

OPERATION & MAINTENANCE MANUAL

**MITSUBISHI
DIESEL ENGINES**

S6B3

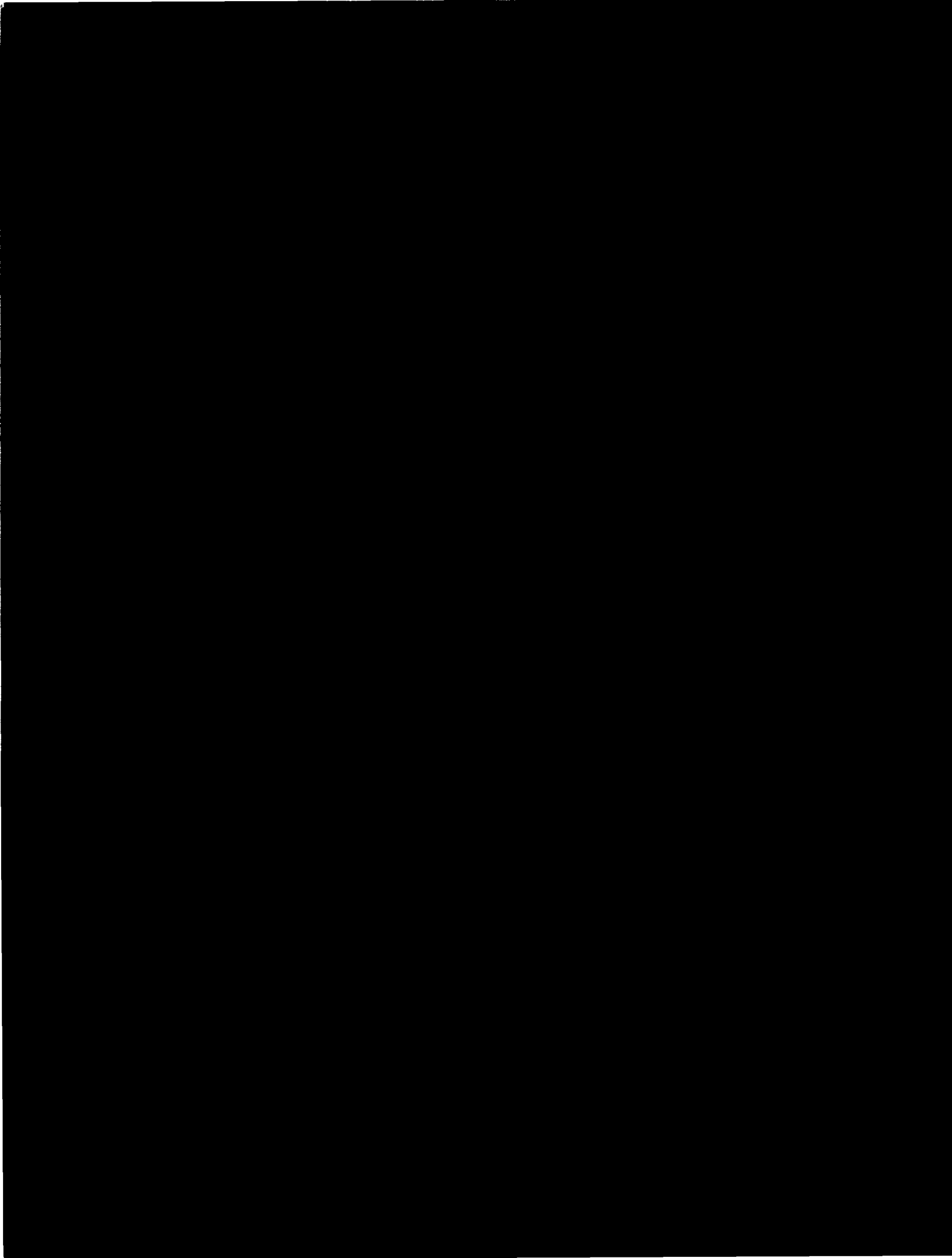
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APPLICATIONS

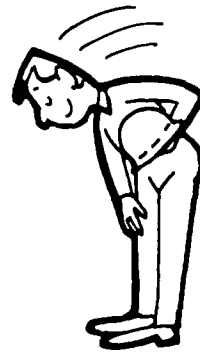
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- Prime power
- Locomotive drive
- Construction machinery drive
- Marine generator drive
- Marine prime power



**MITSUBISHI
HEAVY INDUSTRIES, LTD.**



**WE WELCOME YOU TO THE
GROWING LIST OF PEOPLE
WHO OWN AND USE OUR
DIESEL ENGINE**



500001

S6B3

This manual is written to familiarize you with the operation and maintenance of your S6B3 diesel engine, and provide important safety information. We suggest that you carefully read this manual to learn about your new engine.

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

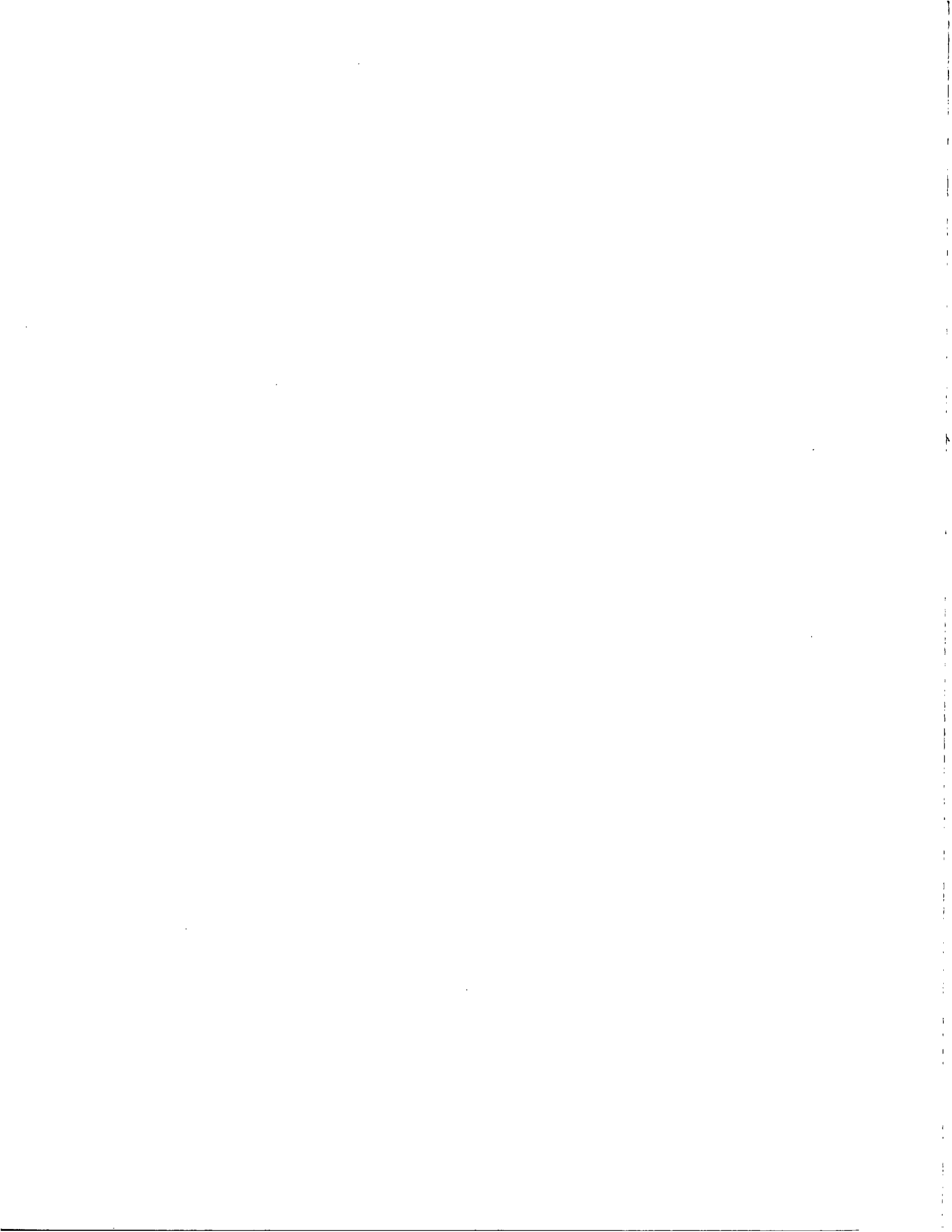
After reading this manual, be sure to keep it near your engine as a ready reference when you need it. See your Mitsubishi dealer for any further information you feel you need. He will be glad to help you and answer any questions you may have about handling of your new engine.

The descriptions, illustrations and specifications contained in this manual were in effect at the time it was approved for printing. Mitsubishi reserves the right to change specifications or design without notice and without incurring obligation.

WARNING AND OTHER SYMBOLS

The following symbols are used in this manual to emphasize important and critical instructions. They are used for the following conditions:

- ! WARNING** Operating procedures, practices, etc., which if not correctly followed, will result in personal injury or loss of life.
- ! CAUTION** Operating procedures, practices, etc., which if not strictly observed, will result in damage to or destruction of engine.
- NOTE** An operating procedure, condition, etc., which is essential to highlight.
- ✓ Right or normal as a result of inspection
- ✗ Wrong or abnormal (service needed) as a result of inspection



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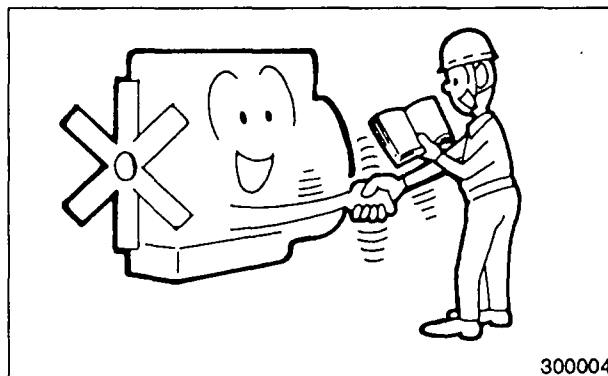


SAFETY RULES

Recommendation of daily operation record

It is obvious to every engine user and operator that an engine should not be run to destruction. Daily recording is a preventive maintenance program and will serve as a guide for:

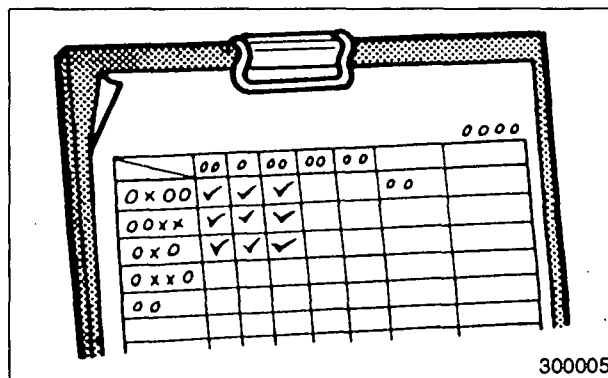
- Effective troubleshooting (to help a serviceman of your Mitsubishi dealer pin-point the trouble)
- Quick servicing and less downtime (to help him save time for servicing)
- Grasp of operating conditions (to help you recognize conditions, signs or indications of approaching trouble)



Items to be recorded

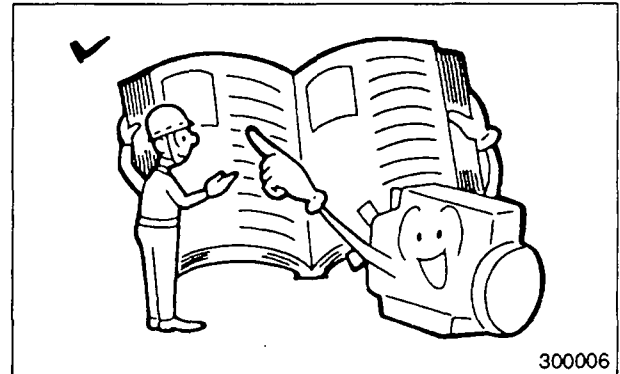
The following items are recommended to be recorded as "daily readings":

1. Operating hours (service meter reading)
2. Refill capacities and specifications of fuel, lubricant and coolant
3. Engine oil and coolant change intervals
4. Engine oil pressure, exhaust temperature, inlet air pressure and coolant temperature
5. Parts serviced, kinds of service (adjustment, repair or replacement) and results of service
6. Changes in operating conditions (for example, "Exhaust smoke turned black," or "Sound or vibration excessive.")

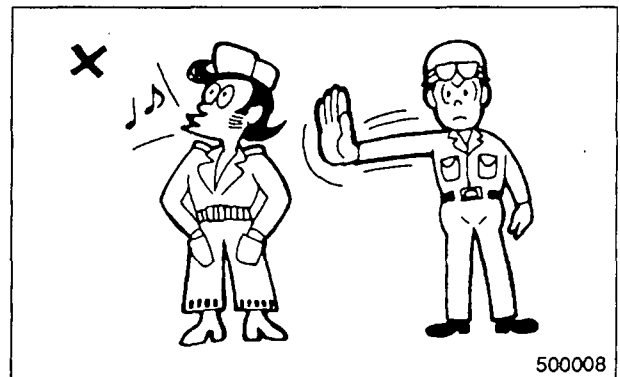


SAFETY RULES

- ⚠ Study OPERATION & MAINTENANCE MANUAL to become thoroughly familiar with all engine controls and instruments — and service procedures.

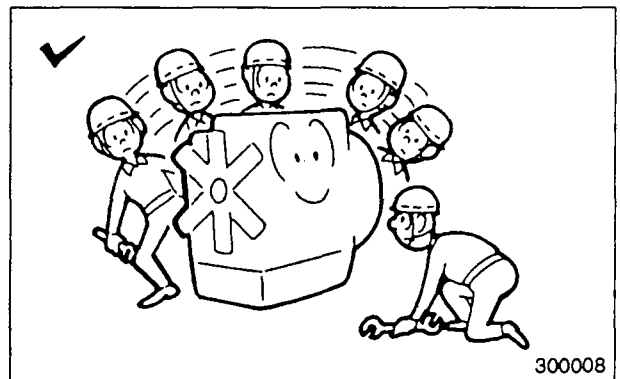


- ⚠ Wear hard hat and safety shoes — and, if job conditions require, safety goggles, heavy gloves, ear protectors, respirators, etc.

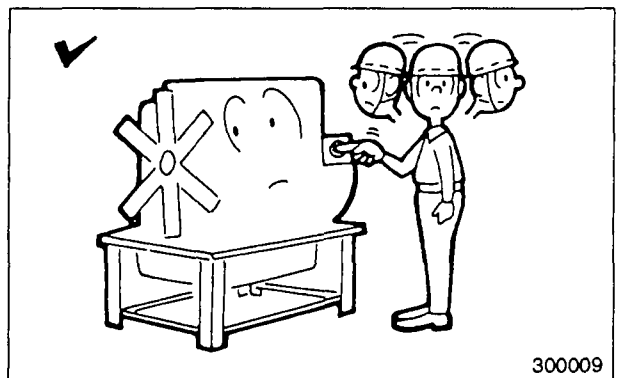


Before operation

Before starting and during warm up period, check under and around engine for visual defects — leaks of fuel, oil and coolant, loose or missing parts.

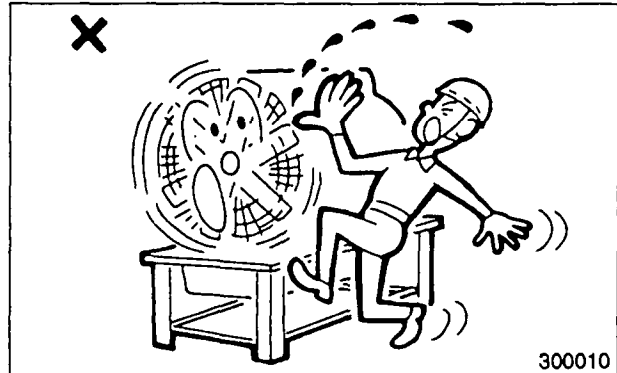


- ⚠ When starting engine, walk around it once more — open eyes and be alert to people and obstacles that may be within operating area.

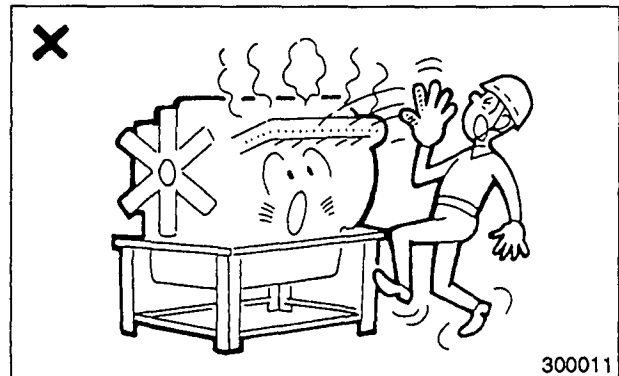


During operation

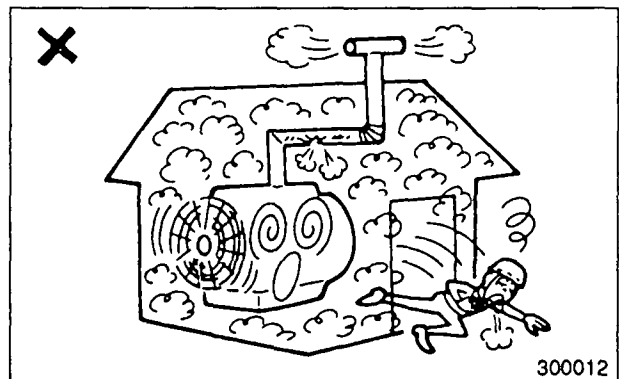
- ⚠ Do not touch any moving part of a running engine, or clothing or hair can be caught in moving parts, resulting in personal injury or loss of life.



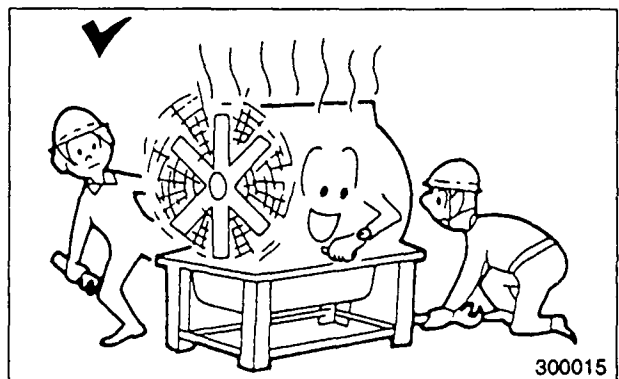
- ⚠ Keep hands off hot parts — turbo-charger, exhaust pipe, etc. — during operation or immediately after shutting off engine.



- ⚠ If necessary to operate engine within an enclosed area, provide adequate ventilation — and pay attention to exhaust piping and exhaust gas leaks.

**Idling operation for engine cooling**

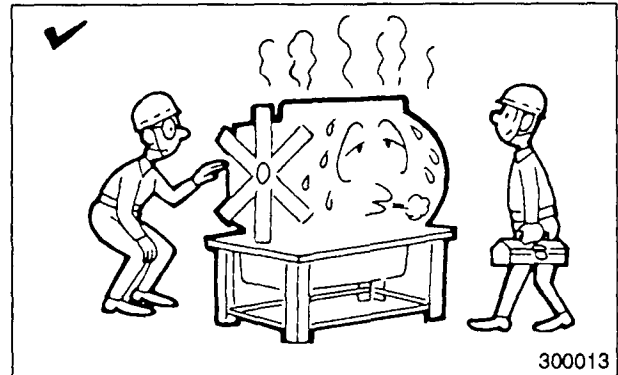
After the load is removed, allow the engine to run at low idle speed for about 5 to 6 minutes. During this period, check around the engine for visual defects. Shutting off the engine immediately after removing the load is very hard on the engine parts.




SAFETY RULES

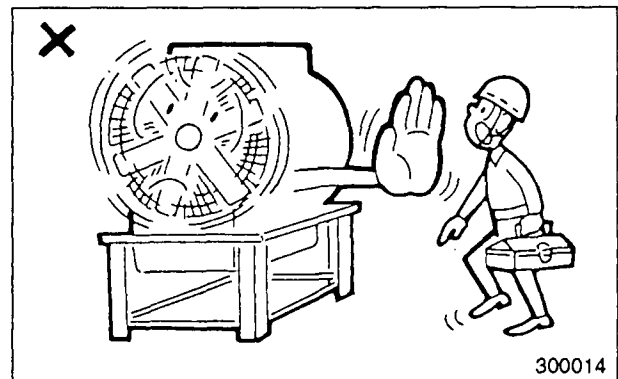
After operation


At end of operating period, walk around engine to check for any defects, and make repairs to prepare for the next day.

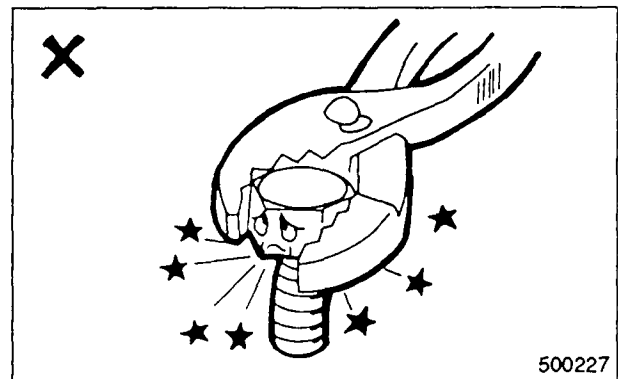



Maintenance

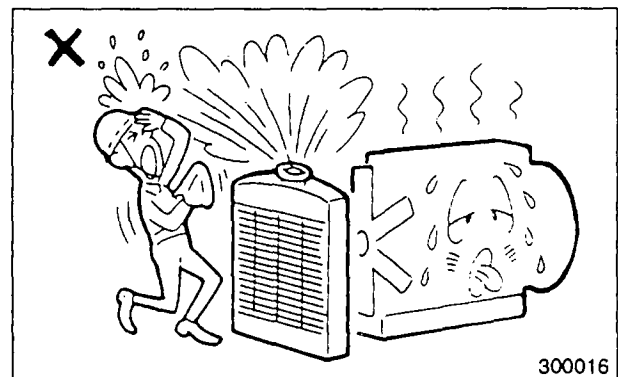
 Be sure to shut off engine, and turn off battery main switch (or close air tank valve) before servicing engine. If necessary to crank engine for inspection, signal to other man before cranking. After cranking, be sure to lock turning bar.




 Use right tools correctly. Thoughtless use of tools including use of a wrong tool can cause personal injury and damage to engine.




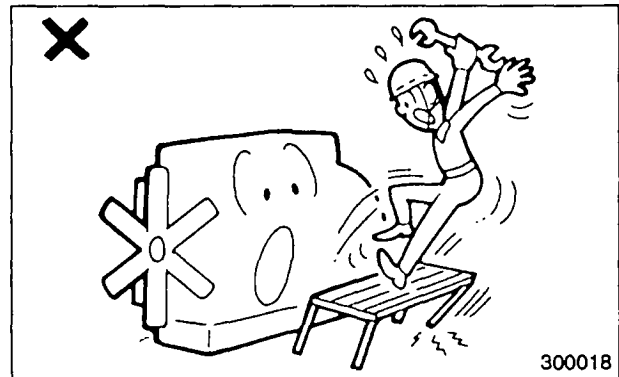
 When removing radiator filler cap immediately after shutting off engine, be sure to release pressure to avoid having scalding by hot water or steam blow out of radiator.




 Do not smoke while handling highly flammable materials. Do not use open cans of gasoline or diesel fuel for cleaning parts near any open flame. Good commercial, nonflammable solvents are preferred.

