

DL06

Shop Manual

65.99897-8121

November 2006

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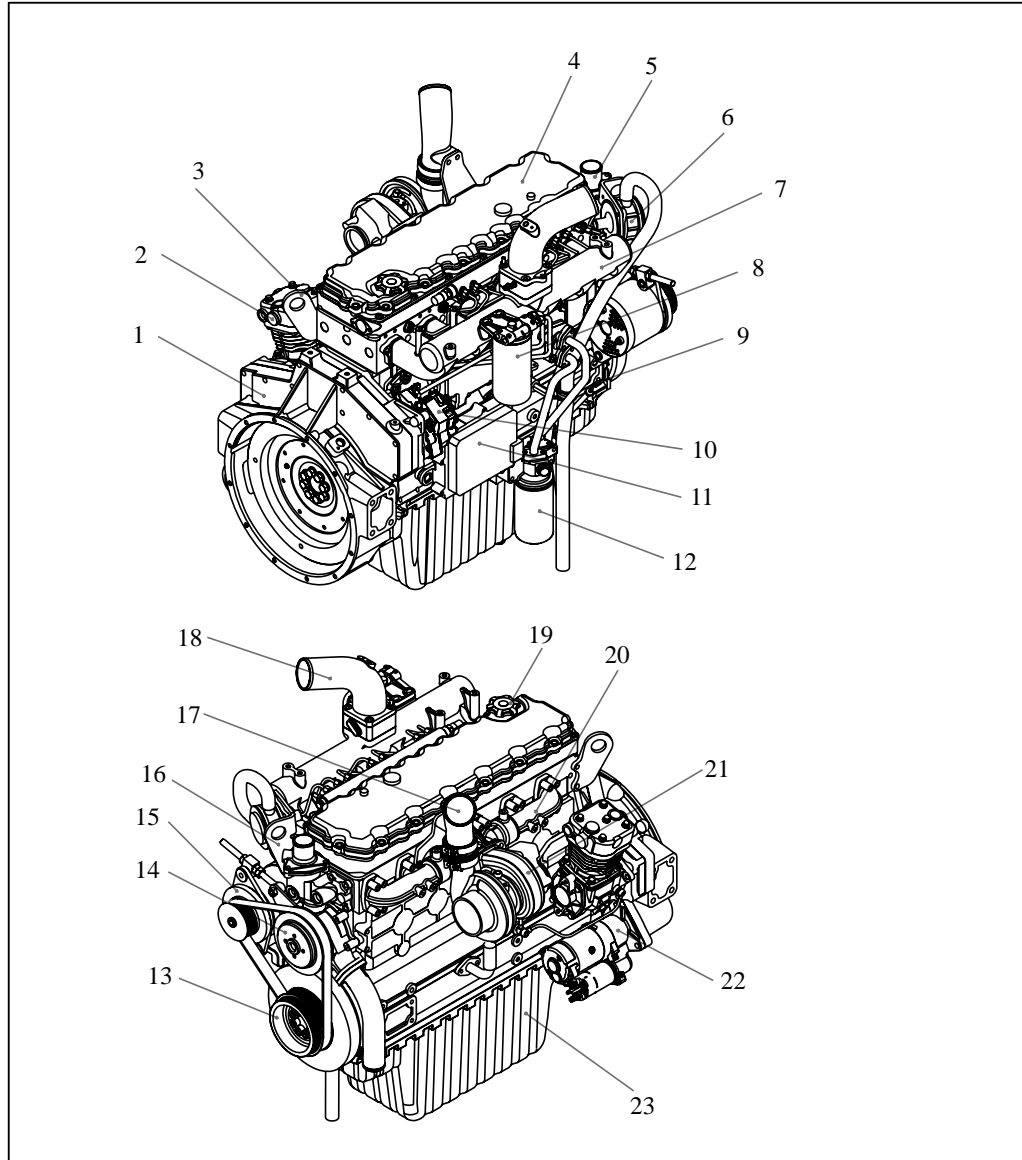
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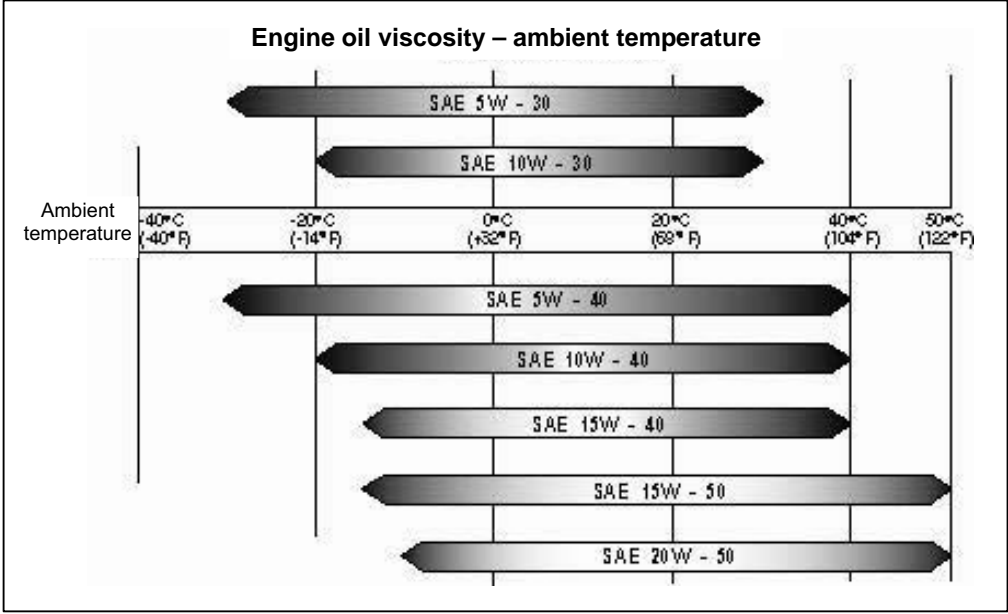
1.2. Engine Specifications

