coolant.

Torque Values

General

This section details all the torque figures to be used on the JCB Ecomax Engine. Some of the torques must be used in conjunction with the recommended procedures contained in this manual, for instance if the torques need to be applied in a specific sequence. For convenience, the list below is arranged in alphabetical order to help you quickly locate the item.

Table 51.

Alternator Retaining Bolts Refer to Table 63.
DEF (Diesel Exhaust Fluid) filter Cover Refer to Table 65.
Delta Pressure Pipes to SCRoF (Selective Catalytic Reduction on Filter) Canister Refer to Table 67.
Exhaust Manifold Bolts Refer to Table 59.
Exhaust V-band Clamps
Fan Belt Tensioner Bolts Refer to Table 55.
Fuel Filter Retaining Strap Bolt Refer to Table 54.
Inlet Manifold Bolts Refer to Table 60.
Lifting Bracket Bolts Refer to Table 62.
Oil Cooler Drain Plug Refer to Table 52.
Oil Sump Plug and Retaining Bolts Refer to Table 53.
PTO (Power Take-Off) Pump Bolts Refer to Table 61.
Starter Motor Retaining Bolts Refer to Table 64.
Thermostat Housing Bolts Refer to Table 56.
Water Inlet Connector Bolts Refer to Table 57.
Water Temperature Sender/Switch Refer to Table 58.

Table 52. Oil Cooler Drain Plug

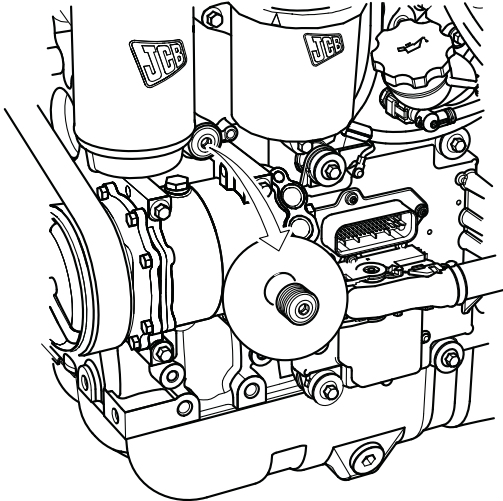
Item	Torque	Angle	Figure
	N·m		
Oil Cooler drain plug	35–40	-	

Table 53. Oil Sump Plug and Retaining Bolts

Item	Torque	Angle	Figure
	N·m		
A. Oil sump retaining bolts	22–26	-	
B. Oil sump plug	40–60	-	

Table 54. Fuel Filter Mounting Bolt

Item	Torque	Angle	Figure
	N·m		
Fuel filter bolt	45	-	

Table 55. Fan Belt Tensioner Bolts

Item	Torque	Angle	Figure
	N·m		
Fuel filter bolt	22–26	-	

Table 56. Thermostat Housing Bolts

Item	Torque	Angle	Figure
	N·m		
Thermostat housing retaining bolts	22–26	-	

Table 57. Water Inlet Connector Bolts

Item	Torque	Angle	Figure
	N·m		
Water inlet connector retaining bolts	22–26	-	

Table 58. Water Temperature Sender/Switch

Item	Torque	Angle	Figure
	N·m		
Water temperature sender/switch	18–26	-	

Table 59. Exhaust Manifold Bolts

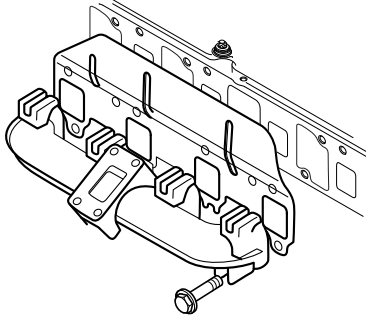
Item	Torque	Angle	Figure
	N·m		
Exhaust manifold retaining bolts (T3)			
- first stage	25	-	
- final stage angle torque	-	90°	

Table 60. Inlet Manifold Bolts

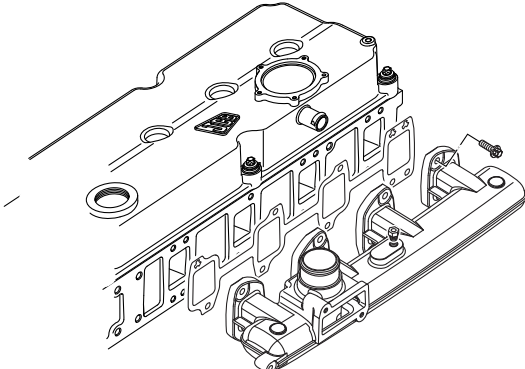
Item	Torque	Angle	Figure
	N·m		
Inlet manifold retaining bolts (T3)	43–47	-	

