

# 1. Safety Regulations & Specifications

## 1.1. Safety Regulations

### 1.1.1. General notes

- Day-to-day use of power engines and the service products necessary for running them presents no problems if the persons occupied with their operation, maintenance and care are given suitable training and think as they work.
- This summary is a compilation of the most important regulations, These are broken down into main sections which contain the information necessary for preventing injury to persons, damage to property and pollution. In addition to these regulations those dictated by the type of engine and its site are to be observed also.



#### **IMPORTANT:**

**If despite all precautions, an accident occurs, in particular through contact with caustic acids, fuel penetrating the skin, scalding from oil, antifreeze being splashed in the eyes etc, consult a doctor immediately.**

### 1.1.2. To prevent accidents with injury to persons

#### **(1) Engine starting and operation**

- Before putting the engine into operation for the first time, read the operating instructions carefully and familiarize yourself with the “critical” points. If you are unsure, ask your DOOSAN representative or service man.
- For reason of safety we recommend you attach a notice to the door of the engine room prohibiting the access of unauthorized persons and that you draw the attention of the operating personal to the fact that they are responsible for the safety of person who enter the engine room.
- The engine must be started and operated only by authorized personnel.
- Ensure that the engine cannot be started by unauthorized person.
- When the engine is running, do not get too close to the rotating parts.
- Do not touch the engine with bare hands when it is warm from operation risk of burns.
- Exhaust gases are toxic. If it is necessary to run an engine in an enclosed area, remove the exhaust gases from the area with an exhaust pipe extension.

#### **(2) Maintenance and care**

- Always carry out maintenance work when the engine is switched off. If the engine has to be maintained while it is running, e.g. changing the elements of change-over filters, remember that there is a risk of scalding. Do not get too close to rotating parts.
- Change the oil when the engine is warm from operation.



#### **CAUTION:**

**There is a rise of burns and scalding. Do not touch oil drain plug or oil filters with bare hands.**



**CAUTION:**

**Ensure that used engine oil is disposed of properly.  
- Engine oil can endanger the water supply.**

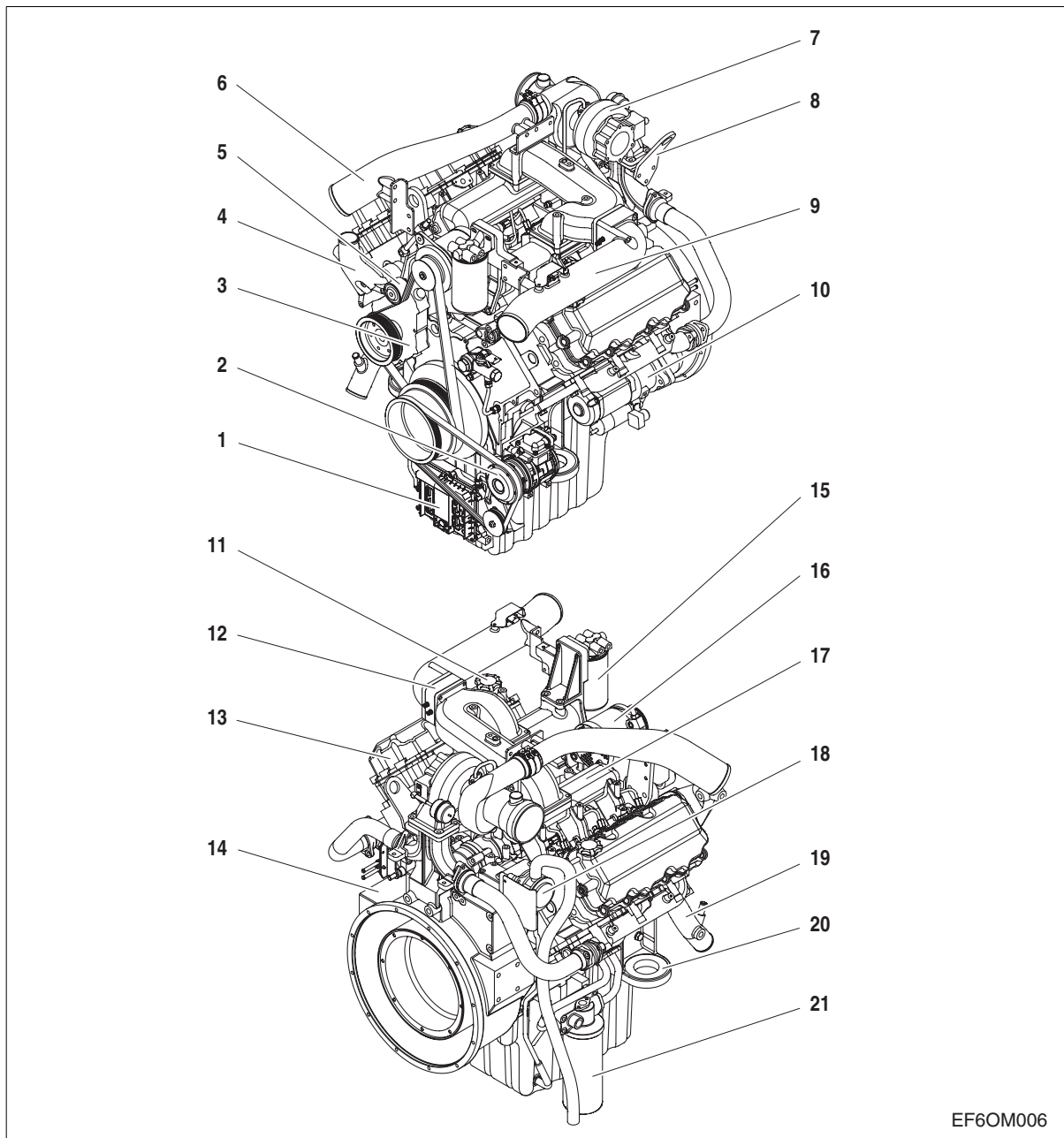
For this reason do not let engine oil get into the ground, waterways, the drains or the sewers. Violations are punishable. Collect and dispose of used engine oil carefully. For information on collection points please contact the seller, the supplier or the local authorities.

