

Document Title: <b>Engine, description</b>	Function Group: <b>200</b>	Information Type: <b>Service Information</b>	Date: <b>2014/4/14</b>
Profile: <b>CEX, ECR28 [GB]</b>			

## Engine, description

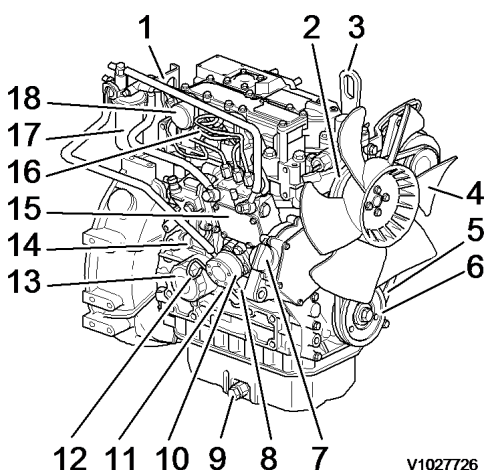
**Model code (3TNV76)**

**Model code**

Symbol	Description	Remarks
3	Number of cylinders	
TNV	Model series	
76	Cylinder bore (mm)	

- The engine is a 3-cylinder, indirect injected, water cooled diesel engine.

### Engine, front view

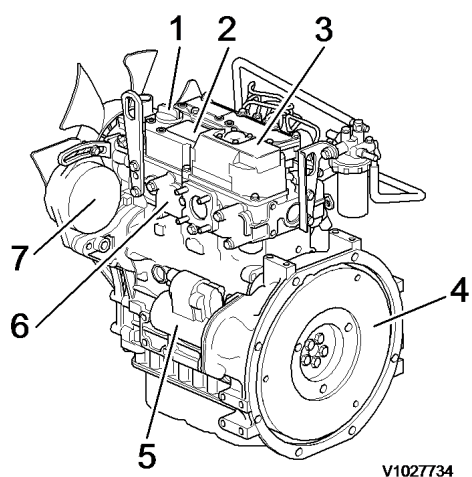


**Figure 1**

### Engine, front view

- Lifting eye
- Cooling water pump
- Lifting eye
- Fan
- V-belt
- V-pulley
- Filler port (lube oil)
- Fuel oil inlet
- Drain plug (lube oil)
- Mechanical fuel feeding pump
- Fuel priming lever
- Dipstick
- Oil filter
- Governor lever
- Fuel injection pump
- Intake manifold
- Fuel filter
- Air intake port

**Engine, rear view**



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**Figure 2**

**Engine, rear view**

1. Filler port (lube oil)
2. Bonnet (rocker arm cover)
3. Engine name plate
4. Flywheel
5. Starter motor
6. Exhaust manifold
7. Alternator

Document Title: <b>Precautions</b>	Function Group: <b>200</b>	Information Type: <b>Service Information</b>	Date: <b>2014/4/14</b>
Profile: <b>CEX, ECR28 [GB]</b>			

## Precautions

Make preparation as follows before starting engine inspection and service.

- Fix the engine on a horizontal base.
- Remove the coolant hoses, fuel oil pipes, wire harness, control wires etc. connecting the driven machine and engine, and drain coolant, lubricating oil and fuel.
- Remove soil, oil, dust, etc. from the engine by washing with solvent, air, steam, etc. Carefully operate so as not to let any foreign matter enter the engine.
- Any part which is found defective as a result of inspection or any part whose measured value does not satisfy the standard or limit shall be replaced.
- Any part predicted to dissatisfy the standard or limit before the next service as estimated from the state of use should be replaced even when the measured value then satisfies the standard or limit.

Document Title: <b>Periodic inspection and maintenance procedure</b>	Function Group: <b>200</b>	Information Type: <b>Service Information</b>	Date: <b>2014/4/14</b>
Profile: <b>CEX, ECR28 [GB]</b>			

## Periodic inspection and maintenance procedure

### Check before daily operation

Be sure to check the following points before starting the engine every day.

### Visual check around engine

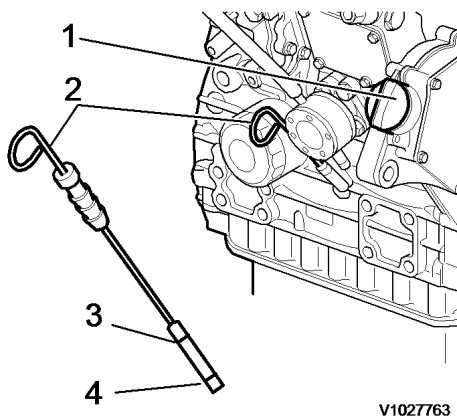
- Oil leak from the lubrication system
- Fuel leak from the fuel system
- Cooling water leak from the cooling water system
- Damaged parts
- Loosened or lost bolts
- Fuel, radiator rubber hoses, V belt cracked, loosened clamp

### Fuel tank level check and fuel supply

Check the remaining fuel oil level in the fuel tank and refuel the recommended fuel if necessary.

### Lube oil level check and replenishment

- Checking oil level.  
Check the engine oil level with the dipstick, after adjusting the posture of the machine unit so that the engine is level. Insert the dipstick fully and check the oil level. The oil shall not be contaminated heavily and have appropriate viscosity. No coolant or diesel oil shall be mixed.  
The level shall be between the upper and lower limit lines on the dipstick.



**Figure 1**  
**Checking oil level and replenishing with engine oil**

1. Filler port (lube oil)
2. Dipstick
3. Upper limit
4. Lower limit

**Engine oil capacity, unit: liter (gal.)**

<b>Total volume</b>	<b>Effective volume</b>
---------------------	-------------------------

- Replenishing oil pan with engine oil.  
If the remaining engine oil level is low, fill the oil pan with the specified engine oil to the specified level through the filler port.

**NOTE!**

The oil should not be overfilled to exceed the upper limit line. Otherwise, oil may jet out from the breather or the engine may become faulty.

**Coolant inspection**

Daily inspection of the coolant should be done only by sub-tank.

