SERVICE MANUAL

BACKHOE LOADER
2DX

EN - 9813/8500 - ISSUE 2 - 09/2017

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.

Contents

00 - General

Health and Safety

Hot Components

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

Turning the Engine

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

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.*

WARNING! *To bleed the injectors you must turn the engine. When the engine is turning, there are parts rotating in the engine compartment.Before starting this job make sure that you have no loose clothing (cuffs, ties etc) which could get caught in rotating parts.When the engine is turning, keep clear of rotating parts.*

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

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

WARNING! *Hot oil and engine components can burn you. Make sure the engine is cool before doing this job.Used engine crankcase lubricants contain harmful contaminants. In laboratory tests it was shown that used engine oils can cause skin cancer.*

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

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

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.

Technical Data

Table 3.

Model	4R810NA BS-III
Type	Koel engine T4.1041
Net power	49.5 HP@2200 RPM (Revolutions Per Minute)
Peak torque at RPM	203 @1300 RPM
Rating standard	ISO (International Organization for Standardization) 3046
Low idle RPM	800-900 RPM
High idle RPM	M2 class governing
Alternator	12 V MICO, 65Amps

Operation

The Four Cylinder Cycle

This section describes the cycle sequence for the 4 cylinder engine.

With the crankshaft positioned as shown, the pistons in numbers 1 and 4 cylinders are at top dead centre and pistons in numbers 2 and 3 cylinders are at bottom dead centre.

It is important to note that number 1 cylinder is firing and about to start its Power stroke. Rotating the crankshaft a further full rotation would position the pistons as described but the engine would be at a different stage in its four stroke cycle, with number 1 cylinder about to start its Induction stroke.

Firing Order

A cylinder is said to be firing, when the fuel/air mixture ignites and the piston is about to start its power stroke.

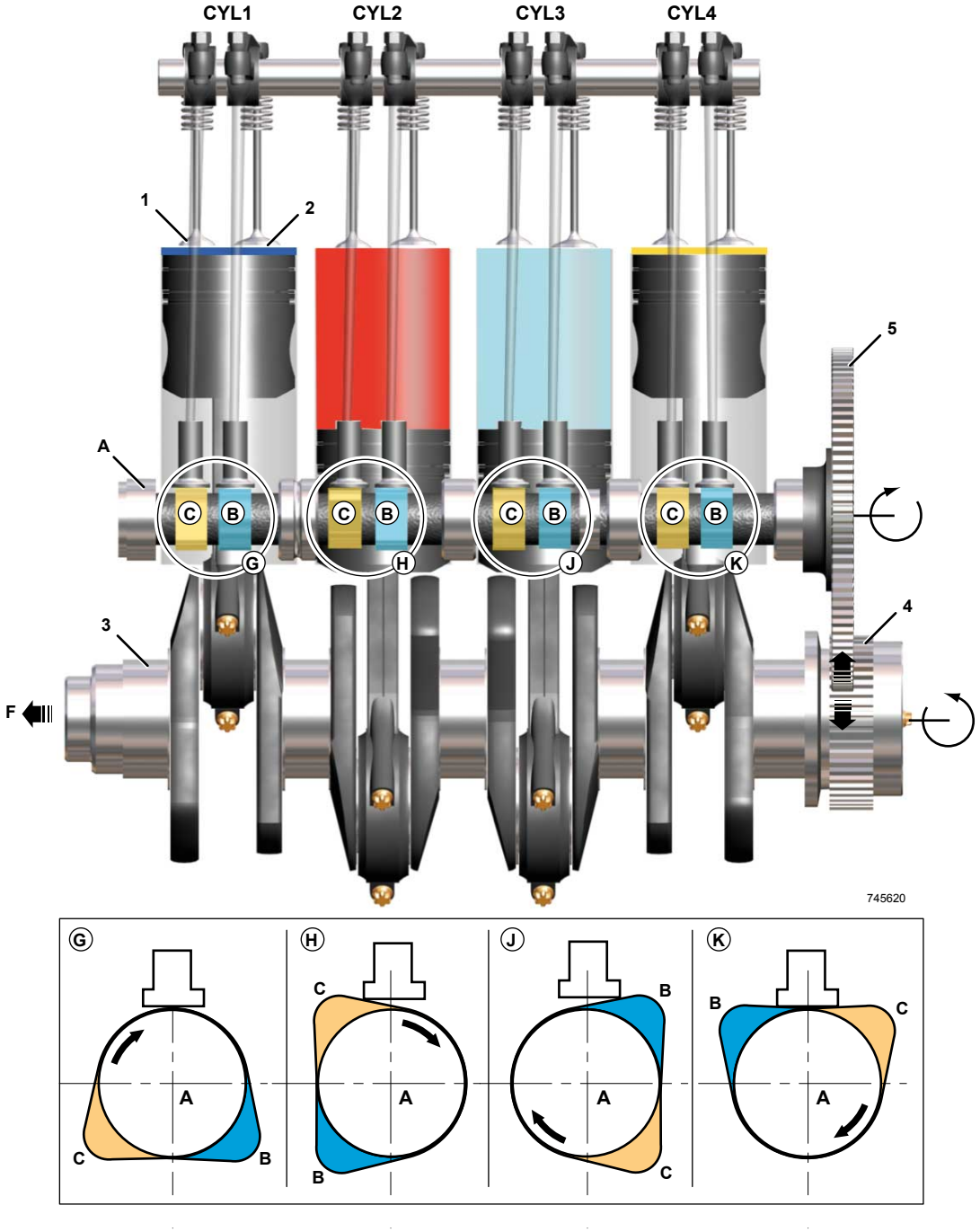
From the stages described, it can be seen that number 1 cylinder will be next to fire. Number 3 cylinder is starting its compression stroke and is next in the cycle, followed by cylinders 4 and 2. The firing order is therefore; 1, 3, 4, 2.

