MITSUBISHI DIESEL ENGINE

OPERATION MANUAL

MITSUBISHI DIESEL ENGINE

S4Q,S4Q2

SWIRL CHAMBER TYPE

May '93

Quality makes the Difference

INTRODUCTION

This manual has operation instructions and maintenance information for the Mitsubishi S4Q-11C, S4Q-12C, S4Q-61GC, S4Q-61GT and S4Q2-61GT diesel engines. The information, specifications and illustrations in this manual are on the basis of the S4Q-61GT engine unless the model is particularly specified.

OPERATION section is a reference for the new operator and a refresher for the experienced one. Read — study — and keep it handy. Illustrations guide the operator through correct procedures of checking, starting, operating and stopping the engine. Operating techniques outlined in this manual are basic. Skill and techniques develops as the operator gains knowledge of the engine.

MAINTENANCE section is a guide to engine care. The illustrated, step-by-step instructions are grouped by service intervals. Items without specific intervals are listed under "When Required." Items in the Lubrication and Maintenance Chart are referred to the detailed instructions which follow.

SAFETY INFORMATION

Most accidents involving operation and maintenance are caused by a failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. The operator must read and understand all safety precautions and warnings before operating or performing lubrication and maintenance on this engine.

Basic safety precautions are listed in SAFETY section. If these precautions are not observed, bodily injury or death could occur to you and other persons. Warnings in this manual are identified by this symbol:

Operations that may cause damage to, or destruction of, the engine are identified by these symbols:

It is impossible to anticipate every possible circumstance that might involve a potential hazard. The warnings in this manual are therefore not all inclusive. If a procedure or operating technique not specifically recommended by Mitsubishi is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the engine will not be damaged or made unsafe by the operation or maintenance procedures you choose.

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General

1. Attach a "DO NOT OPERATE" or similar tag to the starter switch before checking or servicing the engine.
2. Perform all maintenance unless otherwise specified as follows:

   The engine stopped.

   The battery switch turned off and the key removed.
3. Do not make any check while the engine is running unless otherwise specified. If it is necessary to make checks with the engine running, make sure all protective guards or covers are secured in place on the engine.
4. Use caution when cranking the engine with the turning handle. Be sure to remove the turning handle from the engine after cranking.
5. Make sure no one is working on, or close to, the engine before starting it. Keep the engine free of foreign material, such as debris, oil, tools and other items which are not parts of the engine.
6. Stay clear of all rotating and moving parts during operation. Keep objects away from moving fan blades. They will throw or cut any object or tool that falls or is pushed into them.
7. Always use tools that are in good condition and be sure you understand how to use them before performing any service work on the engine.
8. Wear a hard hat, safety goggles and other protective equipment as required by job conditions.
9. When using pressure air for cleaning, wear a protective face shield and protective clothing.
10. Do not wear loose clothing or jewelry that can catch on controls or other parts of the engine.
11. Battery electrolyte is an acid and can cause personal injury if it contacts skin or eyes. If you spill acid on yourself, flush skin immediately with lots of water. If acid gets in your eyes, flush them immediately with large amount of water and see a doctor at once.
12. Cooling system conditioner contains alkali. Avoid contact with skin and eyes, and do not drink, to prevent personal injury.
13. Start and operate the engine in a well ventilated area only. In an enclosed area, vent the exhaust to the outside.

Fire or Explosion Prevention

1. Repair any loose or damaged fuel and oil lines, tubes, and hoses. Leaks can cause fire.
2. Do not smoke while refueling, or in a refueling area.
3. Shut off the engine when refueling and use extra caution if the engine is hot.
4. When pouring fuel into the tank, ground the funnel or spout against the filler neck to avoid static electric spark.
5. Do not smoke in areas where batteries are charged, or where flammable materials are stored.
6. Clean and tighten all electrical connections. Check daily for loose or frayed electrical wires. Have all loose or frayed wires tightened, repaired or replaced before operating the engine.
7. Keep all fuels and lubricants stored in properly marked containers, away from all unauthorized persons.
8. Store all oily rags or other flammable material in a protective container, in a safe place.
9. Remove all flammable materials such as fuel, oil and other debris before they accumulate on the engine.
10. When starting the engine from an external electrical source, always connect the positive (+) boost cable to the positive (+) terminal of the battery of the engine. Attach the negative (–) boost ground cable last, to the hanger (lifting hook), away from the battery.
11. Always have a fire extinguisher near the engine and know how to use it. Check and have it serviced as recommended on its instruction plate.

Burn Prevention

1. Hot oil and components can cause severe burns. Do not allow hot oil or components to contact the skin. Wear heavy gloves and eye protection when draining or handling hot oil.
2. At operating temperature, the engine coolant is hot and under pressure. The radiator and all lines to the engine contain hot water or steam. Any contact can cause severe burns.
3. Check the coolant level only after the engine has been stopped and the filler cap is cool enough to remove with your bare hand. Remove the radiator filler cap slowly to relieve pressure.

Operating Engine Properly

1. Never attempt to break the seals of the injection pump governor for maximum speed and maximum injection quantity settings. Breaking these seals and varying the settings could result in —

- Accelerated wear of engine components
- Increase in fuel and oil consumption
- Maladjusted injection quantity and poor engine performance

2. Always keep the engine room well ventilated. Unless it is properly ventilated, the air supply will be inadequate, resulting in lack of air for fuel combustion and loss of power.
3. Start the engine properly. After every 30 seconds of engine cranking, allow 2 minutes for the starting motor to cool before cranking again.
4. After starting the engine, warm it at slow idle for five to 10 minutes before operating under full load, for maximum engine life.

NOTE

Long periods of warming up the engine is not recommended. This can result in carbon deposits in the combustion chambers and incomplete fuel combustion.

5. Do not turn OFF the battery switch when the engine is running to avoid damage to alternator.
6. Avoid overloading. This can cause incomplete combustion often indicated by black exhaust, high fuel consumption and carbon deposits in the combustion chambers, affecting engine life.
7. During the first 50 hours of operation, break-in the engine under a lighter load and lower speeds than normal. Proper break-in contributes to maximum service life of the engine.
8. Stopping the engine immediately after it has been working under load can result in accelerated wear of the engine components. Before stopping, operate the engine at low idle for five minutes. This allows hot areas in the engine to cool gradually, extending engine life. With the engine so running, make a walk-around inspection, checking for oil, fuel or coolant leaks.

Servicing Engine Properly

1. Use the recommended fuel, oil and coolant listed in this manual. Use of any other fuel, oil or coolant can result in higher maintenance costs and reduced engine service life.
2. Be sure to perform pre-start inspection and periodic service on items specified in this manual. Improper performance of inspection or service is dangerous and could result in damage to the engine, or injury or death.
3. At the end of each day of operation, check the engine for broken, defective or missing parts. If your daily check uncovers any item that needs attention — repair, replacement or adjustment, report it soon. Remember, the most minor defect could result in more serious trouble.
4. When washing the engine, cover the air inlet and exhaust openings with tape to prevent water or cleaning agent from getting inside the engine. Do not attempt to wash the engine when it is running. If water or cleaning agent gets inside the combustion chambers, hammering action of water can cause damage to the engine.
5. Service the air cleaner properly to keep dust and grit-laden air out of the engine because clean air is essential to satisfactory engine operation and long engine life. Dust and dirt entering the engine will cause rapid wear of piston rings, cylinders and pistons with a resultant loss of power and high oil consumption. Also, dust and dirt allowed to build-up in the air cleaner passages will eventually restrict the air supply to the engine and result in heavy carbon deposits on the pistons and valves due to incomplete combustion.

(1) Do not service the air cleaner element when the engine is running.

(2) When removing the air cleaner from the engine for servicing, prevent dust from entering the air passage to the cylinders.

(3) Service the air cleaner element at reasonable intervals, or when the signal of the indicator is visible (if equipped).

(4) Do not use the element if any tears, rips or damage is evident.

