Section **2**

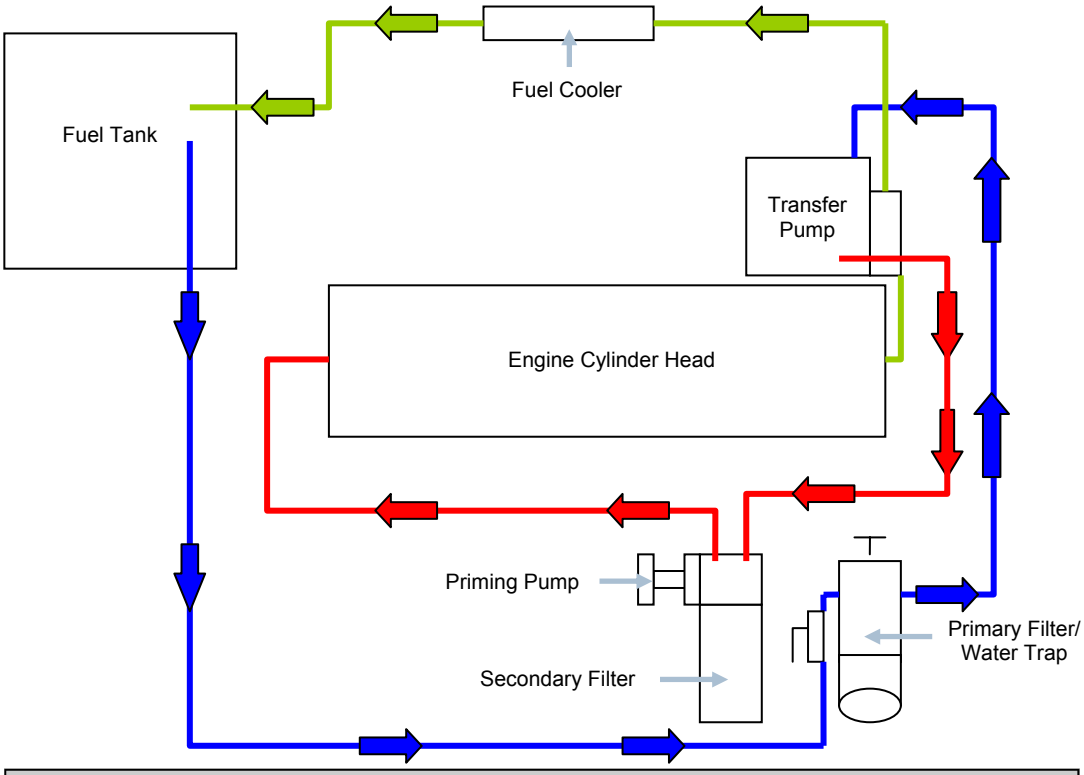
Engine System

FUEL SYSTEM

GENERAL DESCRIPTION

The diesel engine fuel system consists of the fuel injectors, fuel lines, transfer pump, fuel/water separator, fuel filter, hand primer pump, fuel cooler and fuel tank. Fuel is delivered from the fuel tank to the suction side of the fuel transfer pump via a fuel/water separator. The transfer pump delivers diesel fuel to the injector assemblies (via a secondary filter) through drilled galleries in the cylinder head. The fuel injector assemblies provide internal pressure intensification for discharge into the cylinders with excess fuel returned to the storage tank via the vent valve and fuel cooler. Fuel supply is controlled by the transfer pump which opens the racks on the unit injectors via mechanical linkages. The fuel injectors and transfer pump are factory set precision components and no adjustments should be attempted without the necessary tools and training. If either the governor or injectors are suspected to be faulty consult your local Bucyrus representative.

Tampering with the engine transfer pump and fuel injector settings will result in adverse engine performance and may void the conditions for which the engine system has been certified such as operating temperature and exhaust emissions. Consult your local Bucyrus representative before attempting to adjust the engine governor and fuel injectors.



Fuel System Line Drawing

SAFETY PRECAUTIONS

The following safety precautions are not intended to be exhaustive. Safe work practices should be used when servicing or operating heavy machinery.

When the temperature of diesel fuel is elevated, which occurs when fuel is circulated through an operating engine, the following hazards exist:

- Scalding or burns from contact with hot liquid.
- Presence of combustible vapour around the fuel source.

ALWAYS give the diesel engine an opportunity to cool down before performing fuel system servicing.

ALWAYS wear personal protective equipment including safety glasses, gloves and suitable clothing.

ALWAYS perform fuel system servicing in a well ventilated area.

ALWAYS keep naked flames, sparks and other heat sources away from the machine.

ALWAYS clean up any spilled fuel immediately to remove the potential for ignition and slip or fall injuries.

ALWAYS be aware of, and isolate, other forms of energy and pinch points (fan, belts, pulleys) when accessing the engine compartment including pneumatic stored pressure, engine coolant pressure and other heat sources such as engine block and exhaust system components.

ALWAYS avoid oxy-cutting or welding near or onto any unshielded fuel system components.

I**MMEDIATELY** wash off spilled fuel when exposure to the skin has occurred.

FUEL TANK

Care and Maintenance

Daily: Keep the fuel tank full and refill to prevent condensation and the growth of micro-organisms which may contaminate the fuel and cause system blockage.

Servicing

Check supply lines for leaks and/or degradation and check the condition of the seal in the fuel filler cap, level gauge and breather every 1000 service hours.

Open the drain plug and drain the water from the fuel tank every 250 hours or sooner if water collection bowl on the water trap filter has water in it. The drain plug is located underneath the machine at the front of the fuel tank (directly under fuel gauge). Completely drain and clean the fuel tank every 2000 service hours. Remove any sediment in the bottom of the fuel tank with a clean, lint free cloth. A bolt on inspection hatch may be removed from the top and the side of the tank to gain access.

Ensure park brake is on and the wheels are chocked before draining fuel tank as access is from under the machine.

Fuel Filler Cap

Fuel Tank Inspection Cover Drain Plug Underneath

FUEL LINES

Care and Maintenance

Daily: carry out a visual inspection for fuel leaks on all external fuel lines and connections. Check that hoses are not resting on or touching sharp edges, rotating elements or heat sources such as exhaust system components.

Servicing

As hoses and associated fittings have a finite service life. Carry out a thorough inspection every 1000 service hours. Inspect all fuel lines for signs of deterioration, including hose clamps and anchor ties and replace as required. Replace all fuel system hoses at major overhaul or every five years.

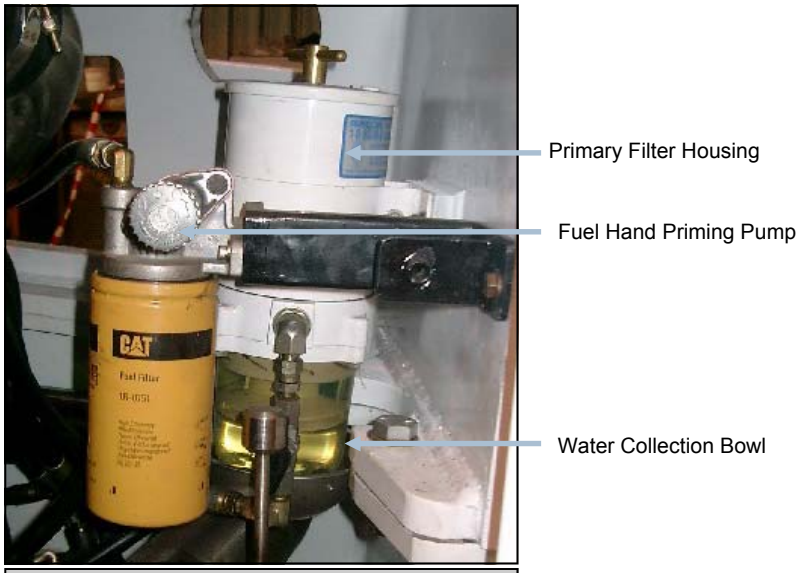
PRIMARY FUEL FILTER/WATER SEPARATOR

Care and Maintenance

Daily: visually inspect the filter/separator collection bowl for the presence of water . If water or sediments are present, draining is required.

To drain the filter/separator collection bowl:

1. Ensure that the engine has had sufficient time to cool and is isolated and tagged as described in Section 1.
2. Place a suitable container under the collection bowl.
3. Loosen the brass T-handle on top of the filter unit and remove the lid to break the vacuum.
4. Remove the drain plug at the bottom of the unit to expel any contaminants.
5. Replace the drain plug.
6. Re-prime the unit by filling with clean fuel.
7. Replace the lid and snugly tighten the T-handle (*hand tight only*).
8. Hand prime fuel system before attempting to start machine.
9. Discard expelled fuel in a responsible manner.



Primary Fuel Filter

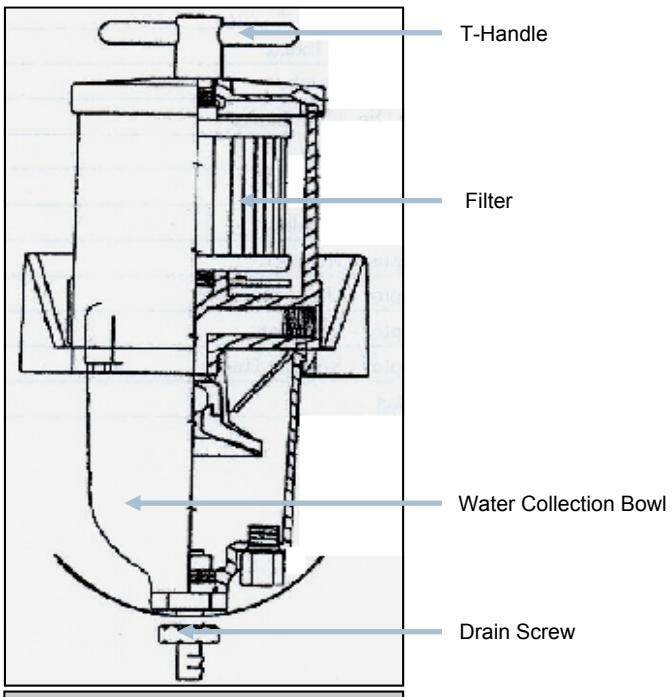
Servicing

The filter element should be replaced every 250 service hours.

To replace filter element:

1. Ensure that the engine has had sufficient time to cool and is isolated and tagged as described in Section 1.
2. Loosen the brass T-handle on top of the filter unit and remove the lid.
3. Remove the filter element by grasping the moulded handle and slowly pulling upward with a twisting motion until the filter element is clear of the housing.
4. Discard the used filter element, lid and T-handle seals in a responsible manner.
5. Insert the new filter element by grasping the moulded handle and slowly pushing downward with a twisting motion.
6. Replace the lid and T-handle seals with those supplied with the new filter element. Apply a coating of fuel to the new seals prior to assembly.
7. Refill the unit with clean fuel.
8. Replace the lid and snugly tighten the T-handle (*hand tight only*).
9. Hand prime the fuel system before attempting to start the machine.
10. Start the engine and check for any leaks.

Do not use tools to tighten the water separator T-handle. Over tightening will result in damage. Ensure that the seal between the filter body and lid is in the correct position before tightening the T-handle. Remedy any leaks.



