5. INSPECTION AND MAINTENANCE

This section contains a description of simple maintenance procedures that can be performed by you. For information on detailed inspection, replacement of parts, and adjustments that you cannot perform yourself, please contact your dealer.

⚠ CAUTION

- **Failing to perform regular maintenance can result in serious accidents, or engine trouble. In addition, damages resulting from a lack of maintenance may not be covered by warranty.**
- **Be sure to perform regular inspections even when the engine is not being used for an extended period of time.**

ADVICE

- In the event that operation hours and length of service time are mentioned together as the interval for inspection and maintenance, follow whichever comes first.
- Items in this section are based on the standard specifications of HINO industrial engines. Depending on the machine model, they may be different for your engine. Please refer to the "OPERATION MANUAL" of your machine.

PRECAUTIONS OF SAFETY

① Perform the inspection and the maintenance work in a safe place.
② Be sure to stop the engine and remove the starter key.
③ Use appropriate tools, machines and measuring devices for the inspection and the maintenance work.
④ Use appropriate clothing during the inspection and the maintenance work.

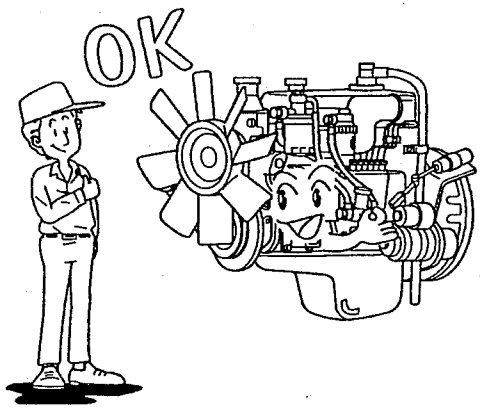
⚠ CAUTION

- **Engine parts such as the radiator and the exhaust system are very hot just after the engine has been stopped. Be sure to let the engine cool down before you start work, or you may burn yourself.**
- **When replacing the various types of oil, oil filters and the coolant, be sure to wait until they have cooled down sufficiently. They are very hot just after the engine has been stopped and you may burn yourself.**
- **When disposing the oil, coolant and parts that have been replaced, be sure to do so in an environmentally safe manner.**
- **Be sure not to come into contact with the revolving parts of the engine while it is running. Your body parts or pieces of clothing may get caught, resulting in unexpected injury or accidents.**

ADVICE

Do not step on pipes and auxiliary devices. Doing so may cause damage and failures.

⑤ After the inspection and the maintenance, perform a test run of the engine to make sure that all parts are functioning properly.



F-642

⚠ CAUTION

- **The injection pump is an essential part that affects engine performance and function. It is adjusted to optimum condition and sealed at the factory. An improper adjustment will not only adversely affect engine performance but also will generate black smoke, thus harming the social environment. Therefore, never touch the seal.**
  If you break the seal or do the maintenance improperly, your warranty will be voided.
- **After finishing the work, be careful not to leave rag, paper and any tool in the engine compartment. Especially, flammable materials can cause fire.**

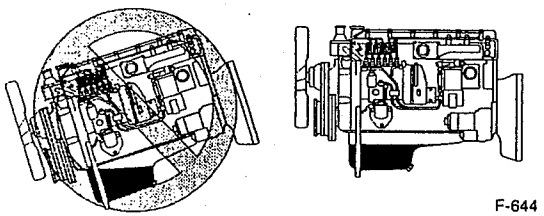
F-643

DAILY (BEFORE STARTING THE ENGINE) INSPECTION

Daily (before starting the engine) inspection is the inspection performed by the operator once a day before the engine is started.

ENGINE OIL LEVEL

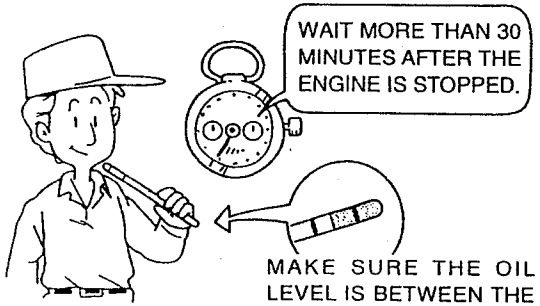
* When checking the oil level or replenishing the oil, make sure the engine is on the level ground.



F-644

MAKE SURE THE ENGINE IS ON THE LEVEL GROUND.

① Pull out the oil level gauge and wipe off the oil sticking to the gauge by using a rag.
② Reinsert the gauge fully and pull it out again.



MAKE SURE THE OIL LEVEL IS BETWEEN THE UPPER AND THE LOWER MARKS. F-555

- If the oil level is within the slotted zone, it is normal.
  If the oil is insufficient, replenish the oil.

* For details of replenishment the oil, refer to "ENGINE OIL" on page 6-2.

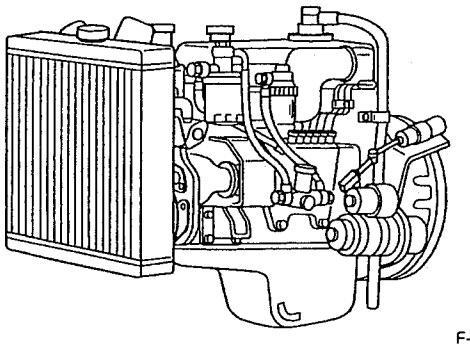
⚠ WARNING

- **When replenishing the oil, be sure not to spill any oil. If the oil sticks to the exhaust pipe, it may catch fire because of a high temperature. Be careful when replenishing.**
- **Be careful not to burn yourself when inspecting the vehicle immediately after driving, since the engine is extremely hot.**

ADVICE

- Do not add oil above the upper mark on the oil level gauge. Operating the engine with more than the specified amount of oil can cause an engine malfunction.
- Always check the oil level before starting the engine. Make sure that the engine is on level ground. You cannot check the exact oil level with the engine is running or if the engine is inclined.
- If the engine has been running, stop the engine and wait at least 30 minutes before checking the oil level.

COOLANT LEVEL AND LEAKAGE FROM THE COOLING SYSTEM



F-645

- Check to see that the levels of coolant in the radiator and the reserve tank ★ are sufficient.
- Check the radiator and its hoses for leakage of coolant. Also, check to see if there is any trace of coolant leakage under the engine.

* If the coolant level is excessively low, there is the danger of coolant leakage from the cooling system. Contact your dealer.
* For details of replenishment the coolant, refer to "INSPECTION OF THE COOLING SYSTEM" on page 5-18 and "RADIATOR CAP OPERATION" on page 5-22.

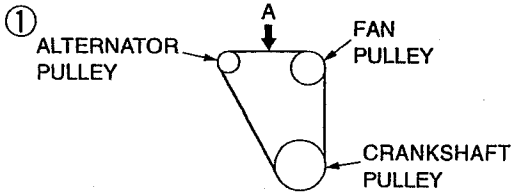
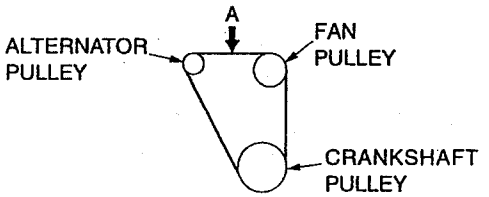
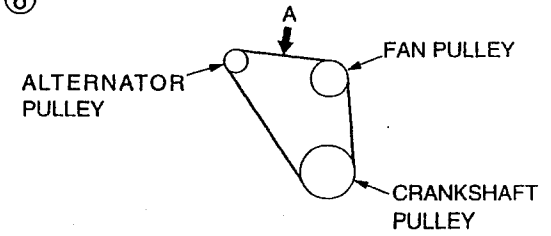
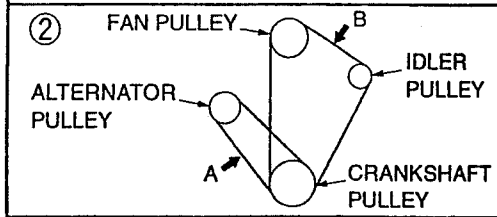
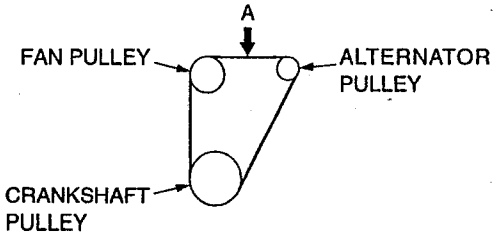
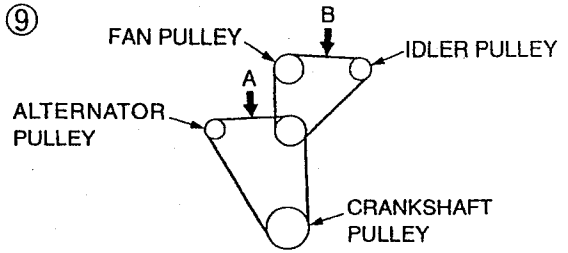
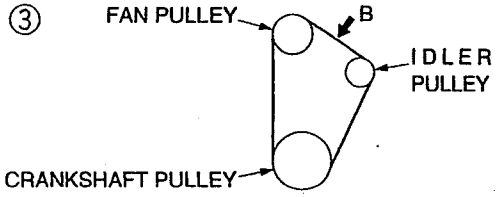
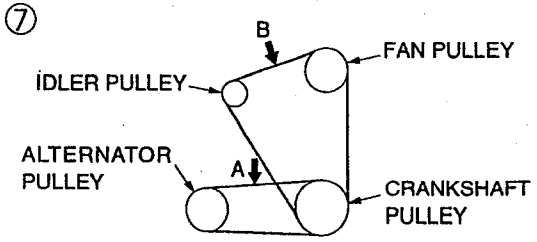
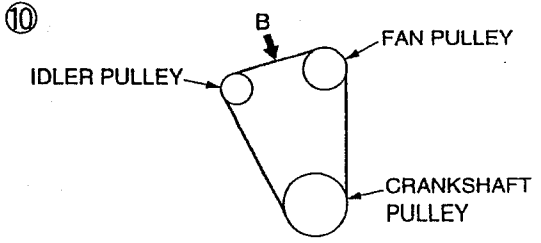
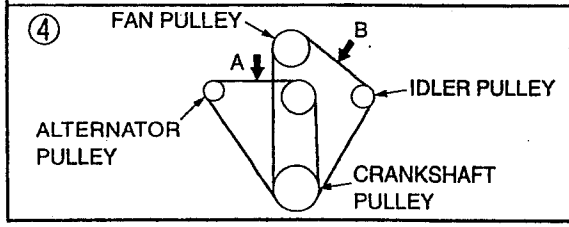
ADVICE

Check the coolant level and add the coolant while the engine is cold.

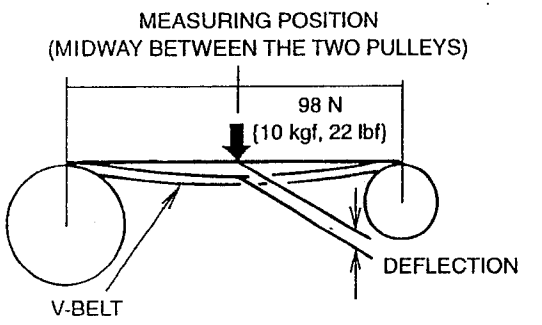
TENSION AND DAMAGE OF THE V-BELTS

■ MEASURING POSITIONS OF THE ALTERNATOR BELT AND THE FAN BELT

- Measure belt tension at points A and B.

ENGINE MODELS W04C-T, W04D, W04D-T, W06D, W06D-T AND W06E	ENGINE MODELS H06C-T, H06C-TI, H07C-T AND H07D	
① 	⑤ 	⑧ 
② 	⑥ 	⑨ 
③ 	⑦ 	⑩ 
④ 		

▶ How to measure the deflection



- Check the V-belts for proper tension by applying a pressure of 98 N {10 kgf, 22 lbf} with your finger or a special tool, compression gauge midway between the two pulleys and measure the belt deflection. The amount of deflection is an indication of the amount of belt tension.
- If the tension is out of the standard value, adjust the tension.

* For details on the adjustment of the V-belt, refer to "ADJUSTMENT OF THE V-BELT TENSION" on page 5-15.

■ STANDARD TENSION FOR THE V-BELTS

Unit: mm {in}

ENGINE MODEL	NO.	STANDARD DEFLECTION	
		MEASURING POSITION (A)	MEASURING POSITION (B)
W04C-T W04D W04D-T W06D W06D-T W06E	①	10 – 15 {0.40 – 0.59}	–
	②	12 – 17 {0.48 – 0.66}	4 – 7 {0.16 – 0.27}
	③	–	
	④	10 – 15 {0.40 – 0.59}	10 – 15 {0.40 – 0.59}
H06C-T H06C-TI H07C-T H07D	⑤	10 – 15 {0.40 – 0.59}	–
	⑥		
	⑦		6 – 10 {0.24 – 0.39}
	⑧	12 – 17 {0.48 – 0.66}	–
	⑨	10 – 15 {0.40 – 0.59}	6 – 10 {0.24 – 0.39}
	⑩	–	

- Also, check the V-belts for damage. Replace them with new belts if damaged.

ADVICE

The items mentioned here based on the standard specifications of HINO engines for industrial use. Depending on the machine model, they may not be the same for your engine. Please refer to the "OPERATION MANUAL" of your machine.

FUEL LEVEL

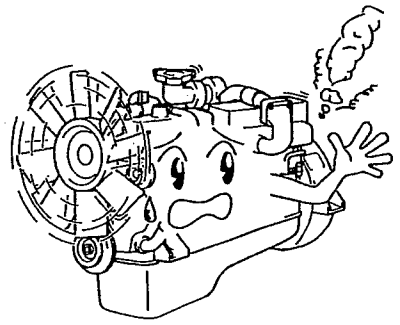
Check to see if there is sufficient fuel in the tank. Also, make sure that there is no leakage of fuel.

⚠ WARNING

It is dangerous since fuel leakage (including at the pipe and hose connections) can cause a fire. If fuel is leaking, replace the packings at each connection point or retighten them.

THE COLOR OF THE EXHAUST GAS

After warming up the engine sufficiently, check the color of the exhaust gas.



F-557

Colorless or light blue ..... Normal
Black..... Abnormal, incomplete combustion
White..... Abnormal, oil combustion due to oil loss via the piston ring or the valve guides

* Due to the cold weather in winter the smoke may appear white. Be careful not to get confused.

⚠ WARNING

Do not operate the engine in a poorly ventilated area. It is dangerous because the exhaust gas can cause carbon monoxide poisoning.

IRREGULARITIES FOUND DURING PREVIOUS OPERATION

Check to see that irregularities found the previous day or the last time the engine was operated do not pose a hazard. If you find anything abnormal that you cannot repair yourself, contact your dealer for inspection and repairs.

INSPECTION OF EACH PARTS

ENGINE OIL FILTER

Different types of oil filters (center bolt type, spin-on type, full-flow by-pass spin-on type, inverted spin-on type) are used for the various types of machine, depending on what the engine is used for. This section describes the typical oil filters used in HINO industrial engines.

■ OIL FILTER ELEMENT REPLACEMENT INTERVAL

REPLACEMENT INTERVAL
Every 250 hours of operation

ADVICE

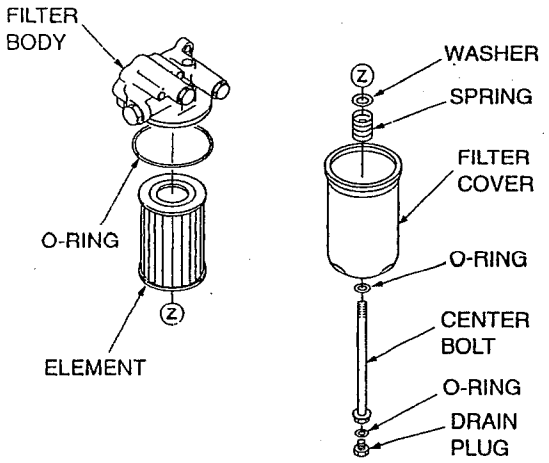
Replacement intervals for the element is different depending on the type of machine. Please refer to the "OPERATION MANUAL" of your machine.

- Replace the oil filter element simultaneously with the engine oil change.
  Also, if the oil filter warning lamp lights, be sure to replace the element regardless of the specified interval.

* In case of engines equipped with a turbocharger, be sure to use high quality engine oil to ensure the turbocharger performance quality.

■ REPLACEMENT PROCEDURE

▶ Center bolt type



F-558

* As dirt may get into the oil filter, be sure to remove all dirt and dust from around the filter before starting work.

⚠ CAUTION

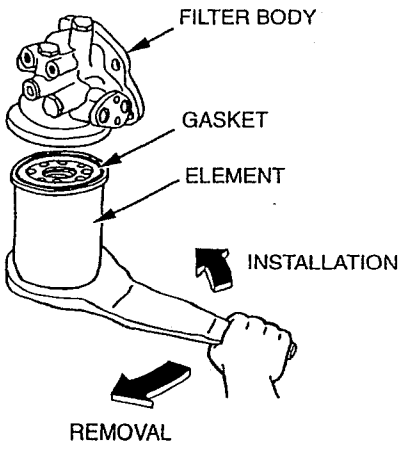
Just after driving, the engine oil is still hot and can burn you. Wait a few minutes to let the oil cool down before changing or checking it.