**! WARNING**

**Risk of scalding and burns when the expansion tank cap (radiator cap) is opened due to high pressure in the cooling system.**

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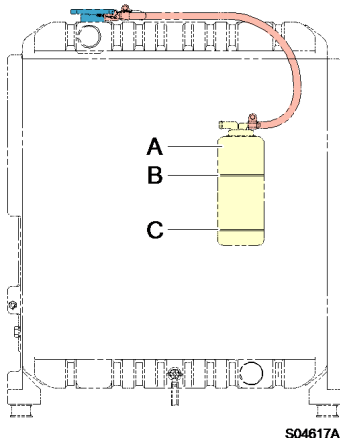
**! WARNING**

**Before removing the radiator cap, stop the engine and let it cool down sufficiently. When removing it, turn it slowly to release the pressure.**

**NOTE!**

Securely tighten the filler cap after checking the radiator. Steam can spurt out during operation, if the cap is not properly tightened.

- Checking coolant volume  
Check the coolant level in the sub-tank. If the water level is close to the LOW mark, open the sub-tank cap and replenish the sub-tank with clean soft water or premix to the FULL mark.  
The coolant level of the sub-tank shall be between the upper and lower limit lines.

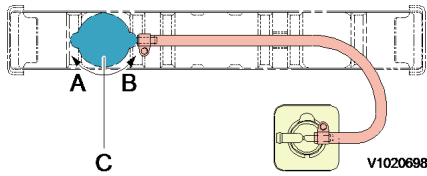


**Figure 2**  
**Checking, coolant level in the sub-tank**

- A. Sub-tank
- B. Upper limit
- C. Lower limit

- Replenishment engine with coolant  
If the sub-tank coolant level is lower than the LOW mark, open the radiator cap and check the coolant level in the radiator. Replenish the radiator with coolant, if the level is low.  
**Check the coolant level while the engine is cool. Checking when the engine is hot is dangerous. And the coolant volume is expanded due to the heat.**

Daily coolant level check and replenishing shall be done only at the sub-tank. Usually do not open the radiator cap to check or replenish.



**Figure 3**  
**Replenishment, coolant**

- A. Tighten
- B. Loosen
- C. Radiator cap

**NOTE!**

If the coolant runs short quickly or when the radiator runs short of coolant with the sub-tank level unchanged, coolant may be leaking or the air tightness may be lost. Increase in the sub-tank level during operation is not abnormal. The increased coolant in the sub-tank returns to the radiator when the engine is cooled down. If the level is normal in the sub-tank but low in the radiator, check for loosened clamping of the rubber hose between the radiator and sub-tank or a tear in the hose.

Engine: The radiator shall be filled up.

**Coolant capacity, unit: liter (gal)**

Coolant volume in the engine
0.9 (0.23)

**Fuel pipe and cooling water pipe inspection and maintenance**

Check the rubber hoses for fuel and cooling water pipes cracked. If the cracked hose is found, replace it with new one. Check the loosened clamp. If found, tighten it.

**Warning lamp & instruments function check**

Before and after starting the engine, check to see that the alarm function normally. Failure of alarm cannot warn the lack of the engine oil or the cooling water. Make it a rule to check the alarm operation before and after starting engine every day.

**Checking accelerator operation**

Make sure the accelerator of the machine unit can be operated smoothly before starting the engine. If it feels heavy to manipulate, lubricate the accelerator cable joints and pivots. Adjust the accelerator cable if there is a dislocation or excessive play between the accelerator and the governor lever.

**Inspection after initial 50 hours operation**



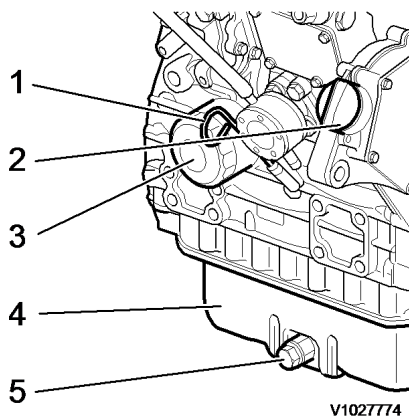
**Hot oil and hot engine coolant can cause severe burns!**

**NOTE!**

Replace engine oil after the engine oil becomes warm. It is most effective to drain the engine oil while the engine is still warm.

In early period of use, the engine oil gets dirty rapidly because of the initial wear of internal parts. Replace the engine oil earlier. Engine oil filter should also be replaced when the engine oil is replaced. Engine oil and engine oil filter replacing procedures are as follows. Remove the oil filler cap to drain easily while draining the engine oil.

- Drain engine oil
  - Prepare a waste oil container collecting waste oil.
  - Remove the drain plug using a wrench to drain the engine oil.
  - Securely tighten the drain plug after draining the engine oil.

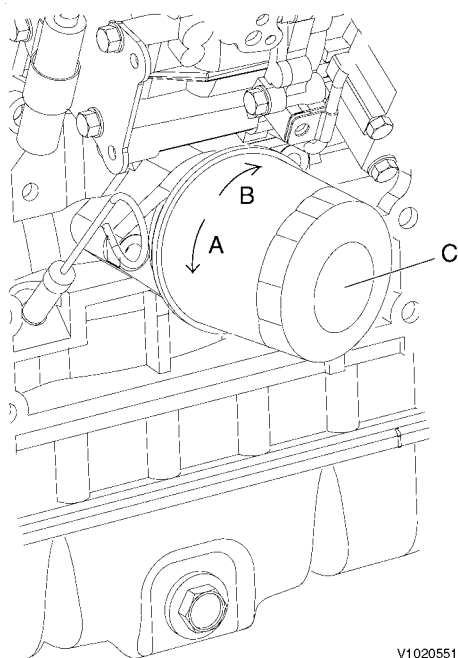


**Figure 4**  
**Dipstick gauge, oil pan and drain plug**

1. Dipstick
2. Oil filler cap
3. Oil filter
4. Oil pan
5. Drain plug

- Replacing oil filter

- Turn the engine oil filter counterclockwise using a filter wrench to remove it.
- Clean the mounting face of the oil filter.
- Moisten the new oil filter gasket with the engine oil and install the new engine oil filter manually turning it clockwise until it comes into contact with the mounting surface, and tighten it further to 3/4 of a turn with the filter wrench.
- Tightening torque: 2.0 ~ 2.4 kgf·m (14.4 ~ 17.3 lbf·ft).
- Applicable oil filter part number: 119305-35150.



**Figure 5**  
**Replacement, engine oil filter**

- A. Loosen
- B. Tighten

C. Engine oil filter

- Filling oil and inspection

- Filling oil and inspection

**NOTE!**

Do not overfill the oil pan with engine oil. Be sure to keep the specified level between upper and lower limit on the dipstick.