### **1.1.6. General repair instructions**



1. Before performing service operation, disconnect the grounding cable from the battery for reducing the chance of cable damage and burning due to short-circuiting.
2. Use covers for preventing the components from damage or pollution.
3. Engine oil and anti-freeze solution must be handled with reasonable care as they cause paint damage.
4. The use of proper tools and special tools where specified is important to efficient and reliable service operation.
5. Use genuine DOOSAN parts necessarily.
6. Used cotter pins, gaskets, O-rings, oil seals, lock washer and self-lock nuts should be discarded and new ones should be prepared for installation as normal function of the parts can not be maintained if these parts are reused.
7. To facilitate proper and smooth reassemble operation, keep disassembled parts neatly in groups. Keeping fixing bolts and nut separate is very important as they vary in hardness and design depending on position of installation.
8. Clean the parts before inspection or reassembly. Also clean oil ports, etc. using compressed air to make certain they are free from restrictions.
9. Lubricate rotating and sliding faces of parts with oil or grease before installation.
10. When necessary, use a sealer on gaskets to prevent leakage.
11. Carefully observe all specifications for bolts and nuts torques.
12. When service operation is completed, make a final check to be sure service has been done property.
13. Work the fuel line after the common rail pressure and engine temperature is checked with the SCAN-200. (past about 5 minutes after engine stop)

### 1.5.3. Engine assembly

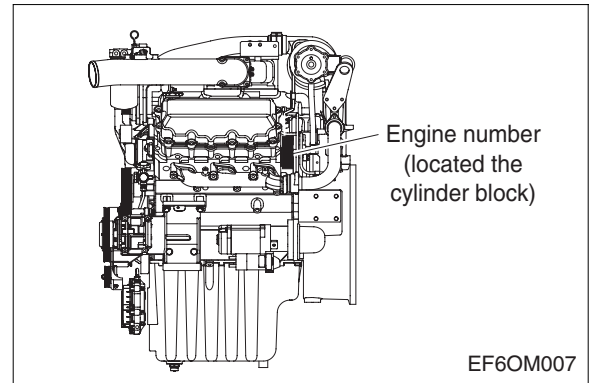


- |                                              |                                                 |                      |
|----------------------------------------------|-------------------------------------------------|----------------------|
| 1. Electric control unit (ECU)               | 8. Lifting hook                                 | 15. Fuel filter      |
| 2. Air con. compressor                       | 9. Air pipe<br>(Intercooler to intake manifold) | 16. Alternator       |
| 3. Water pump                                |                                                 | 17. Intake manifold  |
| 4. Water outlet                              | 10. Starting motor                              | 18. Breather         |
| 5. Idle pulley                               | 11. Oil filler cap                              | 19. Water inlet      |
| 6. Air pipe<br>(turbocharger to intercooler) | 12. Air heater                                  | 20. Mounting bracket |
| 7. Turbocharger                              | 13. Cylinder head cover                         | 21. Oil filter       |
|                                              | 14. Flywheel housing                            |                      |

## 2. Technical Information

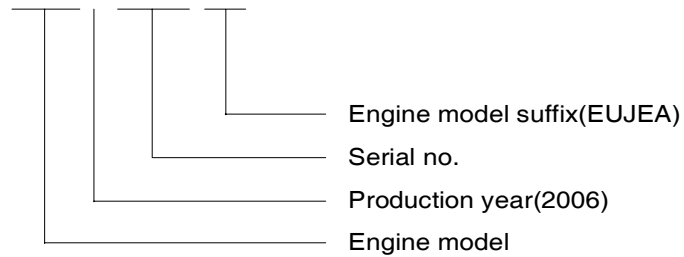
### 2.1. Engine Model and Serial Number

- The engine model and serial number is located on the engine as illustrated.
- These numbers are required when requesting warranty and ordering parts. They are also referred to as engine model and serial number because of their location.



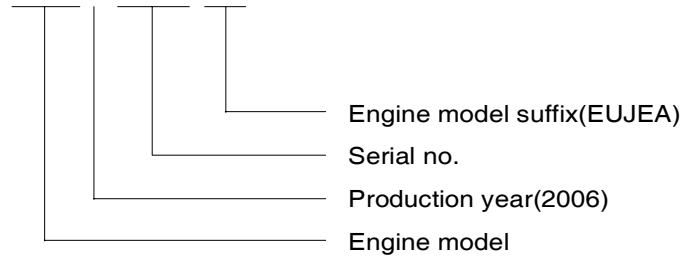
#### ● Engine serial No. (example 1 : DV11)

DV11 6 00001 EA



#### ● Engine serial No. (example 2 : DV11)

DV11 6 00001 EB



### 2.3.8. Engine oil



- Check oil level with the oil level gauge and replenish if necessary.
- Check the oil level with the engine cooled. If the engine is warm, allow time for 5 ~ 10 minutes for oil drain into the crankcase before checking oil level. The oil level must be between **Max.** and **Min.** lines on the gauge.
- Engine oil should be changed at the specified intervals. Oil filter cartridge should be changed simultaneously.