The stages in the four stroke cycle for each cylinder are as follows:

Table 4. The Four Stroke Cycle

Cylinder number	Piston operation	Valve operation
1	The piston is at the top of its Compression stroke and is about to start its Power stroke.	Inlet and exhaust valves closed
2	The piston is at the bottom of its Power stroke and is about to start its Exhaust stroke.	Inlet valves closed, exhaust valves about to open
3	The piston is at the bottom of its Induction stroke and is about to start its Compression stroke.	Exhaust valves closed, inlet valves about to close.
4	The piston is at the top of its Exhaust stroke and is about to start its Induction stroke.	Valve Operation Exhaust valves about to close, inlet valves about to open

Figure 90. Typical Four Cylinder Engine



CYL1 Cylinder number 1
CYL2 Cylinder number 2
CYL3 Cylinder number 3
CYL4 Cylinder number 4
A Camshaft
B Camshaft lobe - Inlet valve operation
C Camshaft lobe - Exhaust valve operation
F Front of engine
1 Exhaust valves
2 Inlet valves
3 Crankshaft
4 Crankshaft gear
5 Camshaft drive gear

Four Stroke Cycle

Induction

As the piston travels down the cylinder, it draws filtered air at atmospheric pressure and ambient temperature through an air filter and inlet valves into the cylinder.

Compression

When the piston reaches the bottom of its stroke, the inlet valves close. The piston then starts to rise up the cylinder compressing the air trapped in the cylinder. This causes the temperature and pressure of the air to rise. Fuel is injected into the cylinder when the piston is near to TDC (Top Dead Centre).

Power

The piston continues to rise after the start of fuel injection, causing a further increase in pressure and temperature.

The temperature rises to a point at which the fuel/air mixture ignites. A cylinder is said to be firing when the fuel/air mixture ignites.

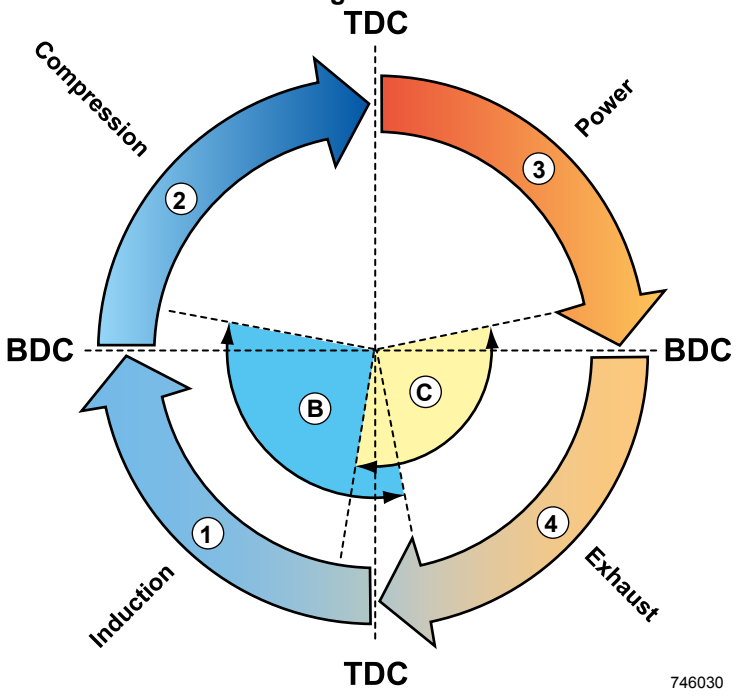
This combustion causes a very rapid rise in both temperature and pressure. The high pressure generated propels the piston downwards turning the crankshaft and producing energy.

Exhaust

Once the piston has reached the bottom of its travel, the exhaust valves open and momentum stored in the flywheel forces the piston up the cylinder expelling the exhaust gases.