Primary Filter Housing

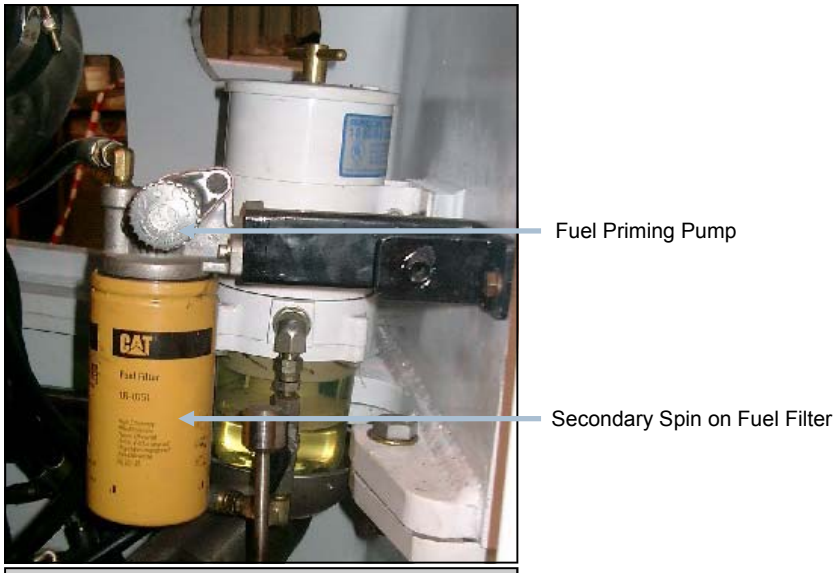
SECONDARY FUEL FILTER

Servicing

To replace filter element (every 250 hours):

1. Ensure that the engine has had sufficient time to cool and is isolated and tagged as described in Section 1.
2. Have the replacement filter element filled with fuel and ready to install immediately after the used filter element is removed. This will prevent fuel system aeration. Fill via the outer ring of small holes (inlet holes) and coat the sealing gasket with clean fuel.
3. Place a suitable container under the filter element and unscrew the cartridge.
4. Unscrew the used cartridge and dispose of in a responsible manner.
5. Immediately install the new filter element and tighten until the sealing gasket just touches the mounting adaptor head, then tighten a further ¾ turn (*hand tight only*).
6. Hand prime the fuel system before attempting to start the engine.
7. Start the engine and check for leaks. (*Remedy and leaks immediately*).

Do not use tools to tighten the filter element cartridge. Over tightening will result in damage. Ensure that the seal between the filter element cartridge and mounting adaptor head is in the correct position before tightening the last ¾ turn.



Secondary Fuel Filter Assembly

FUEL SYSTEM - PRIMING

If the engine fails to start after filter replacement or has run out of fuel when operating, the following procedure is to be used to prime the fuel system to purge trapped air.

The fuel system should be primed under the following conditions:

1. Running out of fuel.
2. Storage.
3. Replacement of fuel filters.

To prime the fuel system:

1. Fill the fuel tank with the recommended grade of fuel. If it is not possible to completely fill the tank then add a minimum 50 litre to the tank.
2. Unlock the fuel priming pump plunger and operate until resistance is felt, a considerable amount of stroke may be required.
3. Push in the plunger and tighten by hand.
4. Promptly start the engine, if the engine runs rough increase the engine RPM to approximately ½ the rated RPM and check for fuel leaks.

Do not use the starter motor and fuel pump to prime the fuel filters. Continuous use of the starter motor can result in damage. Allow the starter motor to cool for two or three minutes before cranking the engine again.

If the engine will not start, further priming may be necessary. If the engine continues to misfire or smoke after starting, further priming may be required.

Fuel Priming Pump

LUBRICATION SYSTEM

GENERAL DESCRIPTION

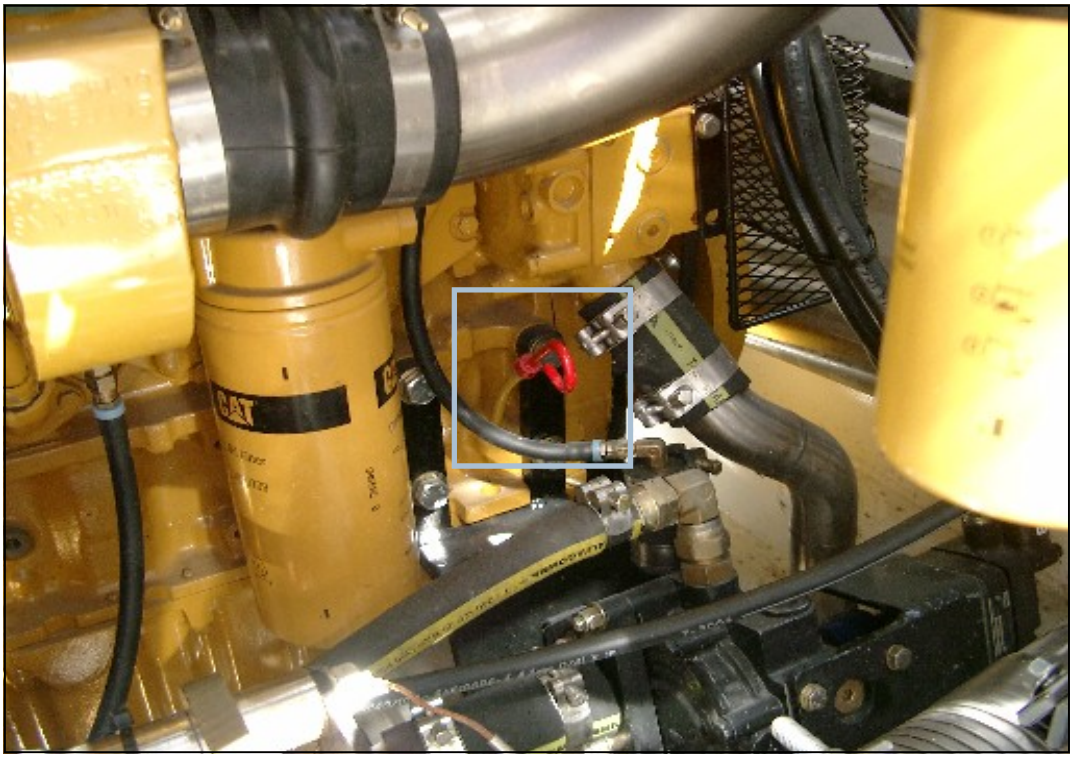
The engine lubrication system provides essential lubrication for the engine working components. The system consists of an engine oil reservoir (sump), and level gallery, oil pump, oil pressure regulator and relief valve, oil cooler, and filter assembly. Lubricating oil is drawn by suction from the oil pan (sump) via the intake screen to the pump where it is pressurised. Oil then passes through a short gallery in the engine cylinder block to the oil cooler housing. At the same time oil is directed to the relief valve where excess oil is discharged back to the sump when the pump pressure exceeds 600 kPa (88 psi). From the oil cooler adaptor plate oil passes through the full flow filter, through the oil cooler then back into the cylinder block where the oil is internally routed. Bypass valves are located at the oil cooler and filter assemblies to maintain flow if either become blocked.

Stabilised oil pressure is maintained within the cylinder block by a pressure regulator valve located in the cylinder block oil gallery opposite to the cooler. The regulator discharges oil back to the sump if the pressure at the valve exceeds 345 kPa (50 psi). Regulated oil is forced through the various working components within the engine.

A low oil pressure sensor is located behind the operator's display panel. This sensor monitors engine oil pressure and below 70 kPa (10 psi) shuts down the engine via the diesel control system.

NOTICE

The engine dipstick is secured into the tube via a flared nut and should be tightened firmly.



Engine Dipstick

SAFETY PRECAUTIONS

The following safety precautions are not intended to be exhaustive. Safe work practices should be used when servicing or operating heavy machinery.

ALWAYS give the engine an opportunity to cool down before performing lubrication system servicing.

ALWAYS wear personal protective equipment including safety glasses, gloves and suitable clothing

ALWAYS clean up any spilled oil immediately to remove the potential for slip, trip or fall injuries.

ALWAYS be aware of, and isolate, other forms of energy and pinch points (fan, belts, pulleys) when accessing the engine compartment including pneumatic stored pressure, engine coolant pressure and other heat sources such as engine block and exhaust system components.

ALWAYS ensure that the engine is not running and the machine's park brake is applied before working on the engine lubrication system.

OIL FILTER

The spin on type engine oil filter should be replaced when the engine oil is changed every 250 service hours.

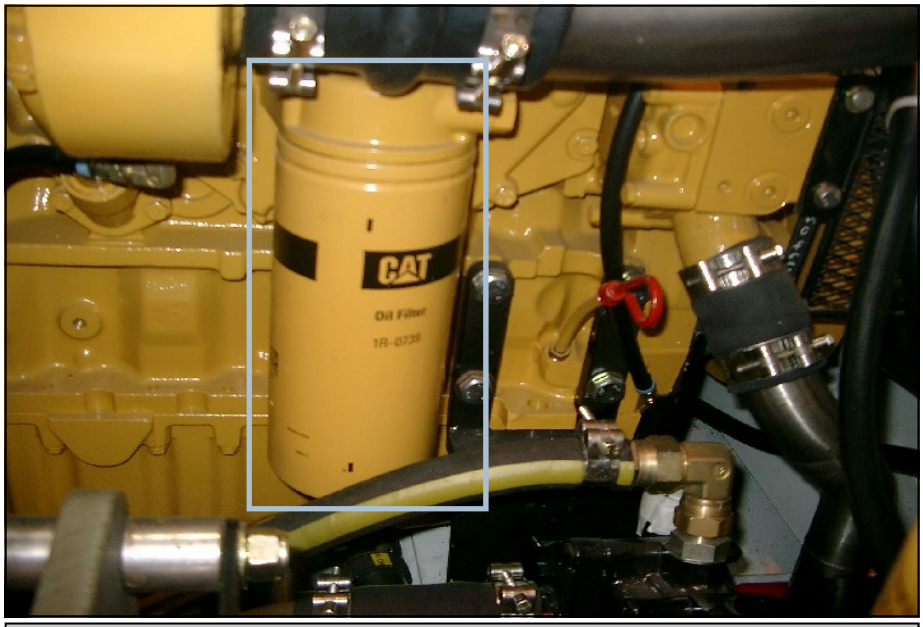
Servicing

To replace the engine oil filter:

1. Ensure that the engine has had sufficient time to cool and is isolated and tagged as described in Section 1.
2. Remove the oil filter cartridge, located adjacent to the fuel/water separator, using a strap wrench.
3. Dispose of the used oil filter cartridge in a responsible manner.
4. Clean the oil filter adaptor with a clean, lint free, cloth.
5. Lightly coat the oil filter gasket with clean engine oil.
6. Screw the new oil filter cartridge onto the adaptor by hand until the gasket just touches the mounting adaptor head. Tighten an additional ⅔ of a turn.

Over tightening the oil filter cartridge may damage the seal resulting in an oil leak.

7. Add oil as required to bring the oil level to the *full* mark on the dipstick (see page 13).
8. Start and run the engine for a short period and check for leaks.
9. After any leaks have been rectified stop the engine and allow the oil to return to the sump (this will take approximately five minutes).
10. Add oil as required to bring the level up to the *full* mark on the dipstick.



Engine Oil Filter

CHECKING/FILLING ENGINE OIL

Care and Maintenance

Check engine oil level and fill as required daily.

If the oil level is constantly above the *full* mark on the dipstick, and there has been no oil added, this may indicate that either fuel or coolant dilution has occurred. This can result in serious engine damage and should be investigated and rectified immediately.

