

Fuel Charging and Controls - Turbocharger - TDV6 3.0L Diesel -**Torque Specification**

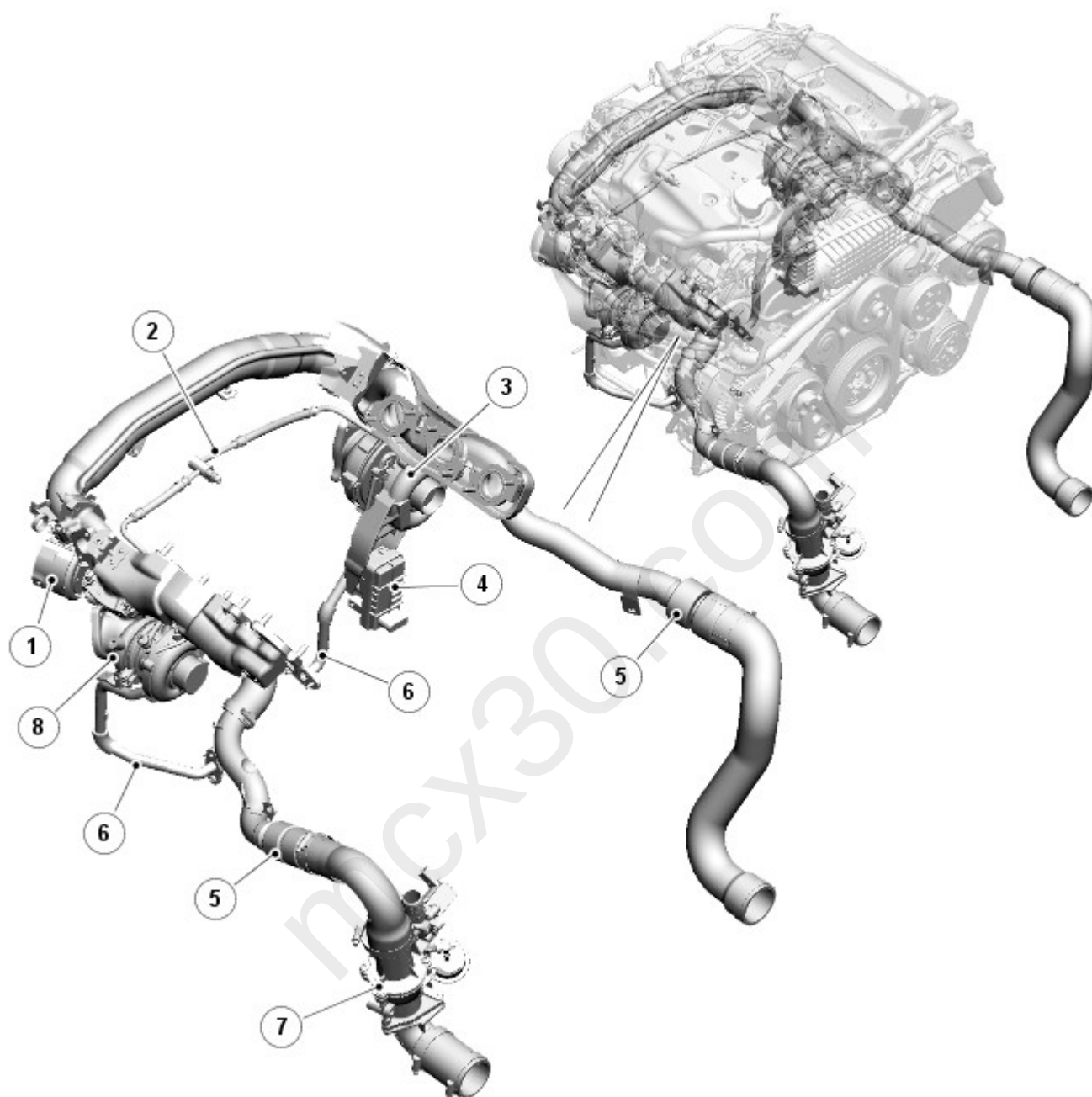
Description	Nm	lb-ft	lb-in
Exhaust manifold threaded stud	13	10	-
Exhaust manifold retaining nuts	24	18	-
Turbocharger oil return tube to turbocharger retaining bolt	9	-	80
Turbocharger oil return tube to engine retaining bolt	9	-	80
Turbocharger bracket retaining bolts	23	17	-
Turbocharger to exhaust manifold retaining nuts	24	18	-
Exhaust manifold heatshield retaining bolt	11	8	-
Exhaust heatshield retaining bolt	9	-	80
Exhaust heatshield retaining nut	10	-	7
Turbocharger oil supply tube retaining bolt	9	-	80
Turbocharger oil supply tube union bolt	30	22	-
Exhaust gas recirculation (EGR) valve retaining bolts	9	-	80
EGR valve tube to exhaust manifold retaining bolts	9	-	80