- Warm up the engine by running for 5 minutes while checking any oil leakage.
  - Stop the engine after warming up and leave it stopped for about 10 minutes then recheck the engine oil level with dipstick and replenish the engine oil. If any oil is spilled, wipe it away with a clean cloth.

**Checking and adjusting radiator fan V-belt**

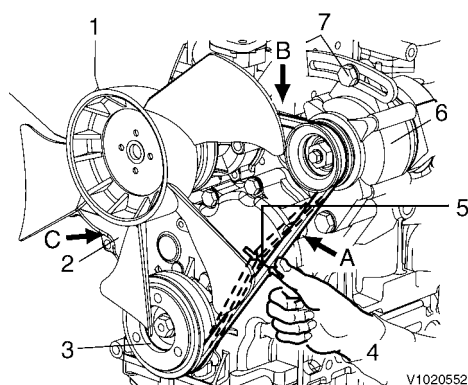
When there is not enough tension in the V-belt, the V-belt will slip making it impossible for the alternator to generate power and water pump and cooling fan will not work causing the engine to overheat. Check and adjust the V-belt tension (deflection) in the following manner.

- Press the V-belt with your thumb [approx. 98N (10kgf)] at the middle of the V-belt span to check the tension (deflection).

Available positions to check and adjust the V-belt tension (deflection) are at the A, B or C direction as shown in the illustration right.

You may choose a position whichever you can easily carry out the check and adjustment on the machine unit.

- "New V-belt" refers to a V-belt which has been used less than 5 minutes on a running engine.
  - "Used V-belt" refers to a V-belt which has been used on a running engine for 5 minutes or more.
  - The specified deflection to be measured at each position should be as follows.



**Figure 6**

**Checking and adjustment, radiator fan V-belt**

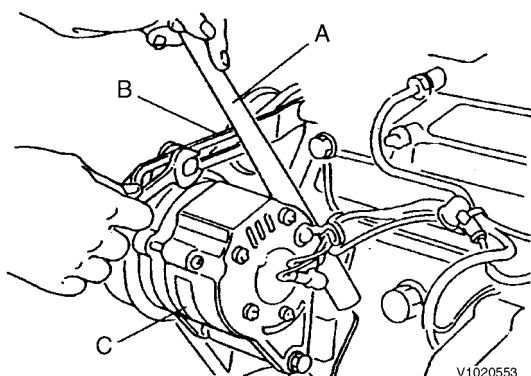
1. Radiator fan
2. V-belt
3. Crankshaft V-pulley
4. Press with thumb
5. Deflection
6. Alternator
7. Set screw

**V-belt deflection, unit: mm (in)**

Direction	A	B	C
For used V-belt	10 ~ 14 (0.39 ~ 0.55)	7 ~ 10 (0.28 ~ 0.39)	9 ~ 13 (0.35 ~ 0.51)
For new V-belt	8 ~ 12 (0.31 ~ 0.47)	5 ~ 8 (0.20 ~ 0.31)	7 ~ 11 (0.28 ~ 0.43)



- If necessary, adjust the V-belt tension (deflection). To adjust the V-belt tension, loosen the set screw and move the alternator to tighten the V-belt.  
After replacing with a new V-belt and adjusting it, run the engine for 5 minutes and readjust the deflection to the value in the table above.
- Visually check the V-belt for cracks, oiliness or wear.  
If any, replace the V-belt with a new one.



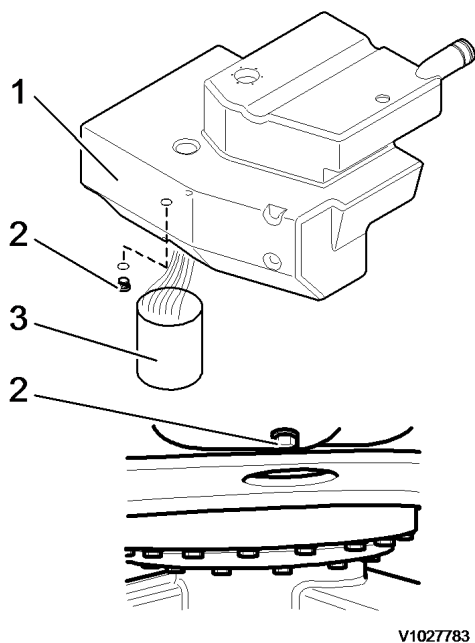
**Figure 7**  
**Adjustment, V-belt tension**

- A. Bar
- B. Adjuster
- C. Alternator

#### **Inspection 50 hours**

Be sure to check the following points every 50 hours operation.

#### **Draining of the fuel tank**

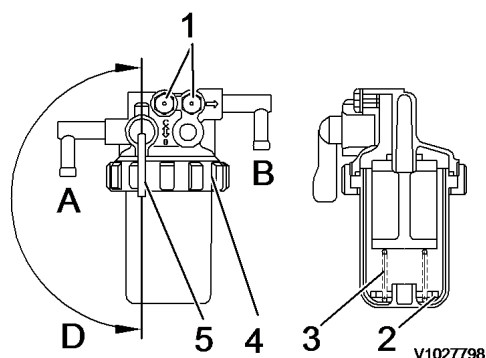


**Figure 8**  
**Draining, fuel tank**

- 1. Fuel tank
- 2. Drain plug
- 3. Oil container

- Prepare a waste oil container.
- Turn the drain cock valve of the fuel tank to drain (water, dirt, etc.) from the fuel tank bottom.
- Drain until fuel with no water and dirt flow out. Then tighten the drain cock valve firmly.