① Place a container for the oil to be drained under the oil filter and then drain the oil by loosening the drain plug at the lower part of the oil filter.
② Loosen the center bolts by approximately one turn to facilitate the draining of oil.
* To ensure safety and to prevent the ground form getting dirty, make sure all of the drained oil is drained into a container.
③ After draining, tighten the drain plugs securely.
④ After removing the center bolts, remove the elements together with the filter covers.
* Be careful not to lose the springs, the washer and the seat.
⑤ Wash all parts, except the elements and the O-rings, in detergent oil.
⑥ Install new elements in the filter covers, in reverse order of disassembling.
* Elements cannot be washed and reused.
* Install new O-rings included in the element kit.
* When installing, make sure not to damage the O-rings by twisting. Also, pay attention not to install the element and the seat in reverse order.
⑦ After replacing the elements, run the engine and let the elements be fully soaked with oil, then check the engine oil level.

⚠ CAUTION

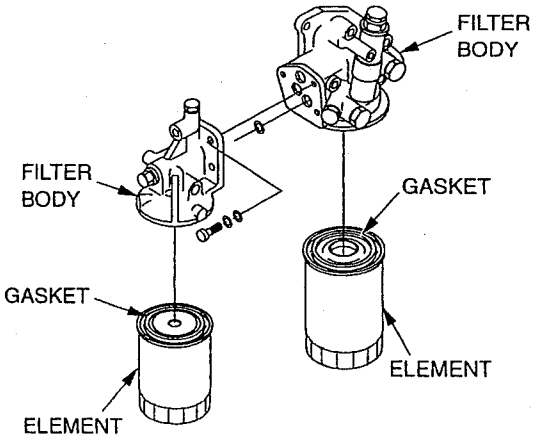
After replacement of the oil filter, operate the engine for trial to check to see if there is any oil leakage around the oil filter. Oil leakage can cause a fire.

▶ Spin-on type



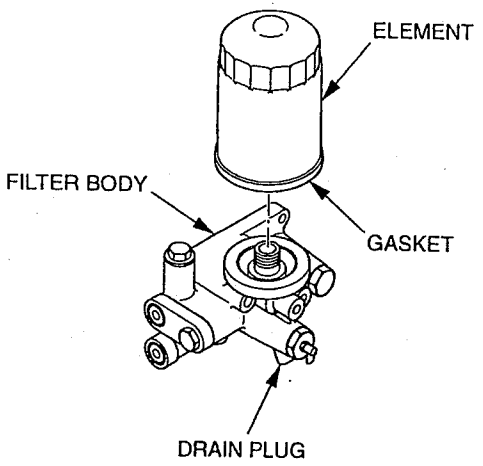
D12-11-02ZA

▶ Spin-on type (full-flow by-pass type)



F-560

▶ **Spin-on type (inverted type)**



F-646

* As dirt may get into the oil filter, be sure to remove all dirt and dust from around the filter before starting work.

⚠ CAUTION

Just after driving, the engine oil is still hot and can burn you. Wait a few minutes to let the oil cool down before changing or checking it.

① Remove the elements by turning it to the left using the fuel filter wrench, the special tool. If the oil filter is inverted type, place a container for the oil to be drained under the drain plug and then drain the oil by loosening the drain plug at the lower part of the filter body.

* To ensure safety and to prevent the ground form getting dirty, make sure all of the drained oil is drained into a container.

② Remove any dirt and mud that may be sticking on the sealing face (contact face of the element gasket) of the oil filter main body.

③ Apply oil to the gaskets of the new oil filter element and install it by turning it lightly by hand to the right until it comes in contact with the sealing face of the main body.

* Be sure to use the new gasket contained in the element kit.
* When installing, make sure not to damage the gasket by twisting.
* Do not reuse the old element.

④ From this state, tighten the filter element by approximately 3/4 to 1 turn using the oil filter wrench.

⑤ After replacing the element, run the engine and let the element be fully soaked with oil, then check the engine oil level.

⚠ CAUTION

After replacement of the oil filter, operate the engine for trial to check to see if there is any oil leakage around the oil filter. Oil leakage can cause a fire.

FUEL FILTER

There is two types of fuel filter, center bolt type and spin-on type.

■ REPLACEMENT OF FUEL FILTER

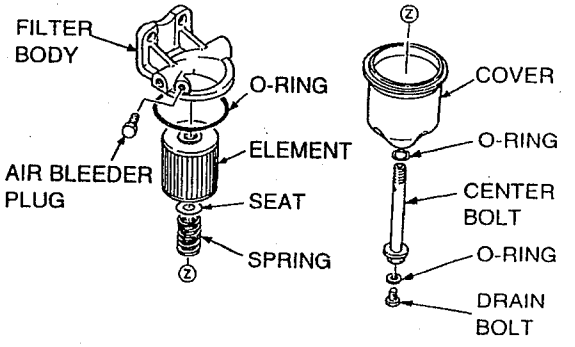
REPLACEMENT INTERVAL
Every 500 hours of operation

ADVICE

- Replacement intervals for the element is different depending on the type of machine. Please, refer to the "OPERATION MANUAL" of your machine.
- If you have been using substitute fuel, shorten the interval between periodic inspection and cleaning.

■ REPLACEMENT PROCEDURE

▶ **Center bolt type**



F-063

* As dirt may get into the filter, be sure to remove all dirt and dust from around the filter before starting work.

① Loosen the drain plug, then loosen the air bleeder plug and drain the fuel from the drain hose.

⚠ WARNING

- **Be sure to drain the fuel into a container and dispose of it properly. Be careful not to spill any of the fuel.**
- **If fuel is spilled on engine parts, wipe it off entirely. It is dangerous since it can cause a fire.**

② After having confirmed that no more fuel is coming out from the drain hose, loosen the center bolt, remove the cover, and take out the element.

③ Install a new element, in reverse order of disassembling.

* Be sure to replace all of the old O-rings with new ones included in the element kit.

④ After installing the filter, bleed the air from the fuel system.

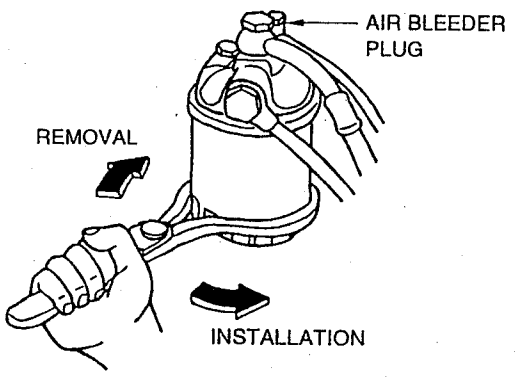
⚠ CAUTION

After replacement of the element, operate the engine for trial to check to see if there is any fuel leakage around the fuel filter. Fuel leakage can cause a fire.

* For details of air bleeding the fuel system, refer to "AIR BLEEDING OF THE FUEL SYSTEM" on page 5-12.

M2-388

▶ Spin-on type



D12-12-01ZA

* As dirt may get into the filter, be sure to remove all dirt and dust from around the filter before starting work.

① After loosening the air bleeder plug, remove the element by turning it to the left using the fuel filter wrench of the special tool.

⚠ WARNING

- **Be sure to drain the fuel into a container and dispose of it properly. Be careful not to spill any of the fuel.**
- **If fuel is spilled on engine parts, wipe it off entirely. It is dangerous since it can cause a fire.**

② Remove any dirt such as dust, mud, etc. on the sealing surface (contacting surface of the element gasket) of the fuel filter main body.

③ Apply the fuel thinly to the gasket of the new element.

④ Install the element by turning it lightly to the right by hand until the gasket comes in contact with the sealing surface of the main body.

* It will cause looseness of the element that you stop turning it before the gasket contacts the sealing surface.
* It will cause damage to the element that you turn it after the gasket contacts the sealing surface.

⑤ From this state, turn the element further by 7/10 turn using the fuel filter wrench.

⚠ WARNING

Use the designated special tool and fuel filter wrench to tighten the fuel filter. Use of a ordinary tool (for example, chain-type tool) can scratch or dent the peripheral surface of the fuel filter. If the fuel filter is damaged, it can cause fuel to leak, thus resulting in a fire or other serious accidents.

* Use the scale for checking the turning angle on the element surface to tighten it by 7/10 turn.
* When installing the element, be careful not to damage it by twisting the gasket.
* Use a new gasket contained in the element kit.
* Do not reuse the element.

⑥ After installing the element, bleed air from the fuel system.

⚠ WARNING

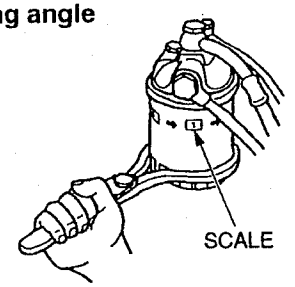
After replacing the filter, inspect the external surface of the fuel filter for checking scratches and dents. It is dangerous to use a scratched or dented fuel filter, since it can cause fuel to leak and lead to a fire or other serious accidents.

⚠ CAUTION

After replacement of the element, operate the engine for trial to check to see if there is any fuel leakage around the fuel filter. Fuel leakage can cause a fire.

* For details of air bleeding the fuel system, refer to "AIR BLEEDING OF THE FUEL SYSTEM" on page 5-11.

● **How to use the scale for checking the turning angle**



D12-12-06ZA

① After step ④ of the fuel filter replacement procedure, select a graduation (number from 1 to 10) at an easy-to-see position.

* The selected number will move with the fuel filter element.

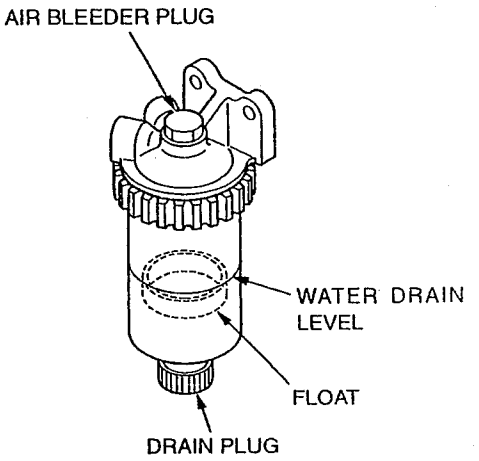
② Select a location on the main body or other non-movable section near the selected number, and mark it with a marker or memorize that location. The location is the starting point of turning.

③ Tighten the element until the seventh graduation from the selected number reaches the location marked or memorized in step ②.

* Each graduation on the scale represents every 36 degrees. When the element is turned four graduations from a reference point, the turning angle is 252 degrees (7/10 turn).
* Figures are indicated in the following order: 1 → 2 → 3 → 4 → 5 → 6 → 7 → 8 → 9 → 10 → 1 ...
* For example, when "1" is selected, turn the element until "8" reaches the starting mark. When "5" is selected, turn until "2" reaches the mark.

WATER SEPARATOR

In addition to the fuel filter, some engine models are also equipped with an optional water separator.



F-561

■ TIMING FOR DRAINING WATER FROM THE WATER SEPARATOR

- Drain the water whenever you notice during daily inspection that the float has reached the water drain level indicating the need for water to be drained.

① Loosen the drain plug and air bleeder plug, and drain the sediment and water content.

⚠ WARNING

- **Be sure to drain the fuel into a container and dispose of it properly. Be careful not to spill any of the fuel.**
- **If fuel is spilled on engine parts, wipe it off entirely. It is dangerous since it can cause a fire.**

② Tighten the plug when the float reaches the bottom.

* As air will enter the fuel system when sediment and water content are being drained, be sure to carry out air bleeding of the system.

* For details of air bleeding of the fuel system, refer to "AIR BLEEDING OF THE FUEL SYSTEM" on page 5-11.

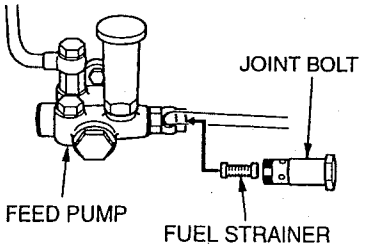
③ Check to see that there is no fuel leakage.

M2-390

FUEL STRAINER

■ WASHING OF STRAINER

WASHING INTERVAL
Every 120 hours of operation



F-523

- Remove the fuel strainer by removing the joint bolt on the fuel pipe of the feed pump and wash the strainer with diesel fuel.

* Be sure to replace the gasket with a new one. After assembling fuel strainer, bleed the air from the fuel system.

⚠ WARNING

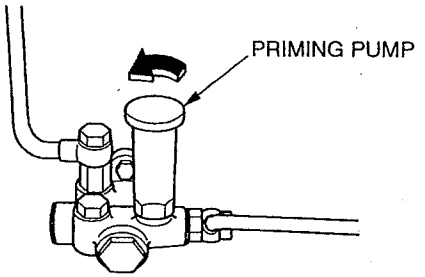
- **After reinstalling the strainer, run the engine and make sure that no fuel leaks from the joint bolt. It is dangerous since fuel leakage can cause a fire.**
- **Be sure to drain the fuel into a container and dispose of it properly. Be careful not to spill any of the fuel.**
- **If fuel is spilled on engine parts, wipe it off entirely. It is dangerous since it can cause a fire.**

AIR BLEEDING OF THE FUEL SYSTEM

After replacing the fuel filter or if you have run out of fuel, air might have entered the fuel system and a simple supply of fuel cannot start the engine. Bleed the air according to the following procedure:

■ AIR BLEEDING PROCEDURE

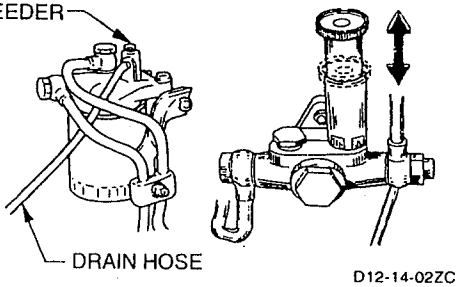
① Turn the priming pump of the feed pump counterclockwise until it pops up.



F-522

② After loosening the air bleeder plug of the fuel filter, pump the priming pump up and down to feed the fuel.

(EXAMPLE)



D12-14-02ZC

③When the fuel coming out of the drain hose is free of bubbles, tighten the air bleeder plug.
④Pump the priming pump 5 to 6 times, then press it down. While making sure it goes in smoothly, turn it clockwise and tighten it securely.

ADVICE

Do not tighten the priming pump piston forcibly when housing it, or it may be damaged.

⑤After the air bleeding is completed, wipe off any leaked fuel. Run the engine and check for fuel leakage.
* If the injection pump shows any sign of trouble, always have it inspected and adjusted at your dealer.

⚠ WARNING

- **Be sure to drain the fuel into a container and dispose of it properly. Be careful not to spill any of the fuel.**
- **It is dangerous since fuel leakage (including at the pipe and hose connections) can cause a fire. If fuel is leaking, replace the packings at each connecting point or retighten them.**
- **If fuel is spilled on engine parts, wipe it off entirely. It is dangerous since it can cause a fire.**

■ INSPECTION OF FUEL PIPE AND HOSE

Fuel pipes and hoses are important for safety. Inspect them as follows.

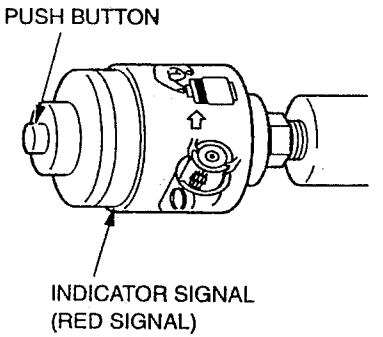
- Check connections and clips for looseness and tighten firmly if loosened.
- Check for scratches, rust, wear and hose deterioration. Replace if necessary.

⚠ WARNING

It is dangerous since fuel leakage (including at the pipe and hose connections) can cause a fire. If fuel is leaking, replace the packings at each connection point or retighten them.

AIR CLEANER

■ DUST INDICATOR



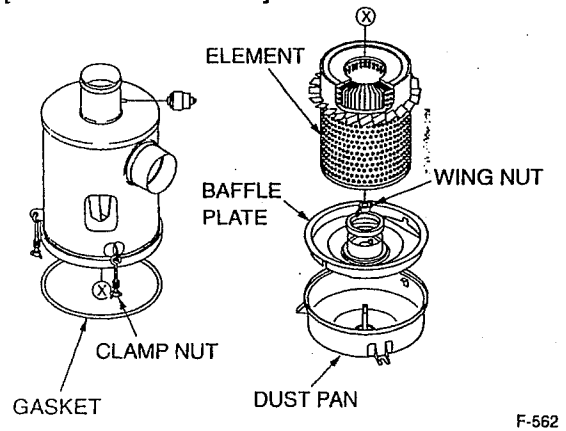
D12-19-06ZC

- The air cleaner is equipped with a dust indicator which indicates that the air cleaner element is clogged.
- If the indicator signal is "YELLOW", it is normal.
- If the indicator signal is "RED", clean or replace the element regardless of the specified interval.
- After cleaning or replacing the element, press the push button and cancel the red signal.