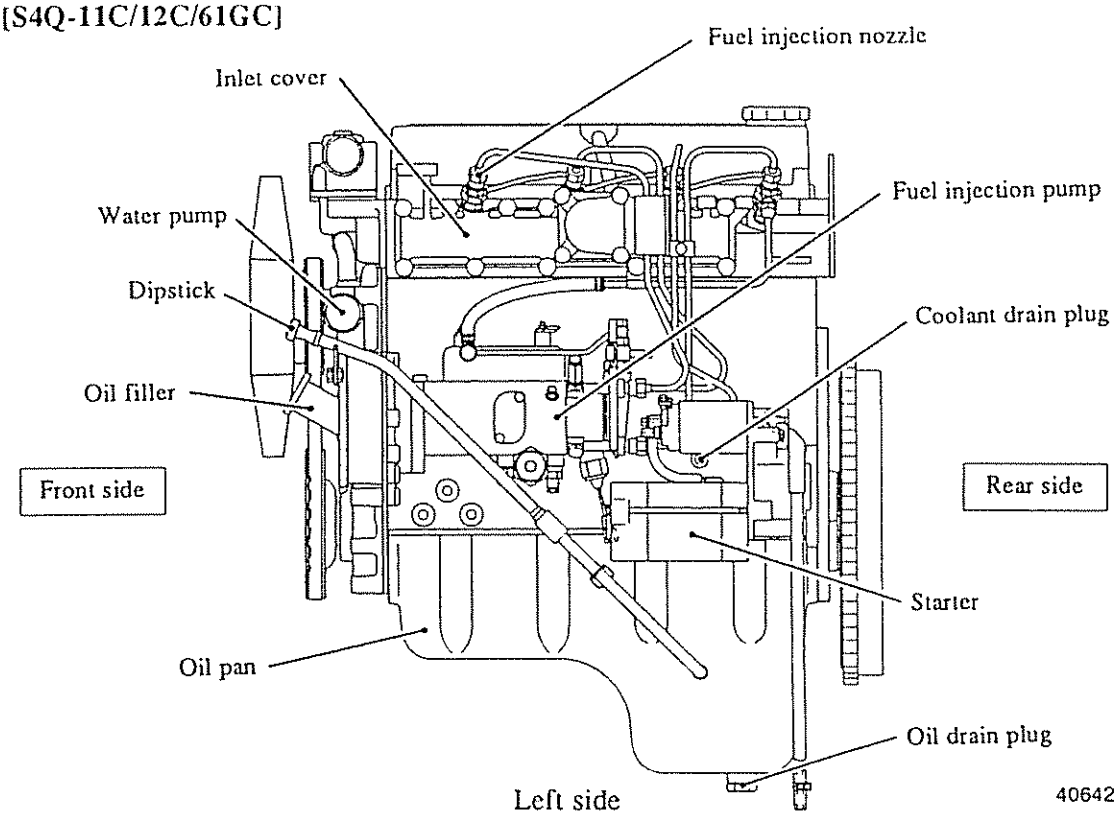
If Any Trouble Should Occur

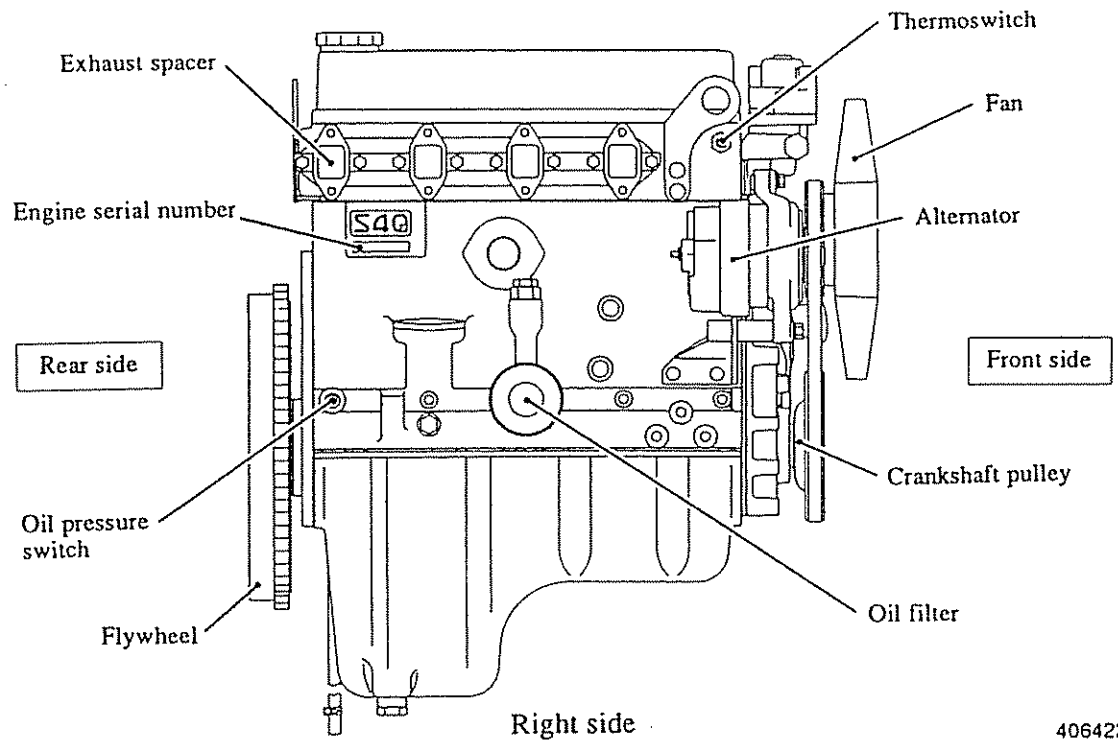
1. If the engine stops abnormally, try to find a problem and its source, then make the necessary repair, before starting the engine again.
2. Stopping an overheated engine immediately can result in seizure of engine components due to sudden coolant temperature rise. Operate the engine at low idle for a while to allow hot areas in the engine to cool gradually before stopping. Do not add coolant to an overheated engine immediately after it has been stopped to prevent damage to engine components such as cylinder head, etc.: allow the engine cool first, then add coolant gradually.
3. If the engine oil pressure becomes low, stop the engine and check for the cause. Operating the engine with low oil pressure can cause seizure of the bearings and other parts.

SPECIFICATIONS

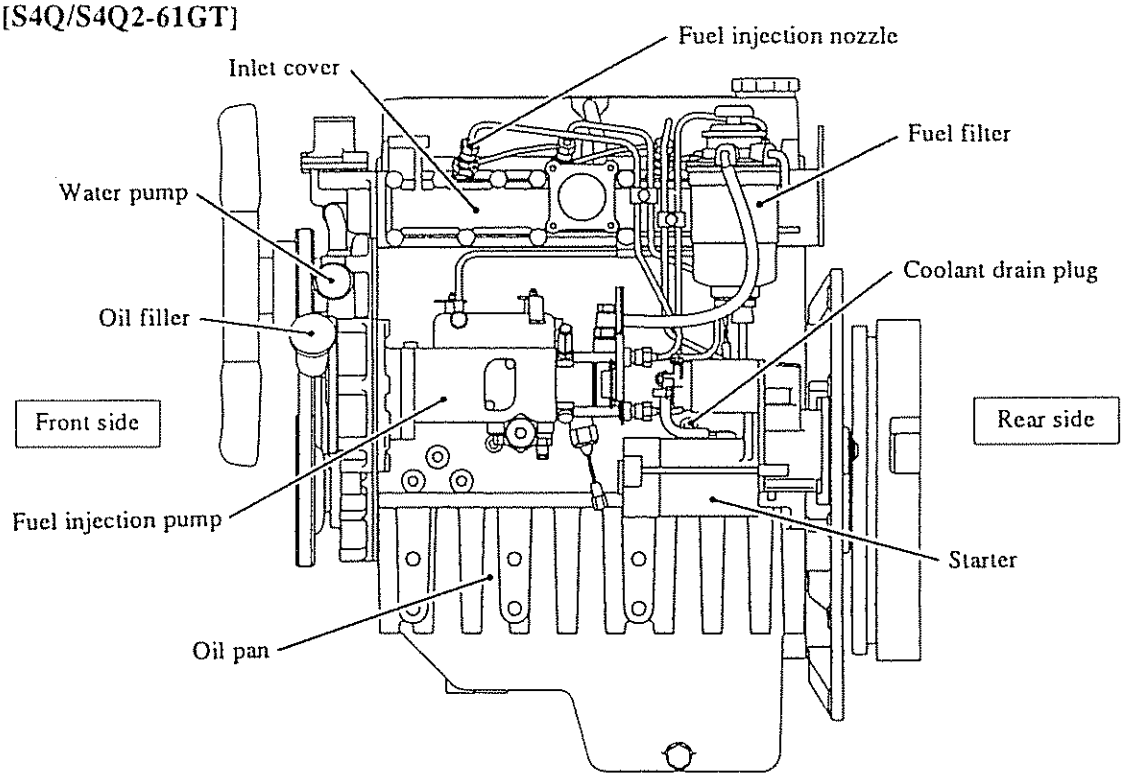
Engine model		S4Q				S4Q2
		11C	12C	61GC	61GT	61GT
Type		Water-cooled, 4-stroke cycle, diesel engine				
No. of cylinders — arrangement		4 — in-line				
Bore x Stroke		88 x 95 mm (3.46 x 3.74 in.)				88 x 103 mm (3.46 x 4.06 in.)
Displacement		2.311 liters (141 cu in.)				2.505 liters (153 cu in.)
Type of combustion chamber		Swirl				
Compression ratio		22				
Firing order (injection sequence)		1 – 3 – 4 – 2				
Rotation		Counterclockwise (when seen from flywheel end)				
Dimensions (length x width x height)		651 x 483 x 708 mm (25.6 x 19.0 x 27.9 in.)				722 x 527 x 717 mm (28.4 x 20.7 x 28.2 in.)
Dry weight		180 kg (397 lb)				245 kg (540 lb)
Fuel system	Fuel injection pump	Bosch throttle type				
	Fuel filter	Cartridge type				
	Fuel injection nozzle	Throttle type				
	Injection pressure (valve opening pressure)	120^{+10}_{0} kgf/cm^2 (1706^{+142}_{0} psi) [$11\ 768^{+981}_{0}$ kPa]				
Lubrication system	Type	Force feed				
	Engine oil	API Service Classification CC				
	Engine oil capacity	Oil pan: 7 liters (1.8 U.S. gal) Complete system: 8 liters (2.1 U.S. gal)				
	Oil filter	Cartridge type (with built-in bypass valve)				
Cooling system	Type	Pressure				
	Capacity	Complete system: 3.7 liters (1.0 U.S. gal)				
Cranking system	Type	Electric				
	Starter	12 V – 2.2 kW				
Charging system	Alternator	12 V – 50 A				

[S4Q-11C/12C/61GC]





[S4Q/S4Q2-61GT]