- First oil change : After 50Hr operating

First oil change	After 50Hr operating
Oil change interval	Every 500Hr

- The following oils are also recommended.

Engine oil	SAE No.	API No.
DV11	SAE 10W40	ACEA-E5 (API CI-4)

- Engine oil capacity

Engine oil capacity			
Engine model	Oil pan inside		Total (lit)
	Max. (lit)	Min. (lit)	
DV11	41	27	44

### 2.3.24. Valve clearance adjust procedure



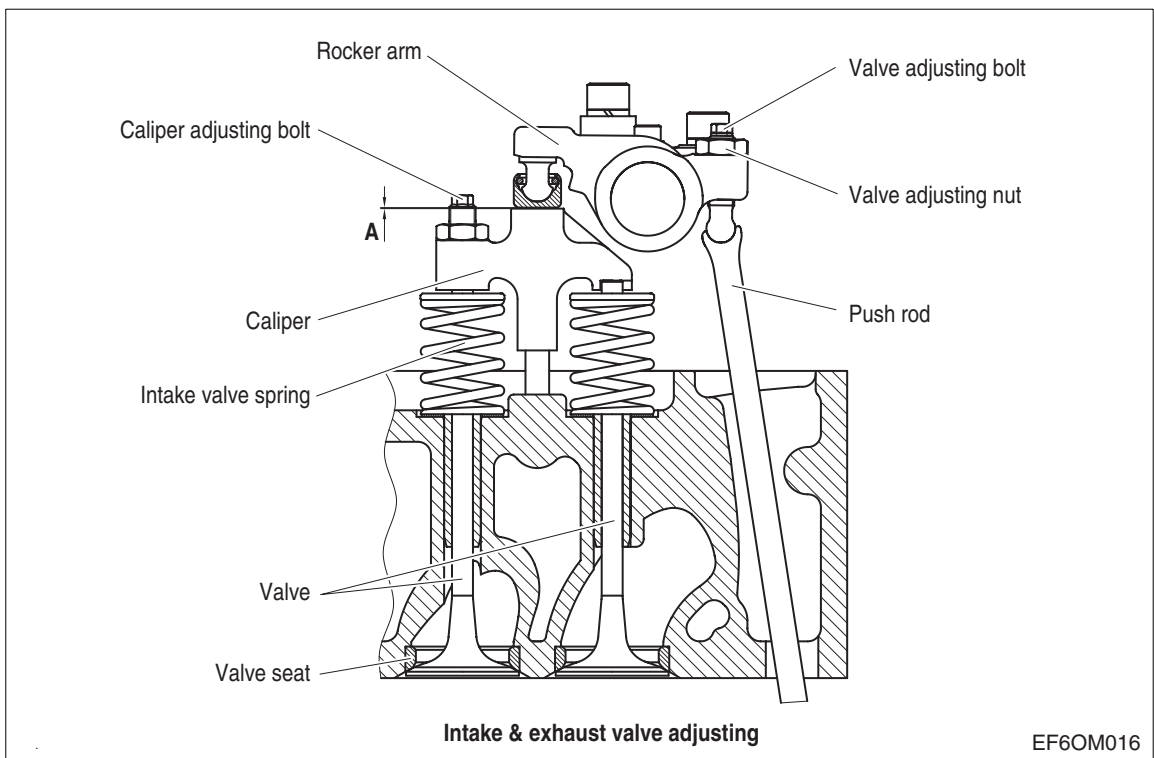
- After letting the #1 cylinder's piston come at the compression top dead center by turning the crankshaft, adjust the valve clearances.



- Loosen the lock nuts of rocker arm adjusting screws and push the feeler gauge of specified value between a rocker arm and a valve stem and adjust the clearance with adjusting screw respectively and then tighten with the lock nut.