Items	Engine model	DL06
Engine type		Water-cooled, 4 cycle, In-line, Turbo charged & inter-cooled
Combustion chamber type		Direct injection type
Cylinder liner type		Replaceable dry liner
Timing gear system		Gear driven type
No. of piston ring		2 compression ring, 1 oil ring
No. of cylinder-bore x stroke (mm)		6 – 100 ×125
Total piston displacement (cc)		5,890
Compression ratio		17.4 : 1
Engine dimension (length x width x height) (mm)		1,069 x 815 x 1,164
Rotating direction (view from flywheel)		Counter clockwise
Engine weight (kg)		560
Firing order		1 – 5 – 3 – 6 – 2 - 4
Fuel high pressure pump type		Bosch CP3.3 fuel high pressure pump type
Engine control type		Electric control type (ECU)
Injector type		Multi – hole (8 x Ø0.136)
Fuel injection pressure (kg/cm ²)		250bar(operating pressure 1,600bar)
Valve clearance (mm)	Intake valve	0.3
	Exhaust valve	0.4
Intake valve	Open at	21° (B.T.D.C)
	Close at	33° (A.B.D.C)
Exhaust valve	Open at	56.2° (B.B.D.C)
	Close at	22.2° (A.T.D.C)
Fuel filter type		Full-flow (cartridge)
Oil pressure (kg/cm ²)	at idle speed	1.5 ~ 3.0
	at rated speed	3.0 ~ 5.5
Using lubrication oil		ACEA-E5(API CI-4 class)
Lubrication method		Full forced pressure feed type
Oil pump type		Gear type driven by crankshaft
Oil filter type		Cartridge type
Lubricating oil capacity (max./min.) (lit)		27 / 17 , 22 / 16
Oil cooler type		Water cooled
Hydraulic indicator		Oil pressure unit
Water pump		Belt driven centrifugal type
Cooling method		Pressurized circulation
Cooling water capacity(engine only) (lit)		10.6
Thermostat	Type	Wax pallet type
	Open at (° C)	71°C (82°C)
	Open wide at (° C)	90°C (95°C)
	Valve lift (mm)	10 (10)

1.5.3. Engine assembly
(1) DL06 (Fork lift)



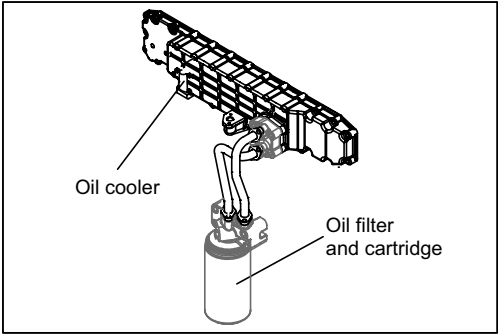
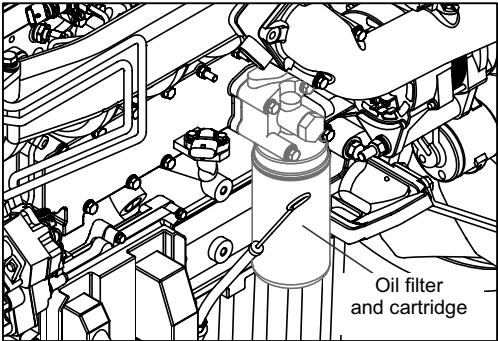
- | | | | | | |
|---|----------------------|----|---|----|--|
| 1 | Flywheel housing | 10 | Fuel high pressure pump | 18 | Air pipe
(intercooler to intake manifold) |
| 2 | Air compressor | 11 | Engine control unit(ECU) | 19 | Oil filler cap |
| 3 | Lifting hook (rear) | 12 | Oil filter | 20 | Exhaust manifold |
| 4 | Cylinder head cover | 13 | Crank shaft pulley | 21 | Turbo charger |
| 5 | Cooling water outlet | 14 | Cooling water pump | 22 | Starter |
| 6 | Breather (CCV) | 15 | Alternator | 23 | Oil pan |
| 7 | Intake manifold | 16 | Lifting hook (front) | | |
| 8 | Fuel filter | 17 | Air pipe
(turbocharger to intercooler) | | |
| 9 | Oil level gauge | | | | |



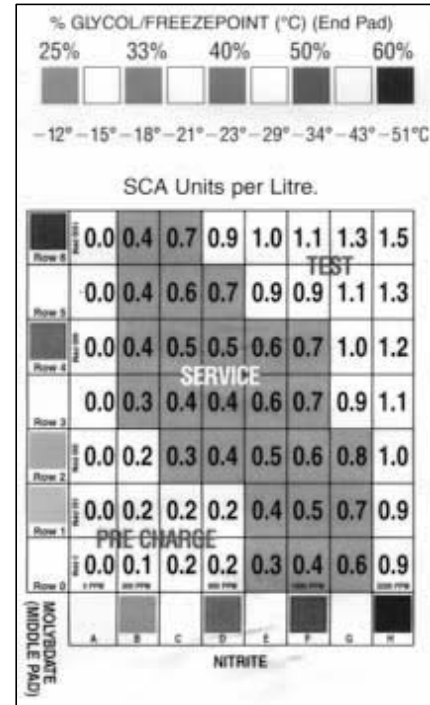
2.3.9. Oil filter & cooler



- Oil filter is assembled to the oil cooler. Oil cooler is plane tube and is cooled by the cooling water.
- Check for oil pressure and oil leaks, and repair or replace the oil filter if necessary.
- Change the oil filter cartridge simultaneously at every replacement of engine oil.