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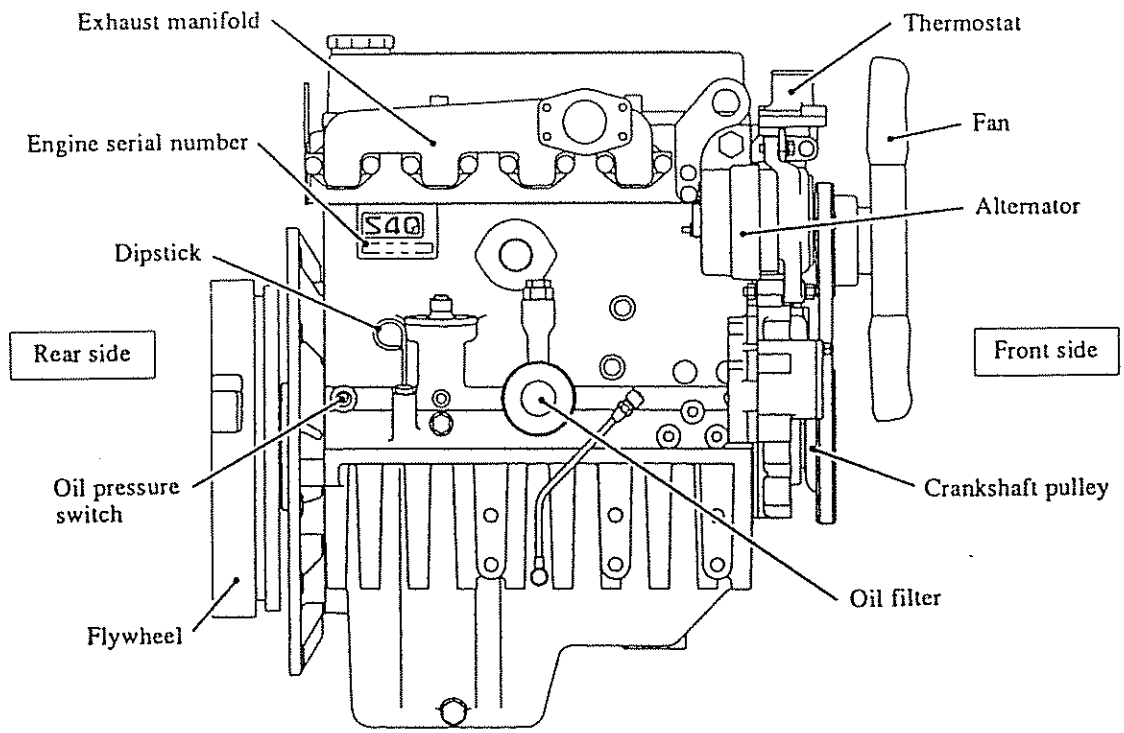

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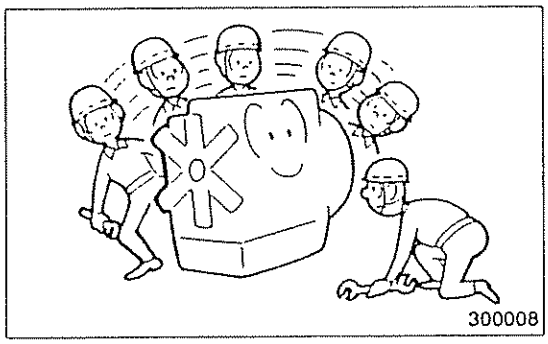
PRE-START INSPECTION

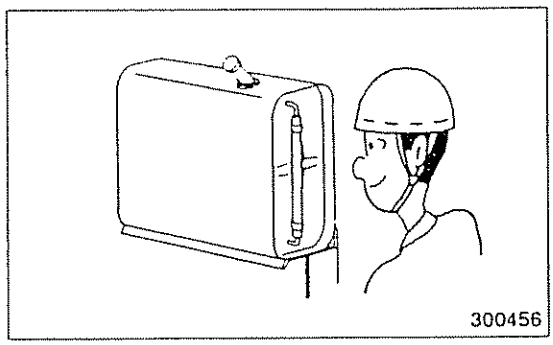
Walk-Around Inspection

Look around for such items as loose bolts, debris build-up, oil, fuel or coolant leaks, broken or worn parts.



Check Fuel Level

Maintain the fuel to the full level in the sight gauge.

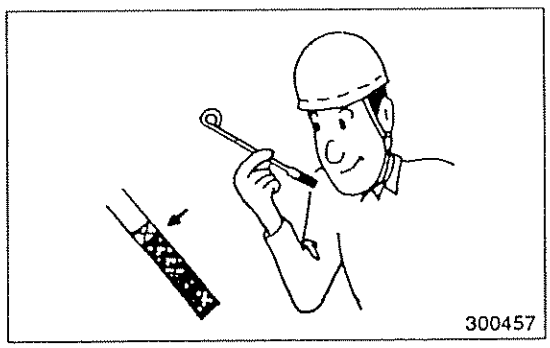


Check Engine Oil Level

Maintain the engine oil level between MAX and MIN marks on the dipstick. Add oil if necessary. (See page 16.)

NOTE

To check the oil level, the dipstick should be withdrawn, wiped clean, reinserted, and again withdrawn so that the oil level on the dipstick can be seen.



Check Coolant Level

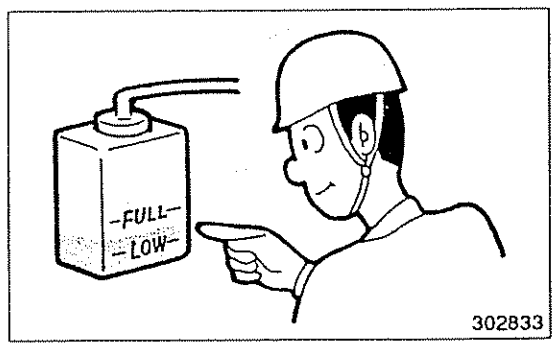
Maintain the coolant level to FULL mark on the reserve tank (when the engine is cold). Add coolant if necessary.

NOTE

When adding coolant, maintain the recommended concentration of Long Life Coolant. (See page 21.) Do not add water only. This dilutes Long Life Coolant and adversely affects freeze protection.

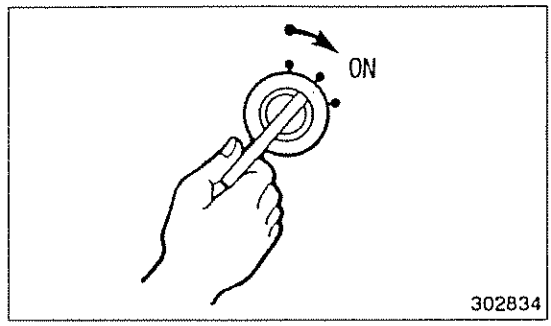
⚠ CAUTION

Check the coolant level only when the engine is cold.

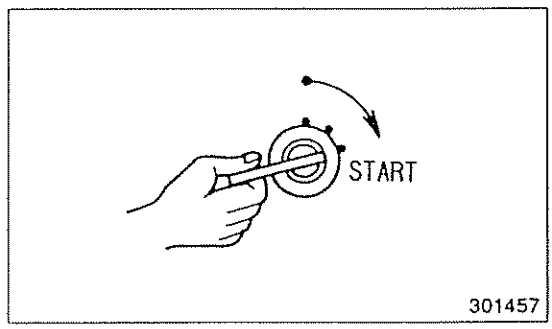


STARTING THE ENGINE

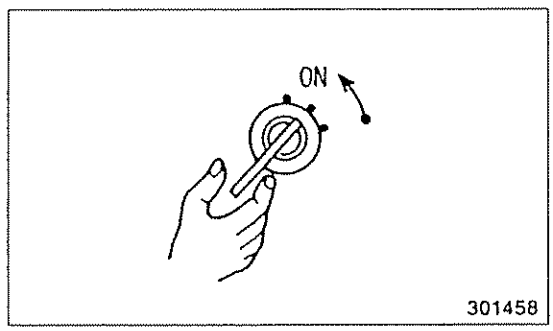
1. Turn the starter switch key to ON position. Make sure the oil pressure, coolant temperature, alternator and glow plug indicators come on. The glow plug indicator will come on for 6 seconds.



2. When the glow plug indicator light goes off, turn the key to START position. The glow plug indicator will also come on even in START position.



3. Release the key when the engine starts. The key will return to ON position when released.



⚠ WARNING

Make sure no one is working on, or close to, the engine before starting it. Keep the engine free of foreign material, such as debris, oil, tools and other items which are not parts of the engine.

⚠ CAUTION

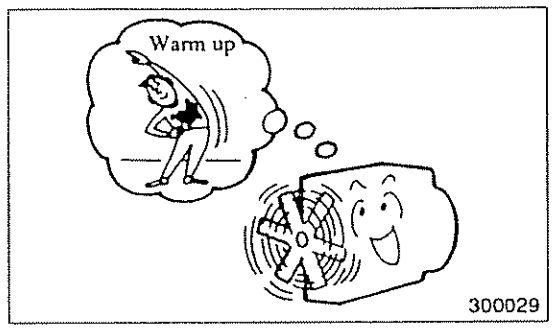
- After every 30 seconds of engine cranking, allow 2 minutes for the starting motor to cool before cranking again.
- Do not apply the load to the engine (disengage the clutch if equipped) when cranking the engine for starting.

WARMING UP THE ENGINE

Allow the engine to warm up at low idle for five to 10 minutes. Proper warm-up is absolutely essential to maximum service life, performance and economy of the engine.

NOTE

Long periods of warming up the engine is not recommended. This can result in carbon deposits in the combustion chambers and incomplete fuel combustion.