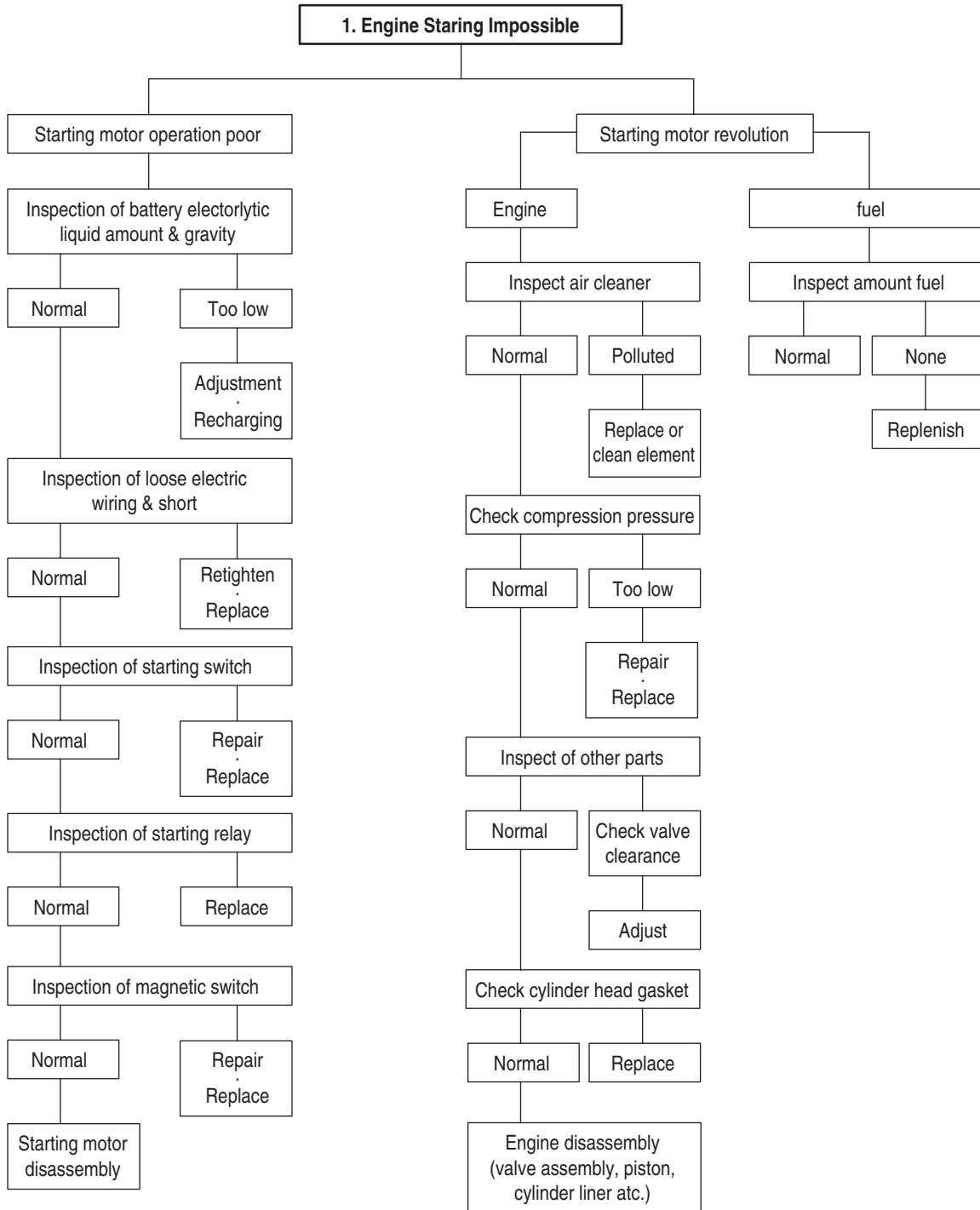
- As for the valve clearance, adjust it when in cold, as follows.

Engine model	Intake valve (A)	Exhaust valve (A)
DV11	0.4 mm	0.5 mm



## 2.4. Diagnosis and Remedy

- The following description summarizes the probable cause of and remedy for general failure by item.
- Inspect the electrical parts problem with SCAN-200 and refer diagnostic manual.
- Immediate countermeasures should be taken before a failure is inflamed if any symptom is detected.



### 3. Disassembly and Reassembly of Major Components

#### 3.1. Engine Disassembly

##### 3.1.1. General precautions



- For the various tool storage before disassembly and parts storage after disassembly, the shelf for parts is prepared.
- At the time of disassembly and reassembly, do the work with the naked and clean hand, and also the working place must be maintained clean.
- The torn parts after disassembly must be kept not to collision each other.
- In disassembling, torn parts should be laid in disassembled order.
- Before performing service operation, disconnect the grounding cable from the battery for reducing the chance of cable damage and burning due to short-circuiting.