■ AIR CLEANER

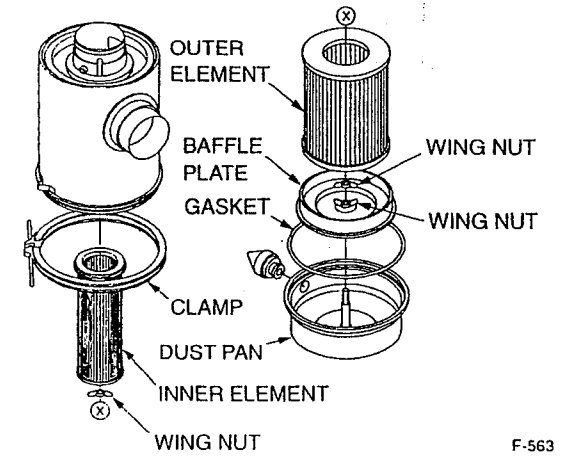
The type of the air cleaner is different depending on the type of the machine. Typical air cleaners are described here.

[SINGLE ELEMENT TYPE]



F-562

[DUAL ELEMENT TYPE]



F-563

■ CLEANING AND REPLACEMENT OF AIR CLEANER ELEMENT

▶ Cleaning of the case

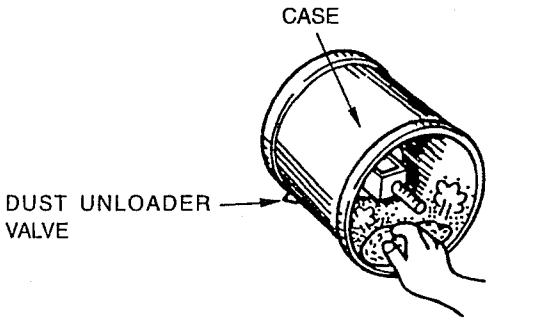
CLEANING INTERVAL
Every 250 hours or when the indicator signal is red.

(In case of a dual element type, inspect and clean only the outer element)

ADVICE

If the engine is operated where there is severe dust, increase the frequency of inspection and cleaning.

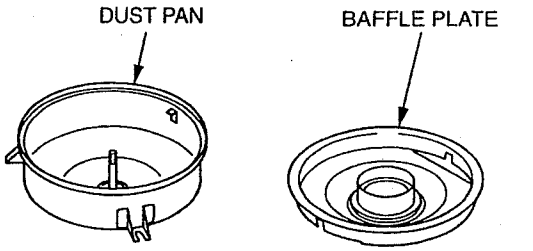
① After removing the clamp nut, remove the dust pan.
② Remove the wing nuts securing the case and the element, and then remove the element.
③ Clean the dust sticking to the inside of the case with a cloth.



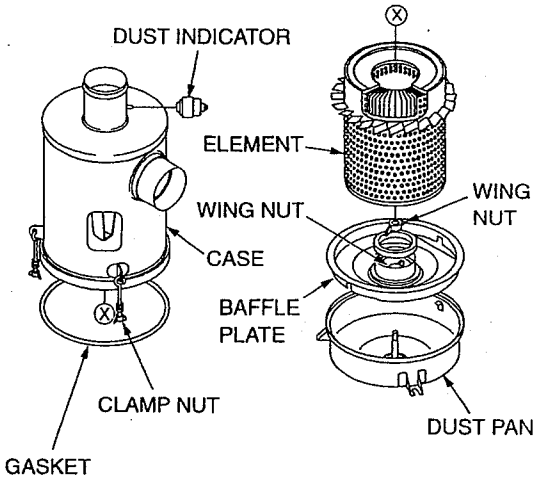
D12-19-03ZA

● Cleaning the dust pan

- Loosen the wing nut in the center of the dust pan and remove the baffle plate. Remove the dust accumulated in the dust pan.



F-564



F-597

* Be sure not to drop the gasket when cleaning.

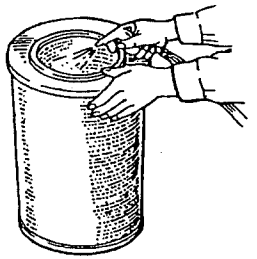
④ Install the element in reverse order of the disassembly.

* Be sure to tighten the clamp nut securely.

ADVICE

Incomplete tightening of the clamp nut may cause defect of the element packing surface, introduction of dust into the engine and cause premature wear of pistons and liners.

▶ Cleaning the element (dry dirt or dust)



D12-19-07ZA

- To clean away dry dirt or dust, use a compressed air gun (air pressure: lower than 690 kPa {7.0 kgf/cm², 99.56 lbf/in²}). Always blow off from the inside of the element to outside.

* Never try to remove dirt or dust by striking or banging.

⚠ CAUTION

When handling compressed air be sure to protect your eyes by using safety glasses or goggles.

ADVICE

Excessively high compressed air usage or deformation of the element caused by hitting the element will result in engine troubles.

▶ Element washing (soot, oil, etc.)

D12-19-08ZA

- Washing the element which is dirty with soot and oil :
  Wash the element by soaking it in a non-sudsing detergent solution for about 30 minutes. Rinse it with clean water and air dry the element completely.
  Do not apply fire or compressed air.

⚠ WARNING

Never use kerosene, gasoline or other solvents to clean elements. Use of them can cause overrunning of the engine resulting in engine damage.

ADVICE

- Check to see that the inside of the element is not soiled with dust etc.
- When drying in an oven, drying should be done at below 80°C {176°F}.
- Never reinstall the element until it is completely dry.
- Make sure that the dried element is not broken and that the packing is not broken nor deformed.

▶ Replacement of element

REPLACEMENT INTERVAL
Every 1,000 hours of operation

- In case of a dual element type, replace the inner and outer elements simultaneously.

* Although the outer element of the dual element type cleaner can be cleaned and reused, the inner element cannot be reused.

ADJUSTMENT OF THE V-BELT TENSION

- There are different types of V-belts used for the machines, depending on what the engine is used for. Typical V-belt types are described here.
- Looseness or excessive tension of the V-belts can cause an improper charging or an alternator or water pump failure. Always adjust the tension of the V-belts to ensure correct tension.

■ V-BELT TENSION ADJUSTMENT INTERVAL

M2-394

TENSION ADJUSTMENT INTERVAL
Every 120 hours of operation

⚠ WARNING

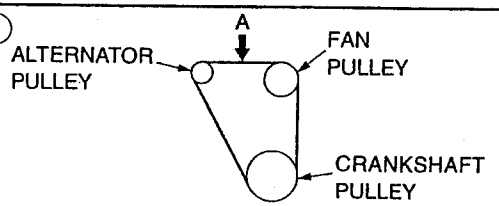
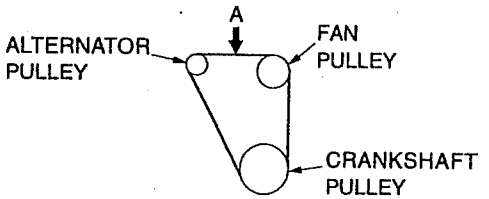
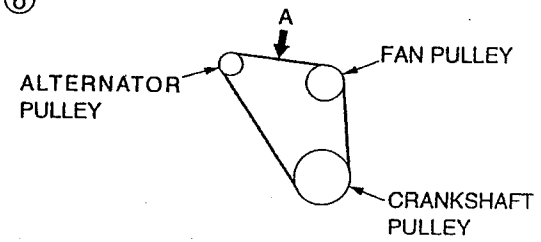
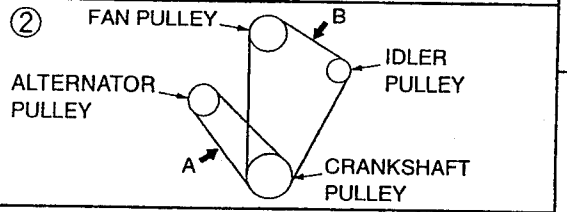
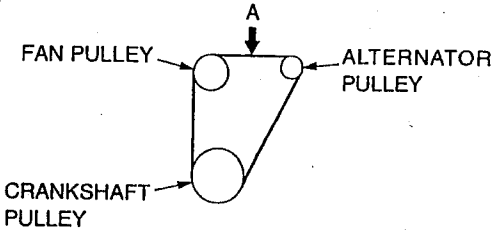
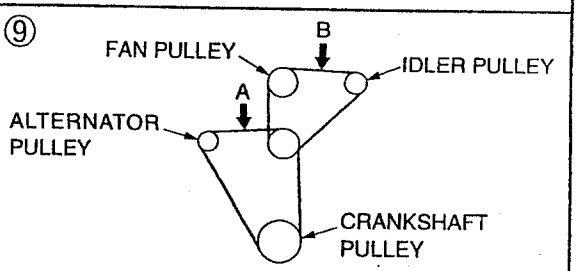
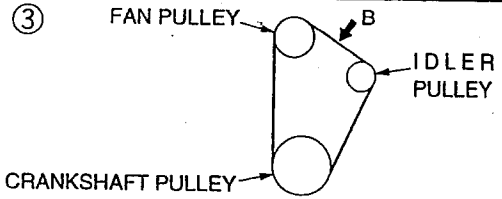
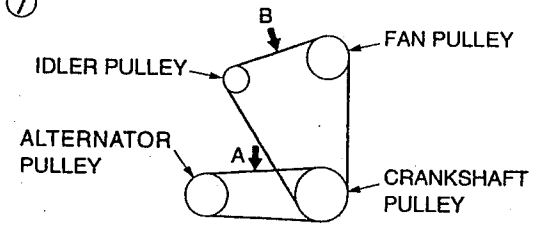
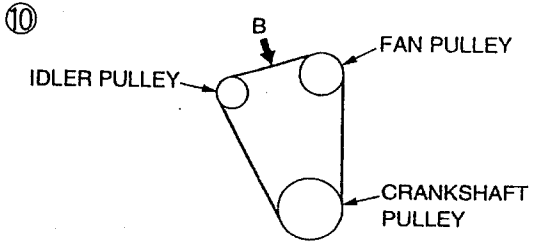
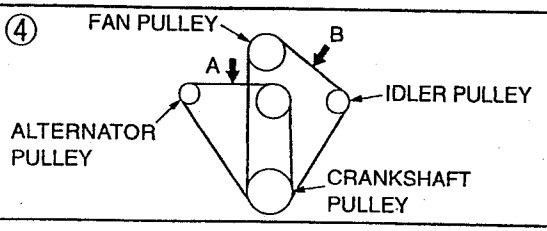
- **After completing the adjustment, make sure that all bolts and nuts are securely tightened.**
- **Over-tension can result in damage to the belts and bearings.**
- **Do not allow oil and grease, etc., to get on the V-belts since this can cause slipping.**

ADVICE

- When replaced with a new belt, initially the fitness of the belt has not been established.
  Run the engine at idling speed for about three to five minutes. After that, adjust the belt tension again.
- Items described here are based on the standard specifications of HINO engines for industrial use. Depending on the machine model, they may be different from your engine. Please refer to the "OPERATION MANUAL" of your machine.
- When replacing a two piece V-belt set, be sure to replace both with new ones simultaneously.

■ MEASURING POSITIONS OF THE ALTERNATOR BELT AND THE FAN BELT

- Measure belt tension at points A and B

ENGINE MODELS W04C-T, W04D, W04D-T, W06D, W06D-T AND W06E	ENGINE MODELS H06C-T, H06C-TI, H07C-T AND H07D	
① 	⑤ 	⑧ 
② 	⑥ 	⑨ 
③ 	⑦ 	⑩ 
④ 		

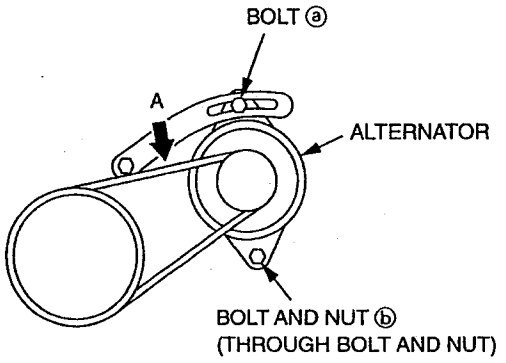
■ STANDARD DEFLECTION FOR THE V-BELTS

Unit: mm {in}

ENGINE MODEL	NO.	STANDARD DEFLECTION	
		MEASURING POSITION (A)	MEASURING POSITION (B)
W04C-T W04D W04D-T W06D W06D-T W06E	①	10 – 15 {0.40 – 0.59}	–
	②	12 – 17 {0.48 – 0.66}	4 – 7 {0.16 – 0.27}
	③	–	
	④	10 – 15 {0.40 – 0.59}	10 – 15 {0.40 – 0.59}
H06C-T H06C-TI H07C-T H07D	⑤	10 – 15 {0.40 – 0.59}	–
	⑥		
	⑦		6 – 10 {0.24 – 0.39}
	⑧	12 – 17 {0.48 – 0.66}	–
	⑨	10 – 15 {0.40 – 0.59}	6 – 10 {0.24 – 0.39}
	⑩	–	

■ ALTERNATOR BELT ADJUSTMENT PROCEDURE

- Measure the belt deflection at point A.



F-565

① Loosen the bolt ⓐ and the bolt and nut ⓑ.
② Measure the belt deflection of the point A (midway between the pulleys) by applying and holding a pressure of about 98 N {10 kgf, 22 lbf} to the point A with your finger, or by using a compression gauge of the special tool. If the deflection is out of the standard, adjust it by moving the alternator so that the deflection comes to within the standard.

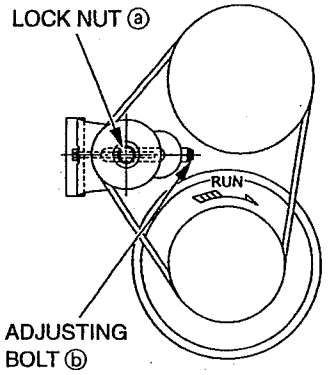
ADVICE

When moving the alternator, be careful not to damage the stator coil between the front and the rear parts and the through bolt.

③ After adjusting the tension, tighten the bolt ⓐ and then tighten the bolt and nut ⓑ securely.

■ FAN BELT ADJUSTMENT PROCEDURE

- Measure the belt deflection at point B.

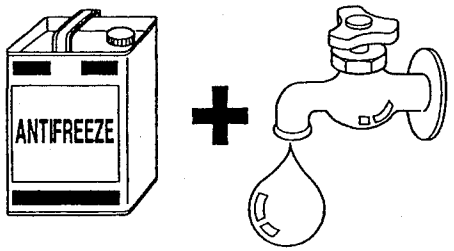


F-647

① Loosen the lock nut ⓐ.
② Turning the adjusting bolt ⓑ, adjust the belt deflection until it is within the standard.
③ After adjusting the deflection, tighten the lock nut ⓐ securely.

INSPECTION OF THE COOLING SYSTEM

■ THE COOLANT USED



F-570

- As the coolant, use a mixture of water and antifreeze.

ADVICE

Use tap water (soft water) when preparing the antifreeze mixture. Hard water will cause the formation of scale and rust.

▶ Antifreeze

- Use only ethylene glycol base antifreeze. **Do not use methanol base, methoxy-propanol base antifreeze, etc.**
- For a list of recommended brands, refer to "RECOMMENDED LUBRICANT LIST" on page 6-8.

■ PREPARATION OF COOLANT

ANTIFREEZE-WATER MIXING TABLE

Outside temperature °C {°F}	Antifreeze %
–12 {10.4}	30
–15 {5}	35
–20 {– 4}	40
–25 {–13}	45
–30 {–22}	50
–35 {–31}	55
–40 {–40}	60

- In winter, when the outside temperature is below 0°C {32°F} or in cold areas, the coolant may freeze and cause to damage the engine, the radiator, or the other parts. Therefore, be sure to use a proper percentage of antifreeze in the coolant based on the table above.

ADVICE

- Do not use coolant with more than 60 percent antifreeze or less than 30 percent antifreeze. Concentrations under 30 percent will result in a loss of corrosion protection and freezing protection. Concentrations over 60 percent will result in a loss of freezing protection.
- The coolant mixture used for replenishment should always be of the same brand and concentration as that of currently used in the cooling system.
- Replenishing of only water will result in low concentration of antifreeze and a loss of freezing protection.

■ HANDLING OF ANTIFREEZE

⚠ WARNING

- **Antifreeze is poisonous. Never drink it.**
- **If the antifreeze accidentally enters your eyes, immediately wash your eyes with clean water and get medical treatment.**
- **If the antifreeze gets on a painted surface, immediately rinse it with water.**

⚠ CAUTION

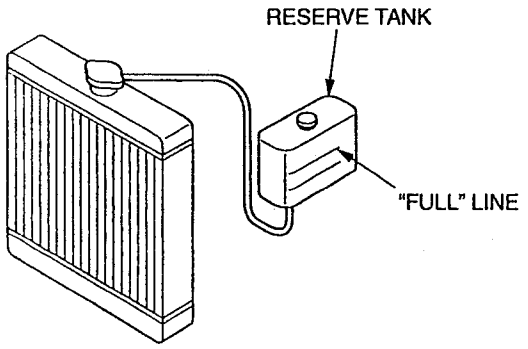
- **Keep antifreeze away from fire. Be careful.**
- **If the antifreeze gets on your skin or clothes, immediately rinse with plenty of water and then wash with soap and water.**
- **When storing the antifreeze, make sure to cover it and store it out of reach of the children.**

■ REPLENISHMENT

▶ Cooling systems equipped with a reserve tank ★

M2-398

(EXAMPLE)



F-572

- Remove the reserve tank cap and fill the tank with coolant to the "FULL" line.