- (4) Compare the end pad “a)” color of the strip with color block of a row at the upper part of the standard color chart (below of the letter “GLYCOL/FREEZEPOINT”). Same color in the block of the row means the content of anti-freeze in the coolant. (Normal range is between 33% and 50%)
- (5) Compare the middle pad “b)” color of the strip with the color that the column block color of MOLYBDATE at the left side of the table intersects the row block color of NITRITE at the bottom (pad “c)” color of the strip) on the table “SCA Units per Litre”.



(Normal range of “SCA Units per Litre” is between 0.3 and 0.8 : “green color area”)



NOTE:

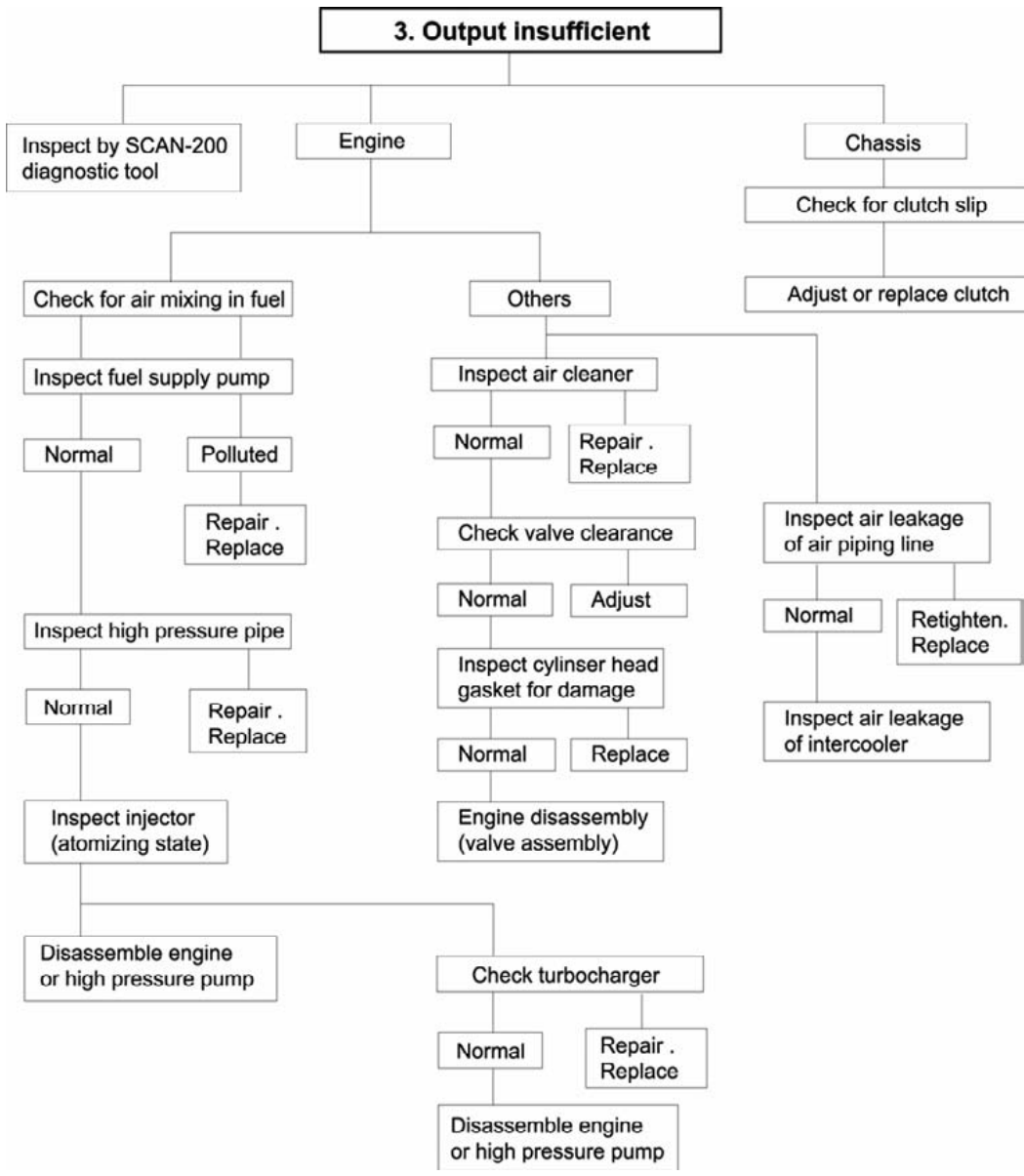
During the comparison, if uncertain about color match, pick the lower numbered block. (example : if the color of NITRITE pad is between standard color “D” and “F”, then use column E)

- (6) If the value of “SCA Units per Litre” is less than 0.3, refill the DCA4 liquid (anti-corrosion agent) a little, but larger than 0.8, drain some amount of engine coolant and replenish the fresh water instead. The content of the anti-freeze and anti-corrosion agent can be regulated by this way.



