# Exhaust & Turbocharger (WD615)

# Exhaust System

## General

**Supercharger:**

All WD615 Series diesel engines are of a turbocharged intercooled model, and the supercharger marched for the engine is an exhaust gas turbocharger. The engine generates power as a result of the combustion of fuel in the cylinder, and the input amount of fuel is limited by the intake amount of air into the cylinder, so the power generated is also limited. If the running performance of the engine has been in optimum state, in order to increase the output power, only more air is compressed into the cylinder to increase the amount of fuel and further improve the capacity to do work through combustion. Under current technical condition, the turbocharger is the only machine which can increase output power with the engine's working efficiency unchanged.

The greatest advantage of the turbocharger lies in significantly boosting the engine's power and torque without increasing the engine's displacement. Generally speaking, the power and torque of the engine which is equipped with the turbocharger will increase by 20％~30％. The disadvantage of the turbocharger lies in lagging; in other words, the engine delays to increase or decrease output power because the impeller has a slow response to the sudden change of the throttle due to inertia effect. A vehicle which accelerates suddenly or overtakes another vehicle will have insufficient power at that moment.

The exhaust gas turbocharger is mainly composed of an impeller and a turbine, and also includes some other control elements. The impeller and turbine are connected by a shaft, which is known as rotor, the exhaust gas from the engine drives the impeller, which in turn draws the turbine to rotate, so as to turbocharge the intake system. As the turbocharger is installed at the engine's exhaust side, the working temperature of the turbocharger is high, and the speed of the turbocharger's rotor is very high, which can reach several hundred thousand rpm. Such high speed and temperature disable common mechanical needle or ball bearings to work for the rotor, so non-locating bearings must be used for the turbocharger, which is lubricated by engine oil and cooled by coolant.



**Intercooler:**

High temperature not only affects charging efficiency, but also is easy to result in explosion. Accordingly, a device is needed to lower the intake temperature, which is an intercooler. It is installed between the turbocharger outlet and intake pipe and used for cooling air into the cylinder. The intercooler, as a radiator, uses air or water for cooling, and the heat of air escapes to the atmosphere through cooling. According to the test, the intercooler with good performance can not only keep the engine's compression ratio at a certain valve without explosion, but also lower temperature to increase intake pressure and further boost the effective power of the engine. This vehicle is air-air cooled, and the resistance of the intercooler shall be lower than 5 kPa (in rated condition).

**Precautions**

**As the turbocharger usually operates at high speed and high temperature, the temperature of the turbocharger's exhaust gas end is about 600℃, and the turbocharger's rotor rotates by 7,000~100,000 r/min, the following points shall be noted in order to ensure that the turbocharger operates normally:**

**1. DO NOT drive immediately after the engine starts**

- After the engine starts, especially in winter, run it at idle speed for a while, which allows lubricating oil to sufficiently lubricate bearings before the turbocharger's rotor operates at high speed. Therefore, never step on the accelerator sharply just after the engine starts, to avoid damaging the oil seal of the turbocharger. The engine shall be idled appropriately (about 5min, which can be shortened for a short stop) after starting, and then loaded.

**2. DO NOT shut down the engine immediately**

- DO NOT shut down immediately the engine which has operated at high speed for a long time. When the engine is running, some oil is supplied to the bearings of the turbocharger's rotor for lubrication and cooling. If the operating engine is shut down suddenly, the oil pressure goes down to 0 rapidly, the high temperature of the turbocharger's turbine part is transferred to the middle, and the heat in the bearing support housing can not be taken away quickly while the rotor of the turbocharger is still rotating under inertia effect. Thus, if the engine in hot state is shut down suddenly, the oil remaining in the turbocharger will get overheated to damage the bearings and shaft. As a result, the engine, which has operated with large load for a long time, shall be run at idle speed for 3~5min, and then shut down after the rotor rotates at low speed. It is specially prohibited to shut down the engine suddenly after stepping on the accelerator strongly.

**3. Keep clean**

- Keep clean while dismantling the turbocharger. Block each pipe joint with clean cloth to prevent foreign matters from falling into the turbocharger and damaging the rotor. Be careful not to hit or damage the impeller during repair. Remove the obstructions after reassembly.