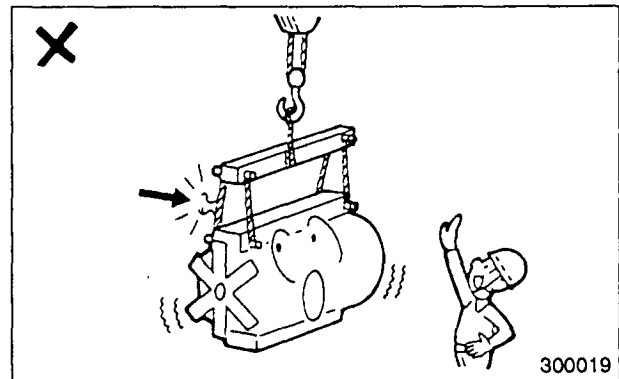



 Do not attempt to "climb up" engine for access to upper parts. Use a safe footstool for maintenance without accidents.

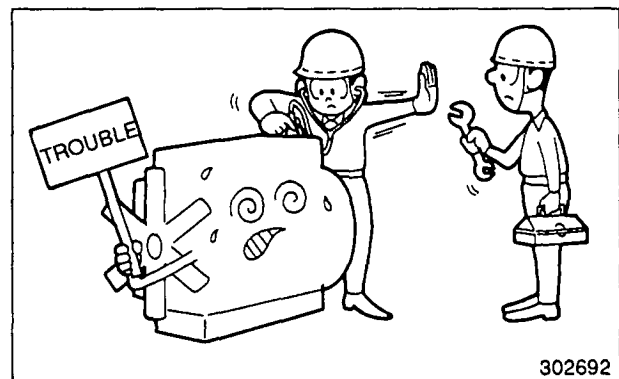


 When lifting engine, use slings free of broken strands. Be sure that the hoist has enough capacity for an engine to be lifted. Make use of hangers provided on engine, and lift it carefully.

Put wads to sling contacting surfaces of engine to protect both slings and engine.



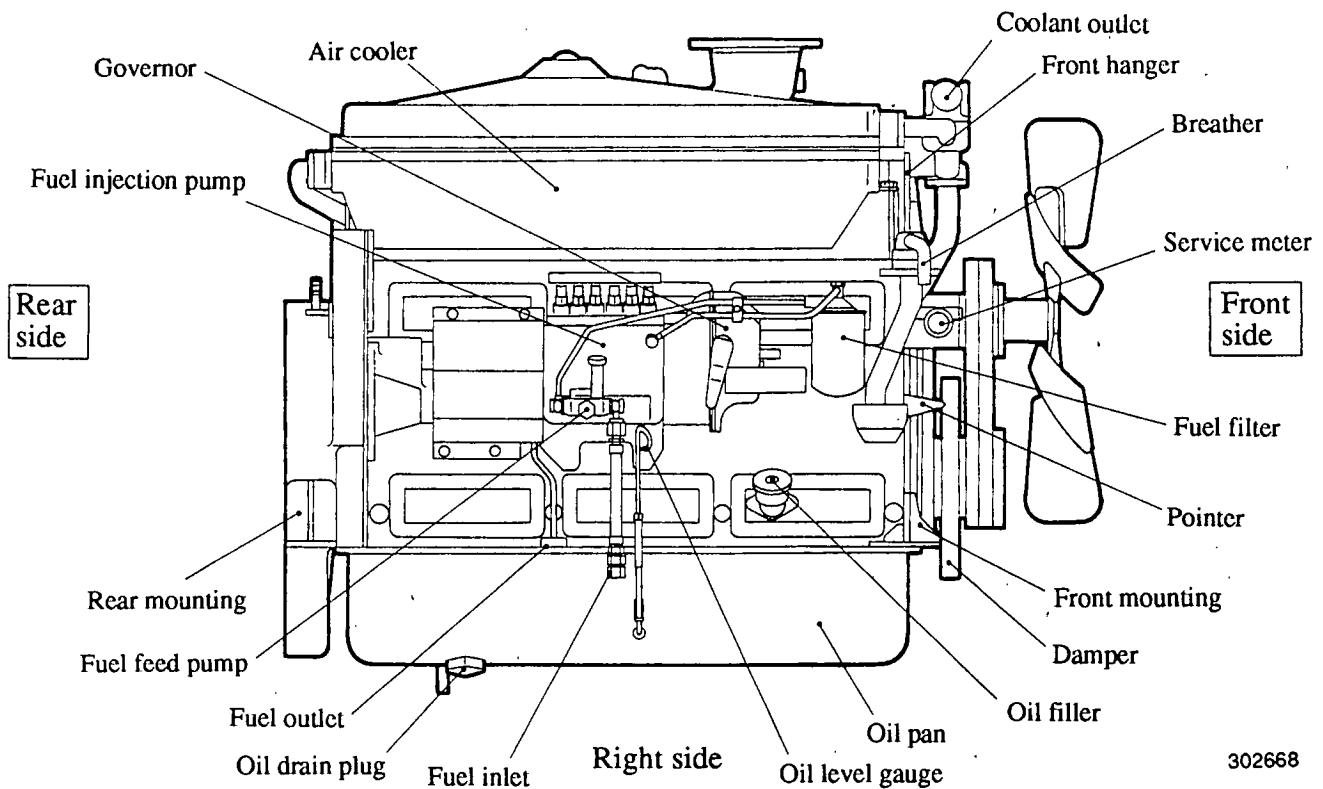
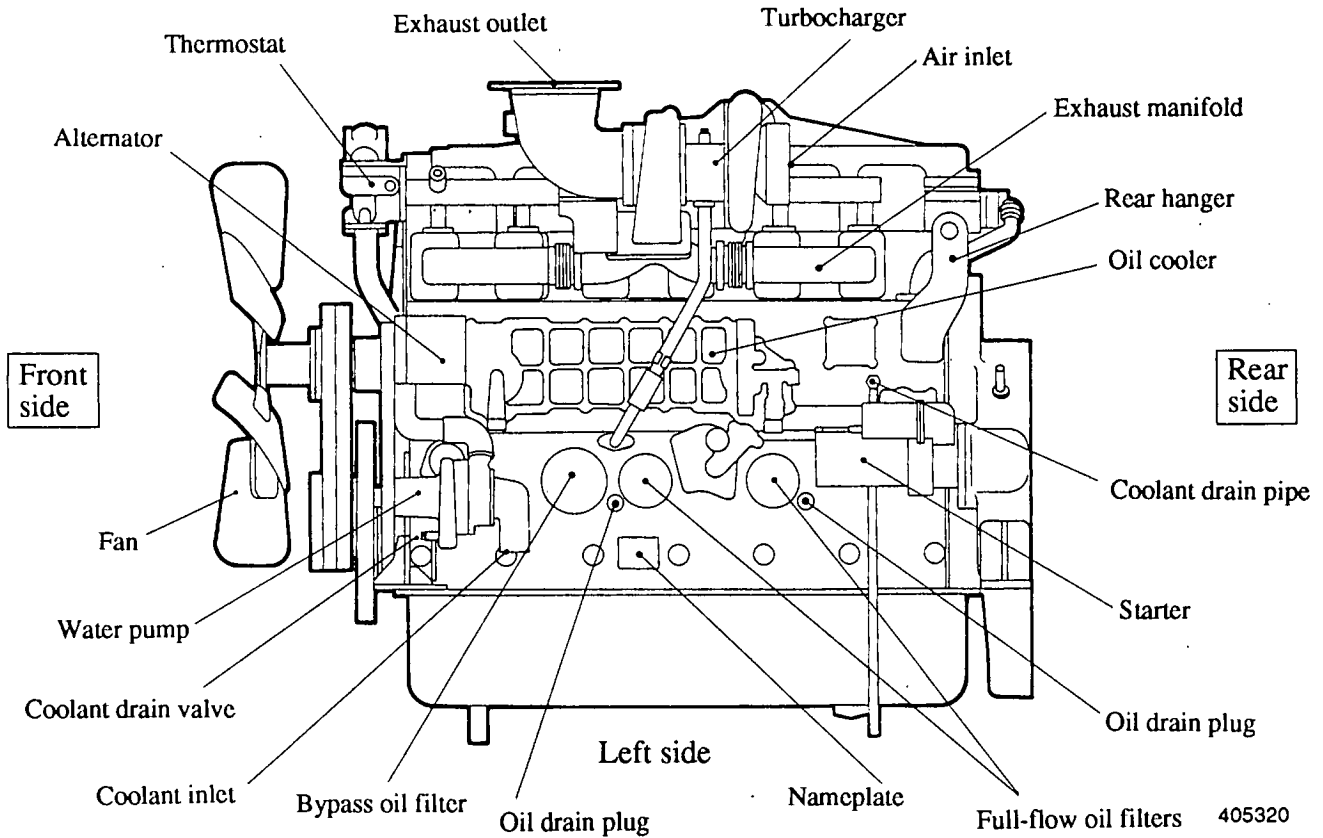
 If engine stops and any trouble sign is found, check for problems and have repairs made before you start engine again.



SPECIFICATIONS

Model designation		S6B3	
		TA	TK
Type		Water-cooled, 4-stroke cycle, turbocharged	
		Aftercooled	Intercooled
Number of cylinders		6	
Bore x stroke		135 x 170 mm (5.31 x 6.69 in.)	
Piston displacement		14.60 liters (891 cu in.)	
Fuel injection system		Direct	
Compression ratio		14.2 : 1	
Firing order		1 - 5 - 3 - 6 - 2 - 4	
Rotation		Counterclockwise as seen from flywheel side	
Dimensions	Length	1400 mm (55.1 in.)	
	Width	885 mm (34.8 in.)	
	Height	1270 mm (50.0 in.)	
Dry weight		1200 kg (2650 lb)	
Fuel system	Fuel	Diesel fuel oil (ASTM D 975 N0. 1-D or No. 2-D) Furnace oil (ASTM D 396 N0. 4)	
	Injection pump	Bosch P type	
	Fuel filter	Paper-element (cartridge type)	
	Injection nozzles	Hole type	
	Injection pressure	250^{+5}_0 kgf/cm ² (3555^{+71}_0 psi) [$24.5^{+0.5}_0$ MPa]	
Lubrication system	Type	Pressure feed (by oil pump)	
	Oil specification	API CD class	
	Capacity	Oil pan: 40 liters (11 U.S. gal), approx. Whole engine: 50 liters (13 U.S. gal), approx.	
	Oil filters	Paper-element type (cartridge type)	
	Oil cooler	Water-cooled multi-disc type (built in crankcase)	
Cooling system	Type	Forced circulation	
	Capacity	30 liters (8 U.S. gal), approx.	
Starting system		Electric or air motor	
Starter		24V - 6 kW	
Alternator		24V - 35A	
Turbocharger		Mitsubishi TD10 type	
Flywheel		SAE 14 in. or 18 in.	
Flywheel housing		SAE #1 or #0	

NOMENCLATURE



Remark: Direction of rotation of this engine is counterclockwise as seen from rear side.

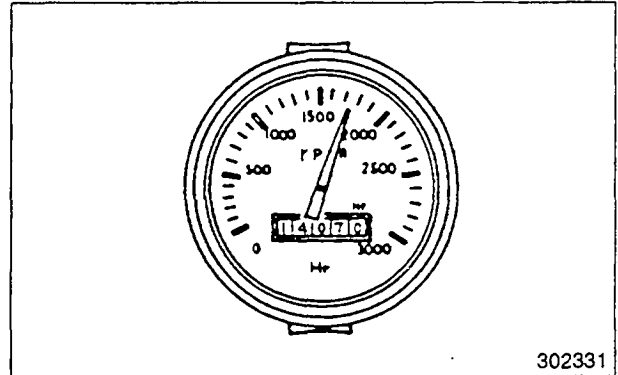
CONTROLS AND INSTRUMENTS

Instruments

Learn the location and purpose of all controls and instruments of your engine before operating it.

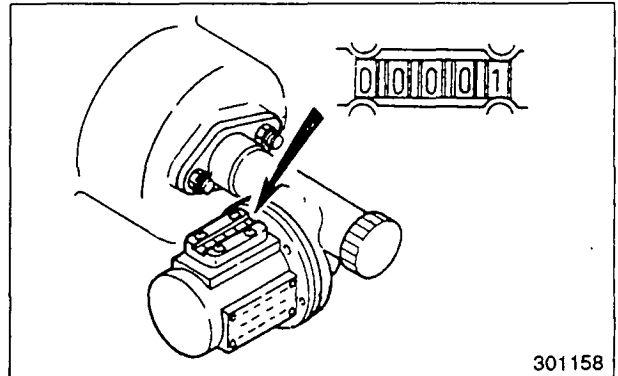
1. Tachometer

Indicates engine speed in rpm (revolutions per minute).



2. Service meter

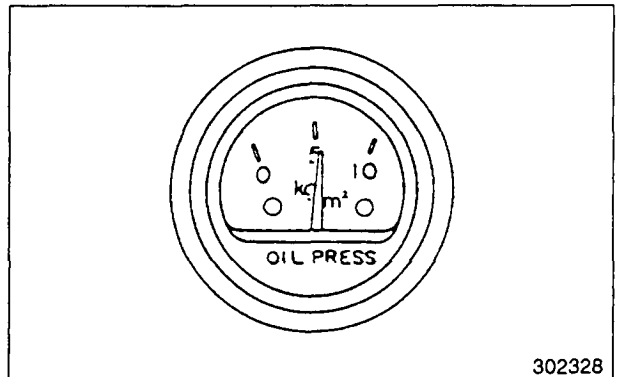
Indicates the total number of hours the engine has operated. Use it to determine service intervals. There are two types of service meter available for this engine, one being exclusive type and the other being built in the tachometer.



3. Oil pressure gauge

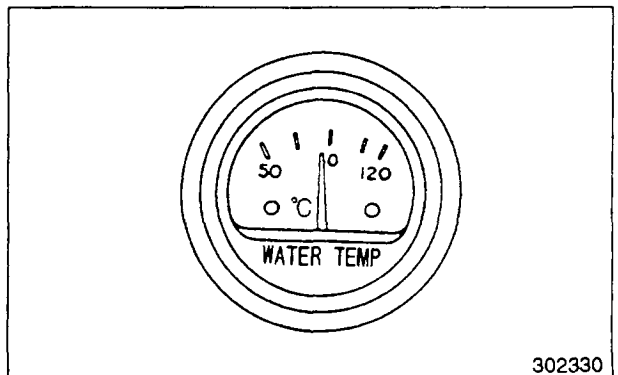
Indicates the engine oil pressure.

- (1) The maximum reading is normal immediately after the engine starts.
- (2) After the engine has warmed up, the reading should be 4 to 6.5 kgf/cm² (57 to 92 psi) [392 to 637 kPa] (when SAE #30 engine oil is used).
- (3) The reading will be lower at low idle speed than at normal speed.
- (4) If the reading is lower than 3 kgf/cm² (43 psi) [294 kPa] at rated speed, or if it is lower than 1 kgf/cm² (14 psi) [98 kPa] at low idle speed, immediately stop the engine; check for the problems; and have repairs made before you start the engine again.



4. Coolant temperature gauge

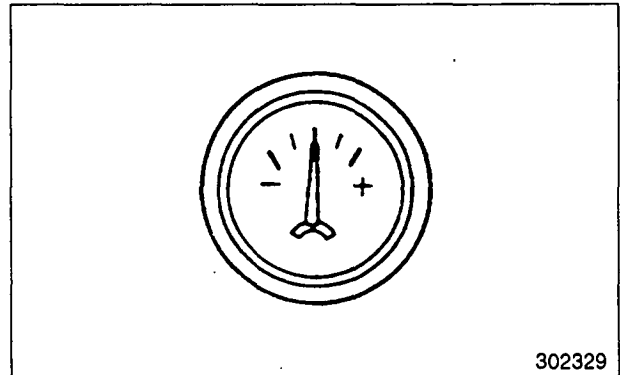
Indicates the coolant temperature. Normally, the reading will be 65°C to 85°C (149°F to 185°F) at an outside temperature of 20°C to 30°C (68°F to 86°F).



5. Ammeter

Indicates the amount the battery is being charged or discharged.

- (1) The pointer is normally in the charging range (on the + side of zero) when the battery is being charged.
- (2) As the battery is fully charged, the pointer will remain slightly in the charging range of center.



Controls for starting and stopping

1. Starter switch

HEAT (I):

Turn the switch key to HEAT to heat the engine (with an air heater) when starting it in cold weather.

OFF:

Turn the switch key to OFF only when the engine is stopped. All of the electrical circuits are disconnected. Remove the key.

ON (III):

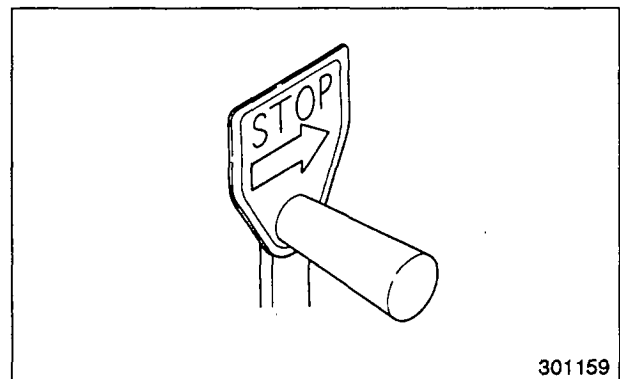
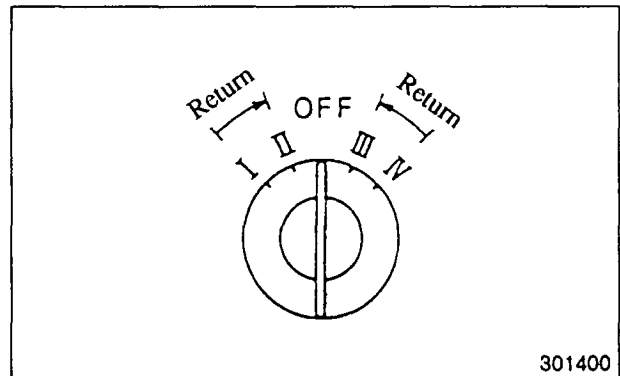
Release the switch key after the engine starts and the switch will turn to ON. The charging and lamp circuits are connected.

START (IV):

Turn the switch key to START to crank or start the engine.

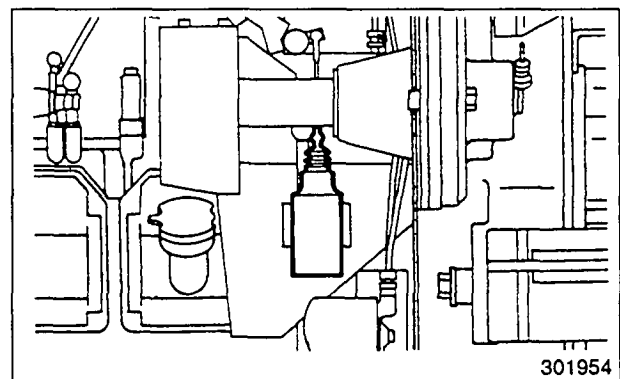
2. Manual stop lever

- (1) Move this lever in the direction of arrow to stop the engine.
- (2) Use this lever in an emergency.
- (3) Use this lever when the engine cannot be stopped with the starter switch.
- (4) Shut off fuel supply when the engine cannot be stopped with this lever.



3. Stop solenoid

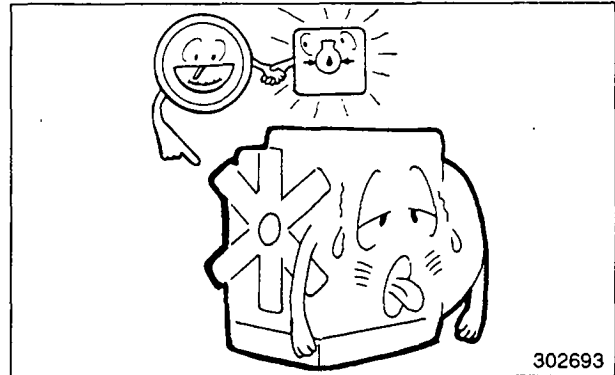
The stop solenoid is energized when the starter switch is in OFF. This solenoid, when energized, moves the fuel injection pump rack to the non-injection position to stop the engine.



Alarm lamps and indicator

1. Low oil pressure alarm lamp

- (1) Glows when the oil pressure is lower than $3_{-0.3}^0$ kgf/cm² ($43_{-4.3}^0$ psi) [294_{-29}^0 kPa] at engine speed lower than 1500 rpm.
- (2) Glows when the oil pressure is lower than 1.5 ± 0.2 kgf/cm² (21 ± 2.8 psi) [147 ± 20 kPa] in the entire speed range.



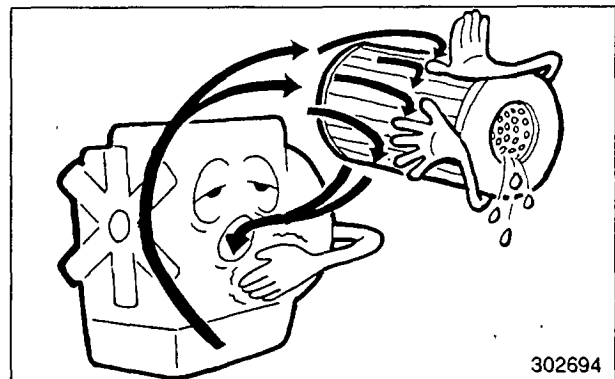
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2. Oil filter alarm lamp

Glows when the difference in pressure across the oil filter is greater than 1.5 kgf/cm² (21 psi) [147 kPa]. When this lamp glows immediately replace the oil filter.

NOTE

Change the engine oil when replacing the oil filter.



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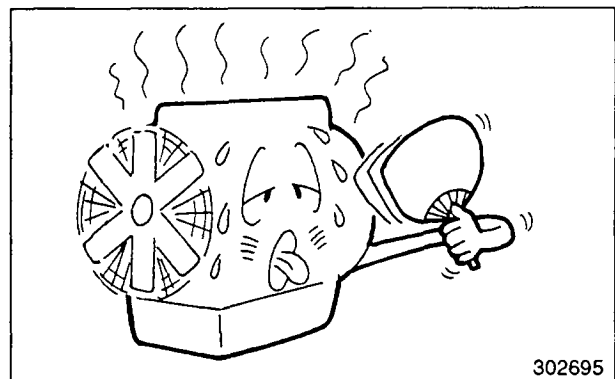
3. High coolant temperature alarm lamp

Glows when the coolant temperature rises above $95 \pm 2^\circ\text{C}$ ($203 \pm 3.6^\circ\text{F}$) at the radiator inlet.

NOTE

The coolant temperature at which the alarm lamp glows differs from one specification of the engine to another.

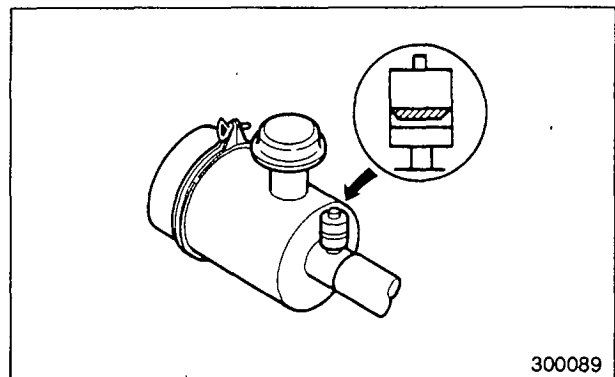
When the alarm lamp glows, run the engine at low idle speed for a while to let it cool gradually. Then stop the engine and check the cooling system.



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4. Air cleaner indicator

The indicator shows RED signal when the air cleaner element is clogged (when the difference in pressure across the element is greater than 635 mmH₂O (25 in.H₂O)). Immediately clean the element when the indicator shows RED signal. After cleaning the element, reset the indicator by pushing the button at the bottom of the indicator.



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BEFORE STARTING THE ENGINE

BEFORE OPERATION

Anyone charged with the care and operation of the engine is responsible for “new engine initial service” — service for a new or reconditioned engine or an engine which has been stored for a

long period of time. Check the following points before starting the engine for the first time. For the second and subsequent services, refer to Maintenance Schedule.

Walk-around checks

- Check for damage or missing parts.
- Check for loose bolts or nuts.

Cooling system

- Fill with make-up water (water containing Long Life Coolant of 30% to 60% concentration by volume).
- Check for leaks.
- Check fan and water pump drive belt tension.
- Bleed air by running engine at idle speed.
- Steam clean the radiator fins.