To check the engine oil:

1. Park the machine on flat, level ground.
2. Ensure that the engine has had sufficient time to cool and is isolated and tagged as described in Section 1.
3. Allow five minutes for the engine oil to return to the sump.
4. Locate the dipstick at the front of the engine compartment on the driver's side.
5. Remove the dipstick by pulling upward and wipe with a clean, lint free, cloth.
6. Reinsert dipstick into the spout, remove and check oil level.
7. Fill engine as required to *full* mark on engine dipstick.

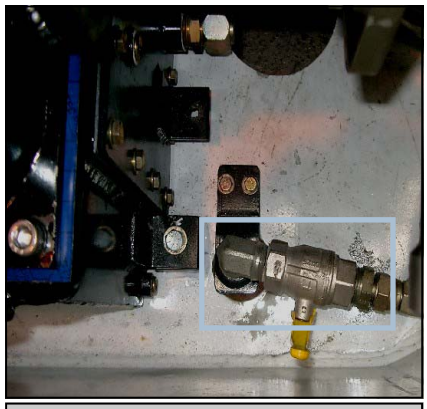
CHANGING ENGINE OIL

Change engine oil every 250 service hours.

If either fuel or coolant dilution is evident in the engine oil investigate and rectify immediately as serious engine damage will result.

To change the engine oil:

1. Park the machine on flat, level ground.
2. Ensure that the engine has had sufficient time to cool and is isolated and tagged as described in Section 1.
3. Place a suitable container under the drain valve.
4. Locate the remote drain valve on the driver's side at the rear of machine.
5. Remove the drain plug and open the drain valve allowing warm oil and waste particles to drain from the crankcase of the engine.
6. Close drain valve, fit the drain plug and refill engine as described above.



Engine Oil Drain

FLUSHING THE LUBRICATION SYSTEM

When the engine lubrication system is contaminated by coolant (ethylene glycol antifreeze solution or water soluble material) the following cleaning procedure is recommended.

Use “Cellosolve” or equivalent solution.

Use extreme care when handling these solvents to avoid serious injury to personnel or damage to finished surfaces. Always consult the Material Safety Data Sheet before use.

1. Drain all engine lubrication oil as described on page 13.
2. Remove and discard the oil filter element and replace as described on page 12.
3. Mix two parts Cellosolve (or equivalent) with one part SAE 10 engine oil and fill the engine crankcase to the correct operating level as indicated on the dipstick.
4. Start and run the engine at fast idle (1000 RPM to 1200 RPM) for 30 minutes to one hour, checking engine oil pressure regularly.
5. Stop the engine and immediately drain the crankcase and filters.
6. Replace the drain plug, fill the engine with SAE 10 oil and run the engine again at fast idle for 10-15 minutes then drain the oil.
7. Remove and replace the oil filter element.
8. Replace the drain plug and fill the engine with the specified grade of oil for normal operation (see Section 1).

Ensure that the source of contamination has been corrected before returning the engine to service.

AIR INTAKE SYSTEM

GENERAL DESCRIPTION

The scavenging process in the 3126 Caterpillar engine system forces a charge of air into the cylinders by the turbocharger. This air sweeps out all of the burned gases through the exhaust valve ports. This air also helps cool the internal engine parts. At the beginning of the compression stroke each cylinder is filled with fresh, clean air which provides for efficient combustion.

The air, entering the turbocharger via the air cleaner is picked up by the turbo rotor blades and carried to the discharge side of the turbo. The continuous discharge of air from the turbo enters the air chamber of the cylinder block via the flame trap and sweeps through the intake ports of the cylinder liners.

The turbocharger is mounted on the outlet flange of the exhaust manifold. After the engine has started exhaust gases flowing through the turbine housing cause the turbine wheel and shaft to rotate. The intake turbocharger impellor, mounted on the opposite end of the turbine shaft, draws in fresh air via the air cleaner. The turbocharger delivers high pressure fresh air to the intake side of the heat exchanger. The air delivered from the turbocharger is at elevated temperature due to the compression process. To increase the efficiency of the combustion process the heated air is cooled via a heat exchanger (aftercooler) mounted in the cylinder block opening between the cylinders. Engine coolant flows from rear to front, through the aftercooler while air flows downward through the cooler and is cooled before entering the combustion chambers.

SAFETY PRECAUTIONS

The following safety precautions are not intended to be exhaustive. Safe work practices should be used when servicing or operating heavy machinery.

ALWAYS give the engine an opportunity to cool down before performing air intake system servicing.

ALWAYS wear personal protective equipment including safety glasses, gloves and suitable clothing, particularly when cleaning filters using compressed air.

ALWAYS be aware of, and isolate, other forms of energy and pinch points (fan, belts, pulleys) when accessing the engine compartment including pneumatic stored pressure, engine coolant pressure and other heat sources such as engine block and exhaust system components.

AIR CLEANER/INDICATOR ASSEMBLY

The Caterpillar dry type air cleaner is a dual element system which provides clean engine intake air via replaceable primary and secondary replaceable impregnated paper filters. The filter assembly is fitted with a service indicator device that provides a visual indication of excessive intake vacuum caused by a dirty or blocked air intake filter.

Servicing

The air intake system should be visually inspected for signs of a bypass of the air cleaner and any signs of external damage daily or every 10 service hours.

Inspect the air intake system for:

1. External damage to flange joints, rubber intake pipe joiners retaining bolt security.
2. Air cleaner assembly mounting security.
3. Check the dust cap is secured and sealed around the air cleaner body.
4. Check the air inlet hood for blockage or damage.
5. Check the intake flame arrester for damage.

The air cleaner filter service indicator should be checked daily or every 10 service hours.

To check the air cleaner indicator:

1. Ensure that the engine has had sufficient time to cool and is isolated and tagged as described in Section 1.
2. Locate the service indicator mounted on air cleaner assembly outlet pipe.
3. Observe the position of the *red* indicator signal. If the indicator signal is locked in full view, filter cartridge service is necessary.
4. After the filter cartridge has been cleaned or replaced depress the reset button on the service indicator to remove the *red* signal from view.

To remove and service the air cleaner filter elements:

1. Ensure that the engine has had sufficient time to cool and is isolated and tagged as described in Section 1.
2. Locate the air cleaner assembly on the off driver's side over the fuel tank.
3. Undo the clamp assembly by loosening the retaining wing nut and remove the dust cap.
4. Remove the filter elements from the hosuing assembly and wipe the inside of the housing assembly and the inside of the dust cap clean with a dry cloth.
5. To clean the filter element position the element on a clean surface on its end.
6. Using a hand-held pneumatic blower, carefully reverse blow compressed air through the filter element removing captured dust.

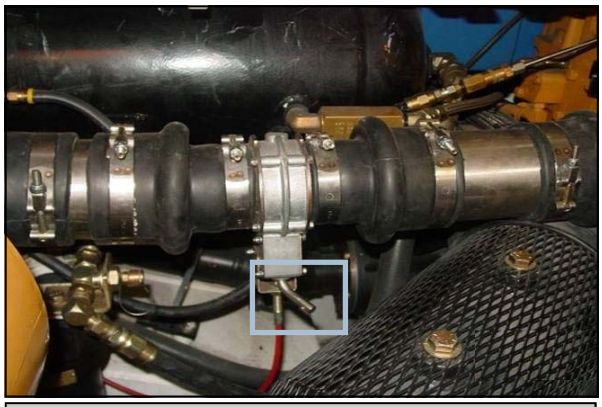
Wear suitable eye and hearing protection when using compressed air. Do not exceed 30 kPa pressure.

If the filter element is damaged or ruptured replacement is necessary. Replace the filter element if the *red* indicating signal is showing after servicing.

EMERGENCY INTAKE SHUT OFF VALVE

The emergency intake shut off valve (strangler valve) is fitted between the air filter housing and the intake side of the turbocharger. The valve is used to shut the engine off when normal shutdown procedures do not work.

Emergency Intake Shut Off Valve Stop Button



Emergency Intake Shut Off Valve Reset Lever

The valve is activated from the operator's compartment by a stop button. The valve must be in the open position before starting the engine. The valve can be reset by rotating the reset lever to the latched position. The engine will not start if the valve is closed.

Restarting of the engine should be done in compliance with the Manager's Rules.

Maintenance

Daily:

1. Check that all the fasteners locating the valve and any associated intake systems or support bracket are securely tightened.
2. Check that all flexible hoses between the valve and engine are free from damage and suitable for further service.

Monthly Testing of Valve:

1. Run the engine preferably at low idle.
2. Press the stop button in the operator's compartment to activate the intake shut off valve.
3. The engine should shut off with in a few seconds.

If the engine does not shut off items to check are:

1. The cable from the stop button to the valve is correctly adjusted and in good working order.
2. The integrity of the intake system between the valve and the engine.
3. That the valve is not sticking when actuated (possible internal/external restriction).

If this does not resolve the problem, contact Bucyrus.

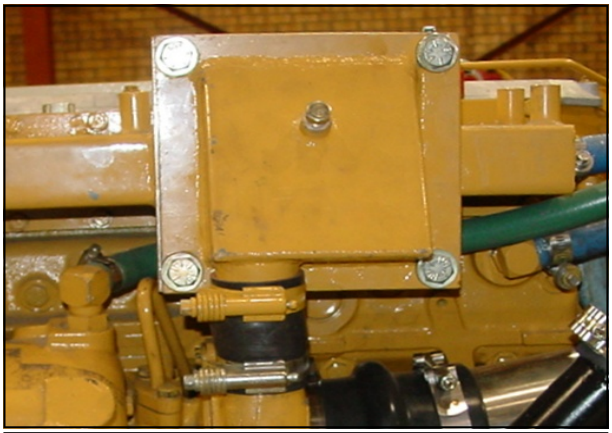
INLET FLAME TRAP/FLAMEPROOF JOINTS

The Caterpillar 3126 diesel engine system is approved as a *flameproof* diesel engine system suitable for use in underground coal mines. The flameproof design allows the engine to be used in the designated hazardous or potentially gassy areas within the mine.

The principle of flameproofing the engine system involves designing it to withstand an internal explosion without damaging the structural integrity of the engine components. This ensures that the internal explosion will not propagate to the outside atmosphere with sufficient energy to cause an external explosion.

In the case of the air intake system the flameproofing commences at the aftercooler flame trap and proceeds to the intake manifold, engine block gasket.

This engine system is tested and approved for use in an atmosphere with a maximum methane (CH_4) concentration of 1% by volume. If higher levels are encountered the machine must be driven immediately to a ventilation intake area within the mine where the methane concentration is less than 1% by volume.



Flame Trap Housing

SERVICING AIR INTAKE SYSTEM

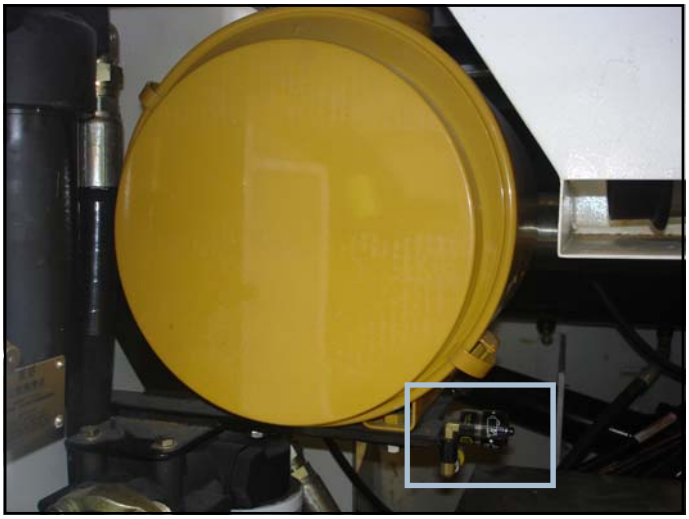
As with other maintenance and examination schedules the flameproof intake system should be inspected, by a suitably appointed and qualified person, at intervals consistent with mine site and statutory maintenance schemes. The following is the suggested intervals for maintenance and inspection of the flameproof air intake components.