NOTE:

Every year coolant must be replaced. It is essential the coolant should be mixture of fresh water, proper anti-freeze and anti-corrosion agent.



3. Disassembly and Reassembly of Major Components

3.1. Engine Disassembly

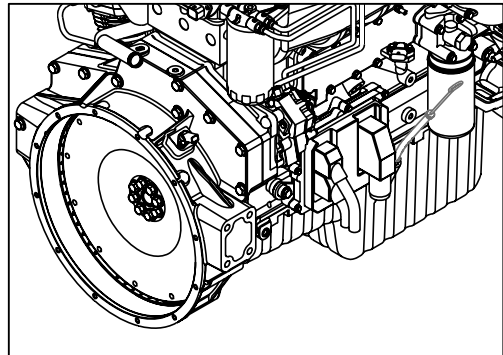
3.1.1. General precautions



- Maintenance operation should be carried out in a bright and clean place.
- Before disassembly, provide parts racks for storage of various tools and disassembled parts.
- Arrange the disassembled parts in the disassembly sequence and use care to prevent any damage to them.

3.1.2. Oil level gauge

- Take out the oil level gauge.



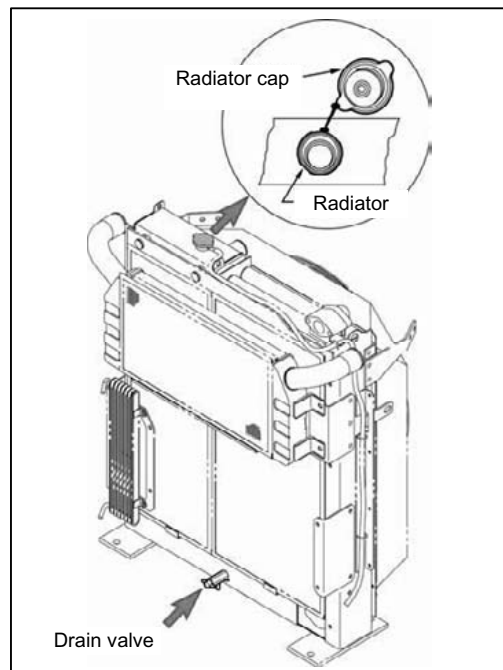
3.1.3. Cooling water

- Remove the radiator cap. Open the drain valve at the radiator lower part to drain the coolant as the right figure.



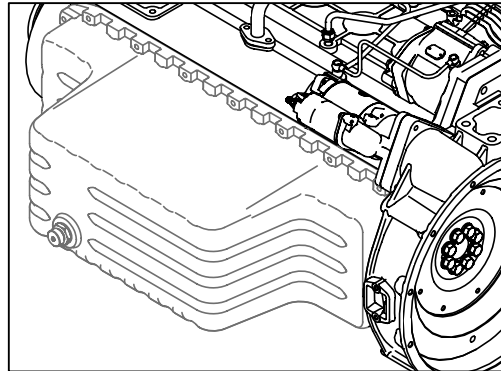
CAUTION:

When removing radiator filler cap while the engine is still hot, cover the cap with a rag, then turn it slowly to release the internal steam pressure. This will prevent a person from scalding with hot steam spouted out from the filler port.



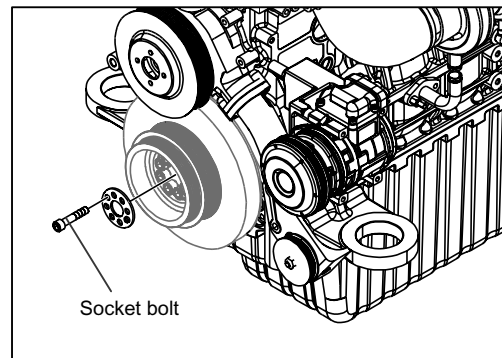
3.1.27. Oil pan

- Unscrew the oil pan fixing bolts and separate the oil pan.
- Remove the oil pan gasket and discard it.



3.1.28. Vibration damper

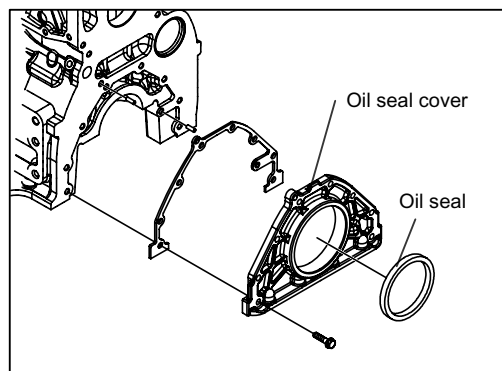
- Unscrew the crankshaft pulley fixing bolts in reverse sequence of installing sequence and remove the vibration damper assembly.



3.1.29. Front oil seal cover

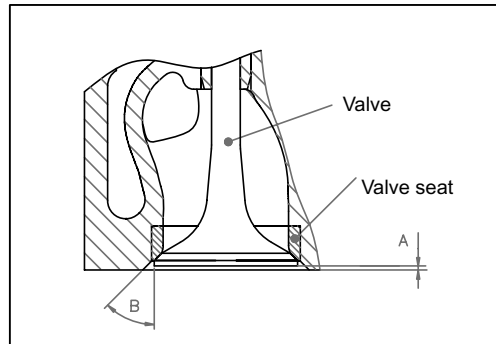


- Disassemble the oil seal using an oil seal removing jig.
- Remove the cover fixing bolts and disassemble the cover from the timing gear case.