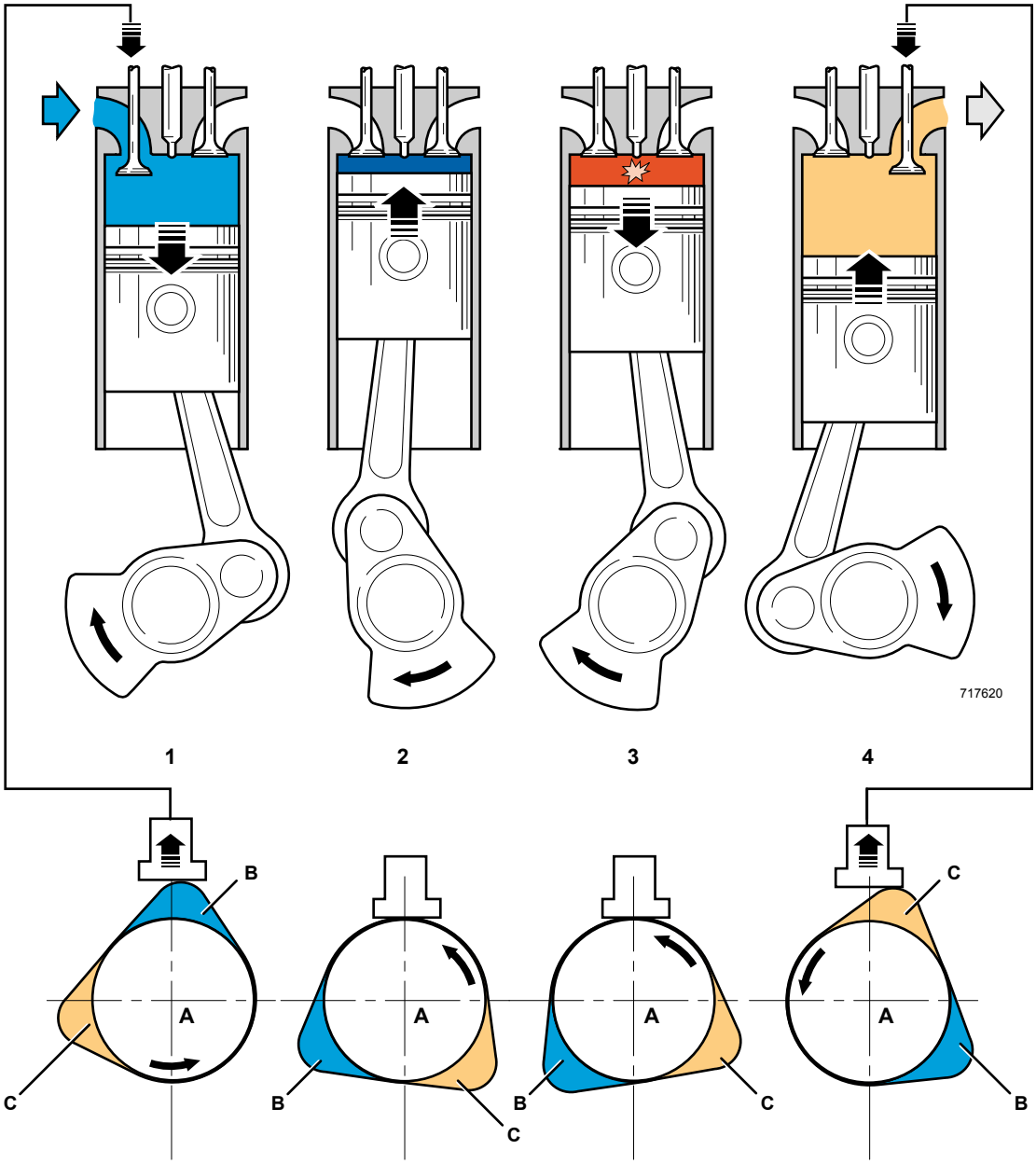
In a running engine, these four phases are continuously repeated. Each stroke is half a revolution of the crankshaft, thus, in one cycle of a four stroke engine, the crankshaft revolves twice.

Figure 91.



1 Induction stroke
2 Compression stroke
3 Power stroke
4 Exhaust stroke
A Camshaft
B Camshaft lobe - Inlet valve operation
C Camshaft lobe - Exhaust valve operation
BDC Bottom dead centre
TDC TDC

Figure 92.



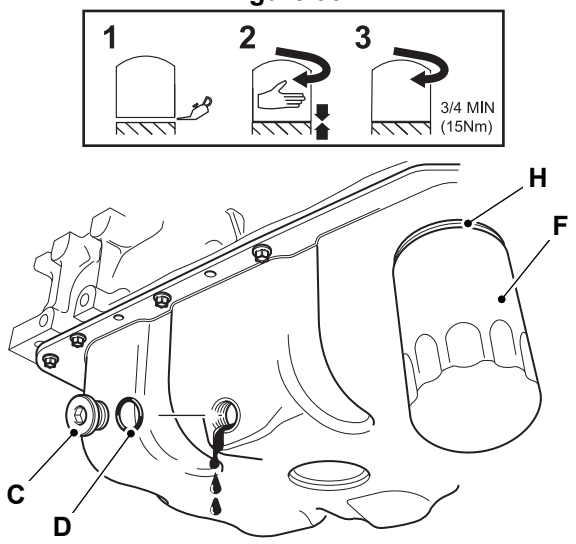
1 Induction stroke
2 Compression stroke
3 Power stroke
4 Exhaust stroke
A Camshaft
B Camshaft lobe - Inlet valve operation
C Camshaft lobe - Exhaust valve operation

Drain and Fill

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

1. Make the machine safe. Refer to (PIL 01-03).
2. Open the engine compartment cover. Refer to (PIL 06-06).

Figure 93.