Fuel system

- Fill fuel tank.
- Prime fuel system.
- Check for leaks.

Electrical system

- Check battery electrolyte level and specific gravity.
- Check for loose terminal.
- Check gauges and lamps for operation.

Lubrication system

- Fill oil pan.
- Check for oil leaks.
- Check oil pressure rise at idle speed.

Air inlet system

- Check air cleaner for clogging.
- Check for air leaks.

After the break-in period (the first 50 hours of operation) of a new or reconditioned engine, perform the following services:

Change of engine oil

Change of oil filter

Retightening of bolts and nuts

CAUTION

- a) During break-in period, avoid applying load suddenly or running engine at high speed.
- b) If engine vibration or sound is excessive, immediately stop engine and check for cause. Have repairs made before starting engine again.

BEFORE STARTING THE ENGINE

Walk-around checks

Damage or missing parts	Engine
Loose bolts, nuts, etc.	Control link
	Crankshaft pulley and damper
	Fuel injection pump couplings and drive shafts
	Mounting brackets
	Plugs, covers, joints and connectors for coolant, oil and fuel circuits

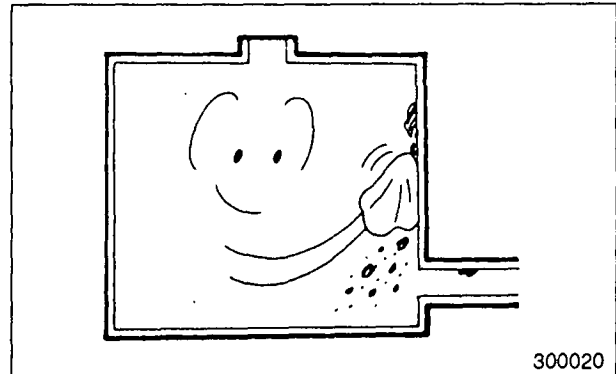
NOTE

For tightening torques, consult your Mitsubishi dealer, or refer to Service Manual if available.

Fuel system

Filling fuel tank

Before filling the tank, remove the inspection lid (when so equipped) and check the tank interior for cleanliness. If there is any dirt in the tank, flush the interior by pouring a little fuel into the tank and allowing it to drain from the drain port. Then, fill the tank with recommended fuel. After filling, check the amount of fuel in the tank with level gauge.

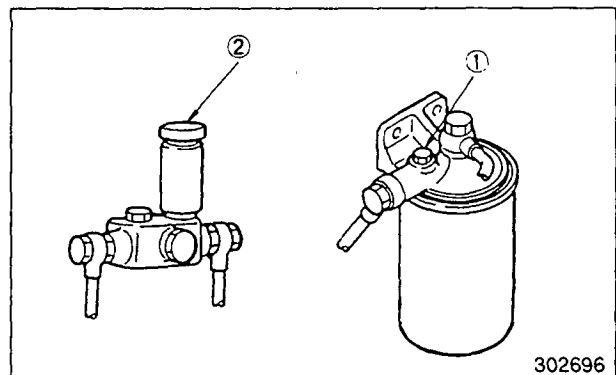


Priming fuel system

Prime the fuel filter and injection pump in that order — that is, from the fuel tank side.

1. Fuel filter

- (1) Loosen air vent plug (1) about 1.5 turns on the filter.
- (2) Unlock priming pump (2) by twisting it counterclockwise and operate it.
- (3) Tighten plug (1) when fuel runs free of air bubbles.

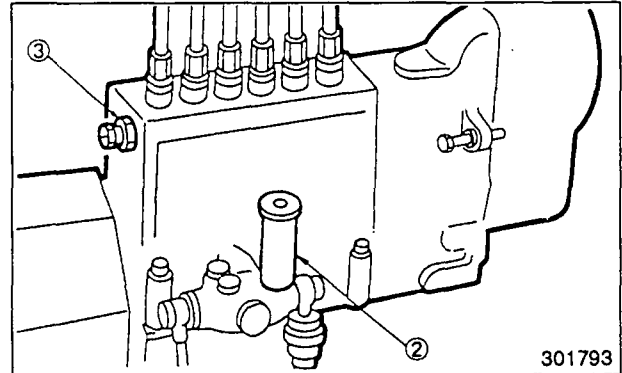


2. Fuel injection pump

- (1) Loosen air vent plug (3) about 1.5 turns on the injection pump.
- (2) Operate priming pump (2) and allow fuel to run until free of air bubbles. Lock the priming pump by twisting it clockwise while depressing it, and then tighten vent plug (3).

⚠ CAUTION

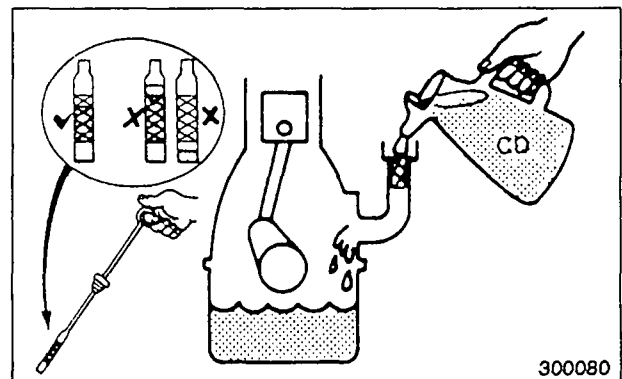
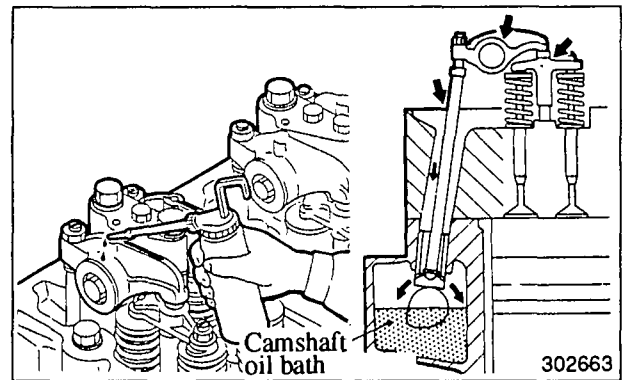
- a) If vent plug is tightened before priming pump is locked, pressure acts on the feed pump, making it difficult to lock the priming pump.
- b) Wipe off fuel spilled out of each vent plug hole with wiping rag.



Lubrication system

Filling oil pan

- (1) Use a clean jug to pour oil into the oil pan. Use API Service Classification CD oil.
- (2) Remove the rocker cover. Lubricate the valve mechanism and fill the camshaft oil bath through tappet hole. (The capacity of the oil bath is about 600 cc (37 cu in.) per cylinder.)
- (3) Check the oil level in the oil pan. The oil level should be between the maximum and minimum marks on the dipstick.
- (4) Check the oil pan and related parts for oil leaks.
- (5) Crank the engine with the fuel supply shut off to make sure the oil pressure rises normally within 10 seconds of cranking. If the pressure does not rise, allow 1 minute intermission and crank it again.
- (6) Start the engine and run it for about 10 minutes. Then stop the engine and add oil up to the specified level.



⚠ CAUTION

When cranking or running the engine, follow Step 3, **Cooling system**, which follows.

BEFORE STARTING THE ENGINE

Cooling system

Filling the system

- (1) Tighten the engine and water pump drain valves (or the radiator drain plug on a radiator-cooled engine). The engine is shipped from the factory with its cooling system drained.
- (2) Remove the radiator filler cap and fill up the radiator by slowly pouring soft water and pure Long Life Coolant alternately into it in several parts until the radiator is full.

CAUTION

To bleed air out of the cooling system, loosen the valve at the top of thermostat.

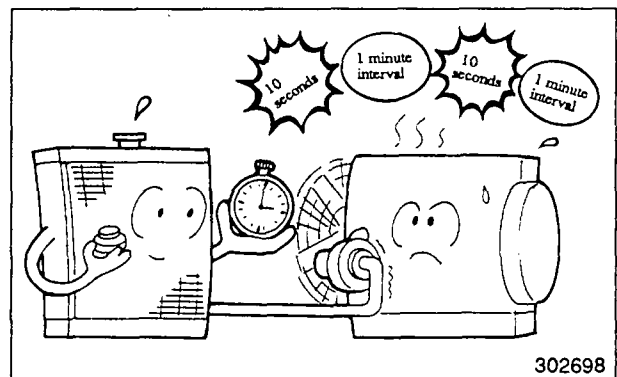
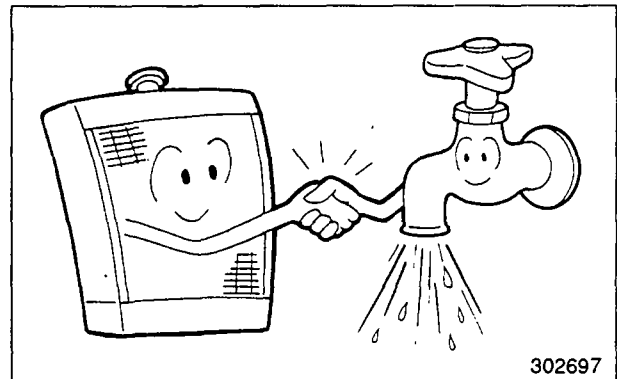
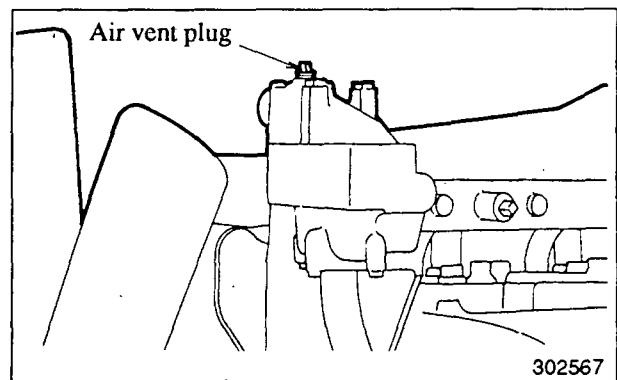
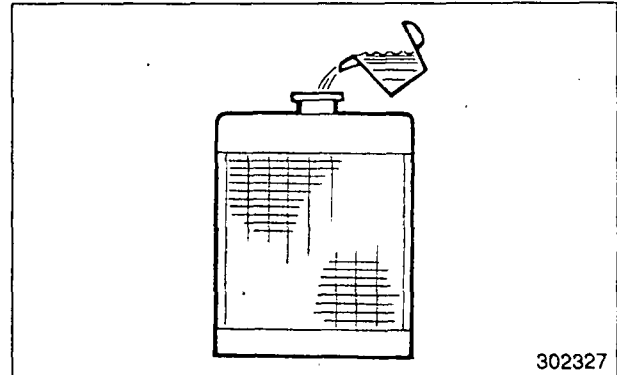
NOTE

- a) Water used in the cooling system should be soft, or as free as possible from scale forming minerals. Remember, some waters pumped out of ground in a mining or hot-spring area contain such minerals harmful to the material of cylinder liners.
- b) Use Long Life Coolant of 30% to 60% concentration by volume year-round.
- c) For the specifications and amount of Long Life Coolant, see COOLANT SPECIFICATIONS.

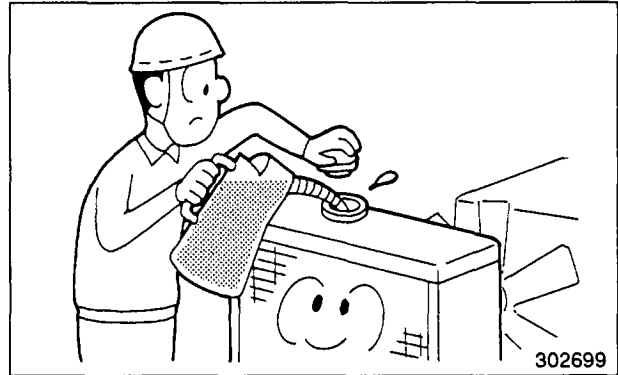
- (3) After filling up the radiator, crank the engine with the starter, with the radiator filler cap removed, several times, for 10 seconds each time, at intervals of about 1 minute, in order to bleed air out of the water pump.

CAUTION

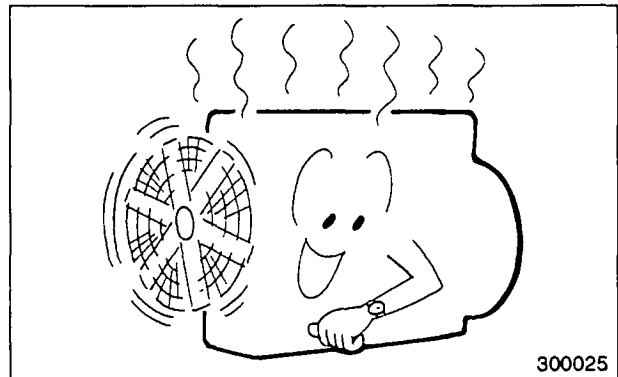
- a) To crank the engine for bleeding, keep the manual stop lever in STOP position (with the fuel supply shut off).
- b) When cranking or running the engine, follow Step 5, Lubrication system.



- (4) Check the coolant level in the reserve tank or radiator, and add coolant if necessary.



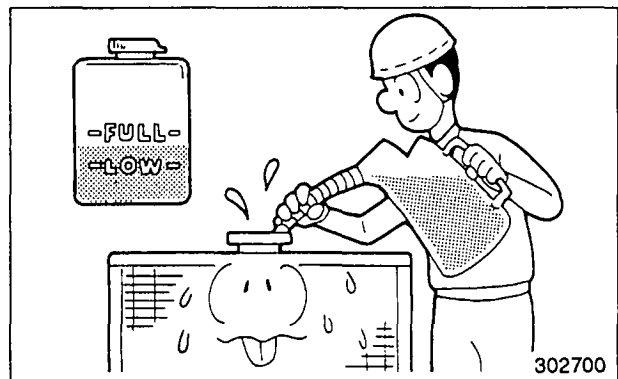
- (5) Start the engine and run it under light load until the normal operating temperature (the thermostat opening temperature) is reached to mix Long Life Coolant with water in the system.



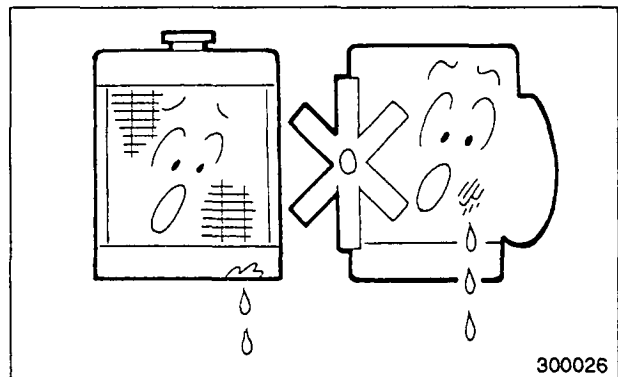
- (6) Stop the engine and check the coolant level in the reserve tank or radiator. If the level is low, add coolant. When adding coolant to the reserve tank, fill up to the FULL mark.

NOTE

When adding coolant, maintain the specified concentration of Long Life Coolant.



- (7) Check the hose joints for coolant leaks.



Electrical system

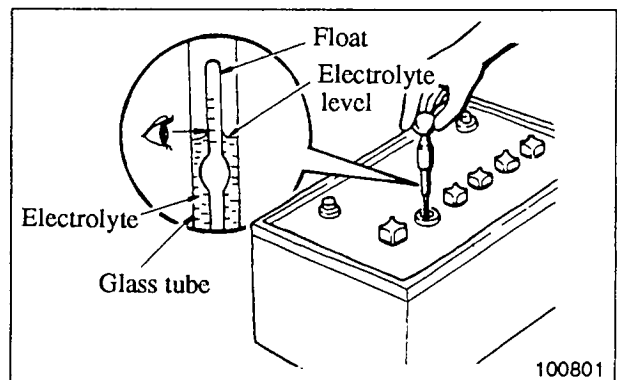
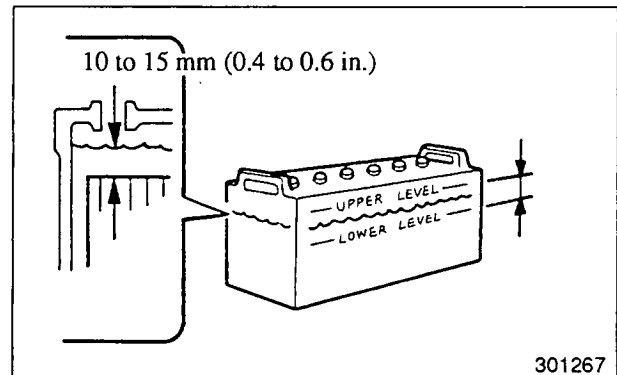
Care of wet battery (with electrolyte)

- (1) Remove the vent caps and check the electrolyte level in each battery cell. It should be between the UPPER LEVEL and LOWER LEVEL marks on the battery case.
- (2) When adding electrolyte to the battery, fill each cell slowly.
- (3) When the electrolyte level is lower than the LOWER LEVEL mark, add distilled water.
- (4) Check the specific gravity of electrolyte with a battery hydrometer as shown. If it is below 1.22 at 20°C (68°F) or below, recharge the battery.

! WARNING

Electrolyte is an acid. If you drip it on your skin or clothing, flush it at once with water.

Battery gives off flammable fumes that can explode. Do not allow sparks or open flame near the battery.



Care of dry-charged battery

- (1) Slowly fill each battery cell with ready-mixed electrolyte.
- (2) To activate the battery or get it ready for service, first, slow-charge it for 1 to 2 hours. For charging, adjust the current input to the battery to 1/10 of the battery capacity.

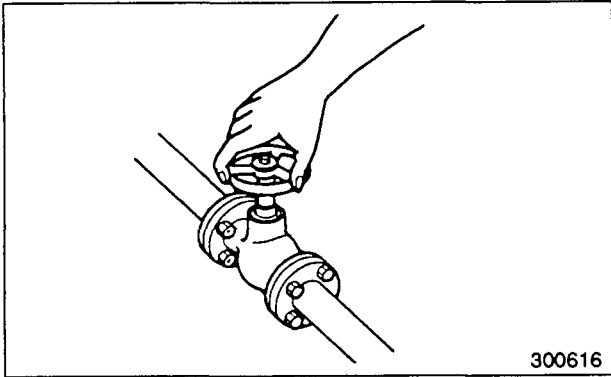
Circuits

Check each circuit for loose terminals, miswiring or other defects.

Others

Check the following valves and plugs to make sure they are open or closed properly:

- Fuel supply valveOpen
- Radiator coolant drain valve (radiator) Closed
- Coolant drain valve (engine)..... Closed
- Coolant drain valve (water pump).. Closed
- Oil drain plug Closed
- Air supply valve (air tank) Open (air-start engine)



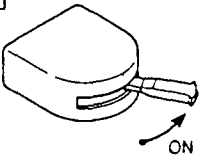
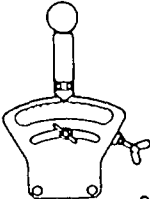
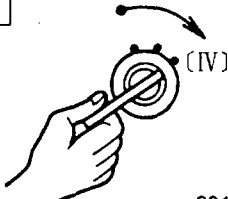
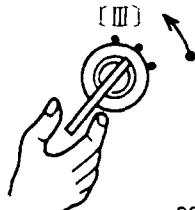
OPERATING THE ENGINE

Perform service items listed under Every 10 hours or daily before starting the engine.

Starting the engine

Two methods of starting the engine are in use, the electric-starter method and air method (option).

Electric-starter method

1  300458 Turn ON battery switch.	2  300082 Move speed control lever to start (low idle) position.	3  301457 Turn starter switch key to start (IV) position.	4  301458 As soon as engine starts, release starter switch.
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NOTE

If the engine fails to start within 30 seconds, release the starter switch and wait 2 minutes to allow the electric starter to cool before using it again.

Air method (option)

1 Run air compressor to raise pressure in air tank. Air-motor method: 9.9 kgf/cm ² (141 psi) [1 MPa] Air method: 32 kgf/cm ² (455 psi) [3 MPa]	2 Open air supply valve at air tank.	3 Move speed control lever to start (low idle) position.	4 Turn on switch or pull lever.	5 As soon as engine starts, close air supply valve. (Keep this valve open for automatic starting.)
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NOTE

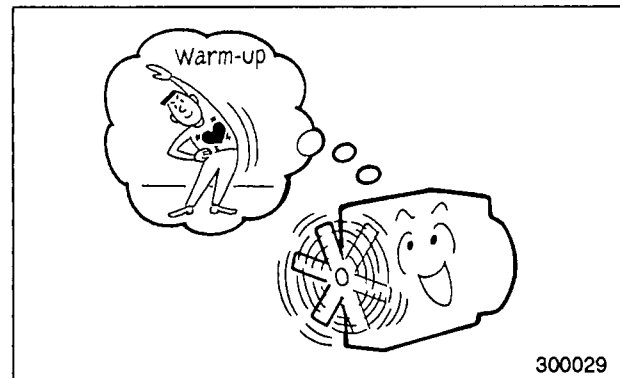
If the engine fails to start, raise the air tank pressure and try again.

CAUTION

- a) Do not run the electric starter for more than 30 seconds at a time. A failure to follow this precaution can run down the battery or burn the starter.
- b) Do not turn the battery and starter switch to OFF position while the engine is running. Keep it in ON (III) position.
- c) In case of the air-motor method, open the air tank drain cock to drain moisture every 50 hours or monthly.
- d) After starting a new or reconditioned engine, or an engine which has been stored or left standing for a long period of time, check oil pressure rise and bleed the cooling system.
- e) When starting the engine, do not apply load to it (disengage the clutch when so equipped).

After starting the engine

- (1) After starting in temperatures below 5°C (41°F), allow the engine to run at low idle speed for 5 to 10 minutes for warming up.
- (2) When the starting temperature is below 5°C (41°F) — that is, when the coolant temperature does not rise even after 5 to 10 minutes of warm-up run, use of additional cold weather starting aid is recommended.
- (3) At starting temperatures above 5°C (41°F), 30 seconds or more of warm-up run is required.
- (4) The oil pressure will be 2 to 3 kgf/cm² (28 to 43 psi) [196 to 294 kPa] (at low idle speed) at the end of warm-up period. If the engine is revved up immediately after it has been started — that is, when the oil temperature is still low, the oil pressure would be higher than the normal level — 4 to 6.5 kgf/cm² (57 to 92 psi) [392 to 637 kPa] but it will restore to the normal level as the oil temperature rises.

**CAUTION**

If your engine is a standby (quick-start) engine, it is not necessary to warm it up. However, be sure to perform routine service.

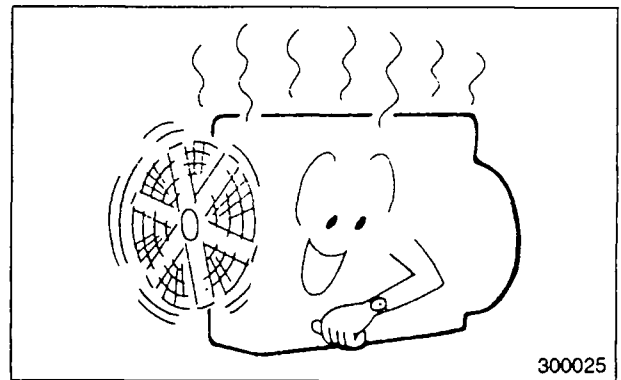
Starting the load

Apply the load after the engine has run long enough to warm up — that is, when the coolant temperature gauge pointer has moved. During operation, check the following:

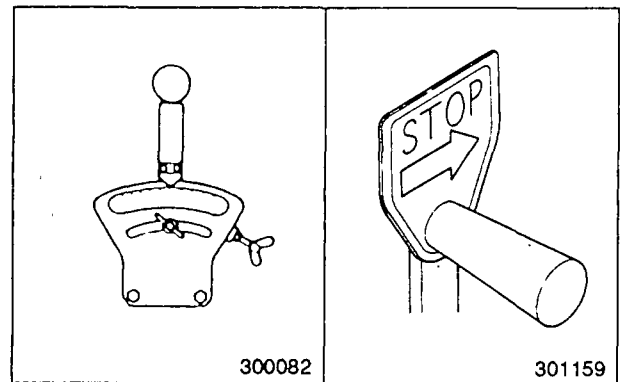
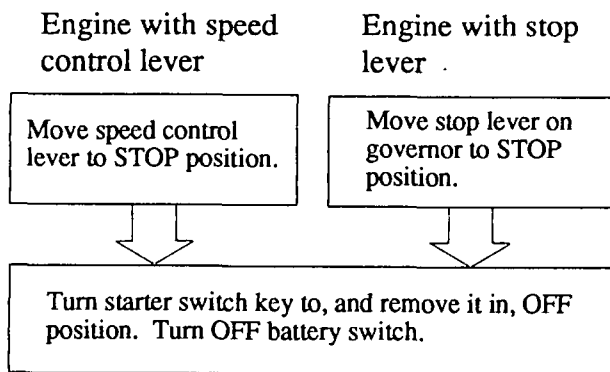
- (1) Excessive vibration and sound
- (2) Abnormal exhaust smoke
- (3) Fuel, oil and coolant leaks
- (4) Gauge reading

Stopping the engine

Operate the engine at low idle speed for more than 30 seconds.