STARTING THE LOAD

When the engine has run long enough to warm up, apply the load. During operation, check to be sure —

1. All indicators are OFF.
2. The engine is free from abnormal noise and vibration.
3. Exhaust smoke is normal.

⚠ WARNING

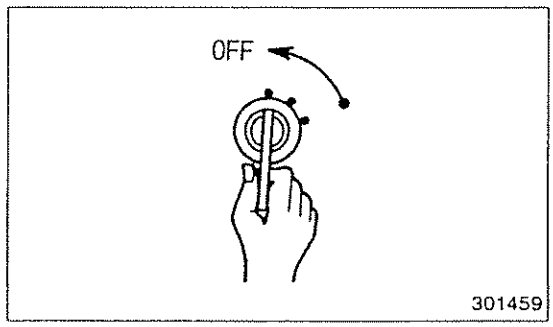
- **Stay clear of all rotating and moving parts during operation.**
- **At operating temperature, the engine is hot. Any contact can cause severe burns.**

⚠ CAUTION

- Always keep the engine room well ventilated. Unless it is properly ventilated, the air supply will be inadequate, resulting in lack of air for fuel combustion and loss of power.
- During the first 50 hours of operation, operate the engine under a lighter load and lower speeds than normal. Proper break-in contributes to maximum service life of the engine.
- Avoid overloading. This can cause incomplete combustion often indicated by black exhaust, high fuel consumption and carbon deposits in the combustion chambers, affecting engine life.
- Do not turn OFF the battery switch when the engine is running to avoid damage to alternator.
- Do not turn the starter switch key to START position when the engine is running to avoid damage to the starter.

STOPPING THE ENGINE

Turn the starter switch key to OFF position.



⚠ CAUTION

- Operate the engine at low idle for five minutes. This allows hot areas in the engine to cool gradually, extending engine life. With the engine so running, make a walk-around inspection, checking for oil, fuel or coolant leaks.
- If the engine stops abnormally, try to find a problem and its source, then make the necessary repair, before starting it again. After starting the engine, check to be sure the engine has no problem.
- Remove the key from the starter switch. Leaving it in ON position after the engine has stopped can cause the battery to discharge.

1. Service the engine in accordance with the "Lubrication and Maintenance Chart." Under extremely severe or dusty operating conditions, service it more frequently than is specified in the "Lubrication and Maintenance Chart."
2. Perform service on items at multiples of the original requirement. For example, at Every 500 Service Hours, also service those items listed under Every 100 Service hours, Every 50 Service Hours and Every 10 Service Hours [pre-start inspection].
3. For special items with asterisk (*), rely on the expert knowledge of the servicemen, and the service facilities at your Mitsubishi dealer.

LUBRICATION AND MAINTENANCE CHART

Service hours	Item	Remarks (specifications)	Page
10 [Pre-Start Inspection]	Walk-around inspection		9
	Check engine oil level.		9
	Check fuel level.		9
	Check coolant level.		9
50	Drain water and sediment from fuel tank.		14
	Check battery electrolyte level and specific gravity.		14
	Drain water from water separator and clean element.		15
First 50 Service Hours of New or Reconditioned Engine	Change engine oil.	Oil pan: 7 liters (1.8 U.S. gal) Complete system: 8 liters (2.1 U.S. gal)	16
	Change oil filter.		16
	Retighten bolts and nuts.		*
250	Change engine oil.	Oil pan: 7 liters (1.8 U.S. gal) Complete system: 8 liters (2.1 U.S. gal)	16
	Change oil filter.		16
	Clean radiator fins.		*
500	Check and adjust valve clearance.	0.25 mm (0.0098 in.) for both inlet and exhaust	*
	Change water separator and fuel filter elements.	After changing, prime (page 22).	18
	Check and adjust injection pressure.	120 kgf/cm² (1706 psi) [11 768 kPa]	*
	Check and adjust fan belt.	Deflection: 13 mm (0.5 in.)	19
	Check glow plugs.		*
1000	Retighten bolts and nuts.		*
	Check starter.		20
	Check alternator.		20
Every 2 Years	Change coolant.	Complete system: 3.7 liters (1.0 U.S. gal)	21
When Required	Prime fuel system.		22
	Clean air cleaner element.		23
	Change air cleaner element.		23

EVERY 50 SERVICE HOURS

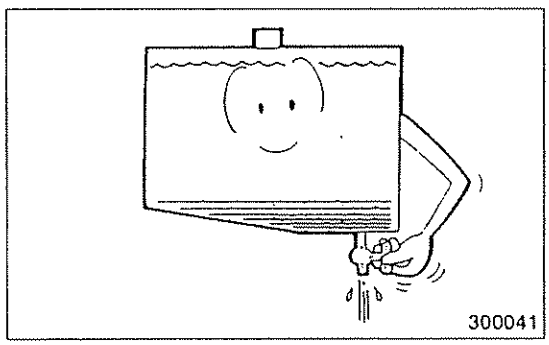
Drain Water and Sediment from Fuel Tank

Remove the drain plug and allow water and sediment to drain. Drain at least one to two liters (0.3 to 0.5 U.S. gal) of fuel to remove water and sediment.

It is evident that invisible particles of dirt in sediment which might pass through the filter can damage the finely finished parts of the fuel injection system.

⚠ WARNING

Do not smoke while draining off water and sediment. Keep flames and sparking devices away. Clean up any spillage before starting the engine.



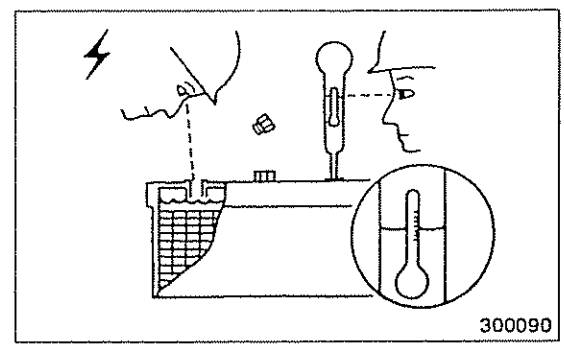
Check Battery Electrolyte Level and Specific Gravity

1. Maintain the electrolyte level between UPPER and LOWER marks on the case. In a battery without level marks, maintain the level 10 to 15 mm (0.4 to 0.6 in.) above the cells. Remove the filler caps and add distilled water if necessary.
2. Test the specific gravity of battery electrolyte with a battery hydrometer. The following table of specific-gravity reading gives a general idea of battery condition.

Specific gravity at 20°C (68°F)	Battery condition	
1.26 — 1.28	Fully charged	—
1.22 — 1.26	Three-fourths charged	To be charged
Below 1.22	One-fourth charged	

⚠ WARNING

- **Battery gives off flammable fumes that can explode.**
- **Do not smoke when observing the battery electrolyte level.**
- **Electrolyte is an acid and can cause personal injury if it contacts skin or eyes.**
- **Always wear protective glasses when working with battery.**

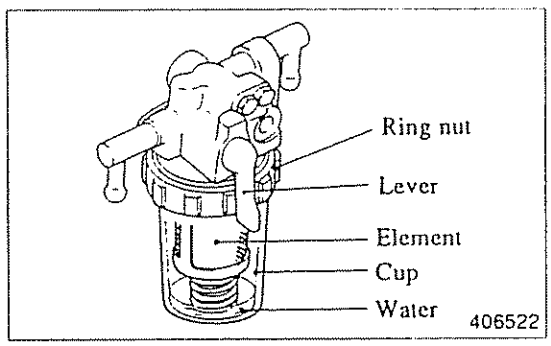


EVERY 50 SERVICE HOURS — Continued

Drain Water from Water Separator and Clean Element

[S4Q-11C/12C/61GC]

1. Turn the lever to CLOSE (C) position to shut off fuel supply.
2. Loosen the ring nut and remove the cup. Empty the cup.
3. Wash the element in clean diesel fuel.
4. Put the element in the cup and install the cup, making sure the O-ring is properly fitted in place. Tighten the ring nut.
5. Turn the lever to OPEN (O) position and prime the fuel system. (See page 22 for priming.)



EVERY 250 SERVICE HOURS

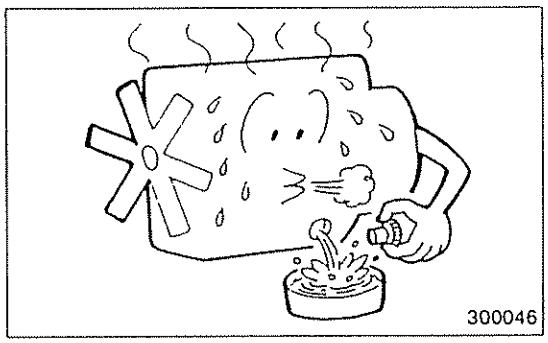
Change Engine Oil and Oil Filter

Draining oil

Immediately after shutting down the engine (when the oil is hot), remove the oil pan drain plug. Allow the oil to drain in a container.

⚠ WARNING

Hot oil and components can cause personal injury. Do not allow hot oil or components to contact skin.



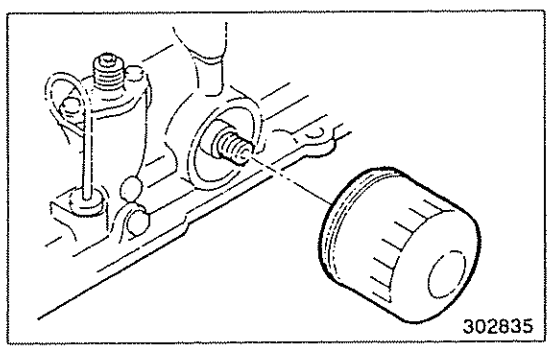
Changing oil filter

1. Remove and discard the used oil filter with a filter wrench.

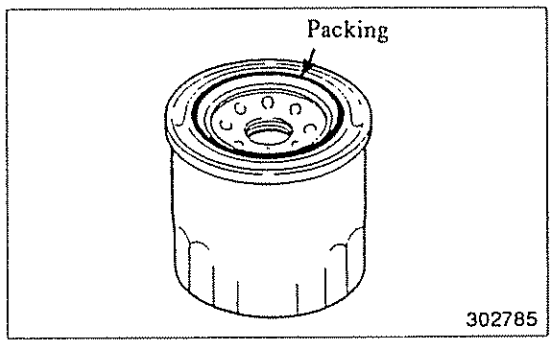
NOTE

Check particles collected in the used oil filter. If they are metallic particles, consult your Mitsubishi dealer.