✻ Replenishment of the coolant to the cooling system is done through the reserve tank, therefore do not remove the radiator cap.

✻ Securely install the reserve tank cap.

ADVICE

Check the coolant level and add the coolant while the engine is cold.

▶ Cooling systems without a reserve tank ★

- Remove the radiator cap and replenish coolant up to the vicinity of the cap.

✻ Securely install the radiator cap.

⚠ WARNING

Never touch the radiator cap until the coolant temperature is below the normal temperature range. Opening the radiator cap carelessly can lead to scalding and other injuries due to spurting out of hot coolant.

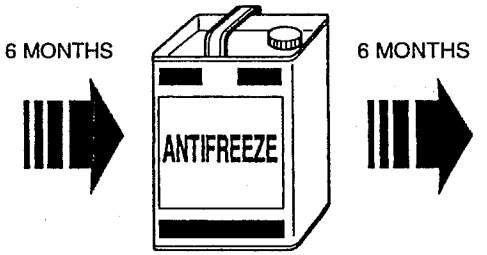
ADVICE

Check the coolant level and add the coolant while the engine is cold.

✻ For handling of the radiator cap, refer to "RADIATOR CAP OPERATION" on page 5-22.

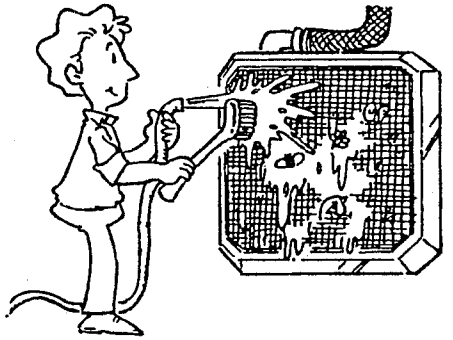
■ REPLACEMENT INTERVAL

REPLACEMENT INTERVAL
Every 6 month



F-573

■ RADIATOR CORE CLEANING



D12-21-02ZA

- Wash the radiator with water regularly. If the front of the radiator is clogged with mud, dust, etc., the cooling efficiency will decrease and the radiator core may corrode.

* When cleaning the radiator, be careful not to damage the radiator fins, etc.

■ COOLANT PATH CLEANING

- Over time, deposits of rust and scale will build up inside the radiator and engine cooling system and will decrease the cooling efficiency. Therefore, when changing the coolant, clean the cooling system with cleaning solution.

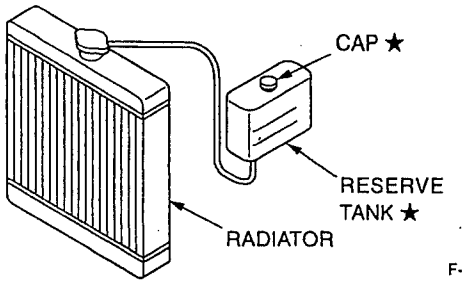
① Drain the coolant.
② Clean the system with the cleaning solution, running the engine at idling speed for about 30 minutes, then stop the engine and drain the cleaning solution.
③ Fill the system with plain tap water, run the engine at idling speed, drain the water, and then refill the cooling system with proper coolant.

■ REPLACEMENT PROCEDURE (DRAINING)

* Replace the coolant when it is sufficiently cool.

① Remove the cap of the reserve tank ★.

(EXAMPLE)



F-598

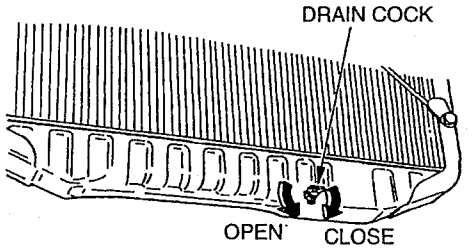
② Remove the radiator cap.

* For details of opening the radiator cap, refer to "RADIATOR CAP OPERATION" on page 5-22.

③ Open the drain cock of the radiator and drain the coolant.

⚠ WARNING

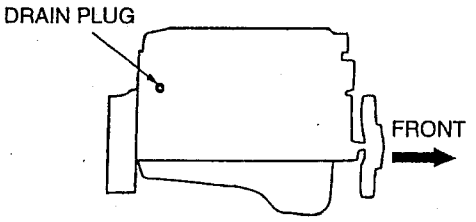
Do not turn the drain cock more than 5 full turns. If you turn it more, the coolant may gush out suddenly and you may be burned.



D12-21-04ZA

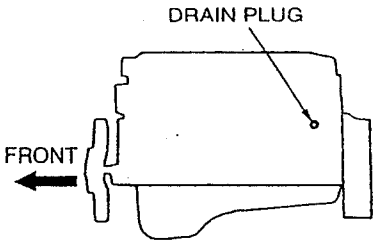
④ Open each drain plugs of the engine and drain the coolant.

[ENGINE MODELS W04C-T, W04D, W04D-T, W06D, W06D-T AND W06E]

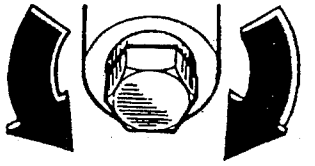


D12-21-05ZC

[ENGINE MODELS H06C-T, H06C-TI, H07C-T AND H07D]



D12-21-06ZB



D12-21-07ZA

⑤ Drain the coolant inside the reserve tank ★ by removing the hose at the bottom of the tank. After draining, connect the hose securely.

⑥ After completing draining, close the drain cock and drain plugs.

⚠ CAUTION

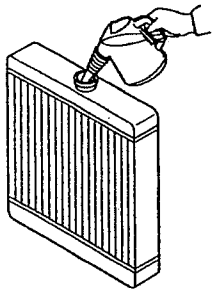
Handle the disposal of drained coolant with a method that is environmentally sound.

ADVICE

Never operate without refilling the cooling system with the coolant after draining. This will cause a failure of the water pump and an engine burning.

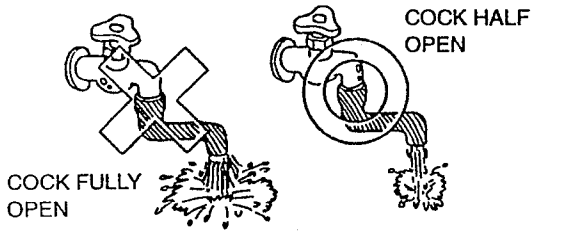
■ REPLACEMENT PROCEDURE (REFILL)

① Pour the coolant (antifreeze + tap water) slowly into the filler port of the radiator until it is full.



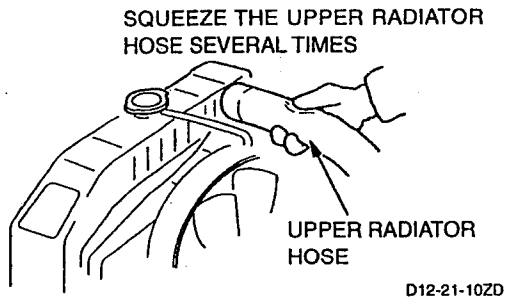
F-574

* When using a water tank, pour slowly because air can easily mix with the coolant.
* When filling with a hose, the cock at the water supply should be only half open. Do not fully open it.



D12-21-09ZA

② When the radiator is filled up to the opening, squeeze the upper radiator hose several times. Any air inside the hose will come out, and the coolant level will become lower. Then, pour in coolant again until it comes up to the radiator cap opening level.



D12-21-10ZD

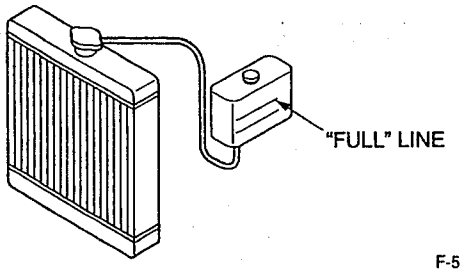
③ Tighten the radiator cap securely.

* For details of closing the radiator cap, refer to "RADIATOR CAP OPERATION" on page 5-22.

(Engine models equipped with a reserve tank ★)

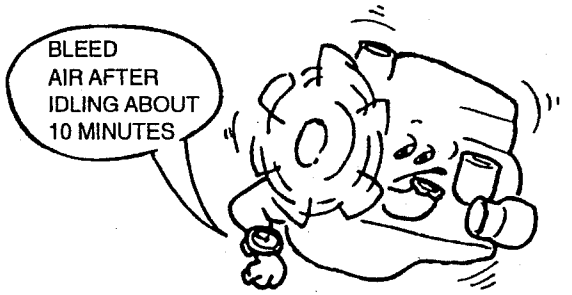
④ Fill the coolant up to the "FULL" line of the reserve tank and close the cap.

(EXAMPLE)



F-599

⑤ In order to properly bleed air from the system, run the engine at a little higher than normal idling speed. Bring the temperature to the normal temperature range and run the engine for about 10 minutes.



D12-21-13ZB

ADVICE

Air mixed into the coolant can cause overheating and coolant leakage from the water pump.

⑥ Stop the engine and after the engine has cooled, check the amount of coolant in the radiator and reserve tank.
Then fill both with coolant to bring them to the proper levels.

⑦ After refilling, close the radiator cap and the reserve tank cap securely.

⚠ WARNING

Never touch the radiator cap until the coolant temperature is below the normal temperature range. Opening the radiator cap carelessly can lead to scalding and other injuries due to spurting out of hot coolant.

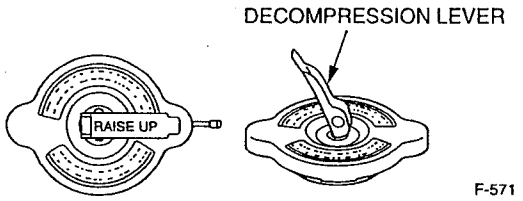
M2-400

RADIATOR CAP OPERATION

■ **OPENING**

▶ **Operation when the engine is cold**

● **Radiator cap with a decompression lever**

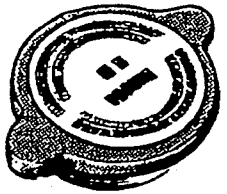


F-571

[COMPRESSION] [DECOMPRESSION]

- Before removing the radiator cap, pull up the decompression lever and release the pressure. Then, remove the cap by turning it counterclockwise.

● **Radiator cap without a decompression lever**



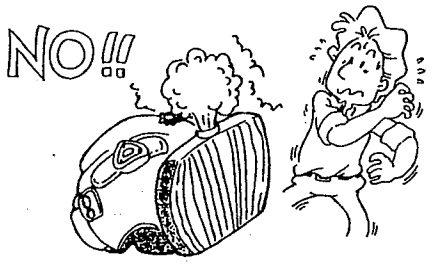
F-618

- Loosen the radiator cap slowly and make sure that vapor is not spurting out, then remove the cap.

▶ **Operation when the engine is hot (Emergency operation)**

● **Radiator cap with a decompression lever**

- If you remove the radiator cap carelessly, hot coolant and vapor may spurt out and burn you. However, if it is necessary to remove the radiator cap for unavoidable reasons such as in an emergency, operate it according to the following procedure.

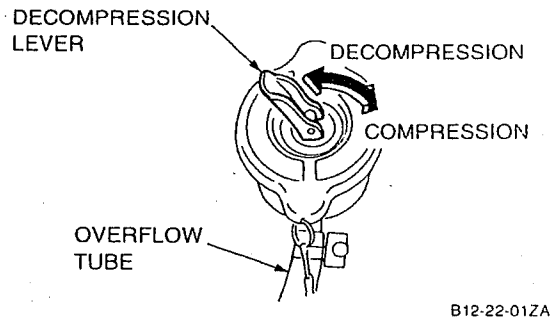


D1-06-01ZB

① When the coolant temperature gauge indicates a point near the dangerous temperature zone, keep the engine running at an idling speed until the needle returns to the normal operating temperature zone.

⚠ WARNING

Never touch the radiator cap until the coolant temperature is below the normal temperature range. Opening the radiator cap carelessly can lead to scalding and other injuries due to spurting out of hot coolant.



B12-22-01ZA

② Set the decompression lever in the center of the cap in the upright position. It will take a few minutes or longer to complete decompression (depending on conditions). If overheating occurs, it will take 30 minutes or longer for decompression.

③ Cover the cap with several layers of thick rags and loosen the cap slowly. If the spurting out of vapor is too strong, immediately tighten the cap and wait until the coolant temperature comes down.

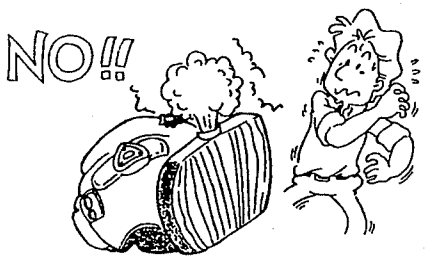
ADVICE

Checking decompression of cooling system

- Check to see if the sound of steam blowing out of the radiator cap has stopped.
- Check to see if boiling water and steam have finished blowing out of the overflow tube.

● **Radiator cap without a decompression lever**

- If you remove the radiator cap carelessly, hot coolant and vapor may spurt out and burn you. However, if it is necessary to remove the radiator cap for unavoidable reasons such as in an emergency, operate it according to the following procedure.



D1-06-01ZB

① When the coolant temperature gauge indicates a point near the dangerous temperature zone, keep the engine running at an idling speed until the needle returns to the normal operating temperature zone.

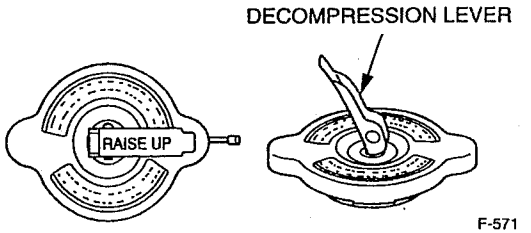
⚠ WARNING

Never touch the radiator cap until the coolant temperature is below the normal temperature range. Opening the radiator cap carelessly can lead to scalding and other injuries due to spurting out of hot coolant.

② Cover the cap with several layers of thick rags and loosen the cap slowly. If the spurting out of vapor is too strong, immediately tighten the cap and wait until the coolant temperature goes down.

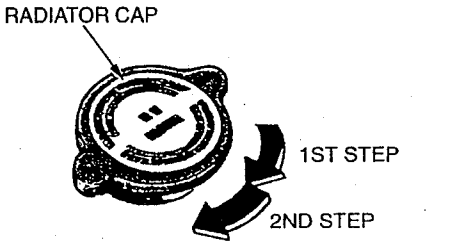
■ **CLOSING**

● **Radiator cap with a decompression lever**



- Turn the radiator cap clockwise until it is tightly closed, and lower the decompression lever to make the coolant in the radiator compressed condition.

● **Radiator cap without a decompression lever**



D12-22-01ZA

- As the radiator cap is of the pressure type, always close it tightly (2nd step) clockwise.

BATTERY

This engine has a 24 volt electrical system powered by two 12 volt batteries connected in series and has negative (–) ground.

■ **INSPECTION INTERVAL**

- To maintain a long battery life, carry out the following inspection.

INSPECTION INTERVAL	
Electrolyte level	Daily inspection (before starting the engine)
Specific gravity	Every 12 months

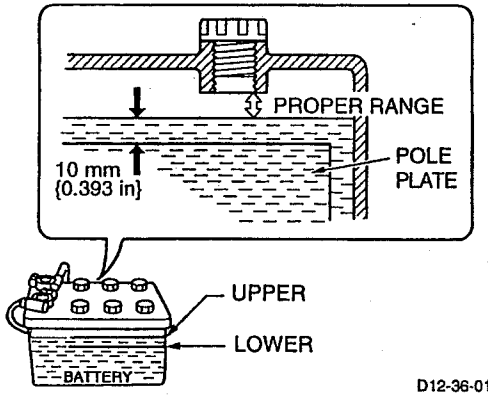
⚠ DANGER

Since the batteries produce explosive hydrogen gas, keep open flame and electric sparks away from the batteries. It is very dangerous and could cause the batteries to catch fire and cause the batteries to explode.

⚠ WARNING

Battery electrolyte is sulfuric acid and can burn your skin and clothing. If battery electrolyte should contact your skin, wash the area thoroughly with soap and water. If it should contact your eyes, immediately flush your eye thoroughly with water and get prompt medical treatment.

■ CHECK ELECTROLYTE LEVEL



D12-36-01ZB

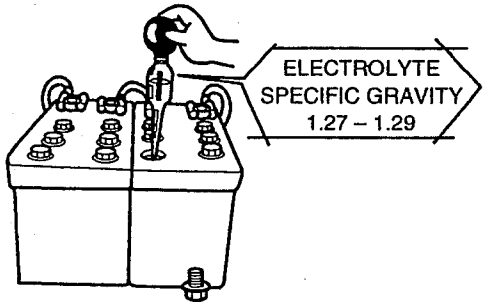
- Remove the battery cover and check to see that the electrolyte level is not too low.
- If the battery electrolyte level is between the "UPPER" and "LOWER" level lines on the side of battery, it is normal.
  If the level is low, fill with battery replenisher or distilled water.