< Valve depression >

	Standard	Limit
Intake (A)	0.35 ~ 0.65 mm	0.85 mm
Exhaust (A)	0.35 ~ 0.65 mm	0.85 mm



< Valve angle >

Intake valve (B)	Exhaust valve (B)
60°	45°

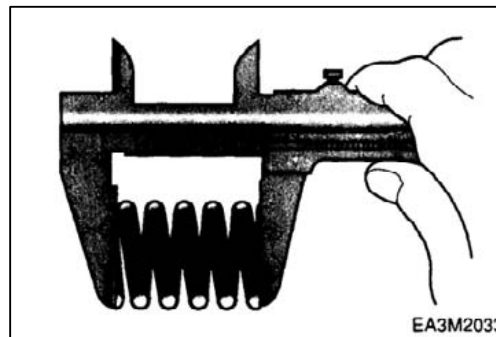


- It is necessary to work boring of inner diameter of it when replace the valve seat.
- Apply valve lapping compound to the valve head seating face on the valve seat and lap the valve seat by turning it until it is seated in position, then wipe out the lapping compound.

4) Valve spring



- **Visual check**
Check the appearance of valve spring and if necessary replace the spring.

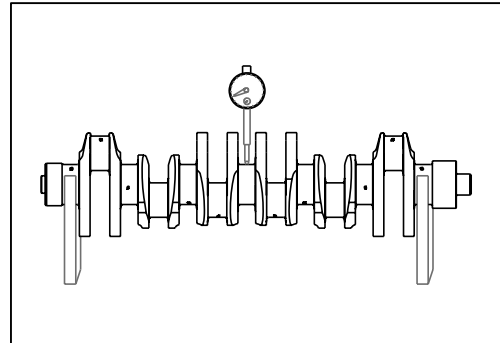


- **Valve spring free length**
Use a vernier caliper to measure the valve spring free length.
If the measured value is less than the specified limit, the valve spring must be replaced.

3) Crankshaft run-out



- Support the crankshaft on V-blocks.
- Turn the crankshaft with a dial indicator placed on the surface plate and take the amount of crankshaft run-out.



Standard	Limit
0.06 mm	Less than 0.15 mm

(2) Crankshaft bearing and connecting rod

1) Visual check



- Visually check the crankshaft bearing and connecting rod bearing for scratch, uneven wear or damage.

2) Oil clearance between crankshaft and bearing

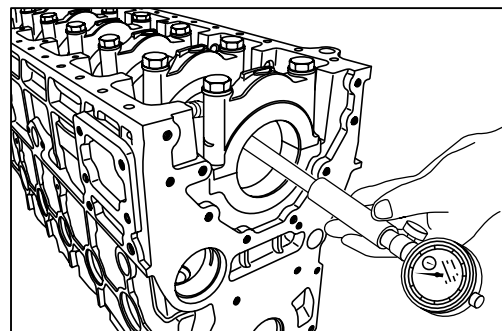
(Method 1 : dial gauge)



● Main bearing clearance

Install the main bearing in the cylinder block, tighten the bearing cap to specified torque, then measure the inside diameter

Torque	30±2 kg.m
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Compare the two values obtained through measurement of main bearing inside diameter with the outside diameters of crankshaft journals to determine the oil clearance.

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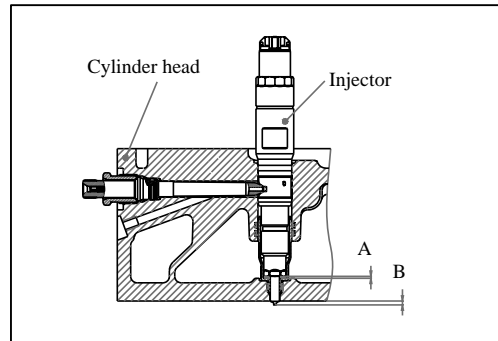
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Standard	Limit
0.170 ~ 0.30	0.50 mm

3.2.7. Projection of injector

- Insert a seal ring on the cylinder head and assemble the injector. (Refer to 3.3 chapter for assembly order)
- Measure the clearance between the cylinder head bottom and injector tip. If the measured valves are beyond the limit, replace the seal ring.



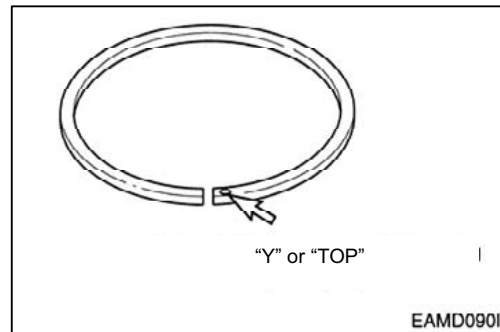
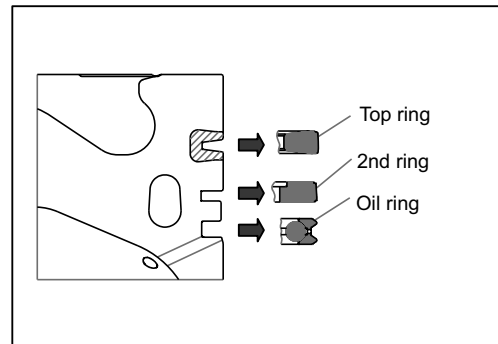
A (Thickness of seal ring)	2.0 mm
B (Projection of nozzle)	3.0 mm