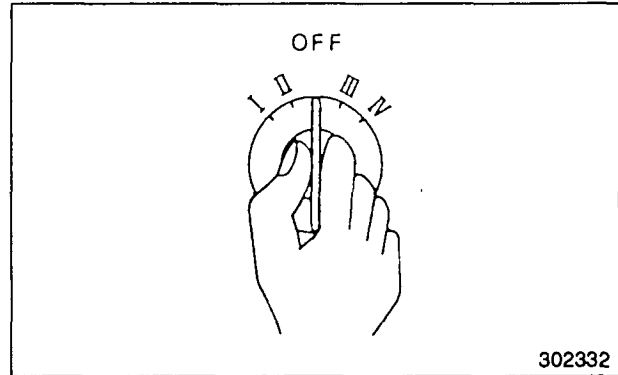


Follow the stopping procedure outlined below:



 **CAUTION**

- a) Stopping the engine immediately after it has been working under load can result in overheating and accelerated wear of the engine components. Be sure to operate the engine at low idle speed for more than 30 seconds to allow hot areas in the engine to cool gradually, extending engine life.
- b) Never try to rev up the engine just before stopping it.
- c) Keep on pulling the stop lever until the engine stops “rocking” to prevent it from turning it in reverse direction.



MAINTENANCE

1. Satisfactory performance, long life and trouble-free operation of the engine depend to a great extent on proper maintenance. Be sure to perform recommended service according to the MAINTENANCE SCHEDULE.
2. Use the service meter to determine servicing intervals. Calendar intervals shown (daily, monthly, etc.) may be used instead of service meter intervals if they provide more convenient servicing schedule and approximate the indicated service meter reading. Recommended service should always be performed at the interval that occurs first. Service intervals depend on application and operating conditions of the engine. Adjust the intervals to meet the actual operating conditions. Take service meter reading and keep a record of it. Perform service on items at multiples of the original requirement. For example, at Every 250 hours or 1 year, also perform those items listed under Every 10 hours or daily and Every 50 hours or monthly.

NOTE

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

Test run	Once-a-week no-load test run for 5 to 10 minutes	Check for: Ease of starting Lube oil pressure Color of exhaust smoke Abnormal vibration and others
	Once-a-month load test run for 15 to 30 minutes (Operate at half the full load, min.)	

3. Where the engine is used for stand-by duty, it must be thoroughly checked and kept in perfectly operable condition at all times. This is because it has to be started and run under severe conditions and is expected to give full performance no matter when it is put in operation. Test the engine periodically by running it in no-load condition, as follows:

Avoid accidents

- (1) Never attempt to service the engine during operation.
- (2) Wear safety shoes, safety goggles, safety hat, etc. if necessary. Dress properly for the job. Use right tools correctly.
- (3) When servicing engine, turn off battery switch, and pull starter switch key.
- (4) Do not use open cans of diesel fuel or kerosene for cleaning parts near any open flame.

MAINTENANCE SCHEDULE

○ : Checking, cleaning, washing, adjusting, etc.
 ● : Changing.
 * : Item to be performed on a new, reconditioned or long-stored engine for the first time.

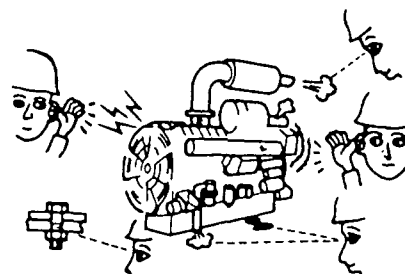
Group	Service		Service intervals					Remarks
			Every 10 hours or daily	Every 50 hours or monthly	Every 250 hours or 1 year	Every 500 hours or 2 years	Every 1000 hours or 3 years	
Mechanical	Valve clearance	Check			*		○	
	Bolts and nuts	Retighten		*			○	
	Walk-around checks		○					
	Fan, water pump and alternator drive belts	Check tension			○			
Lubrication system	Oil pan	Check oil level	○					
		Check for water or fuel in oil		○				
		Change oil		*	●			
	Oil filters	Change		*	●			Also change when filter alarm lamp glows
	Bypass oil filter	Change			●			
	Governor oil filter	Change				●		
Fuel system	Fuel tank	Check the amount of fuel	○					
		Drain water		○				
	Fuel filter	Change				●		
	Injection nozzles	Adjust					○	
		Change						At top overhaul
Injection timing	Check					○		
Cooling system	Coolant	Check level	○					
		Change	Every 2 years					
	Radiator fins	Clean			○			
	Heat exchanger	Wash					○	
	Zinc rods	Change				●		

MAINTENANCE

Group	Service		Service intervals						Remarks	
			Every 10 hours or daily	Every 50 hours or monthly	Every 250 hours or 1 year	Every 500 hours or 2 years	Every 1000 hours or 3 years	Every 2000 hours or 5 years		
Air inlet and exhaust systems	Air cleaner (paper-element type)	Check indicator	○							
		Clean element			○					
		Change element					●			
	Precleaner (silencer type)	Clean			○					
	Exhaust muffler	Drain water			○					
	Air cooler	Clean						○		
	Turbocharger	Check						○		
Starting system	Electric starting	Batteries	○						Check specific gravity from time to time.	
		Alternator						○		
		Starter						○		
	Air starting	Oiler	○							
		Air filter (air-motor type)	Drain water		○					
			Wash element				○			
		Air tank	Check air pressure	○						Before starting
			Drain water		○					
	Check safety valve for operation			○						
Protective device operation	Water temperature rise: $95 \pm 2^{\circ}\text{C}$ ($203 \pm 3.6^{\circ}\text{F}$) Engine oil pressure drop, kg/cm^2 (psi) [kPa] • At rated speed: 3 ± 0.2 (43 ± 2.8) [294 ± 20] • At low idle speed: 1.5 ± 0.15 (21 ± 2.1) [147 ± 15] Overspeeding: 112 to 115%						○	Check when malfunction is suspected. (Check on stand-by engine every 1 year.)		
Others	Vibration damper	Check						○	Leaks, cracks in rubber or flaw	
		Change							Every 8000 hours	
	Coupling (rubber bushings)	Check			○				Cracks or other defects	
	Valves in pipeline	Check	○							
	Speed control lever	Check	○							
	Top overhaul kit	Change	At top overhaul							
Overhaul kit	Change	At overhaul								

EVERY 10 HOURS OR DAILY

Walk-around checks

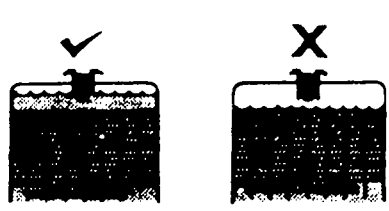


300085

Check for:

- Loose or missing bolts and nuts
- Abnormal vibration, noise and exhaust color
- Water, oil, air, exhaust gas and fuel leaks
- Open electric circuit and loose pipe joints
- The amount and color of mist from breather

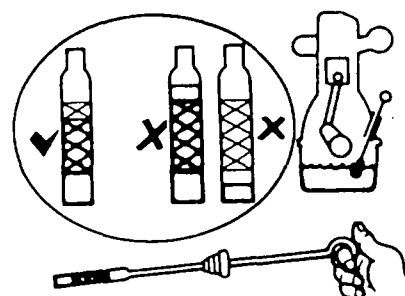
Radiator — Check coolant level.



300160

Coolant level should be just below bottom of fill pipe. Check coolant level in reserve tank, when so equipped, by observing sight gauge. If coolant level is low, add make-up water (water containing antifreeze of correct concentration).

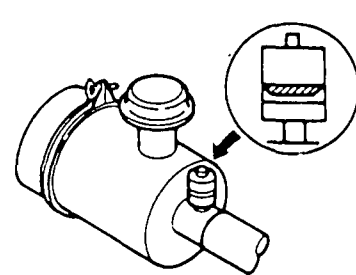
Oil pan — Check oil level.



301272

Maintain oil level between "full" and "low" marks on gauge.

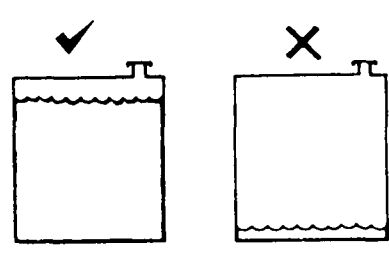
Air cleaner indicator — Check.



300089

Clean or change air cleaner element if indicator shows RED signal.

Fuel tank — Check the amount of fuel.



300087

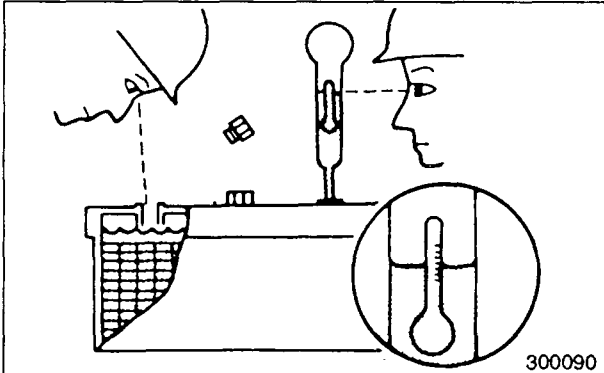
Check the amount of fuel in the tank before the day's operation.

NOTE

Fill fuel tank at the end of each day of operation to drive out moist air and to prevent condensation.

EVERY 10 HOURS OR DAILY — continued

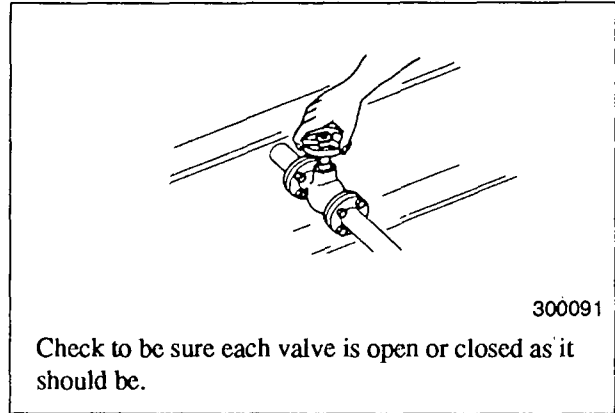
Battery — Check electrolyte level and specific gravity.



300090

Electrolyte level should be 1 cm (0.4 in.) above cell plates.
Check specific gravity from time to time, and recharge battery before it drops below 1.22.

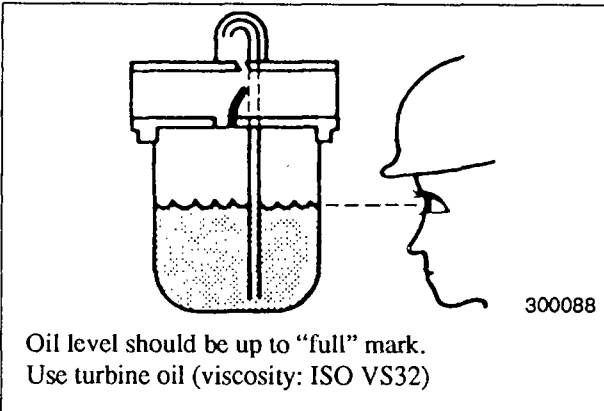
Valves in pipeline — Check.



300091

Check to be sure each valve is open or closed as it should be.

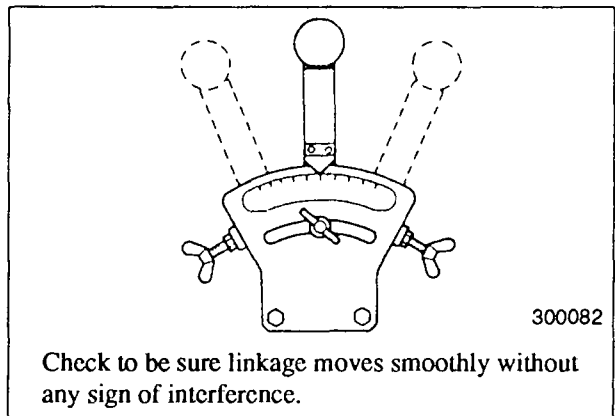
Oiler (air-motor engine) — Check oil level.



300088

Oil level should be up to "full" mark.
Use turbine oil (viscosity: ISO VS32)

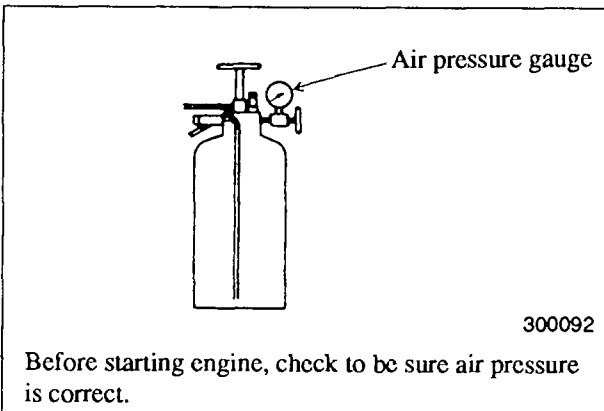
Speed control lever — Check.



300082

Check to be sure linkage moves smoothly without any sign of interference.

Air tank (air-motor engine) — Check air pressure.

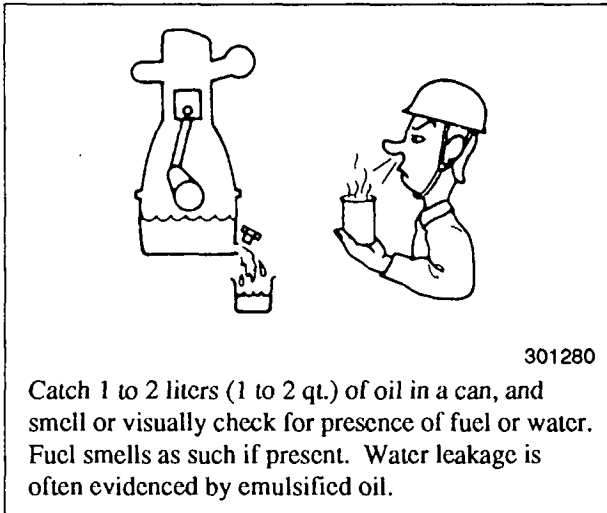


300092

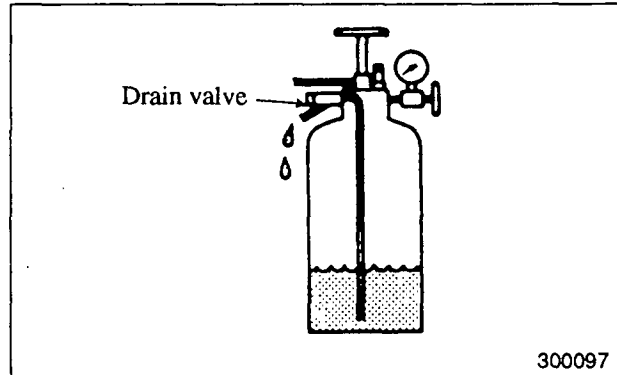
Before starting engine, check to be sure air pressure is correct.

EVERY 50 HOURS OR MONTHLY

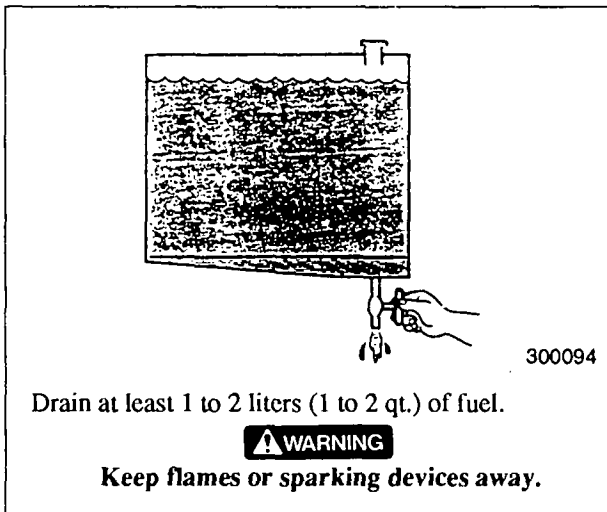
Oil pan — Check for water or fuel in oil.



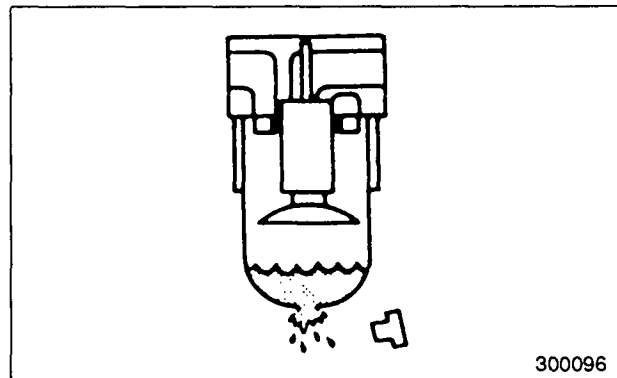
Air tank (air-motor type) — Drain water.



Fuel tank — Drain water.



Air filter (air-motor type) — Drain water.



EVERY 250 HOURS OR 1 YEAR

Oil pan — Change oil.

301597

300046

Drain oil when engine is still hot — that is, shortly after shutting down engine. Select API Service Classification CD oil for refilling.

CAUTION

You are prohibited from disposing of waste oil. For disposal of such an oil, consult your Mitsubishi dealer.

Air cleaner — Clean element.

Use pressure air — 7 kgf/cm² (100 psi) [0.7 MPa] maximum. Insert light inside clean, dry element and check. Replace element if pinholes or tears are found. Clean air cleaner case. If indicator shows RED signal shortly after installation of clean element, change element.

300104

Precleaner — Clean.

Precleaner Silencer

300105

Remove precleaner and wash it in warm water and non-sudsing household detergent.

Oil filters and bypass oil filter — Change.

Bypass oil filter

Oil filters

Oil drain plugs

302204

Spread out element of each filter just removed from engine and check for presence of metallic particles trapped in it. If any metallic particles are found, consult your Mitsubishi dealer.

NOTE

Change filters when oil filter alarm lamp glows, regardless of service intervals.

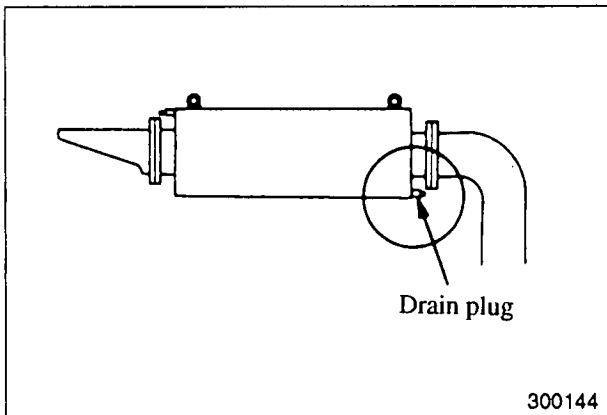
Radiator fins — Clean

300932

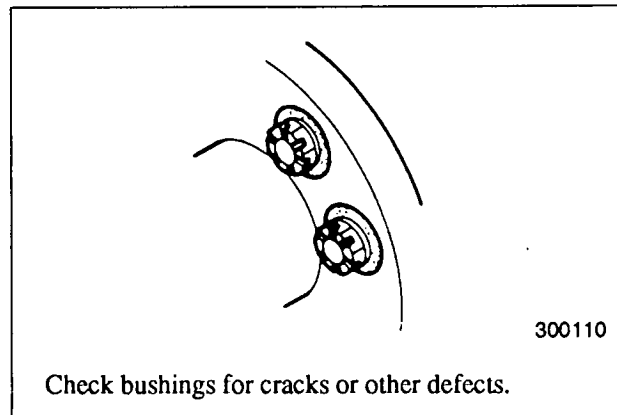
Direct pressure air in direction opposite to air flow.

EVERY 250 HOURS OR 1 YEAR — continued

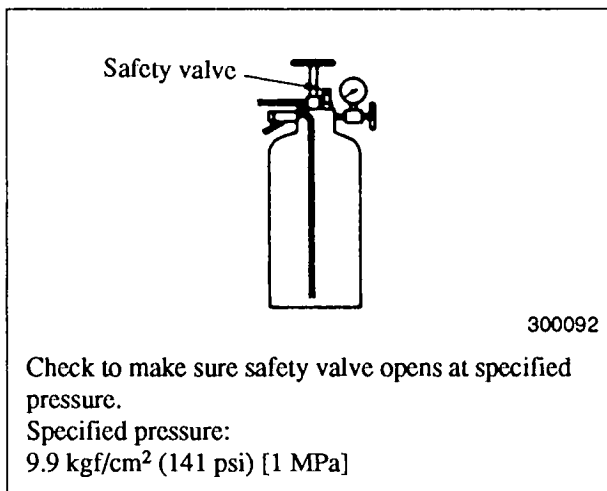
Exhaust muffler — Drain water.



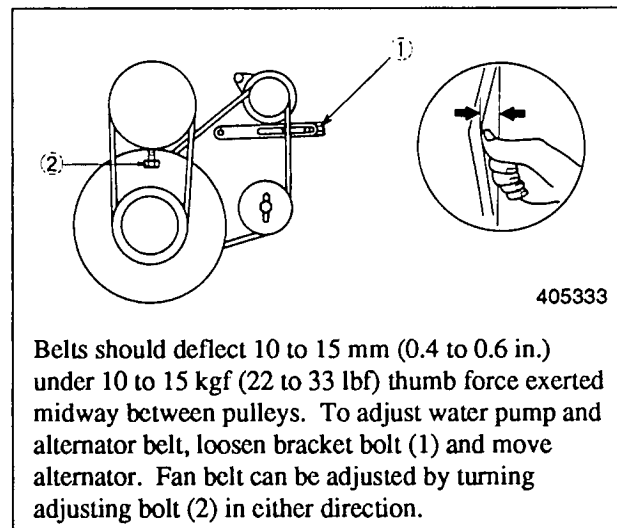
Coupling (rubber-bushing type) — Check.



Air tank (air-motor type) — Check safety valve for operation.

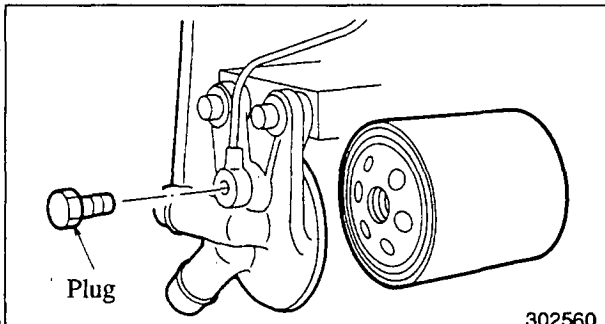


Fan, water pump and alternator drive belts — Check tension.



EVERY 500 HOURS OR 2 YEARS

Governor oil filter (Woodward type) — Change.