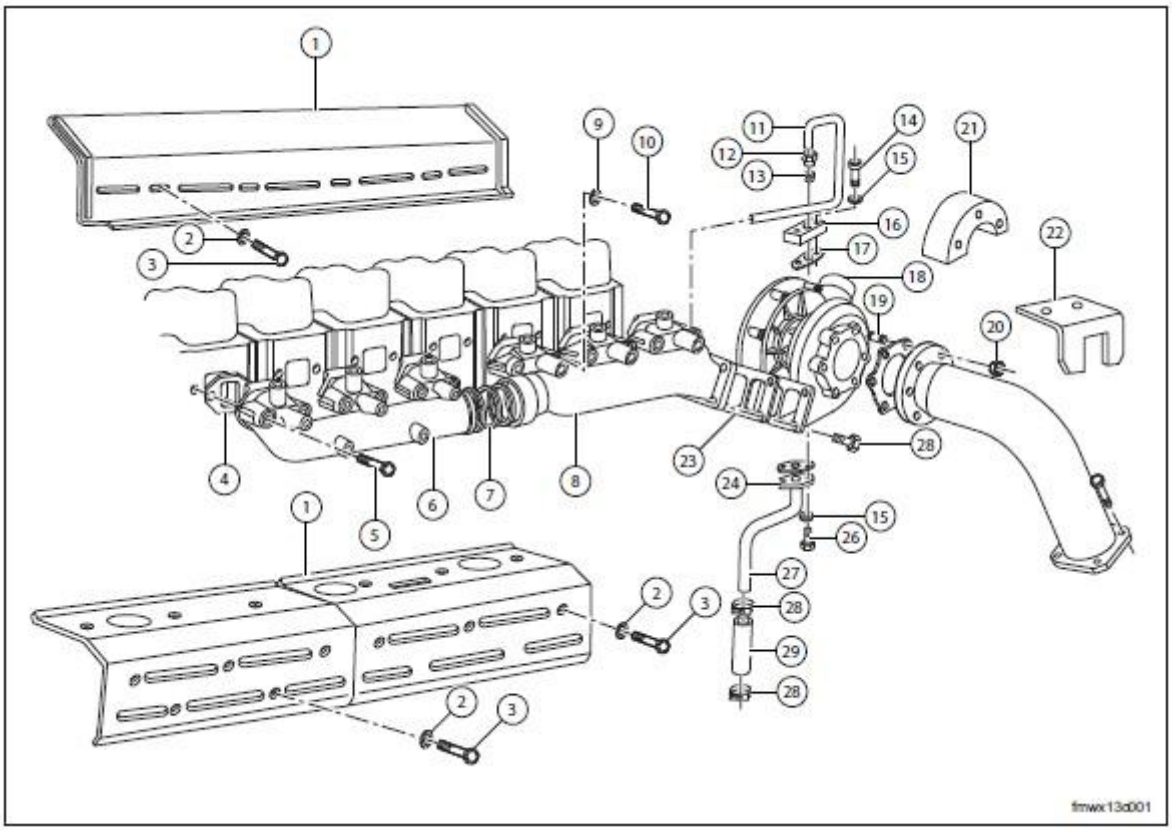
**4. Wash the turbocharger**

- As the turbocharger usually operates at high temperature, the partial coking of engine oil in the lubricating oil pipeline easy occurs due to the effect of high temperature, which will cause and damage to on bearings as a result of insufficient lubrication. Therefore, the lubricating oil pipeline shall be washed after the turbocharger has operated for a period of time.