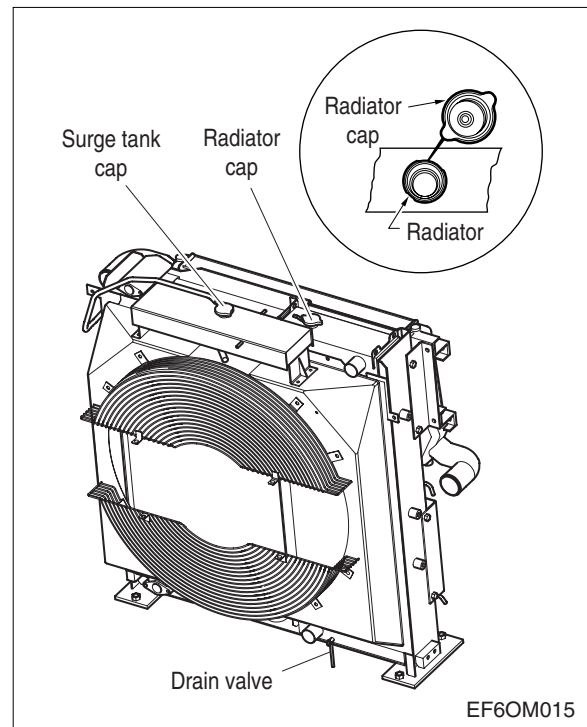
##### 3.1.2. Cooling water

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

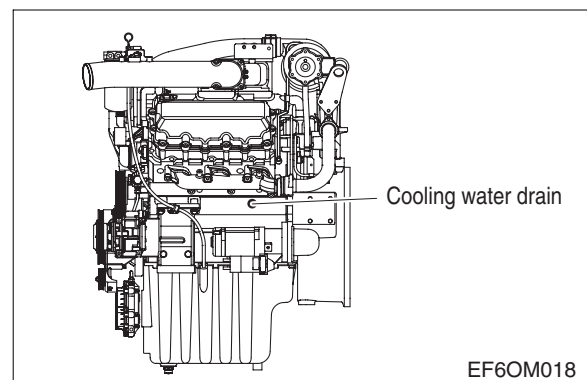


##### CAUTION :

**When removing surge tank cap or 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.**



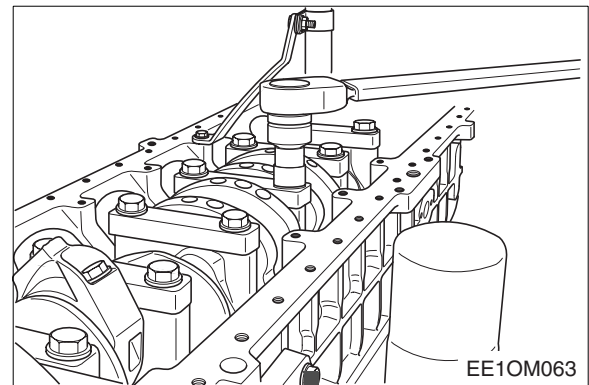
- Remove the cooling water drain plug from the cylinder block and oil cooler, various pipes, etc. and let the cooling water discharge into the prepared vessel.





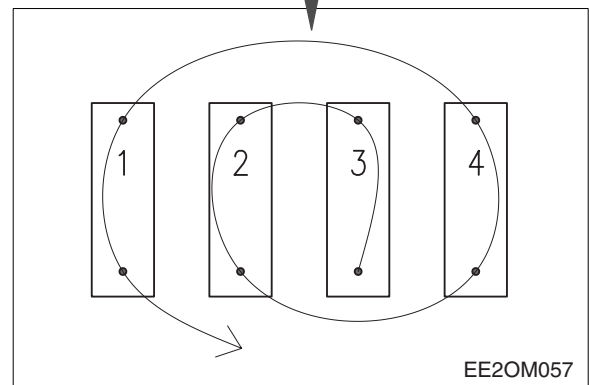
### 3.1.32. Crank shaft

- Remove the fixing bolts from bearing caps.
- Remove the main bearing cap fixing bolts in the reverse order of assembling.
- Maintain the removed bearing caps in the order of cylinders.
- Temporarily install the bolts at the both side of crankshaft, and lift the crankshaft with a rope.



#### NOTES :

**Do not mangle with the metal bearings and bearing caps randomly. To prevent mixing, temporarily assemble the metal bearings to the corresponding bearing caps in turn.**

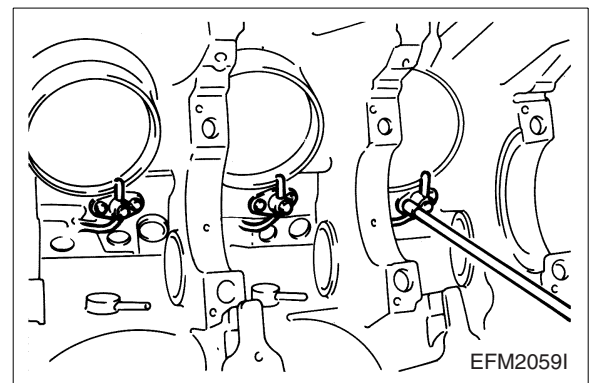


### 3.1.33. Cam shaft & tappet

- Pull out the tappets from the cylinder block.
- Remove the camshaft being careful not to damage the camshaft and its bearings.

### 3.1.34. Oil spray nozzle

- Remove the oil injection nozzle fixing bolts and tear down the oil injection nozzles.



### 3.2.6. Crank shaft

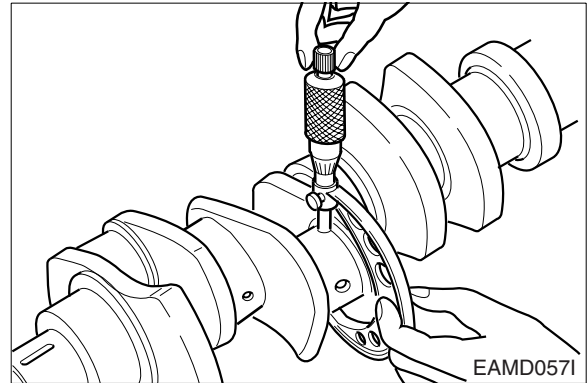
#### 1) Inspection and measurement

- Inspect for any scratch or damage on the crankshaft journal and crank pin with naked eyes.
- Inspect for any crack by means of magnetic powder and color check, and replace the cracked ones.