C Drain plug
D O-ring
H Seal
F Filter

3. Place a suitable container below the sump drain plug.
4. Remove the sump drain plug and its O-ring.
5. Drain the engine oil.
6. Clean and install the drain plug with a new O-ring.
7. Tighten the drain plug to the correct torque value.
   Torque: 40–60N·m
8. Remove the filter canister, if necessary use a chain wrench.
9. Clean the seal face of the filter head.
10. Smear the seal on the new filter canister with clean engine oil.
11. Screw the filter canister on until it just contacts the filter head.
12. Turn the filter canister at least a further 3/4 of a turn.
13. Through the top filler point, fill the engine with the recommended oil to the MAX mark on the dipstick.
14. Clean the spilt oil.
15. Install the filler cap and make sure that it is secure.
16. Operate the engine, until the oil pressure low warning light has extinguished.
17. Check for oil leakage.
18. When the oil has cooled, check the oil level again and if necessary top up with clean engine oil.

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 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.

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

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

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 connected. If connectors are open install the correct caps or seal with water proof tape.
3. Cover the alternator with a plastic bag to prevent water ingress.
4. Seal the engine air intake, exhaust and breather system.
5. Make sure that the oil filler caps and dipstick are correctly installed.
6. Use a low pressure water jet and brush to soak off 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 electronic control unit (ECU), alternator or fuel injectors. DO NOT place the jet nozzle closer than the specified distance to any part of the engine.

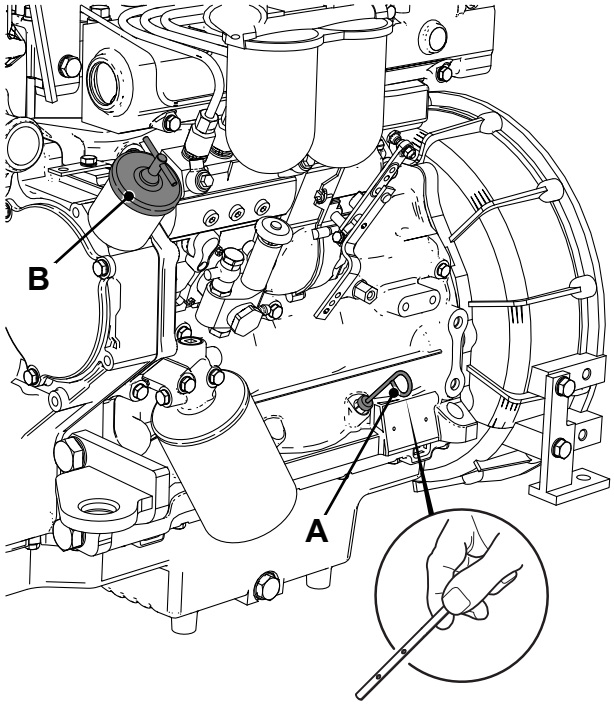
   Distance: 600mm
9. When the pressure washing is complete, move the machine away from the wash area, or alternatively, clean away the material washed from the machine.
10. Before working on specific areas of the engine, use a compressed air jet to dry off any moisture. When the area is dry, use a soft clean brush to remove any sand or grit particles that remain.
11. When removing components, be aware of any dirt or debris that may be exposed. Cover any open ports and clean away the deposits before proceeding.

Additional cleaning must be carried out prior to working on the high pressure fuel system. Refer to Fuel System, General, Clean.

Check (Level)

1. Open the engine compartment cover. Refer to (PIL 06-06).
2. Make sure that the oil level is between the maximum and minimum marks on the dipstick.

Figure 94.



A Dipstick
B Filler

3. If necessary, fill the recommended oil through filler to the maximum level.
4. Install the filler cap and the dipstick.
5. Make sure that they are fully inserted and tightened.