**5. Inspect the operating condition of the turbocharger usually**

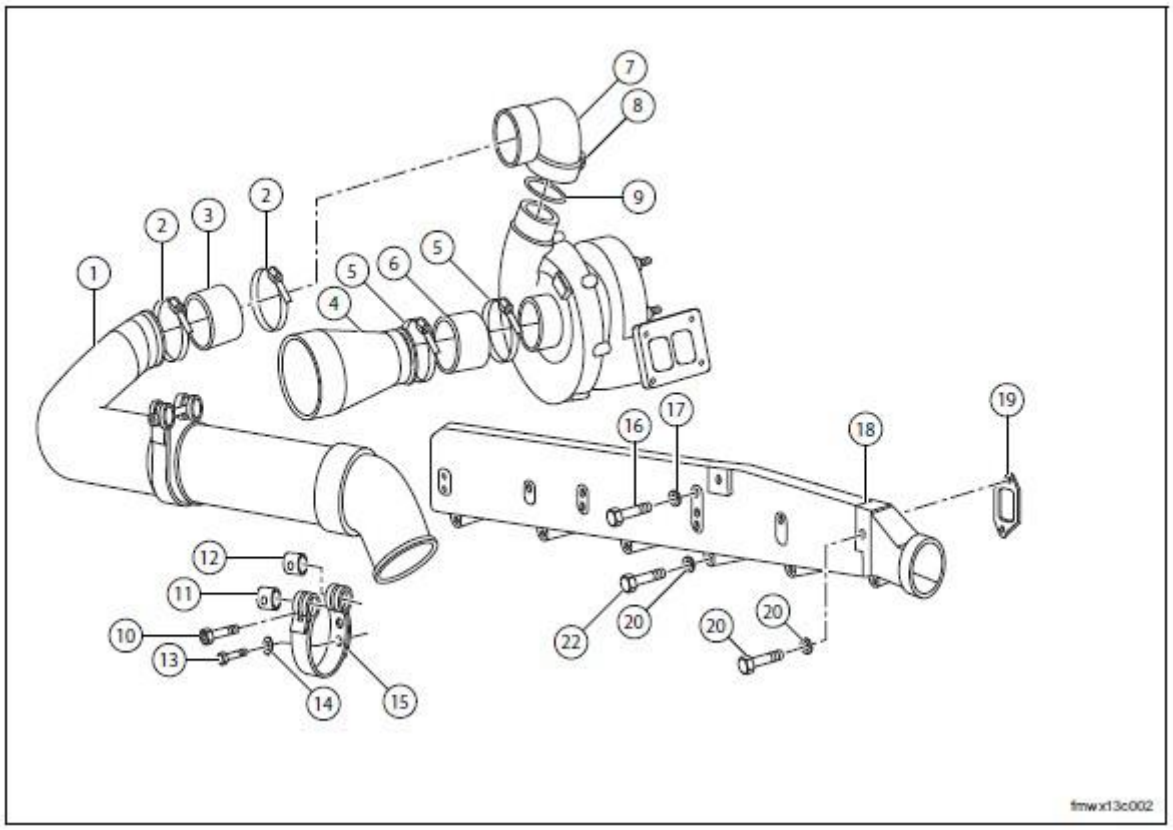
- Inspect the connection of various air pipes before driving and after stopping, and prevent the turbocharger from failing due to looseness and falling and air from going into the cylinder due to short circuit. Make sure the tightness of the turbocharger's pipeline system and parts, and the heat dispersion of the intercooler.

**Part Drawing**




| | |
|---|---|
| 1 | Front Heat Shield |
| 2 | Rear Heat Shield |
| 3 | Small Washer |
| 4 | Bolt |
| 5 | Exhaust Pipe Gasket |
| 6 | Front Exhaust Manifold |
| 7 | Sealing Ring, Exhaust Pipe |
| 8 | Rear Exhaust manifold |
| 9 | Thrust Washer |
| 10 | Fastening Bolt, Exhaust Pipe |
| 11 | Oil Inlet Pipe |
| 12 | Pipe Joint Nut |
| 13 | Clamp Sleeve |
| 14 | Hex Socket Cap Head Screw |
| 15 | Self-locking Washer |

| | |
|---|---|
| 16 | Flange, Oil Inlet Pipe |
| 17 | Gasket, Oil Inlet Pipe |
| 18 | Exhaust Gas Turbocharger |
| 19 | Stud Bolt |
| 20 | Prevailing Torque Type All-metal Hex Nut, Style 2 |
| 21 | Heat Shield |
| 22 | Bracket |
| 23 | Turbocharger Gasket |
| 24 | Gasket, Oil Return Pipe Flange |
| 25 | Hex Head Bolt |
| 26 | Oil Return Pipe Bolt |
| 27 | Oil Return Pipe |
| 28 | Hose Clamp |
| 29 | Hose for Turbocharger Oil Return |