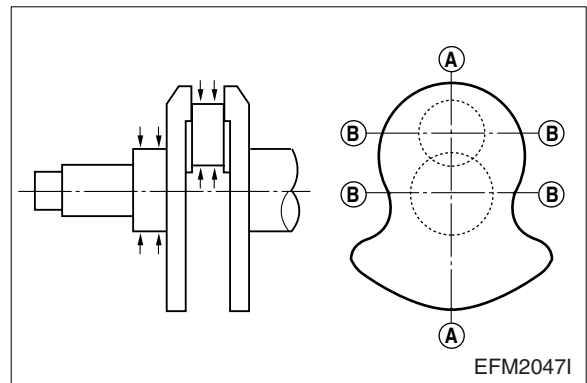
#### a) Journal and pin diameter



- With outside micrometer, measure the outside diameter of crank journal and crank pin at the direction and position of the figure shown and take the wear.
- In case that the lopsided wear is more than the limit value, grind to the undersize, and use the undersized bearing.



- If the amount of wear is within the limit, you can correct the wear using an oil stone or oiled grinding paper of fine grain size. (be sure to use grinding paper which has been immersed in oil)



#### <Journal and pin outside diameter>

	Standard
Journal diameter	$\phi$ 103.98 ~ $\phi$ 104.00 mm
Pin diameter	$\phi$ 89.98 ~ $\phi$ 90.00 mm

- In case that pin's wear is more than the limit value, grind the crankshaft journal and crank pin, and use the undersized bearings.



- Be sure to use grinding paper which has been immersed in oil.

#### < Kinds of bearings for undersize>

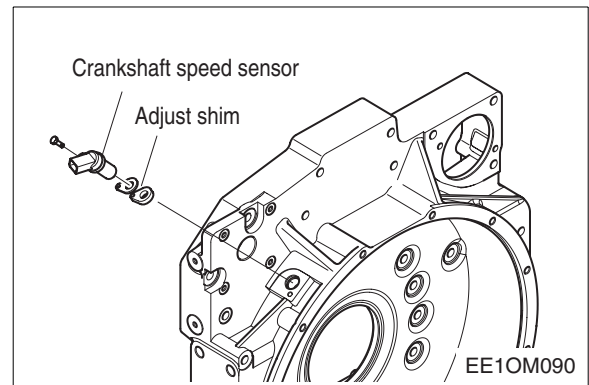
- ◆ Standard
- ◆ 0.25 (Inside diameter 0.25mm less than standard)
- ◆ 0.50 (Inside diameter 0.50mm less than standard)
- ◆ 0.75 (Inside diameter 0.75mm less than standard)
- ◆ 1.00 (Inside diameter 1.00mm less than standard)

### 3.3.25. Crankshaft speed sensor



- Measure the clearance of the assembling part of the sensor and fly wheel, then assemble it with the adjust shim.

Clearance	1.0 ± 0.1 mm
Torque	1.0 kg.m

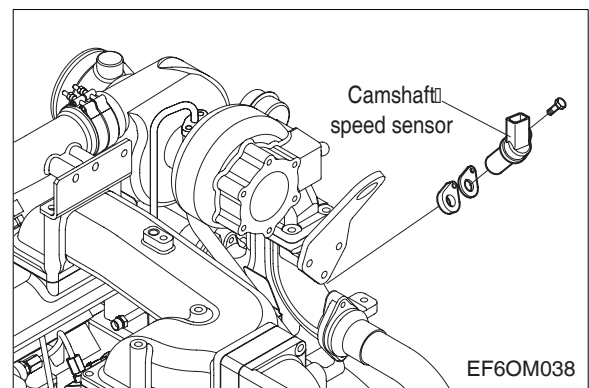


### 3.3.26. Camshaft speed sensor



- Measure the clearance of the assembling part of the sensor and timing gear, then assemble it with the adjust shim.