#### Draining of the oil/water separator



**Figure 9**  
**Draining, oil/water separator**

1. Air bleeding screw
2. Float ring
3. Retaining spring
4. Retaining ring
5. Fuel cock

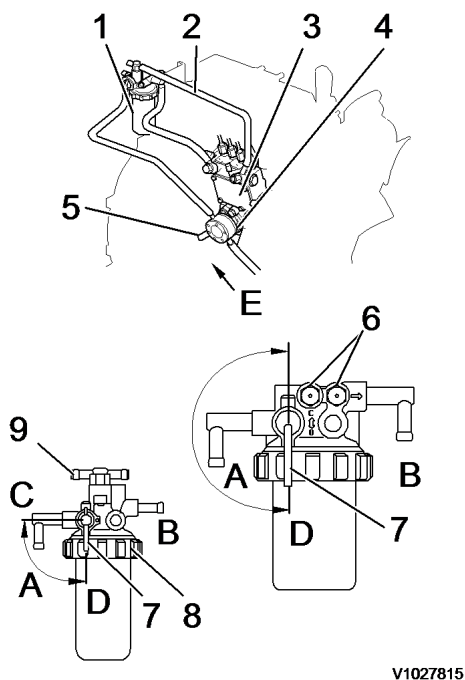
- A. Inlet
- B. Outlet
- C. Close
- D. Open

Drain off the oil/water separator whenever there is a lot of drain collected in the oil/water separator at the bottom of the cup even if not the time for periodic inspection hour. The cup of the oil/water separator is made from semi-transparency material and in the cup, the red colored float ring which rises on the surface of the drain is installed to visualize the amount of drain. Also, the oil/water separator with a sensor to detect the drain for warning device on the control panel is provided as an option.

Drain off the oil/water separator in the following manner.

- Close the fuel cock.
- Loosen the retainer ring, and remove the cup, then throw collected water and trash away.
- Put a float ring and a spring in the cup and tighten the retainer ring.  
Tightening torque: 13 ~ 16 Nm (1.3 ~ 1.6 Kgf.m).
- Be sure to bleed off any air in the fuel system.

#### Bleeding the fuel system



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**Figure 10**  
**Bleeding, fuel system**

1. Fuel filter
2. Fuel return hose
3. Fuel injection pump
4. Mechanical fuel feed pump
5. Priming lever
6. Air bleeding screw
7. Fuel cock
8. Retaining ring
9. Joint for fuel return

- A. Inlet
- B. Outlet
- C. Close
- D. Open
- E. From oil/water separator

Bleed the fuel system according to the following procedures. When there is air in the fuel system, the fuel injection pump will not be able to function.

- Check the fuel oil level in the fuel tank. Refuel if insufficient.
- Open the cock of the oil / water separator.
- Loosen the air bleeding screw on the oil /water separator by turning 2 ~ 3 times to the counterclockwise using a screw driver or spanner.
- When the fuel coming out is clear and not mixed with any air bubbles, tighten the air bleeding screw.
- Feed the fuel with the fuel priming pump or electro-magnetic fuel feed pump.
  - In case of the engine using the electro-magnetic fuel feed pump. Turn the starter switch to the ON position and hold it in the position for 10 ~ 15 seconds to operate the fuel feed pump.
  - Move the priming lever by hand up and down, and feed fuel until the fuel surface inside the fuel filter cup goes up and the air disappears inside. (Move the lever until feeling your hand slightly heavy).  
Don't do air bleeding by a starting motor.

#### **Battery inspection**

#### **NOTE!**

Fire due to electric short-circuit

- Make sure to turn off the battery switch or disconnect the negative cable (–) before inspecting the electrical system. Failure to do so could cause short-circuits and fires.
- Always disconnect the (–) Negative battery cable first before disconnecting the battery cables from battery. An accidental "Short circuit" may cause damage, fire and or personnel injury. And remember to connect the (–) Negative battery cable (back onto the battery) LAST.

#### **NOTE!**

Proper ventilation of the battery area

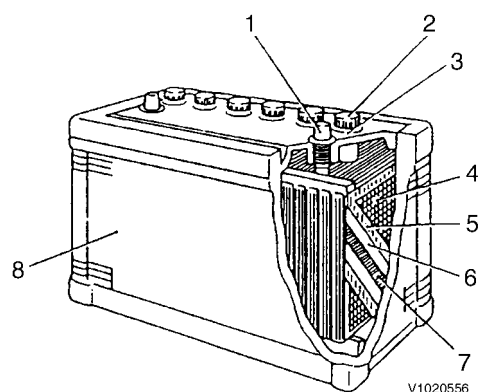
- Keep the area around the battery well ventilated, paying attention to keep away any fire source. During operation or charging, hydrogen gas is generated from the battery and can be easily ignited.

#### **NOTE!**

Do not come in contact with battery electrolyte

- Pay sufficient attention to protect your eyes or skin from being in contact with the fluid. The battery electrolyte is diluted sulfuric acid and causes burns. Wash it off immediately with a large amount of fresh water if you get any on you.

#### **Battery structure**

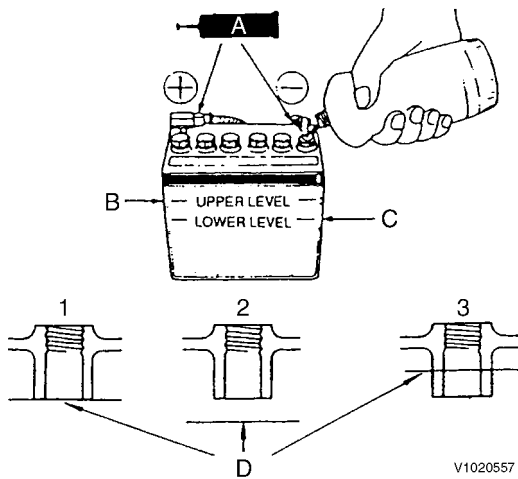


**Figure 11**

#### **Structure, battery**

1. Terminal
2. Cap
3. Cover
4. Cathode plate
5. Separator
6. Glass mat
7. Anode plate
8. Battery case

#### **Electrolyte level**



**Figure 12**  
**Checking, electrolyte level**

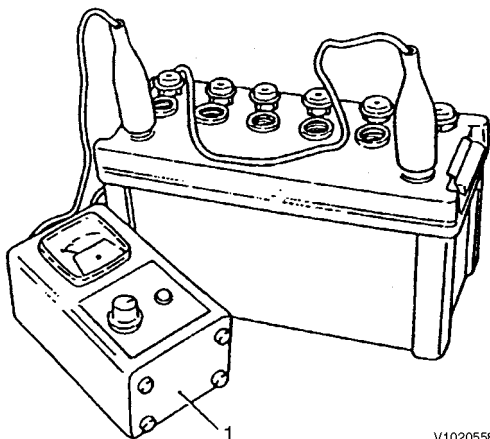
1	OK
2	Too low
3	Excessive
A	Grease
B	Upper limit
C	Lower limit
D	Electrolyte level

- Check the level of fluid in the battery.  
When the amount of fluid nears the lower limit, fill with battery fluid (available in the market) to the upper limit. If operation continues with insufficient battery fluid, the battery life is shortened, and the battery may overheat and explode.
- Battery fluid tends to evaporate more quickly in the summer, and the fluid level should be checked earlier than the specified times.
- If the engine cranking speed is so slow that the engine does not start up, recharge the battery.
- If the engine still will not start after charging, replace the battery.
- Remove the battery from the battery mounting of the machine after daily use if leaving the machine in a place that the ambient temperature could drop at  $-15^{\circ}\text{C}$  ( $5^{\circ}\text{F}$ ) or less. And store the battery in a warm place until the next use, to start the engine easily at low ambient temperature.