Daily or every 10 service hours:

Visually check joint fasteners (nuts, bolts and studs) securing flameproof joints i.e. flame trap flange to after cooler, after cooler to cylinder head.

NOTICE

Refer to the Diesel Engine System approval drawings for flame path dimensions and conditions



Air Cleaner and Indicator Assembly

Indicator assembly

Intake Clamps and Rubber Boots

Air Intake System

When system has been disassembled and reassembly is complete, check all flameproof joints for integrity using soapy water solution and 0.2 mm feeler gauge.

Every 250 service hours:

1. Check tightness of all joint fasteners (nuts, bolts and studs) securing flameproof joints i.e. flame exhaust manifold to engine block, exhaust manifold to turbo, turbo to exhaust downpipe, exhaust downpipe to exhaust conditioner. Use soapy water around joints to check for any leaks.

Every 2000 service hours or 2 service years. (Code D):

1. Disassemble all flameproof joint connections clean and inspect for surface finish, flatness, corrosion or damage. Repair as required.
2. Hydrostatically pressure test all exhaust system exhaust and water jacket chambers external to the engine block i.e. exhaust downpipe and purifier.

Water jacket	Hydrostatic test	250 kPa (35 psi)
Gas path	Hydrostatic test	1000 kPa (145 psi)

3. After testing and inspection are completed and passed, reassemble using new gaskets and correct torque settings.
4. When reassembly is complete check all flameproof joints for integrity using soapy water solution and 0.2 mm feeler gauge.

COOLING SYSTEM

GENERAL DESCRIPTION

The cooling system performs two prime functions:

1. To effectively dissipate the heat generated by the engine and the engine lubricant during the combustion process.
2. To effectively limit the surface temperature of the engine external components, including exhaust gases, to the maximum allowable limit of 150°C.

For the engine cooling, the coolant is drawn from the cool radiator core by the engine water pump and is forced through the oil cooler housing and into the cylinder block. A parallel cooling circuit commencing from the water pump outlet and runs continuously back to the hot core of the radiator.

From the cylinder block coolant passes up through the air compressor cylinder head, manifolds, cylinder heads and when the engine is at normal operating temperature, through the thermostats and back into the hot core of the radiator. It also flows from the engine water pump to the exhaust conditioner flange through to the downpipe and back to the water pump. Coolant then flows through the radiator fins where the temperature is lowered by the air stream generated by the radiator fan.

Upon starting a cold engine, or when the coolant is below thermostat operating temperature, the coolant flow to the radiator is blocked or restricted by the thermostat. A bypass provides coolant circulation within the engine during this warm up period.

A header tank provides top up coolant into the suction side of the water pump and the cold radiator core via gravity feed.

The cooling system runs at a nominal 100 kPa pressure and can reach temperatures of more than 100°C. Release stored pressure and wear personal protective equipment when accessing.

SAFETY PRECAUTIONS

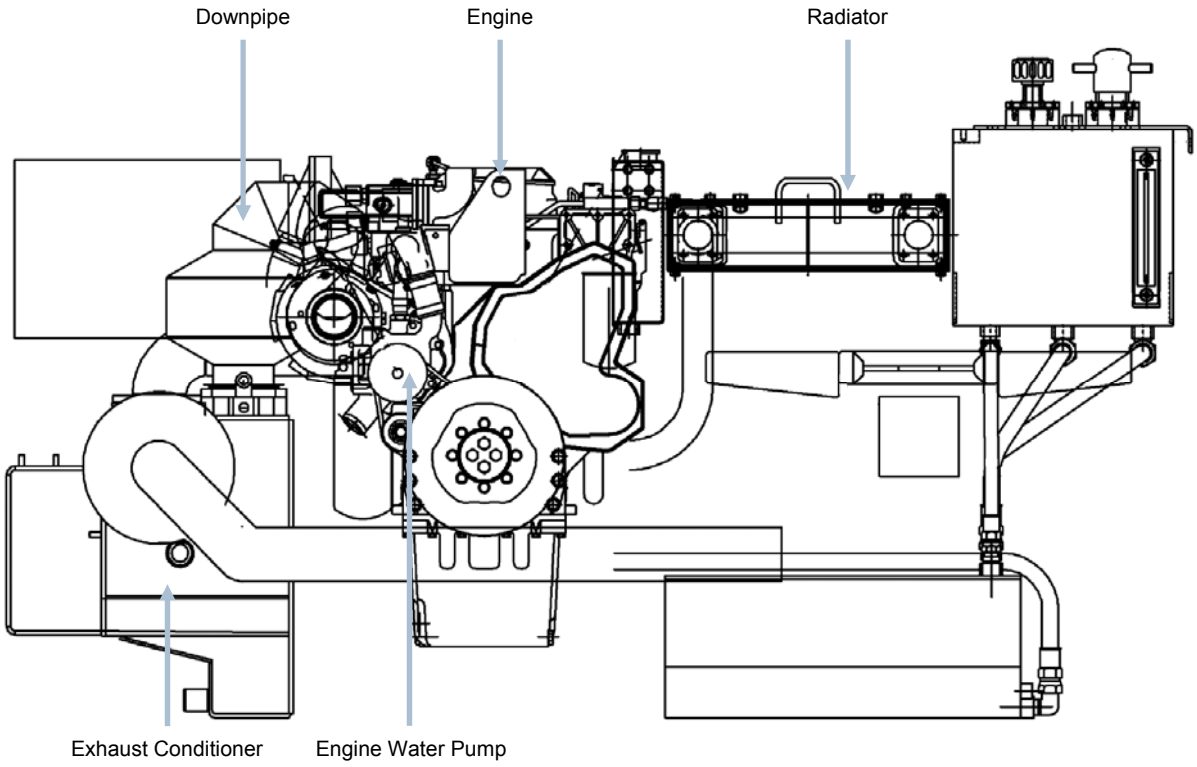
The following safety precautions are not intended to be exhaustive. Safe work practices should be used when servicing or operating heavy machinery.

ALWAYS give the engine an opportunity to cool down before performing air intake system servicing.

ALWAYS wear personal protective equipment including safety glasses, gloves and suitable clothing, particularly when accessing the coolant system.

ALWAYS be aware of, and isolate, other forms of energy and pinch points (fan, belts, pulleys) when accessing the engine compartment including pneumatic stored pressure, coolant pressure and other heat sources such as engine block and exhaust system components.

ENGINE PACKAGE



Engine Package

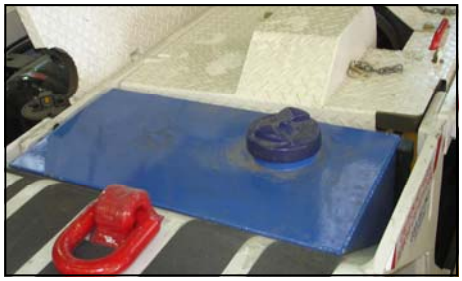
EXPANSION TANK

The expansion tank is situated on the rear driver's side of the machine. Coolant is drawn from and returned to the tank as the coolant expands and retracts with heat. The expansion tank is non-pressurised and is fitted with sight gauges for filling the system. The system should be filled from this point

WARNING

Fill *only* from the *expansion tank* as this is non-pressurised. Ensure only recommended coolants are used and mixed with the correct percentage of coolant to water, otherwise serious damage can be caused to the engine cooling system.

Expansion Tank Sight Glass



Non-pressurised Expansion Tank

HEADER TANK

The header tank provides additional coolant via gravity feed and provides system pressure relief via a relieving cap. It is connected to a expansion tank which is non-pressurised and is used for topping up the coolant. The expansion tank also has a visual inspection glass for determining coolant system level during maintenance.

WARNING

Cooling system fluid will be under pressure and hot. Always relieve pressure by lifting the relief lever on relief cap before removal. Wear personal protective equipment such as safety glasses, long sleeve shirt and gloves to avoid scalds and burns from hot coolant.

Engine Coolant Relief Cap

Pressurised Header Tank

FAN ASSEMBLY

The hydraulically driven fan assembly provides the necessary air flow through the radiator to remove the heat absorbed by the coolant. (see Section 4 Hydraulic System - Fan Drive).

The fan assembly and blades should be inspected every 250 service hours.

Check fan tip speed with tachometer every 1000 hours (fan speed high idle 1758 RPM).

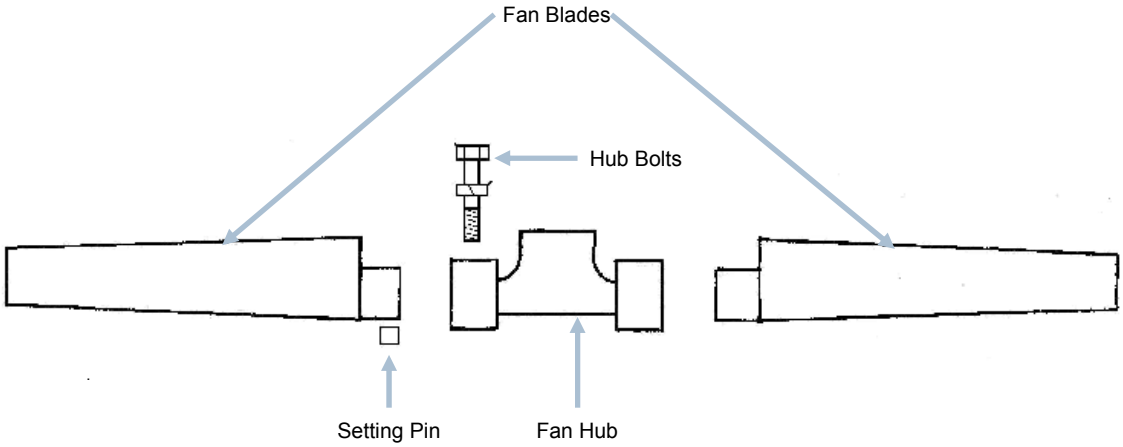
To inspect the fan assembly:

1. Ensure that the engine has had sufficient time to cool and is isolated and tagged as described in Section 1.
2. Check the fan blades for cracks and/or chips and replace or repair the fan if required.

Fan replacement is achieved by the following:

1. Removing the holddown bolts on the radiator.
2. Lift the hinged radiators up, and ensure that the gads struts that hold the radiators in position are in good working order..
3. Remove the four bolts from the transmission oil cooler and remove the cooler.
4. The fan hub mounting bolts are then removed detaching the fan and spacer from the hub, this is then able to be removed.
5. The blades are then replaced as necessary.
6. Ensure the blades are installed with the same pitch setting as the blades that are being replaced.

Replace all fan shrouds, guards and machine covers before returning the machine to service.