Table 61. Power Take Off (PTO) Pump Bolts

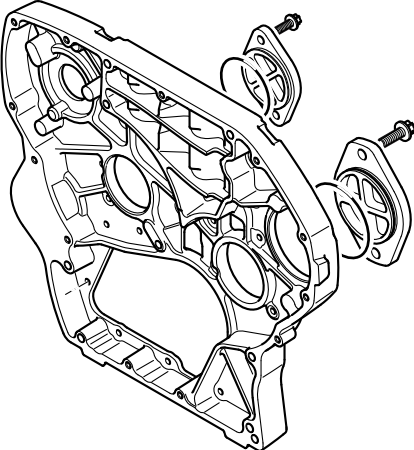
Item	Torque	Angle	Figure
	N·m		
PTO pump bolts			
- SAE `A' - M10 bolts	43–51	-	
- SAE `B' - M12 bolts	73–89	-	

Table 62. Lifting Bracket Bolts

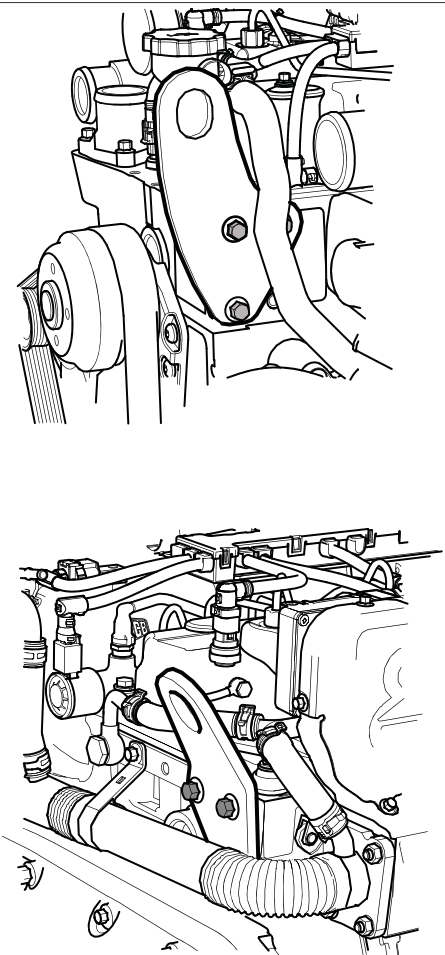
Item	Torque	Angle	Figure
	N·m		
Lifting bracket retaining bolts	43-51	-	

Table 63. Alternator Retaining Bolts

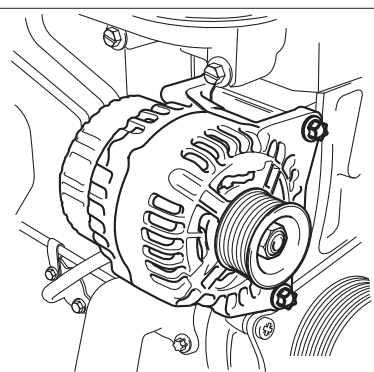
Item	Torque	Angle	Figure
	N·m		
Alternator retaining bolts	47	-	

Table 64. Starter Motor Retaining Bolts

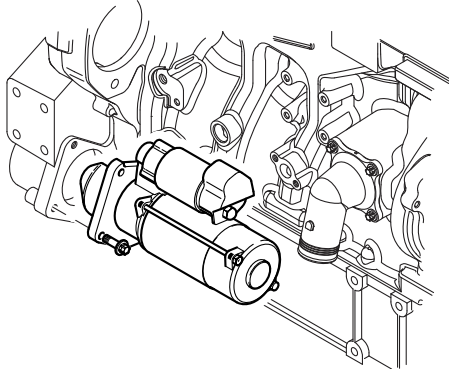
Item	Torque	Angle	Figure
	N·m		
Starter motor retaining bolts	43–51	-	

Table 65. DEF Filter Cover

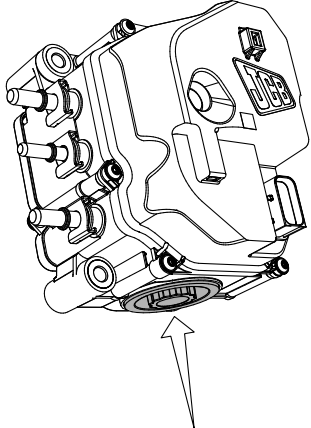
Item	Torque	Angle	Figure
	N·m		
DEF Filter cover	22.5 ± 2.5N·m	-	

Table 66. exhaust v band clamps

Item	Torque	Angle	Figure
	N·m		
Slipped 3", Fixed 3", Slipped 2.5"	14 ± 1N·m	-	
2.5" Fixed 3"	12 ± 1N·m	-	

Table 67. Delta Pressure Pipes to SCRoF Canister

Item	Torque	Angle	Figure
	N·m		
Delta Pressure Pipes to SCRoF Canister"	27 ± 3N·m	-	

Electrical System

General

Consult the machine manufacturers documentation.

Engine

Exhaust After Treatment (EAT)

Introduction

For the applicable regulations this engine has been designed in compliance with, the emissions control system is essential for meeting the requirements of exhaust emission content. The emissions control system is defined as any device, system or element of design which controls or reduces engine exhaust emissions.

Your engine is equipped with a fully automated after-treatment system. It has a sophisticated system of self-monitoring and fault detection to ensure it is both reliable and compliant to applicable emissions legislation. An operator warning system informs when the system is not functioning correctly or when intervention is required. Failure to respond to this warning system and rectify any detected fault will lead to the activation of a derate. This system will limit engine performance until the detected fault is rectified and may result in the machine being unable to conduct its mission.