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Fuel Charging and Controls - Turbocharger - TDV6 3.0L Diesel - Turbocharger - Component Location

Description and Operation

COMPONENT LOCATION



E121149

ItemDescription

1	Secondary turbocharger turbine shut-off valve
2	Turbocharger oil supply
3	Primary turbocharger (variable vane)
4	Primary turbocharger control module (variable vane actuator)
5	Charge air tube
6	Turbocharger oil drain
7	Secondary turbocharger recirculation valve and shut-off valve
8	Secondary turbocharger (fixed vane)

Fuel Charging and Controls - Turbocharger - TDV6 3.0L Diesel - Turbocharger - Overview

Description and Operation

INTRODUCTION

The 3.0L V6 diesel engine uses two turbochargers; a fixed vane type (secondary) and a variable vane (primary) type. The fixed vane turbocharger is fitted to the [RH \(right-hand\)](#) cylinder bank and the variable vane turbocharger is fitted to the [LH \(left-hand\)](#) cylinder bank.

Both turbochargers are used in a parallel sequential turbocharging system which enables the engine to achieve quick throttle response at low engine speeds and efficient use of exhaust gas energy at high engine speeds.

The variable vane turbocharger has an [ECM \(engine control module\)](#) controlled electronic rotary actuator. The rotary actuator adjusts the turbine vanes to optimize the exhaust gas flow and velocity onto the turbine wheel to maintain the required boost pressure.

The parallel sequential turbocharging system comprises the two turbochargers and the [ECM](#). The primary variable nozzle turbine operates through the entire engine speed range but is at its most efficient at engine speeds of up to 2800 rpm. At engine speeds above 2800 rpm under load, the fixed vane secondary turbine comes into operation, with both of the turbochargers now running in a parallel bi-turbo mode.

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Fuel Charging and Controls - Turbocharger - TDV6 3.0L Diesel - Turbocharger - System Operation and Component Description