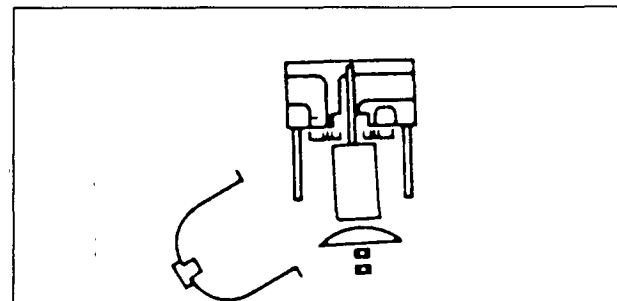
302560

Do not attempt to reuse oil filter by cleaning it. Always use a new element.

NOTE

After installing a new filter in place, remove plug from filter bracket and fill up filter with engine oil through plug hole.

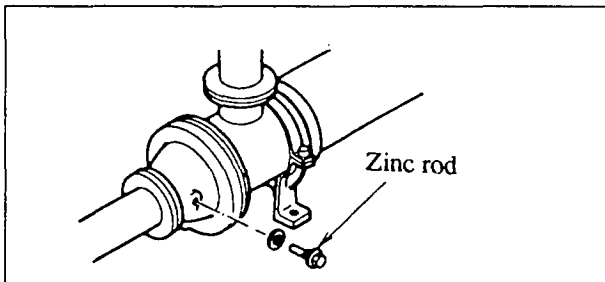
Air filter (air-motor type) — Wash element.



300115

Wash element with diesel fuel.

Zinc rods (sea-water cooling) — Change.

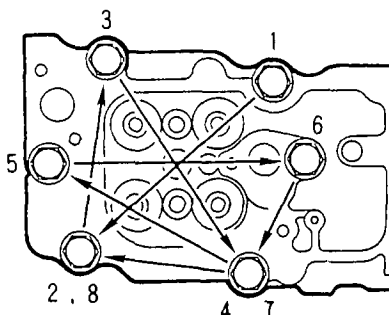


300113

Change zinc rods for sea water-cooled heat exchanger, marine gear oil cooler, air cooler, etc.

EVERY 1000 HOURS OR 3 YEARS

Bolts and nuts — Retighten.



36 kgf-m
(260 lbf-ft)
[71 N-m]
(wct)

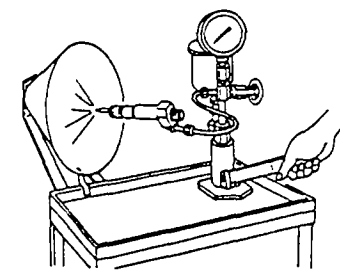
405354

Retighten bolts and nuts on:

- Cylinder heads
- Timing gear case
- Crankshaft pulley
- Injection pump coupling and shaft
- Mounting brackets
- Exhaust manifold
- Turbocharger

Retighten cylinder head bolts in number sequence (1-2-3-4-5-6-7-8) shown above.

Fuel injection nozzles — Check discharge pattern



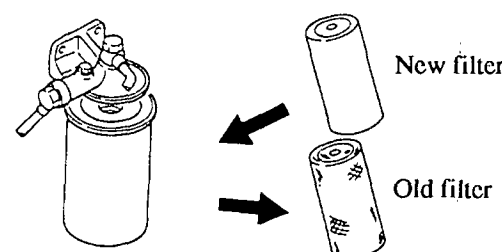
300518

Injection pressure:
250 kgf/cm² (3555 psi) [24.5 MPa]
Discharge pattern (shape of discharge) should be the same through all eight orifices.

NOTE

Check each nozzle for discharge pattern especially when exhaust smoke is abnormal. See "Fuel injection nozzles — Check and adjust."

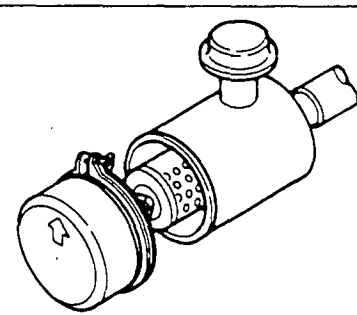
Fuel filters — Change.



302545

Lubricate new filter gasket with clean diesel fuel. Install filter (cartridge). Tighten filter additional 1/2 to 3/4 turn after filter gasket contacts filter base.

Air cleaner — Change element.



300121

- Stop engine before removing air cleaner element.
- Keep dust out of air inlet system.

CAUTION

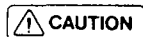
- This air cleaner is dry type. Never put oil in it.
- Never attempt to service air cleaner with engine running.
- Service air cleaner more often when operating in extremely dusty conditions.

EVERY 1000 HOURS OR 3 YEARS — continued

Injection timing — Check and adjust.

To adjust injection timing, proceed as follows:

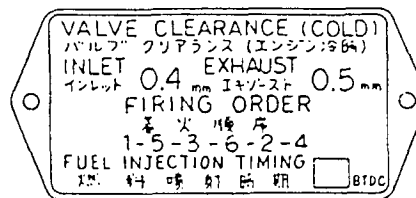
1. Injection timing is indicated on caution plate attached to rocker cover.
2. Put a turning bar on crankshaft pulley and turn crankshaft in normal direction (clockwise as seen from front end) to align 1,6 index number mark punched on damper with pointer (1). With crankshaft so positioned, piston for No. 1 cylinder is at top dead center on compression stroke and inlet and exhaust valves for No. 1 cylinder have some clearance. If these valves have no clearance, turn crankshaft once again.



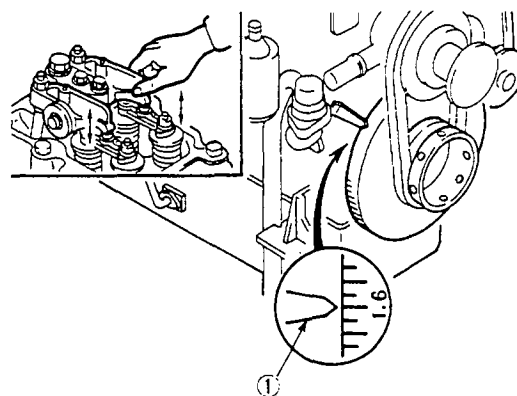
Be careful not to confuse No. 1 cylinder with No. 6. When No. 1 is in the above-mentioned position, its inlet and exhaust valves are both fully seated, presenting some clearance.

3. Turn back crankshaft about 60°, and turn it forward slowly until timing mark (3) on pump coupling aligns with pointer (2) on end face of pump case. In this position of crankshaft, read degrees of angle (injection timing) on scale (4) provided on damper, indicated by pointer (1). Minus (-) mark on scale means "before top dead center."

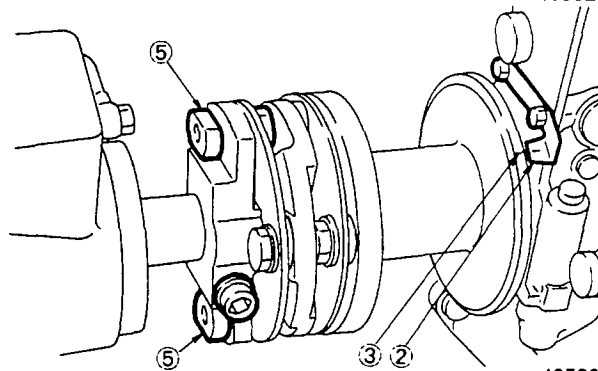
4. To adjust injection timing, proceed as follows:
 - (1) Align injection timing mark for No. 1 cylinder with engine pointer.
 - (2) Loosen two bolts (5) securing injection pump drive coupling.
 - (3) Turn injection pump shaft to align timing mark (3) on coupling with pointer (2) on end face of pump case.
 - (4) Tighten one bolt (5).
 - (5) Turn crankshaft and tighten another bolt (5).
 - (6) Again check injection timing by turning crankshaft.



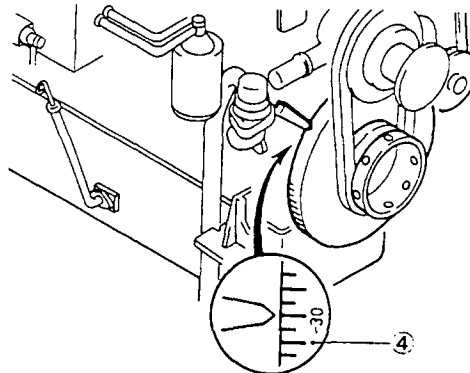
300247



405325



405326



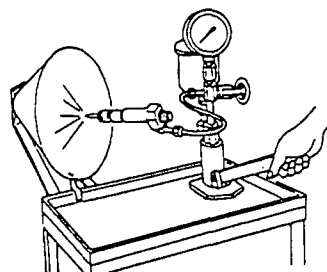
405327

EVERY 1000 HOURS OR 3 YEARS — continued

Fuel injection nozzles — Check and adjust.

Injection pressure inspection and adjustment

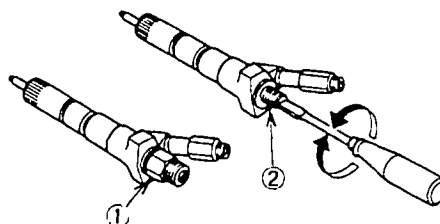
1. Set injection nozzle on a tester. Push down tester lever gently to pressurize. See if fuel discharge begins at 250 kgf/cm² (3555 psi) [24.5 MPa].
2. Remove cap nut (1) from nozzle holder, and tighten or loosen adjusting screw (2) with a screwdriver. Tightening screw will increase pressure, and vice versa.
3. After adjusting, put back on cap nut (1) and tighten it to 4 to 5 kgf-m (29 to 36 lbf-ft) [39 to 49 N-m].



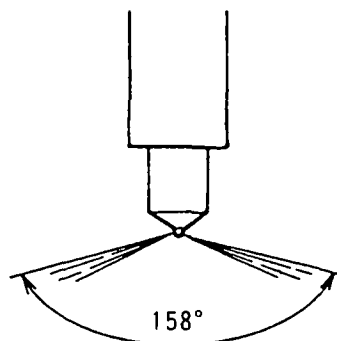
300518

Discharge pattern inspection

1. Check discharge pattern at the time of checking injection pressure.
2. Discharge pattern should be as follows:
 - (1) Discharge should occur from all eight orifices at the same time.
 - (2) Discharge angle should be 158°.
 - (3) Discharge should be finely and uniformly atomized.
 - (4) No dribbling.
3. If discharge pattern is indifferent or bad, remove nozzle tip and wash needle valve (3) and body (4).
4. To remove nozzle tip which is spring loaded, remove cap nut (1) and loosen adjusting screw (2). Then, remove retaining nut (5) and take out the tip.



300386



302562

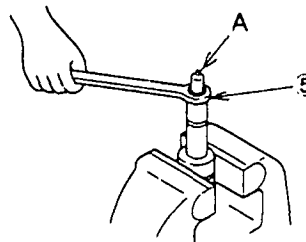
CAUTION

Be careful not to hit part (A) of nozzle tip.

5. For washing needle valve and body, use clean kerosene. After washing, put needle valve in body in clean diesel fuel.

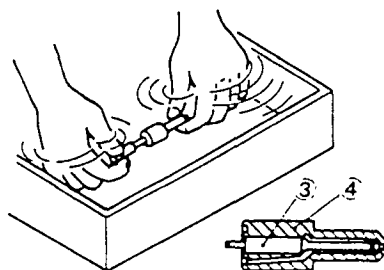
CAUTION

Needle valve and body are selectively fitted; never change this combination by replacing either part.



300123

6. Tighten retaining nut (5) to 6 to 8 kgf-m (43 to 58 lbf-ft) [59 to 78 N-m].
7. If the foregoing adjustment and cleaning do not improve discharge pattern, replace nozzle tip.



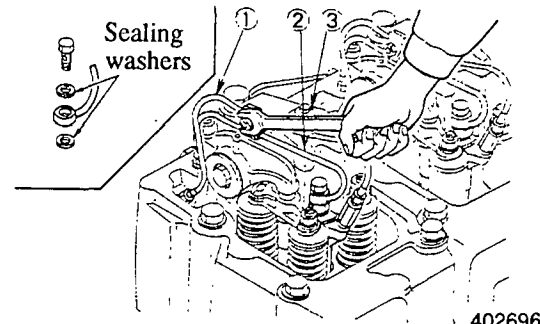
300337

EVERY 1000 HOURS OR 3 YEARS — continued

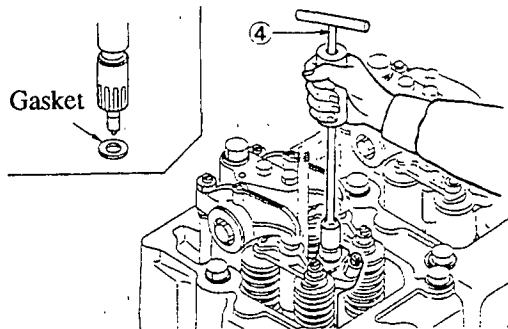
Injection nozzle — Removal and installation.

Removal

1. Loosen nut securing fuel pipe (1) and remove the pipe inside rocker cover. Remove leak-off pipe (2).
2. Unscrew gland nut (3) and, after removing gland and spacer, pull out nozzle.
3. To remove nozzle, use nozzle remover (4) (36291-00900).



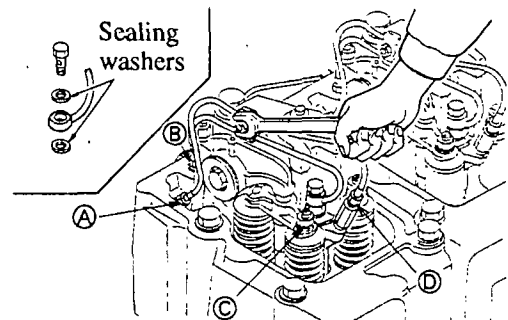
402696



402697

Installation

1. To install, follow reverse of removal procedure. Tighten gland nut to 6 kgf·m (43 lbf·ft) [588 N·m] while keeping clearance between body and valve spring as equal as possible all the way around. After installing nozzle, check each fuel pipe joint for leaks.
2. With rocker cover off engine, run engine at about 600 rpm and check to make sure there is no leaks at points (A), (B), (C) and (D). Stop engine and install rocker cover.



402696

EVERY 1000 HOURS OR 3 YEARS — continued

Valve clearance — Check.

Check valve clearance in firing-order sequence (injection sequence) shown below by turning crankshaft with turning bar.

Firing order	1-5-3-6-2-4
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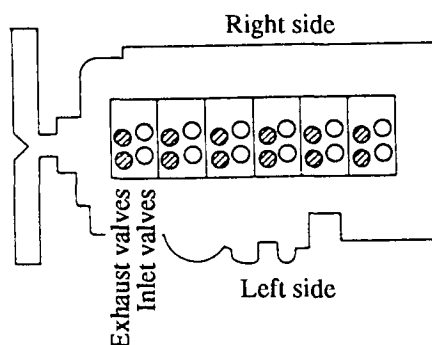
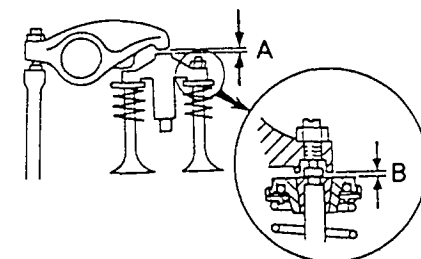
Unit: mm (in.)

	Valve clearance (A) (cold)	Bridge-to-valve rotator clearance (B)
Inlet valves	0.4 (0.016)	1.5 (0.059), minimum
Exhaust valves	0.5 (0.020)	

Adjust valve clearance if it is incorrect.

NOTE

Inlet valves are on left side and exhaust valves on right side of each cylinder head as seen from right or left side of engine.



300516

302563

Valve clearance — Adjust.

Valve height adjustment

1. Before adjusting valve clearance, adjust heights of two valves (bring bridge into contact with valves). If valve seats are worn, one valve differs from another in height, producing some clearance between valve stem (2) and bridge (1) (resulting in change in valve clearance).
2. Loosen lock nut (3) and back off adjusting screw (4).
3. Hold rocker arm (5) by finger in such a manner as to push down on bridge and tighten adjusting screw (4) until it touches valve stem (2) while observing the screw through inspection hole. From that position, turn adjusting screw additional 10° and tighten lock nut (3).

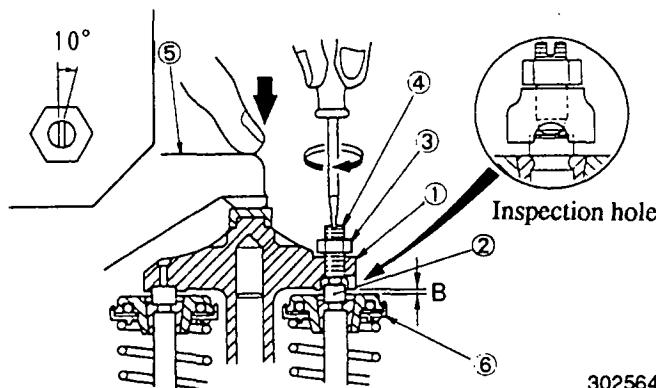
NOTE

If clearance (B) between bridge (1) and valve rotator (6) is less than 0.5 mm (0.020 in.), valve cotter would come off. Be sure to keep this clearance greater than 1.5 mm (0.059 in.).

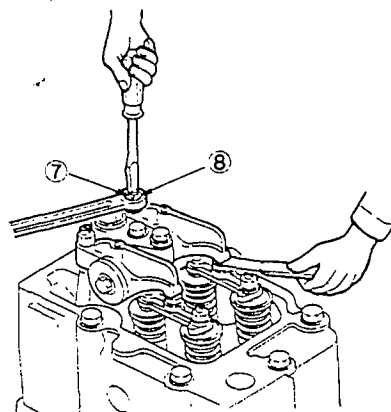
Valve clearance adjustment

1. Loosen lock nut (8) for adjusting screw (7) (on push rod side of rocker).
2. Turn adjusting screw (7) in either direction to reduce or increase valve clearance between rocker arm and bridge with a feeler gauge inserted between the two.

3. After adjusting valve clearance, tighten lock nut (8) good and hard.



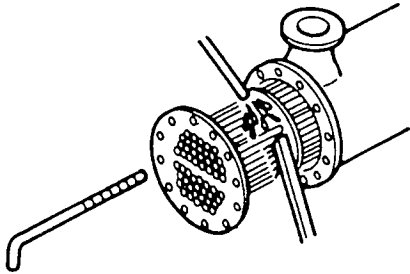
302564



402675

EVERY 2000 HOURS OR 5 YEARS

Heat exchanger — Wash.



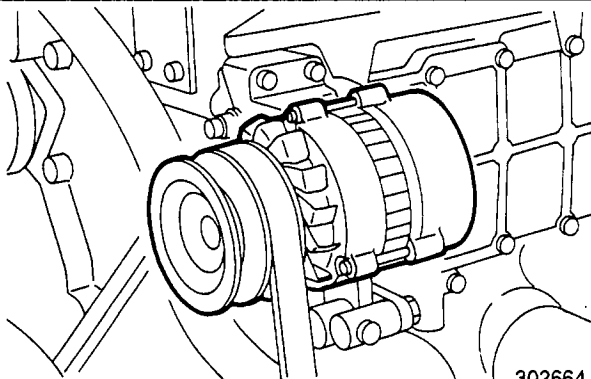
300125

Wash outside surfaces of pipes with a brush by dashing fresh water over them. Remove scale from inside of pipes by inserting a bar.

NOTE

Use a fine, soft wire brush for cleaning.

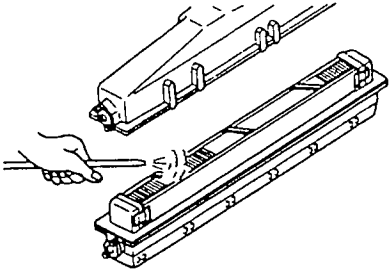
Alternator — Check.



302664

Visually check for any defects. Remove V-belt from alternator pulley and turn alternator by hand to listen for abnormal noise.

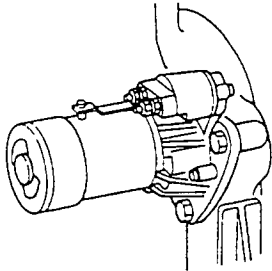
Air cooler — Clean.



300155

Remove air cooler, and direct pressure air in direction opposite to air flow. Remove scale from inside of fresh-water or sea-water pipes by inserting a bar.

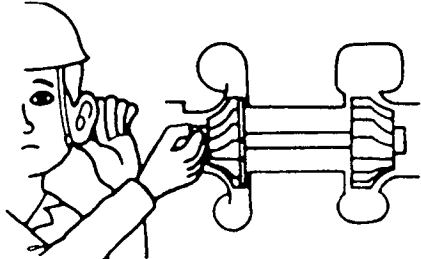
Starter — Check.



300525

Visually check for any defects. Check pinion for smooth shifting and meshing.

Turbochargers — Check.



300124

Turn compressor wheel by hand to feel for rattling and listen for abnormal noise. If wheel is noisy or rattles, replace bearings.

EVERY 2000 HOURS OR 5 YEARS — continued

Vibration damper — Check.

Visually check for fluid leaks, flaws, distortion, discoloration of painted surface and flaking. Check cover for swelling (by measuring with a scale), fluid leaks past staked portions, discoloration of painted surfaces and flaking.

Damper operating temperature

Proper heat dissipation from damper surfaces is essential to damper function. When each engine is shipped from the factory, its damper is verified to be free from abnormal temperature rise. However, damper temperature would rise abnormally in some operating conditions. Make sure surrounding area is well ventilated.

1. In case of a viscous damper, its surface temperature should not exceed 100°C (212°F) on a standby-power engine or 90°C (194°F) on a prime-power engine after about one-hour rated-output operation. In case of a viscous-rubber damper, it should not exceed 90°C (194°F) on a standby-power engine or 80°C (176°F) on a prime-power engine.

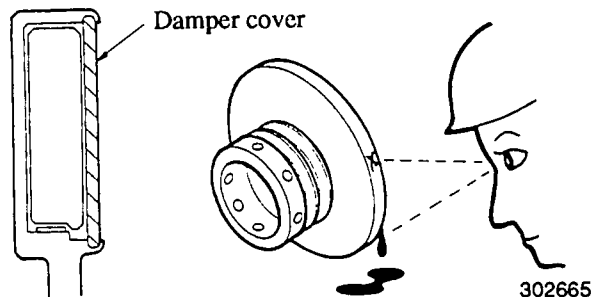
Use of Thermo Label is recommended to check the damper temperature on a prime-power engine. For Thermo Label, consult your Mitsubishi dealer.

Part name	Measuring range	Part number
Thermo Label 75-95	75° to 95°C (167° to 203°F)	32522-04100
Thermo Label 100-120	100° to 120°C (212° to 248°F)	32522-04200

2. When installing a protective cover to the damper, select a cover which does not cause damper temperature to rise abnormally.

NOTE

Under no circumstances should a cover enclosing the damper be installed to the engine.



EVERY 2 YEARS

Coolant — Change.

1. Start engine and run it until coolant temperature is 75° to 85°C (167° to 185°F). Stop engine.
2. Raise lever of radiator filler cap (1) to release pressure. Then remove cap (1).
3. Open radiator drain valve (2), engine drain valve (3) and water pump drain valve (4) and drain coolant.

CAUTION

Coolant containing antifreeze is harmful. For disposal of such a coolant, consult your Mitsubishi dealer.

4. Close drain valves. Fill cooling system with cleaning solution that does not attack rubber and metal. Start engine and run it at 800 to 900 rpm for about 15 minutes. Stop engine. Open drain valves and drain solution.
5. Close drain valves. Fill system with soft water and run engine at 800 to 900 rpm for about 10 minutes.
6. Stop engine. Open drain valves and flush system by pouring water into it. Continue to pour water until clean water flows from engine.
7. Close drain valves and remove radiator filler cap.
8. Pour soft water and pure Long Life Coolant alternately into radiator in several parts until radiator is full.