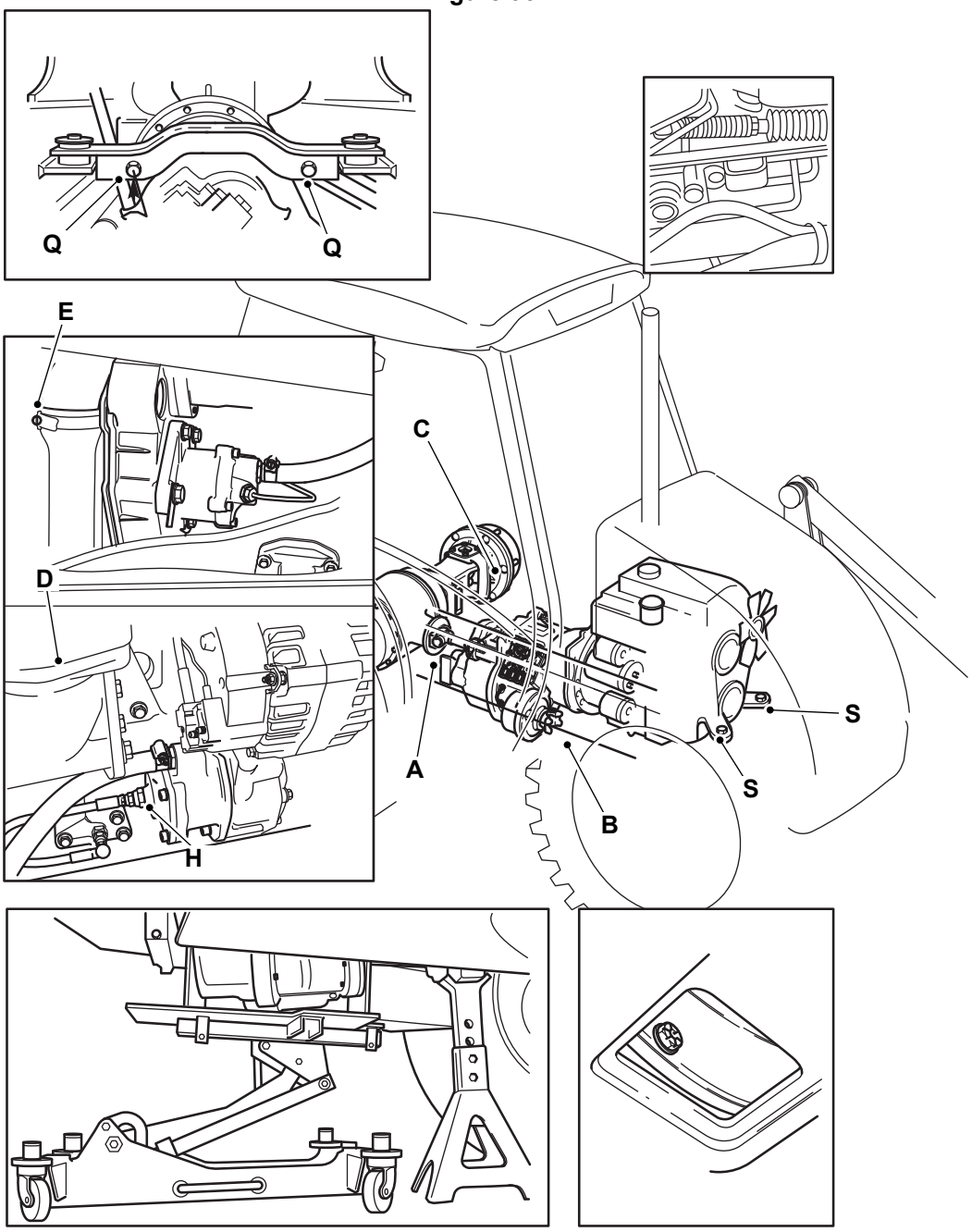
Remove and Install

Remove

1. Make the machine safe. Refer to (PIL 01-03).
2. Open the engine compartment cover. Refer to (PIL 06-06).
3. Isolate the battery. Refer to (PIL 33-03).
4. Remove retaining bolts and then lift off the front grille.
5. Remove retaining bolts from both sides and lift off the front nose guard.
6. Disconnect the hydraulic oil cooler hoses from the hydraulic oil cooler.
7. Plug and cap open ports to prevent ingress of dirt.
8. Make sure that the adaptor must be held with a spanner whilst installing or removing the hose.
9. It may be easier to remove the top hose connection once the cooler has been removed from the machine.
10. Drain the cooling system.
11. Remove the transmission oil cooler hoses.
12. Remove the radiator top hose and bottom hose.
13. Make a suitable alignment mark to allow correct repositioning of the radiator shroud.
14. Remove retaining bolts and lift off the fan guard.
15. Remove retaining bolts (both sides) and lift off the radiator sub-assembly including radiator, hydraulic and transmission coolers, and shroud.
16. Make sure that the engine fan is not get damaged.
17. Support the subassembly with suitable lifting equipment.
18. If required, the shroud, radiator and coolers can be removed as individual items.
19. Loosen and remove the exhaust silencer retaining bolts, remove the silencer.
20. Loosen and remove the retaining clamp for the air filter intake hose.
21. Remove the air intake filter. Use tape to close the opening in the air intake manifold, this will prevent ingress of dirt.
22. Loosen and remove the brake master cylinder reservoir retaining bolts.
23. Do not remove the pipes attached to the master cylinder reservoir but put the reservoir out of the way.
24. Make sure that the fluid level does not drain down.
25. Label and remove all electrical connections, the number of connectors will vary depending on the ancillary equipment fitted to the engine. Typical electrical connectors are:
    - 25.1. Starter motor
    - 25.2. Alternator
    - 25.3. Coolant temperature sender
    - 25.4. Engine oil pressure switch
    - 25.5. Engine temperature sender
26. Loosen and disconnect the fuel lines from the fuel sedimenter.
27. Plug all the open orifices to prevent ingress of dirt and loss of fuel.
28. Loosen and remove the retaining bolts for the fuel sedimenter.
29. Remove the sedimenter.
30. If installed, loosen and disconnect the ether cold start fuel line from the engine. Plug and cap open orifices to prevent ingress of dirt and loss of fluid.
31. Disconnect the throttle linkage from the arm on the fuel injection pump.
32. Leave at least one of the locking nuts in position, this will ensure that the engine revs are set correctly when reassembling.
33. Loosen and remove the rear propshaft to gearbox retaining bolts.
34. On 4WD machines, loosen and remove the front propshaft to gearbox retaining bolts.
35. Remove the access plate located at the base of the gearbox.
36. Through the access hole, loosen and remove the torque converter to engine flywheel retaining bolts (turn the flywheel to align bolts with access hole).
37. Disconnect the gearshift lever from the top of the gearbox.