Tampering with or modifying the engine may void the type approval and warranty. The on-board computer will log faults tampering conditions, inspection authorities will be able to read these logs with a scan tool.

The type-approval certificate is valid only when all of the following conditions are met:

- The engine and emissions control system are operated and maintained in accordance with the instructions of this manual.
- Prompt action is taken for the rectification of incorrect operation, maintenance or repair.
- No deliberate misuse or tampering of the engine or emission control system has occurred.

Diesel Particulate Matter

The SCR system combines elements of a DPF (Diesel Particulate Filter), to remove diesel particulate matter or soot and SCR (Selective Catalytic Reduction), to remove Nitrogen Oxides, in the same canister to control tailpipe emissions.

The aftertreatment system is capable of a self-cleaning 'Regeneration' routine in order to maintain its effectiveness and compliance with legislated limits. This is automatic and the machine can continue to be operated normally while this is happening. During regeneration the exhaust gas temperature is raised and the operator has the option to inhibit a regeneration if for example the machine is in a hazardous area.

If the regeneration is not able to complete automatically due to very light duty cycle operation, the operator will be informed by a series of lamps on the dashboard as explained below. If this occurs the operator has a choice to either operate the engine at a higher duty if possible or complete the regeneration cycle with a stationary regeneration.

The stationary regeneration is a procedure that will automatically run the exhaust system hot enough while the machine is stationary. The operator must acknowledge that the engine can run a stationary regeneration by initiating the procedure and cannot use the machine whilst the procedure is running. Refer to the machine operator manual stationary regeneration initiation procedure. A flashing DPF lamp indicates a stationary regeneration is running.

If the operator ignores the DPF warning lamp, and stationary regeneration is not initiated, the DPF will clog and gradually reduce engine performance. Replacement or specialist cleaning will be required.

The DPF escalation can be broken down into 6 levels:

Level 0: Normal operation. No DPF regeneration required. On successful completion of an active, manual or service regeneration engine returns to level 0 operation.

- No DPF lamp.
- Manual regeneration not available to the operator.
- Dealer regenerations can be performed but requires service unlock.

Level 1: DPF Regeneration Required. Engine will aim to regenerate automatically. For most operators an active regeneration is expected to complete with no change to operation.

- No DPF lamp. HEST (High Exhaust System Temperature) lamp used to show when regeneration is active and exhaust temperatures are high.
- Manual regeneration is available to the operator.
- Dealer regeneration is available via service tool without unlock.

Level 2: DPF Regeneration required. Regeneration is required, but has not been able to complete for a period of time/attempts/soot increase. Engine will continue to try to regenerate automatically. Engine may have a partial de-rate should the operator continue to inhibit a regeneration via dashboard switch or menu setting.

- An amber DPF lamp is used to indicate this to the operator to give them the opportunity to complete an active regeneration by working the machine in a more favourable condition, or to complete a stationary regeneration when convenient. Warning is shown to the operator (to indicate that a stand-down, or manual regeneration may be required should there be no change in duty cycle).
- Manual regeneration is available to the operator.
- Dealer regeneration is available via service tool without unlock.

Level 3: DPF Regeneration required urgently. Regeneration has not been able to complete and time, attempts, soot load etc. have reached a threshold where a stationary regeneration is now required. Engine de-rate is applied. Operator is still able to perform a stationary regeneration to rectify this condition.

- Warning to customer is escalated. An amber DPF lamp and MIL (Malfunction Indicator Lamp) lamps are illuminated.
- Automatic regeneration is disabled.
- Manual regeneration is available to the operator.

Level 4: DPF Regeneration not possible (due to safety). Soot load is excessively high through operator inaction or underlying engine condition which needs to be investigated. Dealer action is required to rectify issues and carry out dealer regeneration safely. Final engine de-rate applied.

- Further warning escalation to operator. Red DPF lamp, red stop lamp and engine idle.
- Automatic and manual regeneration disabled.

Level 4b: Soot load is too high to be safely regenerated. Filter needs to be removed and either reconditioned or replaced. Dealer action is required to replace DPF and reset learned values. Forced engine idle applied.

- Red DPF lamp, red stop lamp

Nitrous Oxide Emissions

If a NO_x (Nitrogen Oxide) emission fault is detected the engine will immediately enter a derate condition and the MIL is illuminated. Maximum engine speed is reduced by 40%. Maximum engine torque is reduced by 50%.

DEF Levels

The engine or SCR could be damaged by continued operation with no DEF (Diesel Exhaust Fluid). To protect itself the machine performance will be reduced. Refill the DEF tank to restore performance.