| | |
|---|---|
| 1 | Pipe Assembly |
| 2 | Hose Clamp |
| 3 | Rubber Hose with Fibre |
| 4 | Intake Pipe, Air Compressor |
| 5 | Hose Clamp |
| 6 | Rubber Hose |
| 7 | Connecting Elbow |
| 8 | Clamp |
| 9 | Sealing Ring |
| 10 | Hex Socket Cap Head Screw |
| 11 | Clamping Pin |

| | |
|---|---|
| 12 | Clamping Pin |
| 13 | Hex Head Bolt |
| 14 | Adjusting Washer |
| 15 | Tension Strap |
| 16 | Hex Head Screw Plug |
| 17 | Sealing Washer |
| 18 | Intake Pipe Assembly |
| 19 | Intake Pipe Gasket |
| 20 | Wave Spring Washer |
| 21 | Fastening Bolt, Intake Pipe |
| 22 | Hex Head Bolt |

**Testing & Adjustment**

The turbocharger is a key mechanical part which is used for boosting the engine's power and decreasing exhaust gas emission. Improper use, maintenance and care may cause the turbocharger to be defective and disable the turbocharger to work. This text introduces some common faults and solutions of the turbocharger as follows:

**The turbocharger leaks oil.**

Symptom 1: Excessive oil is consumed, but the color of exhaust smoke is normal and the power does not decrease.

Cause: This condition is generally caused by oil leakage.

Solution:

**1. First of all, inspect whether the external oil pipes (including oil inlet and return pipes of the turbocharger) of the engine lubrication system leak oil.**

**2. Inspect whether there is oil at the exhaust gas outlet of the turbocharger. If any, you can decide that the sealing ring at one end of the turbine is damaged, and replace it.**

Symptom 2: Excessive oil is consumed, the color of exhaust smoke is blue, but the power does not decrease.

Cause: It is caused by that the oil leaked from the compressor end of the turbocharger leaks oil goes into the combustion chamber through the intake pipe of the engine. The possible causes are as follows:

**1. The oil return pipe of the turbocharger is obstructed, and excessive oil accumulates at the middle support of the rotor assembly and flows into the compressor impeller along the rotor shaft.**

**2. After the sealing ring or oil slinger at the compressor impeller end is damaged, oil will go into the impeller chamber through the damaged sealing ring or oil slinger, and then into the combustion chamber through the intake pipe along with turbocharged air in the impeller chamber.**

Solution:



**1. Open the outlet of the air compressor or the straight intake pipe (rubber hose) of the engine, observe whether oil is attached to the pipe orifice or wall. If any, inspect whether the oil return pipe of the turbocharger is unobstructed. If obstructed, it may caused by the accumulation of excessive oil at the middle support. Unblock the oil return pipe and then reassemble.**

**2. If unobstructed, it is caused by that the sealing ring or oil slinger at the impeller end is damaged. Disassemble the turbocharger and repair the damaged part.**

Symptom 3: Excessive oil is consumed, the color of exhaust smoke is blue or black, and the power decreases.

Cause:

**1. The wearing of the clearance between the piston and cylinder is too big, and the oil goes into the combustion chamber and is combusted.**

**2. In process of sucking air into the turbocharger, air flow encounters great resistance (such as clogging of the air filter element, deformation or flattening of the intake rubber hose due to suction, etc.). The low pressure at the inlet of the air compressor will cause oil leakage, and the oil leaked will go into the air compressor, then get into the combustion chamber along with compressed air and be combusted.**

Solution:

**1. Inspect whether there is oil on the wall of the straight intake hose, the hose is flattened, air flow is obstructed, or the air filter element is clogged.**

**2. If there is oil at the pipe orifice and on the pipe wall, wash or replace the air filter element.**

**There is metallic grating noise.**

Symptom: The color of exhaust smoke is black, the power decreases, and there is abnormal noise from the turbocharger.

Cause:

**1. If there is metallic grating noise, it is caused by the friction between the impeller and turbocharger housing due to the excessive wearing of the turbocharger's rotor bearings or thrust bearings.**

**2. If it is air flow noise rather than metallic grating noise, it is the rotation noise generated by the rotation of the turbocharger's rotor at high speed, or the air leakage noise due to poor connection of the intake or exhaust joint.**

Solution:

**1. For the former, replace the damaged part or repair according to the wearing condition.**

**2. For the latter, distinguish carefully, and solve according to the specific condition.**

**The turbocharger's bearing is damaged.**

Symptom: The turbocharger's bearing is damaged, the engine's power decreases, excessive oil is consumed, the color of smoke is black, and the turbocharger fails to work when the fault is serious.