### Battery charge

Use a battery tester or hydrometer and check the battery condition. If the battery is discharged, recharge it.

### Measurement with a battery tester



**Figure 13**  
**Measurement, battery charge**

1. Tester

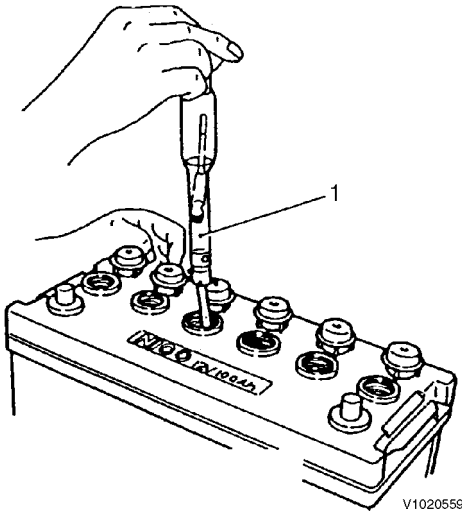
When checking the battery with the batter tester, connect the red clip of the tester to the battery positive (+) terminal and black clip to the battery negative (-) terminal by pinching them securely, and judge the battery charge level from the indicator position.

Green zone: Normal

Yellow zone: Slightly discharged

Red zone: Defective or excessively discharged

**Measurement with hydrometer**



**Figure 14**  
**Measurement, battery charge**

1. Float

When using a hydrometer, the measured specific gravity must be corrected according to the temperature at the time of measurement. The specific gravity of battery electrolyte is defined with 20 C (68 °F) as the standard. Since the specific gravity increases or decreases by 0.0007 when the temperature varies by 1 C (33.8 °F), correct the value according to the equation below.

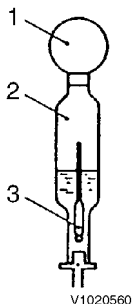
$$S_{20} = S_t + 0.0007 (t - 20)$$

where to,

$S_{20}$  = Converted specific gravity at 20 C (68 °F)

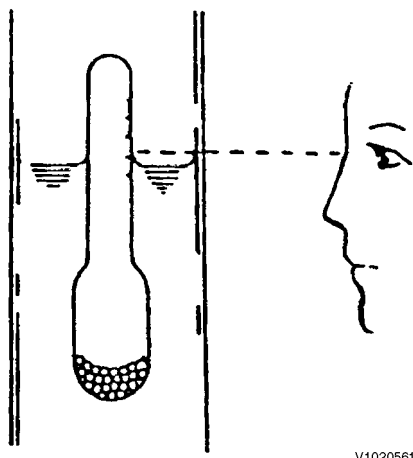
$S_t$  = Specific gravity at measurement

$t$  = Electrolyte temperature at measurement



**Figure 15**  
**Hydrometer structure**

1. Rubber bulb
2. Glass tube
3. Float



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**Figure 16**  
**How to read hydrometer**

#### **Specific gravity and remaining battery charge**

<b>Specific gravity (20 °C)</b>	<b>Discharged quantity of electricity (%)</b>	<b>Remaining charge (%)</b>
1.28	0	100
1.26	10	90
1.24	20	80
1.23	25	75

#### **Terminals**

Clean if corroded or soiled.

#### **Mounting bracket**

Repair or replace it if corroded.

Retighten if loosened.

#### **Battery appearance**

Replace the battery if cracked or deformed.

Clean with fresh water if contaminated.

#### **Inspection every 250 hours or 3 months**

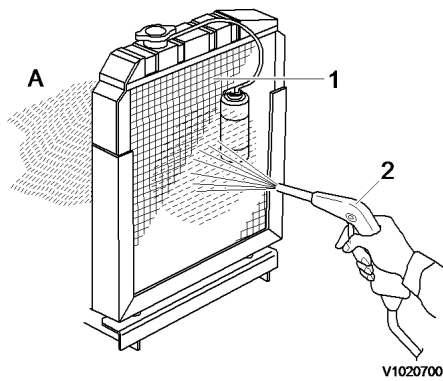
Be sure to check the following points every 250 hours or 3 months operation, whichever comes first.

#### **Oil and filter replacement (The second replacement and after)**

Replace the engine oil every 250 hours operation from 2nd time and

Replace the engine oil filter at the same time.

#### **Inspection and cleaning of radiator fin**



**Figure 17**  
**Inspection and cleaning, radiator fin**

1	Radiator fin
2	Air blow
A	Dust, dirt

Dirt and dust adhering on the radiator fins reduce the cooling performance, causing overheating. Make it a rule to check the radiator fins daily and clean as needed.

Blow off dirt and dust from fins and periphery with compressed air 2 kgf/cm<sup>2</sup> (28 psi) or less] not to damage the fins with compressed air.

If contaminated heavily, apply detergent, thoroughly clean and rinse with tap water shower.

**NOTE!**

Wear protective equipment such as goggles to protect your eyes when blowing compressed air. Dust or flying debris can causes eye injury.

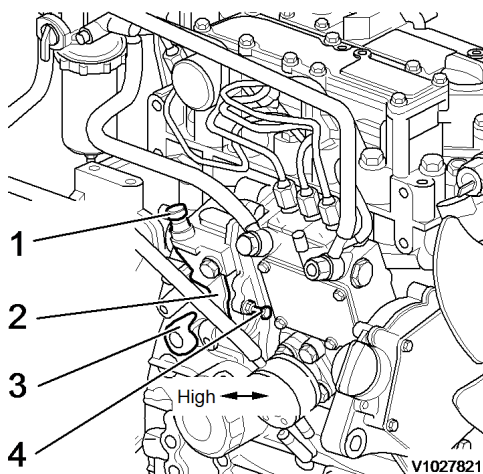
**NOTE!**

Do not use high pressure water or air close to the fins or do not attempt to clean using a wire brush. Radiator fins can be damaged.