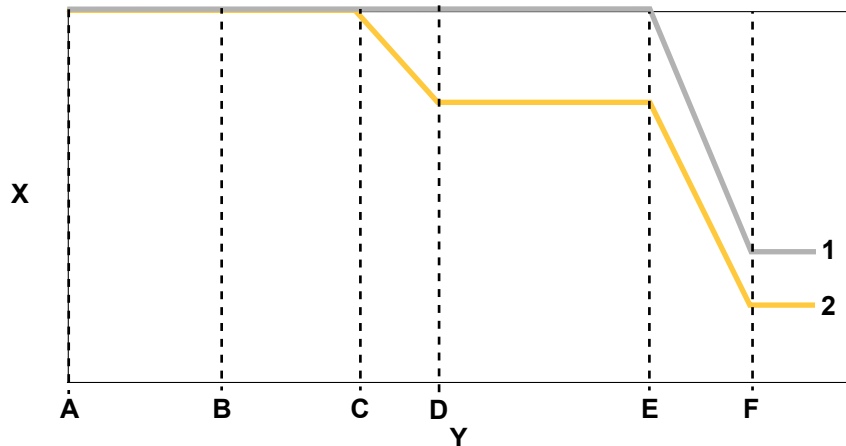
The engine will not shut down if you run out of DEF, however it will:

- Give the driver a warning when the remaining level falls low, which if continually ignored will progressively automatically reduce engine torque and reduce engine speed to tick over, preventing effective working activity.
- Restore power when the DEF tank is refilled.

DEF is required for type approval, operators attempting to operate the machine without DEF may be liable for civil and criminal prosecution in the European Union.

If there are no other engine or emission system faults, the information below explains when the engine power and speed de-ratings occur, according to DEF tank level.

Figure 20. DEF Level Warning Graph



- A** DEF level Low. Early warning to operator (Level 0) - Fill up this shift
- C** 0% DEF level indicated on level gauge. Machine starts to derate (reduced torque) - Fill up now
- E** Engine torque begins reduce further, engine maximum speed begins to reduce - Fill up now

- B** DEF level indicated critical low. Last warning to operator - Fill up now
- D** Engine torque will remain at the levels shown for a period (Level 1) - Fill up now

- F** Engine torque and engine maximum speed will remain at the levels shown (Level 2) - Fill up now

1 Engine speed
X Percentage

2 Engine torque
Y Time

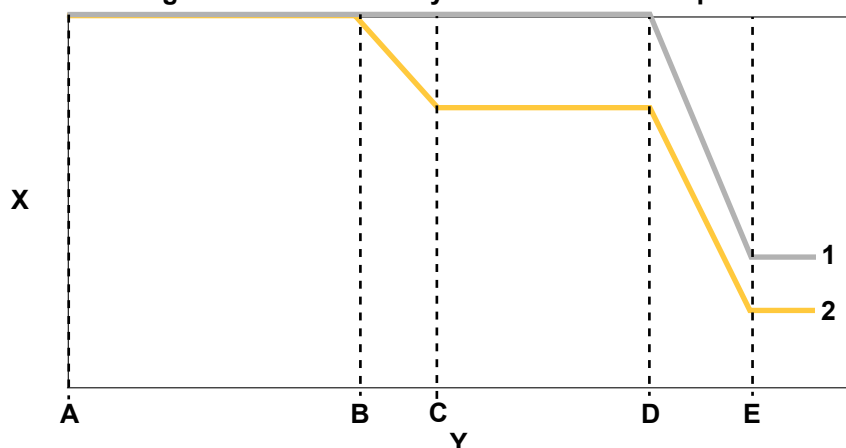
Emissions System - First Fault

The presence of emissions system related faults will result in (initially) warnings given and engine power reduction. If the warnings continue to be ignored, it will lead to a further reduction in engine speed and torque.

If the engine is shut down by the operator during these steps, unless the fault is repaired, the duration of the step will resume from the point at which it was left.

If the fault is still detected again when the engine is restarted, the engine will continue at reduced power.

Figure 21. Emissions System First Fault Graph



- A** Fault detected (Level 0)

- C** Engine torque will remain at the levels shown for a period (Level 1)

- B** Fault continues to be ignored, engine torque reduction begins, engine maximum speed is unaffected

- D** Fault continues to be ignored, engine torque begins reduce further, engine maximum speed begins to reduce

- E Engine torque and engine maximum speed will remain at the levels shown (Level 2)
 2 Engine torque
 Y Time
- 1 Engine speed
 X Percentage

Emissions Systems Faults - Additional Faults Within 40 Hours of The First Fault

If the emissions system detects a second fault within 40 engine hours of a previous fault occurring, the system will reduce power immediately to protect the engine. The system will return to normal operation when the fault(s) are repaired.

Table 68. Emissions system-Faults occurring in less than 40 hours

Parameter	Subsequent Fault Effects
Engine power output	Initial full power reduces to Level 2 over time.
Engine RPM (Revolutions Per Minute) limit	Reducing to Level 2 over time
Driver/operator action needed	If appropriate to the application, park the machine in a safe place. Contact your JCB engines dealer immediately

DEF DO's and DON'Ts

DO's

- Before engine start up, locate and identify both separate diesel and DEF tanks, they do not share the same tank. Do not allow cross contamination between diesel and DEF.
- Act on machine warnings that DEF is running low.
- Ensure that there is sufficient DEF in the machine at all times.
- Use only high quality DEF to ISO 22241-1 from a reputable source.
- Keep all DEF, tanks, tank necks, drums and dispensing equipment clean to prevent contamination.