Cause:

**1. The pressure and flow of lubricating oil is insufficient.**

- Lubricating oil supplied for the turbocharger's journal and thrust bearing is insufficient.
- Lubricating oil which keeps floating between rotor journal and bearing is insufficient.
- The turbocharger has operated at high speed, but lubricating oil is not supplied in time.

**2. Foreign matters or silt goes into the lubrication system.**

**3. Engine oil deteriorates due to oxidization.**

- The diesel engine overheats, and gas going between the piston and cylinder wall is excessive;
- Cooling water is leaked into engine oil;
- Improper engine oil is selected, and engine oil is not replaced periodically according to specified requirement.

Solution:

**1. Inspect whether the pressure of lubricating oil is normal, and the oil amount meets the requirement.**

**2. Replace lubricating oil periodically according to the specified requirement, and ensure the cleanliness of lubricating oil.**

**3. Use lubricating oil strictly according to the specified requirement. Mixing of lubricating oils is not allowed.**

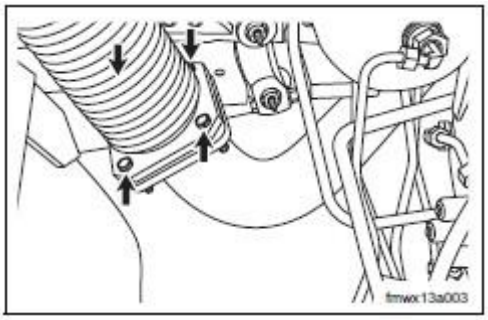
**4. Prevent the engine from operating at high temperature, and keep the engine at normal operating temperature.**

**Exhaust Pipe**

**Overhaul**

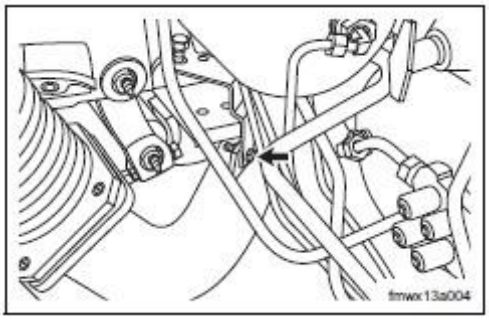
Hint:

Part Drawing, refer to Chapter 13C, Exhaust & Turbocharger – Exhaust System, Part Drawing

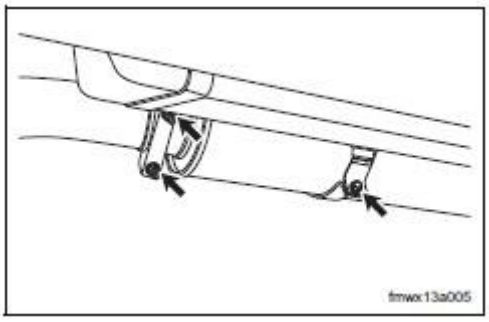



**1. Dismantle the exhaust pipe**

(a). Dismantle the fixing bolts of the exhaust pipe.

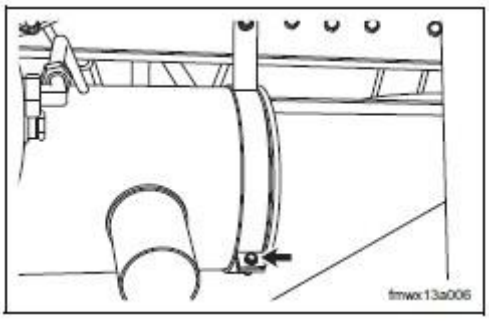



(b). Dismantle the bolts of the exhaust pipe fixing bracket.




(c). Dismantle the fixing nuts of the muffler bracket.

(d). Dismantle the fixing bolts of the muffler clamp.




(e). Dismantle the fixing bolts of the muffler clamp.

(f). Draw out the exhaust pipe.

