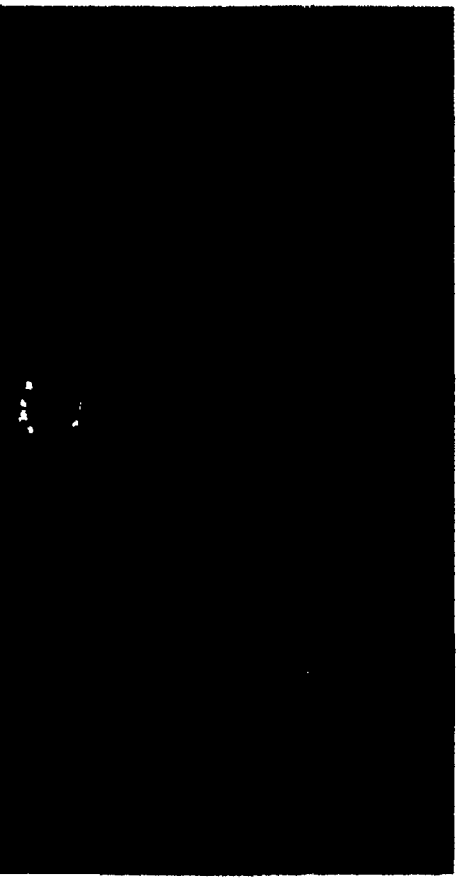
OPERATION & MAINTENANCE MANUAL



MITSUBISHI DIESEL ENGINES

S6R,S6R2

625 KW

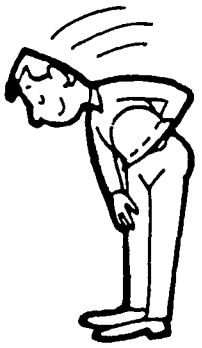
APPLICATIONS

- Generator drive
- General mechanical drive
- Locomotive drive
- Construction machinery drive
- Marine generator drive
- Marine general mechanical drive

MITSUBISHI HEAVY INDUSTRIES, LTD.

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

S6R,S6R2



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This manual is written to familiarize you with the operation and maintenance of your S6R/S6R2 diesel engines, and provide important safety information. We suggest that you carefully read this manual to learn about your new engines.

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 engines.

The engines described in this manual are for industrial drive and marine auxiliary drive (such as generator drive).

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.

TABLE OF CONTENTS

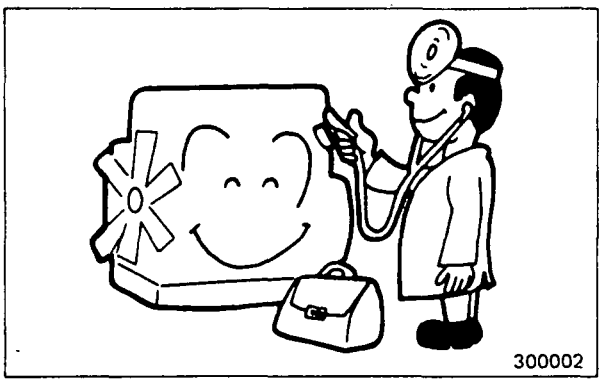
YOUR ENGINE AND MITSUBISHI

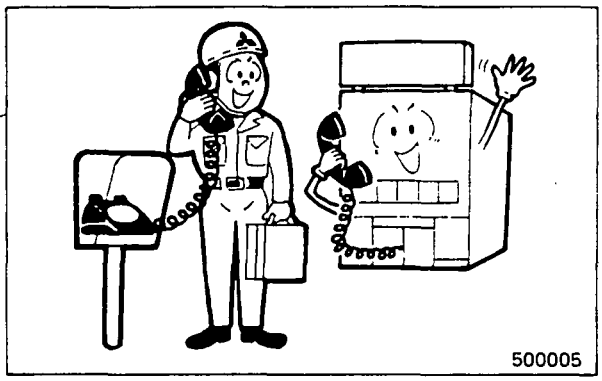
SERVICE ASSISTANCE

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.

Mitsubishi has established district and regional offices throughout the world to help each dealer make himself more helpful to you. Should you feel that you require service assistance beyond that which your dealer is providing, the Mitsubishi office in your area will be pleased to work with you and your dealer.

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.





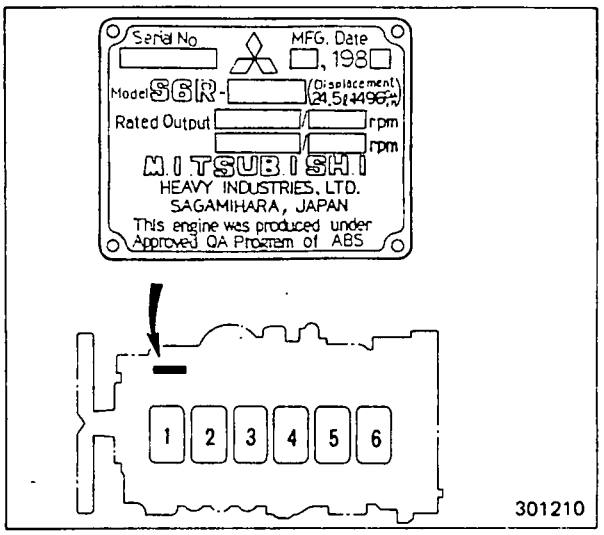
LOCATION OF ENGINE SERIAL NUMBER

The engine serial number is stamped on the nameplate attached to the right front side of the engine.

Example

Model	Serial number
S6R	20012

On the nameplate are also stamped the output and rated speed. The numbers in the illustration show cylinder numbers.



ENGINE MODEL AND APPLICATION CODES

S□□-□T Turbocharged unit

S□□-□TA Turbocharged, aftercooled unit

S□□-□TK Turbocharged, intercooled unit

- Application code
  - P : Generator drive and general mechanical drive
  - L : Locomotive drive
  - MP : Marine generator drive and marine general mechanical drive
- Series code
- No.-of-cylinders code
- Sagamihara Machinery Works

SAFETY – IT'S UP TO YOU

WARNINGS, CAUTIONS and NOTES 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.

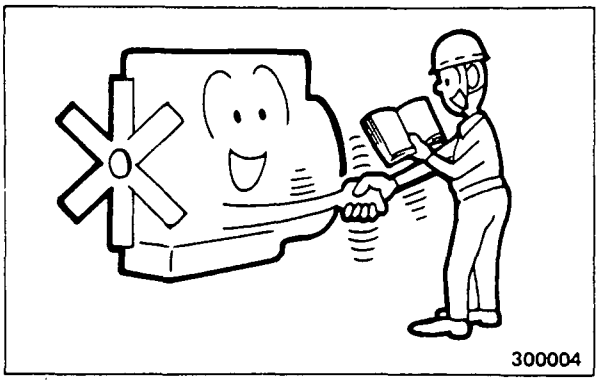
✓ ..... Right or normal

✗ ..... Wrong or abnormal (service needed)

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 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)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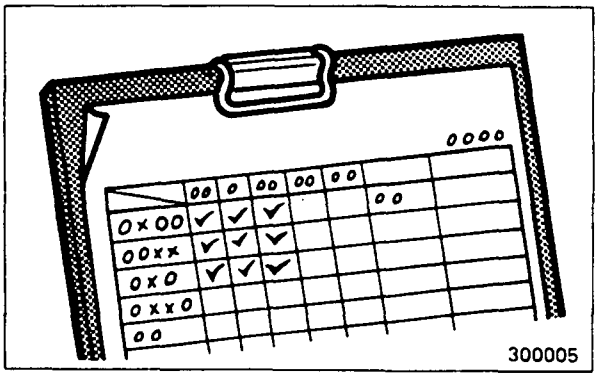
Items to be recorded

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

1. Operating hours (service meter reading)
2. Quantities of engine oil, fuel oil and water (coolant) used for refilling.
3. Engine oil and coolant change periods
4. Engine oil pressure, exhaust temperature, supply air pressure and fresh water 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")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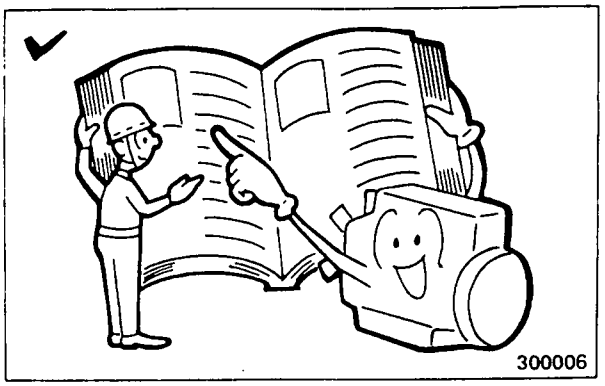
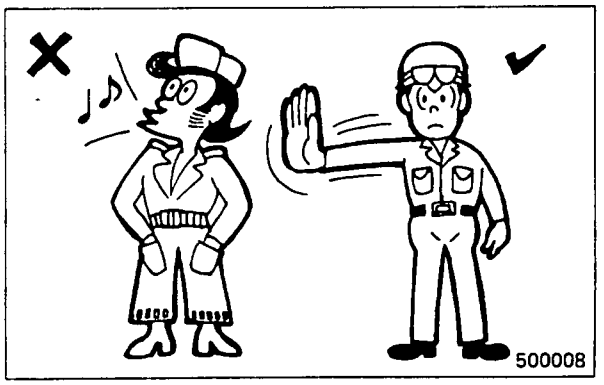
⚠ Study OPERATION & MAINTENANCE MANUAL to become thoroughly familiar with all engine controls and instruments – and service procedures.

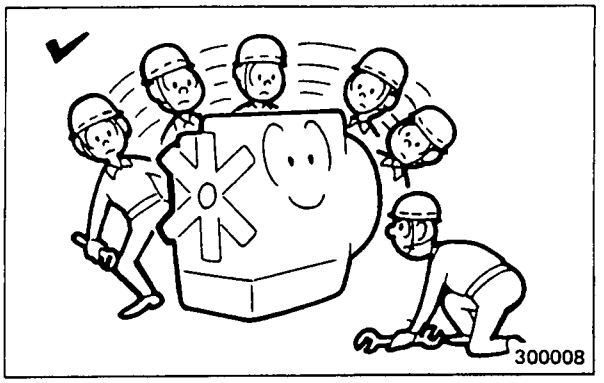


⚠ Wear hard hat and safety shoes – and, if job conditions require, safety goggles, heavy gloves, ear protectors, respiratiors, etc.

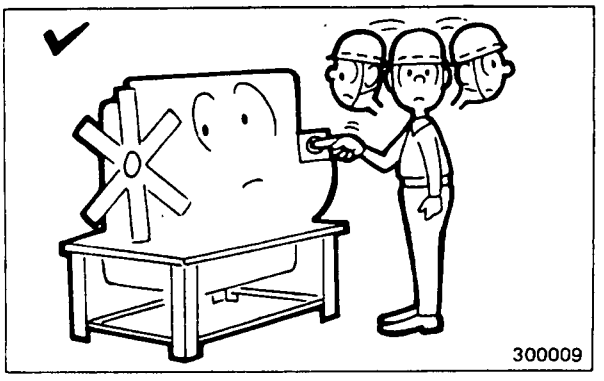


Before operation

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

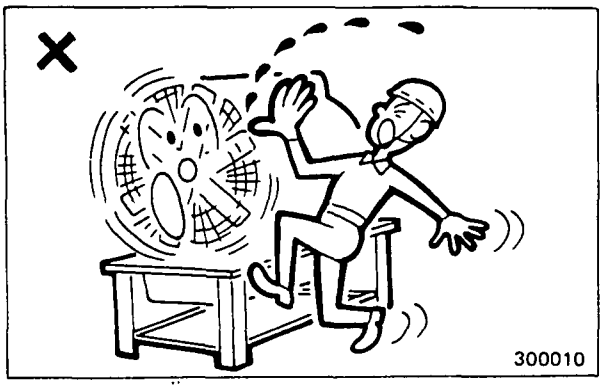


⚠ When starting engine, walk around it once more – open eyes and be alert to people and obstacles that may be within operating range.

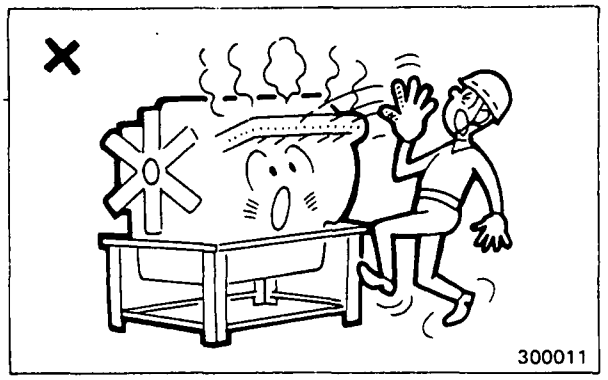


During operation

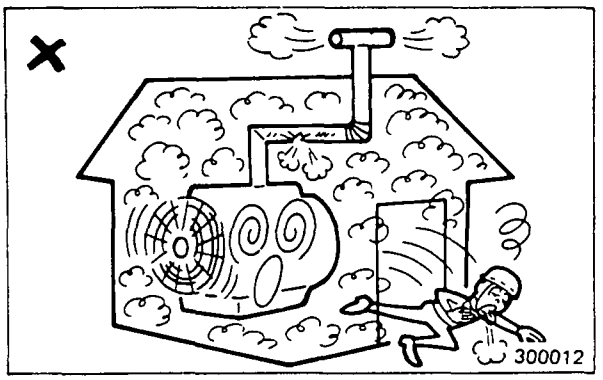
⚠ Do not touch any moving part of a running engine, or clothing or hair can be caught in moving parts, resulting in personal injury or loss of life.



⚠ Keep hands off hot parts – turbocharger, exhaust pipe, etc. – during operation or immediately after shutting off engine.

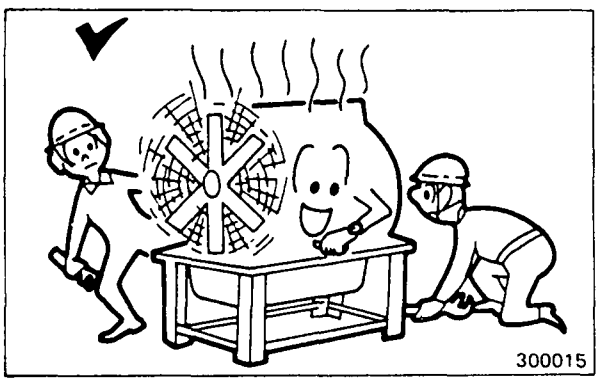


⚠ If necessary to operate engine within an enclosed area, provide adequate ventilation – and pay attention to exhaust piping and exhaust gas leaks.



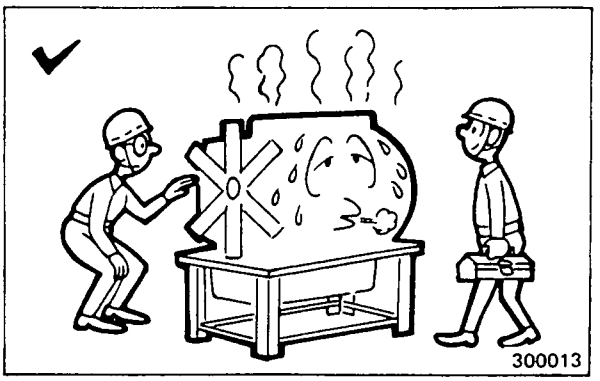
Idling operation for engine cooling

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.



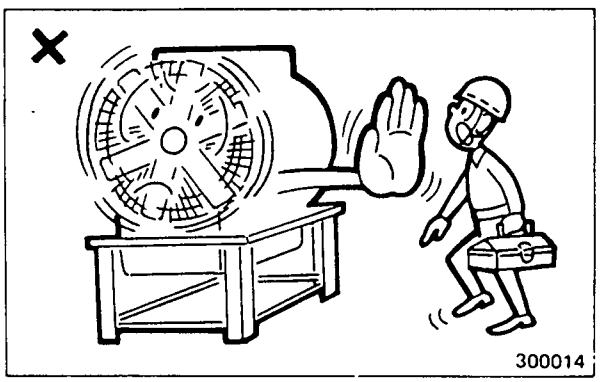
After operation

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

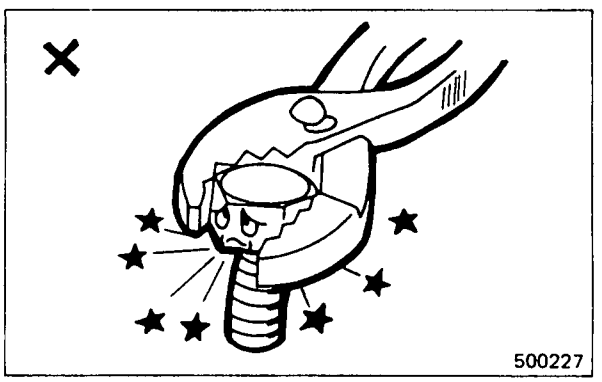


Maintenance

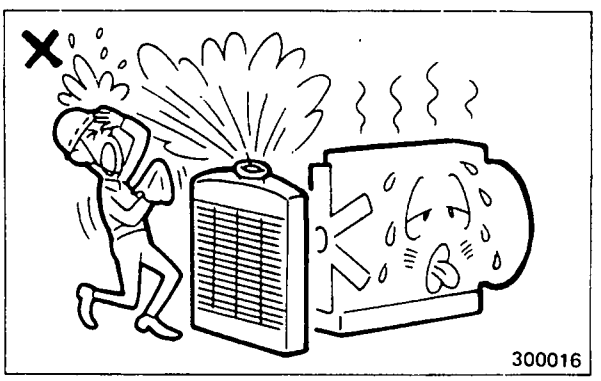
⚠ Be sure to shut off engine, and turn off battery main switch (or close air tank valve) before servicing engine. If necessary to crank engine for inspection, signal to other man before cranking. After cranking, be sure to remove cranking bar.



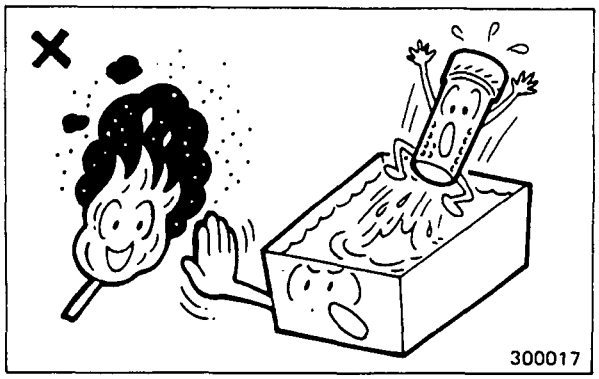
⚠ Use right tools correctly. Thoughtless use of tools including use of a wrong tool can cause personal injury and damage to engine.



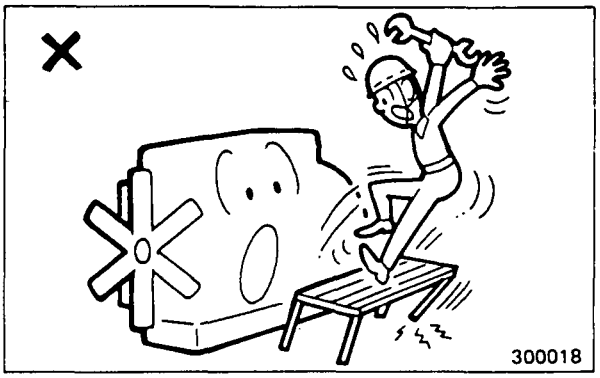
⚠ When removing radiator filler cap immediately after shutting off engine, be sure to release pressure to avoid having scalding by hot water or steam spouted out from radiator.



⚠ 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.

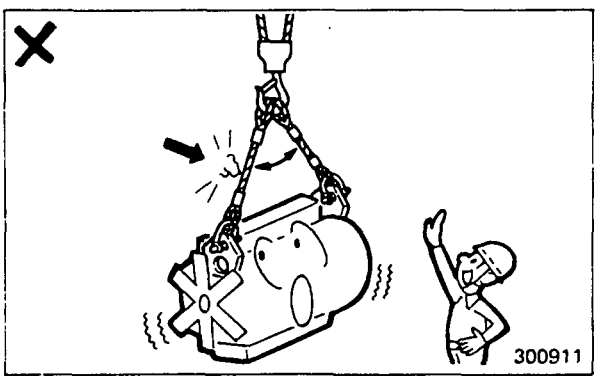


⚠ Do not attempt to "climb up" engine for access to upper parts. Use a safe footstool for maintenance without accidents.