DON'Ts

- Don't allow contamination of your DEF by dirt or fluid as it will damage the SCR system.
- Don't mix DEF with your diesel; it is not a fuel additive.
- Don't put DEF in your diesel tank – if you do, do not start the engine, call your JCB dealer immediately.
- Don't add chemicals to your DEF to prevent freezing.
- Don't dilute DEF with water or any other fluids or the machine may stop or be permanently damaged.
- When the engine is switched off, there is a small pump in the DEF system which purges the line from the supply module to the dosing injector. Don't remove the battery isolator for 80s so this operation can be completed and the system shut down correctly. Some machines may be fitted with a power hold relay to prevent this purge from being interrupted by operating the isolator.

Warranty Information

General

Table 69.

	Signature and stamp		Date
	Annual Insurance (Yes)		Hours

Figure 22. Installation Checklist

			/ /		h
<hr style="border-top: 1px dashed black;"/> <hr style="border-top: 1px dashed black;"/> <hr style="border-top: 1px dashed black;"/>					

Figure 23. 500h/6 Month

			/ /		h
<hr style="border-top: 1px dashed black;"/> <hr style="border-top: 1px dashed black;"/> <hr style="border-top: 1px dashed black;"/>					

Figure 24. 1000h/12 Month

			/ /		h
<hr style="border-top: 1px dashed black;"/> <hr style="border-top: 1px dashed black;"/> <hr style="border-top: 1px dashed black;"/>					

Figure 25. 1500h/18 Month


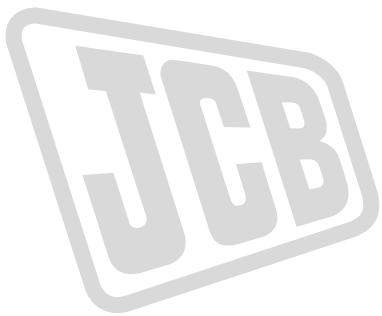



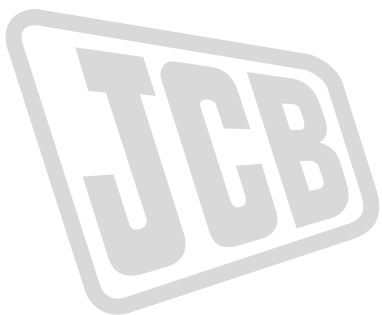


 	 1 / /  h

Figure 26. 2000h/24 Month

 	 1 / /  h




Figure 27. 2500h/30 Month


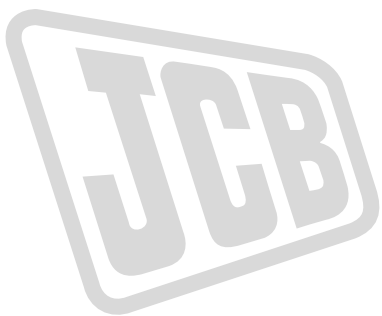



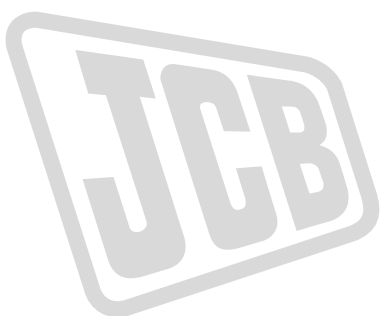


 	 1 / /  h

Figure 28. 3000h/36 Month

 	 1 / /  h




Figure 29. 3500h/42 Month


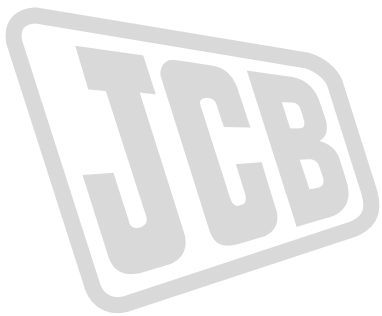



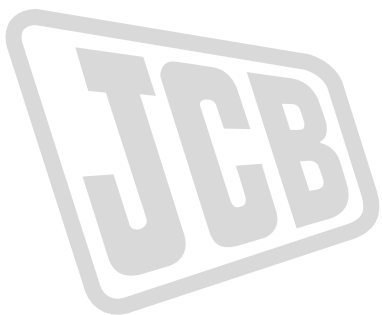


 	 1 / /	 h

Figure 30. 4000h/48 Month

 	 1 / /	 h


		

Figure 31. 4500h/54 Month


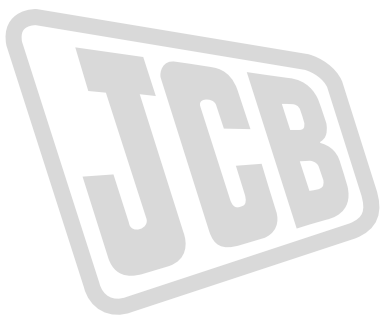



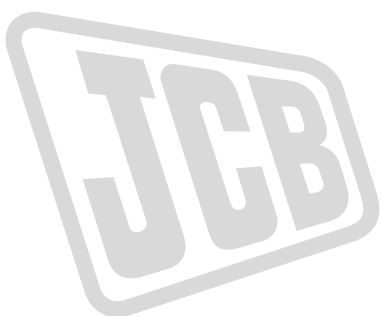


 	 1 / /	 h

Figure 32. 5000h/60Month

 	 1 / /	 h


		