Description and Operation

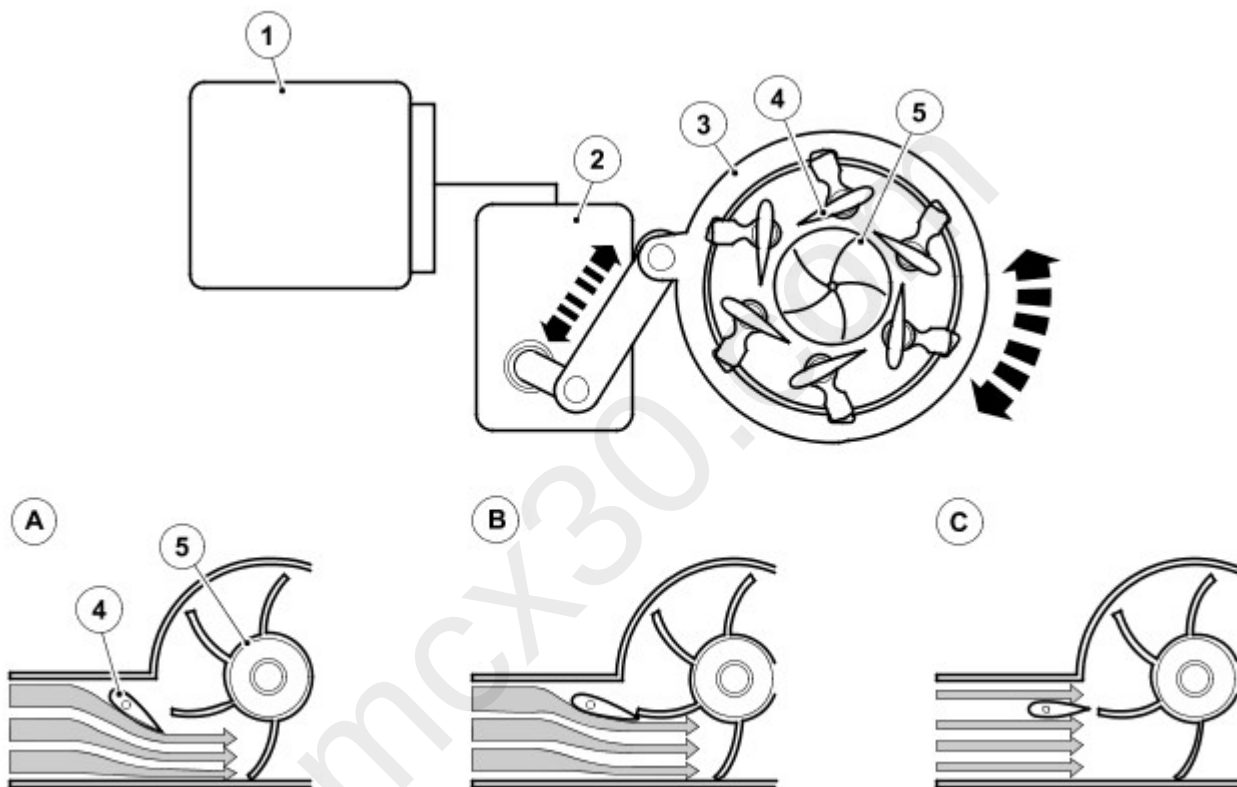
System Operation

TURBOCHARGERS

The turbine wheel of the turbocharger uses the engine's exhaust gasses to drive the compressor wheel. The compressor wheel draws in fresh air which is supplied to the engine cylinders in a compressed form.

The primary variable vane turbocharger allows the optimum inlet geometry (inlet area and flow angle) to be used over a wide range of engine operating conditions. This allows a rapid speed of response and higher boost pressures at low engine speeds. The variable vane angle determines both the inlet area as well as the flow angle, as controlled by the [ECM \(engine control module\)](#). The variable vanes allow efficient use of the exhaust gas energy which in turn improves turbocharger and engine efficiency.

Principles of Variable Vane Operation



E107579

ItemDescription

A	Low engine speed
B	Intermediate engine speed
C	High engine speed
1	ECM
2	Electronic rotary actuator
3	Turbine housing
4	Variable vanes
5	Compressor wheel

The variable vanes in the primary turbocharger are controlled by the [ECM](#). The [ECM](#) controls a rotary electronic actuator attached to the primary turbocharger which is used to adjust the pitch angle of the vanes by rotating the turbine housing. The electronic rotary actuator also provides the [ECM](#) with a feedback signal to determine the pitch angle of the vanes.

The variable vanes in the primary turbocharger improve the exhaust gas power transfer to the turbine wheel which in turn drives the compressor wheel. At low engine speeds this greatly assists the increase in turbocharger boost pressure.

As engine speed, and therefore the exhaust gas velocity, increases, the vanes are opened. The amount of opening is determined by the [ECM](#) to ensure that the power transfer from the turbine wheel to the compressor wheel is within the turbocharger speed and boost pressure requirements.

At high engine speed and exhaust gas flow, the [ECM](#) increases the vane opening to avoid overspeed of the turbines and

provide a smooth high speed operation. At this point the dual mode boosting system comes into affect by utilizing the secondary (fixed vane) turbocharger.