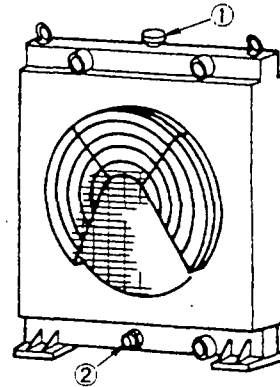
CAUTION

Remove air vent plug (5) at top of thermostat case to help avoid air pockets.

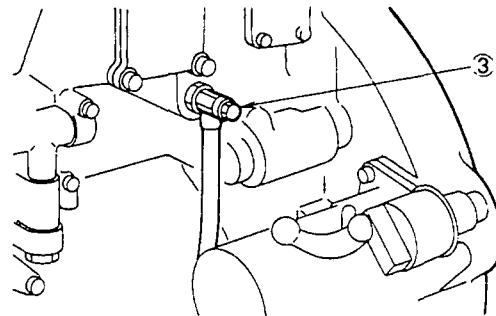
NOTE

For coolant specifications and Long Life Coolant, see page 46.

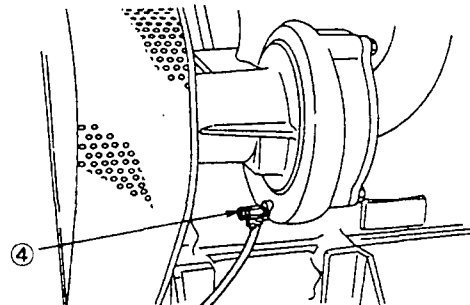
9. Start engine and run it until coolant temperature is 75° to 85°C (167° to 185°F). Stop engine. Check coolant level in reserve tank or radiator and, if necessary, add water premixed with Long Life Coolant of the same concentration as before.



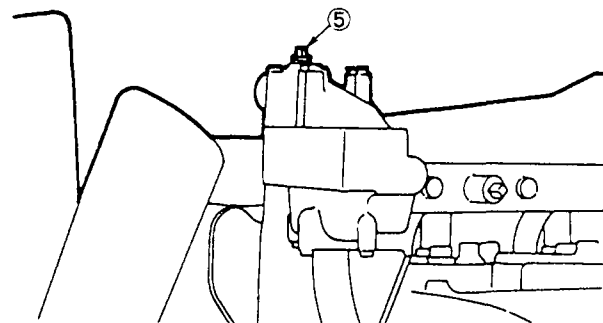
300102



302666



301824

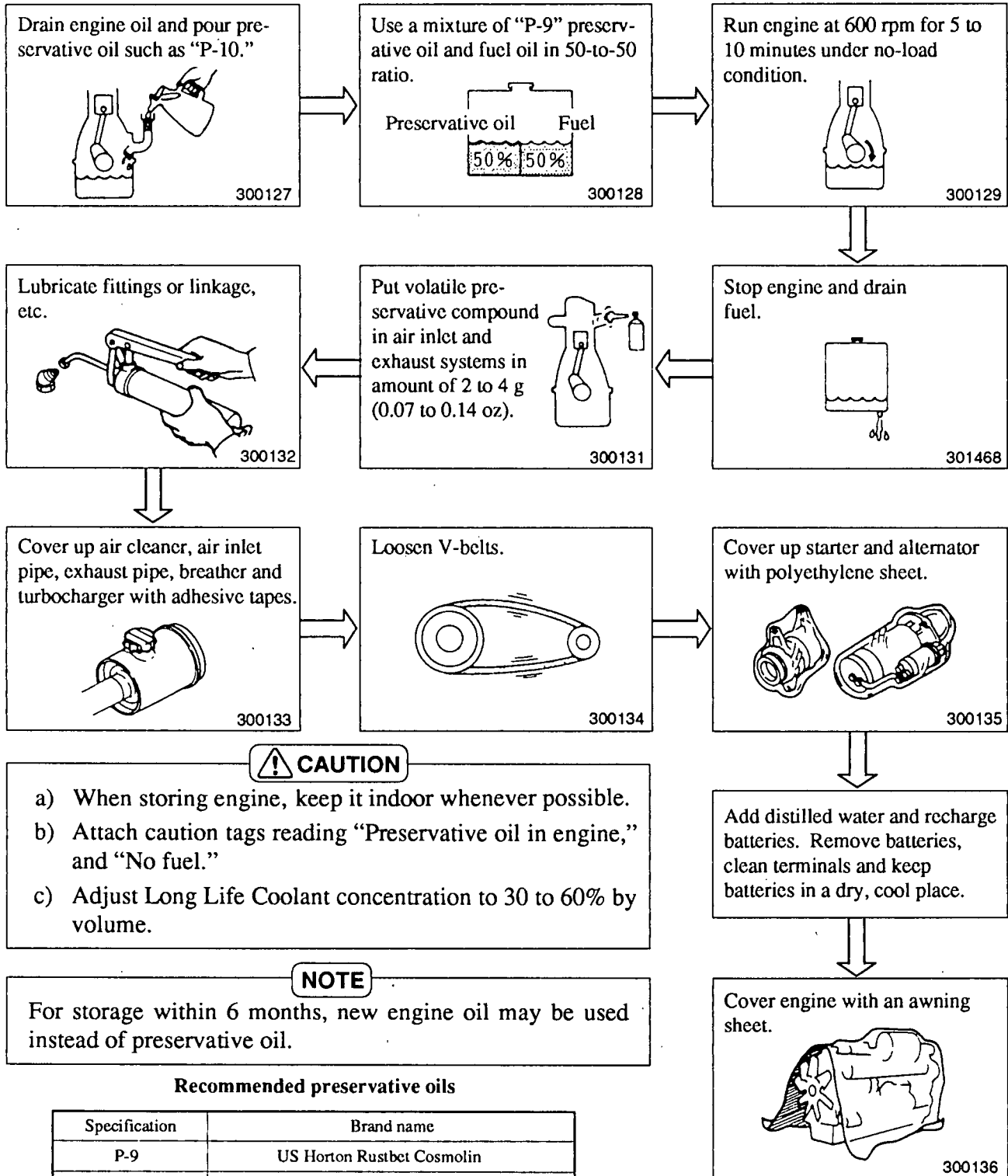


302567

STORAGE

Storing the engine for more than 6 months

Preparation



CAUTION

- a) When storing engine, keep it indoor whenever possible.
- b) Attach caution tags reading "Preservative oil in engine," and "No fuel."
- c) Adjust Long Life Coolant concentration to 30 to 60% by volume.

NOTE

For storage within 6 months, new engine oil may be used instead of preservative oil.

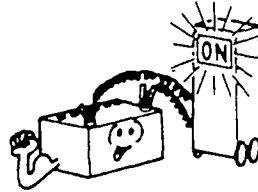
Recommended preservative oils

Specification	Brand name
P-9	US Horton Rustbet Cosmolin
P-10	US Horton Cosmolin 1051, 1049

STORAGE

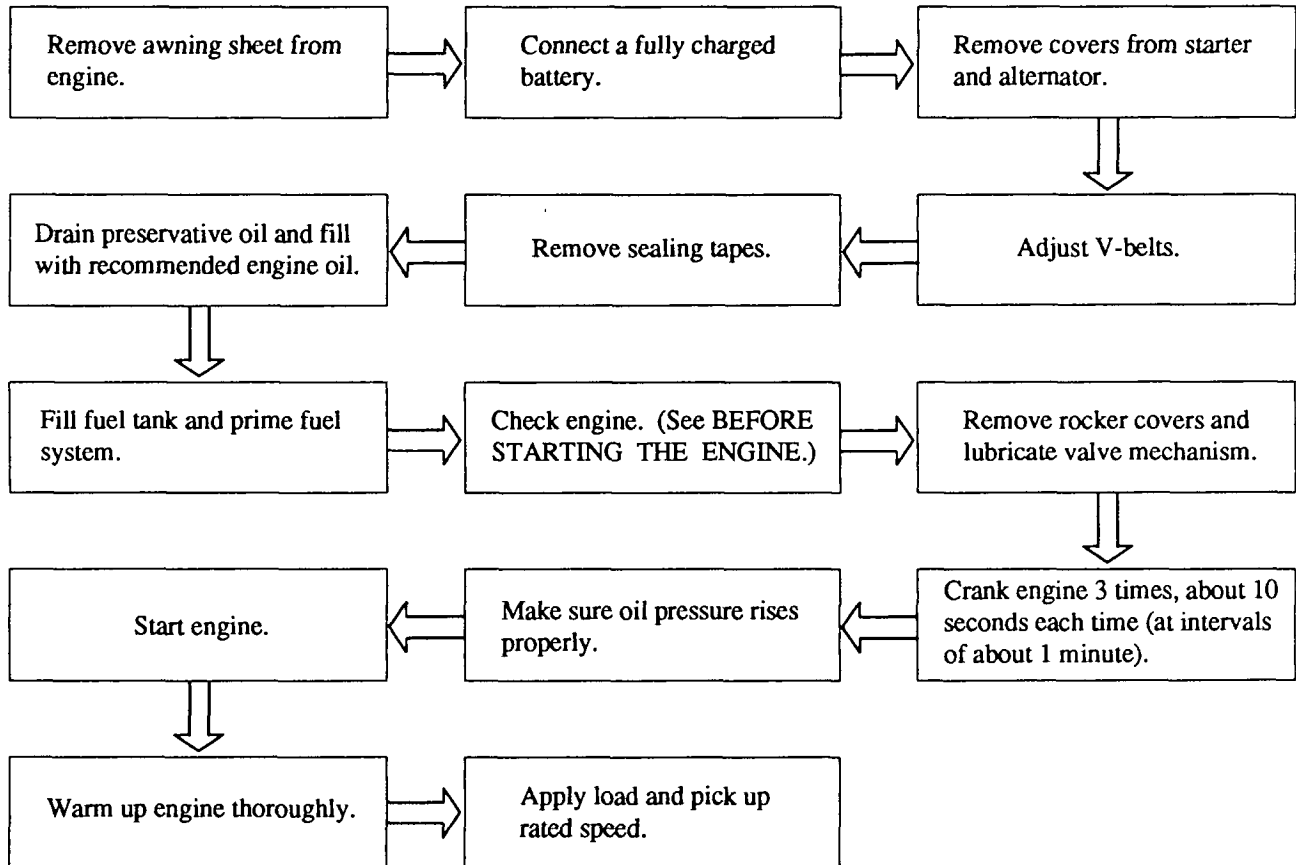
Service during storage

Recharge batteries at least once a month.



300137

Removing the engine from storage



Storing the engine for more than 6 months in ready-to-use condition

Follow this procedure once a month:

- (1) Crank the engine two times with the starter at intervals of about 15 seconds with the fuel supply shut off (the manual stop lever pushed to non-injection position).
- (2) Start the engine and run it at about 800 rpm under no-load condition for about 5 minutes. Increase the engine speed to 1000 to 1200 rpm and run it under no-load condition for about 10 minutes.

FUEL SPECIFICATIONS

1. Types of fuel

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

This engine is designed to burn diesel fuel oils marketed to meet JIS K2204 or ASTM Designation D 975 (grades No. 1-D and No. 2-D) or furnace oils marketed to meet JIS K 2205 or ASTM Designation D 396 (grade No. 4).

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

CAUTION

- a) A filter for diesel fuel oil differs from that for furnace oil. Do not use furnace oil for an engine which burns diesel fuel oil.
- b) It is important to use clean fuel. The clearance between the fuel injection pump plungers and barrels is very small and makes it evident that water and invisible particles of dirt which might pass through the filter can damage these finely finished parts.

NOTE

Some furnace oils marketed would not be suitable for Mitsubishi engines. In selecting a fuel, consult the "Limiting Requirements for Diesel Fuel Oils" chart.

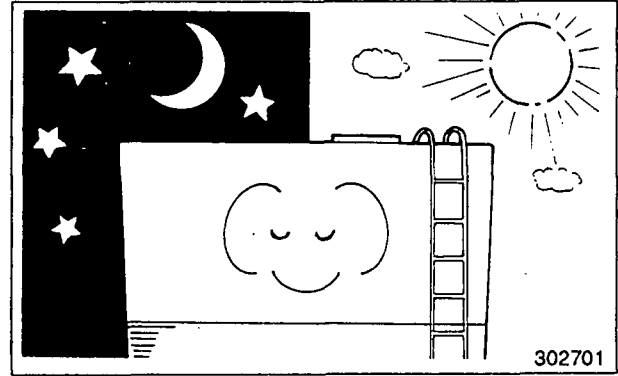
Limiting Requirements for Diesel Fuel Oils

Property	Limit	Remarks
Flash point, min.	Legal	JIS K 2204, 2205 Diesel fuel oil: 50°C (122°F) Furnace oil: 60°C (140°F)
Distillation temperature, 90% point	380°C (716°F), max.	
Pour point	6°C (11°F), min. below the lowest atmospheric temperature	
Cloud point	Below the lowest atmospheric temperature	
Carbon residue on 10% residuum, weight percent	1.0, max.	
Cetane number	45, min.	40, min. under special opening conditions
Kinematic viscosity	2.0 cSt, min. at 30°C (86°F) 8.0 cSt, min. at 50°C (122°F) 10.5 cSt, min. at 40°C (104°F) 16.0 cSt, min. at 30°C (86°F)	
Sulfur, weight percent	1.0, max.	
Water and sediment, volume percent	0.1, max.	
Ash, weight percent	0.03, max.	
Copper strip corrosion, at 100°C (212°F), 3 hrs	No. 3, max.	ASTM: No. 3 JIS K2513: Discoloration No. 3
Gravity, 15/4°C (39°F)	0.80 to 0.87	Reference

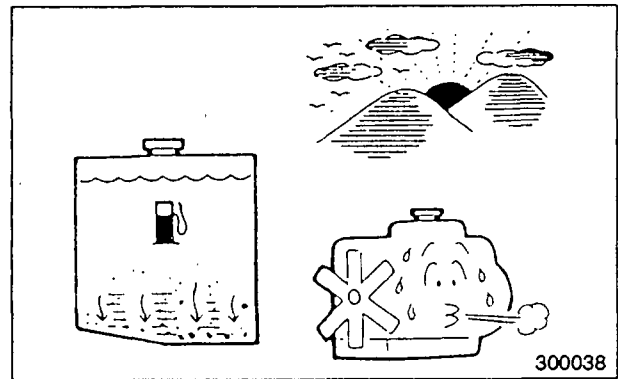
FUEL SPECIFICATIONS

2. Fuel cleanliness

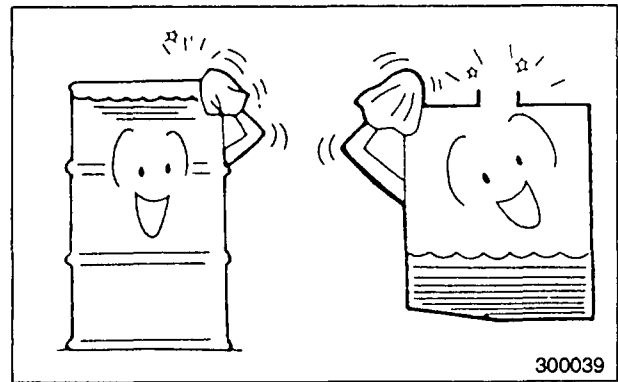
- (1) Use a storage tank, and allow fuel to stand at least 24 hours in this tank before pumping it to the diesel fuel tank. Be sure to drain all water and sediment that has settled to the bottom of the storage tank before the diesel fuel tank is refilled.



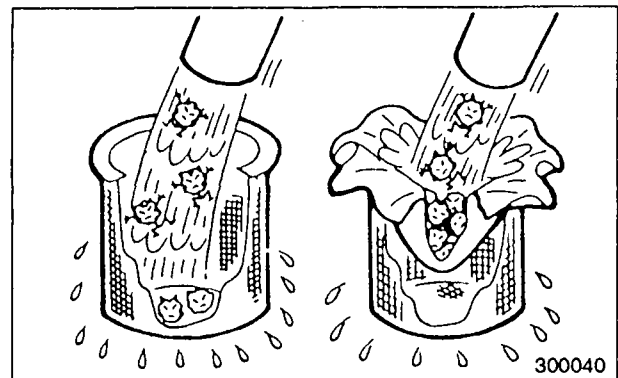
- (2) Fill the diesel fuel tank at the end of the day. This will drive out moisture-laden air and prevent condensation.



- (3) When refilling the diesel fuel tank, use clean tools, such as a hand pump, funnels, containers, hoses, etc. Wipe filler cap clean before removing it. When operating the hand pump, keep in mind that there could be water and sediment that has settled to the bottom of storage tank; tap the needed amount of fuel from clean top portion.



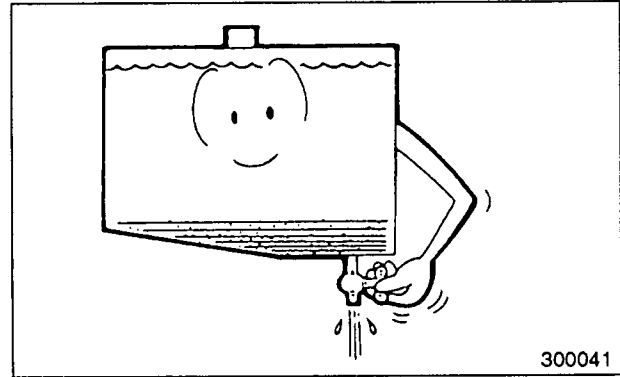
- (4) Be sure to pour fuel through strainer in the filler opening. Use of a lint-free cheese cloth is a good practice for keeping dirt out.



- (5) Occasionally, open the drain cocks of the storage and diesel fuel tank to drain off any water or sediment that may have accumulated.

NOTE

Even clean top portion of fuel oil contains more or less dirt and water. Such dirt and water should be removed before they get inside the engine.



300041

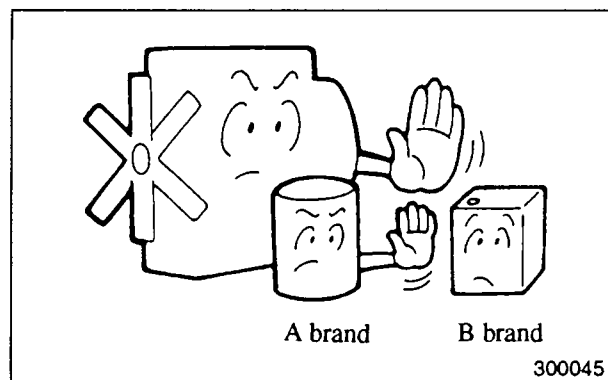
LUBRICANT SPECIFICATIONS

1. Engine oils

Use oils that meet API Service Classification CD (MIL-L-2104C). Consult your Mitsubishi dealer for correct oil recommendations. 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 hence, 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.

CAUTION

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



2. Lubricating grease

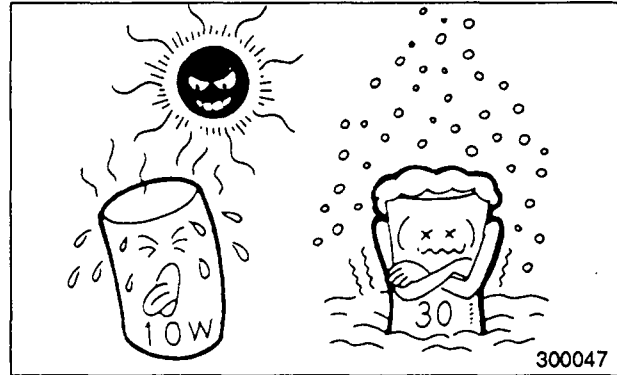
Use clean multipurpose type grease for your engine.

CAUTION

Cleanliness is important for handling engine oil and grease. Use clean handling tools; wipe the filler cap and grease fittings clean; and handle them in a dust-free condition.

3. Lubricant viscosities

Two important considerations relate to satisfactory engine operation under cold ambient temperature conditions — (1) the ability to crank the engine fast enough to secure starting, and (2) adequate lubrication of internal wearing surfaces during starting and warm-up. These considerations can be adequately met through proper grade selection. The recommended oil viscosities and grease consistencies are found on the “Recommended Lubricant Viscosities” chart.



Recommended Lubricant Viscosity

Ambient temp., °C (°F)	-30 (-22)	-25 (-13)	-20 (-4)	-15 (5)	-10 (14)	-5 (23)	0 (32)	10 (50)	20 (68)	30 (86)	40 (104)
Engine oil											
Grease	NLGI No. 0 or No. 1						NLGI No. 2				

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 “Limiting Requirements for Engine Oils” chart. Change the oil if any of these requirements is not met. Also, change it every 750 hours even if all the requirements are met.

NOTE

- a) Oil change intervals depend to a great extent on fuel properties. Be sure to use only recommended fuels.
- b) 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 K2283	+30%, max. of new oil -15%
Total base number (Hcl)	mgKOH/g JIS K2501	2.0, min.
Total acid number	mgKOH/g	+3.0, max. of new oil
Water content	Vol% JIS K2275	0.2, max.
Flash point (coc)	°C (°F) JIS K2265	180 (356), min.
Pentane insolubles	Wt% ASTM D893	0.5, max.
Pentan insolubles coagulated	Wt%	3.0, max.

COOLANT SPECIFICATIONS

Coolant

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

NOTE

Basically, harmful chemical properties and substances contained in water (as coolant) should not exceed the Mitsubishi limits but they are tolerable up to the recommended limits.

Coolant additives

1. Recommended brands of additive

(1) Long Life Coolant (LLC)

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

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

(2) Features of the recommended brands

- None of amines (methyl amines, ethyl amines, n-propyl amines, etc., all being derivatives of ammonia, NH₃) 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.)

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 8.0)	○	○
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)	-	○
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. How to use the non-amine additive
 - (1) The engine coolant with any of the recommended brands of LLC additive should be changed at intervals of 2 years.
 - (2) The proper concentration of LLC additive is from 30% to 60% year-round. Aim at a temperature level lower by 5°C (90°F) than the expected lowest temperature. Remember, a concentration of less than 30% does not provide sufficient corrosion protection. A concentration over 60% adversely affect freeze protection and heat transfer rates, resulting in engine overheating. When adding coolant, prepare a make-up coolant whose LLC additive concentration is equal to that of the coolant in the engine.

Additive Concentration

Lowest expected temperature, °C (°F)	-10 (14)	-20 (-4)	-30 (-22)	-45 (-49)
Concentration of LLC additive, %	30	40	50	60

CAUTION

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

3. Why additives?
 - (1) Basis of the need to give additives to cooling water

Drive for higher engine performance in the recent decades has brought about many changes toward smaller and more lightweight engines, greater power output, lower fuel consumption and lower exhaust emission levels. Engine application too has expanded, introducing engines into the areas of utility power generation, as distinguished from standby service, co-generation and the like: in all these areas, the engine coolant is compelled to withstand severe service conditions, namely, continuous high-power operation with higher coolant temperature and higher speed of recirculation in the cooling circuit.

Many materials involved in the circuit (such as steel, aluminum, copper, solder and rubber) too are subjected to severe service. These materials notably differ in ionizing tendency and this difference promotes corrosion erosion 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 the additives.

- (2) How common additives work

The additive contains several chemical ingredients in such proportions as to produce the chemical reactions that suppress corrosion of engine parts in contact with the coolant. "Corrosion" is but another name of the result of an electrochemical phenomenon called atomic and molecular "ionization."

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

Moreover, if its ingredients are not well proportioned to match the circuit metals which they are meant 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 ingredients, calculated to inhibit this "molecular eating-away or ionic reaction," might accelerate, not retard, 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 ingredient proportions and the circuit metals. Here resides the major pitfall in the use of an additive in cooling water.

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

Case 1:

Amines are generally effective in suppressing the rusting of ferrous metals but are said to be

COOLANT SPECIFICATIONS

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 an 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.

(Example)

Prechambers, cylinder liners (which are liable to develop pits also by "cavitation" or molecular hammering), underside surfaces of cylinder head.

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 attacking aluminum.

(Example)

The mechanical seal of the water pump may rapidly wear down as the secondary effect of silicate gell 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 heat exchangers, become particularly victimized. The cause of coolant leakage from and clogging of the coolant circuit in the exchangers are usually traceable to such a malcondition of the coolant.