* When there is no indication of the level line, set 10 mm {0.393 in} above the pole plate as standard for the proper level.

ADVICE

- When replenishing, be sure not to fill above the "UPPER" level. Otherwise, the electrolyte may overflow and result in the corrosion of battery terminals and other parts.
- Always charge the battery by running the engine after adding replenisher especially in cold weather. In cold weather, the battery may freeze if it is not charged after replenishment.

■ CHECK THE ELECTROLYTE SPECIFIC GRAVITY



D12-36-02ZA

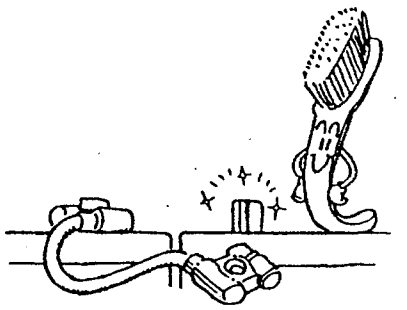
- Measure the electrolyte specific gravity by using a hydrometer.
- Charge the batteries when the electrolyte specific gravity is low.

STANDARD ELECTROLYTE SPECIFIC GRAVITY
1.27 – 1.29

ELECTROLYTE SPECIFIC GRAVITY (AT ELECTROLYTE TEMPERATURE 20°C {68°F})	
Over 1.30	Too high (adjust)
1.22 – 1.29	Good
1.10 – 1.21	Under-charged (charge the battery)
Below 1.10	Too low (remeasure after charging)

* When the electrolyte specific gravity is above 1.30, have it adjusted at your dealer.

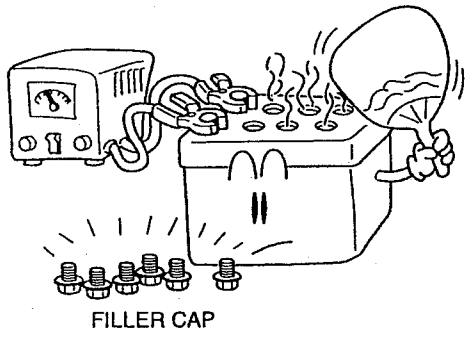
■ CHECK THE TERMINALS



D12-36-03ZA

- Check the terminals for looseness and corrosion.
- Wash away any white powder thoroughly with hot water, then wipe dry.
- Tighten the cable clamps securely after checking and cleaning so that they will not loosen.
- After tightening them, apply a thin coating of grease.

■ CAUTION WHEN CHARGING

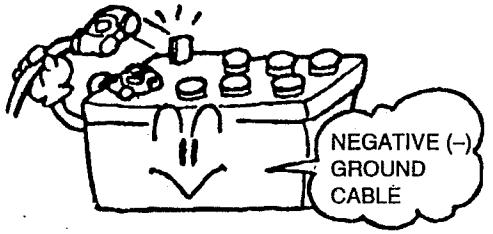


D12-36-04ZA

* When charging with a charger, remove the battery from the machine or remove all of the battery cables.
  Always remove the filler caps and charge in a well ventilated area.
* During rapid charging, always remove all of the battery cables. Otherwise the alternator diode will be burned and damaged.
* When connecting and disconnecting the charger clips to and from the battery terminals, turn the charger switch off.

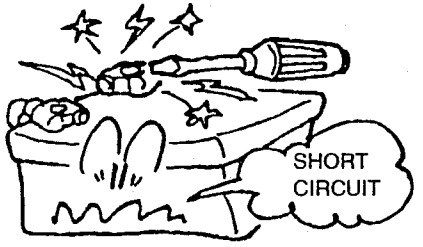
■ GENERAL CAUTION

* When inspecting and doing maintenance work on the electrical system, including the batteries, first turn the starter switch and all other switches "OFF" and disconnect the negative (–) battery terminal cable (the ground cable).



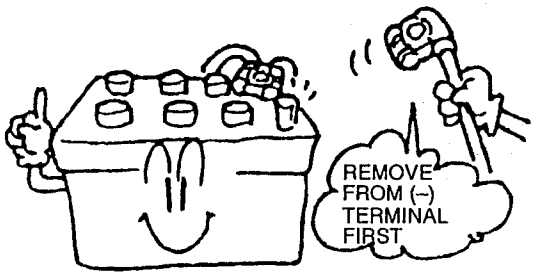
D12-36-05ZA

* If negative (–) battery terminal cable is not disconnected, any metal tools that touch both the positive (+) terminal and any metal body part of the vehicle will cause a short circuit. This can be very dangerous and will cause damages to the electrical system.



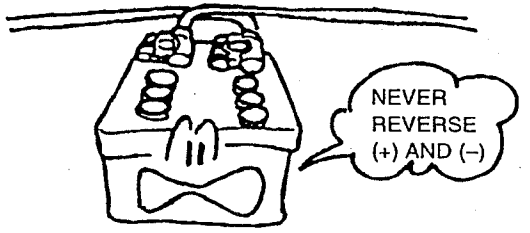
D12-36-06ZA

* When removing the batteries, always disconnect the negative (–) terminal cable (the ground cable) first and when reinstalling, connect the negative (–) terminal cable last.



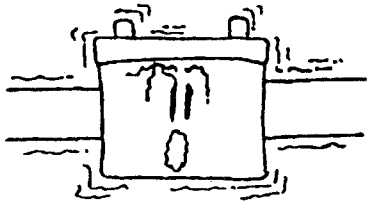
D12-36-07ZA

* When connecting the battery cables, never reverse the polarity of the cables by connecting the positive (+) cable to the negative (–) terminal and the negative cable to the positive (+) terminal. This will reverse the flow of electricity through the electrical system and can blow out the alternator diode, ruin the machine wiring and cause other damages.



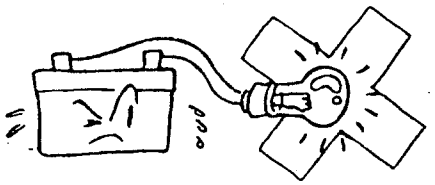
D12-36-08ZA

* When installing the batteries on the machine, install them securely so that they are steady. If the installation is imperfect, the battery case and the pole plates inside may be damaged due to the vibration of the engine.



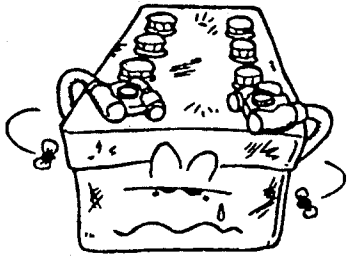
D12-36-09ZA

* Do not take out 12 volt power directly from the batteries. Also, always first consult your dealer before adding 24 volt electrical load to the system.



D12-36-10ZA

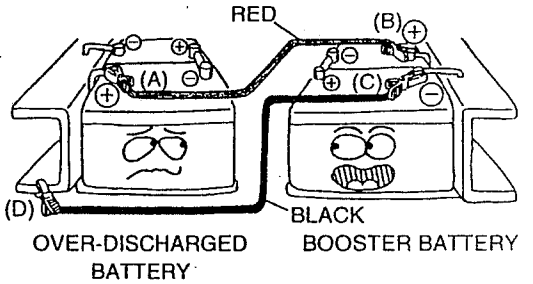
- Always keep the batteries clean. If there is dirt on the batteries, impurities can get into the electrolyte, weaken the pole plates, or cause electrical leakage on the outer surface of the cover, shortening the battery service life.
  Also to prevent corrosion, be sure to apply a thin coat of oil or grease on the inside cable clamps and on the battery terminals.



D12-36-11ZA

■ HANDLING OF A BOOSTER CABLES

- If the batteries are over-discharged, you can start the engine by connecting the battery via a booster cable with the battery of the other machine. Be sure to follow the steps below:



D10-03-01ZA

① Stop the engine connected to the booster battery.
② Connect one clip of the red booster cable to the positive (+) terminal (A) of the over-discharged battery.
③ Connect the other clip of the red cable to the positive (+) terminal (B) of the booster battery.
④ Connect one clip of the black booster cable to the negative (–) terminal (C) of the booster battery.
⑤ Finally connect the other clip of the black cable to the frame or the engine block (D) of the machine with the over-discharged battery, and the clip is connected as far away from the over-discharged battery as possible.

⚠ WARNING

When you make this last connection, sometimes electric sparks may fly momentarily from the booster cable clip. So, connect this to a position well away from the batteries.

⑥ After making sure that all of the booster cable clips are securely connected, start the engine with the over-discharged battery.

* When it is difficult to start the engine in cold weather, start the engine connected to the booster battery, and then after a few minutes, start the engine with the over-discharged battery.

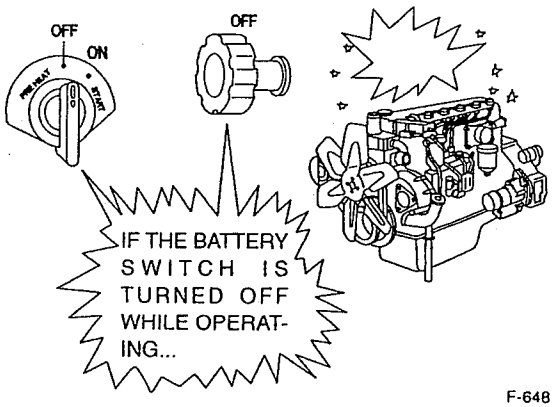
⑦ When the engine with the over-discharged battery has started, disconnect the booster cables in the reverse order of connecting.

ALTERNATOR

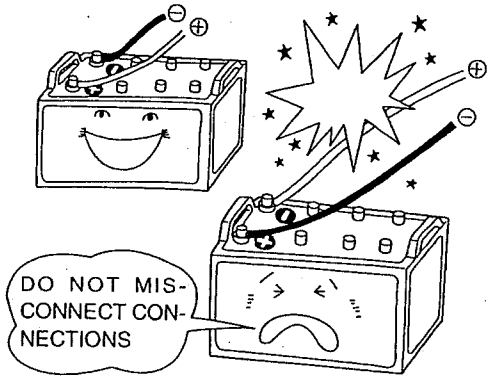
The alternator is easily affected and can be damaged by high temperature, too much voltage, and too much current. Observe the following precautions to prevent damage to the alternator.

⚠ CAUTION

- **Never turn off the battery switch and the starter switch while the engine is running. Turning these switches off while the engine is running will generate high voltage and can damage the diode.**
- **Always turn the starter and battery switches off when the engine has been stopped.**
- **Pay special attention not to mis-connect alternator, relay and battery connections. Especially, if battery terminals are mis-connected and polarity is reversed, it will cause the current to flow in the wrong direction, resulting in damaged diodes and an overheated wire harness.**
- **Be sure to disconnect the battery cables when using a rapid charger. Otherwise the diode may be damaged.**



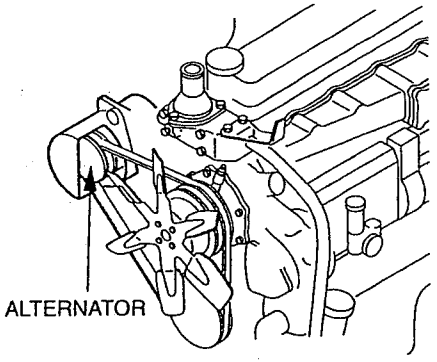
F-648



F-123

⚠ CAUTION

- **When cleaning do not pour water on the alternator. Do not aim steam directly at the alternator when using steam cleaner.**
- **Always use the specified fuse type and make sure it is installed securely.**



F-649

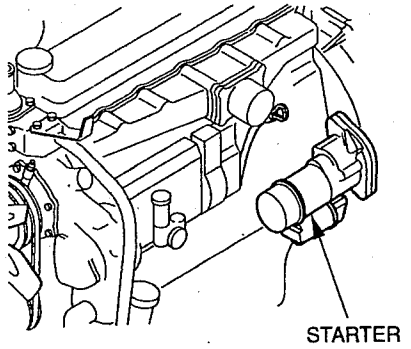
■ **INSPECTION INTERVAL**

In case of alternators equipped with brushes

- Inspect and clean the brushes and the slip rings.
- Measure the brush length and replace it with a new one if necessary.

INSPECTION INTERVAL
Every 1,000 hours of operation

STARTER



F-650

① Each of the terminals is marked with an inscription. Be sure to connect the terminals correctly.

② Inspect and clean the commutator. If the commutator surface deteriorates or gets burned, it will result in bigger sparks. Polish the surface with a No. 400 sandpaper and wipe clean with a dry cloth. If a brush is worn by more than 2/3, replace it with a new one.

■ **INSPECTION INTERVAL**

INSPECTION INTERVAL
Every 1,000 hours of operation

⚠ CAUTION

- **Be sure to use fuses of the specified amperage.**
  Never substitute a copper or other kind of wire for a fuse. Using a fuse that is not of the specified amperage can result in the overheating of the wire harness and cause fire.
- **Do not apply high pressure washing when cleaning areas on the outside of the engine.**
  Although connectors on the engine circumference are waterproofed, high pressure washing may deform the watertight rubbers and cause water to enter inside the connectors. Once water goes into the connectors, the interior waterproof structure will prevent the water from coming out. This will lead to rust and corrosion resulting in broken wires and other damage.

PERIODIC INSPECTION AND MAINTENANCE

PERIODIC INSPECTION

The table lists items requiring daily and periodic inspection. To get maximum performance from the engine and extend its service life, be sure to carry out inspection and maintenance in accordance with the periodic inspection and maintenance tables.

Note:

① Inspection intervals are based on the standard specifications of HINO industrial engines. Depending on the machines, they may be different from your engine. Please refer to the "OPERATION MANUAL" of your machine.

② More frequent inspections may be required, depending on the conditions under which the engine is used.

③ For lubrication related intervals, refer to "LUBRICANTS TABLE" on page 6-7.

(○: Check, ●: Replace)

ITEM \ OPERATION HOURS	INSPECTION INTERVAL (OPERATION HOURS)					NOTES
	New engine with 30 hours of operation	120	250	500	1,000	
MAIN BODY						
Valve clearance checking and adjustment	○			○		Your dealer
Compression checking					○	Your dealer
Cylinder head bolts retightening	○				○	Your dealer
Engine mounting retightening					○	
AIR INTAKE AND EXHAUST SYSTEM						
Intake and exhaust manifolds retightening	○				○	
Oil pan and other auxiliary devices mounting area retightening	○				○	
Air cleaner checking and cleaning and element replacement			○		●	

ITEM \ OPERATION HOURS	INSPECTION INTERVAL (OPERATION HOURS)					NOTES
	New engine with 30 hours of operation	120	250	500	1,000	
TURBOCHARGER						
Turbocharger parts retightening	○	○				
Rotor and impeller rotation condition checking			○			
Rotor play checking				○		
LUBRICATION SYSTEM						
Oil level checking						Daily inspection
Oil pan water content, condition of water mixing with fuel		○				
Oil filter element replacement			●			Refer to "OPERATION MANUAL" of your machine.
Turbocharger lubrication system leakage checking					○	
FUEL SYSTEM						
Injection nozzle pressure and injection quality checking and adjustment				○		Your dealers
Injection timing checking and adjustment	○			○		Your dealers
Fuel injection pump injection value, performance checking					○	
Fuel injection pump, coupling checking	○			○		

ITEM \ OPERATION HOURS	INSPECTION INTERVAL (OPERATION HOURS)					NOTES
	New engine with 30 hours of operation	120	250	500	1,000	
Fuel filter element cleaning, checking and replacement		○		●		Refer to "OPERATION MANUAL" of your machine.
Water separator inside, draining of sediments and water content						Daily inspection
Feed pump strainer checking and cleaning		○				
Fuel tank strainer checking and cleaning				○		
Fuel level checking						Daily inspection
Fuel hose replacing						Every 3 years
Fuel tank inside, sediments and water content checking and draining				○		
COOLING SYSTEM						
V-belt tension and damage checking and adjustment	○	○				Daily inspection
Fan mounting bolt retightening	○					
Coolant replacement				●		Every 6 months
Coolant system cleaning						
Coolant level checking						Daily inspection
Thermostat performance checking					○	
Coolant pump rubber hose replacement						Every 2 years

ITEM \ OPERATION HOURS	INSPECTION INTERVAL (OPERATION HOURS)					NOTES
	New engine with 30 hours of operation	120	250	500	1,000	
ELECTRICAL EQUIPMENT						
Battery electrolyte level checking	○	○				
Battery electrolyte specific gravity, voltage checking			○			
Wiring checking	○			○		
Heater plug, intake air heater performance checking				○		Check performance before the start of winter (check for broken wires, etc.)
Starter performance checking				○		
Starter brush and commutator checking and cleaning					○	Once a year
Alternator brush checking and cleaning					○	Once a year
Regulator performance checking					○	
OTHERS						
Pipe joints retightening		○				
Engine oil leakage checking						Daily inspection
Fuel related parts leakage checking						Daily inspection
Coolant leakage checking						Daily inspection

ITEM / OPERATION HOURS	INSPECTION INTERVAL (OPERATION HOURS)					NOTES
	New engine with 30 hours of operation	120	250	500	1,000	
Air suction rubber hose checking		○				
Exhaust pipe and muffler checking		○				
Meters, gauges and lamps checking						Daily inspection

■ POINTS OF LUBRICATION AND LUBRICATION INTERVALS

Inspection, refilling and replacement intervals shown here are recommended for HINO industrial engines with the standard specifications. Depending on the machines, the requirements for your engine may be different. Please refer to the "OPERATION MANUAL" of your machine.