**Checking and adjusting radiator fan V-belt**

Check and adjust the V-belt tension. (See Inspection initial after 50 hours, checking and adjusting radiator fan V-belt).

**Adjustment of governor lever and accelerator device**



**Figure 18**  
**Adjustment, governor lever and accelerator device**

1. High idle limiting screw
2. Governor lever
3. Accelerating wire bracket
4. Low idle limiting screw



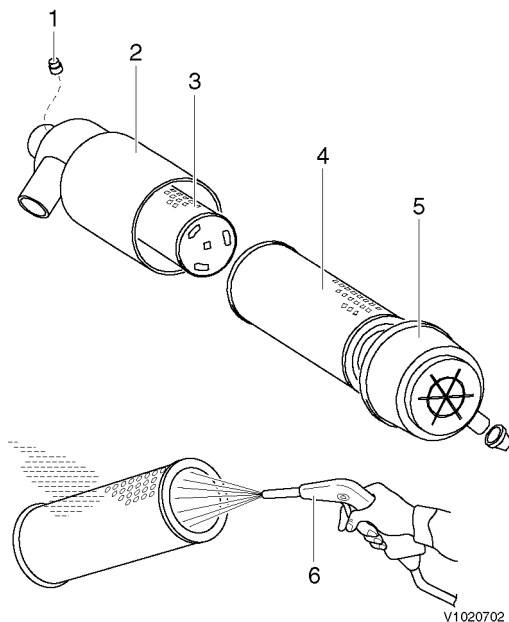
The governor lever and accelerating devices (accelerating lever, pedal, etc.) of the machine unit are connected by an accelerating cable or rod. If the cable becomes stretched or the connections loosen, deviation in the position may result and make operation unsafe. Check the cable periodically and adjust if necessary. Do not strongly move the accelerating cable or accelerating pedal. It may deform the governor lever or stretch the cable to cause irregular engine speed control. Checking and adjusting procedure are as follows:

- Check that the governor lever of the engine makes uniform contact with the high idling and low idling limiting screw when the accelerating device is in the high idling speed or low idling speed position
- If either the high or the low idling speed side does not make contact with the limiting screw, adjust the accelerating cable. Loosen the accelerating cable fixing nut and adjust the cable to contact the limiting screw.

**NOTE!**

Do not release the limiting screws. It will impair the safety and performance of the product and functions and result in shorter engine life.

**Air cleaner element cleaning**



**Figure 19**  
**Cleaning, air cleaner element (double type)**

1. Dust indicator (optional)
2. Air cleaner case
3. Inner element
4. Outer element
5. Dust pan
6. Air blow

The engine performance is adversely affected when the air cleaner element is clogged by dust. So periodic cleaning after disassembly is needed.

**NOTE!**

Wear protective equipment such as goggles to protect your eyes when blowing compressed air. Dust or flying debris can causes eye injury.

- Undo the clamps on the dust pan and remove the dust pan.
- Pull out the outer element.
- Blow air 3.0 ~ 5.0 kgf/cm<sup>2</sup> (43 ~ 71 psi) from inside the element to blow dust off as shown in the illustration left. Apply the air blowing pressure as low as possible so as not to damage the element.  
If having the air cleaner with double elements, do not remove and clean the inner element.  
The aim of installing the inner element is for back up protection when the outer element is unexpectedly damaged during engine running.

- Replace the element with new one, if the element is damaged, excessively dirty or oily.
- Install the dust pan to the air cleaner case placing the TOP mark upward.

**NOTE!**

When the engine is operated in dusty conditions, clean the element more frequently. Do not run the engine with air cleaner or element removed, as this may cause foreign material to enter and damage the engine.

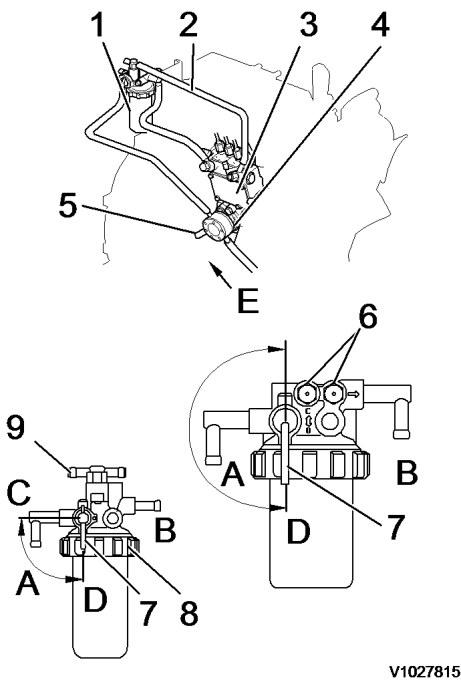
**Inspection every 500 hours or 6 months**

Be sure to check the following points every 500 hours or 6 months operation, whichever comes first.

**Air cleaner element**

Replace the air cleaner element periodically even if it is not damaged or dirty. When replacing the element, clean inside of the dust pan at the time. If having the air cleaner with double elements, do not remove the inner element. If the engine output is still not normal (or the dust indicator still actuates if having the air cleaner with a dust indicator) even though the outer element was replaced with a new one, replace the inner element with a new one.

**Fuel filter element**



**Figure 20**  
**Replacement, fuel filter**

1. Fuel filter
2. Fuel return hose
3. Fuel injection pump
4. Mechanical fuel feed pump
5. Priming lever
6. Air bleeding screw
7. Fuel cock
8. Retaining ring
9. Joint for fuel return

- A. Inlet
- B. Outlet
- C. Close
- D. Open
- E. From oil/water separator

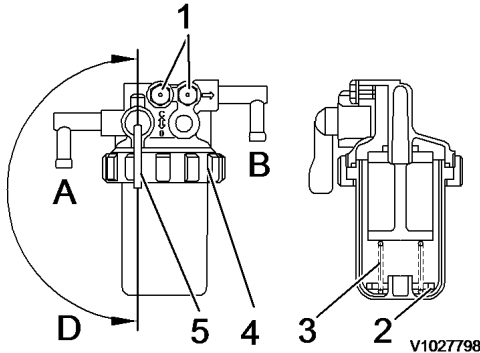
Replace the fuel filter at specified intervals before, it is clogged with dirt to adversely affect the fuel flow. Also, replace the fuel filter after the engine has cooled.