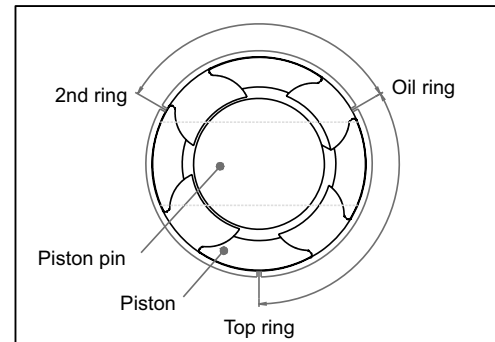
- Install the piston ring in the piston using piston ring pliers.



- Identify the mark "Y" or "TOP" on the ring end to prevent the top and bottom of the piston ring from being interchanged and make the marked portion face upward.



- Adjust the angle among individual piston ring gaps to 90° and fit a piston assembling jig onto the piston, use care not to match the ring gaps with the pin direction.
- Install the bearing by aligning it with the connecting rod key groove and apply oil to the bearing and piston.
- Insert the piston by aligning the oil gallery port with the direction of the spray nozzle.



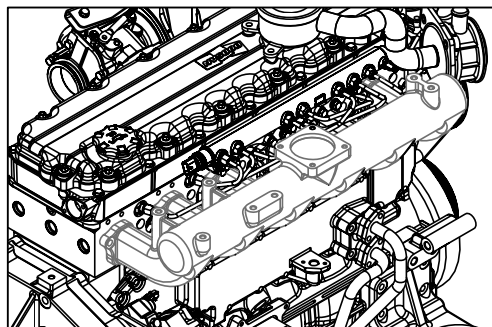
- Use care not to damage the cylinder liner and piston, and slightly lift and insert the piston into the cylinder so that the ring may not be damaged by the fillet of the liner.

3.3.25. Intake manifold



- Put in the new gasket between the cylinder head and manifold, and assemble the intake manifold by tightening the fixing bolts.

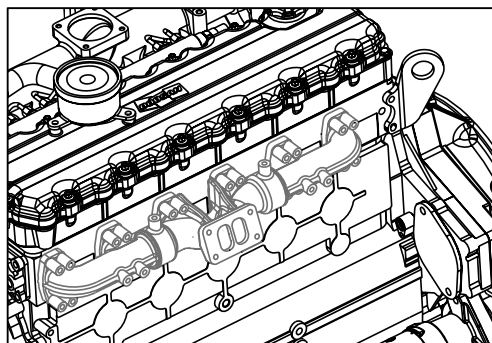
Torque	4.4 +0.5 kg.m
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3.3.26. Exhaust manifold



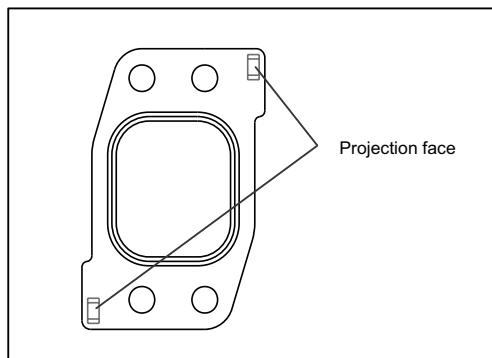
- Install the exhaust manifold gasket over the stud bolts by aligning the gasket with the exhaust port on the cylinder head so that the face and back of the gasket can be positioned correctly.



- Install the exhaust manifold gasket. The projection face must be facing the exhaust manifold.



- Assemble the exhaust manifold and the heat resisting plate, the tightening order of bolts is from the middle to left and right alternately.



Torque	5.0+0.5 kg.m
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- The required high-speed solenoid switching is achieved by using high voltages and currents. This means that the solenoid valve triggering stage in the ECU must be designed accordingly. The start of injection is controlled by the angle-time control system of the EDC(Electronic Diesel Control).This uses a sensor on the crankshaft to register engine speed, and a sensor on the camshaft for phase detection(working cycle).

3.4.5. Fuel system

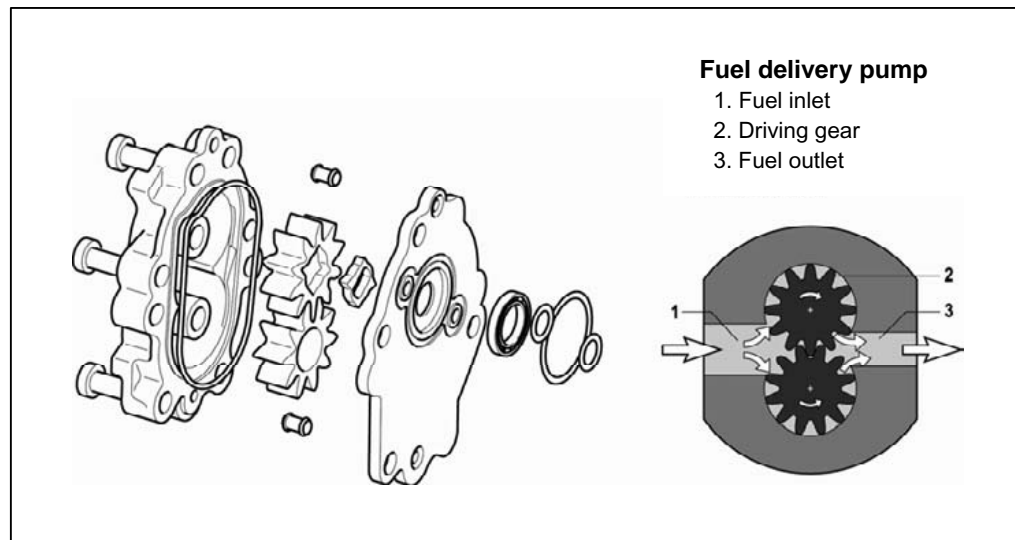
- The common rail fuel injection system comprises a low pressure stage for the low pressure delivery of fuel, a high pressure stage for the high pressure delivery, and the ECU.