2. Make sure all of the old filter packing is removed from the filter base and clean the base with a clean cloth.



3. Check the new oil filter to be sure the packing is properly fitted in the groove.
4. Apply a thin coat of engine oil to the packing on the new filter.
5. Install the filter by hand until its packing contacts the base. Tighten 3/4 to 1 turn more.



Filling with oil

1. Install the drain plug and tighten it to the specified torque.

Torque	4.5 ± 0.5 kgf·m (32.5 ± 4 lbf·ft) [44 ± 5 N·m]

2. Fill the crankcase with oil.

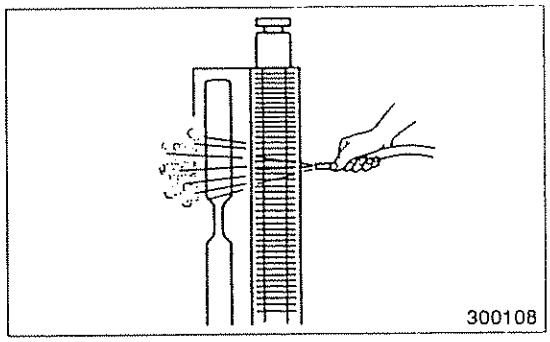
Refill capacity	Oil pan: 7 liters (1.8 U.S. gal) Complete system: 8 liters (2.1 U.S. gal)
API Service Classification	CC

3. Start and run the engine at low idle for a few minutes, and check for leaks. Retighten the filter if leakage is noticed.
4. Stop the engine and leave it standing for about 30 minutes. Check the oil level. Maintain the oil level between MAX and MIN marks on the dipstick. Add oil if necessary.

EVERY 250 SERVICE HOURS — Continued

Clean Radiator Fins

Direct pressure air along the fins from the side opposite to the fan to remove dirt and debris build-up.

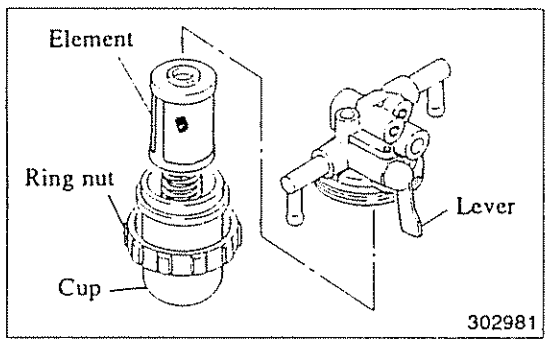


EVERY 500 SERVICE HOURS

Change Fuel System Elements

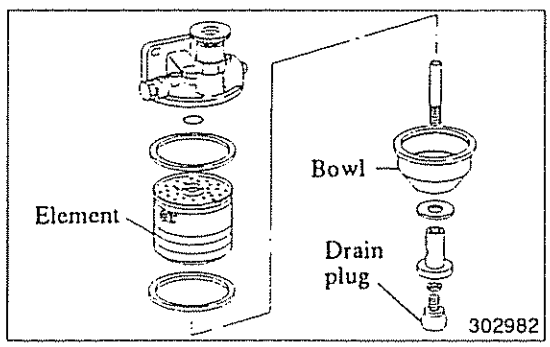
Water separator element [S4Q-11C/12C/61GC]

1. Turn the lever to CLOSE (C) position to shut off fuel supply.
2. Loosen the ring nut and remove the cup.
3. Remove and discard the element.
4. Put the new element in the cup and install the cup, making sure the O-ring is properly fitted in place. Tighten the ring nut.
5. Turn the lever to OPEN (O) position.



Fuel filter element [S4Q-11C/12C/61GC]

1. Loosen the drain plug and allow the fuel to drain.
2. Loosen the plug that holds the bowl and element. Remove the bowl and element. Discard the element.
3. Install the new element and bowl with the plug. Make sure the seal rings are properly fitted in place.
4. Tighten the drain plug.

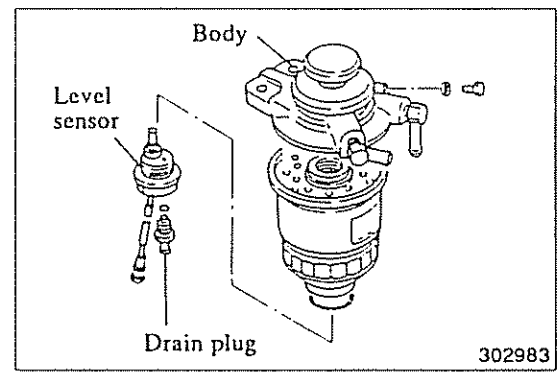


Fuel filter element [S4Q/S4Q2-61GT]

1. Loosen the drain plug and allow the fuel to drain.
2. Remove the connector from the level sensor.
3. Remove the element from the body.
4. Remove the level sensor from the element. Discard the element.
5. Install the level sensor to the new element.
6. Install the new element to the body.
7. Install the connector to the level sensor.
8. Tighten the drain plug.

NOTE

After replacing the elements, be sure to prime the fuel system. (See page 22 for priming.)

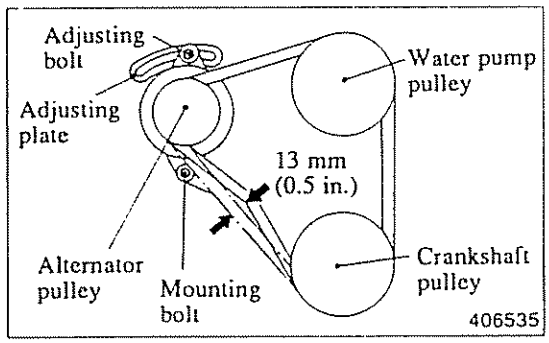


EVERY 500 SERVICE HOURS — Continued

Check and Adjust Fan Belt

Checking

Measure the deflection of the belt. Apply thumb pressure midway between the crankshaft pulley and the alternator pulley. Deflection should be 13 mm (0.5 in.).

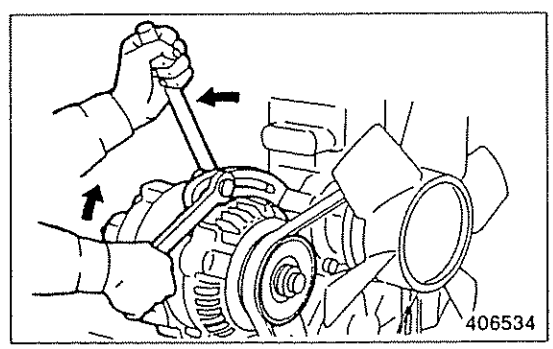


Adjusting

1. Loosen the adjusting bolt and mounting bolt.
2. Insert a pry bar between the alternator and cylinder block, to move the alternator to obtained the required belt deflection.
3. Tighten the mounting bolt and adjusting bolt.

⚠ CAUTION

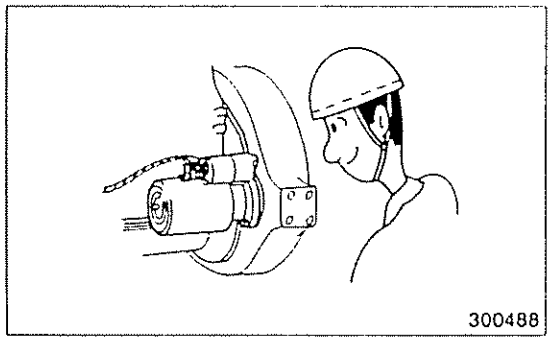
- If the fan belt is too tight, excessive stresses are placed upon the fan bearings and belt, which might shorten the life of both. If it is too loose, it will slap against the pulleys, causing unnecessary wear to the belt and possibly slipping to the extent that the engine will overheat.
- Keep the belt free from oil or grease.



EVERY 1000 SERVICE HOURS

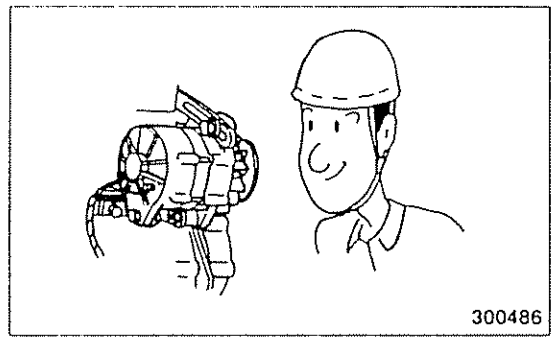
Check Starter

1. Visually check for defects.
2. Check to see if the pinion is shifted into mesh with the flywheel ring gear when the starter is energized. If the pinion does not shift properly, consult your Mitsubishi dealer.



Check Alternator

1. Visually check for defects.
2. Remove the belt from the alternator. Turn the pulley by hand to check the alternator for smooth rotation. If the alternator fails to rotate smoothly, consult your Mitsubishi dealer.



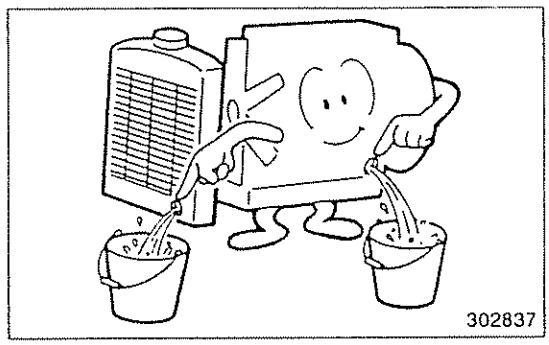
EVERY 2 YEARS

Change Coolant

Long Life Coolant (antifreeze) used in your engine retains its efficacy for two years. Be sure to change the coolant every two years.