Figure 33. 5500h/66 Month


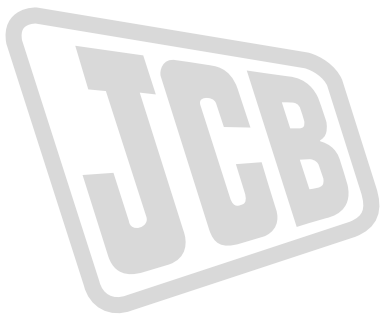



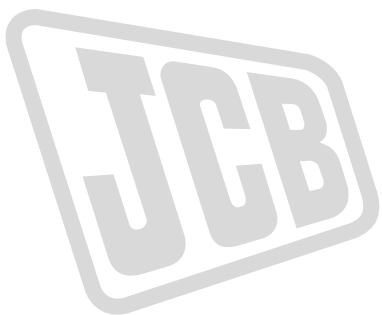


 	 1 / /		h

Figure 34. 6000h/72 Month

 	 1 / /		h


			

Figure 35. 6500h/78 Month


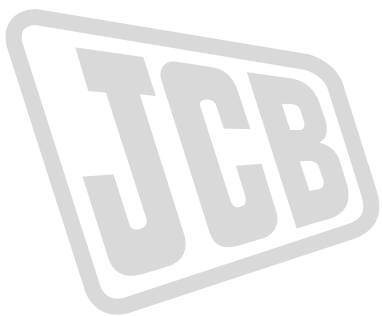



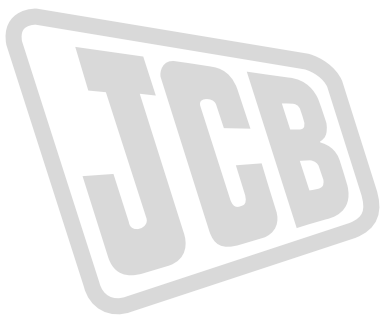


 	 1 / /		h

Figure 36. 7000h/84 Month

 	 1 / /		h


			

Figure 37. 7500h/90 Month


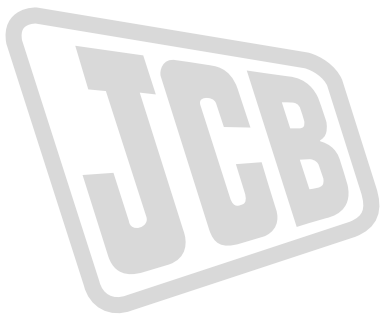


 	 1 / /  h

Figure 38. 8000h/96 Month


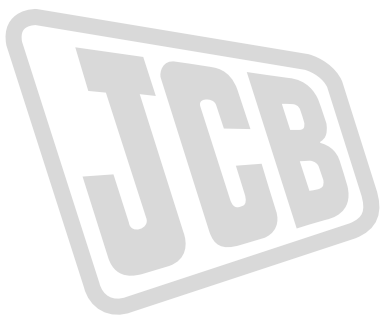



 	 1 / /  h
	

Figure 39. 8500h/102 Month


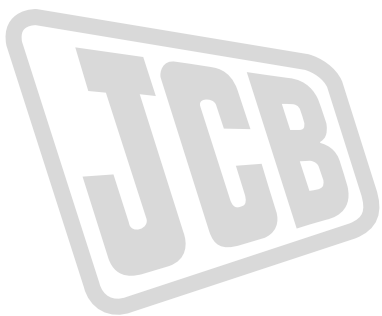


 	 1 / /  h

Figure 40. 9000h/108 Month


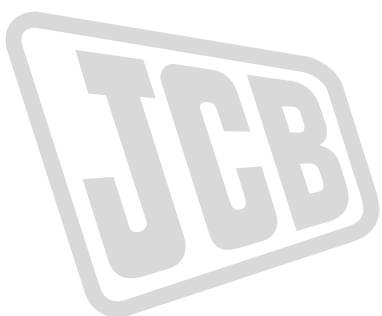



 	 1 / /  h
	

Figure 41. 9500h/114 Month


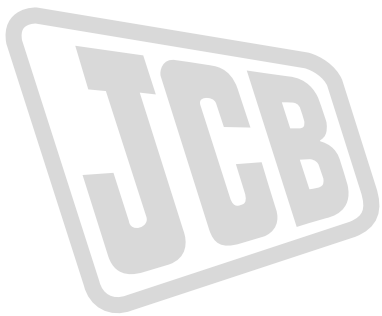


 	 1 / /  h

Figure 42. 10000h/120 Month






 	 1 / /  h
	

Figure 43. 10500h/126 Month






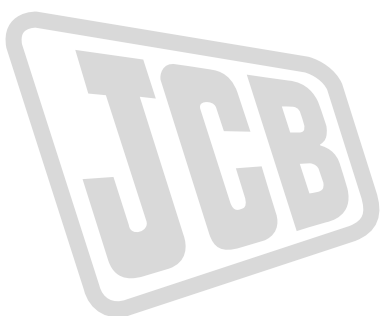



 	 1 / /  h

Figure 44. 11000h/132 Month

 	 1 / /  h
	

Service Record Sheet

Table 70.