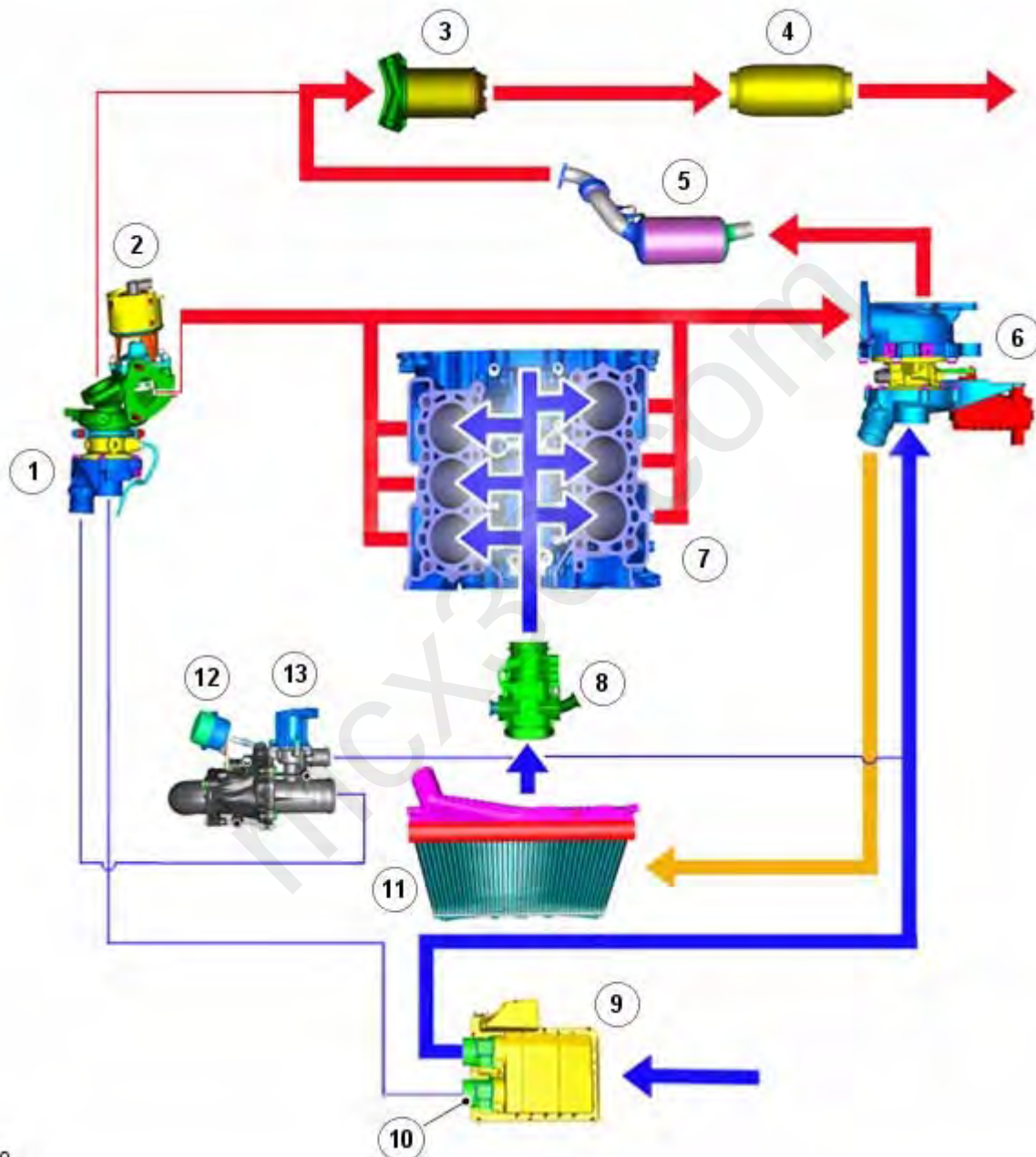
The fixed vane turbocharger incorporates an outlet temperature senor, which is located adjacent the oxygen sensor in the close coupled catalytic converter and, an outlet pressure sensor which receives inputs from the APP (accelerator pedal position) and ECM.

Refer to: [Electronic Engine Controls](#) (303-14B Electronic Engine Controls - TDV6 3.0L Diesel, Description and Operation).

Dual Mode Boosting

The dual mode boosting system comprises two turbochargers and software within the ECM. The two turbochargers can operate in two modes; mono turbocharger operation or bi-turbocharger operation.