Draining

1. Start and operate the engine at low idle until the coolant temperature is 70°C to 80°C (158°F to 176°F). Stop the engine.
2. Raise the radiator filler cap lever to relieve pressure. Then remove the cap.
3. Open the radiator drain valve and remove the engine drain plug. Allow the coolant to drain into containers.



Flushing

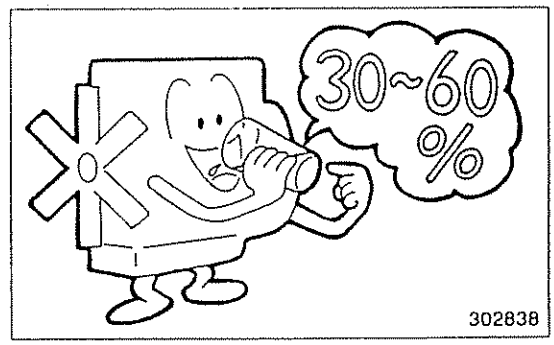
1. Close the radiator drain valve and install the engine drain plug.
2. Fill the cooling system with a cleaning solution which does not chemically attack rubber and metal surfaces. Start and operate the engine at 800 to 900 rpm for 15 minutes. Stop the engine and drain the cleaning solution.
3. Close the radiator drain valve and install the engine drain plug.
4. Fill the system with clean water and operate the engine at 800 to 900 rpm for 10 minutes. Continue to flush the system until the draining water is clear.

Refilling

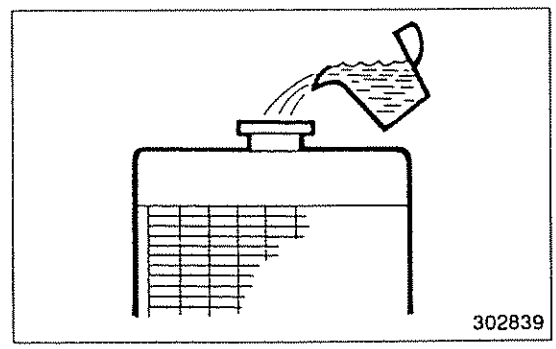
1. Tighten the radiator drain valve and install the engine drain plug.
2. Pour pure, undiluted LLC (antifreeze) into the radiator. Recommended concentration of LLC is shown in the chart below:

Recommended LLC Concentrations (reference)

Ambient temperature, °C (°F)	–10 (14)	–20 (–4)	–30 (–22)	–45 (–49)
LLC concentration, %	30	40	50	60



3. Add water to the radiator slowly to help avoid air pockets in the system.



4. Start and operate the engine at low idle until the coolant temperature is 70°C to 80°C (158°F to 176°F). Stop the engine.
5. Check the coolant level in the reserve tank. Add water if the level is low. Maintain the coolant level to FULL line on the tank when the engine is cold.

WHEN REQUIRED

Prime Fuel System

Air in the lines may cause the fuel system to become air bound, resulting in inability to start the engine or misfiring of one or more cylinders. Prime the fuel system —

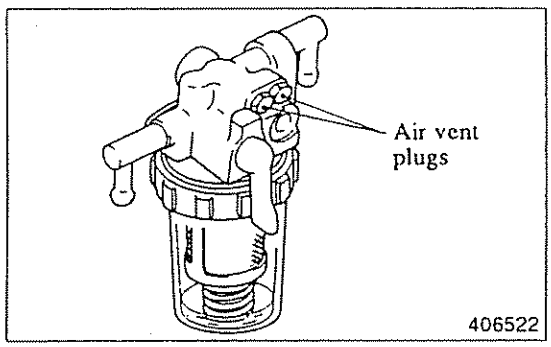
1. After the engine has been fueled for the first time after installation.
2. After the engine has been refueled after running out of fuel.
3. After the water separator and fuel filter elements have been cleaned or changed.

Prime the water separator, fuel filter and fuel injection pump in that order (from the fuel tank side).

Procedure

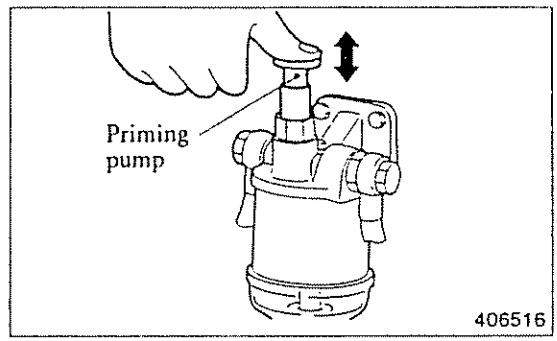
Water separator [S4Q-11C/12C/61GC]

1. Turn the starter switch key to ON position to operate the electric fuel pump.
2. Loosen the air vent plugs of the water separator.
3. When the fuel flows free of bubbles from the air vents, turn the key to OFF position and tighten the plugs.



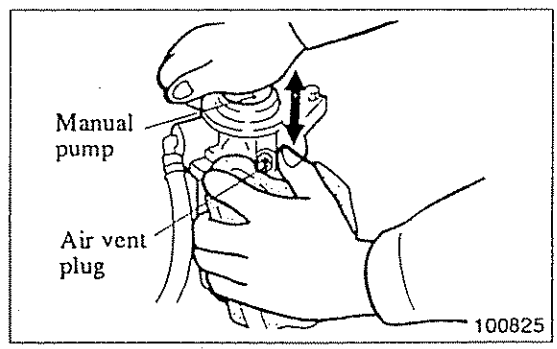
Fuel filter [S4Q-11C/12C/61GC]

1. Turn the starter switch key to ON position to operate the electric fuel pump.
2. Turn the fuel filter priming pump to the left to unlock. Operate the pump about 20 times.
3. Turn the key to OFF position. Turn the priming pump to the right to lock.



Fuel filter [S4Q/S4Q2-61GT]

1. Loosen the air vent plug of the fuel filter with a wrench.
2. Put a clean cloth around the air vent to take in leakage, and operate the manual pump.
3. Tighten the plug when the fuel flows free of bubbles from the air vent.

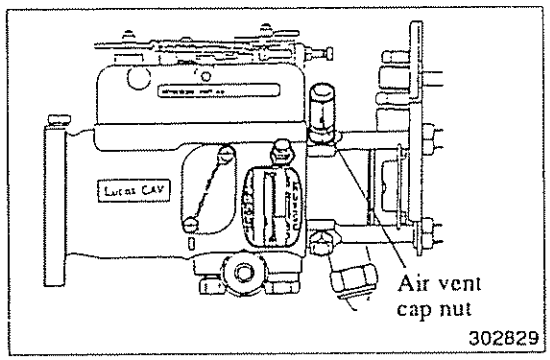


Fuel injection pump [S4Q/S4Q2-61GT]

1. Loosen the air vent cap nut with a wrench, and finger turn it to the stop.
2. Turn the starter switch key to ON position.
3. When the fuel flows free of bubbles from the air vent, turn the key to OFF position and tighten the cap nut.
   Tightening torque: 80 kgf·cm (5.8 lbf·ft) [7.8 N·m]

NOTE

Fuel may leak or spill onto the hot surfaces or electrical components during priming. Cover them with vinyl sheet to avoid contact of fuel. If the manual pump valve is clogged, difficult priming can result. In such a case, remove the air vent bolt and inlet-side hose from the filter and clean the valve with pressure air.

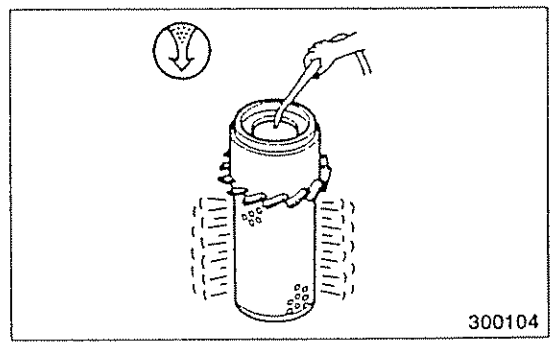


Clean/Change Air Cleaner Element

Service the air cleaner only when required, or when the dust indicator shows RED (if equipped).

Cleaning

1. Direct air — 7 kgf/cm² (100 psi) [686 kPa] maximum — inside the element along the length of pleats.
2. Insert a light inside the clean element and check. Discard the element if rips or tears are found.



NOTE

Discard the element if it is excessively dirty.

⚠ CAUTION

- Never service the air cleaner when the engine is running. Without the air cleaner, dust and dirt enter the engine and can cause rapid wear of engine parts with a resultant loss of power and high oil consumption.
- Do not clean the element by bumping or tapping.

⚠ WARNING

When using pressure air for cleaning. Wear a protective face shield, protective clothing and protective shoes.

FUEL SPECIFICATIONS

1. Recommended types of fuels

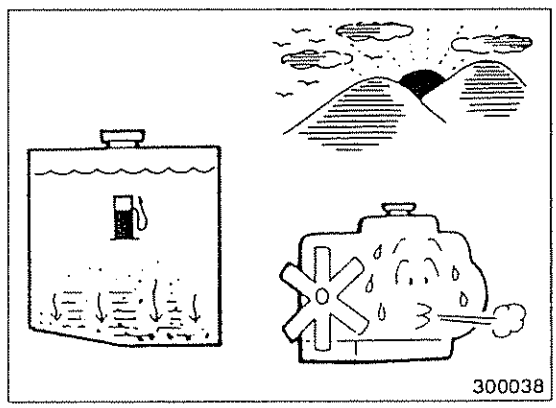
The quality of fuel is a very important factor in obtaining satisfactory engine performance, long engine life, and acceptable exhaust emission levels.

This engine is designed to burn fuels marketed to meet ASTM Designation D 975 (grades No. 1-D and No. 2-D).