	Date		Annual Insurance (Yes)
	Hours		Signature and stamp

Figure 45. Installation Checklist

			/ /		h

Figure 46. 500h/3 Month

			/ /		h

Figure 47. 1000h/6 Month

			/ /		h

Figure 48. 1500h/9 Month


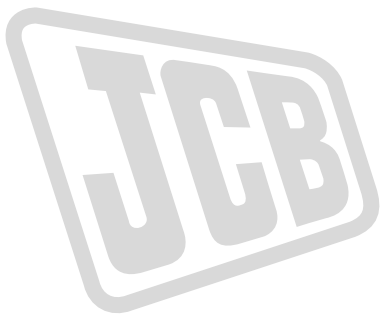



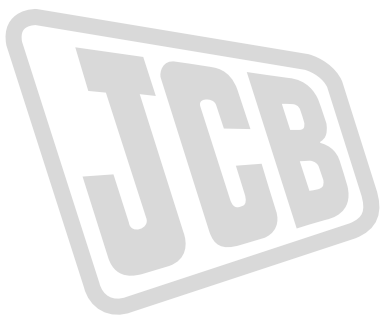


 	 1 / /		h

Figure 49. 2000h/12 Month

 	 1 / /		h




Figure 50. 2500h/15 Month


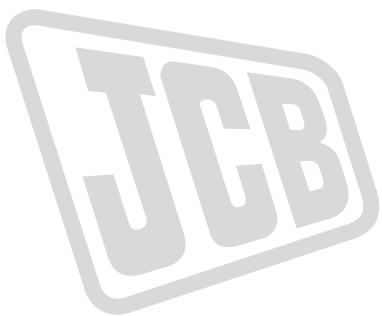


 	 1 / /		h

Figure 51. 3000h/18 Month


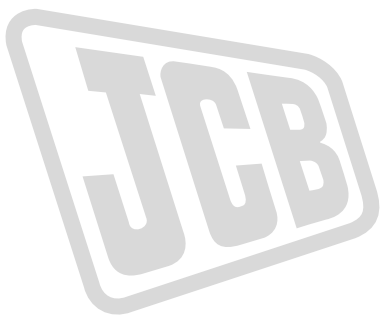


 	 1 / /		h

Figure 52. 3500h/21 Month


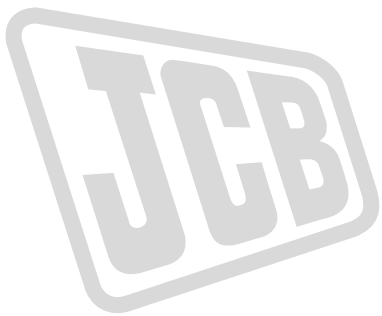



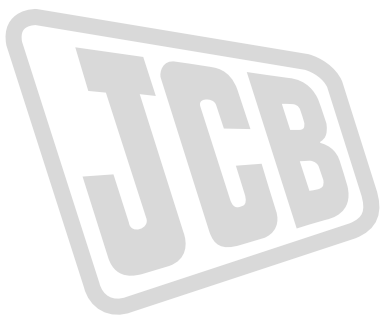


 	 1 / /		h

Figure 53. 4000h/24 Month

 	 1 / /		h




Figure 54. 4500h/27 Month


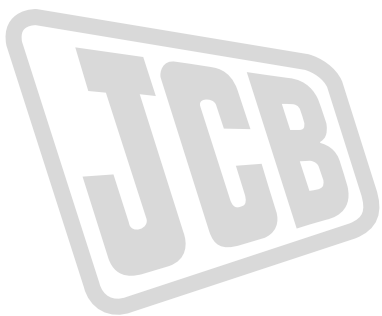


 	 1 / /		h

Figure 55. 5000h/30Month


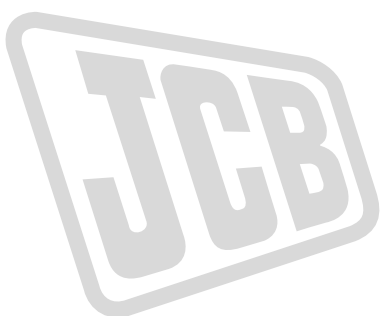


 	 1 / /		h

Figure 56. 5500h/33 Month


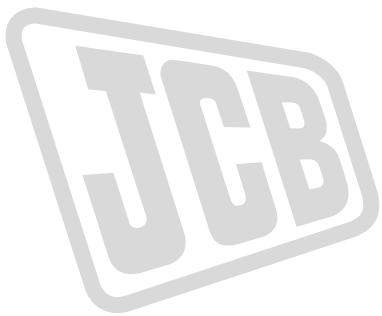