(Example)

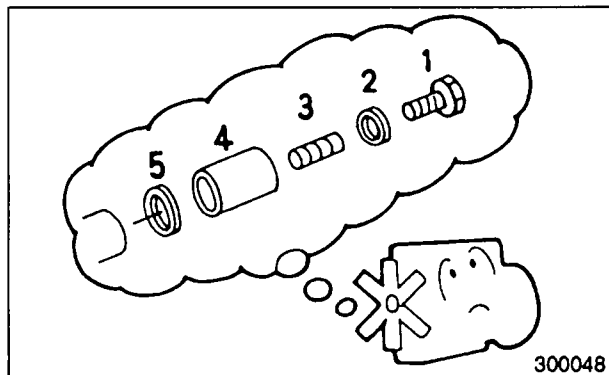
Heat exchangers fitting the above description are radiators, air coolers, oil coolers and the like.

TROUBLESHOOTING

General instructions

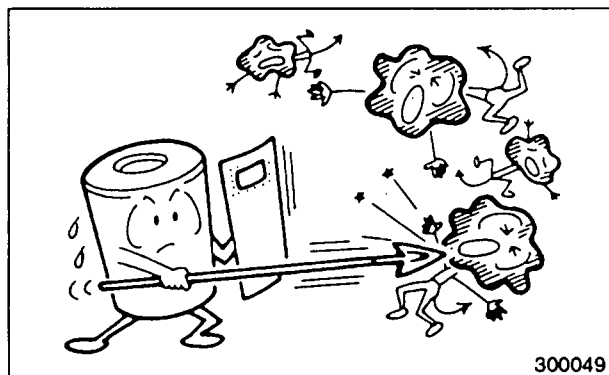
1. Think before acting

Upon noting an abnormal symptom, recall what you did the last time when you ran across the same symptom. If what you did was correct and successful, do the same. If the symptom noted is new to you, think of possible causes in accordance with the troubleshooting procedure which follows.



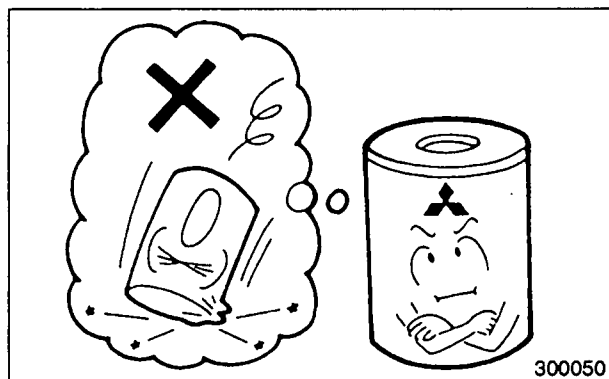
2. Dust and dirt are often the ultimate causes.

“Wear” is usually a result of abrasive particles. When disconnecting or disassembling a part or component, be sure to keep off dust and dirt.



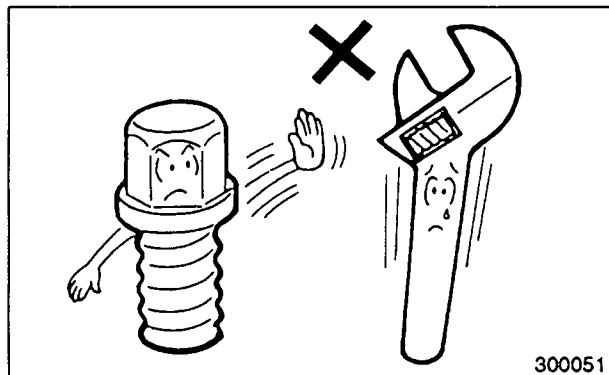
3. Use genuine Mitsubishi parts.

Use only genuine parts to replace those that have failed or reached the service limit. When ordering, specify the needed replacement parts by referring to the Mitsubishi Parts Catalogues.



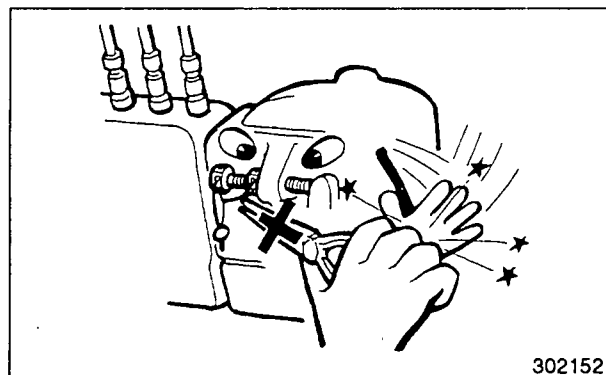
4. Perform servicing work safely.

Use the right kind of hand tools to carry on each working step in repair work. Avoid injury to yourself and damage to the parts by using improper tools. When lifting or carrying a part too heavy for one person to handle, get another person's help and, if necessary, use a jack or a hoist to avoid personal injury.



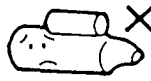
⚠ CAUTION

- a) Never attempt to break the seals of the governor for maximum speed setting and maximum injection quantity setting.
- b) The maximum injection quantity of injection pumps has been set on the basis of the output horsepower of each engine verified in the bench test. Never attempt to vary this injection quantity in field.



302152

Electric-starter engine

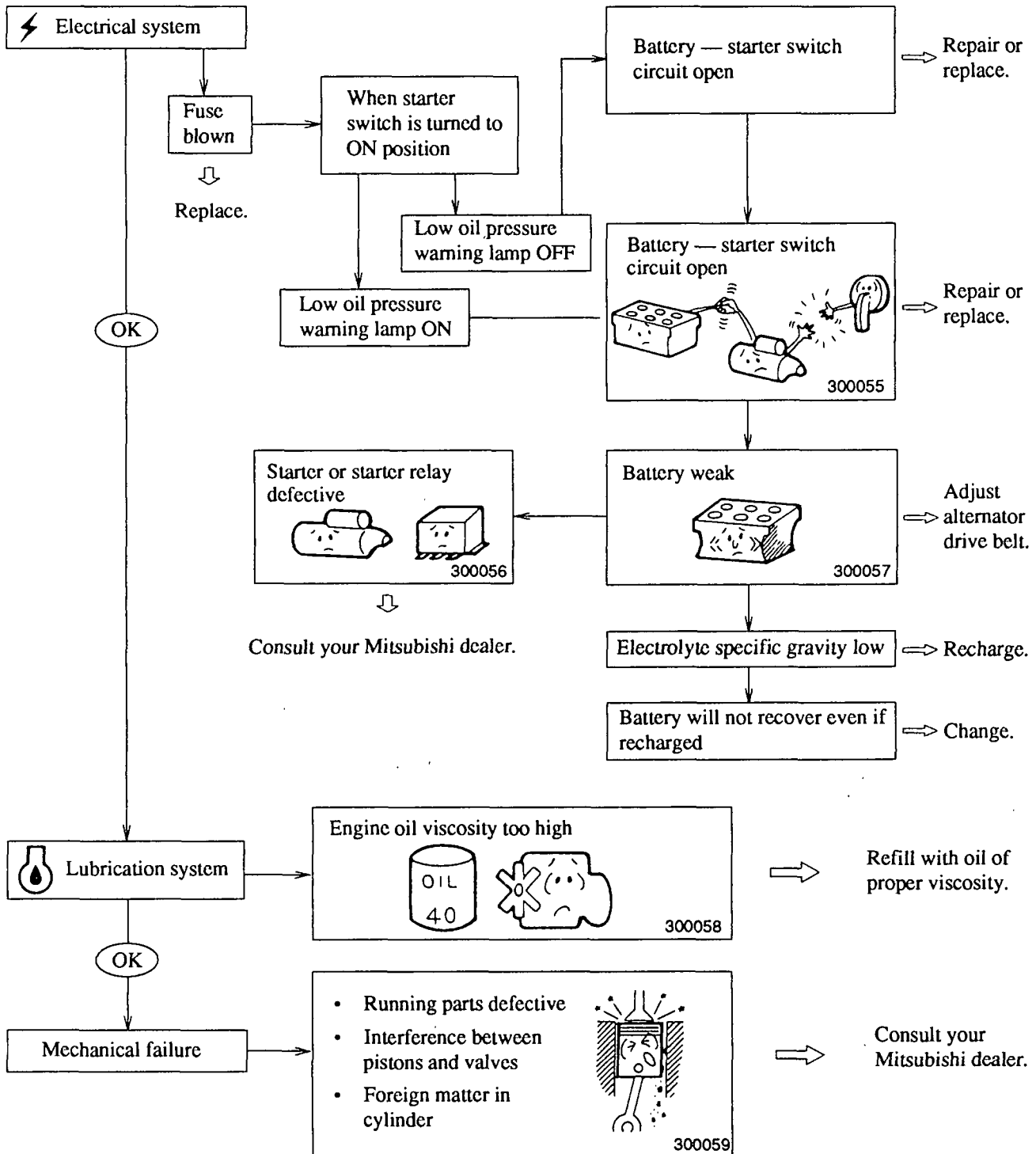


300053



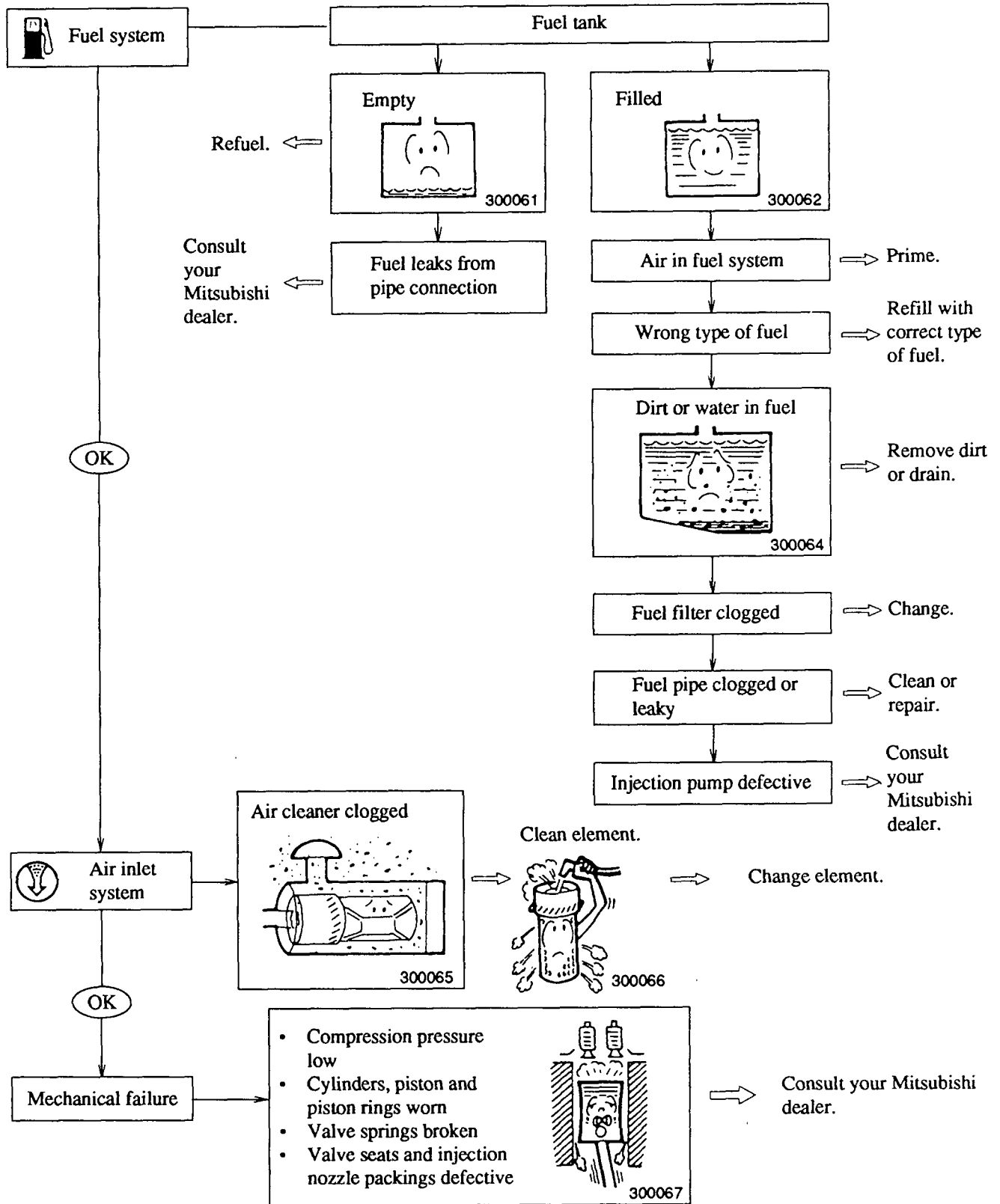
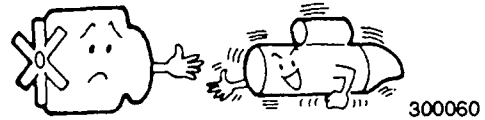
300054

Starter will not crank engine or cranks slowly, resulting in a failure to start

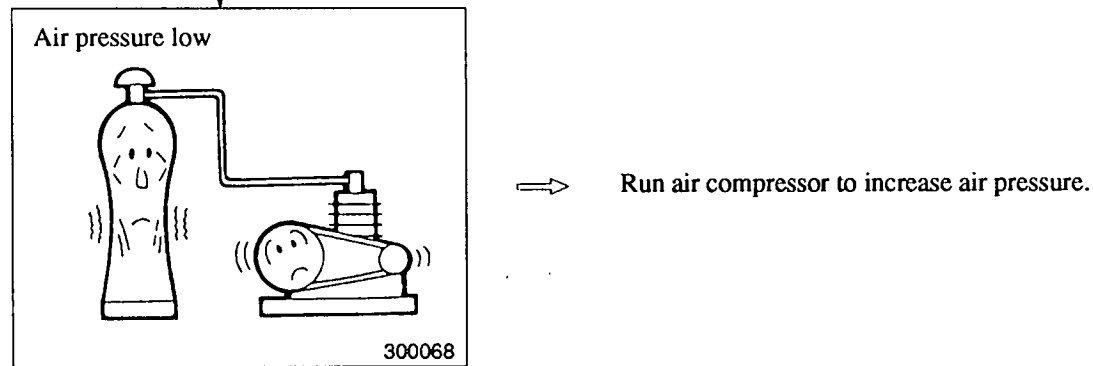
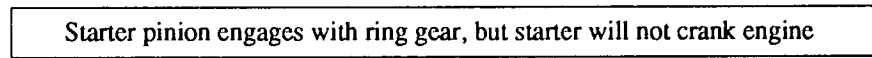
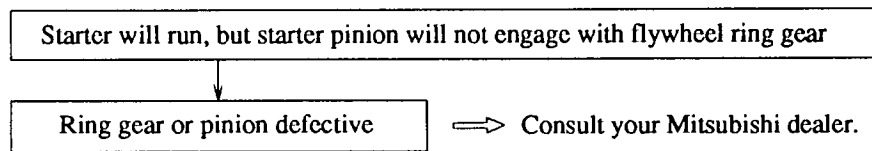
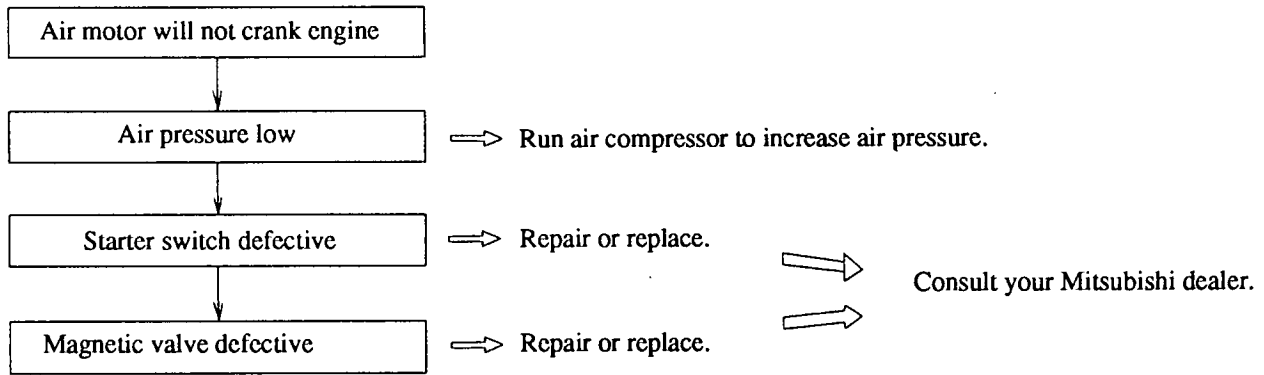


Electric-starter engine — continued





Starter will crank engine, but engine will not start



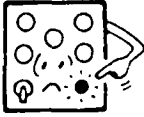


Air-motor engine



Others

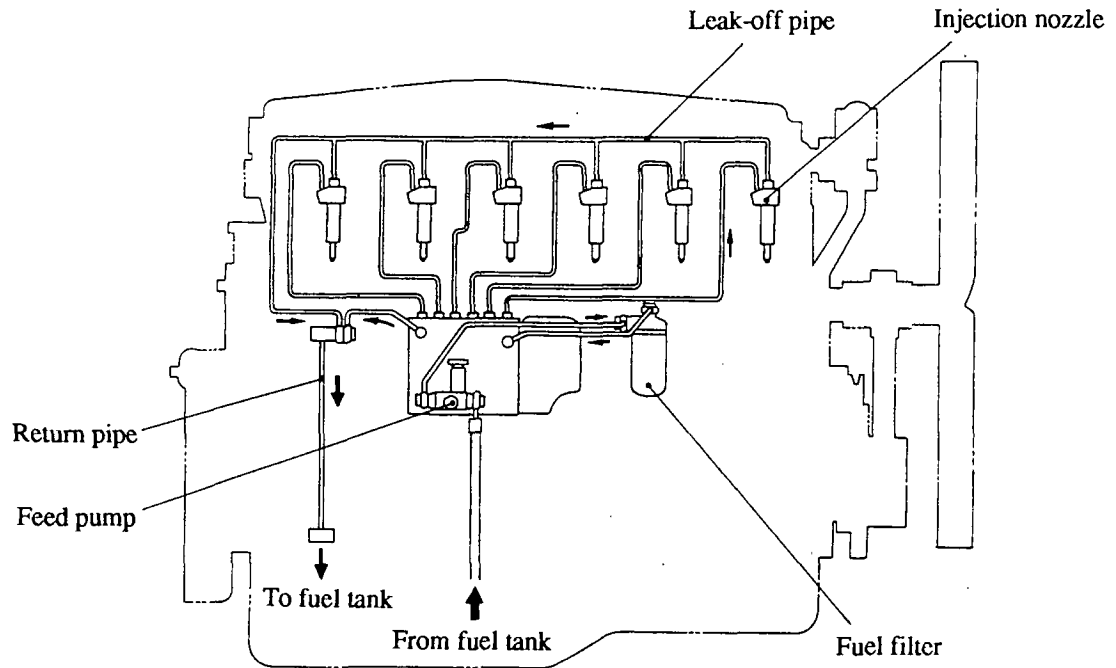
Complaint	Possible causes	Remedy
<p>Engine lacks power</p>  <p>500040</p>	<ul style="list-style-type: none"> • Incorrect grade of oil • Wrong type of fuel • Insufficient air (air cleaner clogged) • Engine overcooled • Fuel feed pump gauze filter clogged • Engine overheating • Valve clearance incorrect • Injection pump defective • Injection nozzles defective • Injection timing incorrect • Compression pressure low (cylinders and pistons worn) 	<ul style="list-style-type: none"> • Use recommended type and SAE number of oil. • Change. • Clean or change element. • Use radiator cover or replace parts. * Clean gauze filter. • Flush cooling system or replace parts. • Readjust. * Readjust or replace. * Readjust or replace. * Readjust. * Disassemble and replace parts.
<p>White or blue exhaust smoke</p>  <p>500041</p>	<ul style="list-style-type: none"> • Too much oil in crankcase • Oil viscosity too low • Engine overcooled • Thermostat defective (no water temperature rise) • Injection nozzles defective • Injection timing incorrect • Compression pressure low • Wrong type of fuel (low cetane number) 	<ul style="list-style-type: none"> • Drain to correct level. • Refill with correct viscosity of oil. • Use radiator cover or replace parts. * Replace. * Readjust. * Readjust. * Disassemble and replace parts. • Change.
<p>Black or gray exhaust smoke</p>  <p>500042</p>	<ul style="list-style-type: none"> • Wrong type of fuel • Valve clearance incorrect • Injection pump defective • Compression pressure low • Insufficient air (air cleaner clogged) • Injection timing incorrect • Injection nozzles defective 	<ul style="list-style-type: none"> • Refill with correct type of fuel. • Readjust. * Readjust or replace. * Disassemble and replace parts. • Clean or change element. * Readjust. * Readjust or replace.
<p>High fuel consumption</p>  <p>500043</p>	<ul style="list-style-type: none"> • Injection pump defective • Injection nozzles defective • Injection timing incorrect • Wrong type of fuel • Compression pressure low • Insufficient air 	<ul style="list-style-type: none"> * Readjust or replace. * Readjust or replace. * Readjust. • Refill with correct type of fuel. * Disassemble and replace parts. • Clean or change air cleaner element. Check turbocharger.

Complaint	Possible causes	Remedy
<p>High oil consumption</p>  <p>500044</p>	<ul style="list-style-type: none"> • Too high oil level in crankcase • Incorrect grade of oil • Oil leaks • Cylinders and piston rings worn • Valve stem seals worn 	<ul style="list-style-type: none"> • Maintain oil level in correct range on gauge. • Use recommended type and SAE number of oil. • Retighten or replace. * Disassemble and replace parts. * Disassemble and replace.
<p>Engine overheats</p>  <p>500047</p>	<ul style="list-style-type: none"> • Radiator or heat exchanger dirty • Fan belt loose • Lack of coolant • Water pump defective • Thermostat defective 	<ul style="list-style-type: none"> • Wash. • Replace. • Refill. * Replace. * Replace.
<p>Low oil pressure</p>  <p>500045</p>	<ul style="list-style-type: none"> • Lack of oil • Oil viscosity too low • Oil filters clogged • Oil pump defective • Oil pressure regulating valve defective • Oil pressure sensor circuit defective 	<ul style="list-style-type: none"> • Refill up to level. • Refill with correct viscosity of oil. • Replace element. * Readjust, clean or replace. * Readjust or replace. * Replace.

- Remarks:
1. Consult your Mitsubishi dealer for items marked with asterisk (*).
 2. Consult your Mitsubishi dealer for any item other than those listed above.
 3. When communicating with your Mitsubishi dealer, give model designation, serial number and service meter reading of your engine.