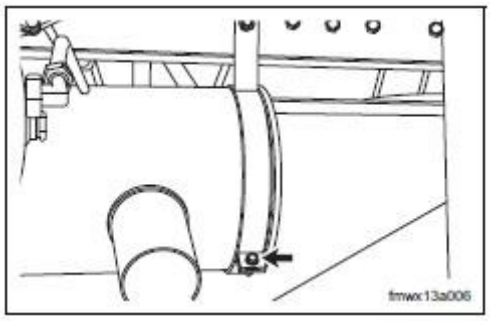
**2. Inspect the exhaust pipe**

(a). Inspect whether there is excessive corrosion, cracking or air leakage of the exhaust pipe and muffler.

(b). Inspect the exhaust pipe and muffler.

**Caution:**

**If any performance of the exhaust pipe and muffler fails to meet the requirements, replace with a new exhaust pipe and muffler assembly.**

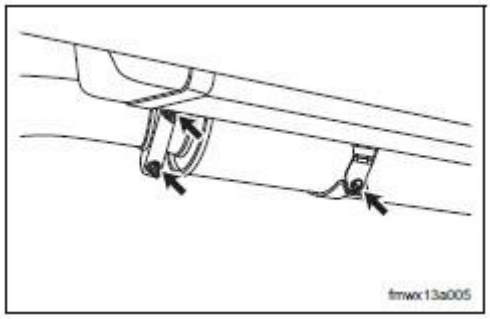



**3. Install the exhaust pipe**

(a). Install the exhaust pipe.

(b). Install the fixing bolts of the muffler clamp.

**Torque: 80±10N.m**

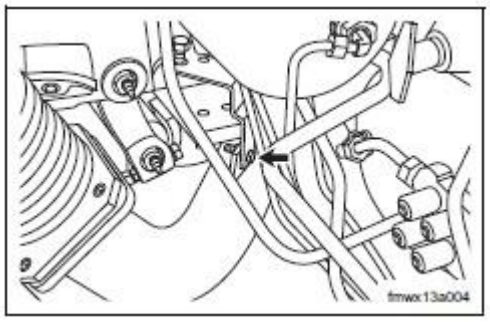



(c). Install the fixing nuts of the muffler bracket.

**Torque: 80±10N.m**

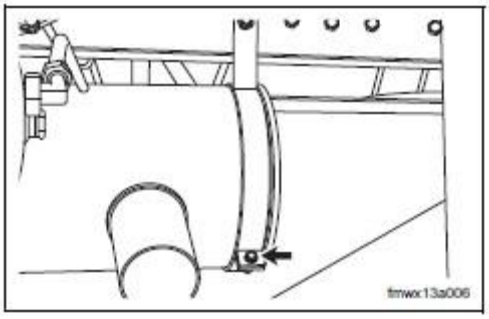
(d). Install the fixing bolts of the muffler clamp.

**Torque: 80±10N.m**




(e). Install the bolts of the exhaust pipe fixing bracket.

**Torque: 45±5N.m**




(f). Install the fixing bolts of the exhaust pipe.

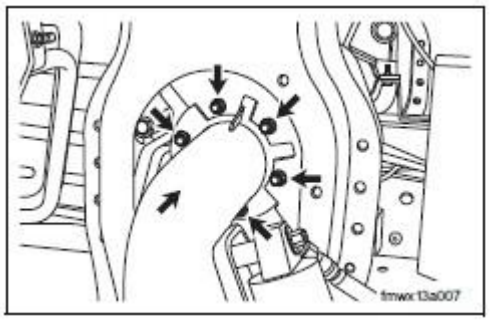
**Torque: 45±5N.m**

**Turbocharger**

**Overhaul**

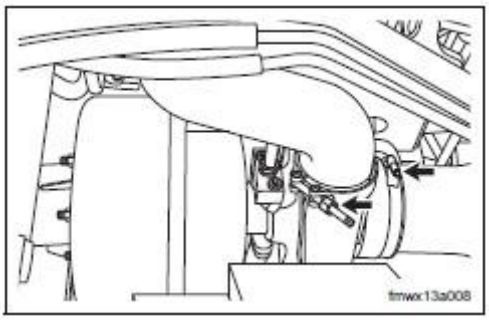
Hint:

Part Drawing, refer to Chapter 13C, Exhaust & Turbocharger – Exhaust System, Part Drawing

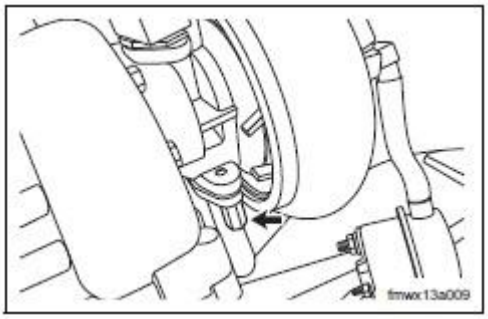



**1. Dismantle the turbocharger**

(a). Dismantle the heat shield and exhaust pipe.