* For a list of recommended brands, refer to "RECOMMENDED LUBRICANT LIST" on page 6-8.

(○: Check, ◎: Replenish, ●: Replace)

ITEM \ INTERVAL, ETC.	INSPECTION INTERVAL (OPERATION HOURS)					USING OIL & GREASE	REMARKS
	NEW ENGINE WITH 30 HOURS OF OPERATION	120	250	500	1,000		
Engine	●		●			Refer to the "RECOMMENDED LUBRICANT LIST" on page 6-8.	Before starting the engine ○
Engine control joints			◎				Grease nipples
Cooling fan holder				◎			
Tension pulley				◎			
Starter					●		Disassembly needed
Alternator					●		Disassembly needed

MAINTENANCE AND INSPECTION OF EMERGENCY OWN POWER PLANT

Engines used in own power plant for emergency or fire prevention purposes have to be on standby at all times, ready to operate at full capacity when needed.
Therefore, to ensure such engines can operate at peak performance at all times, be sure to carry out the inspection and maintenance described below.
Also, if maintenance standards are established by the local laws, observe all regulations when conducting the following inspections.

Note:
① The inspection intervals are based on the standard specifications of HINO industrial engines. Depending on the machines, they may be different from your engine. Please refer to the "OPERATION MANUAL" of your machine.
② More frequent inspections may be required, depending on the conditions under which the engine is used.
③ For lubrication related items, refer to the "LUBRICANTS TABLE" on page 6-7.

(○: Check, ●: Replace)

ITEM \ INTERVAL, ETC.	INSPECTION INTERVAL					NOTES
	Every week	Every month	Every year	Every 3 years	Every 5 years	
MAIN BODY						
Valve clearance checking and adjustment			○			
Cylinder head retightening			○			
AIR INTAKE AND EXHAUST SYSTEM						
Air cleaner checking, cleaning and replacement of element			●			
TURBOCHARGER						
Turbocharger parts retightening	○	○				
Rotor and impeller rotation checking			○			
Rotor play checking				○		

ITEM \ INTERVAL, ETC.	INSPECTION INTERVAL					NOTES
	Every week	Every month	Every year	Every 3 years	Every 5 years	
LUBRICATION SYSTEM						
Oil pan interior, checking that water content and diesel fuel get mixed.		○				
Oil filter element replacement			●			Clean inside of case
Turbocharger lubrication system leakage checking					○	
FUEL SYSTEM						
Fuel level in fuel tank checking	○					
Injection nozzle pressure and injection performance checking			○			
Injection timing checking			○			
Fuel filter element replacement			●			
Water separator interior, draining of sediments and water content	○					
Feed pump strainer cleaning		○				
Fuel tank strainer cleaning		○				
Fuel hoses replacement				●		
Fuel tank interior, draining of sediments and water content			○			
Fuel tank interior cleaning					○	

ITEM \ INTERVAL, ETC.	INSPECTION INTERVAL					NOTES
	Every week	Every month	Every year	Every 3 years	Every 5 years	
COOLING SYSTEM						
Coolant level checking	○					
V-belt tension and damage checking			○			
Fan mounting bolt retightening			○			
Coolant replacement			●			
Coolant pump rubber hose replacement						Every 2 years
ELECTRIC EQUIPMENT						
Coolant, oil temperature retaining heater checking		○				
Heater plug, intake air heater performance checking			○			Check before start of winter
Starter, alternator performance checking				○		
Safety relay, emergency relay performance checking			○			
OTHERS						
Engine outer bolts retightening			○			
Fuel, lubricants, coolant, gas leakage checking	○					

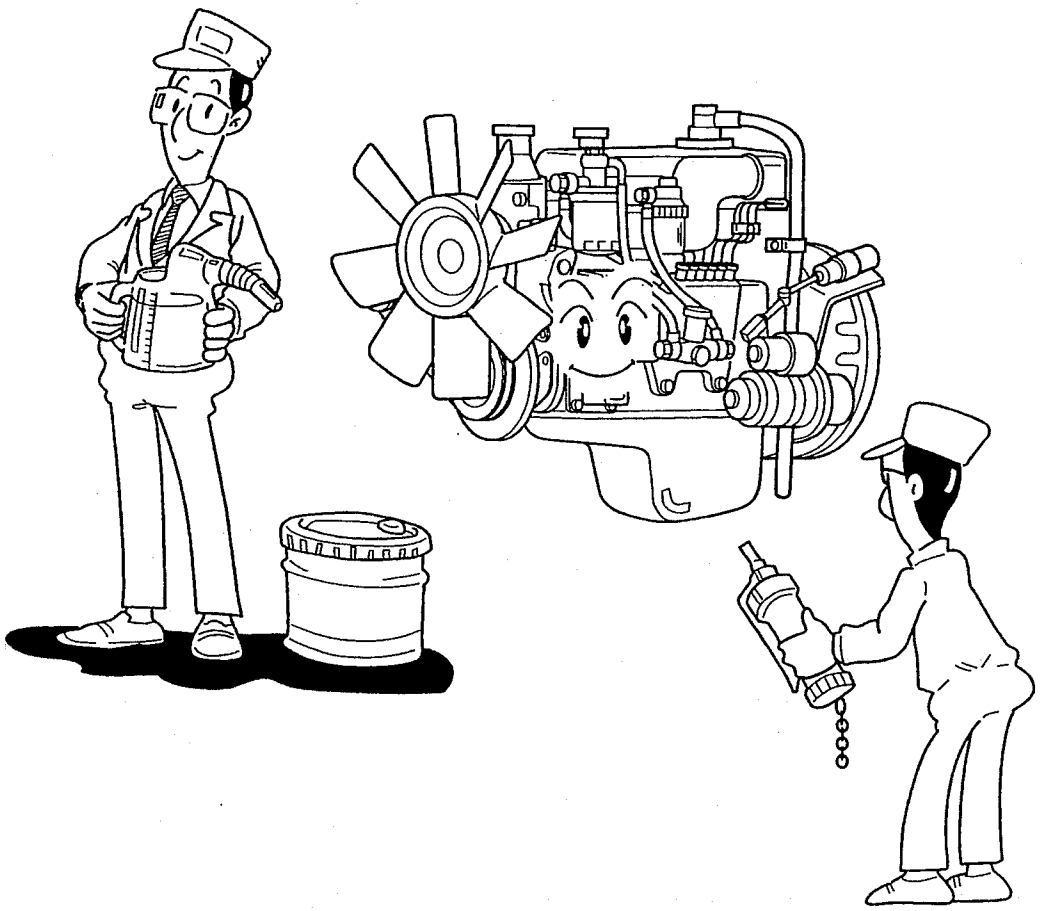
■ POINTS OF LUBRICATION AND LUBRICATION INTERVALS (INSPECTION AND MAINTENANCE OF EMERGENCY OWN POWER PLANT)

Inspection, replenishment and replacement intervals shown here are recommended for HINO industrial engines with the standard specifications. Depending on the machines, the requirements for your engine may be different. Please refer to the "OPERATION MANUAL" of your machine.

(○: Check, ◎: Replenish, ●: Replace)

LUBRICATING POINTS / INTERVAL, ETC.	LUBRICATION INTERVAL					NOTE
	Every week	Every month	Every year	Every 3 years	Every 5 years	
Oil level check	○					
Engine			●			
Engine control joints			◎			
Cooling fan holder			◎			
Tension pulley			◎			
Starter					●	Disassembly needed
Alternator					●	Disassembly needed

6. LUBRICATION



F-651

ADVICE

Items contained in this section are based on the standard specifications of HINO industrial engines. Depending on the machine model, they may not be the same as your engine. Please refer to the "OPERATION MANUAL" of your machine.

M2-418

RECOMMENDED LUBRICANTS

Periodical replenishment and change of oil and grease play an important role in the maintenance of performance quality, prolongation of service life and prevention of accidents. Be sure to follow the recommendations.

⚠ CAUTION

Handle the disposal of drained oil and grease with a method that is environmentally sound.

ADVICE

When inspection and replacement interval is indicated in both hours of operation and length of time, perform inspection and replacement according to whichever comes first.

■ PRECAUTIONS DURING OIL REPLENISHMENT AND REPLACEMENT

* After replenishment or replacement of oil, wipe off the oil deposited around the oil filler cap or filler plug and drain plug and be sure to check to see if there is any oil leakage.
* When changing the oil, be sure to use a container for the drained oil.
* Never throw out any waste oil in an open space or in a ditch.

⚠ CAUTION

Be sure to wipe off the oil scattered around. Leaving it as it may result in catching fire and it is very dangerous.

■ PRECAUTIONS DURING GREASING

* Shortage of grease may result in an excessive play, abnormal noises and seizure due to premature wear of different parts. Always maintain correct greasing to prevent it.
* Remove mud or dirt from grease nipples, bleeders and places to be greased before you undertake greasing.
* After greasing, be sure to wipe off the excessive grease.

ENGINE OIL

Engine oil must offer stable performance in high temperatures and resist oxidation. The oil viscosity must remain consistent in a wide range of temperatures. It is necessary to use engine oils of different viscosity values in summer and winter. Select an appropriate oil type in accordance with the engine operating conditions.

■ RECOMMENDED BRANDS

- For a list of recommended brands, refer to "RECOMMENDED LUBRICANT LIST" on page 6-8.

■ REPLENISHMENT

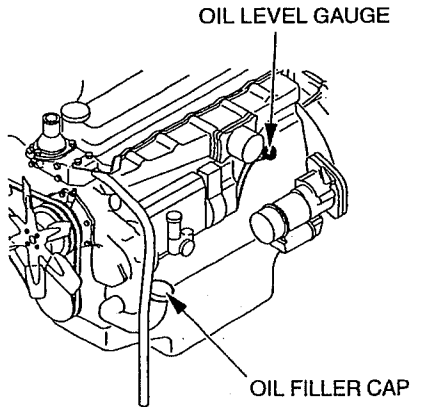
① If the oil level is low, replenish engine oil through the oil filler.

⚠ CAUTION

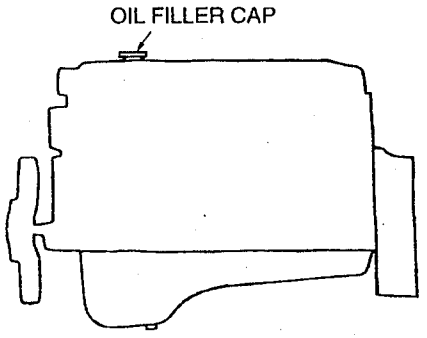
When replenishing the oil, be sure not to spill any oil. If the oil sticks to the exhaust pipe, it may catch fire because of a high temperature. Be careful when replenishing.

② Check the oil level 10 minutes after replenishing.

* For details of checking the oil level, refer to the "ENGINE OIL LEVEL" on page 5-3. The position of the oil filler cap may be different depending on the machines. Please refer to the "OPERATION MANUAL" of your machine.



F-652



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■ REPLACING OF ENGINE OIL

CHANGING INTERVAL
Every 250 hours of operation

ADVICE

- Depending on the machine model, oil replacement intervals may be different from your engine. Please refer to the "OPERATION MANUAL" of your machine.
- If the engine is used frequently at high revolutions and under high loads, oil deteriorates quickly. Also change the engine oil early if it is found dirty when checking the oil level regardless of the specified interval.
- Simultaneously with oil replacement, make sure to replace the oil filter element.

① Remove the oil filler cap and the drain plug of the oil pan to drain oil. Also drain oil from the oil filter.

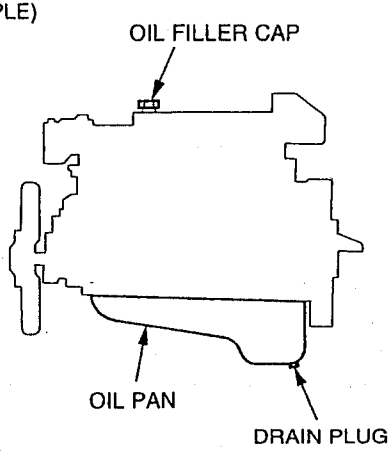
- The oil can be drained more easily if the engine is warm.

* For details of draining the oil from the oil filter, refer to "ENGINE OIL FILTER" on page 5-6.

⚠ CAUTION

Just after driving, the engine oil is still hot and can burn you. Wait a few minutes to let the oil cool down before changing or checking it.

(EXAMPLE)



F-653

② After the oil is completely drained, tighten the drain plugs securely.

* Always use a new drain plug gasket.

③ Fill the oil through the oil filler. (For the specified oil level for each engine model, refer to "ENGINE OIL LEVEL TABLE" on page 6-5.

④ About 10 minutes after filling the oil, check the oil level with the oil level gauge.

⑤ Start the engine and run it in idling.

⑥ Stop the engine. Wait more than 30 minutes and after that, check the oil level with the oil level gauge. If the oil level is low, replenish the oil.
Also, check the drain plugs for leakage.

■ ENGINE OIL LEVEL TABLE

ADVICE

Items contained here are based on standard specifications of HINO industrial engines. Depending on the machine model, they may not be the same as your engine. Please refer to the "OPERATION MANUAL" of your machine.

Unit: L {gal (US), gal (UK)}

ENGINE MODEL	OIL PAN SHAPE	OIL LEVEL		
		MAX.	MIN.	TOTAL OIL CAPACITY
W04C-T W04D W04D-T	 Standard	8.0 {2.11, 1.76}	5.0 {1.32, 1.10}	10.5 {2.77, 2.31}
	 Standard			
	 Deep-set	14.0 {3.70, 3.08}	9.0 {2.38, 1.98}	16.5 {4.36, 3.63}
W06D W06D-T W06E	 Standard	10.0 {2.64, 2.20}	7.0 {1.85, 1.54}	13.0 {3.43, 2.86}
	 Standard			
	 Deep-set	17.0 {4.49, 3.74}	9.0 {2.38, 1.98}	20.0 {5.28, 4.40}

Unit: L {gal (US), gal (UK)}

ENGINE MODEL	OIL PAN SHAPE	OIL LEVEL		
		MAX.	MIN.	TOTAL OIL CAPACITY
H06C-T H06C-TI	 Standard	11.0 {2.91, 2.42}	7.0 {1.85, 1.54}	15.0 {3.96, 3.30}
	 Deep-set	20.0 {5.28, 4.40}	16.0 {4.23, 3.52}	24.0 {6.34, 5.28}
	 Deep-set			
	 Deep-set			
	 Deep-set			
H07C-T H07D	 Standard	11.0 {2.91, 2.42}	7.0 {1.85, 1.54}	13.5 {3.57, 2.97}
	 Deep-set	20.0 {5.28, 4.40}	16.0 {4.23, 3.52}	23.0 {6.08, 5.06}
	 Deep-set	24.0 {6.34, 5.28}		27.0 {7.13, 5.94}

GREASING

To ensure a long service life, you must perform the required lubrications according to the specified schedule. Points to be lubricated may be different depending on the machines. Please refer to the "OPERATION MANUAL" of your machine. Items shown here are based on the standard specifications of HINO industrial engines.

[TENSION PULLEY AND COOLING FAN HOLDER]

■ RECOMMENDED BRANDS

- For a list of recommended brands, refer to "RECOMMENDED LUBRICANT LIST" on page 6-8.

■ GREASING INTERVAL

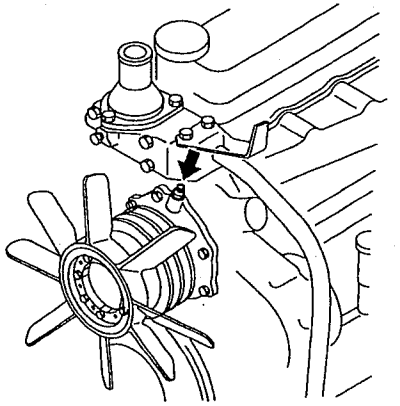
GREASING INTERVAL
Every 500 hours of operation

ADVICE

- Remove mud or dirt from grease nipples before greasing.
- If the tip of a grease nipple is found to be deformed, replace the nipple with a new one.