3.4.6. Fuel tank

- The fuel tank must be of non-corroding material, and must remain free from leaks at double the operating pressure, and in any case at 0.3 bar.

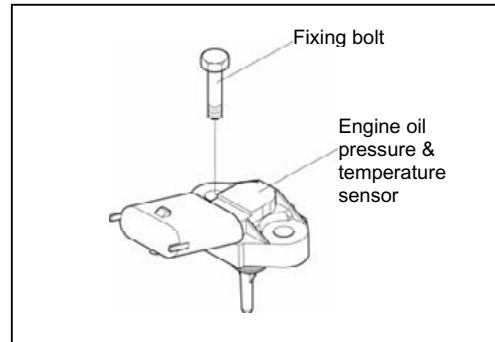
3.4.7. Fuel delivery pump

- The fuel delivery pump is installed on back side of the fuel high pressure pump, is a gear type fuel pump. The pump draws the fuel from the fuel tank and continually delivers the required quantity of fuel in the direction of the high pressure pump.



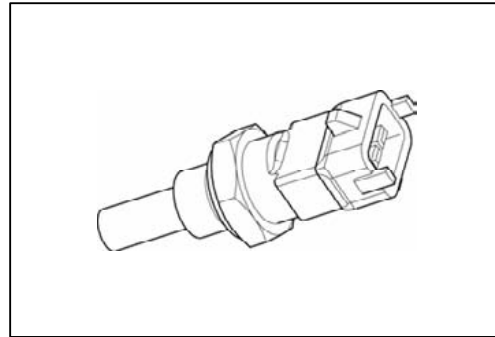
3.4.18. Engine oil pressure & temperature sensor

- The engine oil pressure and oil temperature sensor measure in the engine lube oil and measuring data is inputted into ECU.



3.4.19. Engine coolant temperature sensor

- The engine coolant temperature sensor measure in the engine coolant circuit and measuring data is inputted into ECU.



3.7. Operating condition of the ECU

3.7.1. Engine starting

- Setting of a basic temperature for decision of the fuel quantity.
Set to a basic temperature the minimum value between coolant temperature and fuel temperature and intake air temperature.
- Engine speed sensor signal measurement
 - Using by crankshaft speed sensor.
 - Using by camshaft speed sensor.
 - Supply to the engine after decided properly fuel quantity to starting the engine.

3.7.2. Vehicle running

- Essential data for the running of the vehicle.
 - Accelerator pedal position signal
 - Engine speed
 - Vehicle speed

3.7.3. Engine idle adjusting

- Adjusting of engine's idle speed by the necessity of the driver.
- Method of the adjusting is possible by using the cruise control switch.
- **Preparing condition for the adjusting of the idle speed**
 - Cruise control switch : no trouble
 - Pedal brake : no trouble
 - Vehicle speed : stop
 - Coolant temperature : more than limit
 - Engine speed : less than limited scope of the speed
- **Adjusting method of the idle speed**
 - When the brake pedal is depressed.
 - After the cruise [RESUME] switch is depressed for one minute.
 - Engine speed increase : cruise control [SET/INC] switch is depressed.
 - Engine speed decrease: cruise control [SET/DEC] switch is depressed.
- **Storage of the variable of the idle speed**
 - Cruise control [RESUME] switch is depressed after variation of the speed.
 - When the switch [RESUME] is stored at the condition of depressing, the last stored value keep constantly after start the engine.
 - When the engine is stopped at the condition of doing not depressed [RESUME] switch, return to the first value.

4.4.4. Lubricating oil

As cold weather leads to the rise of oil viscosity, engine speed becomes unstable after starting. Therefore the lubricating oil for winter should be used to prevent this instability. Refer to lubricating system section.

4.5. Engine components check after long time running

- The purpose of an engine tune-up is to restore power and performance that's been lost through wear, corrosion or deterioration of one or more parts or components.
- In the normal operation of an engine, these changes can take place gradually at a number of points, so that it's seldom advisable to attempt an improvement in performance by correction of one or two items only. Thorough procedure of analysis and correction, it is desirable to change or correct of all items affecting power and performance.
- In case that the engine is perform in advance the prevention against trouble, the engine can be run safely during a long time as that time , there can be used more reliably.
- Economical, trouble-free operation can better be ensured if a complete tune-up is performed once every years, preferably in the spring.
- Below components that affect power and performance to be checked are:.
 - Components affecting intake & exhaust
Air cleaner, inter-cooler, turbo charger, silencer, etc
 - Components affecting lubrication & cooling
Air & oil filter, anti- freeze, etc

5.2. Lubrication system

5.2.1. General descriptions and main data

- **General descriptions**

All the engine oil pumped up from the oil pan by the gear type oil pump is filtrated through the oil cooler and oil filter, and this filtrated oil is forced through the main oil gallery in the cylinder block from where it is distributed to lubricate the various sliding parts, and fuel high pressure pump in order to ensure normal engine performance.