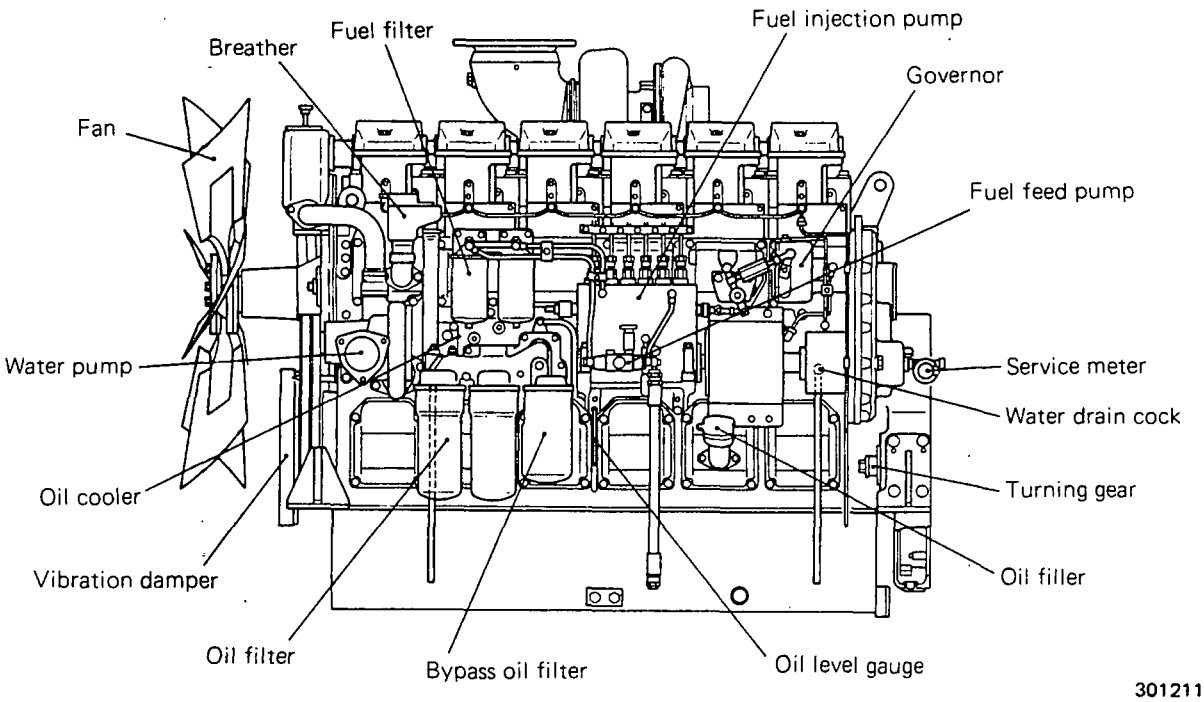
⚠ When lifting engine, use slings free of broken strands. Be sure that the crane has enough capacity for engine to be lifted. Make use of hangers provided on engine, and lift it carefully.

Attach each sling to engine at an angle of less than 60°. Put wads to sling contacting surfaces of engine to protect both slings and engine.

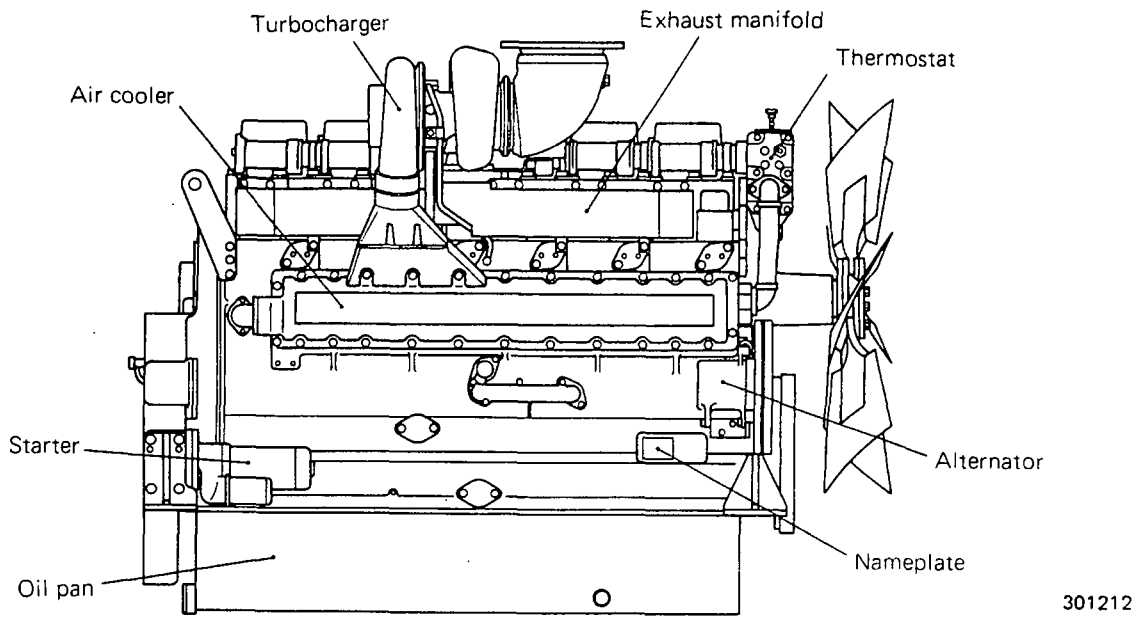


MAJOR COMPONENTS

External views



Left-side view



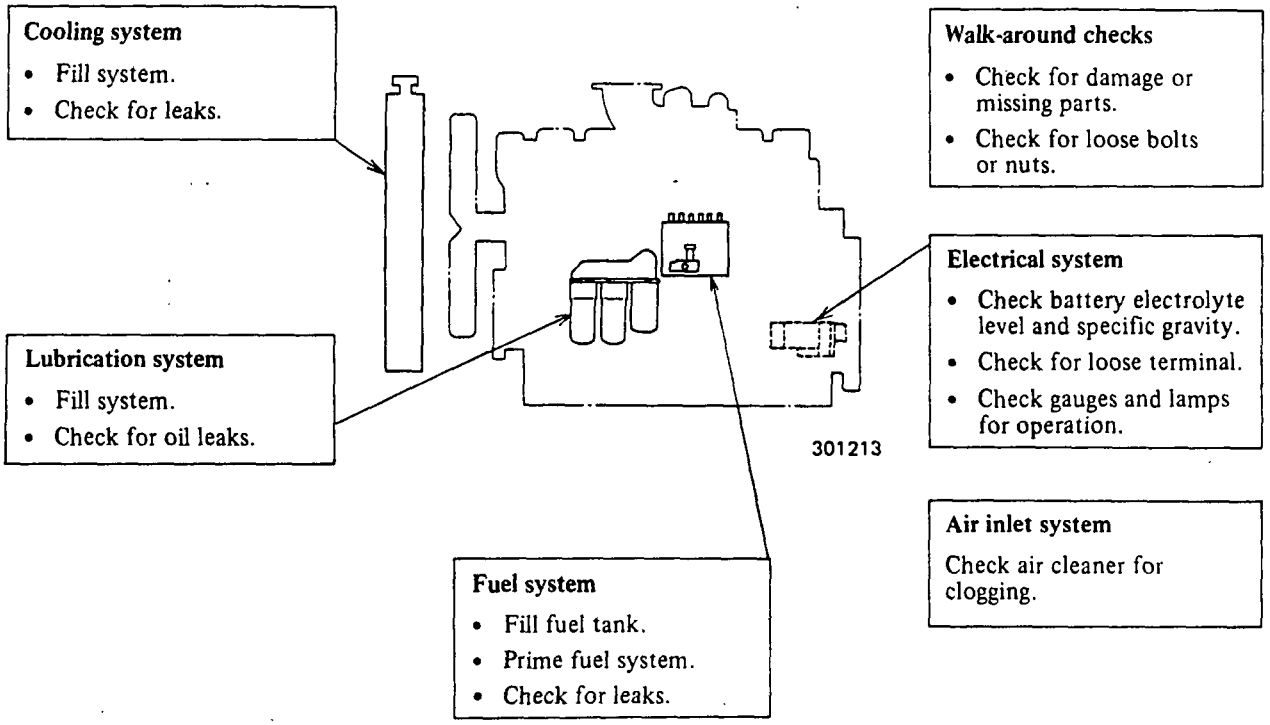
Right-side view

NOTE: Direction of rotation of this engine is counterclockwise as viewed from flywheel side.

NEW ENGINE INITIAL SERVICE

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.



After initial 50 service hours, perform the following services:

- Change of engine oil
- Change of oil filter
- Adjustment of valve clearance
- Retightening of bolts and nuts

⚠ CAUTION

During break-in period of a new or reconditioned engine, avoid sudden application of load and high-speed operation for engine life.

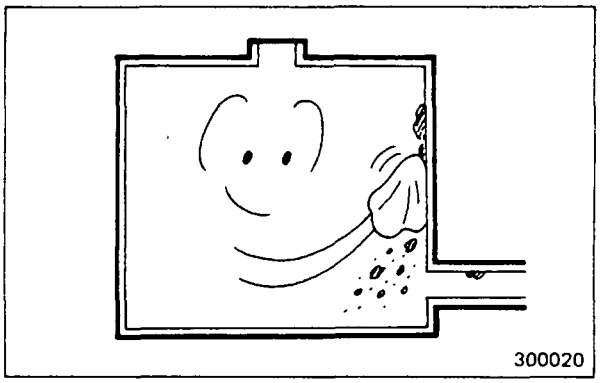
WALK-AROUND CHECKS

- Damage or missing parts — Engine
- Loose bolts and nuts — Cylinder heads
  - Crankshaft pulley
  - Fuel injection pump coupling and drive shaft
  - Mounting brackets
  - Turbocharger
  - Exhaust pipe

FUEL SYSTEM

Filling the fuel tank

Before filling the fuel tank, check to be sure that the tank and pipes are free of dirt, water or other foreign substances. After filling, check the fuel level in the tank with the level gauge.

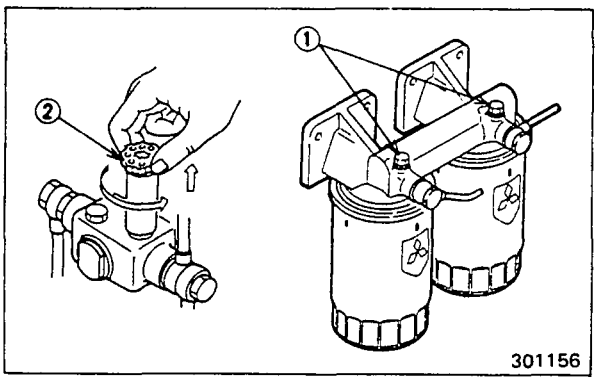


Priming the fuel system

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

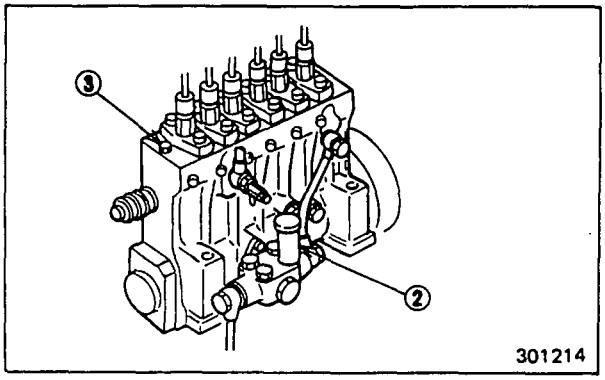
- **Fuel filter**

1. Loosen air vent plugs (1) about 1-1/2 turns on the filter.
2. Operate the priming pump handle (2).
3. Tighten plugs (1) when the flow of fuel at the plugs is free of air bubbles.



- **Fuel injection pump**

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



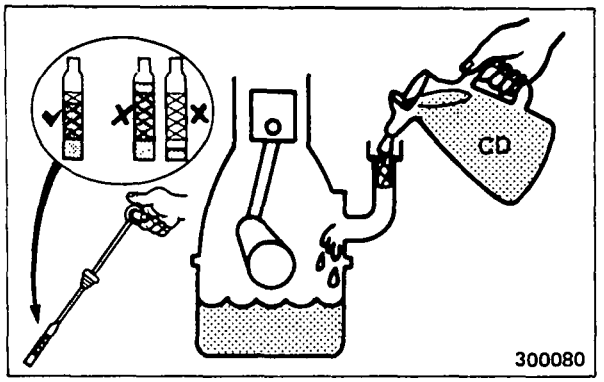
⚠ CAUTION

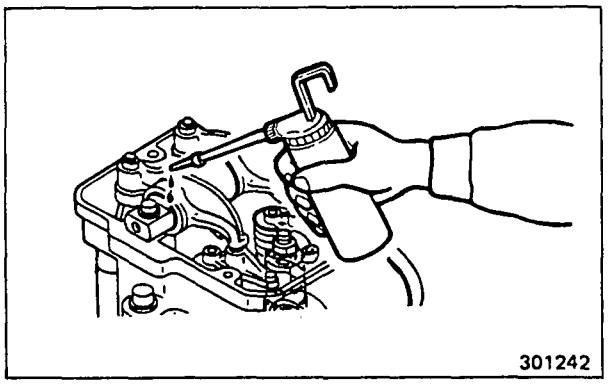
1) If all vent plugs are tightened before priming pump is locked, pressure acts on feed pump, making it difficult to lock the priming pump.
2) Wipe off fuel spilled out of each vent plug hole with wiping rag.

LUBRICATION SYSTEM

Filling the oil pan

1. Use a clean jug to pour oil into the oil pan. Use engine oil of API service classification "CD."
2. After filling, check the oil level with the level gauge. The level should be within the operating range on the gauge.
3. Remove the rocker cover, and apply oil to the valve mechanism.
4. Check the oil pan and other parts for oil leaks.
5. Start and run the engine for a while. Stop the engine and, after waiting for about 10 minutes, add oil up to the level specified in 2 above.





COOLING SYSTEM

Filling the cooling system

1. Tighten the drain cocks on the left front and rear sides of the engine (or the radiator drain plug on a radiator-cooled engine). The engine is shipped from the factory with its cooling system drained.
2. Use clean water that is low in scale forming mineral. Remember, some waters pumped out of ground in a mining or hot-spring area contain active impurities harmful to the metal of cylinder liners.

NOTE

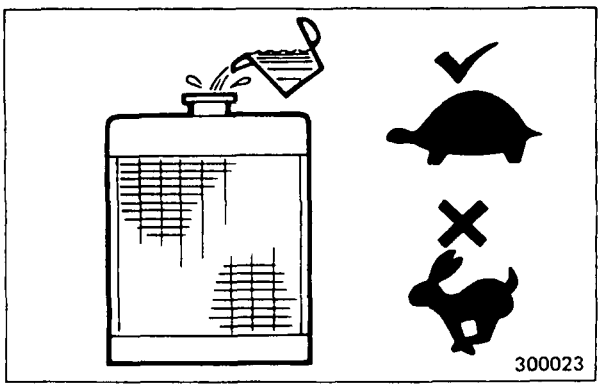
Use rust inhibitor in the cooling system at all times. It retards, and in some cases, completely eliminates mineral deposits within the cooling system. Use anti-freeze solution when the temperature is below freezing.

3. To fill the cooling system of a radiator-cooled engine for the first time, or to change the coolant in such an engine, proceed as follows:

a) Remove the radiator filler cap, and slowly fill the radiator until it is full. Pour water at a rate of 10 liters (2.6 U.S. gal) per minute.

NOTE

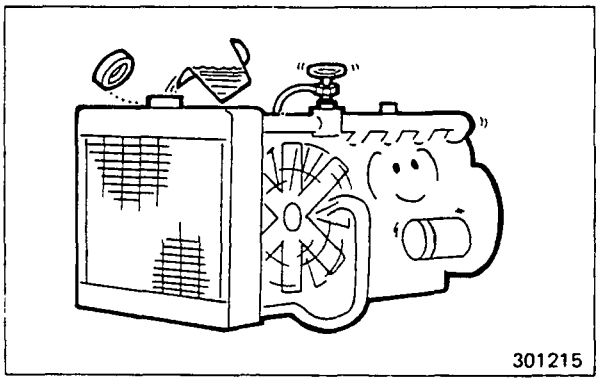
To bleed air out of the cooling system, loosen the valve at the top of thermostat.



b) When the radiator is full, leave the radiator filler cap removed and crank the engine with the starter three times, for 5 to 6 seconds each time, at intervals of about 20 seconds, in order to bleed air out of the water pump.

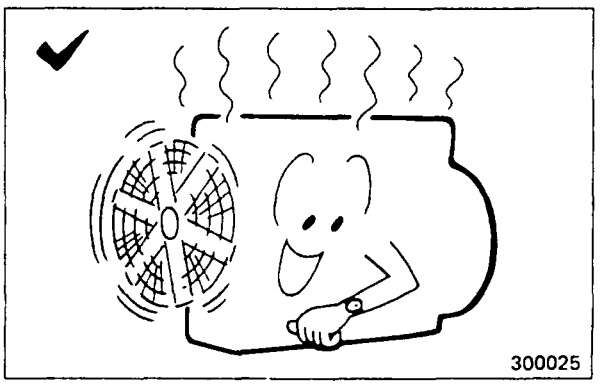
⚠ CAUTION

To crank the engine for air bleeding, keep the stop lever in STOP (returned) position. (See page 14.)



c) Check the coolant level in the radiator, and add water if necessary.

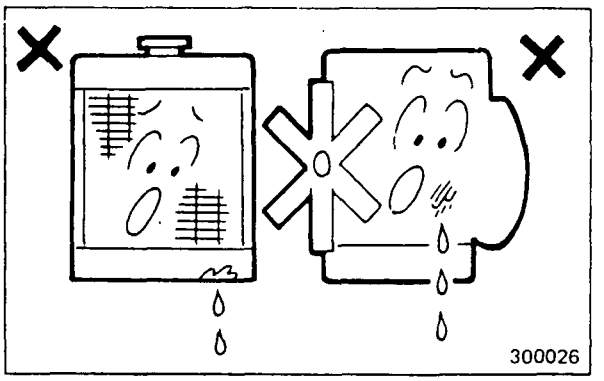
d) Crank the engine with the fuel supply shut off for 30 seconds to make sure that the oil pressure rises normally. If the pressure does not rise in 30 seconds, wait for about 1 minute, and crank it again.



e) Start the engine, and run it at 600 to 700 rpm for 3 to 5 minutes.

f) Stop the engine, and check the coolant level in the radiator again. If the level is low, refill the radiator fully, and install the cap.

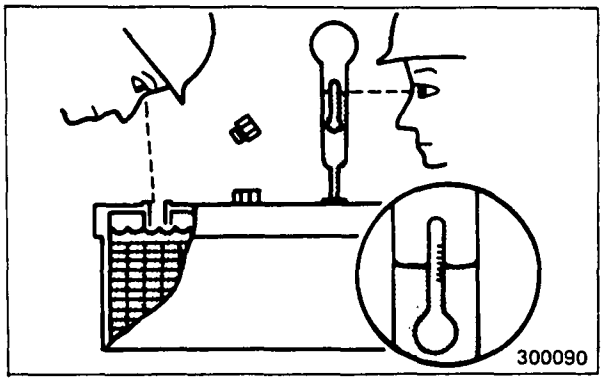
g) Check the hose joints for coolant leaks.



ELECTRICAL SYSTEM

Battery electrolyte level and specific gravity

1. Remove the filler caps, and check the electrolyte level in each cell. It should be 1 cm (3/8 in.) above the cell plates.
2. When filling the cells of the battery for the first time, slowly pour dilute sulfuric acid (electrolyte) in the cells.
3. If the battery is already filled with electrolyte, check its level and, if the level is low, add distilled water.
4. Check the specific gravity of electrolyte. If the SG is below 1.22 at 20°C (68°F), recharge the battery.



⚠ WARNING

1) Electrolyte, sulfuric acid, is very corrosive. If you drip it on your skin or clothing, flush it off at once with water.
2) Do not allow sparks or open flame near the battery.

Circuits

Check each circuit for loose terminals.

OTHERS

Check the following valves and cocks to make sure they are opened or closed properly:

- Fuel supply valve . . . . . Opened
- Coolant drain cock (radiator) . . . . Closed
- Coolant drain cock (engine) . . . . Closed
- Oil drain valve . . . . . Closed
- Air supply valve (air tank) . . . . . Opened

OPERATING THE ENGINE

Controls and instruments

- **Water temperature gauge**

  Indicates temperature of engine coolant.

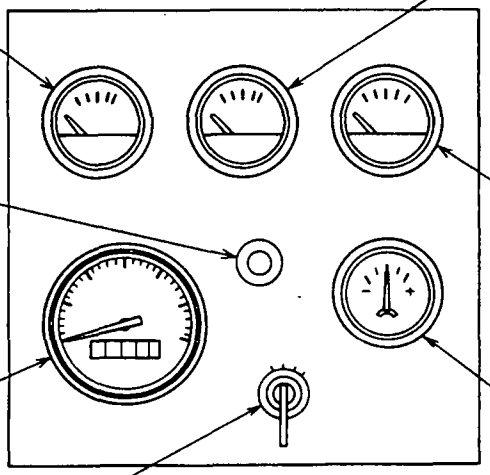
  Normal range:
  70 – 90°C
  (158 – 194°F)

- **Oil filter alarm lamp (pilot lamp)**

  Glows when paper-element type oil filter is clogged.

- **Tachometer**

  Indicates engine speed in rpm (revolutions per minute).



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- **Oil temperature gauge**

  Indicates temperature of engine lubricating oil.

  Normal range:
  70 – 110°C
  (158 – 230°F)

- **Oil pressure gauge**

  Indicates pressure of lubricating oil.

  Normal range:
  5 – 6.5 kgf/cm^2
  (71 – 92 psi)
  [0.5 – 0.6 MPa]

- **Ammeter**

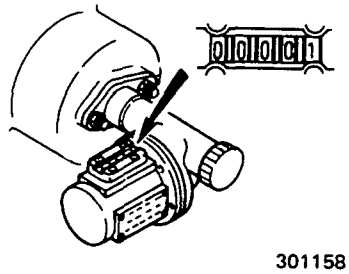
  Indicates battery charging current.

  Normal indication: (+) side

- **Starter switch**

  HEAT: Operates air heater to start engine easily in cold weather. (air-heater model)
  OFF: Insert and pull out key. All electrical circuits are OFF.
  ON: Keep engine running. Charging and lamp circuits are ON.
  START: Start engine. Key will return to ON when released.

- **Service meter**

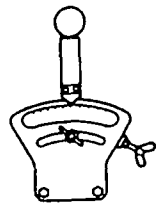


301158

Rely on this meter to check, service or lubricate engine.

NOTE: Dial advances one number when engine is operated for 1 hour at 1500 rpm.

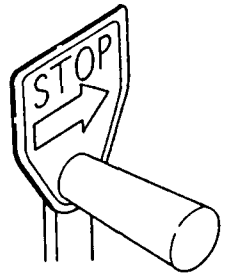
- **Speed control lever**



300082

Use the lever to control engine speed. Pull it to stop engine.