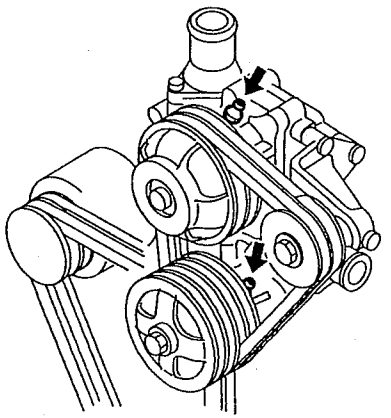
■ POINTS OF LUBRICATION

[ENGINE MODELS W04C-T, W04D, W04D-T, W06D, W06D-T AND W06E]
(Standard type)



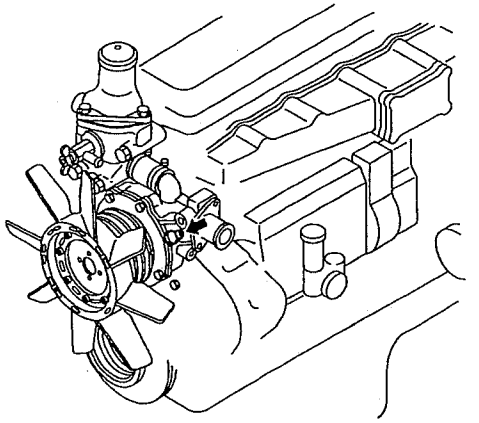
F-654

(High-mount fan type)



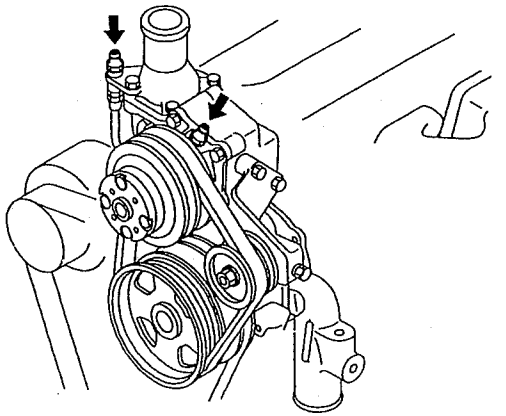
F-655

[ENGINE MODELS H06C-T, H06C-TI, H07C-T AND H07D]
(Standard type)



F-656

(High-mount fan type)



F-657

[STARTER]

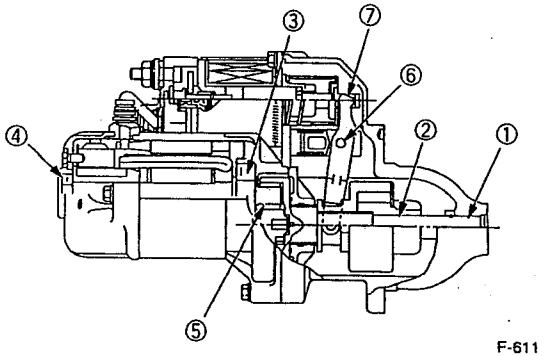
■ RECOMMENDED BRANDS

- For a list of recommended brands, refer to "RECOMMENDED LUBRICANT LIST" on page 6-8.

■ GREASING INTERVAL

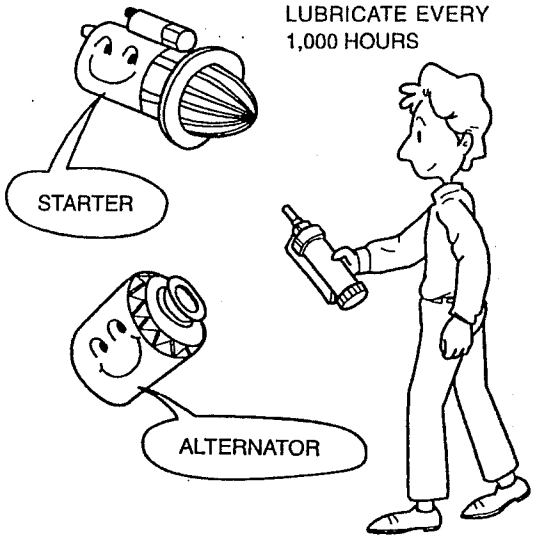
GREASING INTERVAL
Every 1,000 hours or whenever disassembled

- Lubricate every 1,000 hours or whenever the starter is disassembled. Lubricate the seven locations shown in the illustration.
  ① Metal A (front)
  ② Metal B (pinion)
  ③ Bearing A (center)
  ④ Bearing B (rear)
  ⑤ Reduction gear
  ⑥ Shift lever
  ⑦ Engage switch tip



F-611

[POINTS TO BE LUBRICATED ON THE STARTER]



F-583

[ALTERNATOR]

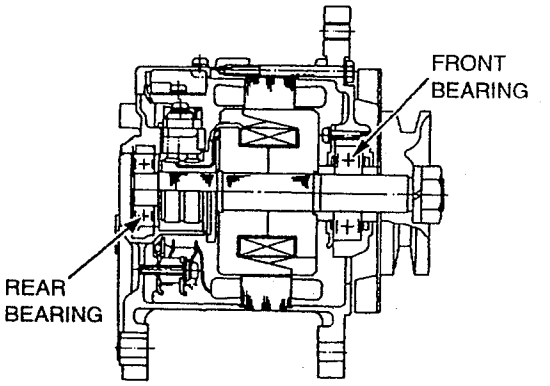
■ RECOMMENDED BRANDS

- For a list of recommended brands, refer to "RECOMMENDED LUBRICANT LIST" on page 6-8.

■ GREASING INTERVAL

GREASING INTERVAL
Every 1,000 hours or whenever disassembled

- Lubricate the front and the rear bearings every 1,000 hours or whenever the alternator is disassembled. At such time, replace any bearing that do not operate smoothly. Also replace damaged oil seals with new ones.



F-512

[POINTS TO LUBRICATED ON THE ALTERNATOR]

LUBRICANTS TABLE

ADVICE

Items contained here are based on standard specifications of HINO industrial engines. Depending on the machine model, they may not be the same as your engine. Please refer to the "OPERATION MANUAL" of your machine.

(◎: Replenish, ●: Replace)

INTERVAL, ETC. / LUBRICATING POINTS	LUBRICATION INTERVAL (HOURS OF OPERATION)					SPECIFIED LUBRICANT	QUANTITY	PAGE TO REFER
	New engine with 30 hours of operation	120	250	500	1,000			
Engine	●		●			Refer to the "RECOMMENDED LUBRICANT LIST" on page 6-8.	Refer to the "ENGINE OIL LEVEL TABLE" on page 6-4.	6-2
Engine control joints			◎					–
Tension pulley				◎			As required	6-5
Cooling fan holder				◎			As required	6-5
Starter					●		As required	6-6
Alternator					●		As required	6-6

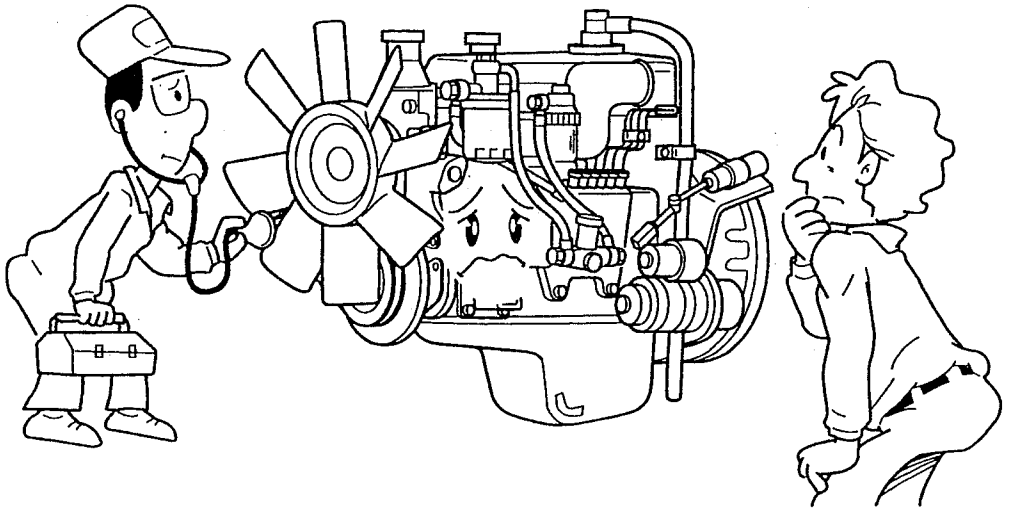
RECOMMENDED LUBRICANT LIST

NOTE: Lubricants were amended according to new classification by A.P.I. (American Petroleum Institute).

No.	LUBRICANTS	POSITIONS	ATMOS-PHERIC TEMP.	SAE NO.	BP	CALTEX	CASTROL	ESSO	GULF	MOBIL	SHELL	TOTAL
1	ENGINE OIL (A.P.I. CD) Previous Classification (A.P.I. DS) (MIL-L-2104C) (MIL-L-45199B)	Cylinder Block Injection Pump Air Cleaner Engine Control Joints	Above 32°C (90°F)	40	Vanellus C-3 40	RPM DELO 400 Oil SAE 40 or 15W/40 RPM DELO 300 Oil SAE40	Castrol or Deusol CRD 40, Turbomax Castrol or Deusol RX Super 40, 15W/40	Essolube D-3 40, XD-3 40	Gulf Super Duty Motor Oil 40, 15W-40	Mobil Delvac 1340 Mobil Delvac Super 15W-40	Myrina Oil 40, 20W-40, 15W-40 Rimula X Oil 40 Rimula CT 40	TOTAL Rubia S 40 TOTAL Rubia TM 15W40
			32°–0°C (90°–32°F)	30	Vanellus C-3 30	RPM DELO 400 Oil SAE 30 or 15W/40 RPM DELO 300 Oil SAE 30	Castrol or Deusol CRD 30 Castrol or Deusol RX Super 30, 15W/40	Essolube D-3 30, XD-3 30	Gulf Super Duty Motor Oil 30, 15W-40	Mobil Delvac 1330 Mobil Delvac Super 15W-40	Myrina Oil 30, 20W-40, 15W-40 Rimula X Oil 30, 10W-30 Rimula CT30	TOTAL Rubia S 30 TOTAL Rubia TM 15W40
			0°– –12°C (32°–10°F)	20	Vanellus C-3 20W	RPM DELO 400 Oil SAE 20/20W. 15W/40 RPM DELO 300 Oil SAE 20/20W	Castrol or Deusol CRD 20W/20 Castrol or Deusol RX Super 20W/20, 15W/40	Essolube D-3 20W, XD-3 15W-40	Gulf Super Duty Motor Oil 20, 15W-40	Mobil Delvac 1310 Mobil Delvac Super 15W-40	Myrina Oil 20, 20W-40, 15W-40 Rimula X Oil 20 Rimula CT20	TOTAL Rubia S 20 TOTAL Rubia TM 15W40
2	COOLANT PUMP BEARING GREASE (MIL-G-10924B)	Cooling Fan Holder Tension Pulley			Energrease L-2	Marfak Multipurpose 2 or Marfak All Purpose 2	Castrol LM Grease	Esso Multipurpose Grease	Gulflex Poly	Mobilgrease MP, 77, MS	Retinax A Alvania Grease R2	TOTAL MULTIS 2
3	STARTER GREASE	Bushing, Clutch, Drive Shaft, Pinion Shift Lever & Reduction Gear			——	Molytex Grease EP2	——	——	——	Mobilgrease 29	Aero Shell Grease 17	——
4	ALTERNATOR & STARTER BEARING GREASE	Alternator Bearing Starter Bearing			Energrease LT2	RPM Grease SRI 2	——	——	——	Mobilgrease 28	Aero Shell Grease 7	——
5	ANTIFREEZE (MIL-A-53009)	Engine, Radiator			Anti Frost	AF Engine Coolant	Castrol Anti-Freeze Castrol Long Life Coolant	Esso Anti Freeze Coolant	Cruise Master Antifreeze and Summer Coolant	Mobil Permazone	Shellzona (U.S.A.) Glycoshell Plus (European Countries) Shellsafe Anti-Freeze P281 Coolguard	TOTAL ANTIGEL

7. TROUBLESHOOTING

Correct operating and faithful observance of daily inspection and maintenance procedures together with periodic inspection and maintenance virtually eliminates troubles. Close attention should be paid to any minor troubles, since prompt action keeps minor troubles from becoming major troubles. When any of the following problems appear, check and repair according to the following tables. If a problem is unclear or if repair is not possible, have your dealer check and repair the engine.



F-658

TROUBLESHOOTING

Problem		Possible cause	Remedies	Page to refer
Engine does not start	Starter does not operate or operate slowly	Discharged battery	Charge or replace battery.	5-23
		Battery terminal off, loose, corroded	Tighten securely after cleaning corroded parts.	5-23
		No grounding of system	Ground system properly.	—
		Malfunction of starter and electric system	Contact your dealer.	—
		Engine oil viscosity too high	Replace with proper oil.	6-2
	Starter operates normally	Improper operation of preheat	Use correct preheat procedure.	4-3
		Trouble of preheating device	Contact your dealer.	—
		Lack of fuel in tank	Fill fuel in tank.	3-7
		Dirty fuel filter	Replace element.	5-8
		Accumulation of air in fuel system	Bleed air.	5-11
		Frozen fuel line	Warm up fuel line with hot water (below 60°C {140°F}).	—
		Water in fuel tank	Drain water.	—
		Stop lever of injection pump is not returned	Contact your dealer.	—
		Air cleaner air inlet covered by sheet, etc.	Remove sheet, etc.	—
		Clogged air cleaner element (Dust indicator shows red signal)	Clean or replace element.	5-12
		Crushed intake air hose	Replace hose.	—
Engine does not stop		Engine stop lever is engaged	Contact your dealer.	—
Engine stalls at low speed		Idling speed too low	Contact your dealer.	—
		Lack of fuel in tank	Fill fuel in tank.	3-7
		Dirty fuel filter	Replace element.	5-8
		Accumulation of air in fuel system	Bleed air.	5-11
		Air cleaner air inlet covered by sheet, etc.	Remove sheet, etc.	—
		Clogged air cleaner element (Dust indicator shows red signal)	Clean or replace element.	5-12
		Crushed intake air hose	Replace hose.	—
		Possible switches related trouble	Contact your dealer.	—

Problem	Possible cause	Remedies	Page to refer
Engine lacks in power	Dirty fuel filter	Replace element.	5-8
	Accumulation of air in fuel system	Bleed air.	5-11
	Fuel is not diesel fuel	Drain fuel from tank etc. and refill with diesel fuel.	—
	Air cleaner air inlet covered by sheet, etc.	Remove sheet, etc.	—
	Clogged air cleaner element (Dust indicator shows red signal)	Clean or replace element.	5-12
	Crushed intake air hose	Replace hose.	—
Engine overheats	Insufficient coolant	Check leakage of coolant. Add coolant. Bleed air sufficiently.	5-18
	Clogged front of radiator	Clean front of radiator.	5-19
	Radiator is clogged with scale	Clean radiator with detergent.	5-20
	Thermostat faulty (closed)	Contact your dealer.	—
Exhaust gas is black	Air cleaner air inlet covered by sheet, etc.	Remove sheet, etc.	—
	Clogged air cleaner element (Dust indicator shows red signal)	Clean or replace element.	5-12
	Crushed intake air hose	Replace hose.	—
Fuel consumption is excessive	Fuel leakage	Check fuel system, retighten if loose.	—
	Air cleaner air inlet covered by sheet, etc.	Remove sheet, etc.	—
	Clogged air cleaner element (Dust indicator shows red signal)	Clean or replace element.	5-12
	Crushed intake air hose	Replace hose.	—
Engine oil consumption is excessive	Use of unsuitable oil	Replace with proper oil.	6-2
	Oil level too high	Drain excessive oil.	6-2
	Oil leakage	In case of looseness of bolts and nuts, retighten.	—
	Omission of oil changing	Replace at proper intervals.	6-3
	Clogged oil filter	Replace filter element	5-6
	Omission of engine warm-up	Warm-up properly.	4-5

INDEX

INDEX

M2-432

Hino Motors, Ltd.
OVERSEAS SERVICE DIVISION
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3. HYGIENE EDUCATION IN PRIMARY SCHOOLS

3.1 BACKGROUND

Approximately ninety percent of school buildings were totally destroyed in September 1999. However, planning for primary school rehabilitation did not include for water and sanitation facilities satisfactorily. Most primary schools have the rehabilitation plans of school buildings and toilet & water facilities respectively. Unfortunately, an integrated plan for toilet and water facilities in primary schools at national level has been not regarded so far.

There is a strong correlation between good health and the availability of toilet and water supply facilities. Poor hygiene practices and lack of environmental sanitation caused diarrhoea, scarring of intestinal mucous and worm infestations resulting in poor absorption and thus malnutrition. Malaria, Dengue fever, diarrhoea and gastrointestinal worm infections are some of the more common diseases in East Timor. Thus, poor water and sanitation results in malnutrition and disease, which are factors that limit children's learning capacity by causing fatigue, reduces attentiveness, decreased mental development and forced absence. In addition to water and sanitation facilities, health, nutrition and hygiene education and awareness is urgently needed.

Children who do not enrol for school or whose attendance is poor are more likely to be ill and malnourished. Providing health services and nutritional supplements in schools would thus greatly improve the educational opportunities for the most disadvantaged children. However, health, nutrition and hygiene education have been absent from the school curriculum, and most district health plans do not include education on these topics in primary schools.

3.2 DEFINITION

"School Health" comprehends not only the prevention of diseases and the promotion of health of body and mind for schoolchildren but also the improvement and maintain of school environment. In order to accomplish the goal "School Health" takes appropriate measures which include "Health Education," "Nutrition Education" and "Hygiene Education." "Hygiene Education" overlaps with "Health Education" in the details of practice each other. They have the same goal, but their approaches are different.