WATER PUMP BELT TENSION

To check and adjust the water pump belt tension:

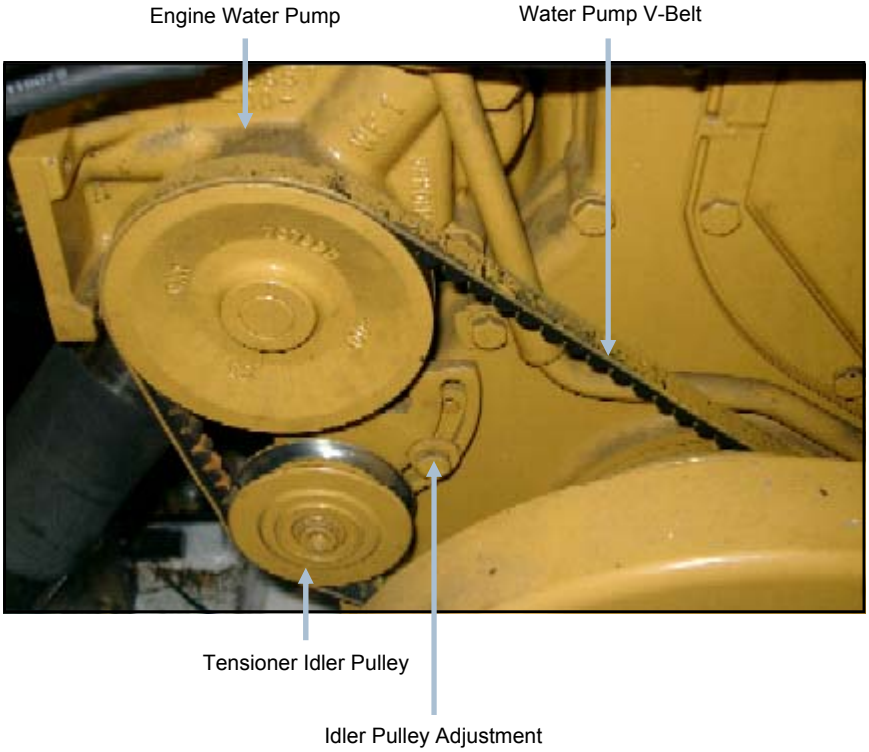
1. Ensure that the engine has had sufficient time to cool and is isolated and tagged as described in Section 1.
2. Loosen the tension on the idler pulley adjusting bolts.
3. Adjust the idler pulley to obtain the correct belt tension.
4. Tighten the idler pulley in position.

WARNING

Replace all guards and machine covers before returning the machine to service.

NOTICE

Correct belt tension is achieved when a firm push with the thumb midway between the two pulleys creates a deflection of no more than the belt depth.



RADIATOR

The machine is fitted with one radiator which provides cooling for the engine. This radiator is situated beside the top make up tank and is hinged for ease of cleaning and access to the cooling fan which is used to draw air through the radiator.

The coolant in the cooling circuit of the engine is circulated through the engine and the radiator by means of the engine water pump. The coolant passing through the radiator is then cooled by forcing air through the radiator fins by means of a hydraulically driven fan. The flow is regulated by the engine thermostat which opens and closes when the temperature is higher or lower than the normal operating temperature of 80°C-85°C. A metal shroud is located around the fan to increase the efficiency of the cooling system. A radiator that is dirty decreases the efficiency of the cooling system and will cause the engine to overheat. The radiator core should be inspected every 25 service hours and cleaned as required.

To clean the radiator core:

1. Ensure that the engine has had sufficient time to cool and is isolated and tagged as described in Section 1.
2. Lift the hinged radiator cover to give access to the radiator.
3. Remove holddown bolts on radiator.
4. Lift the hinged radiator to vertical position and secure.
5. Use an air hose with a suitable blower nozzle to remove loose dirt from the core.

Wear suitable eye protection when using compressed air. Do not exceed 30 kPa pressure.

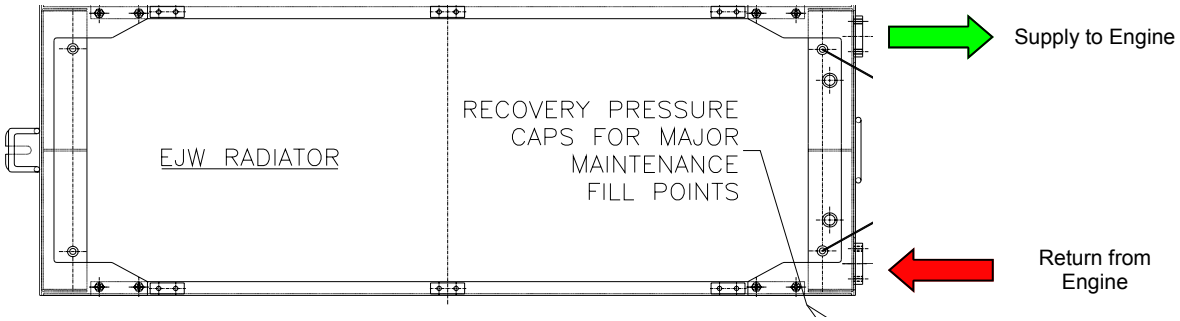
6. With a manual spray gun apply a mineral solvent to the radiator core to remove grease/oil dirt mix. *Do not* use petrol, kerosene or fuel oil as a solvent.

DO NOT use petrol, kerosene or fuel oil as a solvent.

7. Relocate the radiator in place and install holddown bolts.
8. Rinse the radiator with low pressure water to remove solvent/dirt.
9. Replace the radiator guards before returning the machine to service.

Every 250 service hours the radiator, grill and fan shroud mountings should be checked and tightened as necessary. Refer to Section 1 - Recommended Bolt Torque Charts.

High pressure cleaning may result in damage to the cooling fins.


EJW RADIATOR
RECOVERY PRESSURE CAPS FOR MAJOR MAINTENANCE FILL POINTS
Supply to Engine
Return from Engine

CHECKING/FILLING AND FLUSHING COOLANT SYSTEM

The coolant level should be checked and topped up daily with the *recommended coolant conditioner*. The level can be checked by observing the sight glass level on the expansion tank. The upper level indicates the *full* level and the lower level indicates the *low* level. If the lower sight glass is covered, filling is not required.

To top up the cooling system:

1. Ensure that the engine has had sufficient time to cool and is isolated and tagged as described in Section 1.
2. Locate the expansion tank fill cap.
3. Remove the fill cap by turning counter-clockwise.
4. Fill the expansion tank until coolant level is at the upper position on the sight glass.

If refilling after flushing the engine must be run for at least ten minutes at high idle with the fill cap removed to ensure system deaeration. Check the coolant level after running and add if required.

Engine coolant fluid will be under pressure and hot. Always relieve pressure by lifting the relief lever on relief cap before removal. Wear personal protective equipment such as safety glasses, long sleeve shirt and gloves to avoid scalds and burns from hot coolant.

The cooling system should be drained and flushed every 3000 service hours.

To drain the coolant system:

1. Ensure that the engine has had sufficient time to cool and is isolated and tagged as described in Section 1.
2. Relieve the pressure on the engine header tank by lifting the relief lever on the relief cap, once pressure is relieved remove the relief cap.
3. Remove the engine cooling system hose at the water pump. Allow the coolant to drain.

To flush the cooling system:

1. After the cooling system is completely drained. Clean and refit the hose on the engine water pump.
2. Refill with clean demineralised water and Caterpillar Fast Acting Cooling System Cleaner. Add 0.5 litres of cleaner per 15 litres of cooling system capacity. Install the header tank relief cap.
3. Start the engine and run for 30 minutes to circulate the water to reach the temperature to 82°C, stop the engine and allow the engine to cool down.
4. Drain the engine as above flushing the cooling system with fresh water until the dirty water is clean.
5. Clean and refit the hose on the engine water pump.

To fill the cooling system:

1. After the cooling system is completely flushed. Refill with coolant to the specification in Section 1.
2. Start the engine with the relief cap on the header tank removed. Allow the coolant to warm, the thermostat to open and the coolant level stabilise.
3. Check the coolant level. Add coolant mixture if necessary to bring the coolant to the correct level.
4. Refit header tank relief cap.
5. Start the engine and check any coolant leaking at the operational temperature.

The use of water containing minerals will form scale and silt deposits within the cooling system resulting in decreased cooling system efficiency and possible engine overheating. Scale formation must be chemically removed using a reputable descaling solvent. Thoroughly follow the mixing and neutralising directions on the descaling solvent container. The thermostats must be removed from the engine when descaling solvent is used.

FLUSHING A CONTAMINATED COOLING SYSTEM

If the cooling system becomes contaminated it should be thoroughly flushed before the engine becomes contaminated. One possible cause is with a cracked oil cooler, oil will be forced into the cooling system.

To flush the cooling system:

1. Ensure the source of contamination has been rectified.
2. Prepare a mixture of Calgon, or equivalent, at a ratio of 300 grams (dry) to 20 litres of water.
3. Remove the engine thermostat as previously described.
4. Fill the engine with Calgon solution and run for five minutes.
5. Drain the system and repeat the Calgon solution.
6. Drain the system again and fill with clean, demineralised water.
7. Run the engine for five minutes and drain completely.
8. Install the thermostat and refill the system with coolant to the specification in Section 1.

Engine coolant fluid will be under pressure and hot. Always relieve pressure by lifting the relief lever on relief cap before removal. Wear personal protective equipment such as safety glasses, long sleeve shirt and gloves to avoid scalds and burns from hot coolant.

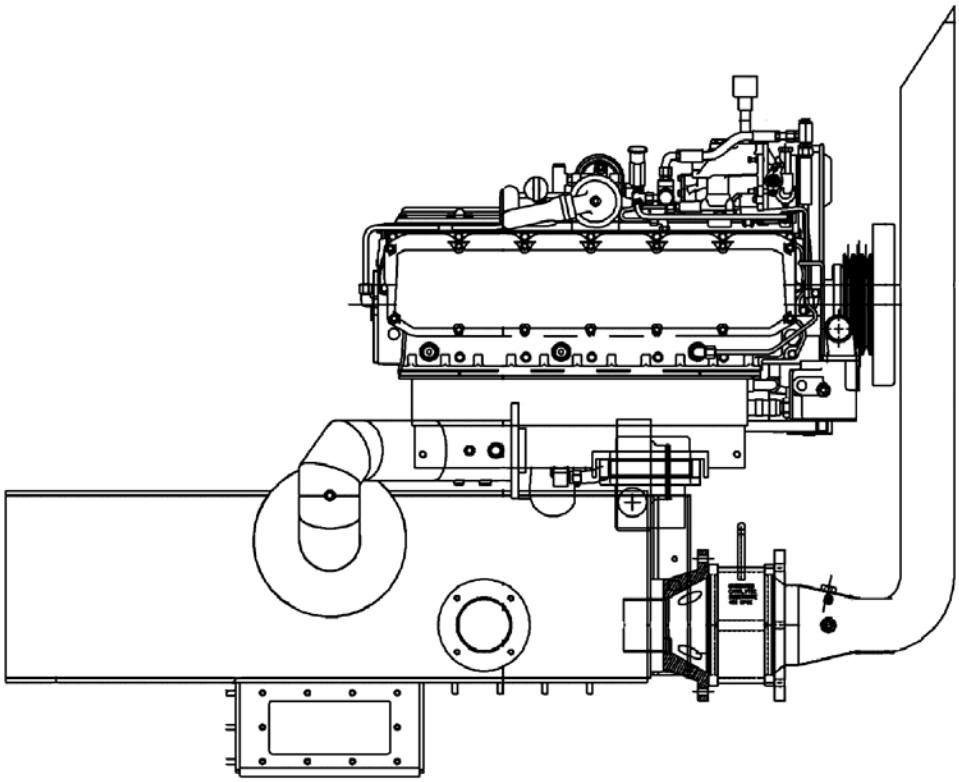
EXHAUST SYSTEM

GENERAL DESCRIPTION

The exhaust system is designed to be used in a hazardous zone of an underground coal mine.