- Close the fuel filter cock.
- Loosen the retaining ring and replace the fuel filter element. Take the water and trash in the cup out. When removing the fuel filter with a piece of rag to prevent the fuel oil from dropping. If you spill fuel, wipe such spillage carefully.
- Install the new fuel filter element and tighten the retainer ring.  
Tightening torque: 1.3 ~ 1.6 kgf·m (9.4 ~ 11.5 lbf·ft)  
Applicable fuel filter part no.: 119740-55650
- Bleed the fuel system.

#### **NOTE!**

Be sure to use genuine Yanmar part (super fine mesh filter). Otherwise, it results in engine damage, uneven engine performance and shortened engine life.

#### **Cleaning oil/water separator**



**Figure 21**

#### **Draining, oil/water separator**

1. Air bleeding screw
2. Float ring
3. Retaining spring
4. Retaining ring
5. Fuel cock

- A. Inlet
- B. Outlet
- C. Close
- D. Open

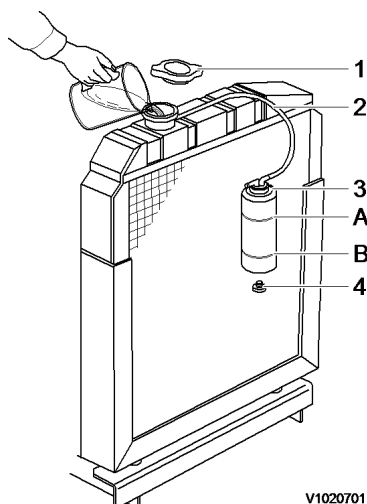
The cup of a water separator is translucent, and the inside can be seen. The float ring rises when water collects at the bottom of the cup. Periodically wash the water separator and inside cup with clean fuel oil.

- Close the fuel cock.
- Loosen the retaining ring and remove the cup. Take the water and trash in the cup out.
- Wash the element and inside cup with clean fuel oil. Replace the element with a new one if any damage.  
Applicable fuel filter part no.: 129335-55700
- Insert the element to the bracket and after putting the float ring in the cup, install it to the bracket by tightening the retaining ring.  
Tightening torque: 1.3 ~ 1.6 kgf·m (9.4 ~ 11.5 lbf·ft)
- Bleed the fuel system.

#### **Inspection every 1000 hours or one year**

Be sure to check the following points every 1000 hours or one year operation, whichever comes first.

#### **Replacing coolant**



**Figure 22**  
**Coolant, replacement**

1	Radiator cap
2	Rubber hose
3	Sub-tank
4	Drain plug
A	Full (max limit)
B	Low (min limit)

### **! WARNING**

**Risk of scalding and burns when the expansion tank cap (radiator cap) is opened due to high pressure in the cooling system.**

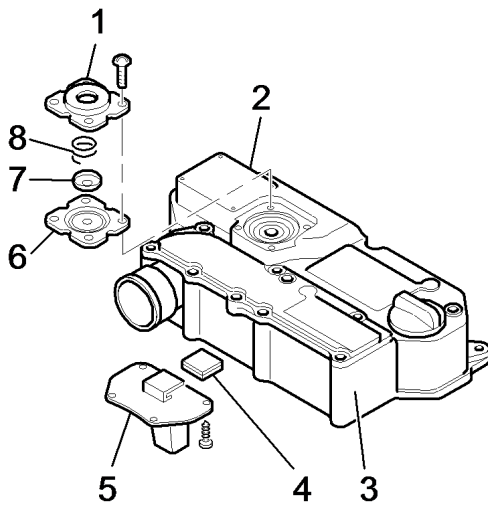
### **! WARNING**

**Before removing the radiator cap, stop the engine and let it cool down sufficiently. When removing it, turn it slowly to release the pressure.**

Coolant contaminated with rust or water scale reduces the cooling effect. Even when antifreeze agent (LLC) is mixed, the coolant gets contaminated due to deteriorated ingredients. Replace the coolant at least once a year.

- Remove the radiator cap.
- Loosen the drain plug at the lower portion of the radiator and drain the coolant.
- After draining the coolant, tighten the drain plug.
- Fill radiator and engine with coolant.

### **Diaphragm inspection**



V1027826

**Figure 23**  
**Inspection, diaphragm**

1. Diaphragm cover
2. Rocker arm cover
3. Intake manifold
4. Breather baffle
5. Baffle plate
6. Diaphragm
7. Center plate
8. Spring

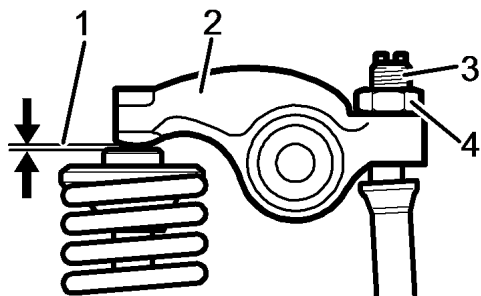
Inspect the diaphragm assy on the rocker arm cover every 1000 hours or **2 years**.

- Loosen screws, and remove a diaphragm assy, and check whether oil and so on doesn't enter between the diaphragm and the cover. If oil and so on enters into the diaphragm assy, the diaphragm doesn't work well.
- Check the damages of the diaphragm rubber and the spring. If necessary, replace with new ones.

When a diaphragm is damaged, pressure control inside the crankcase becomes insufficient, and troubles such as combustion defect and so on occur.

At lubricating oil replacement or lubricating oil supply, the amount of lubricating oil isn't to be beyond the standard upper limit. If the lubricating oil quantity is beyond the upper limit or an engine is operated beyond the allowable maximum angle of an engine, the amount of oil mist may be inducted in the combustion chamber and the oil hammer sometimes may occur.

#### Valve clearance measurement



V1025876

**Figure 24**  
**Measurement, valve clearance**

1. Valve clearance
2. Rocker arm

3. Adjusting screw
4. Lock nut

**NOTE!**

Make the measurement while the engine is cold.

- Remove the rocker cover on cylinder head.
- Turn the crankshaft to bring the piston of the No.1 cylinder to its compression top dead center while watching the rocker arm motion, timing scale and the top mark position of the crankshaft pulley.  
(Position where both the intake and exhaust valves are closed.)