The pour point of the fuel should be at least 6°C (11°F) below the atmospheric temperature at which the engine must start.

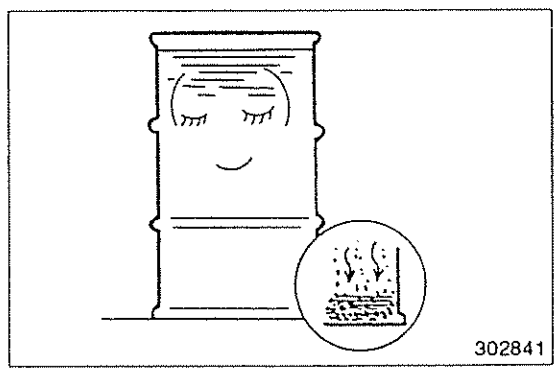
2. Care of diesel fuel tank

Fill the diesel fuel tank at the end of the day, because the incoming fuel will drive out the moisture-laden air and prevent condensation. Every 50 service hours before starting the engine, remove the drain plug and drain off any sediment or water which may have accumulated.

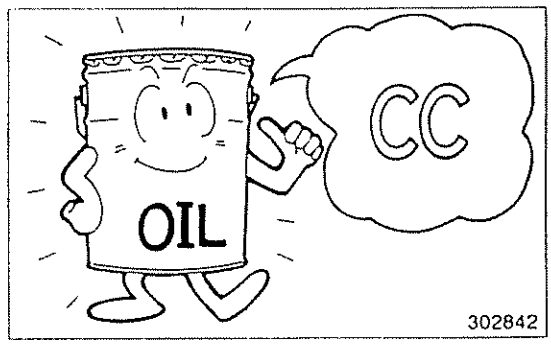


3. Care of fuel supply

It is important to buy clean fuel, and keep it clean. Natural settling is an effective method of cleaning fuel. Allow the fuel to stand at least 10 days in the fuel storage tank after the tank has been filled before the fuel is transferred to the diesel fuel tank. Be sure to drain all water and sediment that has settled to the bottom of the tank before the tank is refilled. Occasionally, drain all of the fuel and clean the tank thoroughly.

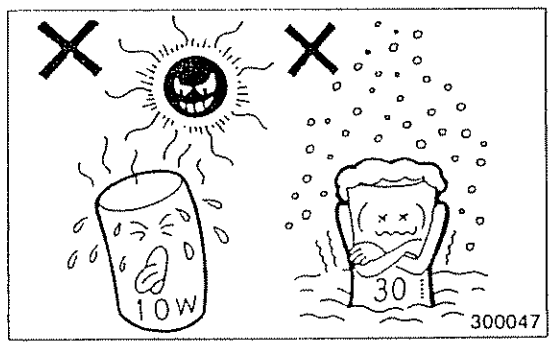


1. Recommended types of engine oils



Use oils that meet the Engine Service Classification CC (MIL-L-2104C). Proper oil selection assures cranking ability by maintaining an oil film on cylinder walls and bearing surfaces in a condition which provides low friction, and therefore, less cranking effort to achieve cranking speeds necessary for reliable starting. Improper oil selection may result in congealed oil film on cylinder walls and bearing surfaces, which result in high friction loads and more cranking effort, thus preventing sufficient cranking speeds for reliable starting and affecting engine life.

2. Recommended oil viscosities



Two important considerations related to satisfactory engine operation under ambient temperature conditions — (1) the ability to crank the engine fast enough to assure starting, and (2) adequate lubrication of internal wearing surfaces during starting and warm-up. These considerations can be adequately met through proper grade selection. Recommended oil viscosities are shown in the chart below:

Recommended Oil Viscosities

Starting temperature, °C (°F)	−30 (−22) −25 (−13) −20 (−4) −15 (5) −10 (14) −5 (23) 0 (32) 10 (50) 20 (68) 30 (86) 40 (104)
Oil viscosities	SAE 30 SAE 5W−20 SAE 40 SAE 10W−30 SAE 15W−40

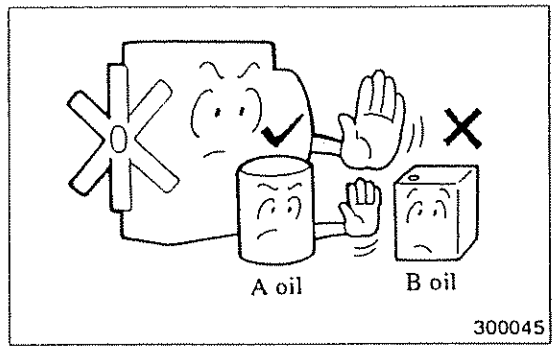
Mitsubishi recommends all-season type engine oil of SAE 10W-30.

3. Recommended brands of oils

Recommended brands of oil are shown in the chart below:

⚠ CAUTION

Avoid mixing oils of different brands. In most cases, different brands are not compatible with each other and, when mixed, can seize parts such as piston rings, cylinders, etc. or abnormally wear moving parts. It is best to stick with one and the same brand of oil at successive service intervals.



Recommended Brands of Oils (Reference)

Manufacturer	Brand	Classification
Mitsubishi Oil	Diamond HD Special	CC
	Diamond HDS-3 Engine Oil	CD
Shell	Silver Parrot Super Oil	CC
	White Parrot Super S-3 Oil	CD
Mobil	Mobil Delvac 1200	CC
	Mobil Delvac 1300	CD
Exxon	Exxon SDX	CC
	Exxon D-3	CD

4. Limiting requirements for engine oils

If a used oil analysis program is conducted in order to determine the condition of the oil, consult the chart below. Change the oil if any of these requirements is not met.

NOTE

- Oil change intervals depend to a great extent on fuel properties. Be sure to use only recommended fuels.
- The limit of total base number is 1/2 of that of a new oil in case of a perchloric-acid analysis method.

Limiting Requirements for Engine Oils

Property		Test method	Limit
Viscosity	cSt @ 100°C (212°F)	JIS K 2283	$^{+30\%}_{-15\%}$, max. of new oil
Total base number (Hcl)	mgKOH/g	JIS K 2501	2.0, min.
Total acid number	mgKOH/g		+3.0, max. of new oil
Water content	Vol%	JIS K 2275	0.2, max.
Flash point (coc)	°C (°F)	JIS K 2265	180 (356), min.
Pentane insolubles	Wt%	ASTM D 893	0.5, max.
Pentan insolubles coagulated	Wt%		3.0, max.

COOLANT AND ANTIFREEZE SPECIFICATIONS

1. Coolant specifications

Water used in the engine cooling system must be soft, or as free from scale forming minerals as possible and meet the requirements shown in the "Coolant Specifications" chart.

NOTE

Basically, harmful chemical properties and substances contained in water (as coolant) must not exceed the Mitsubishi limits but they are tolerable up to the limits shown in the chart below:

Coolant Specifications

Item	Chemical symbol	Unit	Recommended limit	Main malign effect	
				Corrosion and rust	Scale formation
pH, 25°C (77°F)	–	–	6.5 to 8.5 (6.5 to 8.5)	○	○
Electrical conductivity, 25°C (77°F)	–	μΩ/cm	< 400 (< 250)	○	○
Total hardness	$CaCO_3$	PPM	< 100 (< 95)	–	○
M alkalinity	$CaCO_3$	PPM	< 150 (< 70)	–	○
Chlorine ion	Cl^-	PPM	< 100 (< 100)		–
Sulfuric acid ion	SO_4^{2-}	PPM	< 100 (< 50)	○	–
Total iron	Fe	PPM	< 1.0 (< 1.0)	–	○
Silica	SiO_2	PPM	< 50 (–)	–	○
Residue from evaporation	–	PPM	< 400 (< 250)	–	○

The values indicated in ( ) are the limits set forth by Mitsubishi. In addition to the items specified above, turbidity is specified to be above <15 deg.

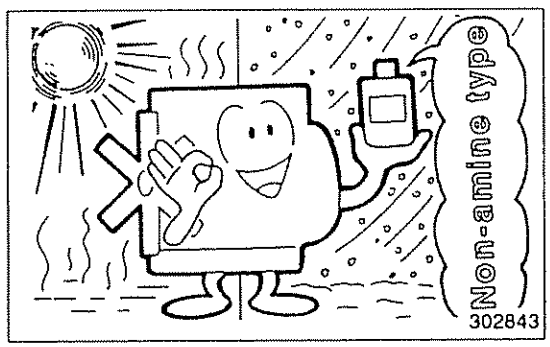
2. Recommended types of LLC's

For Mitsubishi diesel engines, the following brands of all-season, non-amine type LLC's or equivalent are recommended:

Manufacturer	Brand
Mitsubishi Oil	Diamond Diesel Coolant
Mitsubishi Motors	Fuso Diesel Long Life Coolant

Features of recommended brands

- None of amines (methyl amines, ethyl amines, n-propyl amines, etc., all being derivatives of ammonia, NH_3) are contained.
- Silicate and borate are not contained.
- Close to neutral on the pH scale, and hence, slightly basic (alkaline).
- Balanced additive ingredients. some being substitutes for amines.
- Long life. (The coolant with 30% concentration, for example, retains its efficacy for long, not less than 2 years.)



⚠ WARNING

LLC is toxic and can cause personal injury if it contacts skin or eyes. If LLC gets in your eyes, flush them immediately with water and see a doctor at once.

3. How to use non-amine type LLC

(1) The engine coolant with any of the recommended additives should be changed every two years.

NOTE

When using any other LLC, refer to the coolant mixture chart on the container.