- **Stop lever**



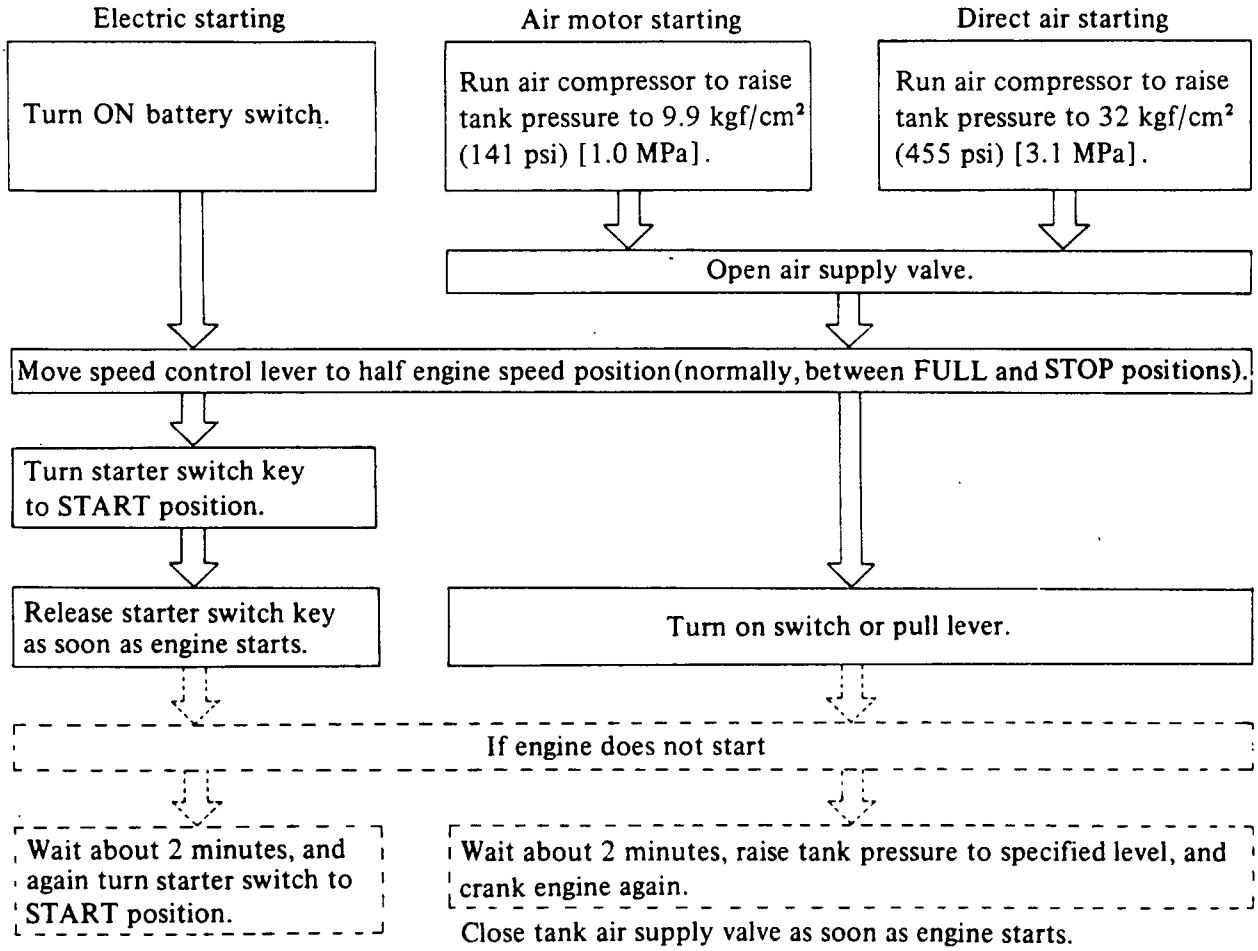
301159

Pull the lever to stop engine in case of emergency.

After performing daily (10-hour) servicing, operate the engine as follows:

STARTING

There are three methods available for starting the engine – electric starting, air motor starting and direct air starting. Disengage the clutch (if equipped) or remove any load from the engine.



Close tank air supply valve as soon as engine starts.

NOTE

Keep the tank air supply valve always opened for automatic starting.

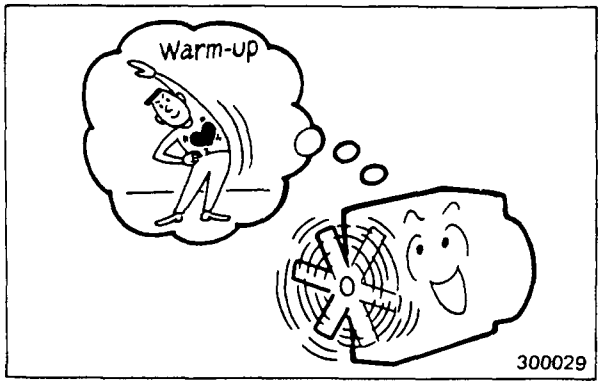
⚠ CAUTION

- Give particular attention to the following rules when using the electric starting:
  1) Do not run the starter for more than 30 seconds at a time. Then allow 2 minutes for cooling before using it again.
  2) When cranking the engine again, wait until the starter stops rotating and the engine stops "rocking" to prevent it from turning in reverse direction.
  3) Keep the starter switch in ON position during operation. Never move it to START or OFF position.
- Air-motor or direct-air starting engine:

  Open the air tank drain valve and drain water every 50 hours or monthly.

WARMING UP

After starting up, allow the engine to idle at about 1000 rpm for 5 minutes to warm it up. During this warm-up period, check to be sure that oil pressure rises properly. The pressure will be 2 to 3 kgf/cm² (28 to 43 psi) [0.2 to 0.3 MPa] during low idling.



⚠ CAUTION

It is not necessary to warm up a stand-by engine. Instead, be sure to perform periodical testing items described in "Maintenance Instructions."

STARTING THE LOAD

After warming up the engine, apply the load. During the operation, check to be sure –

1. The engine makes no abnormal sound and vibration.
2. Exhaust smoke color is normal.
3. Meters and gauges are indicating normally.

- o Tachometer
- o Engine oil pressure gauge
  5 – 6.5 kgf/cm² (71 – 92 psi)
  [0.5 – 0.6 MPa]
- o Water temperature gauge
  70 – 90°C (158 – 194°F)
- o Ammeter
  (+) side
- o Engine oil temperature gauge
  70 – 110°C (158 – 230°F)
- o Oil filter alarm lamp (pilot lamp) – OFF

STOPPING

After the load is removed, allow the engine to idle for about 5 minutes. Shutting off the engine immediately after removing the load is very hard on the engine parts.

⚠ CAUTION

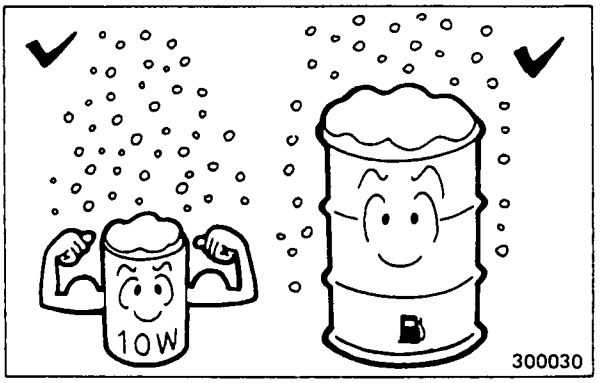
Keep on pulling the stop lever until the engine comes to a complete stop. Do not release the lever before the engine stops to prevent it from turning in reverse direction.

Engine equipped with speed control lever	Engine equipped with stop lever
Move speed control lever to STOP position.	Pull stop lever on governor to STOP position.

Turn starter switch to OFF position, pull out the key, and turn OFF battery switch (electric starting).

OPERATION UNDER EXTREME WEATHERS

COLD WEATHER PRECAUTIONS

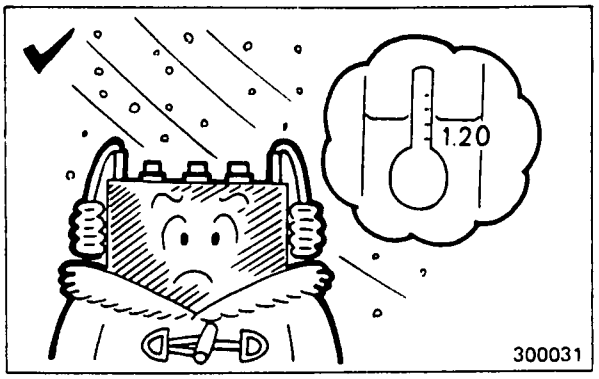


Engine oil and fuel

1. Use engine oil of lower S.A.E. viscosity grade in cold weather. (See page 42.)
2. Use fuel oil of lower pour point.(See page 39.)

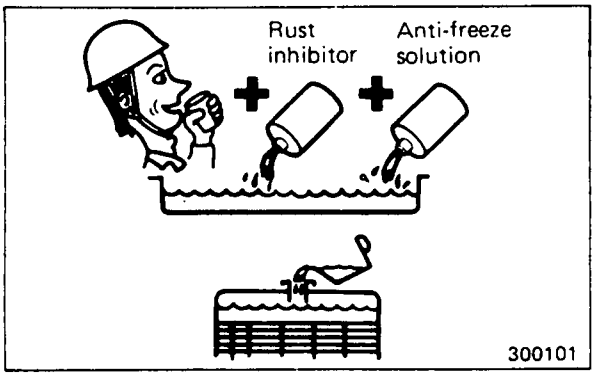
Battery

1. Add distilled water to the battery before starting the engine to prevent electrolyte from freezing.
2. The specific gravity of electrolyte rises as the battery becomes increasingly charged. An electrolyte with S.G. of 1.20 or under freezes at −20°C (−4°F) or so. To avoid such a freeze-up, be sure to keep the battery fully charged at all times, so that the electrolyte S.G. will be 1.28 or over.
3. The lower the temperature, the smaller the capacity of the battery. Try to keep the battery as warm as possible, and make necessary provisions for protecting the battery from the deadly chill of the night.



Cooling water

1. When the temperature is below freezing, use an anti-freeze solution in the cooling system.
2. The larger the proportion of the solution, the lower is the freezing point of the mixture.
3. A commercial anti-freeze solution comes with printed directions. Read them carefully and prepare the mixture in proportions (water and solution) necessary for the lowest freezing temperature expected. This chart will serve as a rough guide for determining the percent proportion of the solution for the mixture:



- **Anti-freeze solution**

a. Use a permanent-type anti-freeze solution.

b. When using anti-freeze solution, mix fresh water, anti-freeze solution and rust inhibitor in a container, and pour the mixture into radiator.

Percent of solution and coolant freezing point (reference)

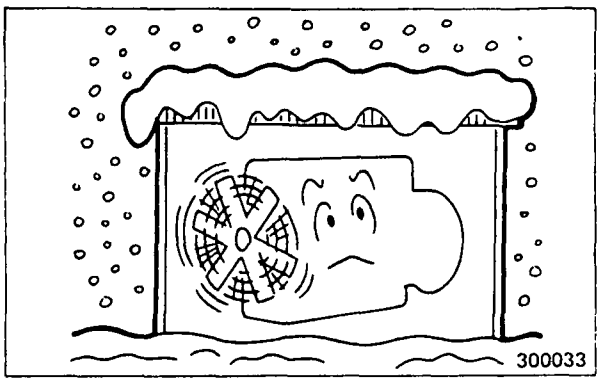
Freezing point °C (°F)	-45 (-49.0)	-36 (-32.8)	-24 (-11.2)	-16 (3.2)	-9 to 0 (15.8 to 32)
Anti-freeze solution %	60	50	40	30	20

⚠ WARNING

The anti-freeze solution is inflammable. Be sure to handle it carefully.

c. Before filling up the cooling system with the anti-freeze coolant, flush the system clean.

d. After the cold season, drain and flush the cooling system and fill it with soft water.



Operating in cold weather

1. During cold weather, the battery is weak, often resulting in hard starting. If the engine fails to start within 30 seconds, wait for about 2 minutes to allow the battery to recover strength, before cranking the engine again.
2. When starting the engine equipped with an air heater in temperatures below -5°C (23°F), or when the engine is hard to start, turn the starter switch to HEAT position for the length of time indicated below to preheat the engine. (See page 14.)

Starting temperature	-5 – -15°C (23 – 5°F)	-15 – -30°C (5 – -22°F)
Heating time	20 – 40 seconds	40 – 60 seconds

NOTE

Cold starting aids are available from your Mitsubishi dealer.

3. After starting the engine, warm it up thoroughly before applying the load.

NOTE

The oil pressure gauge will indicate high pressure when the oil temperature is low immediately after the engine is started. In such a case, keep on idling the engine without increasing engine speed. The oil pressure will drop to the normal level as the oil temperature rises.

At end of operating period

1. Drain out water and sediment that have accumulated in fuel system to prevent freezing.
2. Fill the fuel tank fully to drive out moisture-laden air for preventing condensation.
3. In case of the TK type engine, drain coolant from the air cooler to prevent freezing.

HOT WEATHER PRECAUTIONS

Engine oil

Use engine oil of higher S.A.E. viscosity grade in hot weather. (See page 42.)

Battery

At higher temperatures, the battery is likely to lose its energy by "self-discharging." Remove the battery from the engine, and store it in a cool place.

Cooling water

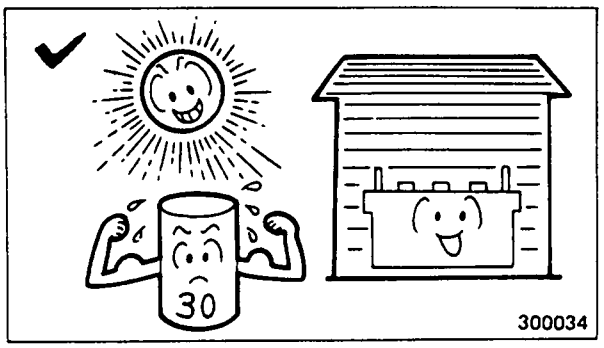
Keep the cooling system filled up at all times. Repair any leaking point upon discovery of such a point. Maintain the water pump, fresh-water cooler and thermostat in the best operable condition.

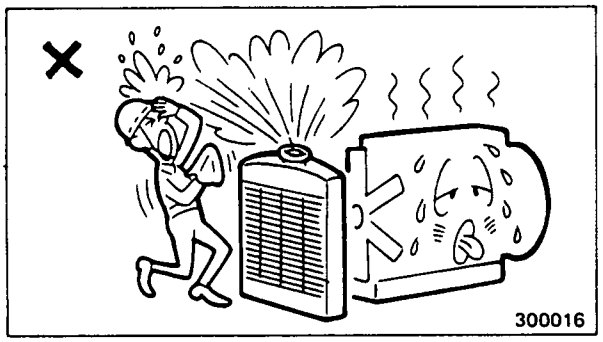
Operating in hot weather

Give particular attention to overheating of the engine by observing the water temperature gauge and oil pressure gauge. When the engine is overheated, remove the load rather slowly, and allow the engine to idle for gradual cooling.

⚠ WARNING

Dangerous is an attempt to pour cold water into the overheated radiator: you will have scalding hot coolant or steam spouted out from the radiator.





MAINTENANCE INSTRUCTIONS

1. Use service-meter or calendar intervals whichever occur first.
2. The maintenance schedule, which follows, is for a fully equipped engine.
3. The established intervals in the schedule are for an average job application. Service the engine earlier than scheduled intervals if necessary. (Service intervals depends on application, operating conditions, fuel oil and lubricating oil used in the engine. Adjust the service intervals to meet the actual operating conditions.)
4. Perform previous interval items at multiples of the original requirement.

   Example: At 250 hours or 1 year, also perform those items listed in "10 hours or daily" and "50 hours or monthly."

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:

Periodical testing

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.)	

○ Check, clean, wash, adjust.
● Change.
Ⓢ Rely on your Mitsubishi dealer if necessary.
* Item to be performed after initial 50 hours of operation of a new, reconditioned or long-stored engine.

MAINTENANCE SCHEDULE

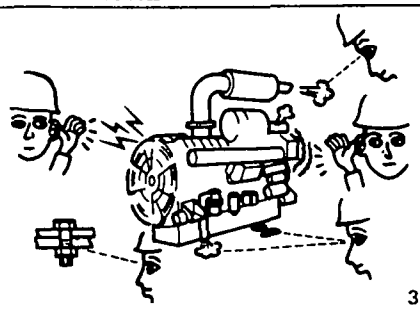
Group	Service		Service intervals						Remarks
			Every 10 hours or daily	Every 50 hours or monthly	Every 250 hours or 1 year	Every 500 hours or 2 years	Every 1000 hours or 3 years	Every 2000 hours or 5 years	
Engine	Valve clearance	Check		*			○		Ⓢ
	Bolts and nuts	Retighten		*			○		Ⓢ
	Walk-around checks		○						
Lubrication system	Oil pan	Check oil level	○						
		Check for water or fuel in oil		○					
		Change oil		*	●				Ⓢ
	Oil filter	Change		*	●				Also change when oil filter alarm lamp glows.
	Bypass oil filter	Change			●				Ⓢ
Fuel system	Fuel tank	Check fuel level	○						
		Drain water		○					
	Fuel filter	Drain water		○					
		Change					●		Ⓢ
	Injection nozzles	Check and adjust					○		Ⓢ
	Injection timing	Check and adjust					○		Ⓢ
Cooling system	Coolant	Check level	○						
		Change	Change coolant twice a year. Use rust inhibitor. Use anti-freeze solution in autumn if freezing temperatures are expected in winter. In spring, drain anti-freeze coolant and refill with soft water.						
	Radiator fins	Clean			○				Ⓢ
	Water pump/ alternator drive belts	Check tension			○				

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	
Cooling system (cont'd)	Fan driction rubber	Check			○				
	Heat exchanger	Wash						○	Ⓢ
	Zinc rods	Change				●			Ⓢ
Air inlet and exhaust systems	Air cleaner (paper-element type)	Check indicator	○						
		Clean element			○				Ⓢ
		Change element					●		
	Air cleaner (silencer type)	Clean			○				Ⓢ
	Exhaust muffler	Drain water			○				
	Air cooler	Clean						○	Ⓢ
	Turbocharger	Check						○	Ⓢ
Starting system	Electric starting: Batteries	Check electrolyte level/ specific gravity	○						Check specific gravity from time to time
	Electric starting: Alternator	Check						○	Ⓢ
	Electric starting: Starter	Check						○	Ⓢ
	Air starting: Oiler	Check oil level	○						
	Air starting: Air filter (air-motor starting)	Drain water		○					
		Wash element				○			Ⓢ
	Air starting: Air filter (direct-air starting)	Drain water		○					
		Wash element				○			Ⓢ
	Air starting: Air tank	Check air pressure	○						Before starting
		Drain water		○					
		Check safety valve for operation			○				Ⓢ

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	
Protective devices operation	Water temperature rise 95 ± 2°C (203 ± 3.6°F)						○		Ⓢ Check when malfunction is suspected (Check engine for stand-by every year.)
	Engine oil pressure drop 1.5 ± 0.15 kgf/cm² (21 ± 2.1 psi) [0.1 ± 0.01 MPa]								
	Overspeed (112 – 115%)								
Others	Vibration damper	Check						○	Leaks, cracks in rubber or flaws
		Change							Every 8000 hours
	Coupling (rubber-bushing type)	Check			○				Ⓢ Cracks or other defects
	Valves in pipeline	Check for setting	○						
	Speed control lever	Check	○						

EVERY 10 HOURS OR DAILY

Walk-around checks

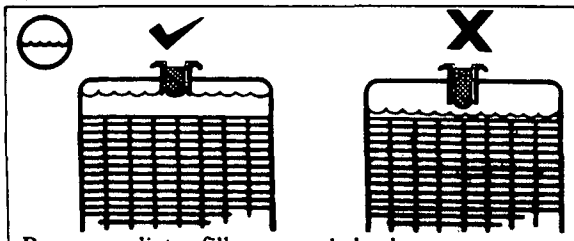


300085

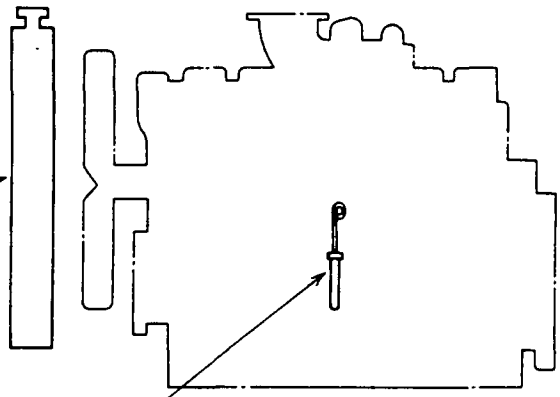
Check for:

- Loose or missing bolts and nuts
- Abnormal vibration, noise and exhaust color
- Water, oil and air leaks
- Broken electric wire and loose terminals
- Loose pipe joints
- Excessive mist from breather

Radiator – Check coolant level

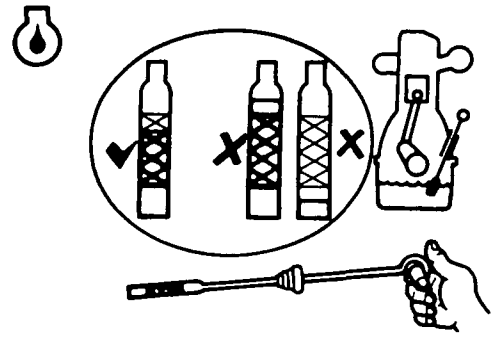


Remove radiator filler cap and check. 300160
Coolant should be visible in filler neck.
Check level in sight gauge on expansion tank.