**NOTE!**

The crankshaft shall be turned clockwise as viewed from the pulley side.

**NOTE!**

The No.1 cylinder position is on opposite side of the radiator.

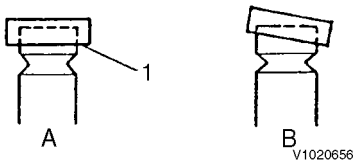
**NOTE!**

See that the top mark on the crankshaft pulley aligns with the mark on the gear case. If there is no valve clearance, inspection in the disassembled state is necessary since the valve seat may be worn abnormally.

- Insert a thickness gage between the rocker arm and valve cap and record the measured valve clearance. (Use it as the data for estimating the wear state.)
- Turn the crankshaft clockwise viewed from radiator side at 240° and make adjustment for the No.3 cylinder. Then adjust the No.2 cylinder in this order.
- In case of 2 cylinder engines, turn the crankshaft clockwise at 180° with 1 turn after the N°1 cylinder's adjustment. The cylinder to be adjust first does not have to be the N°1 cylinder. Select and adjust the cylinder where the piston is the nearest to the top dead center after turning, and make adjustment for other cylinders in the order of ignition by turning the crankshaft.

**Valve clearance inspection and adjustment**

Valve cap inspection

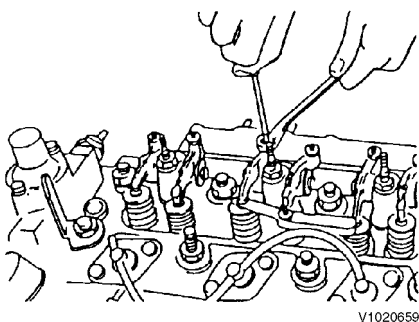


**Figure 25**

**Valve cap inspection**

1. Valve cap
- A. Normal  
B. Abnormal

Valve clearance adjustment

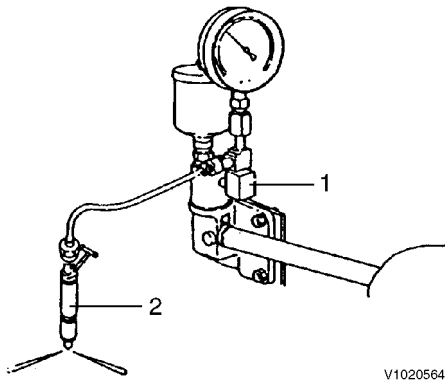


**Figure 26**

### Adjustment, valve clearance

- Loosen the lock nut and adjusting screw, and check the valve for any inclination of valve cap, entrance of dirt or wear.
- Insert a 0.15 or 0.25 mm thickness gage between the rocker arm and valve cap / valve bridge, and adjust the valve clearance. Tighten the adjusting screw.
- Apply oil to the contact surface between adjusting screw and push rod.
- Adjust the other cylinders in the order

### Injection pressure measurement



**Figure 27**  
**Injection pressure measurement**

1. Nozzle tester
2. Injection nozzle



### **WARNING**

Use safety glasses.



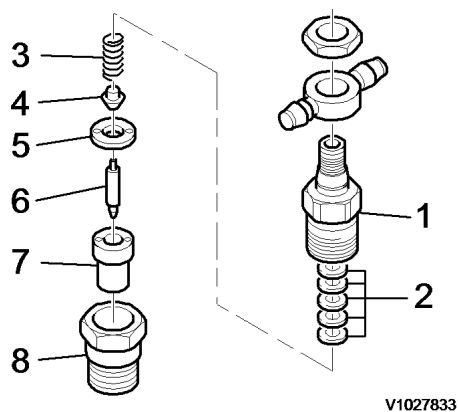
### **WARNING**

**High fuel pressure in the fuel injection equipment means risk of injury to unprotected part of the body. When testing injectors, the personnel must be aware of the potential risks because of the high pressure. If the jet has penetrated the skin, quickly call for medical assistance.**

- Injection pressure measurement:  $125 \pm 5 \text{ kgf/cm}^2$  ( $1978 \pm 71 \text{ psi}$ )
- Remove carbon deposit at the nozzle hole thoroughly before measurement.
- Connect the fuel injection valve to the high pressure pipe of the nozzle tester.
- Operate the nozzle tester lever slowly and read the pressure at the moment when the fuel injection from the nozzle starts.
- If the measured injection pressure is lower than the standard level, replace the pressure adjusting shim with a thicker one.

### Adjusting shims and injection pressure adjustment

Type of pressure adjusting shim thickness, mm (in)	Injection pressure adjustment
0.1(0.0039), 0.2(0.0078), 0.3(0.0118), 0.4(0.0157), 0.5(0.0196)	The injection pressure is increased by approx. 7 ~ 10 kgf/cm <sup>2</sup> (99.5 ~ 142.2 psi) when the adjusting shim thickness is increased by 0.1 mm (0.004 in)



**Figure 28**  
**Exploded view, fuel injection valve**

1. Nozzle holder
2. Pressure adjusting shim
3. Nozzle spring
4. Nozzle spring seat
5. Valve stop spacer
6. Nozzle valve
7. Nozzle body
8. Nozzle case nut

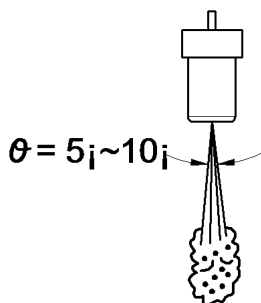
#### **Spray pattern inspection**

- After adjustment to the specified valve opening pressure, use a nozzle tester and check the spray pattern and seat oil-tightness.

#### **Seat oil tightness check**

- After injecting a few times, increase the pressure gradually.
- Hold the pressure for about 5 seconds at a little before the valve opening pressure of 20 kgf/cm<sup>2</sup> (285 psi), and check to see that oil does not drip from the tip end of the nozzle.
- If extreme oil leak from the overflow joint exists during injection by the nozzle tester, check after retightening. If excessive oil is leaking, replace the nozzle assembly.

#### **Spray and injection states**



**Figure 29**  
**Uniform spray pattern (normal)**

- Operate the nozzle tester lever at a rate of once or twice a second and check for abnormal injection.
- If normal injection as shown below cannot be obtained, replace the fuel injection valve.
- No extreme difference in angle( $\theta$ )
- Finely atomized spray
- Excellent spray departure



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