38. Use a suitable trolley jack and support the weight of the gearbox.
39. Attach a `cradle' to the trolley jack that will evenly support the weight of the gearbox.
40. Use a suitable stand and support the weight of the engine.
41. Loosen and remove the gearbox mounting bolts.
42. Remove the gearbox to engine retaining bolts.
43. Pull the transmission and converter clear of the engine.
44. Make sure that the converter stays mounted on the gearbox shaft.
45. Support the engine with suitable lifting equipment.
46. Take the weight of the engine on the hoist.
47. Loosen and remove the engine mounting bolts (both sides).
48. Lift the engine clear of the machine.
49. Put the engine on a suitable stand, the correct dismantling and assembly procedures are detailed in the KOEL engine service manual.

Figure 95.



A Bolt
B Bolt
C Hydraulic oil cooler hoses
D Adaptor
E Transmission oil cooler hoses
H Brake vacuum hose
S Bolt
Q Bolt

Install

1. The installation procedure is the opposite of the removal procedure. Additionally do the following steps.
2. Make sure that the drive tangs are correctly located in the gearbox pump, When mating the gearbox/torque converter to engine.
3. It is vitally important that the torque converter is installed at the gearbox and engine flywheel correctly.

4. Failure to locate the converter correctly will result in damage to the gearbox oil pump on engine start up.
5. When you are satisfied that the torque converter is located correctly, use the access hole in the bottom of the gearbox to install and tighten the flexi-plate to engine flywheel retaining bolts.
6. Rotate the flywheel to align the next bolt hole.
7. Install and tighten all retaining bolts.
8. When installing the radiator sub-assembly, including radiator, cooler and shroud take care not to damage the engine fan.
9. Align the shroud using alignment mark.
10. Make sure that the front nose guard and the engine cover are correctly aligned.
11. Fill the cooling system using correct mixture of water/ anti-freeze.
12. Check engine, coolant and brake oil levels.
13. Make sure that the brake vacuum hose is reconnected at the brake vacuum pump.
14. When connecting the battery, connect the earth (black) lead last.
15. Make sure that the engine idle speed is correct, adjust as required, refer to Technical Data.

Store and Recommission

Consumables

Description	Part No.	Size
Cleaner/Degreaser - General purpose solvent based parts cleaner	4104/1557	0.4L

Engine Storage (up to 6 months)

Before you store the engine make sure that:

- The environment is not humid or exposed to bad weather.
- The storage place is not near an electrical panel.
- Prevent storing the engine in direct contact with the ground.

1. Cover the engine with a proper protective sheet to prevent it from dampness and atmospheric contaminants.

Engine Storage (over 6 months)

1. Follows the precautions mentioned in the above procedure.
2. Fill the engine housing with protective oil up to the maximum level.
3. Refuel the machine with fuel additives for long storage.
4. For machines with expansion tank:
   4.1. Make sure that the coolant is up to the maximum level.
5. For machines without expansion tank:
   5.1. Fill the coolant until the pipes inside the radiator are covered by specified distance.
   Distance: 5mm
   5.2. Do not overfill the radiator, but leave sufficient space for the fuel to expand.
6. Start the engine and run it at idle speed for the specified duration.
   Duration: 2min
7. Bring the engine to 75% of the maximum rated speed for the specified duration.
   Duration: 5–10min
8. Turn off the engine.
9. Drain the fuel tank completely.
10. Spray engine oil (SAE 10W40) on the exhaust and intake manifolds.
11. Seal the exhaust and intake ducts to prevent contamination.
12. Clean the engine.
    Refer to: PIL 15-00-00.
13. Apply protective paints on non-painted parts.
14. Loosen the alternator belt.
15. Cover the engine with a proper protective sheet to prevent it from dampness and atmospheric contaminants.