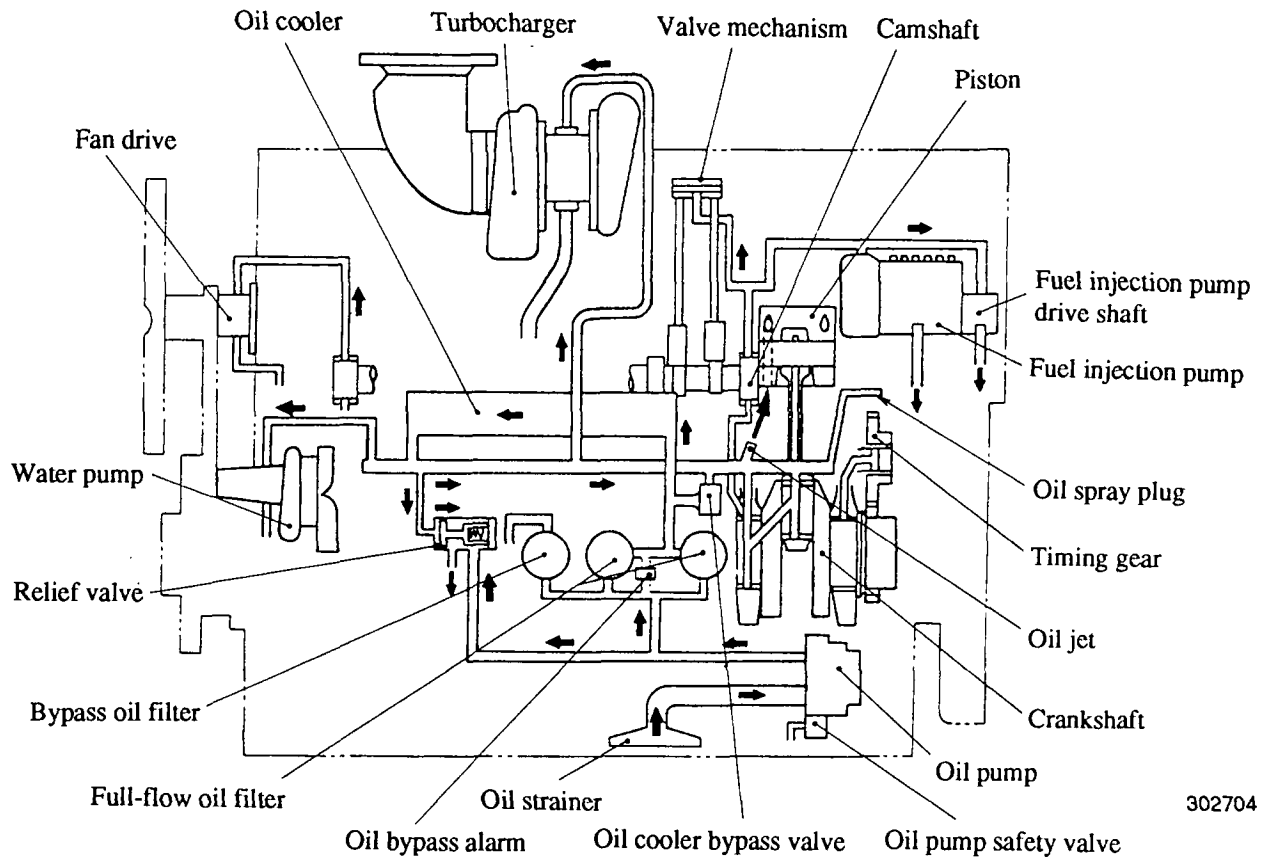
SCHEMATICS

FUEL SYSTEM



302703

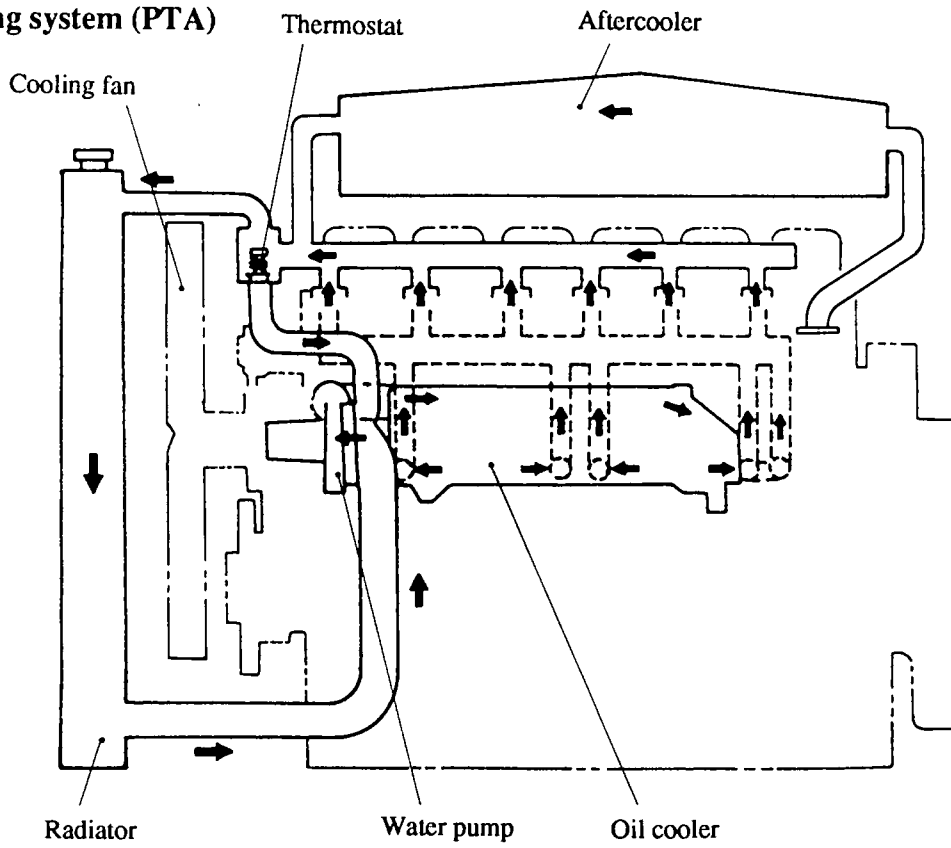
LUBRICATION SYSTEM



302704

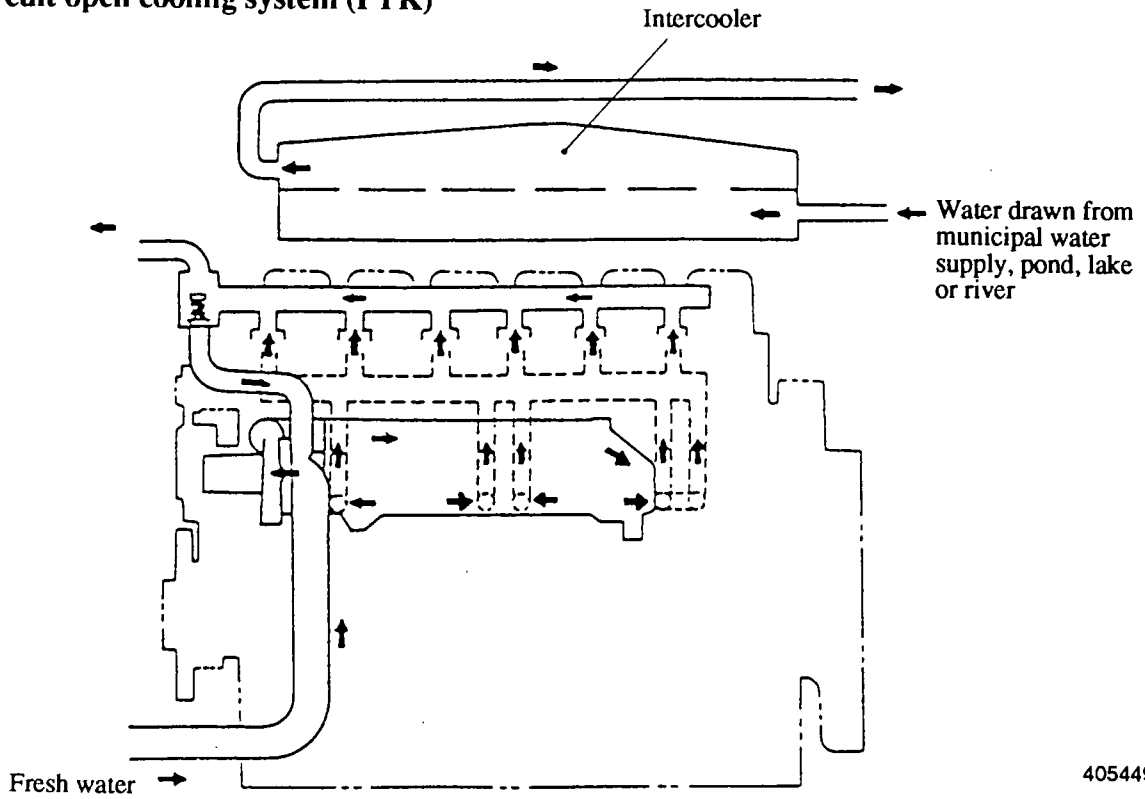
COOLING SYSTEMS

Closed cooling system (PTA)



302705

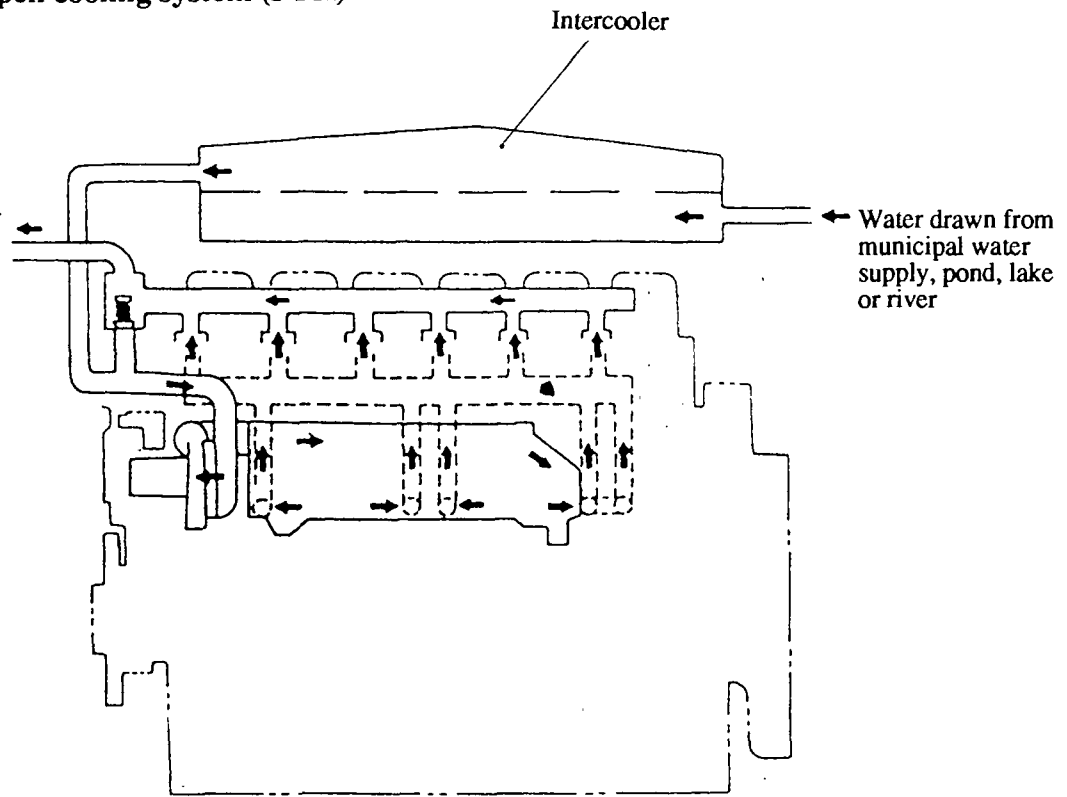
Dual-circuit open cooling system (PTK)



405449

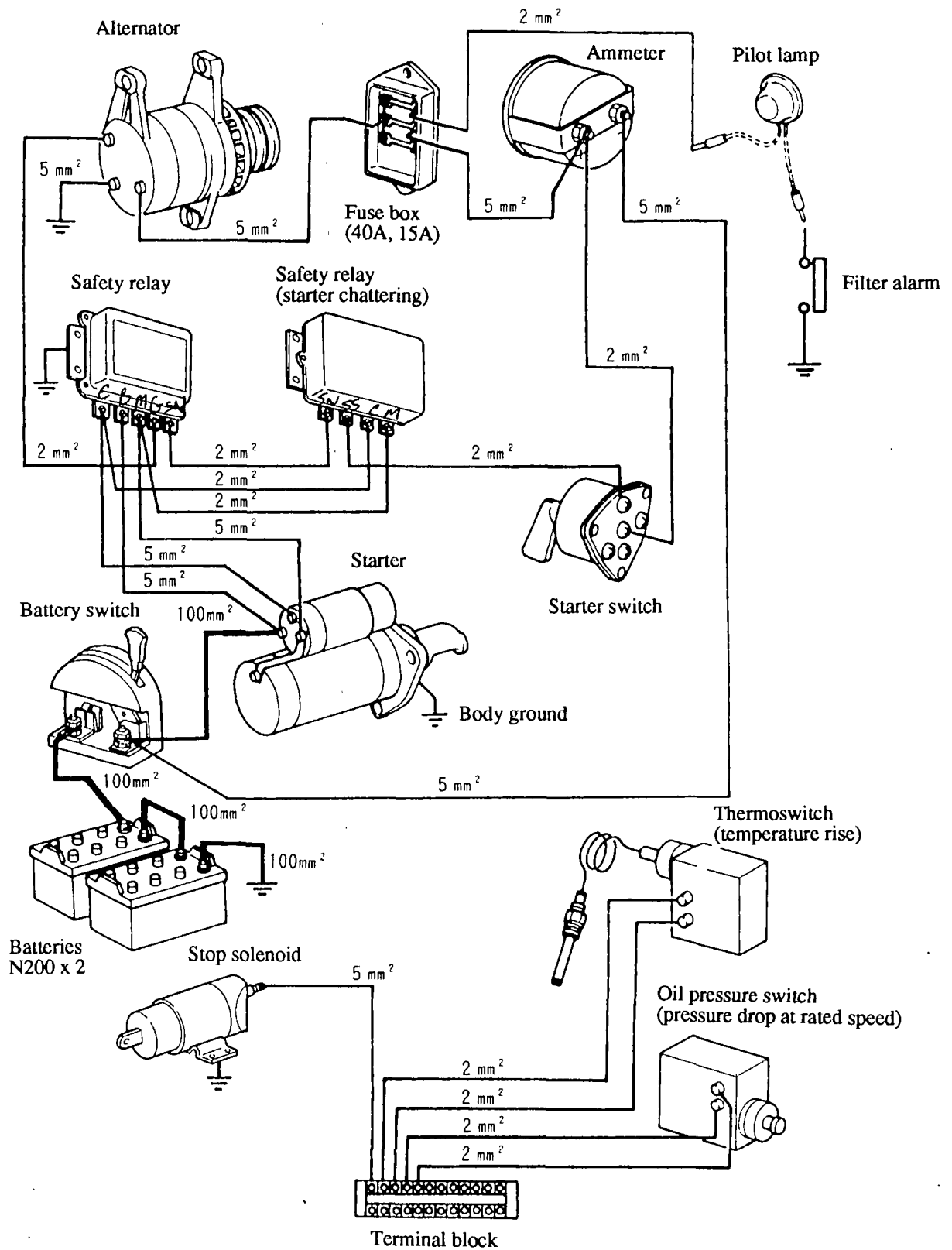
SCHEMATICS

Single-circuit open cooling system (PTK)



405450

ELECTRICAL SYSTEM

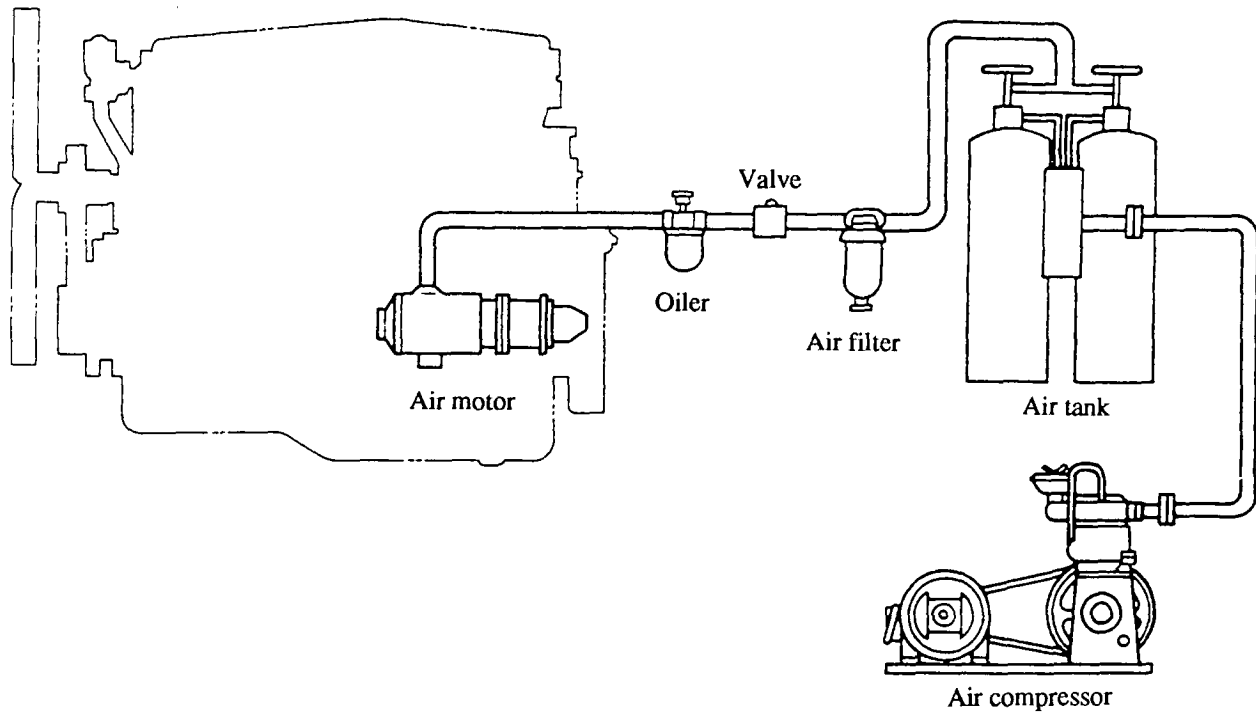


300532

SCHEMATICS

AIR START SYSTEM

Air-motor engine



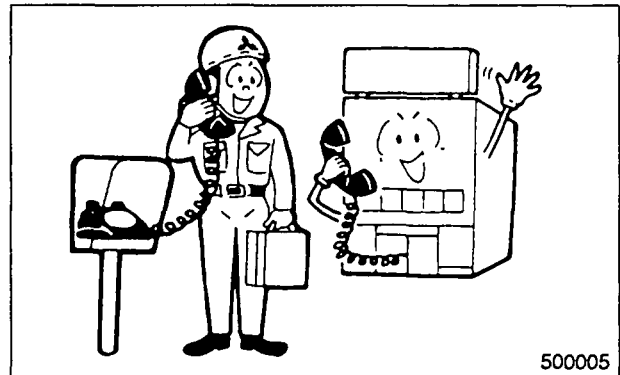
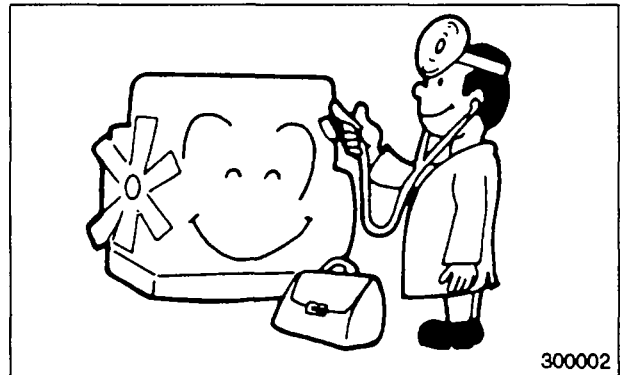
302706

SERVICE ASSISTANCE

Your Mitsubishi dealer is vitally interested in your complete satisfaction with the Mitsubishi engine you purchased from him. He is anxious to know that all of your service needs are quickly and courteously filled.

When consulting your Mitsubishi dealer for replacement part supply or any other service, be sure to give the engine serial number and service meter reading.

If your engine is transferred to elsewhere from the original place of use registered with Mitsubishi, be sure to have the registration changed. Consult your Mitsubishi dealer for the necessary procedure.



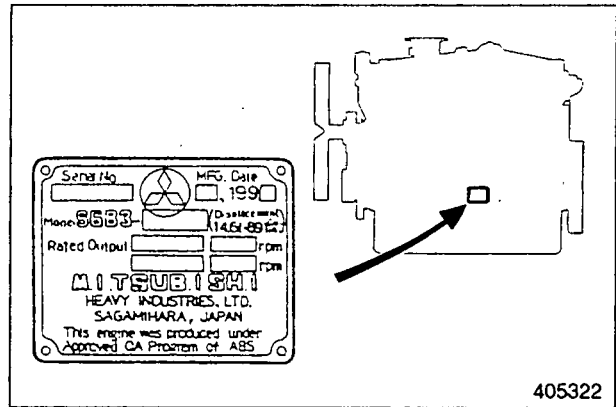
Location of engine serial number

The engine serial number is stamped on the nameplate attached to the left rear side of the engine.

Example:

Model	Serial number
S6B3	30125

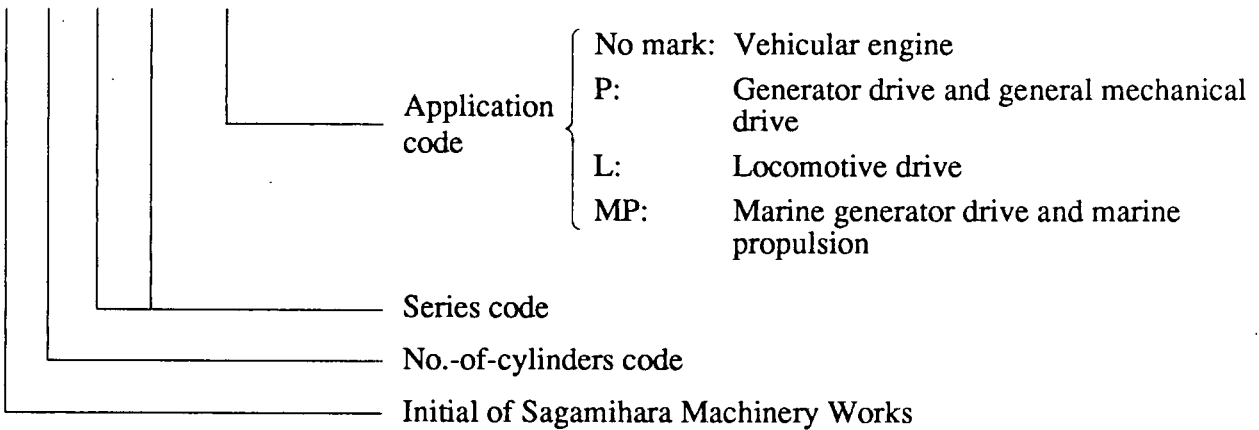
On the nameplate are also stamped the serial number, output and rated speed of the engine. The numbers in the illustration show cylinder numbers.



Engine model and application codes

S □ □ □ - □ TA “TA” stands for turbocharged, aftercooled unit.

S □ □ □ - □ TK “TK” stands for turbocharged, intercooled unit.



Never break the seals

The fuel injection pump (governor) is sealed, so that its two important settings of injection quantity and maximum speed limit shall not be meddled or tampered with.

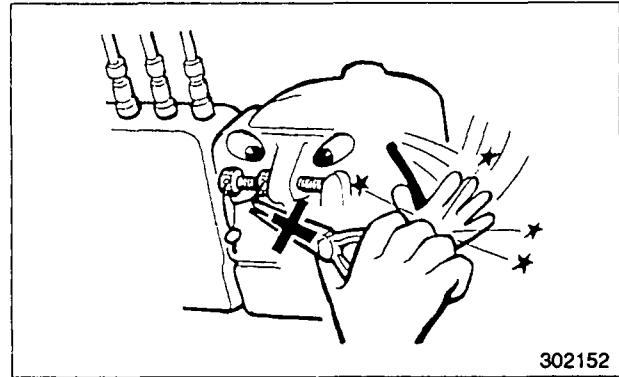
Remember, unauthorized breaking of these seals gives rise to the following possibilities, all harmful to the user:

1. Sliding and rotating parts might wear faster.
2. Failure due to seizure or damage might occur.
3. Engine speed and thermal load might increase abnormally to cause fatal damage to the engine.
4. Consumption of fuel oil and lube oil might increase.
5. The balance between governor setting and injection quantity setting might be lost to result in poor engine performance.

Unauthorized seal-breaking imposes the burden of repair cost, labor included, upon the user even when the resultant difficulties or failures occur during the warranty period.

 **CAUTION**

Breaking the seals or removing any limiting locks provided in the injection pump releases the manufacturer or dealer from the engine warranty.



302152