The system comprises of a exhaust manifold, turbocharger, downpipe/purifier, exhaust conditioner, exhaust flame trap and outlet pipe.

The surface temperature of the system is controlled by water jacketed components. While the exhaust gas temperature is controlled via a *wet bath* type exhaust conditioner.



Engine Package

SAFETY PRECAUTIONS

The following safety precautions are not intended to be exhaustive. Safe work practices should be applied to heavy machinery operation and servicing.

ALWAYS give the engine an opportunity to cool down before performing lubrication system servicing.

ALWAYS wear personal protective equipment including safety glasses, gloves and suitable clothing, and dust mask particularly when accessing the exhaust system.

ALWAYS be aware of, and isolate, other forms of energy and pinch points (fan, belts, pulleys) when accessing the engine compartment including pneumatic stored pressure, engine coolant pressure and other heat sources such as engine block and exhaust system components.

ALWAYS replace all guards and covers before returning the machine to service.

Wear suitable eye protection, gloves and dust mask when performing work on the exhaust systems as particulates may be harmful to the respiratory system. Immediately wash any particulate matter from skin with warm, soapy water.

EXHAUST DOWNPIPE/PURIFIER

The exhaust downpipe/purifier is one complete unit and provides a flameproof link between the water-cooled turbocharger and the exhaust conditioner. It comprises of an exhaust path which is water-cooled by means of a water jacket to maintain the surface temperature below 150°C.

Exhaust gas is delivered into the top of the purifier via the water jacketed downpipe. Gases are channeled through the purifier element and into the exhaust conditioner.

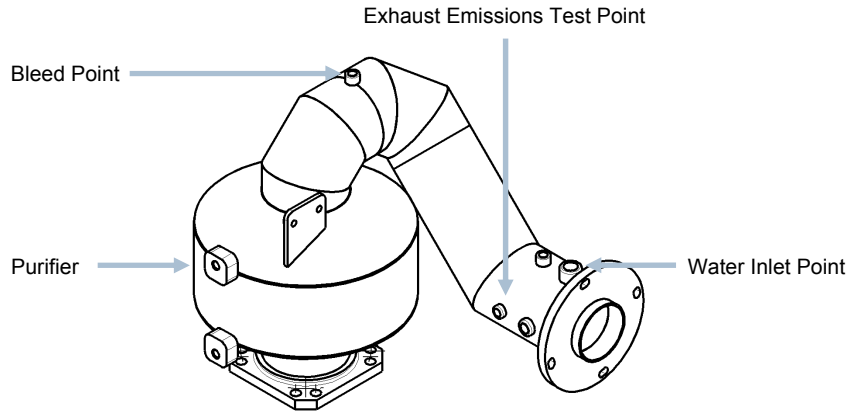
Each end of the downpipe/purifier are fixed flameproof connections which bolt to the turbocharger and the exhaust conditioner.

To remove the downpipe:

1. Ensure that the engine has had sufficient time to cool and is isolated and tagged as described in Section 1
2. Drain the engine cooling system as described on page 28.
3. Undo the exhaust downpipe to turbo flange joint by removing the four retaining bolts.
4. Undo the exhaust downpipe/purifier to exhaust conditioner flange joint by removing the six retaining bolts and remove.
5. Discard the old gaskets in an appropriate manner.
6. The downpipe can now be inspected.

To replace the downpipe:

1. Check the downpipe for any cracks or damage and repair or replace if necessary.
2. Check the water jacket for free flow.
3. Hydrostatically pressure test the purifier water jacket and exhaust path as per the requirements of AS3584.
4. Using new gaskets, plugs and hoses reinstall the exhaust downpipe ensuring that the flange gaskets provide an air tight seal.
5. Refill the engine with specified coolant, run the engine and check for any exhaust leaks.



Water Jacketed Exhaust Downpipe/Purifier

The purifiers functions:

- Converts up to 95% harmful carbon monoxide (CO) into carbon dioxide (CO_2) and removes up to 50% of particulate matter (smoke) to aid in emission control.

The purifier needs to be inspected for deterioration or damage every six months or 1000 service hours

To remove the purifier:

The procedure for the removal of the purifier is the same as the downpipe as they are one unit.

To test downpipe/purifier for Code D inspection:

1. Blank of both ends of downpipe with blanking plates.
2. Hydrostatically test gas path to 1000 kPa using calibrated pressure gauges.
3. Hydrostatically test water jacket to 250 kPa using calibrated pressure gauges.
4. Check the fixed connections on both ends of the downpipe to conform with surface and flatness tolerances nominated on the approval drawing.

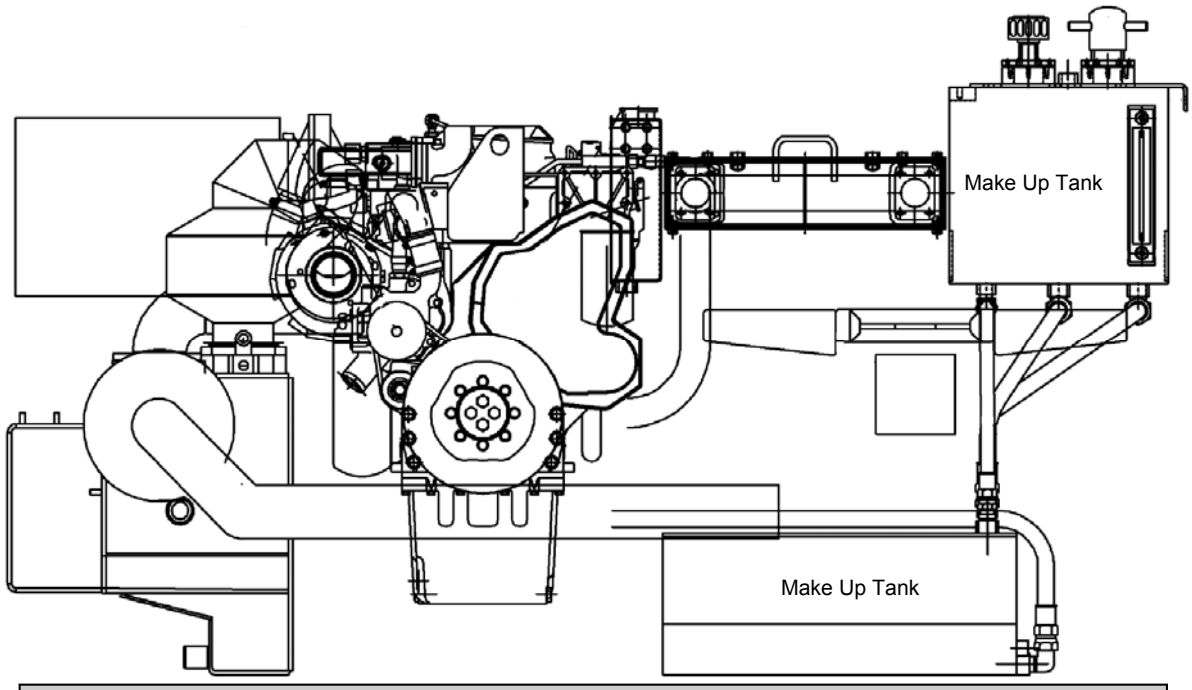
Flatness and Surface Finish

Size mm	Accuracy for Grade H Tolerance mm
< 10	**0.02**
≥ 10 < 30	**0.05**
≥ 30 < 100	**0.1**
≥ 100 < 300	**0.2**
≥ 300 < 1000	**0.3**
≥ 1000	**-----**

EXHAUST MAKE UP TANKS

There are two make up tanks (one upper and one lower) that supply water to the exhaust conditioner. Water flows from the upper tank to the lower tank via two hoses and then from the lower tank to the exhaust conditioner via one hose. There is also a breather line running from the bottom tank to the top tank.

The make up tanks are pressurised at 7 psi from a pressure reducing valve in the pneumatic circuit.



EXHAUST CONDITIONER

Exhaust gas is piped from the engine through a water-cooled manifold and downpipe/ purifier to the exhaust conditioner. The exhaust gas then pass through a water barrier which cools it below 70°C. The exhaust then passes through an outlet flame trap and is directed via the outlet pipe and is dispersed by the radiator fan. Make up water is taken directly via a two-way ball valve to the make up valve and into the low water shutdown chamber. This valve maintains a constant *safe* water level.

Two shutdown floats are positioned in the low water shutdown chamber in the exhaust conditioner, they will shutdown the engine if the water level in the exhaust conditioner goes below the set level.

Wear suitable eye protection, gloves, hearing protection and dust mask when performing maintenance tasks on the exhaust system as particulate mater may be harmful to the respiratory system.

Immediately wash any particulate matter from skin with warm, soapy water.

Ensure Mine Manager's Rules are followed and the equipment is correctly isolated and tagged while maintenance tasks are being performed.

Allow sufficient time for the exhaust items to cool prior to performing maintenance tasks on the exhaust conditioner assembly.

Exhaust Conditioner

Maintenance

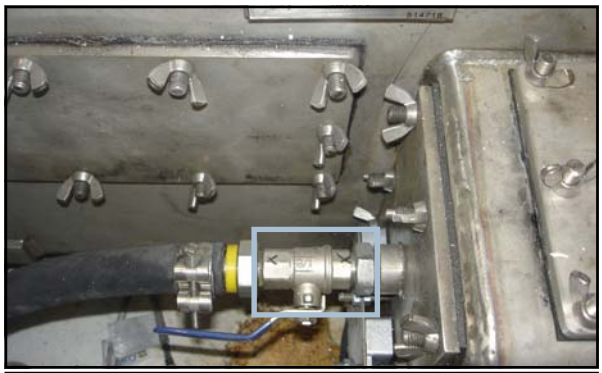
Daily:

1. Flame path and connecting bolts inspection.
2. Exhaust conditioner low water shutdown testing.

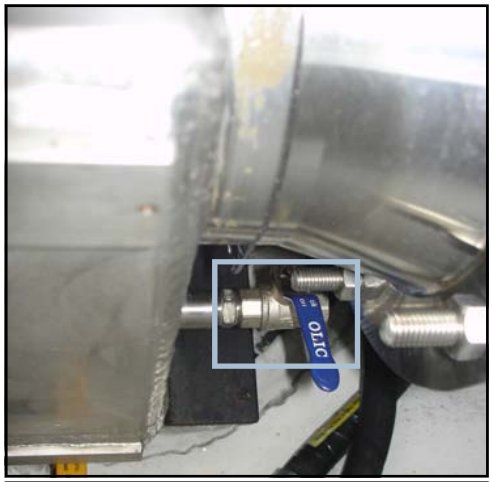
To test the low water shutdown system:

1. Ensure the machine is parked on level surface.
2. Ensure that the make up tanks are full of water.
3. With the engine running at high idle close the main supply/isolation valve to exhaust conditioner.
4. Open the test valve under the exhaust outlet flame trap.
5. Once the water drops below the prescribed level in the float chamber the shutdown float sensors will illuminate on the display panel and the machine will shutdown.
6. Water should flow out the test valve after the machine has stopped.
7. Reset the on/off toggle switch and try to start the machine, it should not start.
8. Close the test valve and open the main supply/isolation valve to allow the exhaust conditioner to fill again.
9. Once the exhaust conditioner has filled restart the machine as per the start up procedure in Section 7 of the Operator's Manual.