Clearance	1.0 ± 0.1 mm
Torque	1.0 kg.m

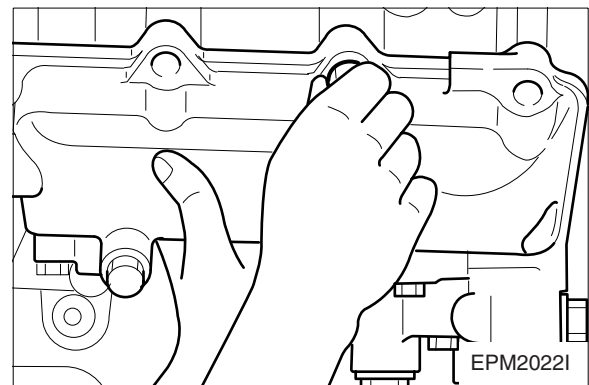


### 3.3.27. Oil cooler



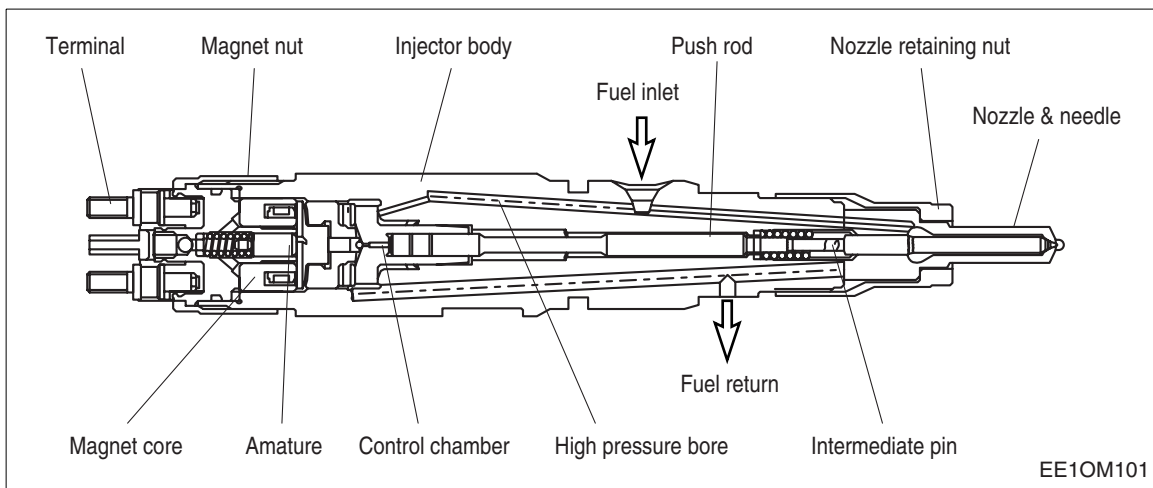
- Attach a gasket on the surface in the oil cooler housing where the oil cooler is installed.
- Tighten the oil cooler with fixing bolts.
- Install the oil cooler assembly by tightening the fixing bolts in the zigzag order.

Torque	4.4 kg.m
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### 3.4.13. Injector

- The start of injection and the injected fuel quantity are adjusted by the solenoid valve of the injector. These injectors supersede the nozzle and nozzle holder of the existing engine. The fuel is fed from the high pressure connector, to the nozzle through the passage, and to the control chamber through the feed orifice.
- The control chamber is connected to the fuel return via a bleed orifice which is opened by the solenoid valve. With the bleed orifice closed, the hydraulic force applied to the valve control plunger exceeds that at the nozzle needle pressure shoulder. As a result, the needle is forced into its seat and seals off the high pressure passage from the combustion chamber.
- When the injector's solenoid valve is triggered, the bleed orifice is opened. This leads to a drop in control-chamber pressure and, as a result, the hydraulic pressure on the plunger also drops. As soon as the hydraulic force drops below the force on the nozzle-needle pressure shoulder, the nozzle needle opens and fuel is injected through the spray holes into the combustion chamber.



- This indirect control of the nozzle needle using a hydraulic force-amplification system is applied because the forces which are necessary for opening the needle very quickly cannot be directly generated by the solenoid valve. The so-called control quantity needed for opening the nozzle needle is in addition to the fuel quantity which is actually injected, and it is led back to the fuel-return line via the control chamber's orifices. In addition to the control quantity, fuel is also lost at the nozzle-needle and valve plunger guides. These control and leak-off fuel quantities are returned to the fuel tank via the fuel return and the collector line to which overflow valve, high pressure pump, and pressure control valve are also connected.

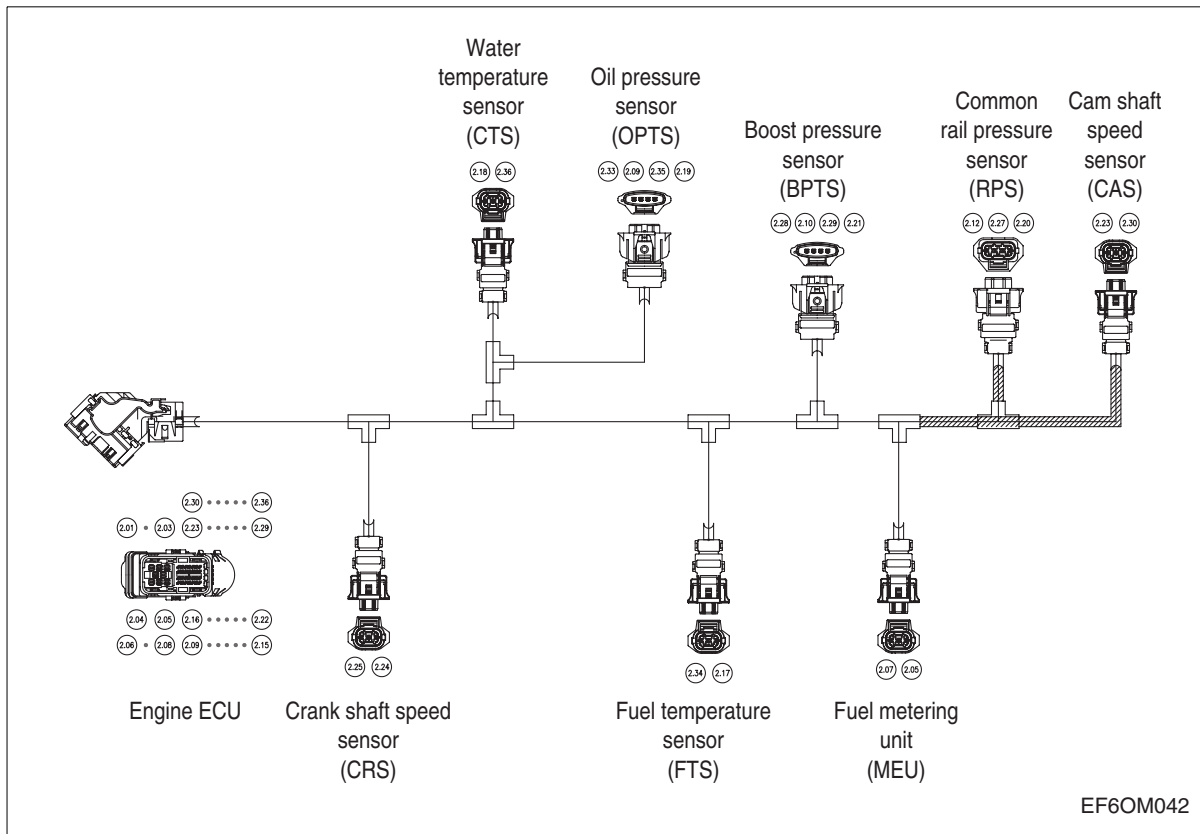
#### 1) Method of operation

The injector's operation can be subdivided into four operating states with the engine running and the high pressure pump generating pressure.