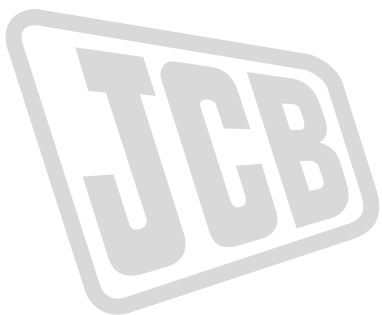


 	 1 / /		h

Figure 57. 6000h/36 Month

 	 1 / /		h




Figure 58. 6500h/39 Month


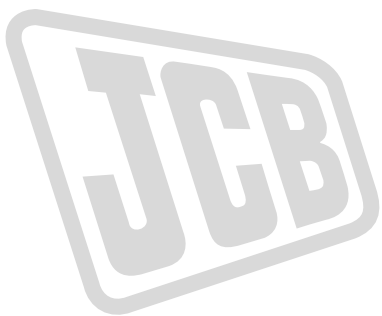


 	 1 / /		h

Figure 59. 7000h/42 Month


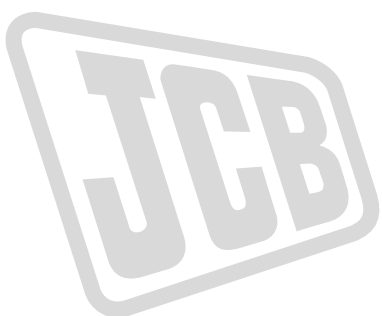


 	 1 / /		h

Figure 60. 7500h/45 Month


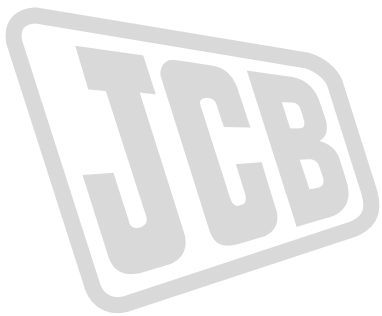



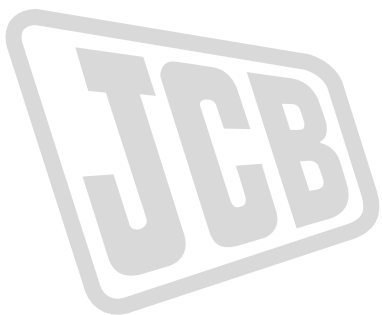


 	 1 / /		h

Figure 61. 8000h/48 Month

 	 1 / /		h




Figure 62. 8500h/51 Month


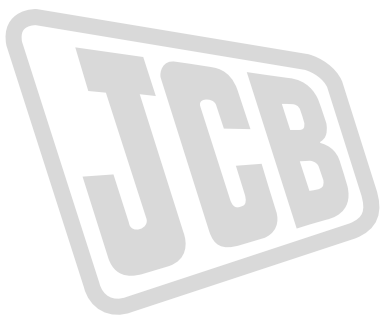


 	 1 / /		h

Figure 63. 9000h/54 Month


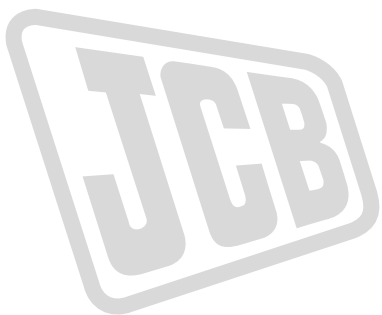


 	 1 / /		h

Figure 64. 9500h/57 Month


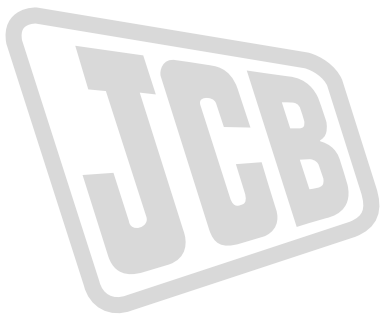


 	 1 / /  h

Figure 65. 10000h/60 Month


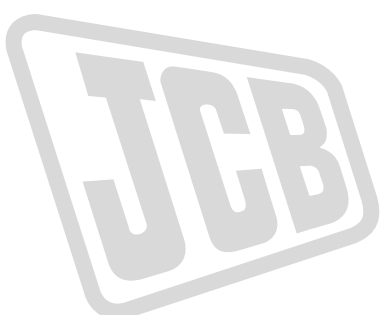



 	 1 / /  h
	

Figure 66. 10500h/63 Month


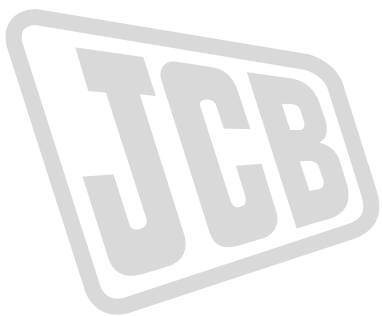



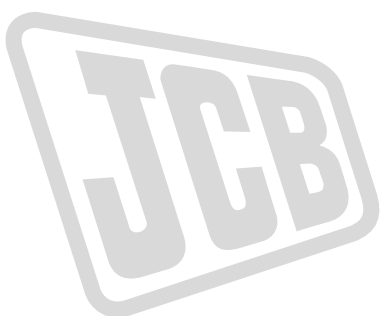


 	 1 / /  h

Figure 67. 11000h/66 Month

 	 1 / /  h