Engine Starting After Storage

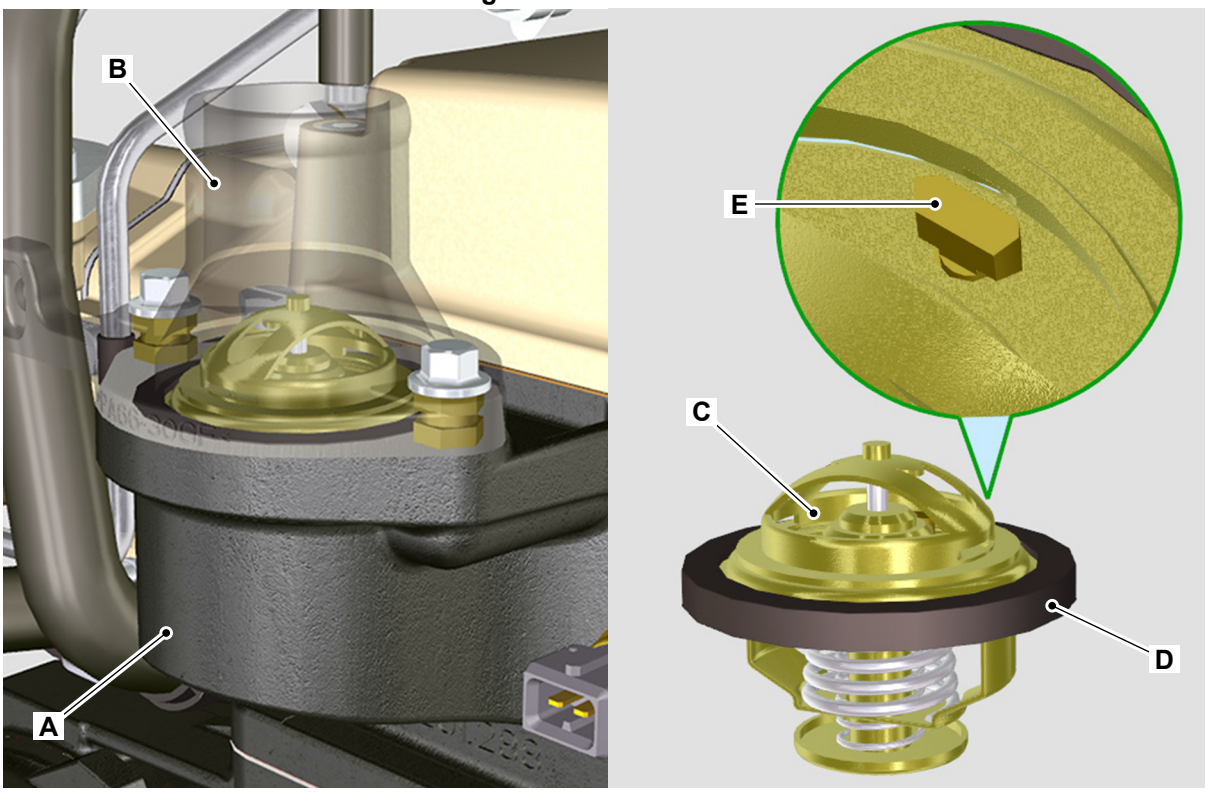
1. Remove the protective sheet.
2. Use a cloth soaked in degreasing fluid to remove the protective treatment from the external parts.
   Consumable: Cleaner/Degreaser - General purpose solvent based parts cleaner
3. Inject lubricating oil (not more than 2cm³) into the intake ducts.
4. Adjust the alternator belt tension.
   Refer to: PIL 15-18-00.
5. Refuel the machine.
6. Make sure that the oil and the coolant are up to the maximum level.
7. Start the engine and run it at idle speed for the specified duration.
   Duration: 2min
8. Bring the engine to 75% of the maximum rated speed for the specified duration.
   Duration: 5–10min
9. Stop the engine.
10. While the oil is still hot, drain the protective oil in a suitable container.
11. Put new oil up to the maximum level.
12. Replace the filters (air, oil, fuel).
13. Drain the cooling circuit completely and put new coolant up to the maximum level.

Important: Over time, lubricants and filters lose their properties, so it is important to consider whether they need replacing, also based on the criteria mentioned in the maintenance schedules.

If the engine is not to be used for an extended period, the protective treatment procedure must be repeated within 730d of the previous one.

Component Identification

Figure 122. Thermostat



A Cylinder head
B Water outlet cover
C Thermostat
D Gasket
E Air bleeding hole

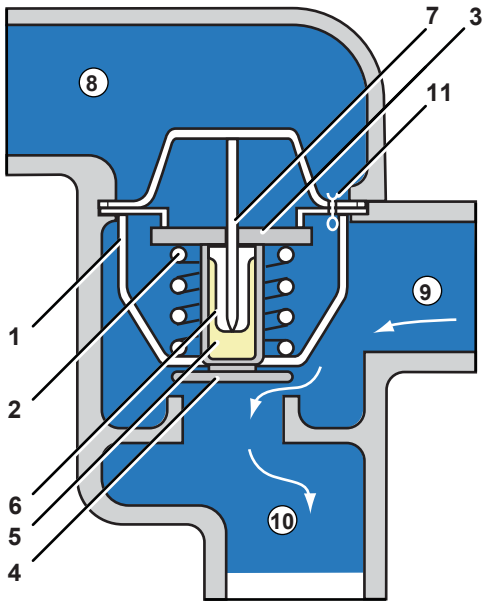
Operation

The thermostat is a wax element type and is configured for by-pass blanking. The thermostat functions as follows:

State A - Closed (Engine Cold)

When the engine is cold the wax pellet has contracted into its housing. This allows the spring to act against the thermostat body and move the valve plate up against its seat, closing the outlet port to the radiator. Since the bottom valve plate is connected to the top valve plate it also moves up, opening the bypass port. The coolant flows from the thermostat housing inlet port into the bypass gallery.

Figure 123.