- Injector closed (with high pressure applied)
- Injector opens (start of injection)
- Injector opened fully, and
- Injector closes (end of injection)

These operating states result from the distribution of the forces applied to the injector's components. With the engine at standstill and no pressure in the rail, the nozzle spring closes the injector.

### 3.5.5. Sensor of engine side(Engine harness-1)



Part name	Signal	Pin position		Wire color	Circuit name
		ECU no.	Connecting pin no.		
2.25	CRS	ECU No.25	Crankshaft sensor 1	White	Speed sensor signal
2.24		ECU No.24	Crankshaft sensor 2	Blue	Speed sensor earth(-)
2.30	CAS	ECU No.30	Camshaft sensor 1	White	Speed sensor signal
2.23		ECU No.23	Camshaft sensor 2	Blue	Speed sensor earth (-)
2.07	MEU	ECU No.07	Fuel metering unit 1	White	Fuel metering unit (high)
2.05		ECU No.05	Fuel metering unit 2	Blue	Fuel metering unit (low)
2.19	OPTS	ECU No.19	Oil pressure sensor1	Blue	Oil pressure sensor earth (-)
2.35		ECU No.35	Oil pressure sensor 2	White	Oil temperature sensor signal
2.09		ECU No.09	Oil pressure sensor 3	White	Oil pressure sensor power supply (5V)
2.33		ECU No.33	Oil pressure sensor 4	White	Oil pressure sensor signal
2.21	BPTS	ECU No.21	Boost pressure sensor 1	Blue	Boost pressure sensor earth(-)
2.29		ECU No.29	Boost pressure sensor 2	White	Boost temperature sensor signal
2.10		ECU No.10	Boost pressure sensor 3	White	Boost pressure sensor power supply (5V)
2.28		ECU No.28	Boost pressure sensor 4	White	Boost pressure sensor signal
2.20	RPS	ECU No.20	Rail pressure sensor 1	Blue	Rail pressure sensor earth (-)
2.27		ECU No.27	Rail pressure sensor 2	White	Rail pressure sensor signal
2.12		ECU No.12	Rail pressure sensor 3	White	Rail pressure sensor power supply (5V)
2.36	CTS	ECU No.36	Coolant temperature sensor 1	White	Coolant temperature sensor signal
2.18		ECU No.18	Coolant temperature sensor 2	Blue	Coolant temperature sensor earth (-)
2.34	FTS	ECU No.34	Fuel temperature sensor 1	White	Fuel temperature sensor signal
2.17		ECU No.17	Fuel temperature sensor 2	Blue	Fuel temperature sensor earth (-)

#### 4.2.2. Check points for break-in

During the break-in (the initial running of the engine) period, be particularly observant as follows:

- Check engine oil level frequently. Maintain oil level in the safe range, between the "min." and "max." marks on dipstick.



**NOTE :**

**If you have a problem getting a good oil level reading on the oil level gauge, rotate the oil level gauge 180° and re-insert for check.**

- Watch the oil pressure warning lamp. If the lamp blinks, it may be the oil pick-up screen is not covered with oil. Check oil level gauge. Add oil to the oil pan, if required. Do not overfill. If level is correct and the status still exists, see your DEALER for possible switch or oil pump and line malfunction.



**Note :**

**Oil pressure will rise as RPM increases, and fall as RPM decreases. In addition, cold oil will generally show higher oil pressure for any specific RPM than hot oil. Both of these conditions reflect normal engine operation.**

- Watch the engine water temperature gauge and be sure there is proper water circulation. The water temperature gauge needle will fluctuate if water level in expansion tank is too low.
- At the end of the break-in period, remove break-in oil and replace the oil filter.
- Fill oil pan with recommended engine oil. Refer to following table

SAE no.	Oil grade
10W40	ACEA-E5 (API CI-4)

- **Engine oil capacity**

Engine oil capacity			
Engine model	Oil pan inside		Total (lit)
	Max. (lit)	Min. (lit)	
DV11	41	27	44

● **Adjusting of valves (Type 1)**

Cylinder No. / Valve adjusting	1		2		3		4		5		6	
	Exhaust	Intake	Exhaust	Intake	Exhaust	Intake	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust
#1 cylinder top dead center (#5 cylinder valve overlap)	⊙	⊙	⊙					⊙			⊙	
Crankshaft 90° revolution							⊙					
360° revolution #5 cylinder top dead center (#1 cylinder valve overlap)				●	●				●	●		●
Crank shaft 450° revolution						○						

● **Adjusting of valves (Type 2)**

Adjusting of the valve overlapping on each cylinder is done as follow.

When each cylinder is valve overlap (Explosion cylinder No. order)	1	4	2	6	3	6
Valve adjusting cylinder No.	5	3	6	1	4	2