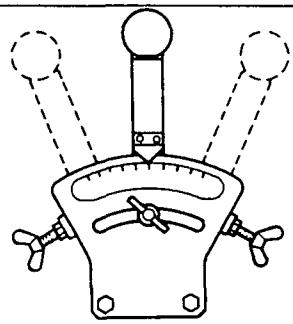
301216

Oil pan – Check oil level



Maintain oil level in operating range. 300084

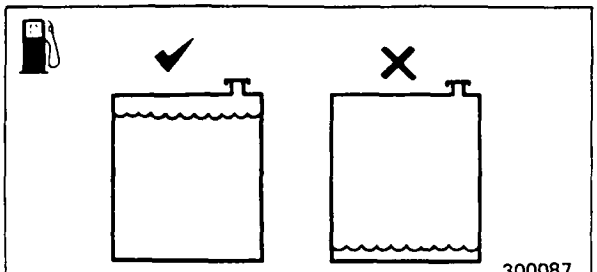
Speed control lever – Check



300082

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

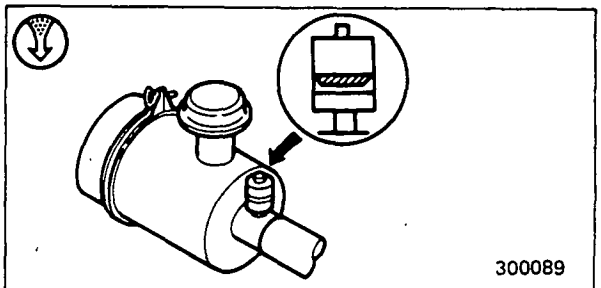
Fuel tank – Check fuel level



300087

Be sure to fill at end of operating period.

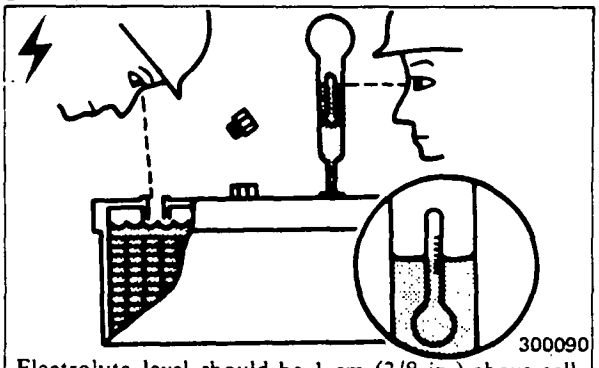
Air cleaner indicator (paper-element type) – Check



300089

Clean element when indicator shows RED.

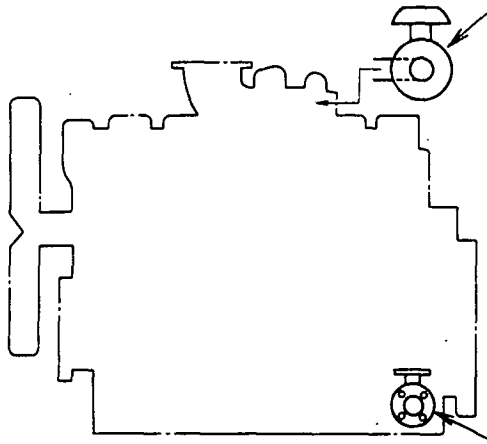
Batteries – Check electrolyte level/specific gravity



300090

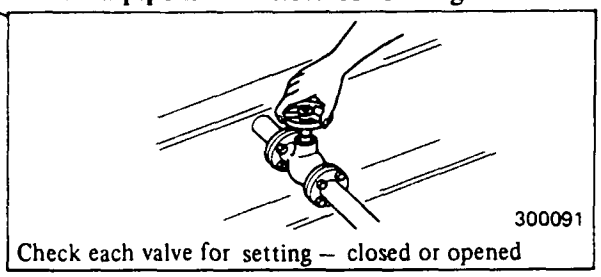
Electrolyte level should be 1 cm (3/8 in.) above cell plates.

Check specific gravity from time to time, and recharge before it drops to below 1.22.



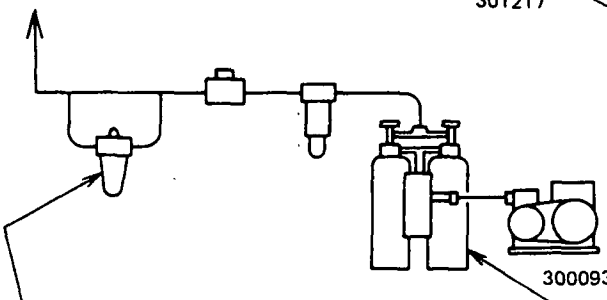
301217

Valves in pipeline – Check for setting



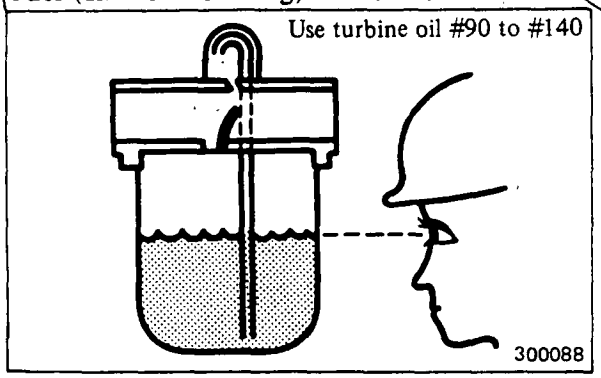
300091

Check each valve for setting – closed or opened



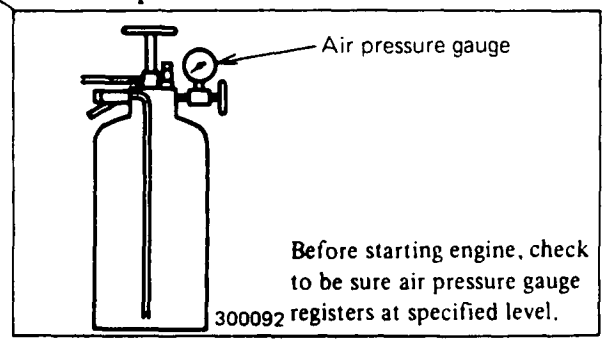
300093

Oiler (air-motor starting) – Check oil level



300088

Air tank (air-motor/direct-air starting) – Check air pressure

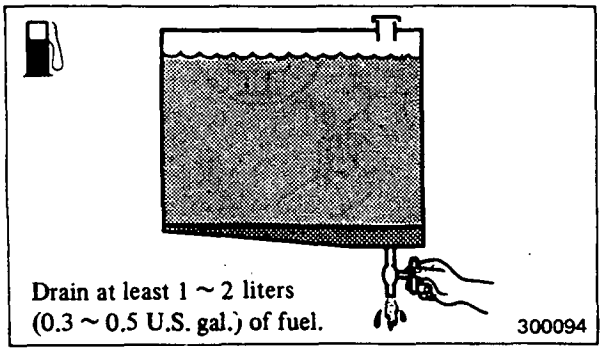


300092

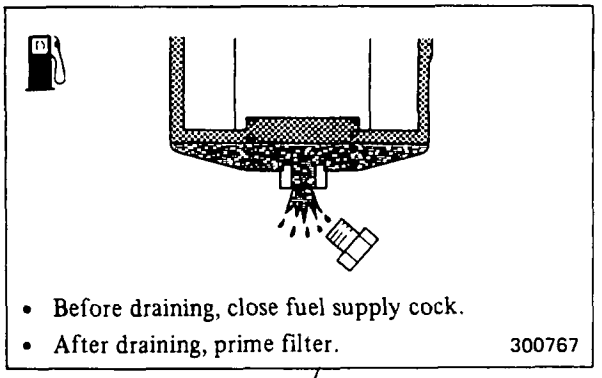
Before starting engine, check to be sure air pressure gauge registers at specified level.

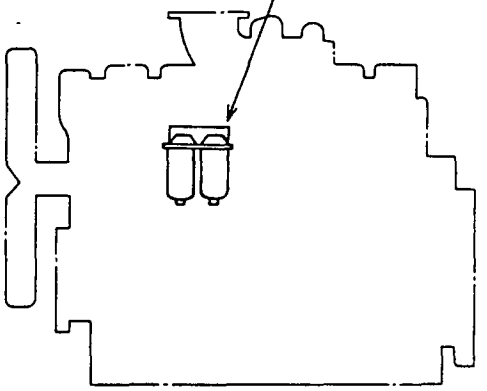
EVERY 50 HOURS OR MONTHLY

Fuel tank – Drain water

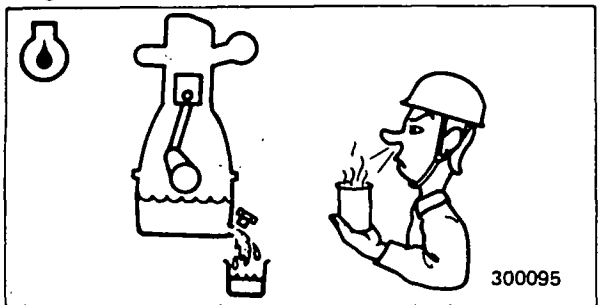


Fuel filter – Drain water



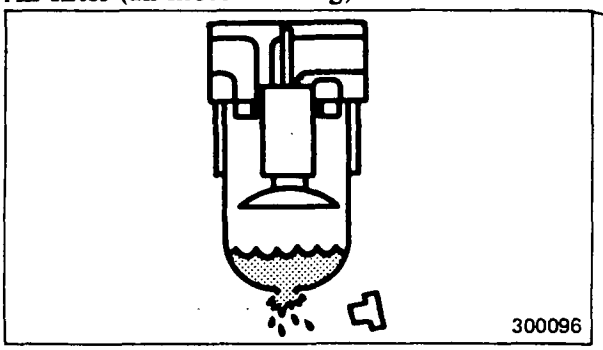


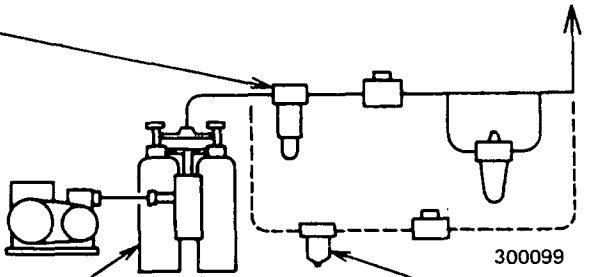
Oil pan – Check for water or fuel in oil



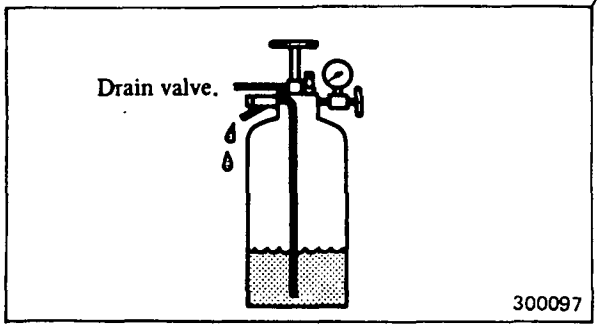
Catch 1 ~ 2 liters (0.3 ~ 0.5 U.S. gal.) of oil in a can, and smell or visually check for presence of fuel or water. Fuel smells as such if present. Water leakage is often evidenced by emulsified oil.

Air filter (air-motor starting) – Drain water

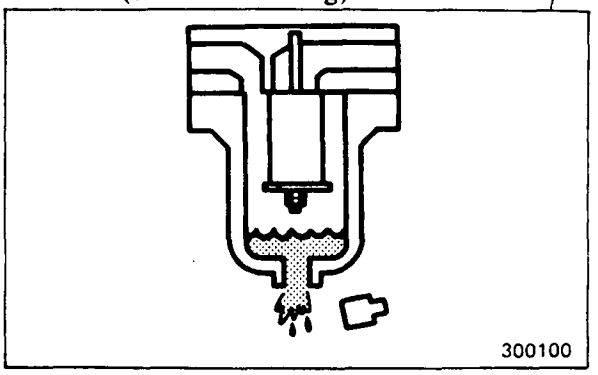




Air tank (air-motor/direct-air starting) – Drain water

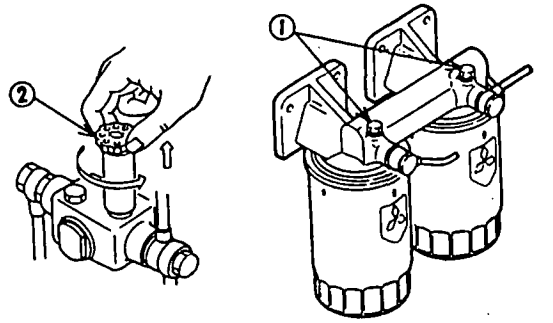


Air filter (direct-air starting) – Drain water



Priming the fuel system

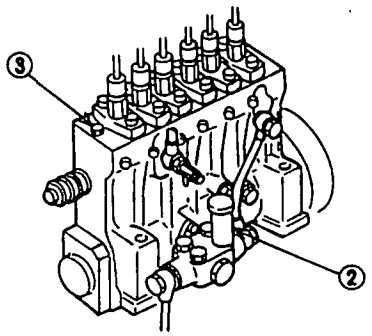
• Fuel filter



301156

1. Loosen air vent plugs (1) on fuel filter.
2. Unlock priming pump handle (2) by twisting it to left, and operate it.
3. Tighten air vent plugs when flow of fuel at vent plug holes is free of air bubbles.

• Fuel injection pump



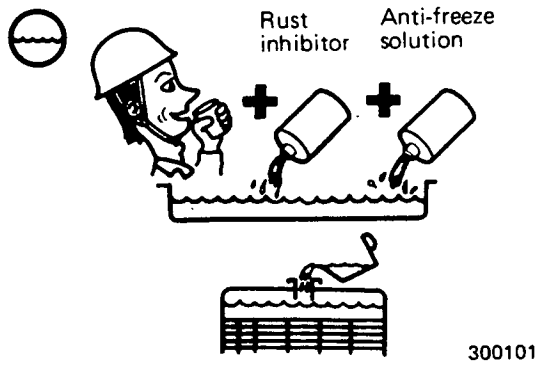
301214

1. Loosen air vent plug (3) about 1.5 turns.
2. Unlock priming pump handle (2) by twisting it to left, and operate it. Stop priming when flow of fuel at vent plug hole is free of air bubbles.
   Lock priming pump handle by twisting it to right.
3. Tighten air vent plug (3).

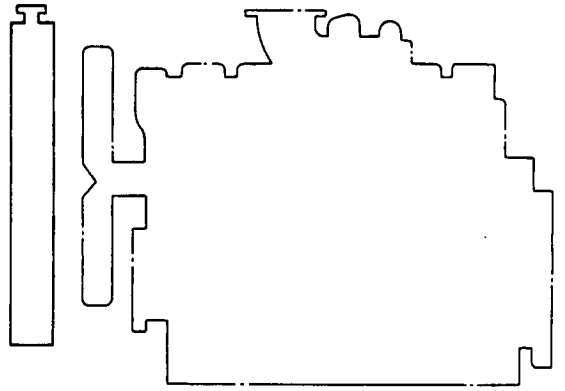
⚠ CAUTION

- Priming pump handle might be unable to restore to its locked position if all air vent plugs are tightened in advance.
- Wipe off fuel spilled out of each vent plug hole.

Changing the coolant (spring and autumn)



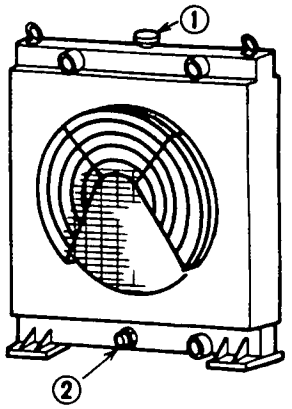
300101


301219

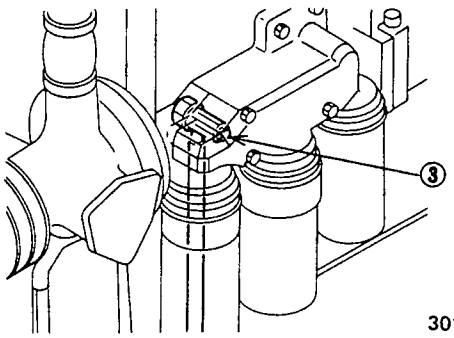
1. Normally, change coolant twice a year.
2. Use clean water that is low in scale forming mineral – such as "city" water.
3. Use anti-freeze solution with rust inhibitor before cold season (in autumn, for example) in an area where freezing temperatures are expected in winter. After cold season (in spring, for example), change coolant with clean water (described in 2 above) containing rust inhibitor.
4. In an area where freezing temperatures are not expected, change coolant once a year.

Procedure

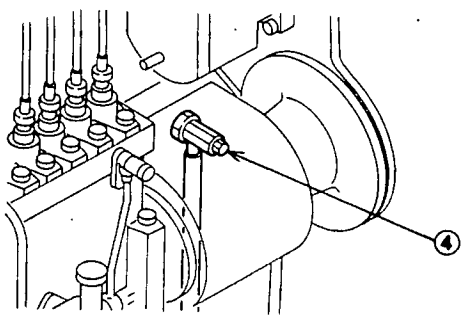
1. Start engine, and run it until water temperature is 70 – 90°C (158 – 194°F).
2. Raise lever at radiator filler cap (1) to relieve pressure, and remove cap.
3. Open radiator drain plug (2) and engine drain cocks (3) and (4), and allow coolant to drain.
4. Close drain cocks, and fill cooling system with flushing solvent (which does not attack rubber and metal). Run engine at 800 – 900 rpm for about 15 minutes. Stop engine, and drain flushing solvent.
5. Close drain cocks, fill cooling system with clean water and run engine at 800 – 900 rpm for about 10 minutes.
6. Stop engine, and open drain cocks. Rinse cooling system with clean water until water flowing out of system is clean.
7. Close drain cocks, and fill system with soft water up to specified level.



300102



301220



301221

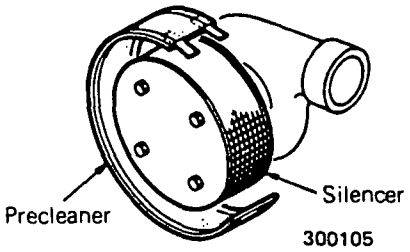
NOTE

When using anti-freeze solution, mix fresh water, anti-freeze solution and rust inhibitor thoroughly in a container, and pour the mixture into radiator.

Recommended rust inhibitor:
Use SANKO-YUSHI-make "Radipet [9]" in mixing proportion of 5% and 95% water.

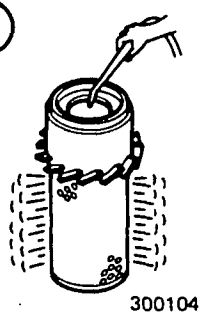
EVERY 250 HOURS OR 1 YEAR

Air cleaner (silencer type) – Clean

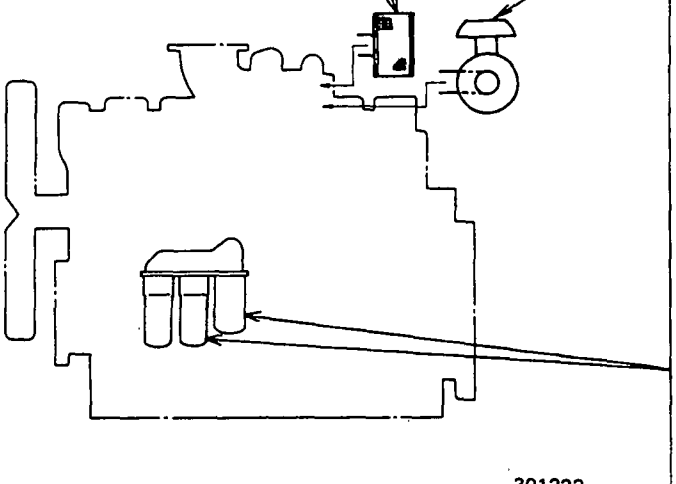


Remove precleaner, and wash it with non-sudsing household detergent.

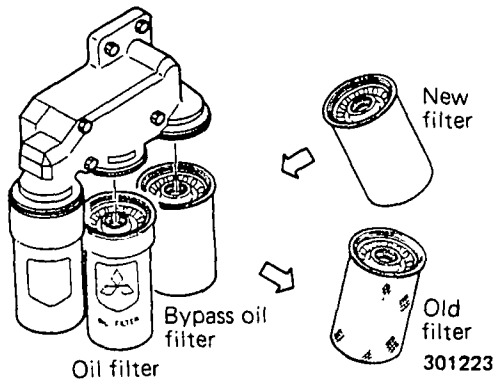
Air cleaner (paper-element type) – Clean element



Use pressure air – 7 kgf/cm² (99.5 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 red signal appears soon after cleaning and resetting, replace element.



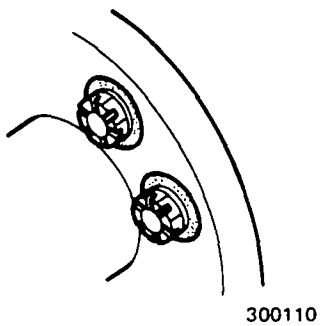
Oil filter and bypass oil filter – Change



Disassemble filter to check for metal particles trapped in its element. If such particles are found, consult your Mitsubishi dealer.

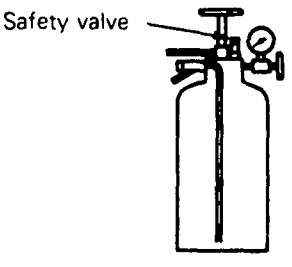
NOTE: Change filter when oil filter alarm lamp glows, regardless of recommended service interval.

Coupling (rubber-bushing type) – Check



Check bushings for cracks or other defects.