If the engine fails to stop or the water stops flowing out the test valve before the engine stops report to service personnel. DO NOT use the machine until the fault is rectified and tested.



Wet Bath Exhaust Conditioner - Main Supply/Isolation Valve



Wet Bath Exhaust Conditioner - Drain Valve

Maintenance

Every 2000 service hours:

1. Adjust the floats.
2. Clean exhaust conditioner.

The water in the exhaust conditioner is very hot. Personal protective equipment and long sleeve clothing should be warn.

To adjust the make up float:

1. Remove the cover on top of the float chamber to allow access to the floats.
2. Open make up supply valve.
3. Allow the water to flow into the scrubber and float chamber.
4. Once the water has stopped measure the water against the prescribed level.
5. If the level is incorrect adjust the make up float to achieve a static water level in the float chamber of 107 mm.

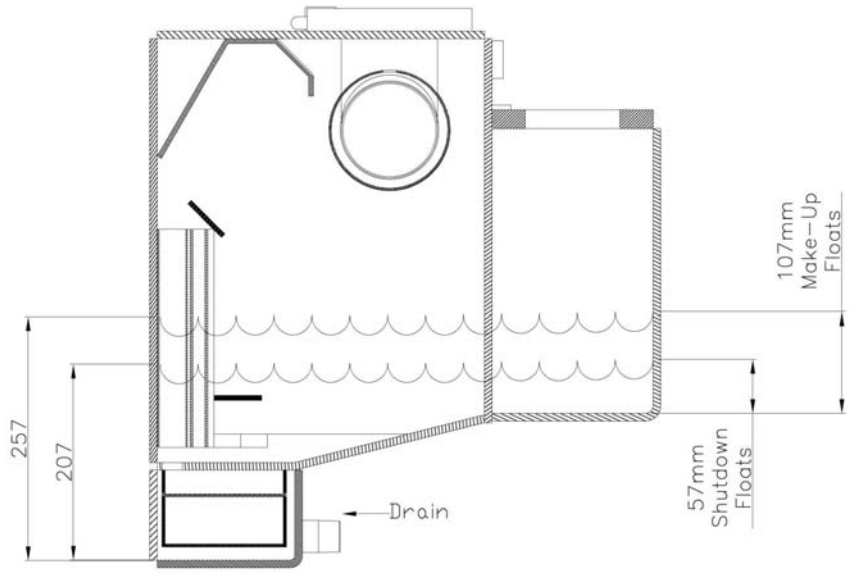
The shutdown floats normally shuts down the engine, however it is important to test floats individually.

Should the system not shutdown at the correct level, the float assemblies can be removed and the floats adjusted to compensate for shutdown levels.

The engine *should not* be running while this test takes place.

To adjust the shutdown floats

1. Close the make up tank isolation valve.
2. Turn on the diesel control system display – *The machine does not have to be running*.
3. Open the test valve in the tank and allow the water to drain.
4. Watch the diesel control system display.
5. When the *Scrubber Level 1* message comes on for low water close the test valve.
6. Record the water level in the float chamber.
7. Adjust the shutdown float level until a water level of 57 mm is achieved.
8. At this point ensure that water is flowing out of the drain tap when the *Scrubber Level 2* message comes *on* – if not float adjustment is necessary.
9. Repeat for the second float.



Exhaust Conditioner

To clean exhaust conditioner:

1. Ensure that the engine has had sufficient time to cool and is isolated and tagged as described in Section 1.
2. Shut off the main supply/isolation valve.
3. Locate the drain valve at the bottom of exhaust conditioner.
4. Open valve to release all water in conditioner.
5. Remove the two inspection covers on the side of conditioner and the float assembly.
6. Remove the exhaust flame trap and clean with detergent and clean water.
7. Clean all soot deposit build up from the exhaust conditioner components.
8. Clean and inspect gasket surfaces.
9. Reinstall the inspection covers, float assembly and exhaust flame trap with new gaskets.
10. Check and fill water in the make up tank and supply/isolation valve.
11. Check for leaks.
12. Start the engine and see if any leaking or shortage of water, fill if necessary.

Over time particulate matter (the small particles that are present in exhaust smoke) will build up on the exhaust conditioner components which may result in decreased efficiency. To minimise build up the exhaust conditioner should be cleaned every 2000 hours.

EXHAUST OUTLET FLAME TRAP

The exhaust system has a flame trap situated between the outlet on the exhaust conditioner housing and the exhaust outlet pipe.

This flame trap prevents any internal explosion from within the engine or exhaust system from entering the mine atmosphere. The flame trap should be cleaned on a weekly basis.

To clean the flame trap element:

1. Ensure that the engine has had sufficient time to cool and is isolated and tagged as described in Section 1.
2. Remove the top two bolts and loosen the remaining four, remove the flame trap element from the housing.
3. Remove and clean old gaskets and inspect the flame path surfaces.
4. Steam clean the flame trap.
5. Reinstall flame trap using new gaskets and tighten all bolts.

Flame Trap Fitted

FLAME PATH JOINTS OR FIXED CONNECTIONS

As with other maintenance and examination schedules the flameproof exhaust system should be inspected, by a suitably appointed and qualified person, at intervals consistent with mine site and statutory maintenance schemes. The following is the suggested intervals for maintenance and inspection of the flameproof components.

Daily:

Visually check joint fasteners (nuts, bolts and studs) securing flameproof joints i.e. exhaust manifold to engine block, exhaust manifold to turbo, turbo to exhaust downpipe, exhaust downpipe to exhaust conditioner, exhaust conditioner to flame trap.

Every 50 service hours:

Check tightness of all joint fasteners (nuts, bolts and studs) securing flameproof joints i.e. flame exhaust manifold to engine block, exhaust manifold to turbo, turbo to exhaust downpipe, exhaust downpipe to exhaust conditioner, exhaust conditioner to flame trap. Use soapy water around joints to check for any leaks.

Every 2000 service hours or 2 service years (Code D):

1. Disassemble all flameproof joint connections and inspect for finish, flatness, corrosion or damage. Repair as required.
2. Discard and replace all fixed joint gaskets.
3. Hydrostatically pressure test all exhaust system exhaust and water jacket chambers external to the engine block i.e. exhaust downpipe and purifier.

Water Jacket	Hydrostatic test – 25 0kPa (35 psi)
Gas Path	Hydrostatic test – 1589.9 kPa (229 psi)
Exhaust Conditioner	Hydrostatic test – 100 kPa (14.5 psi)

EXHAUST EMISSION TESTING PROCEDURE

Statutory requirements specify intervals for testing diesel engine exhaust emissions. For accurate testing the engine must be loaded as near as practical to maximum output power. The following procedure should be followed for loading the diesel engine to near maximum power.

Wear personal protection equipment when working in proximity to a running engine as long term hearing loss may result.

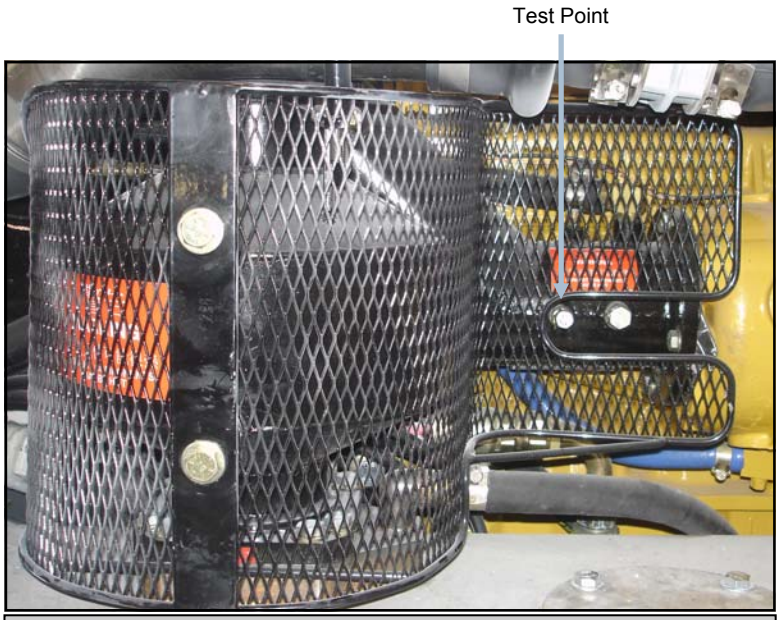
Position wheel chocks at both front wheels to eliminate sudden machine movement.

WARNING

Position all persons clear of the machine to avoid impact if the machine suddenly moves forward.

NOTICE

A gas sampling point is located on the incoming side of the exhaust conditioning system so that raw exhaust samples can be taken.



Exhaust Downpipe

To test exhaust gas emissions:

1. Find a suitable location for testing with sufficient clearance around the machine.
2. Run the machine to bring the engine up to operating temperature.
3. With the park brake released and the brake fully applied, engage the transmission in 4th gear and in the forward direction (direction of the lift arms).
4. Slowly actuate the accelerator pedal to full throttle with the brake applied.
5. When the accelerator is at full throttle actuate the joystick control lever until hydraulic stall is achieved i.e. relief pressure of 20.1 MPa (2900 psi). .
6. The machine is now in full transmission and hydraulic stall (as close as practical to maximum output power).
7. With an operator maintaining transmission and hydraulic stall take gas readings at the exhaust downpipe test point or outlet pipe.

WARNING

Observe the transmission temperature gauge during stall and remove engine load if temperatures approach the maximum indicated on the transmission temperature gauge. Full stall should only be carried out for a minimal period.

THROTTLE CONTROL

GENERAL DESCRIPTION

The throttle control pedal located in the operator's compartment is connected to an arm on the engine governor by a cable. Pedal actuation provides proportional throttle control via the cable to increase the engine revs. The throttle actuation is returned via a spring fitted at the pedal end.

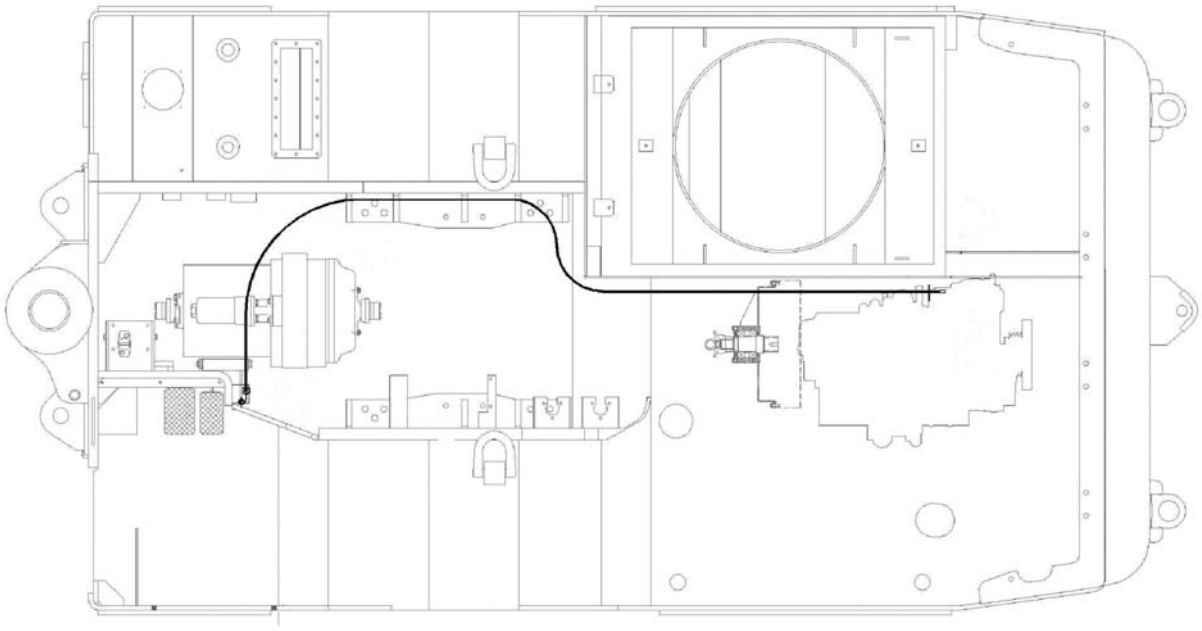
SAFETY PRECAUTIONS

The following safety precautions are not intended to be exhaustive. Safe work practices should be used when servicing or operating heavy machinery.