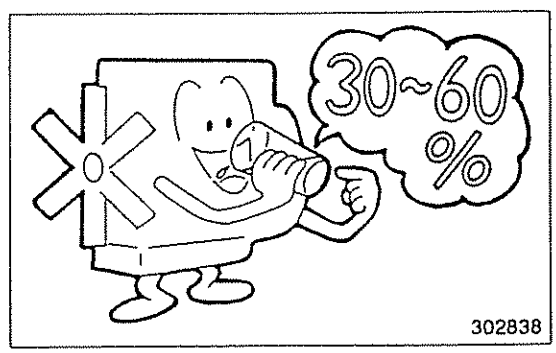
⚠ WARNING

For disposal of a used coolant containing LLC, consult your Mitsubishi dealer.

(2) Proper concentration of LLC is from 30% to 60% year-round. Aim at a temperature level lower by 5°C (9°F) than the expected lowest temperature. LLC of less than 30% concentration does not provide sufficient corrosion protection. Concentrations over 60% adversely affect freeze protection and heat transfer rates. When adding coolant, use LLC of the same concentration.

Recommended LLC Concentrations (Reference)

Ambient temperature, °C (°F)	–10 (14)	–20 (–4)	–30 (–22)	–45 (–49)
LLC concentration, %	30	40	50	60



4. Why LLC?

Today's full-blown trend is toward smaller and more lightweight engines, greater output, lower fuel consumption and lower exhaust emission levels. Engine application has also been expanded. In most applications, the engine coolant is compelled to withstand severe conditions, namely, continuous high-power operation with higher coolant temperature and higher speed of coolant recirculation in the cooling circuit. Many materials involved in the circuit (such as steel, aluminum, copper, solder and rubber) are also subjected to severe service. These materials differ in ionizing tendency and this difference promotes cavitation and deterioration through the medium of engine coolant. The job of breaking the link between cause and effect to preserve the circuit is undertaken by LLC.

5. How LLC works

LLC contains several chemicals (ingredients) in such proportions as to produce chemical reactions that suppress corrosion of engine parts in contact with coolant. "Corrosion" is the result of a phenomenon called "ionization."

The power of LLC to defeat the ionic reaction is generally subject to wear and, in the engine coolant, becomes increasingly weak in time.

Moreover, if its chemicals are not well proportioned to match the circuit metals which they are mean to protect, they become rapidly used up due to aging and allow some metals to precipitate into the coolant or to form new compounds which turn to rusty surface deposits. Some chemicals, calculated to inhibit this ionic reaction, might accelerate the reaction of those metals that have already begun reacting.

For worse, the process of ionic reaction or corrosion will go on faster than when the coolant is straight water having no additives, if there is no good match between the chemical proportions and the circuit metals.

6. Typical reported cases of circuit trouble for which additive is blamed

Case 1:

Amines are generally effective in suppressing the rusting of ferrous metals but are said to be problematic for copper and cupric metals because of copper involvement in pittings reported on Fe metals. The mechanism of Fe-surface pitting may be explained as that of galvanic or local-cell action. Suppose a cluster of copper molecules precipitates out and deposit itself on a surface of Fe, a base metal relative to copper; the copper deposit introduces a localized galvanic cell which, by its ionic action, rapidly eats into the Fe surface to result in a pit.

Case 2:

A silicate (there are several types of silicate) is highly effective in protecting aluminum against rusting. This compound of silicon is unstable in a solution whose pH is 9 or under: it is prone to turn to gel and settle down in the solution. For this reason, the pH is usually specified to be 10 or so. This means that the silicate has to be used in a high-alkalinity coolant. When the silicate is used up, the high alkalinity starts chemically attacking aluminum.

(Example)
The mechanical seal of the water pump may rapidly wear down as the secondary effect of silicate gel in the above context.

Case 3:

As the additive as a whole deteriorates or when its concentration in the coolant is too low, its anti-corrosion performance falls and consequently the circuit metals begin to corrode than when the additive was active. Of those metals badly affected in such a condition, brass and solder, the materials used in the cores of radiator, become particularly victimized. The cause of coolant leakage from and clogging of the coolant circuit in the radiator are usually traceable to such a malcondition of the coolant.

Storage of Engine in Non-Operational Condition

Preparation

1. Drain the engine oil and put a preservative in the engine.
2. Make up a mixture of preservative and fuel oil in 50-to-50 ratio, and put the mixture in the fuel tank.
3. Start and operate the engine at low idle for five to 10 minutes.
4. Stop the engine and spray volatile preservative in the air inlet opening.
5. Drain the preservative-fuel mixture.
6. Apply a coat of preservative to the exposed machined surfaces of the engine.
7. Cover the air inlet and exhaust openings and the breather with taping.
8. Loosen the fan belt.
9. Tape the starter and alternator terminals. Cover the starter and alternator with polyethylene sheet and put a desiccant inside.
10. Disconnect the cables from the battery and charge the battery. Flush the top of the battery with clean water, and coat the parts with grease to retard further corrosion. Keep the battery in a cool, dry place.
11. Cover the engine to protect it against weather.

NOTE

- Store the engine in a well-ventilated room.
- It is not necessary to drain the coolant if it contains LLC.
- Attach "DO NOT OPERATE" or similar warning tag to the starter switch or any control.
- New engine oil may be used instead of preservative.

Recommended Brands of Preservative (Reference)

Specification	Preservative
P-9	US Horton Rustbet Cosmolin
P-10	US Horton Cosmoline 1051, 1049

Service during storage

Charge the battery at least once a month.

Remove the engine from storage

1. Remove covering from the engine.
2. Connect a well-charged battery to the engine.
3. Remove covering from the starter and alternator.
4. Adjust the fan belt.
5. Remove covering and taping from the various ports.
6. Drain preservative and fill with recommended engine oil.
7. Fill the fuel tank and prime the fuel system.
8. Check under and around the engine for such items as loose or missing bolts, oil, fuel or coolant leaks.
9. Remove the rocker cover and lubricate the valve mechanism.
10. Crank the engine three times, 10 seconds each time, at intervals of one minute, with the fuel supply shut off.
11. Make sure the engine oil pressure rises properly.
12. Start the engine.
13. Allow the engine to warm up at low idle.
14. When the engine has run long enough to warm up, apply the load and bring it to operating speed.

Storage of Engine in Operational Condition

Do Steps 1 through 3 below once a month:

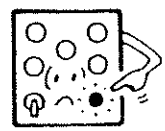
1. Crank the engine two times with the starter at intervals of 15 seconds, with the fuel supply shut off.
2. Start and operate the engine at 800 rpm under no-load condition for five minutes.
3. Increase the engine speed to 1000 to 1200 rpm and operate the engine under no-load condition for 10 minutes.

TROUBLESHOOTING

For special servicing jobs on your engine, rely on the expert knowledge of the servicemen, and the service facilities at your Mitsubishi dealer.

Problem	Cause	Correction
Engine will not start.  302844	Fuse off	Replace.
	Defective starter switch	Repair or replace.
	Slow cranking speed	Recharge battery. Check and replace starter.
	Wrong viscosity grade of oil	Change oil.
	Seized running parts	Repair.
	Air in fuel system	Prime.
	No fuel in tank	Refuel.
	Bad quality fuel	Change fuel.
	Clogged fuel filter	Clean or replace.
	Defective fuel injection pump	Repair or replace.
	Defective control timer unit	Replace.
	Clogged air cleaner element	Clean or replace.
Not enough power  500040	Wrong viscosity grade of oil	Change oil.
	Clogged air cleaner element	Clean or replace.
	Clogged fuel filter	Clean or replace.
	Defective fuel injection pump	Repair or replace.
	Defective fuel injection nozzles	Repair or replace.
	Wrong injection timing	Adjust.
	Bad quality fuel	Change fuel.
	Overheating	Flush cooling system and replace parts.
	Wrong valve clearance	Adjust.
	Poor compression (cylinders, piston rings, etc. worn)	Repair or replace.

Problem	Cause	Correction
Overheating  500047	Not enough coolant in system	Add coolant.
	Leaks in cooling system	Retighten or repair.
	Loose fan belt	Adjust.
	Restriction to air flow through radiator	Remove restrictions.
	Defective water pump	Replace.
	Defective thermostat	Replace.
	Defective fan	Replace.
	High LLC concentration	Adjust LLC concentration.
Too much white or blue smoke  500041	Too much oil in engine	Fill only to correct level.
	Oil viscosity too low	Change oil.
	Defective thermostat (coolant temperature too low)	Replace.
	Defective fuel injection nozzles	Repair or replace.
	Wrong injection timing	Adjust.
	Wrong fuel cetane number	Change fuel.
	Poor compression (cylinders, piston rings, etc. worn)	Repair or replace.
Too much black or gray smoke  500042	Bad quality fuel	Change fuel.
	Defective fuel injection pump	Repair or replace.
	Defective fuel injection nozzles	Repair or replace.
	Wrong injection timing	Adjust.
	Clogged air cleaner element	Clean or replace.
	Wrong valve clearance	Adjust.
	Poor compression (cylinders, piston rings, etc. worn)	Repair or replace.

Problem	Cause	Correction
Fuel consumption too high  500043	Bad quality fuel	Change fuel.
	Defective fuel injection pump	Repair or replace.
	Defective fuel injection nozzles	Repair or replace.
	Wrong injection timing	Adjust.
	Clogged air cleaner element	Clean or replace.
	Poor compression (cylinders, piston rings, etc. worn)	Repair or replace.
Oil consumption too high  500044	Too much oil in engine	Fill only to correct level.
	Oil viscosity too low	Change oil.
	Leaks in lubrication system	Repair or replace.
	Worn cylinders and piston rings	Repair or replace.
	Worn valve stem seals	Replace.
Oil pressure too low  500045	Not enough oil in engine	Add oil.
	Oil viscosity too low	Change oil.
	Clogged oil filter	Replace.
	Defective oil pump	Repair or replace.
	Defective relief valve	Adjust or replace.
	Defective pressure switch	Replace.

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