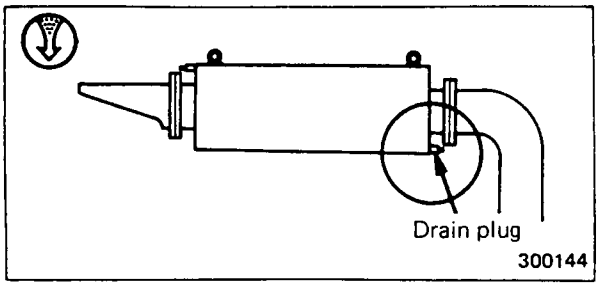
Air tank (air-motor/direct-air starting) – Check safety valve operation



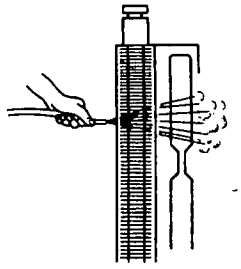
Make sure that safety valve opens when air pressure rises higher than limit.

Air motor: 9.9 kgf/cm² (141 psi) [1 MPa]
Direct air starting: 32 kgf/cm² (455 psi) [3 MPa]

Exhaust muffler – Drain water

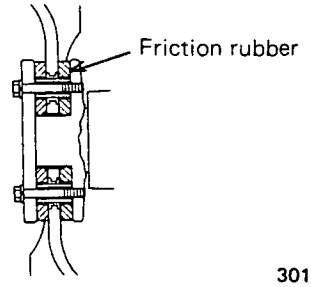


Radiator fins – Clean



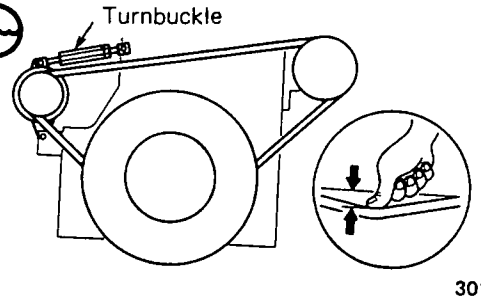
Direct pressure air in direction opposite to air flow.

Fan friction rubber – Check



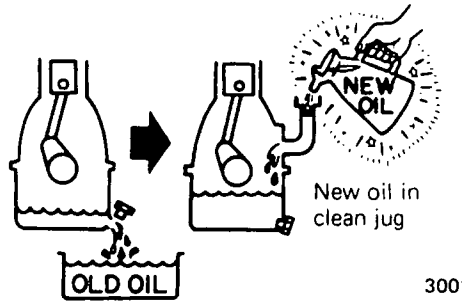
Visually check for deterioration, cracks or other defects.

Water pump/alternator drive belt – Check tension

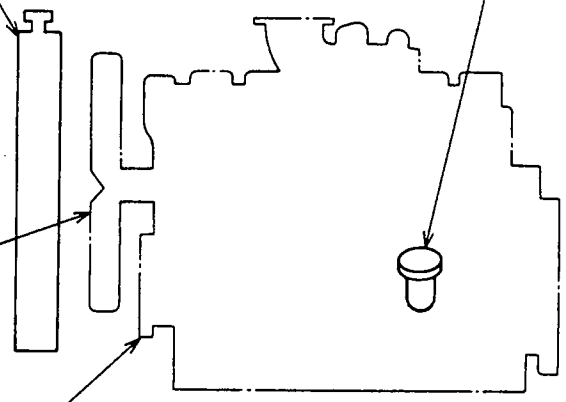


Push belt inward between pulleys with a thumb. Belt should deflect 10 to 15 mm (3/8 to 9/16 in.). Adjust tension by means of turnbuckle.

Oil pan – Change oil

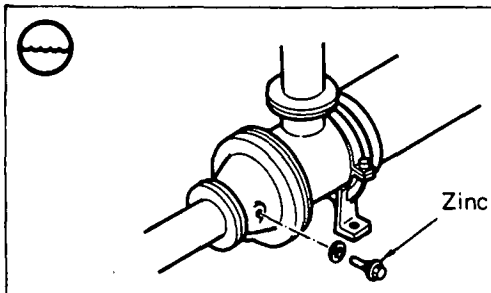


Drain out oil when engine is still hot after operation. Use engine oil of API service classification "CD" (for high-speed, high-load, turbocharged diesel engines).



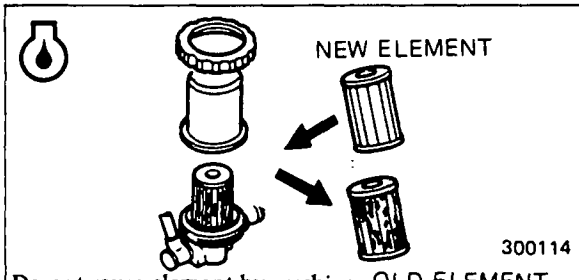
EVERY 500 HOURS OR 2 YEARS

Zinc rods (sea-water cooling) – Change



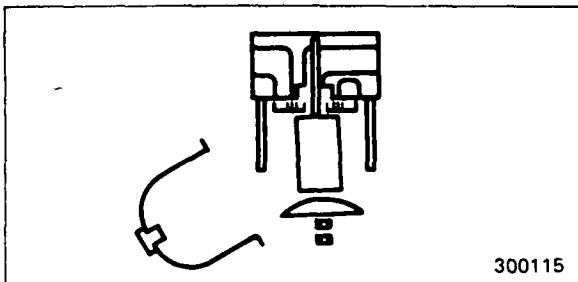
Change zinc rods of heat exchanger, air coolers, etc.

Governor oil filter (Woodward type) – Change element



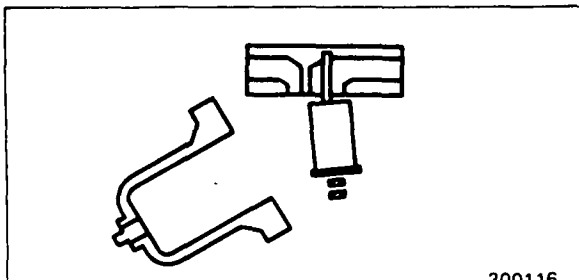
Do not reuse element by washing.

Air filter (air-motor starting) – Wash element



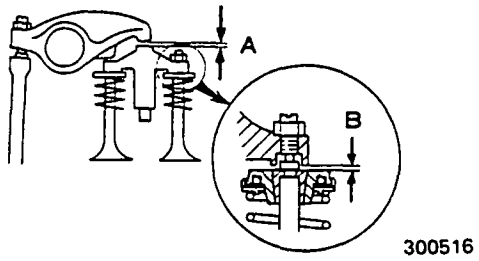
Wash element with diesel fuel.

Air filter (direct-air starting) – Wash element



Wash element with diesel fuel.

Valve clearance – Check (EVERY 1000 HOURS OR 3 YEARS)



Check valve clearance in the firing order shown below. Turn crankshaft by fitting turning bar to crankshaft pulley or rotating turning gear (optional) with a wrench.

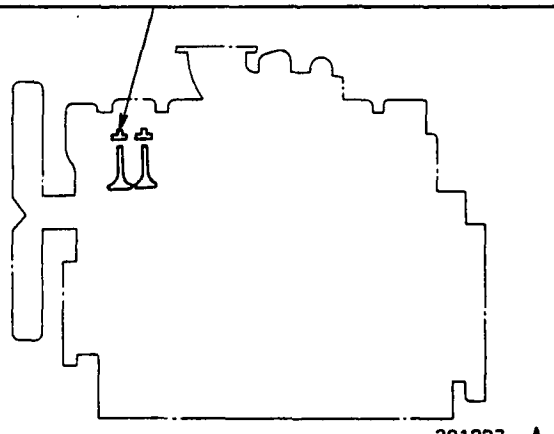
Firing order

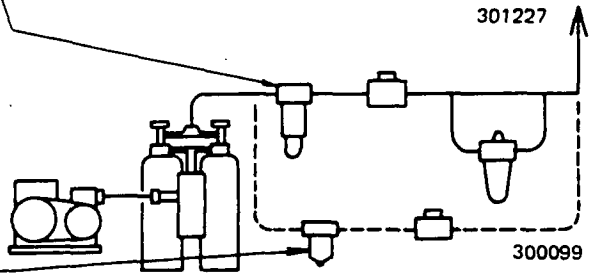
Cylinder No.	1-5-3-6-2-4

Unit: mm (in.)

	Valve clearance (A) [Cold]
Inlet	0.6 (0.024)
Exhaust	0.8 (0.031)

Adjust clearance if it is out of specification.





Valve clearance – Adjust (EVERY 1000 HOURS OR 3 YEARS)

Adjusting valve heights by means of valve bridge

1. Before adjusting valve clearance, adjust and equalize heights of two valves by bringing valve bridge into contact with tops of their stems.

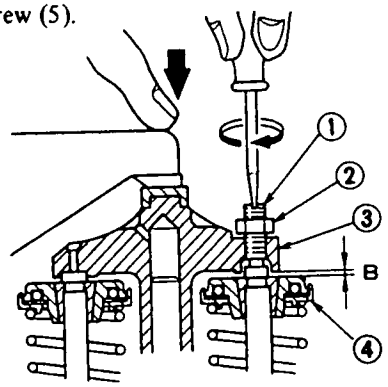
   If seat for one valve is more worn than that for the other, for example, valve heights become unequal to produce some clearance between bridge and stem of a less worn valve, resulting in difference in height (clearance) between two valves.
2. To adjust, loosen lock nut (2), and back off adjusting screw (1).
3. Hold rocker arm with finger, and slowly turn in adjusting screw (1) until it touches valve stem top. From this position, further turn it in about 10 degrees, and tighten lock nut to secure adjusting screw.

NOTE

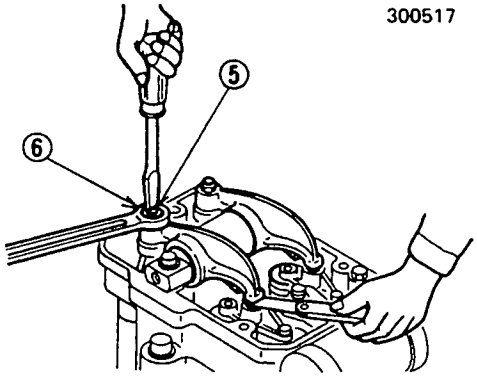
Be sure to adjust clearance (B) between valve bridge (3) and valve rotator (4). If it reaches less than 0.5 mm (0.020 in.), valve cotter may come off.

Adjusting valve clearance

1. Loosen lock nut (6) of adjusting screw (5) on pushrod side of each rocker.
2. While measuring clearance with a feeler gauge, turn adjusting screw (5) in either direction to adjust valve clearance.
3. After adjusting, tighten lock nut (6) to secure adjusting screw (5).



300517



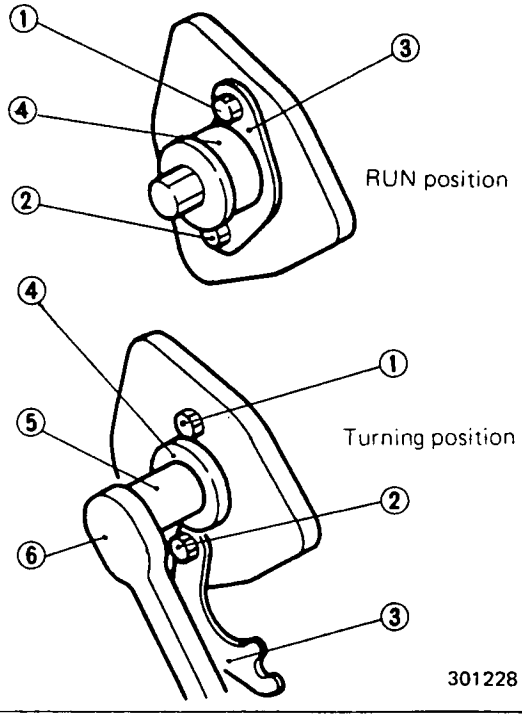
301170

Using turning gear

1. Loosen bolts (1) and (2), and remove plate (3) from the groove of shaft (4). Then, push in shaft (4) all the way.
2. Turn shaft (4) with socket (5) and ratchet handle (6) to crank engine.
3. After cranking engine, pull out shaft (4), restore plate (3) into the groove of shaft (4), and tighten bolts (1) and (2). Make sure plate (3) is fitted in groove of shaft (4) properly.

⚠ CAUTION

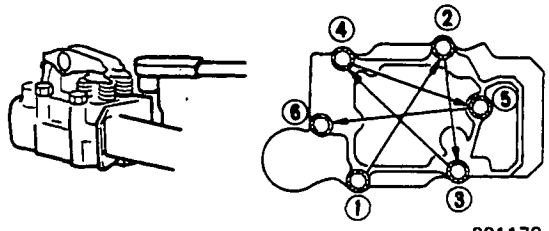
Be sure to return the turning gear to RUN position when starting the engine.



301228

EVERY 1000 HOURS OR 3 YEARS

Bolts and nuts – Retighten



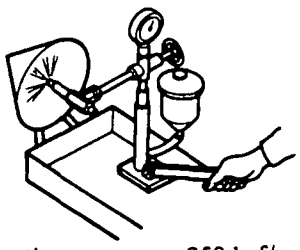
301172

Retighten bolts and nuts on:

- Timing gear case
- Crankshaft pulley
- Fuel injection pump coupling and shaft
- Mounting brackets
- Exhaust manifolds
- Turbocharger

Check cylinder head bolts for tightness and retighten them if necessary. Tighten the bolts in sequence shown above.

Fuel injection nozzles – Check and adjust



300150

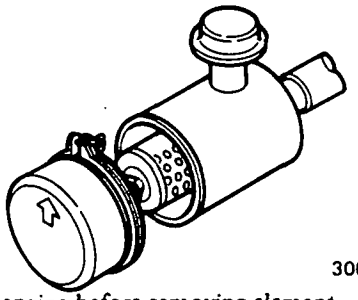
Standard injection pressure: 350 kgf/cm^2 (4977 psi)

Make sure spray occurs from all ten orifices at the same time.

NOTE

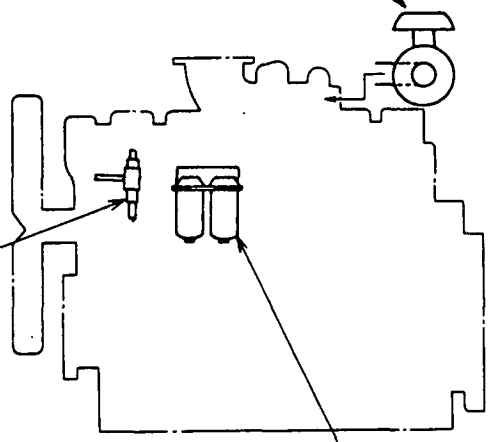
If exhaust smoke is abnormal, check nozzles for spray pattern. See Fuel Injection Nozzles – Check and adjust, pages 34, 35.

Air cleaner – Change element



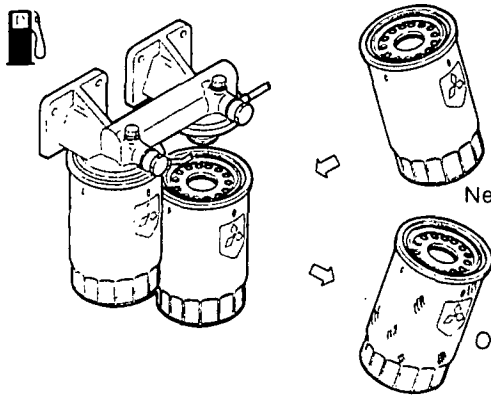
300121

Be sure to stop engine before removing element.



301229

Fuel filter – Change



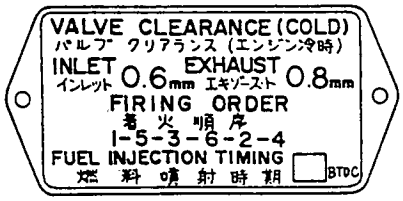
301174

Apply oil to gasket of a new cartridge. Bring gasket into contact with sealing face of bracket, and tighten cartridge 1/2 to 3/4 rotation by hands.

Injection timing – Check and adjust

To adjust injection timing, proceed as follows:

1. Injection timing is indicated on caution plate attached to rocker cover.



301230

2. Engage turning gear with ring gear, and turn crankshaft in normal direction (clockwise as viewed from front side), bringing timing pointer into alignment with 1.6 index number mark punched on damper.

   This crank position corresponds to top dead center on compression stroke in No. 1 cylinder. Its inlet and exhaust valves are fully seated, presenting clearance.

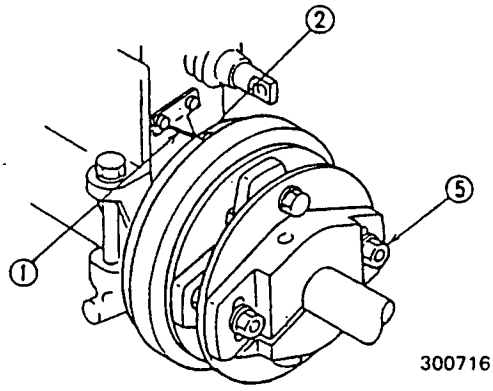
NOTE

   Be careful not to confuse No. 1 cylinder with No. 6 .

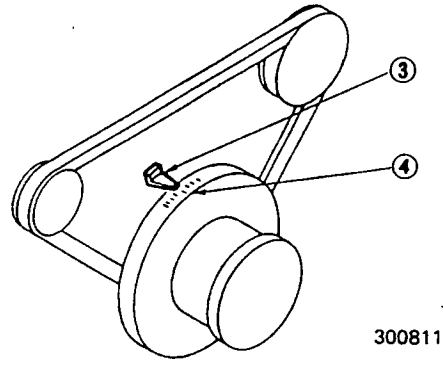
3. Turn back crankshaft about 60°, and turn it forward slowly to align timing mark (2) on pump coupling with pointer (1) on end face of pump case. In this position of crankshaft, read degrees of angle (injection timing) on scale (4) provided on damper, indicated by pointer (3). Minues (-) mark on scale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

4. To adjust injection timing, proceed as follows:

   Make sure that pointer is aligned with injection timing mark for No. 1 cylinder on damper, displace injection pump by loosening two coupling bolts (5) to align pointer (1) on pump case with timing mark (2) on pump coupling. Then, tighten one bolt and, after turning crankshaft, tighten the other. Again check injection timing by cranking engine.



300716

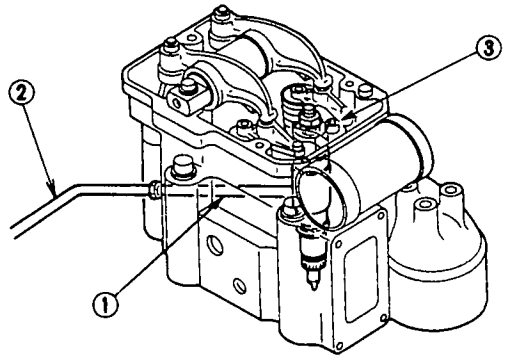


300811

Fuel injection nozzles – Check and adjust

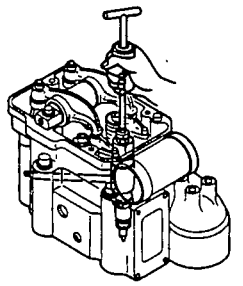
- Removal

1. Disconnect nozzle connector (1) and injection pipe (2) inside the rocker cover from nozzle by loosening securing nut.
2. Unscrew gland nut (3) and, after taking off gland, remove nozzle from cylinder head.



301231

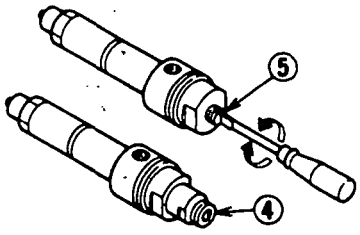
3. To remove nozzle, use nozzle remover (33591-10101).



301176

Injection pressure adjustment

1. Mount injection nozzle in a tester. Push down tester lever gently to pressurize. See if fuel spray begins at 350 kgf/cm^2 (4977 psi) [34.3 MPa].
2. Remove cap nut (4) on nozzle holder, and tighten or loosen adjusting screw (5) with a screwdriver. Tightening screw will increase pressure, and vice versa.



300212

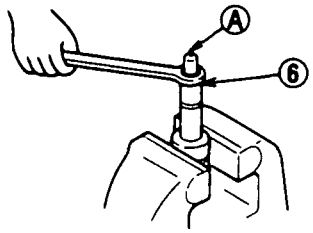
3. After adjusting, put back on cap nut (4) and tighten it to 4 ~ 5 kgf-m (28.9 ~ 36.2 lbf-ft) [39.5 ~ 49.3 N·m].

Fuel spray pattern

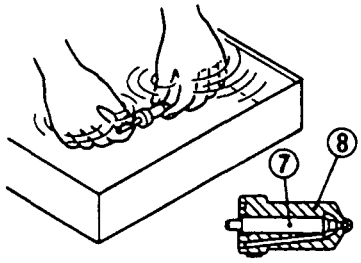
1. Push down tester lever forcefully to let nozzle spray fuel. Spray should occur from all of the ten orifices at the same time, taking a cone shape with an angle of 155 degrees and consisting of finely and uniformly atomized fuel particles. Nozzle should terminate each spray without any after-dribble.
2. If spray pattern is poor, remove nozzle tip. To remove the tip, remove cap nut, loosen adjusting screw with a screwdriver, and loosen retaining nut (6). Be sure to follow these steps in order because the tip is spring-loaded.
3. Wash needle valve (7) and body (8).

CAUTION

When removing nozzle tip, be careful not to tap part (A) of the tip.