ALWAYS give the engine an opportunity to cool down before performing throttle control system servicing.

ALWAYS wear personal protective equipment including safety glasses, gloves and suitable clothing, particularly when bleeding the throttle control cylinders.

ALWAYS be aware of, and isolate, other forms of energy and pinch points (fan, belts, pulleys, drive lines) when accessing the engine compartment including pneumatic stored pressure, engine coolant pressure and other heat sources such as engine block and exhaust system components.



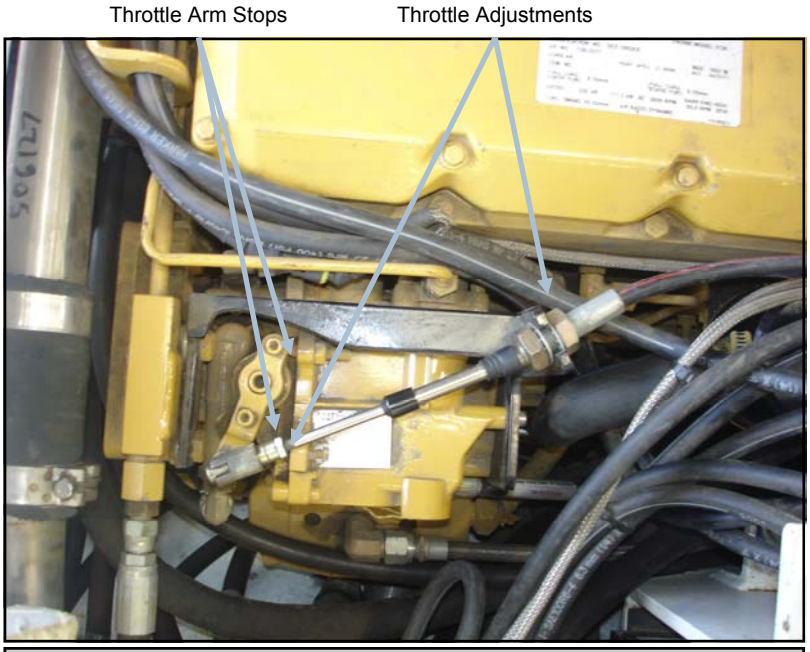
Cable Throttle Control

CABLE ADJUSTMENT

The adjustment and routing of the cable should be checked as prescribed in the preventative maintenance schedules.

Items to check:

1. The throttle lever arm on the governor should come to rest against both idle and high idle stops, there should be a small amount of free play in the cable at the idle stop position.
2. The return spring should be fitted and in good condition, if it is stretched or excessively corroded it should be replaced.
3. The cable condition for fraying and debris build up.
4. The cable movement and retuning motion should be free.



Governor and Cable Mounting

ENGINE SYSTEM TROUBLESHOOTING

The following Engine System Troubleshooting Guide is intended to provide basic guidance for analysing poor engine performance and determining probable causes. This guide is not intended to be exhaustive as particular engine tuning and adjustments, such as exhaust valve adjustment, fuel injector timing, governor adjustment and fuel modulator setting are only intended to be performed by Caterpillar representatives.

Tampering with the engine governor and fuel injector settings will result in adverse engine performance and may void the conditions for which the engine system has been certified such as operating temperature and exhaust emissions.

Symptom	Probable cause	Caused by	Remedy
Excessive crankcase pressure.	Cylinder blow-by.	Cylinder head gasket leaking.	Consult Bucyrus for analysis.
		Piston or liner damage.	Consult Bucyrus for analysis.
		Piston rings worn or broken.	Consult Bucyrus for analysis.
	Breather restriction.	Obstruction or damage to engine oil breather.	Remove breather and clean out or replace as required.
	Excessive exhaust back pressure.	Restriction in exhaust system.	Clean exhaust system.
Abnormal quantity of black or grey exhaust.	Incompletely burned fuel.	Restricted air inlet to the cylinders.	Inspect, clean or replace air cleaner filter (Section 2). Inspect, clean or replace inlet flame trap (Section 2). Clean exhaust system.
	Excessive fuel or irregular fuel distribution.	Improperly timed injectors.	Consult Bucyrus for analysis.
		Improper fuel specification used.	Verify fuel specification (Section 1).
Blue exhaust smoke present.	Lubricating oil not burned in cylinder (blown through cylinder during scavenging period).	Internal lubricating oil leaks.	See high lubricating oil consumption symptom. Consult Bucyrus for analysis.
Engine hard starting.	Engine will not rotate.	Faulty pneumatic start circuit.	See Section 7.
		Internal engine seizure (if engine can not be hand cranked at least one revolution).	Consult Bucyrus for analysis

Symptom	Probable cause	Caused by	Remedy
	Slow engine cranking speed.	Improper lubricating oil viscosity.	Verify lubricating oil specification (Section 1).
		Faulty pneumatic start circuit.	See Section 7.
		Worn or damaged starter motor.	See Section 7.
		Low pneumatic system air pressure.	Verify correct system air pressure and top up with external source if required.
	No fuel delivery to cylinders.	Faulty fuel system.	See no fuel or insufficient fuel symptom.
	Low cylinder compression.	Burned or sticking exhaust valves.	Consult Bucyrus for analysis.
		Compression rings worn or broken.	Consult Bucyrus for analysis.
		Cylinder head gasket leaking.	Consult Bucyrus for analysis.
		Improper valve clearance adjustment.	Consult Bucyrus for analysis.
Abnormal engine operation.	Uneven running or frequent stalling.	Low coolant temperatures.	Check coolant temperature gauge. If the temperature does not reach 71°C–92°C see low coolant temperature symptom.
		Insufficient fuel.	See no fuel or insufficient fuel symptom.
		Faulty injectors.	Consult Bucyrus for analysis.
		Low compression pressures.	Consult Bucyrus for analysis.
		Governor instability (hunting).	Consult Bucyrus for analysis.
	Lack of engine power.	Improper engine tune adjustments or gear train timing.	Consult Bucyrus for analysis.
		Insufficient fuel.	See no fuel or insufficient fuel symptom.
		Restricted air inlet to the cylinders.	Inspect, clean or replace air cleaner filter (Section 2). Inspect, clean or replace inlet flame trap (Section 2).
No fuel or insufficient fuel.	Fuel system air leaks.	Low fuel supply.	Check the fuel tank level and adjust as required.

Symptom	Probable cause	Caused by	Remedy
		Loose, broken connections or cracked lines between the fuel tank and fuel pump.	Inspect for loose connections and damaged lines and replace as required. Carry out a fuel flow test to check for aerated fuel (see Section 2).
		Faulty injectors.	Carry out a fuel flow test to check for aerated fuel (see Section 2). If supply lines are OK consult Bucyrus for further analysis.
	Flow obstruction.	Fuel/water separator, fuel filter or fuel lines restricted.	Carry out a fuel flow test to check for correct fuel flow (see Section 2). Check supply lines for kinks or blockage.
	Faulty fuel pump.	Relief valve not seating.	Carry out a fuel flow test to check for correct fuel flow (see Section 2). Clean and inspect valve seat assembly if inadequate flow is present
		Worn fuel pump gears or body.	Replace fuel pump or overhaul existing assembly. Consult Bucyrus for fuel pump overhaul.
		Fuel pump not rotating.	Check condition of the fuel pump drive. Replace defective parts.
High lubricating oil consumption.	External leaks.	Oil lines or connections leaking.	Visually inspect and rectify as required.
		Gasket or oil seal leaks.	Clean engine with degreaser and run at operating temperature to reveal leaks. Replace gaskets as required.
		Overfilled crankcase.	Check oil level after allowing sufficient time for the oil to settle and drain as required.
		Obstruction or damage to engine oil breather.	Remove breather and clean out or replace as required.
	Internal leaks.	Blower oil seals leaking.	Remove air inlet housing and flame trap. Operate the engine at half throttle and idle and inspect blower end plates for leakage past the seals. Overhaul blower is excessive leakage is evident. Consult Bucyrus for overhaul.
		Turbo oil seals leaking.	Remove intake air and exhaust piping and check for oil on the compressor or turbine sides of the turbocharger.

Symptom	Probable cause	Caused by	Remedy
		Oil cooler core leaking.	Pressure test cooling system. Replace oil cooler if leak is found. Check for coolant/oil contamination and flush as described in Sections 2.
		Worn exhaust valve guides.	Replace valve guides. Consult Bucyrus for valve guide replacement.
Low oil pressure.	Lubricating oil.	Suction loss.	Check the oil level and bring the full level on the dipstick.
		Incorrect lubricating oil viscosity.	Verify correct lubricating oil specification. See Section 1.
	Poor lubricating oil circulation.	Clogged cooler (indicated by high oil temperature).	Remove and clean the oil cooler core.
		Cooler bypass valve not functioning.	Remove bypass valve, clean valve and valve seat, inspect spring.
		Pressure regulator valve not functioning.	Remove pressure regulator valve, clean valve and valve seat, inspect spring.
		Excessive wear on crank shaft bearings.	Consult Bucyrus for bearing replacement.
		Gallery, crank shaft or cam shaft plugs missing.	Replace missing plugs.
	Oil pump faulty.	Intake screen clogged.	Remove and clean oil pan and intake screen.
		Relief valve faulty.	Remove relief valve, clean valve and valve bore, inspect spring. Consult Bucyrus for overhaul.
		Air leak in pump suction.	Disassemble piping and install new gaskets.
		Pump worn or damaged.	Overhaul or replace pump. Consult Bucyrus for overhaul.
Abnormal engine coolant operating temperature.	Coolant temperature too low.	Improper circulation from thermostat not closing.	Remove test and replace thermostat as required. See Section 2.
		Excessive leakage at thermostat seal.	Replace thermostat seals when thermostat is removed. See Section 2.
	Coolant temperature too high.	Insufficient heat transfer through the radiator core.	Clean exterior of core to permit normal air flow. See Section 2.
			Descale cooling system internals to remove flow restrictions. See Section 2.

Symptom	Probable cause	Caused by	Remedy
			Check, adjust and replace fan pulley belts as required. See Section 2.
		Improper circulation from flow restriction.	Remove test and replace thermostat as required. See Section 2.
			Descale cooling system internals to remove flow restrictions. See Section 2.
			Inspect hoses for undue bends, kinks or crushing.

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