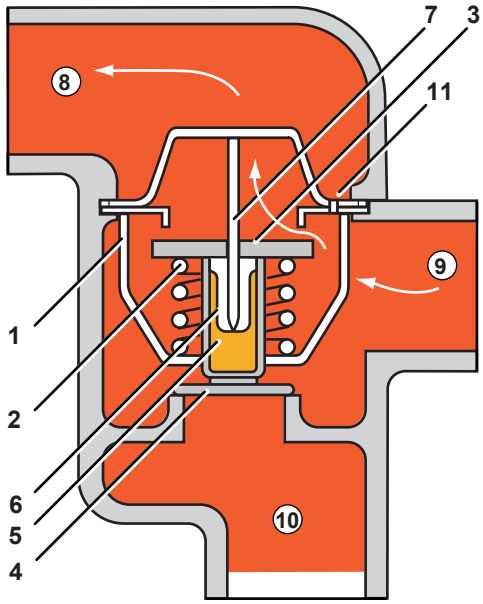


1 Thermostat
2 Spring
3 Top valve plate
4 Bottom valve plate
5 Wax pellet
6 Diaphragm
7 Actuating rod
8 Outlet port to the radiator top hose
9 Inlet port thermostat housing
10 Outlet port bypass gallery
11 1mm diameter orifice

State B - Open (Engine Hot)

When the engine is hot, the wax pellet melts, as it does so it expands and pushes against the diaphragm. The diaphragm reacts against the actuating rod and both the top and bottom valve plates move down into the thermostat body, compressing spring. The outlet port to the radiator is now open and the bypass port is closed. A 1mm diameter orifice allows trapped air to be expelled from the system.

Figure 124.



1 Thermostat
2 Spring
3 Top valve plate
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5 Wax pellet
6 Diaphragm
7 Actuating rod
8 Outlet port to the radiator top hose
9 Inlet port thermostat housing
10 Outlet port bypass gallery
11 1mm diameter orifice

Check (Condition)

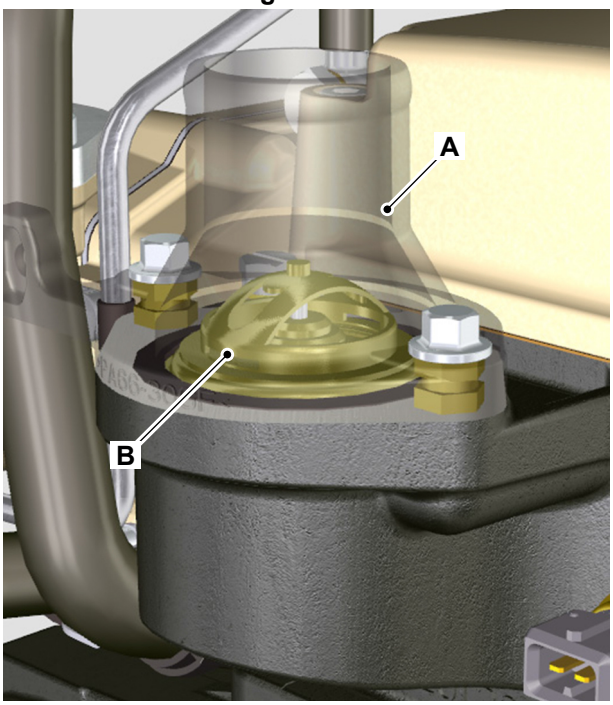
1. If the thermostat is suspected of being faulty, perform a thermostat test, to confirm its serviceability.
2. Note that the thermostat is a non-serviceable item. If the thermostat is faulty or damaged it must be renewed.
3. Inspect the seal for damage or splits. If necessary replace the seal. Make sure that the seal is correctly installed.

Check (Operation)

A period of 3–5min before the thermostat valve starts to operate is normal because of the time required to heat soak the thermostat.

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. Remove the thermostat housing and the thermostat. Refer to Figure 125.

Figure 125.



A Thermostat housing
B Thermostat

3. Suspend the thermostat in a suitable container of coolant. Use an external heat source to gradually increase the temperature of the coolant. Note: When working with boiling water, all the necessary safety precautions must be taken. Refer to Figure 126.

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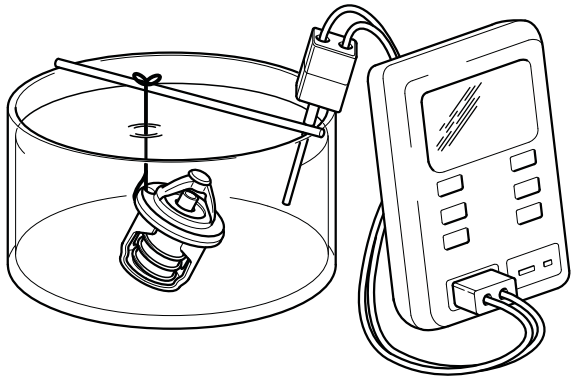
to download the complete manual.

Thank you so much for reading

Figure 126.



4. Use a thermometer to measure the temperature of the coolant.
5. When the coolant reaches the operating range of the thermostat the valve should start to open, the movement of the valve plate should be evident.
6. Record the starts to open temperature, the fully open temperature and the amount of valve lift when fully open.