300123



400229

4. For cleaning fluid, use clean gasoline. After cleaning, assemble needle valve (7) and body (8) in clean diesel fuel.

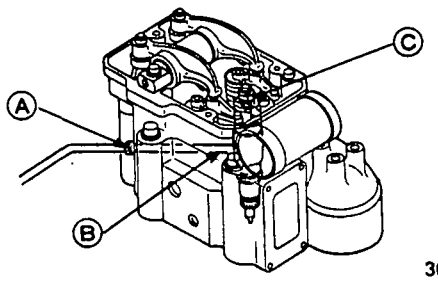
CAUTION

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

5. Tighten cap nut (6) to 18 ~ 20 kgf-m (130 ~ 145 lbf-ft) [177 ~ 196 N·m].
6. If the foregoing adjustment and cleaning do not improve spray pattern, replace nozzle tip.

Installation

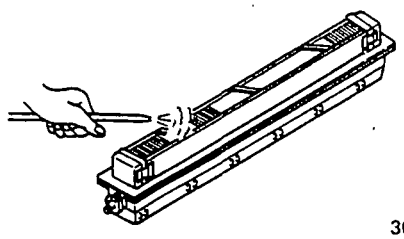
1. To install, use reverse of removal procedure. To install nozzle, tighten nut to 10 kgf-m (72 lbf-ft) [98 N·m] while keeping the gap between body and spring equally. After installing nozzle, check each fuel pipe joints for fuel leaks.
2. Remove rocker cover, and run engine at about 600 rpm Under this condition, check to be sure that no fuel leaks at points (A), (B) and (C). Then, stop engine, and install rocker cover.



301231

EVERY 2000 HOURS OR 5 YEARS

Air cooler – Clean

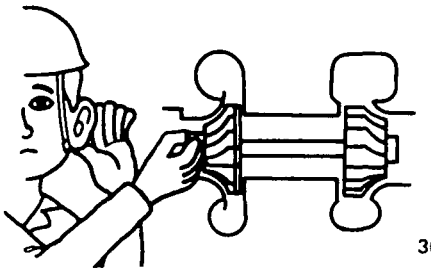


301178

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.

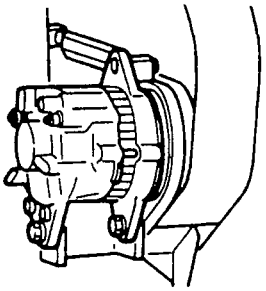
Turbocharger – Check



300124

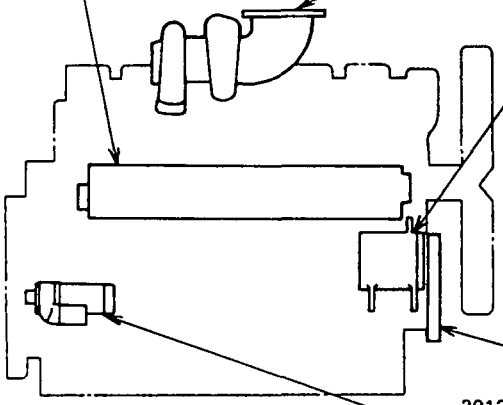
Turn compressor wheel by hand to listen for abnormal noise. If wheel is noisy, replace bearings.

Alternator – Check



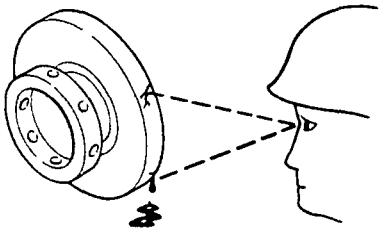
301232

Visually check for any defects. Remove V-belt and check for abnormal rotation.



301233

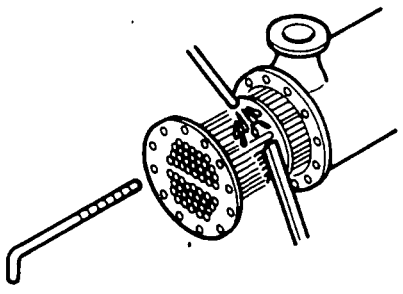
Vibration damper – Check



301179

Check for cracks in rubber and leaks of fluid.

Heat exchanger – Wash

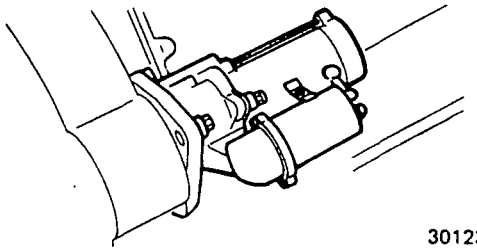


300125

Wash outside surfaces of pipes with a brush by dashing fresh water over them.

Remove scale from inside of pipes by inserting a bar.

Starter – Check



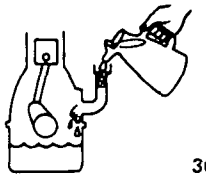
301234

Visually check for any defects. Check pinion for operation.

STORAGE

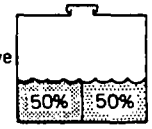
Preparation for long-time storage (3 months or more)

Drain out engine oil, and fill in anticorrosive oil such as "P-10."



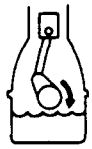
300127

Use a mixture of "P-9" anticorrosive oil and fuel oil in 50-to-50 ratio.



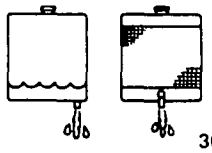
300128

Run engine at 800 ~ 1000 rpm for 5 ~ 10 minutes under no-load condition.



300129

After stopping engine, drain out fuel and coolant.

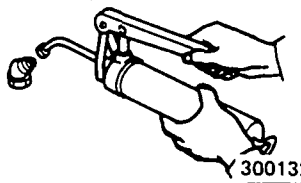


300130

Put volatile anticorrosive compound in air inlet and exhaust system in amount of 3 – 5 g (0.1 – 0.2 oz) of the compound per volume of 28 liters (7.4 U.S. gal).

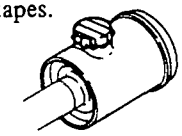
300131

Lubricate fitting or linkage of tension pulley, etc.



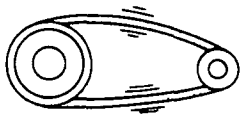
300132

Cover up air cleaner, air inlet pipe, exhaust pipe, breather and turbocharger with adhesive tapes.



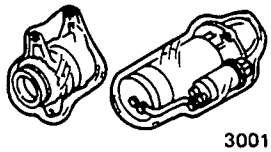
300133

Loosen V-belts.



300134

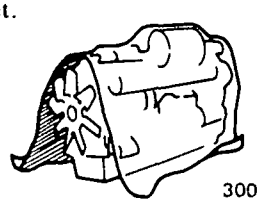
Cover up starter and alternator with polyethylene sheet.



300135

Add distilled water and recharge batteries. Remove batteries, clean terminals and keep batteries in a dry, cool place.

Cover engine with an awning sheet.



300136

⚠ CAUTION

- When storing engine, keep it indoors whenever possible.
- Attach caution tags reading "Anticorrosive oil in engine," and "Before placing engine in service, fill in coolant and fuel."

NOTE

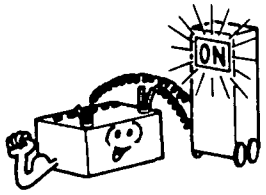
It is not necessary to change engine oil if storage period is shorter than 6 months.

Recommended anticorrosive oils

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

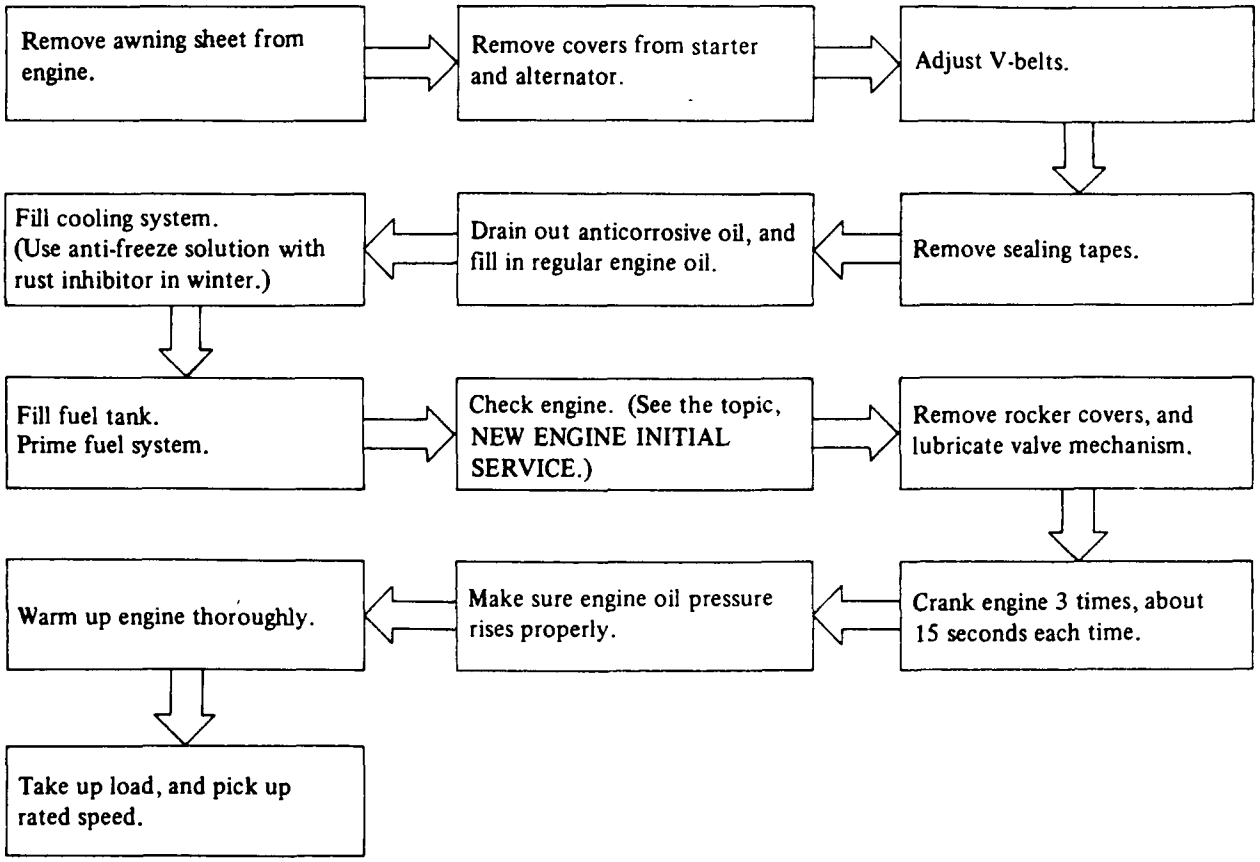
Service during storage

Recharge batteries at least once a month.



300137

Preparing a stored engine for service

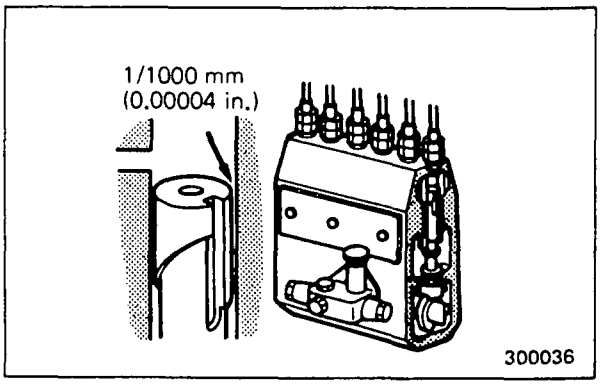


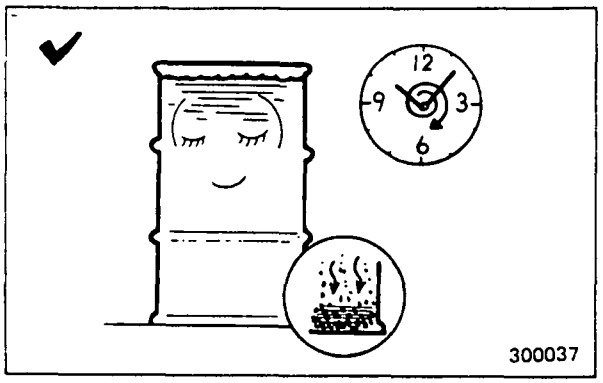
DIESEL FUELS, COOLING WATER AND LUBRICANTS

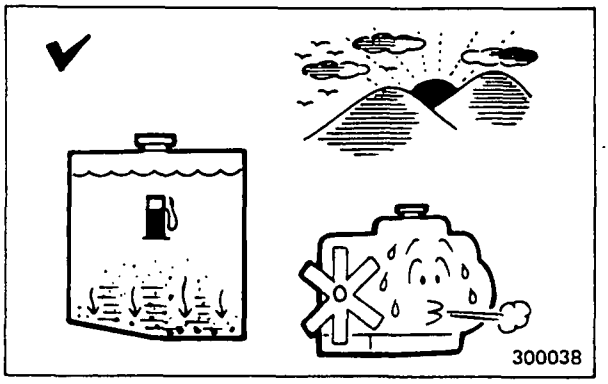
DIESEL FUEL

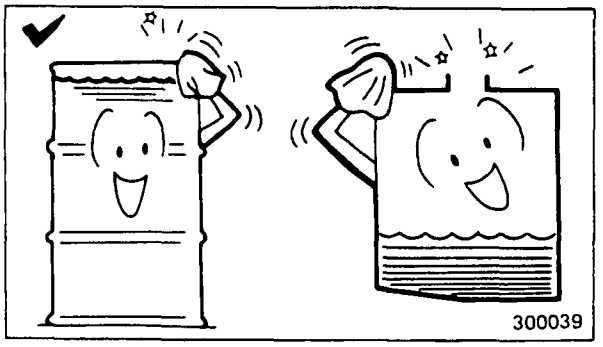
Mitsubishi diesel engines are designed to use diesel fuel oil meeting the requirements of JIS (Japanese Industrial Standard K2204). JIS K2204 diesel fuel oil nearly corresponds to Class 2-D fuel oil specified by ASTM (American Society for Testing and Materials) D975. For pour point, refer to the following chart:

Ambient temp. °C (°F)	−30 (−22)	−20 (4)	−10 (14)	0 (32)	10 (50)	20 (68)	30 (86)	40 (104)
Gas oil (JIS K2204)		No. 3, special	No. 3	No. 2	No. 1	No. 1, special		







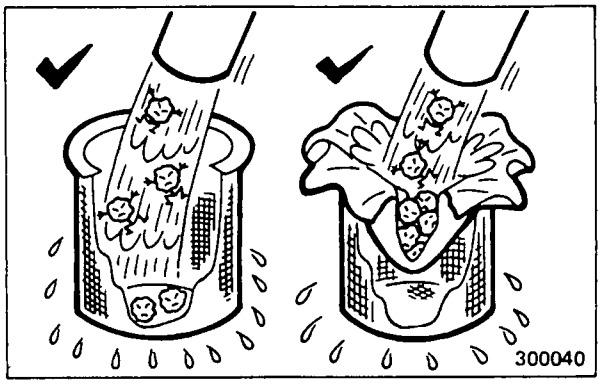


Too much emphasis cannot be placed on the importance of using only clean diesel fuel. The clearance between the plunger and barrel of fuel injection pump and that between needle valve and body of injection nozzle are very small. This makes it evident that invisible particles of dirt which might pass through the filter can damage these finely finished parts.

Care of the fuel supply

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.

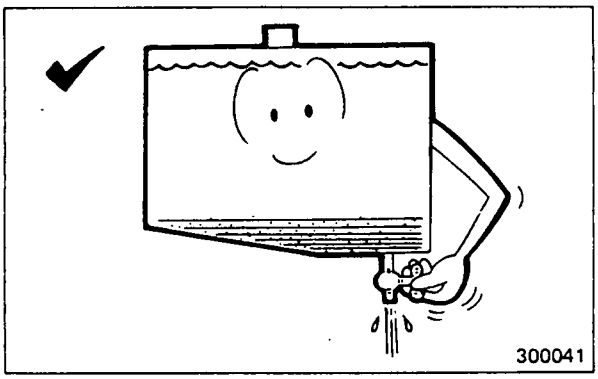
4. Be sure to pour fuel through strainer in the filler opening. Use of a lint-free cheese cloth is a good practice for keeping dirt out.



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

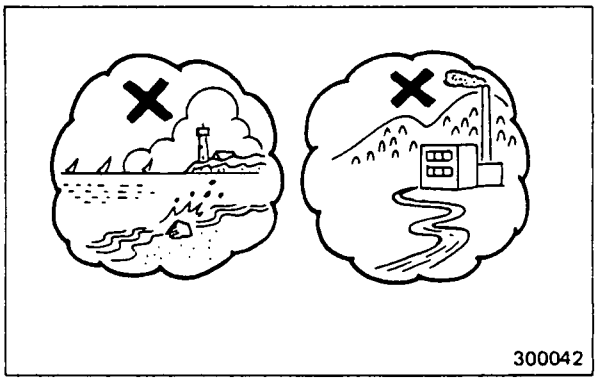
⚠ CAUTION

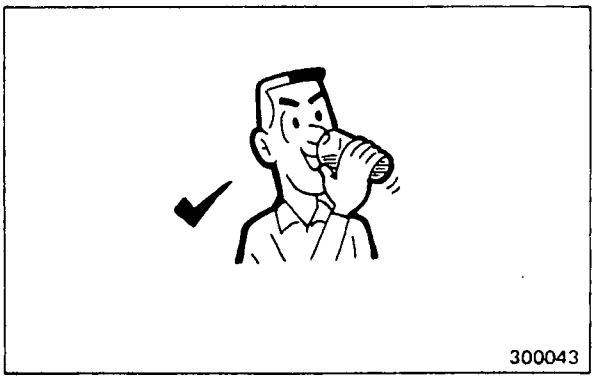
Even clean top portion of fuel oil contains more or less dirt and water. Such dirt and water should be removed before they get inside the engine. This method of cleaning fuel oil is called "draining."



COOLING WATER

1. Water used in the cooling system must be soft, or as free from scale forming minerals as possible. Water, such as is available from the city water supply, is generally soft enough for the engine.
2. River water and well water are most likely to contain large amount of scale forming minerals and should not be used. Remember, some waters, particularly those pumped from ground in a mining or hot-spring area, contain active impurities harmful to cylinder liners of your engine.
3. Be sure to service the zinc rods installed in the sea-water circuits at regular intervals.



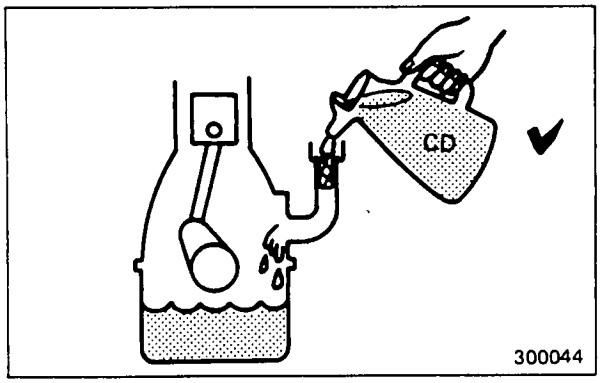


LUBRICANTS

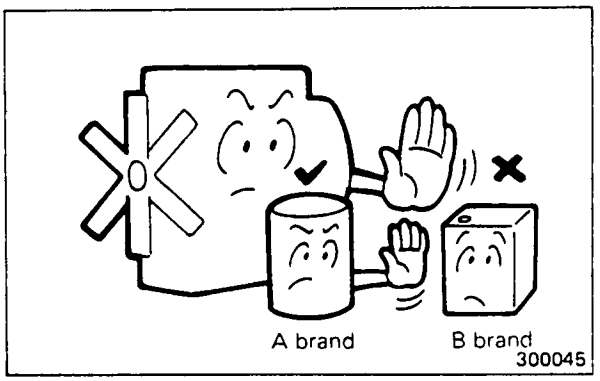
Engine oil

Careful attention to the following information on engine oil and its proper selection will add much to performance, economy and long life of your engine – a high-speed, high-load diesel engine.

1. Be sure to use engine oil of the API (American Petroleum Institute) service classification "CD."

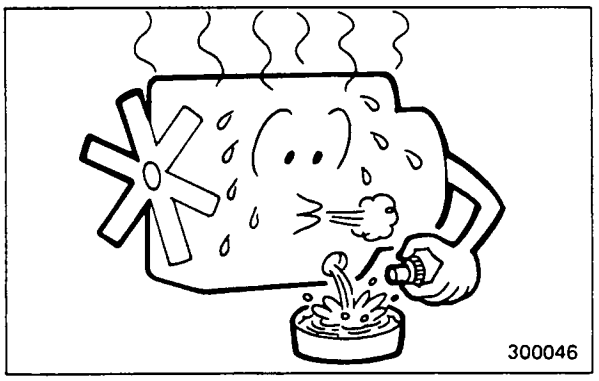


2. Avoid mixing engine oils of different brands. In some cases, different brands are not compatible with each other and, when mixed, can seize parts such as piston rings, cylinder liners, etc. or abnormally wear moving parts. It is best to stick with one and the same brand of engine oil at successive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



3. Draining and refilling

   To change the oil, drain it out while the engine is still hot after a duty operation: the oil is hot and will rush out, washing out the sludge. After draining, allow the engine to idle for about 5 minutes with a flushing oil in the oil pan and refill with fresh oil upon draining the flushing oil.



Grease

Use clean multi-purpose grease for your engine.