- **Specifications**

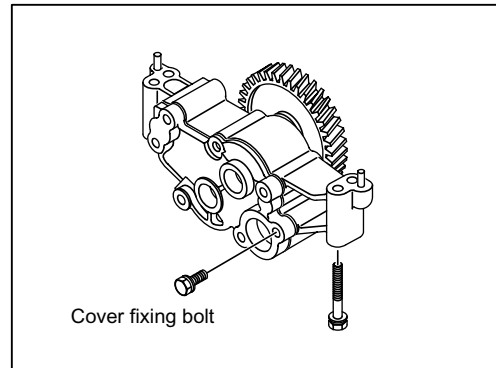
Item	Specifications	Item	Specifications
Lubricating system	Forced pressure circulation	Oil filter type	Full flow
Oil pump type	Gear type	Bypass for cartridge	
Relief valve opening pressure	9 ~10.5 kg/cm ²	Valve opening pressure	1.9~2.3 kg/cm ²
Adjusting valve for spray nozzle		Bypass main gallery	
Opening pressure	2 ~2.4 kg/cm ²	Relief valve	5.3~5.7 kg/cm ²

5.2.2. Oil pump

- **Disassembly**

- (1) Disassembly of oil pump drive gear

- a. Unscrew the screw and disassemble the oil relief valve.
- b. Unfold the washer for the oil pump drive gear fixing nut and remove the nut.
- c. Disassemble the drive gear.

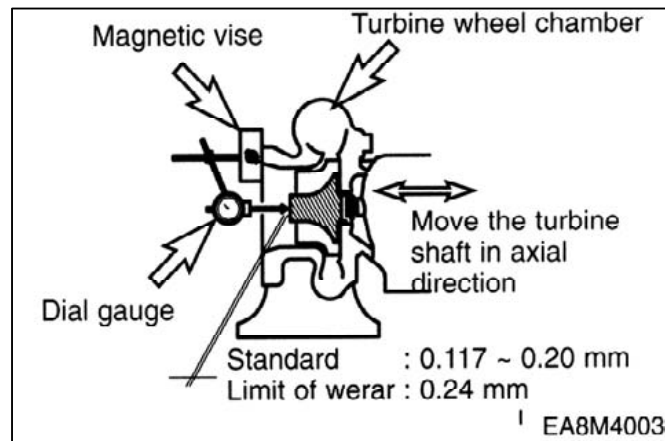


- (2) Remove the oil pump cover fixing nuts and disassemble the oil pump cover.

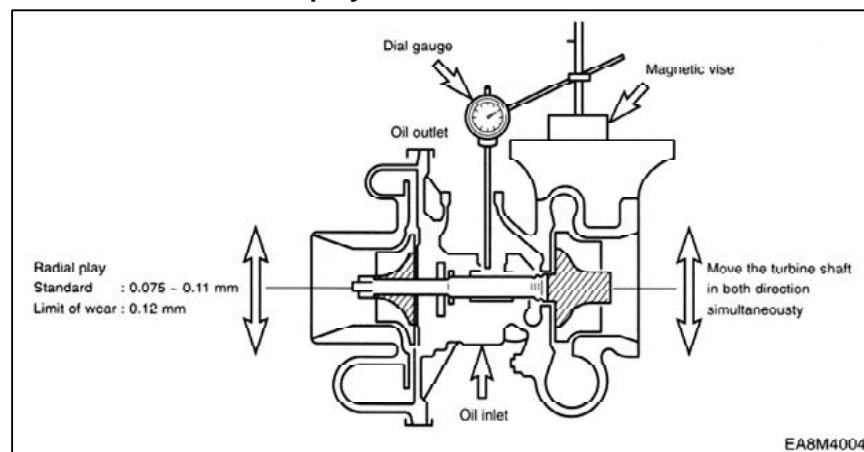
The oil pump cover is fixed with the two dowel pins.

- (3) Disassemble the drive gear and driven gear.

(1) Rotor axial direction end play



(2) Rotor radial direction end play



(3) If the measured axial and radial end plays are beyond the limit of wear, replace or repair the turbocharger.

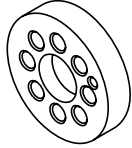


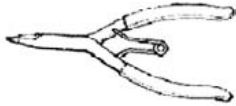

3) Guide for disassembling/cleaning and checking the turbocharger

First, disassemble the turbocharger from the engine and clean/check it with the oil inlet and outlet plugged with tape and so on

4) Precautions for reassembling the turbocharger onto the engine

For reassembly of the turbocharger or handling it after reassembly operation, be sure to observe the following precautions.

Especially, exercise extreme care to prevent foreign matters from entering the inside of the turbocharger.

No	Part no.	Figure	Tool name	Remark
14	EF.121-259		Crankshaft gear insert jig	
15	EF.120-277		Injector insert jig	
16	EF.120-278		High pressure connector dummy	
17	T7621010E		Piston ring plier	
18	EF.123-322		SCAN-200 Diagnostic tool	Memory card

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