3.3 GOAL

Hygiene Education assumes a pivotal role as part of disease prevention. Hygiene Education needs to be widespread and reach the population from various angles in order to be effective. The overall goal of Hygiene Education is to enhance the learning capacity of primary school children by improving health and sanitation.

3.4 STRATEGIES

a.) A Healthy School Environment

Schools should be a safe place for students to learn and play in and with technical assistance could implement activities to improve water and sanitation facilities and reduce mosquito breeding grounds.

b.) Skills-based Hygiene Education Curriculum

The hygiene education curriculum should be age- and gender-appropriate and responsive to the health needs of the local community, and should include activities focussed on the acquisition of skills and knowledge.

c.) Community Partnerships for Health

Schoolchildren can serve as "health ambassadors" to their families and communities. School health programs are an opportunity for schoolchildren, parents, teachers, NGOs, religion groups and political groups to work together and can be an important tool for community health promotion.

3.5 OBJECTIVES

The goal will be achieved by the fulfilling the following two primary objectives:

- Improving sanitation and water supply facilities at primary schools.
- Improving hygiene, sanitary, health and nutrition awareness among primary school children.

3.6 INTEGRATED PROGRAM

It is more important that hygiene education is combined with construction and rehabilitation of sanitation and water supply facilities at primary schools. Therefore, the objectives will be achieved by implementing the following main activities:

- Construction and rehabilitation of toilet facilities at primary schools (one toilet per fifty children).
- Provision of water facilities (one water point per 250 children) in primary schools by connecting schools to community water systems, rehabilitating or installing community systems, or installing school pumps, tanks, wells, etc.
- Promotion of good hygiene, sanitation, health and nutrition practices through an awareness program aimed at primary school children, teachers and parents.

Clean and safety sanitary and water supply facilities are exceedingly important to prevent diseases and to improve health condition for schoolchildren. Construction and rehabilitation of the facilities should be implemented in the early stages of the program.

3.7 PROGRAM ARRANGEMENT

There are mainly three sectors with relation to sanitation matters and hygiene education. Primarily personnel of water and sanitation sector manages construction and/or rehabilitation of sanitation and water supply facilities, secondly those of health sectors concern with sanitation issues as health problems, thirdly those of education sector engage in teaching as a curriculum at school.

When hygiene education program in primary schools is launched, program arrangement necessarily would be arisen among those sectors mutually. Simultaneously, an effective program needs to accept information and activities from other sectors.

Furthermore, as decentralization has permeated programs and activities are launched in districts respectively. Health Administrators at district level would consult the implementation of hygiene education at primary schools with health problems at districts, while Education Administrators would advise curricula at primary schools. Moreover the details and the schedule of Hygiene Education need to be discussed and arranged by the headmasters of primary schools respectively.

As a result, contact agencies and personnel are needed as follows:

	Health Sector	Education Sector
National Level	East Timor Transitional Administration (ETTA) Division of Health Services	Division of Education
District Level	District Affairs, ETTA Health Sector	District Affairs, ETTA Education Sector ／ Education Committee
Sub-District Level	Health Center	Primary School
Personnel	• Health Personnel	• Teachers

3.8 PROGRAM MANAGEMENT

3.8.1 School Health Committee at Primary School

Program management agency as “School Health Committee” at primary school need to be established in order to perpetuate not only maintenance of sanitation and water supply facilities but also improvement of school environment for schoolchildren.

School health committee will be composed schoolchildren, a headperson, teachers, parents, health personnel, religious person and a community leader. This body shall hold meeting periodically and manage a field of school health included health, sanitary and nutrition matters.

3.8.2 Advisory Committee at Sub-district and District Levels

An advisory committee for school health would be created to help oversees the progress of the program at every sub districts and districts. This body would be also ensured a mechanism for discussion of issues and matters related to school health. The committee would be composed of representatives from primary school, health sector, water & sanitation sector, religious group, women's group and community leader.

3.9 DESCRIPTION OF PROGRAM

The plan of hygiene education in primary schools include the following:

- Preparation of materials for hygiene education
- Implementation of hygiene education to primary school children

3.9.1 Topics

The hygiene education program should enhance and extend the knowledge, attitude and practice of schoolchildren at levels of age. It is important that the knowledge is available to schoolchildren practically. The topics managed at hygiene education would encourage "Integrated Management of Childhood Illness" considerably.

Topics to be included are the following:

- To demonstrate the link between water and health

  e.g. the importance of personal hygiene, the importance of hand washing and how to wash hands with soap

- To show the profound influence of water supply and quality on public health

  e.g. the importance of clean water and sanitation, the importance of safe water and safe cooking

- To describe the basic classification of water-related disease

  e.g. the importance of vector control and practice of control against vectors, the process of transmission of vector-borne diseases such as Malaria, Dengue fever, the practice to maintain toilet and water supply facilities

- To describe the concept of faecal-oral route of disease transmission and water-borne disease cycle

  e.g. the process of transmission of intestinal parasites

- To demonstrate the relation between environment and health

  e.g. the importance of managing rubbish disposal and sanitation, the practice to maintain environment in- and out-school building

3.9.2 Personnel

The issues of hygiene education are interrelated with various points in three sectors such as water & sanitation, education and health sector. However, health personnel practically implement hygiene education. The health personnel would be managed by Health Centre / Health Post in the program areas. The method of the program should be periodical visits of specially trained health professionals or volunteers to primary schools. The executer as a hygiene educator not only give schoolchildren hygiene education but also inspect the condition of the school environment at school visits. In addition, the specialty of health personnel would enable to consult from teachers and/or parents for health condition of schoolchildren.

3.9.3 Preparation of Materials for Hygiene Education in Selected Primary Schools

3.9.3.1 Material

Higher level support include the development and distribution of teaching aids such as posters, flip charts, flash cards, leaflets, flyers, calendars, songs games, comic books and magazines on the hygiene education. Posters are especially simple to produce and economical materials for use of hygiene education to primary school children. Informative messages and illustrations regarding the subject include the following:

- Washing hands with soap.
- Regular washing of the hands after using the toilet.
- Regular maintenance of the water and sanitation facility by keeping them clean and operational.
- Using a toilet instead of using a place in a filed and/or a river
- Giving information on the importance of the toilet facility.
- Clean up the toilet and surrounding to prevent the breeding of mosquitoes.

These messages related with health matters would supply the deficit in the messages made by others. If the materials for hygiene education are produced by the size of A4 sheets, the materials will be used for posters to be enlarged by a photocopy machine.

3.9.3.2 Material maker

a) Schoolchildren
To learn and practice on subjects of hygiene education effectively is to make materials in a class by schoolchildren by themselves.

b) Health personnel
Workshop conducted by health sector should plan to make materials for hygiene education in primary schools and community by health personnel participated the workshop. The materials made by participants have the local characteristic qualities by workshop site. To prepare the materials by themselves lead to demonstrate hygiene education to schoolchildren in primary schools.

c) School teachers

Workshop conducted by education sector should plan to make materials for hygiene education in primary schools by school teachers participated the workshop. The materials made by participants have the local characteristic qualities by workshop site. To prepare the materials by themselves lead to demonstrate hygiene education to schoolchildren in primary schools.

3.9.4 Details of Hygiene Education

At first stage of hygiene education program the sixth grade of a primary school is the target school year for hygiene education in principle. It is the reason that the sixth grade is the highest school year at a primary school and they could take care of the schoolchildren of the lower grades in the school.

Time schedule for the implementation of hygiene education is adjusted to the curriculum at the schools respectively. Accordingly, the period of teaching time is mainly thirty to forty-five minutes at one class in one primary school. Too long lessons is not suitable for schoolchildren at one time.

A suitable hygiene educator teaches schoolchildren about basic personal hygiene and sanitation with the materials and other goods such as a piece of soap to demonstrate washing hands effectively.

Topics of the hygiene education time were focused as a first step of milestone as follows:

- The importance of personal hygiene
- The importance of clean water and sanitation
- The importance of hand washing and how to wash hands with soap
- The practice to maintain toilet and water supply facilities

4. WELL REHABILITATION/CONSTRUCTION

4.1 Outline of Well Operation

Wells are often allowed to deteriorate for such a long time that their specific capacity may be impossible to restore completely, even when using the best techniques for rehabilitation. To guard against such a situation, it is essential that the well owner keep good well records so that any decline in its performance will not go undetected. Proper and timely maintenance of a well designed to overcome specific problems can sustain well performance and prolong its life.

Inspection and routine maintenance schedule must be established on the basis of the individual characteristics of the well and pump. It is important to note any changes in the operating characteristics of the well and pump. Otherwise they will deteriorate to the point where even rehabilitation is impossible. As soon as 10 to 15% drop in specific capacity of a well is observed, measures should be taken to determine the cause and correct the problems. If it declines by more than 25%, it is time to consider rehabilitation.

During the operation of the wells, the following items should be regularly checked and recorded to be compared with the initial records attached to this manual.

	Observation Item	Frequency
1	Static water level	Whenever possible after recovery of water level
2	Pumping rate and pumping water level after a specified period of continuous pumping (to calculate specific capacity)	Whenever possible after recovery of water level
3	Operational pumping rate, water level and daily operation period	Daily
4	Sand content in the water sample after a specified period of continuous pumping	Monthly
5	Condition of the submersible pump (Unusual noise, heat and vibration) See chapter 2 – (e) for more detail	Whenever it happens

4.2 Problems and Maintenance

A significant change in any of the conditions listed above indicates that a well or pump is in need of attention. The following five major problems occur with well over a long period of time and they all involve a reduction in the well yield.

(a) Chemical incrustation or biofouling of the well screen

(b) Plugging of the formation around the well screen by fine particles
(c) Sand pumping
(d) Structural collapse of the well casing or screen
(e) Condition of the pump

The next table summarizes common problems occurring in various types of aquifers and the typical maintenance frequency required.

Table 4.1 WELL PROBLEMS AND MAINTENANCE FREQUENCY

Type of Aquifer	Most Common Problems	Major Maintenance Frequency	Application
Alluvial	Silt, clay, sand intrusion; iron precipitation; incrustation of screens; biologic fouling; limited recharge; casing failure	2 – 5 years	Wells in Hera, Dili Central and Liquica
Sandstone	Fissure plugging; casing failure; sand production; corrosion	6 – 10 years	
Limestone	Fissure plugging by clay, silt and carbonate scale	6 – 12 years	Wells in Baucau and Los palos
Basaltic Lavas	Fissure and vesicle plugging by clay and silt; some scale deposition.	6 – 12 years	
Interbedded sandstone and shale	Low initial yield; plugging of aquifer by clay and silt. fissure plugging; limited recharge; casing failure	4 – 7 years	
Metamorphic rocks	Low initial yield; fissure plugging by silt and clay; mineralization of fissures	12 – 15 years	
Consolidated sedimentary	Fissure plugging by iron and other minerals; low to medium initial yield	6 – 8 years	
Semi-consolidated sedimentary	Clay, silt and sand intrusion; incrustation of screens in sand and gravel wells; fissure plugging of limestone aquifers in the interbeded sand, gravel, marl, clay, silt formations; biologic fouling; iron precipitation	5 – 8 years	

Estimates of major maintenance frequencies are based on the following assumptions:
1. Wells are being pumped continuously at the highest sustained rate they are capable of producing.
2. Major maintenance is required when the sustained yield decreases to 75% of the initial yield.
3. Major maintenance is considered to represent a cost expenditure of approximately 10 % of the total current replacement cost. Minor maintenance is excluded.

The measures to prevent and cure each of the above problems are presented below. Although various measures are briefly explained in the following section, it is always best to consult with experienced drilling contractors about the problems and that is when the well operation records come in handy.

4.2.1 Chemical Incrustation or Biofouling

No preventive measures are available although the process of incrustation can be delayed or made less serious by taking the following measures. First the well screen should be

designed to have the maximum possible area to reduce the flow velocity to the minimum through the screen openings. The well should be developed thoroughly. The pumping rate may reduced and the pumping period extended. The pumping load may be divided among a number of smaller diameter wells instead of using one large diameter well. More frequent maintenance and longer cleaning procedure for each well should be practiced.

As for the remedial measure, chemical incrustation can be best removed by treating the well with a strong acid solution that chemically dissolves the incrusting materials so they can be pumped out from the well. Their chief value lies in their ability to dissolve mineral scale as well as some of the iron deposits formed by iron bacteria. The most commonly used acids are hydrochloric (HCl), sulfamic (H_3NO_3S), and hydroxyacetic ($C_2H_4O_3$). Since these chemicals are all highly harmful, great care must be taken in handing them. Only experienced persons with proper equipment should carry out the chemical treatment.

Several mechanical methods are also effective in some cases to remove incrustants. Wire brushing and other means of mechanical scraping can remove the incrustants that have precipitated on the inside of the well screen. Bailing or air lifting will take out the loosened material.

Iron bacteria occur widely in wells open to atmosphere when sufficient iron and/or manganese are present in the groundwater along with dissolved organic material. Precipitation of iron and rapid growth of the bacteria create a voluminous material that quickly plugs the screen pores of the sediment surrounding the well bore.

To avoid introduction of iron bacteria during the construction, all drilling fluid mix water should be chlorinated initially to a 50mg/liter free chlorine concentration. Even if the water is secured from a water supply system that has a chlorination device, more chlorine must be added periodically to maintain 10 mg/L free chlorine residual.

If iron bacteria are found to be growing in a well, they can be controlled by chemical treatments and various types of physical methods as shown in the table below.

Methods to Control Iron Bacteria

Chemical	Physical
Oxidizing agents such as chlorine	Heat
pH adjustors such as acids	Explosives
Quaternary ammonium compounds	Ultrasonics
	Radiation
	Anoxic blocks

4.2.2 Plugging of the Formation around the Well Screen by Fine Particles

Over time, almost all screened wells will undergo some loss in specific capacity. Some of this loss is attributable to the slow movement of fine formation particles into the area around the screen. Depending on the type of screen-slot opening, many of these particles may partially plug the screen itself, or even erode the slot openings under certain conditions.

Movement of sediment into the formation around the screen can be largely prevented by thorough development of the well during its completion. Application of an appropriate development technique for a sufficient length of time will stabilize the formation materials so that subsequent pump cycling and higher discharge rates will not result in sediment movement.

Silt and clay particles tend to adhere strongly to each other, which makes their removal form sand and gravel very difficult. These materials can be effectively removed by treatment with dispersing and sequestering (chelating) compounds. They have the power to separate the clay particles. Furthermore, calcium, magnesium and iron ions adhering to the tiny particles can be removed by the use of these chemicals. Sodium polyphosphates, a family of free flowing dry materials, have been used widely with great success in treating clay-plugging problems. Agitation of phosphate solution is important in removing the maximum amount of fine material from the formation. It can be done by using a surge plunger, compressed air, well pump or high-velocity jet.

4.2.3 Sand Pumping

Some wells always pump sand, a condition usually attributable to poor well design or inadequate development. Localized corrosion of the well screen or casing, or incrustation on only a portion of the screen, can produce higher velocities through either the corroded opening or the non-incrusted areas of the screen. Sand grains moved by these higher velocities erode and enlarge the screen openings mechanically.

4.2.4 Structural Collapse of the Well Casing or Screen due to Corrosion

This type of failure is often produced by low-pH waters containing high total dissolved solids and carbon dioxide concentrations that combine to cause electrolytic corrosion along the casing below the static water level.

Corrosion results from chemical and electrochemical processes. Chemical corrosion occurs when a particular substance is present in water in sufficient concentration to cause rapid removal of material over broad areas. Commonly these substances are carbon dioxide (CO_2), oxygen (O_2), hydrogen sulfide (H_2S), hydrochloric acid (HCl), chloride (Cl) and sulfuric acid (H_2SO_4).

In electrochemical corrosion, flow of an electric current facilitates the corrosive attack on a metal. Two conditions are necessary; a difference in electrical potential on metal surfaces and water containing enough dissolved solids to be a conductive fluid. A potential difference may develop between two different kinds of metals or between nearby but separate areas on the surface of the same metal. Deposition of corrosion products that results in blocked screen slot openings and reduced well yields is evidence of electrochemical corrosion.

General corrosion may be reduced or even prevented by selecting materials that are resistant in corrosive environment. Use of stainless steel screen and casing can effectively prevent corrosion. In order to avoid galvanic corrosion, when it is necessary to use two different metals in the same corrosive environment, they should be kept apart by non-conductive gaskets and insulated bolts or the anodic alloy should have far greater surface area than the cathodic alloy.

4.2.5 Pump Condition

Submersible pumps are generally built with durable materials and designed to last long. However, pumps are often operated under less than ideal physical and chemical conditions and these pumps require maintenance after shorter service period than the ones operated in ideal conditions.

The condition of the pumping unit can be evaluated from the following checklist (applying in part to both vertical turbine and submersible pumps).

- Does the pump operate on its original design curve?

- Is there excessive heating of the motor?
- Has there been a change a change in the pattern of oil consumption of the motor?
- Is there excessive vibration?
- Has the amperage or voltage load to the pump changed?
- Are there cavitation noises or any other unusual sounds?

Has cracking or uneven settlement of the pad or around the pump occurred?

Once a problem is recognized, maintenance has to be performed. For more specific information that applies to the submersible pumps installed in each well, refer to the attached submersible pump manual supplemented with the body of a machine.