⚠ CAUTION

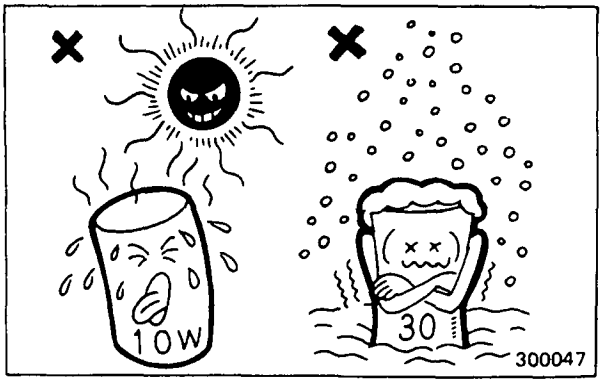
Cleanliness is important for handling the engine oil and grease. Use clean handling tools; wipe the filler cap, grease fittings and plugs clean; and handle them in a dust-free condition.

Selection

Refer to the following charts in selecting engine oil and grease:

Starting temperatures and grades of lubricants

Ambient temp. °C (°F)	−30 (−22)	−20 (4)	−10 (14)	0 (32)	10 (50)	20 (68)	30 (86)	40 (104)
Engine oil	SAE 10W			SAE 30				SAE40
	SAE 10W−30							
Grease	NLGI No. 0, No. 1			NLGI No. 2				



Recommended engine oils

Manufacturer	Brand name
Mitsubishi	Diamond HDS-3 Engine oil
Esso	Essolube D-3
General	General Gemico Super S-3
Idemitsu	Apollo Oil Diesel Motive Custom
Kygnus	Mighty Oil S-3
Kyodo	Kyoseki Delmate D
Cosmo	Cosmo Multi Diesel, Cosmo Diesel CD
Mobil	Mobil Delvac 1300 series
Nippon	High Diesel S-3
Showa-Shell	Shell Rimula Z Oil White Parrot Super S-3

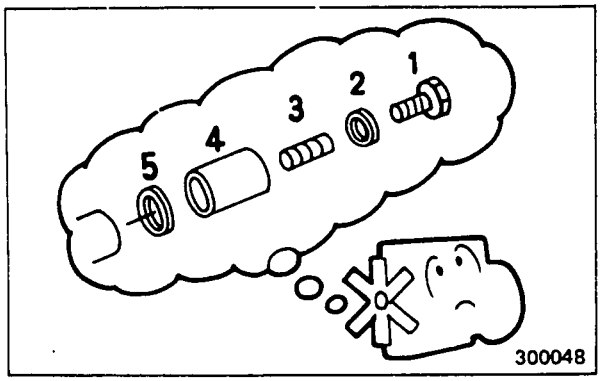
When using oils other than these recommended ones, they should be of API service classification "CD" and meet the requirements of MIL-L-2104C.

TROUBLESHOOTING

General instructions

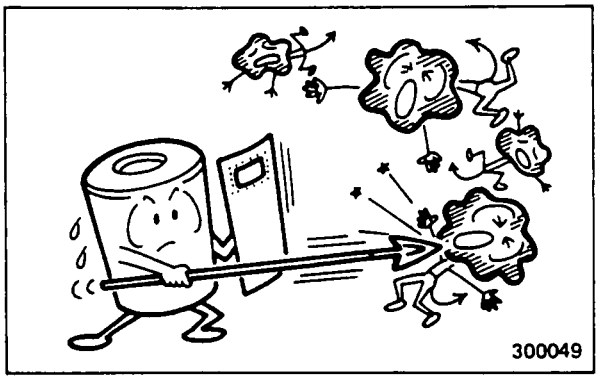
(1) Think before acting

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.



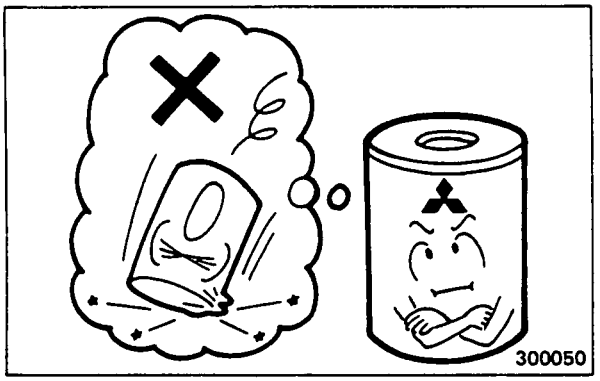
(2) Dust and dirt are often the ultimate causes.

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



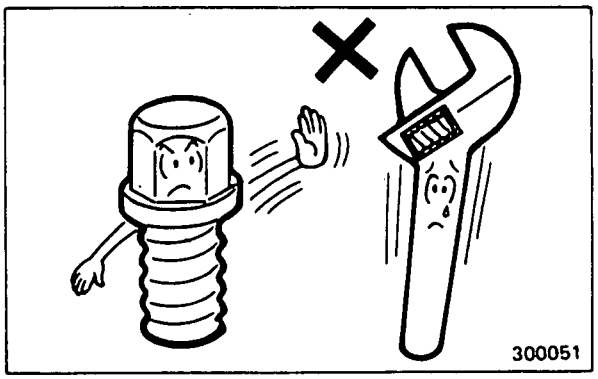
(3) Use genuine Mitsubishi parts.

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.



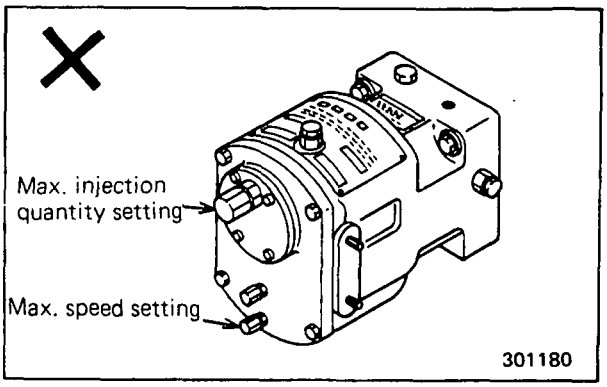
(4) Perform servicing work safely.

Use the right kind of hand tool to carry on each working step in repair work. Avoid injury to yourself and damage to the parts by using improper tool. 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 chain block to avoid personal injury.



⚠ CAUTION

- Never attempt to break the seals of the governor for maximum speed setting and maximum injection quantity setting.
- 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.



Electric-starting engine

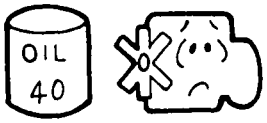
Starter will not crank engine or cranks slowly, resulting in a failure of engine to start

- Electrical system
  - Battery – starter switch circuit open → Repair or replace.
  - O.K.
    - Battery – starter – starter switch circuit open → Repair or replace.

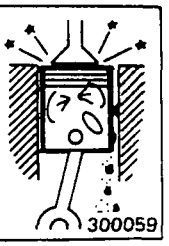
    - Battery weak → Adjust alternator drive belt.

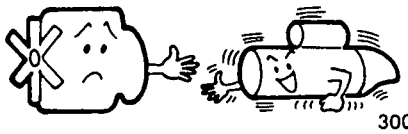
    - Starter, starter relay defective → Consult Mitsubishi dealer.

    - Electrolyte specific gravity low → Recharge.
    - Battery will not recover even if recharged → Replace.
- Lubrication system
  - Engine oil viscosity too high → Refill with oil of proper viscosity.



  - O.K.
- Engine proper
  - Running parts defective
    Interference between pistons and valves
    Foreign matter in cylinder → Consult Mitsubishi dealer.



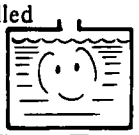
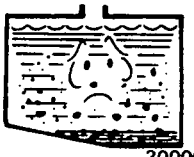

300060

Starter will crank engine, but engine will not start

Fuel system → Fuel tank

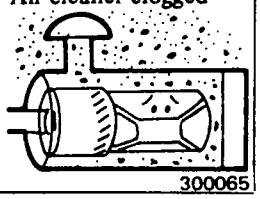
O.K.

Empty  300061
- Refuel.
- Fuel leaks from pipe connection → Consult Mitsubishi dealer.

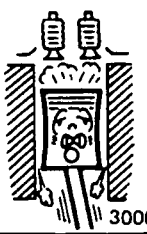
Filled  300062
- Wrong type of fuel → Refill with correct type of fuel.
- Dirt or water in fuel  300064 → Remove dirt or drain.
- Fuel filter clogged → Change.
- Fuel pipe clogged or leaky → Clean or repair
- Injection pump defective → Consult Mitsubishi dealer.

Electrical system → Battery specific gravity low  300063
- Recharge. → Adjust alternator drive belt.
- Circuit defective → Repair or replace.

O.K.

Air inlet system → Air cleaner clogged  300065
- Clean element.  300066
- Change element.

O.K.

Engine proper → Compression pressure low
Cylinders, pistons and piston rings worn
Valve springs broken
Valve seats and injection nozzle packings defective
 300067
→ Consult Mitsubishi dealer.

Air-starting engine

- **Air-motor starting**

Starter will not crank engine

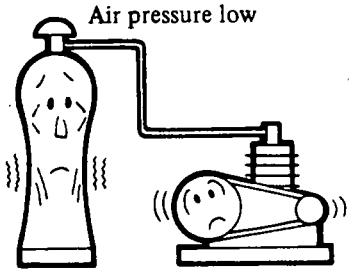
- Air pressure low → Run air compressor to increase air pressure.
- Starter switch defective → Repair or replace.
- Magnetic valve defective → Repair or replace. → Consult Mitsubishi dealer.

Starter will run, but starter pinion will not engage with flywheel ring gear

- Ring gear or pinion defective → Consult Mitsubishi dealer.

Starter pinion engages with ring gear, but starter will not crank engine

- Air pressure low



→ Run air compressor to increase air pressure.

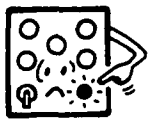
- **Direct-air starting**

Engine will not be cranked

- Air pressure low → Run air compressor to increase air pressure.
- Air filter clogged → Clean or change.
- Starter valve stuck → Consult Mitsubishi dealer.

Others

Complaint	Possible causes	Remedy
Engine lacks power  500040	• Incorrect grade of oil	• Use recommended type and SAE number of oil.
	• Wrong type of fuel	• Change.
	• Insufficient air (air cleaner clogged)	• Clean or change element.
	• Engine overcooled	• Use radiator cover, replace parts.
	• Fuel feed pump gauze filter clogged	• Clean gauze filter.
	• Engine overheating	• Flush cooling system or replace parts.
	• Valve clearance incorrect	• Readjust.
	• Injection pump defective	* Readjust or replace.
	• Injection nozzles defective	* Readjust or replace.
	• Injection timing incorrect	* Readjust.
	• Compression pressure low (cylinders and pistons worn)	* Disassemble and replace parts.
White or blue exhaust smoke  500041	• Too much oil in crankcase	• Fill only to correct level on gauge.
	• Oil viscosity too low	• Refill with correct viscosity of oil.
	• Engine overcooled	• Use radiator cover, or clean, test and replace thermostat.
	• Thermostat defective (no water temperature rise)	* Replace.
	• Injection timing incorrect	* Readjust.
	• Compression pressure low	* Disassemble and replace parts.
	• Wrong type of fuel (low cetane number)	* Change.
Black or gray exhaust smoke  500042	• Wrong type of fuel	• Refill with correct type of fuel
	• Valve clearance incorrect	• Readjust.
	• Injection pump defective	* Readjust or replace.
	• Compression pressure low	* Disassemble and replace parts.
	• Insufficient air (air cleaner clogged)	• Clean or change element.
High fuel consumption  500043	• Injection pump defective	* Readjust or replace.
	• Injection nozzles defective	* Readjust or replace.
	• Injection timing incorrect	* Readjust.
	• Wrong type of fuel	• Refill with correct type of fuel.
	• Compression pressure low	* Disassemble and replace parts.
	• Insufficient air	• Clean or change air cleaner element. Check turbocharger.

Complaint	Possible causes	Remedy
High oil consumption  500044	• Too high oil level in crankcase	• Maintain oil level in operating range on gauge.
	• Incorrect grade of oil	• Use recommended type and SAE number of oil.
	• Oil leaks	• Retighten or replace.
	• Cylinders and piston rings worn	* Disassemble and replace parts.
Engine overheats  500047	• Radiator or heat exchanger dirty	• Wash.
	• Fan belt loose	• Readjust.
	• Lack of coolant	• Refill.
	• Water pump defective	* Replace.
	• Thermostat defective	* Replace.
Low oil pressure  500045	• Lack of oil	• Refill up to level.
	• Oil viscosity too low	• Refill with correct viscosity of oil.
	• Oil filter clogged	• Replace element.
	• Oil pump defective	* Readjust or replace.
	• Oil pressure regulating valve defective	* Readjust or replace.
	• Oil pressure sensor circuit defective	* Replace.

NOTE

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.

SPECIFICATIONS

Model designation		S6R			S6R2		
		T	TA	TK	T	TA	TK
Type		Water-cooled, 4-stroke cycle, turbocharged					
			Aftercooled	Intercooled		Aftercooled	Intercooled
Number of cylinders		6					
Bore x stroke		170 x 180 mm (6.693 x 7.087 in.)			170 x 220 mm (6.693 x 8.661 in.)		
Piston displacement		24.5 liters (1495.1 cu in.)			30.0 liters (1830.8 cu in.)		
Fuel injection system		Direct					
Compression ratio		14.0 : 1					
Firing order		1-5-3-6-2-4					
Rotation		Counterclockwise as viewed from flywheel side					
Dimensions	Length	1722 mm (67.8 in.)					
	Width	1050 mm (41.3 in.)					
	Height	1498 mm (60 in.)			1578 mm (62.1 in.)		
Dry weight		2250 kg (4960 lb)	2300 kg (5070 lb)		2350 kg (5180 lb)	2400 kg (5290 lb)	
Fuel system	Fuel	Diesel fuel oil ASTM No. 2-D					
	Injection pump	Mitsubishi PS6 type					
	Governor	RHD6 (hydraulic all-speed type)					
	Fuel filter	Paper-element (spin-on type)					
	Injection nozzles	Hole type					
	Injection pressure	350 $^{+5}_{0}$ kgf/cm^2 (4977 $^{+71}_{0}$ psi) [34.3 $^{+0.5}_{0}$ MPa]					
Lubrication system	Type	Pressure feed (by oil pump)					
	Oil	API CD class					
	Capacity	100 liters (26.4 U.S. gal) approx.					
	Oil filter	Paper-element type (with bypass filter, spin-on type)					
	Oil cooler	Water-cooled multi-disc type (built in crankcase)					
Cooling system	Type	Forced circulation by centrifugal pump					
	Capacity (engine)	50 liters (13.2 U.S. gal) approx.			55 liters (14.5 U.S. gal) approx.		
	Fresh-water pump	Centrifugal type					
Starting system		Electric or air (air motor or direct air)					
Starter		24 V – 7.5 kW x 1					
Alternator		24 V – 30 A					
Turbocharger		Mitsubishi TD type					

TIGHTENING TORQUE

Important bolts and nuts

Parts attached	Thread Diam.—Pitch mm (in.)	Width across flats mm (in.)	Standard torque			Remarks
			kgf·m	lbf·ft	N·m	
Cylinder heads	22 – 2.5 (0.87 – 0.098)	27 (1.06)	55	398	539	[Wet]
Rocker shaft	14 – 2 (0.55 – 0.079)	17 (0.67)	15	108	147	
Main bearing caps	22 – 2.5 (0.87 – 0.098)	27 (1.06)	50	362	490	[Wet]
Timing gear case	16 – 1.5 (0.63 – 0.059)	24 (0.94)	22	159	216	
Oil pan	12 – 1.25 (0.47 – 0.049)	17 (0.67)	6	43	59	
Mounting brackets (rear)	16 – 1.5 (0.63 – 0.059)	24 (0.94)	22	159	216	
Mounting brackets (front)	12 – 1.25 (0.47 – 0.049)	17 (0.67)	11	80	108	
Connecting rod bearing caps	22 – 1.5 (0.87 – 0.059)	27 (1.06)	55	398	539	[Wet]
Crankshaft pulley, damper	22 – 1.5 (0.87 – 0.059)	32 (1.26)	50	362	490	
Flywheel	22 – 1.5 (0.87 – 0.059)	32 (1.26)	55	398	539	[Wet]
Idler gear	10 – 1.25 (0.39 – 0.049)	14 (0.55)	3	22	29	
Injection pump drive gear	30 – 1.5 (1.18 – 0.059)	46 (1.81)	40	289	392	
Idler shaft	12 – 1.25 (0.47 – 0.049)	17 (0.67)	11	80	108	
Injection pump drive shaft case	12 – 1.25 (0.47 – 0.049)	17 (0.67)	11	80	108	
Oil pump idler gear	12 – 1.25 (0.47 – 0.049)	17 (0.67)	7	51	69	Apply locktite 262
Water pump pulley nut	24 – 1.5 (0.94 – 0.059)	36 (1.42)	25	181	245	
Injection pump coupling	12 – 1.25 (0.47 – 0.049)	17 (0.67)	11	80	108	
Laminated plate	12 – 1.25 (0.47 – 0.049)	17 (0.67)	8.5 – 9.5	61 – 69	83 – 93	
Nozzle inlet connectors	16 – 1.5 (0.63 – 0.059)	19 (0.75)	6.5 – 7.5	47 – 54	64 – 74	
Nozzle gland studs	14 – 1.5 (0.55 – 0.059)	22 (0.87)	10	72	98	
Nozzle holder set screw cap nuts	14 – 1.5 (0.55 – 0.059)	22 (0.87)	4 – 5	29 – 36	39 – 49	
Nozzle tip nuts	28 – 1.5 (1.10 – 0.059)	27 (1.06)	18 – 20	130 – 145	177 – 196	

Remarks: Apply a coat of engine oil to the threads of parts indicated as [Wet].

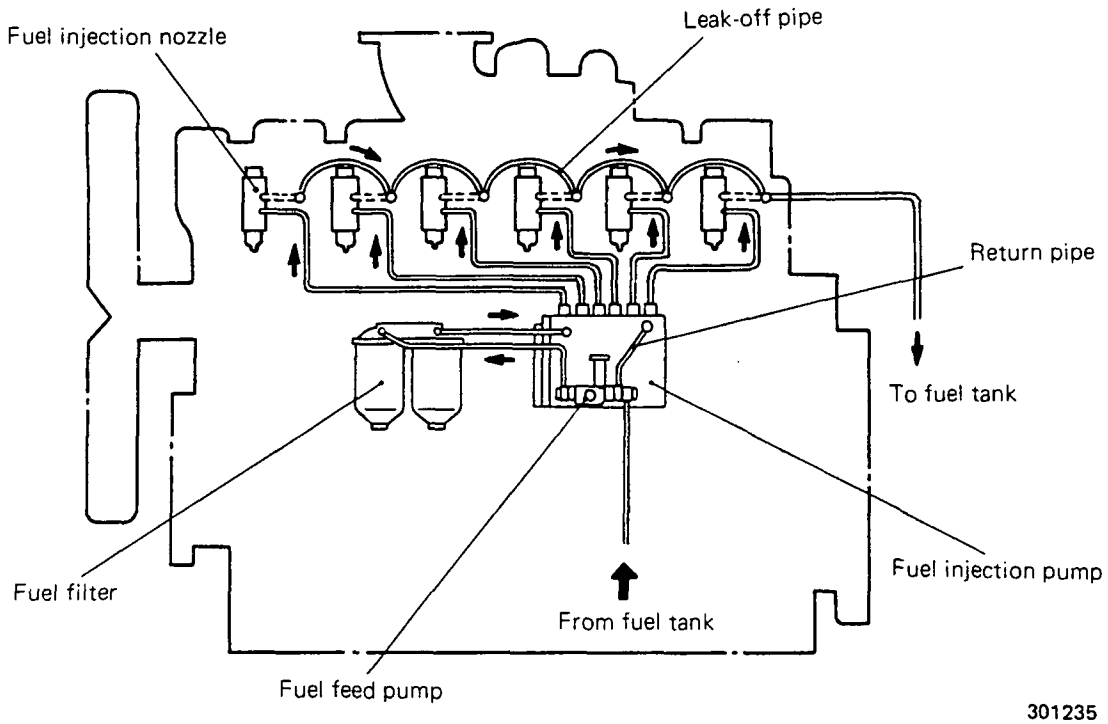
Parts attached	Thread Diam.–Pitch mm (in.)	Width across flats mm (in.)	Standard torque			Remarks
			kgf·m	lbf·ft	N·m	
Rocker case	12 – 1.25 (0.47 – 0.049)	17 (0.67)	11	80	108	
Camshaft	12 – 1.25 (0.47 – 0.049)	17 (0.67)	11	80	108	
Thrust plate	12 – 1.25 (0.47 – 0.049)	17 (0.67)	6	43	59	
Hanger	12 – 1.25 (0.47 – 0.049)	17 (0.67)	11	80	108	
Oil jet check valve	12 – 1.75 (0.47 – 0.069)	17 (0.67)	3.5	25	34	
Rear plate	12 – 1.25 (0.47 – 0.049)	17 (0.67)	11	80	108	
Oil pump	12 – 1.25 (0.47 – 0.049)	17 (0.67)	11	80	108	
Water pump	12 – 1.25 (0.47 – 0.49)	17 (0.67)	6	43	59	
Fan drive camshaft gear	12 – 1.25 (0.47 – 0.049)	17 (0.67)	11	80	108	
Fan drive shaft gear	30 – 1.5 (1.18 – 0.059)	46 (1.81)	40	289	392	
Fan plate	12 – 1.25 (0.47 – 0.049)	17 (0.67)	11	80	108	
Injection pump bracket	12 – 1.25 (0.47 – 0.049)	17 (0.67)	11	80	108	
Injection pump flywheel	24 – 1.5 (0.94 – 0.059)	36 (1.42)	24 – 26	174 – 188	235 – 255	
Plunger assembly	12 – 1.25 (0.47 – 0.049)	19 (0.75)	8 – 8.5	58 – 61	78 – 83	
Delivery valve holder	30 – 1.5 (1.18 – 0.059)	32 (1.26)	24 – 26	174 – 188	235 – 255	
Injection pump coupling shaft	14 – 1.5 (0.55 – 0.059)	22 (0.87)	17 – 18	123 – 130	167 – 177	At slit
Governor drive case	12 – 1.25 (0.47 – 0.049)	17 (0.67)	11	80	108	
Starter	12 – 1.25 (0.47 – 0.049)	17 (0.67)	6	43	59	