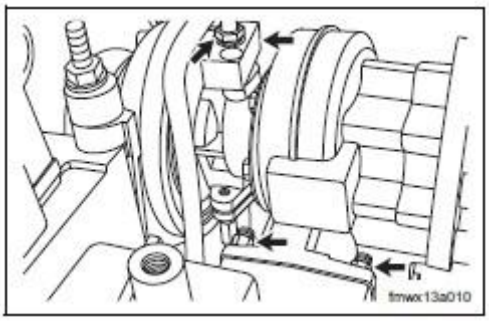



(b). Dismantle the intercooler intake pipe and connecting elbow.




(c). Dismantle the oil return pipe.

- Dismantle the bolts of the oil return pipe.

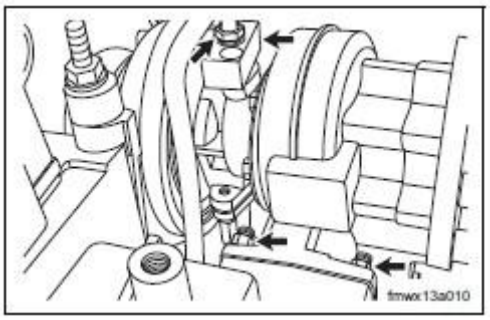



(d). Dismantle the oil inlet pipe.

- Dismantle the hex socket bolts of the oil inlet pipe.

(e). Dismantle the fixing bolts of the turbine.

**2. Inspect the turbocharger. Refer to Chapter 13C, Exhaust & Turbocharger – Exhaust System, Testing & Adjustment.**



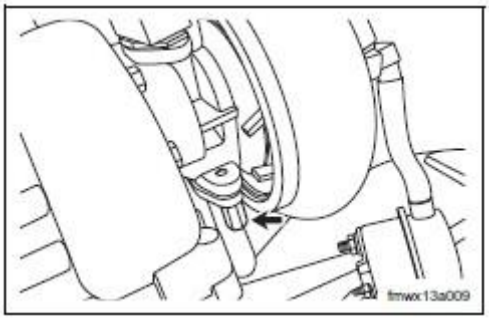

**3. Install the turbocharger**

(a). Install the fixing bolts of the turbine.

**Torque: 45±5N.m**

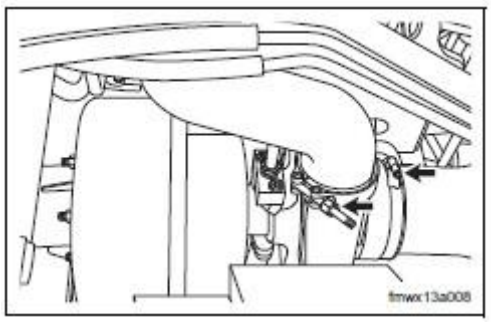
(b). Install the oil inlet pipe.

- Install the hex socket bolts of the oil inlet pipe.

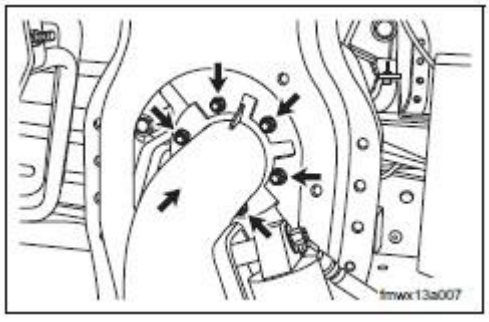



(c). Install the oil return pipe.

- Install the bolts of the oil return pipe.




(d). Install the intercooler intake pipe and connecting elbow.




(e). Install the heat shield and exhaust pipe.

**Torque: 25±5N.m**