General bolts and nuts

Screw thread mm (in.)		Standard torque					
Diameter	Pitch	w/spring washer			w/o spring washer		
		kgf-m	lbf-ft	N·m	kgf-m	lbf-ft	N·m
8 (0.31)	1.0 (0.039)	1.8	13	18	2.2	16	22
	1.25 (0.049)	1.8	13	18	2.1	15	21
10 (0.39)	1.25 (0.049)	3.6	26	35	4.2	30	41
	1.5 (0.059)	3.4	25	33	4.0	29	39
12 (0.47)	1.25 (0.049)	6.5	47	64	7.6	55	75
	1.75 (0.069)	6.0	43	59	7.1	51	70
14 (0.55)	1.5 (0.059)	10.4	75	102	12.2	88	120
	2.0 (0.079)	9.8	71	96	11.5	83	113
16 (0.63)	1.5 (0.059)	15.8	114	155	18.6	135	182
	2.0 (0.079)	15.0	108	147	17.6	127	173
18 (0.71)	1.5 (0.059)	22.9	166	225	26.9	195	264
	2.5 (0.098)	20.7	150	203	24.4	176	239

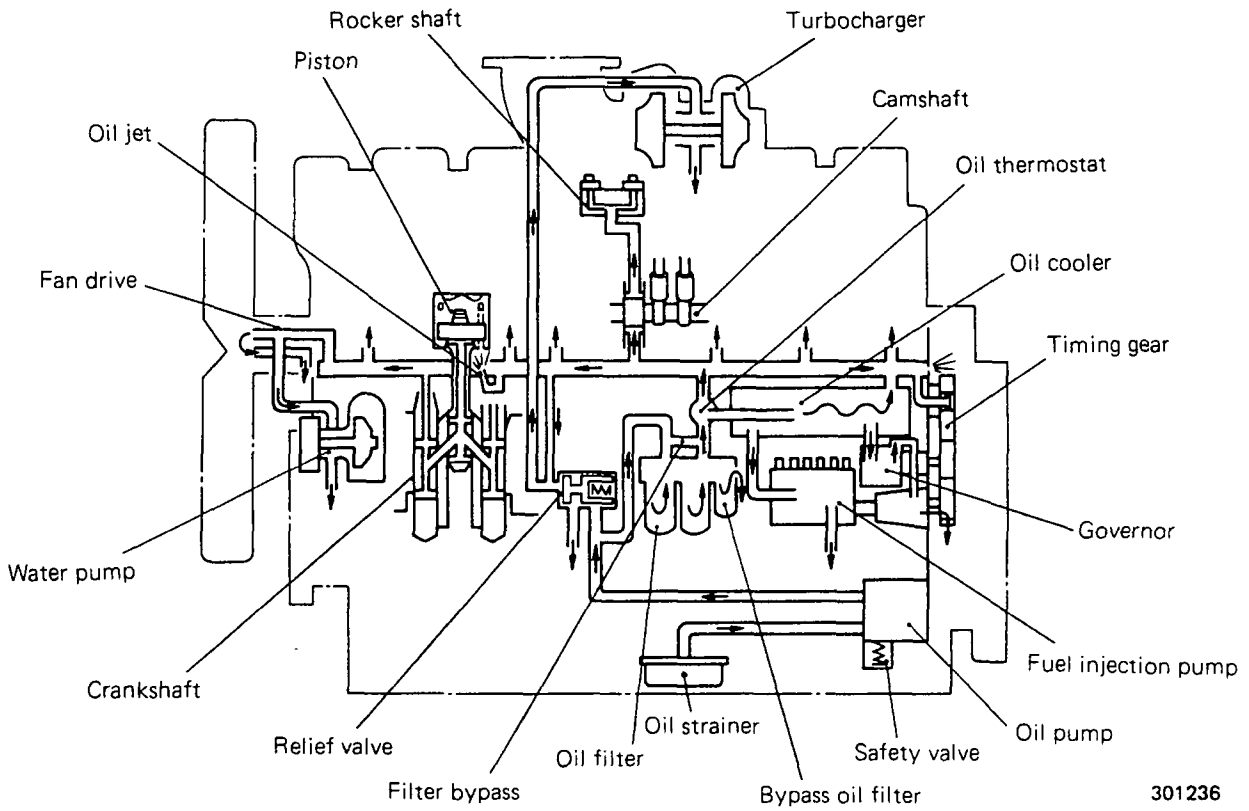
CIRCUIT DIAGRAMS

FUEL SYSTEM



301235

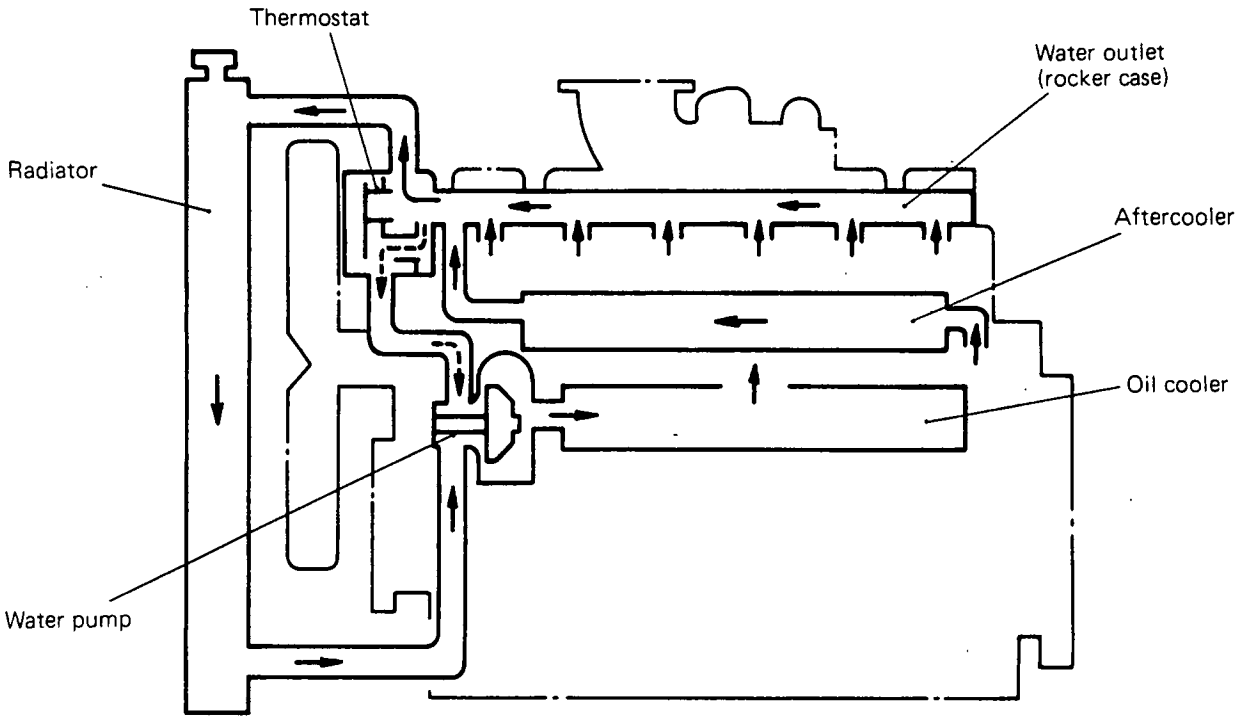
LUBRICATION SYSTEM



301236

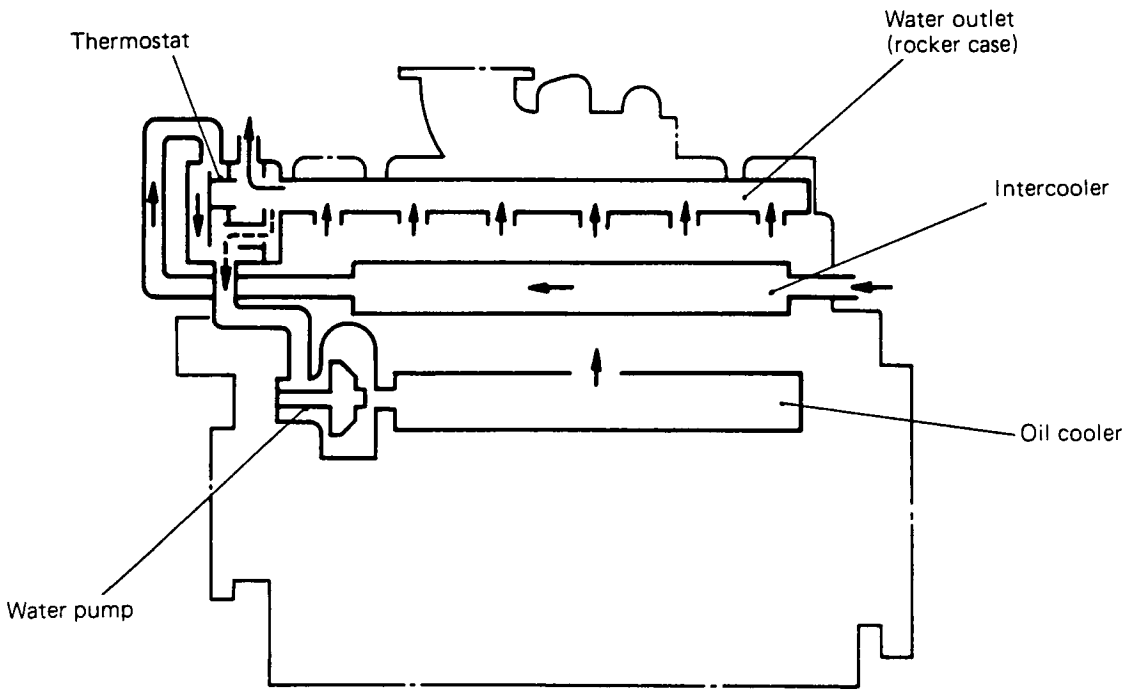
COOLING SYSTEM

With radiator (PTA)



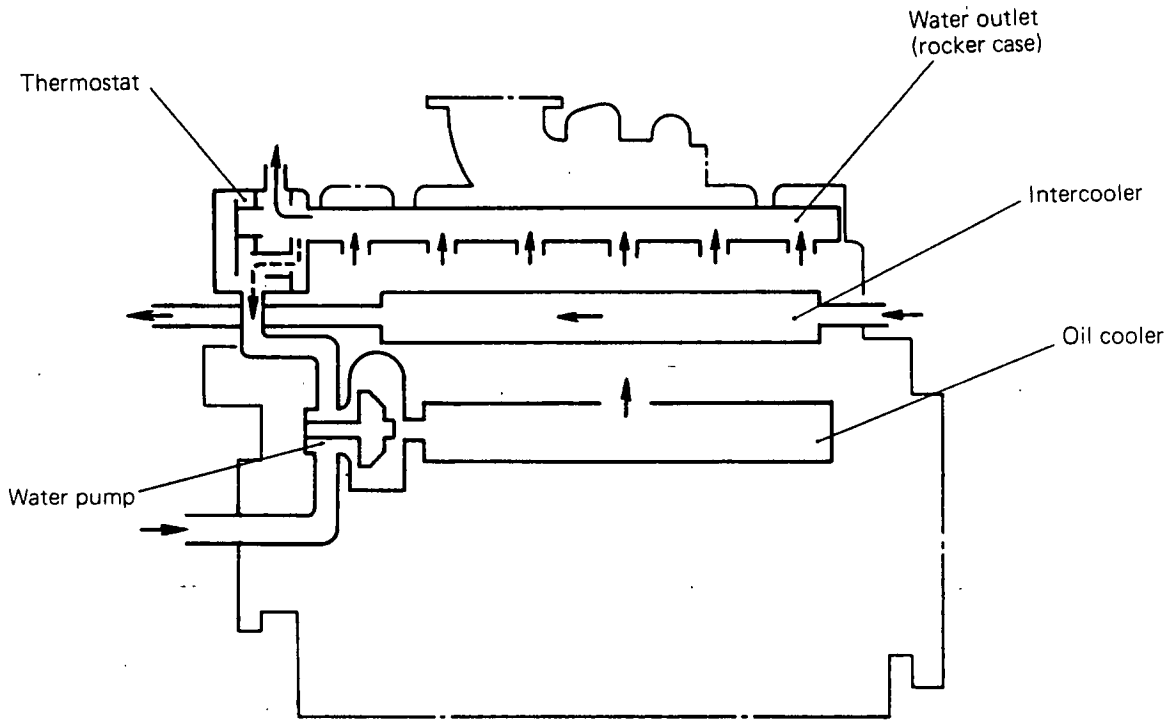
301237

Single cooling system (fresh water series piping) (PTK)



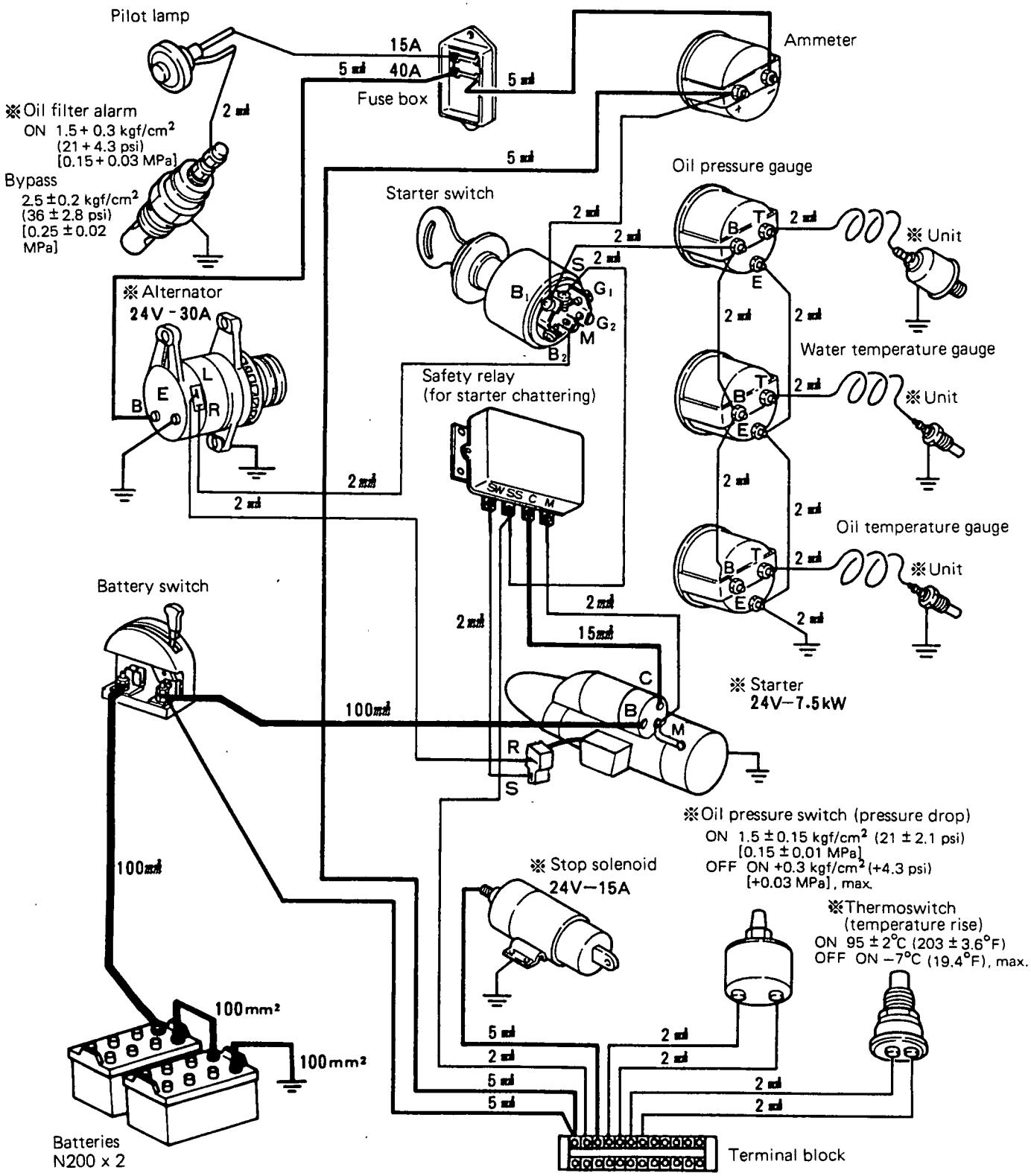
301238

Dual cooling system (parallel piping) (PTK)



301243

ELECTRICAL SYSTEM



301239

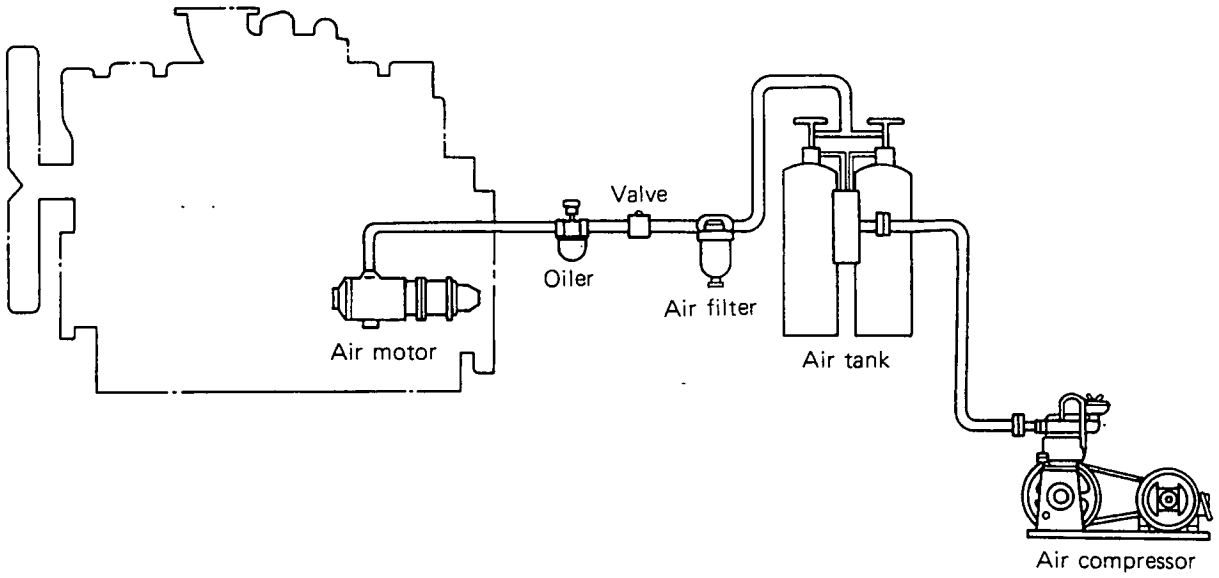
Remarks: 1. The circuit shown above is standard and varies from one specification or application to another.

2. The circuit and its components are to be prepared in field.

3. Asterisk (※) indicates the parts mounted on the engine. Parts having no asterisk are to be prepared as a single item.

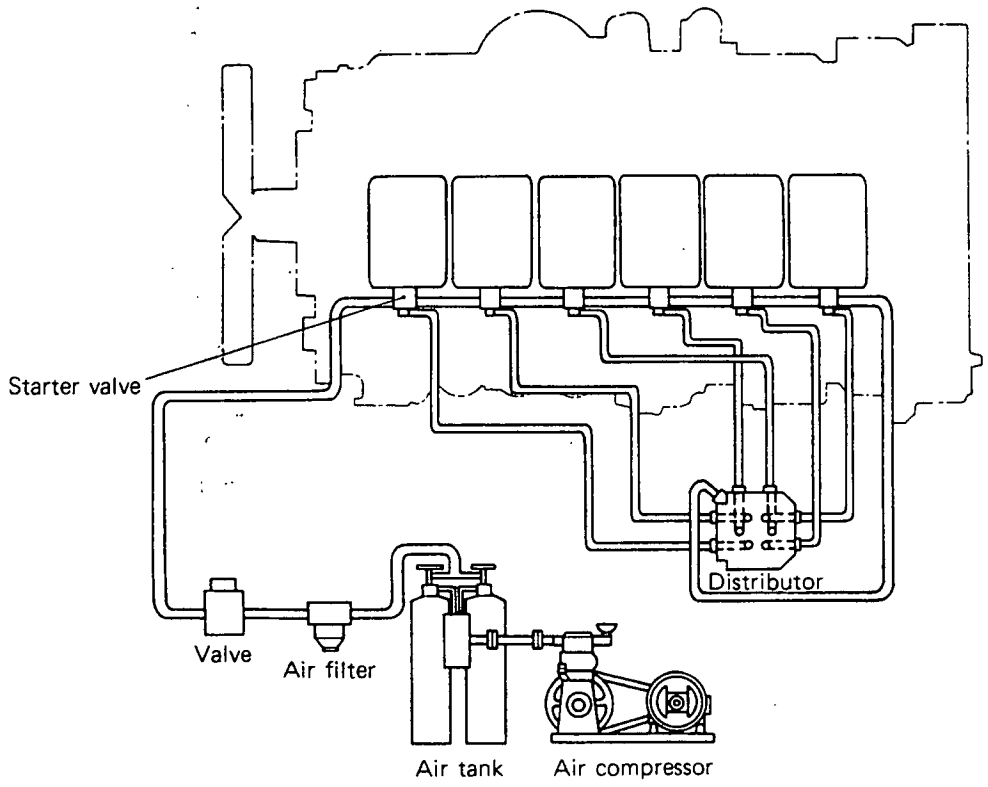
AIR-STARTING SYSTEM

Air-motor starting



301240

Direct-air starting



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