Mono Turbocharger Schematic Diagram



E107580

ItemDescription

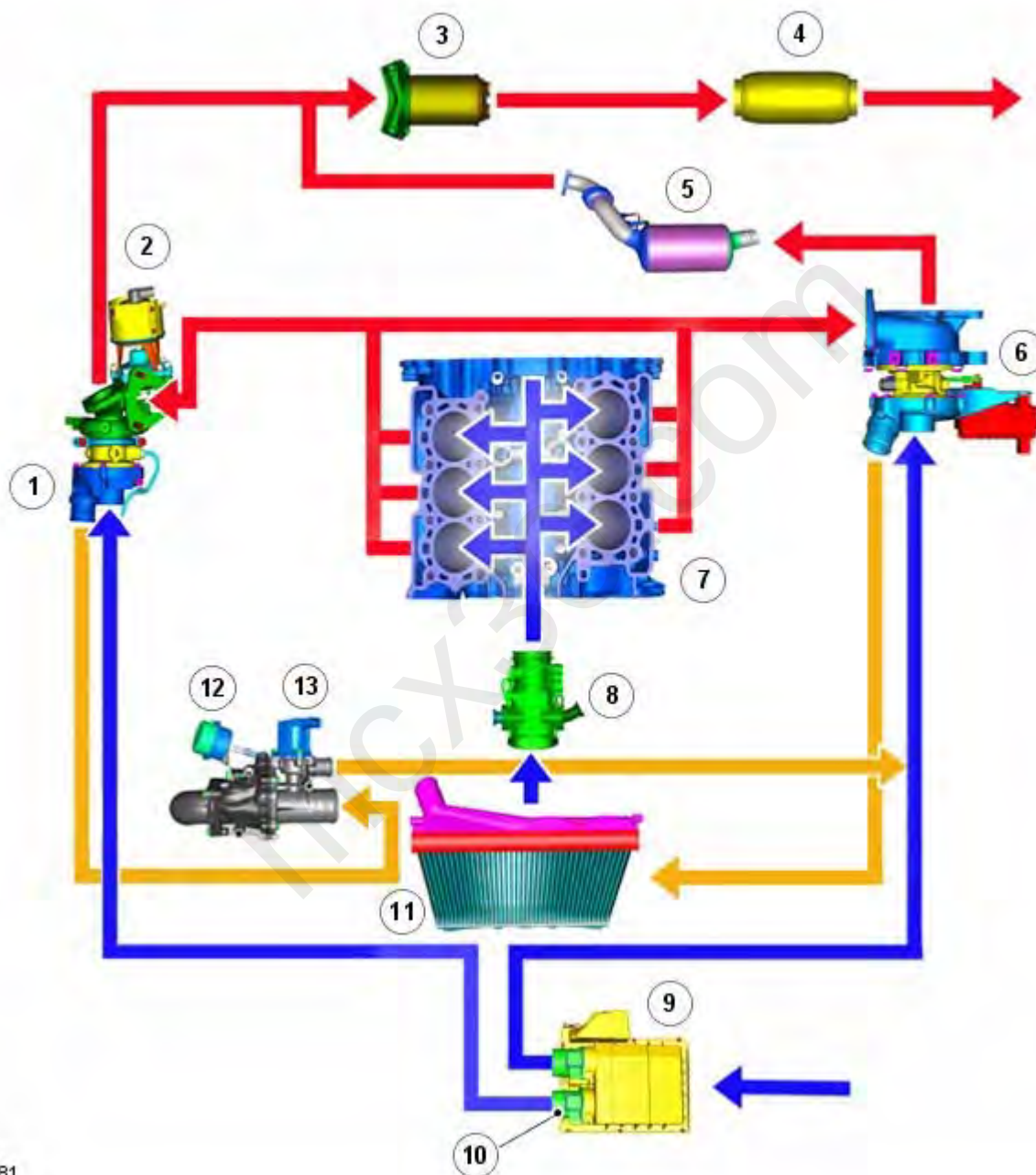
1	Fixed vane turbine
2	Turbine shut-off valve
3	DPF (diesel particulate filter)
4	Flexible center resonators
5	Catalytic converter
6	Variable vane turbocharger
7	Engine
8	Throttle
9	
10	
11	
12	
13	

Air filter
10 MAF (mass air flow) meter
11 Charge air cooler
12 Compressor shut-off valve
13 Recirculation valve

Fresh air is drawn through the air filter and the MAF meter to the primary turbocharger compressor. The compressed air is then passed through the charge air cooler and into the engine.

The turbine shut-off valve on the secondary turbocharger is closed and therefore exhaust gasses are unable to operate the secondary turbocharger turbine. In this condition all turbocharging boost pressure is produced by the primary turbocharger.

Bi-Turbocharger Switching Schematic Diagram



E107581

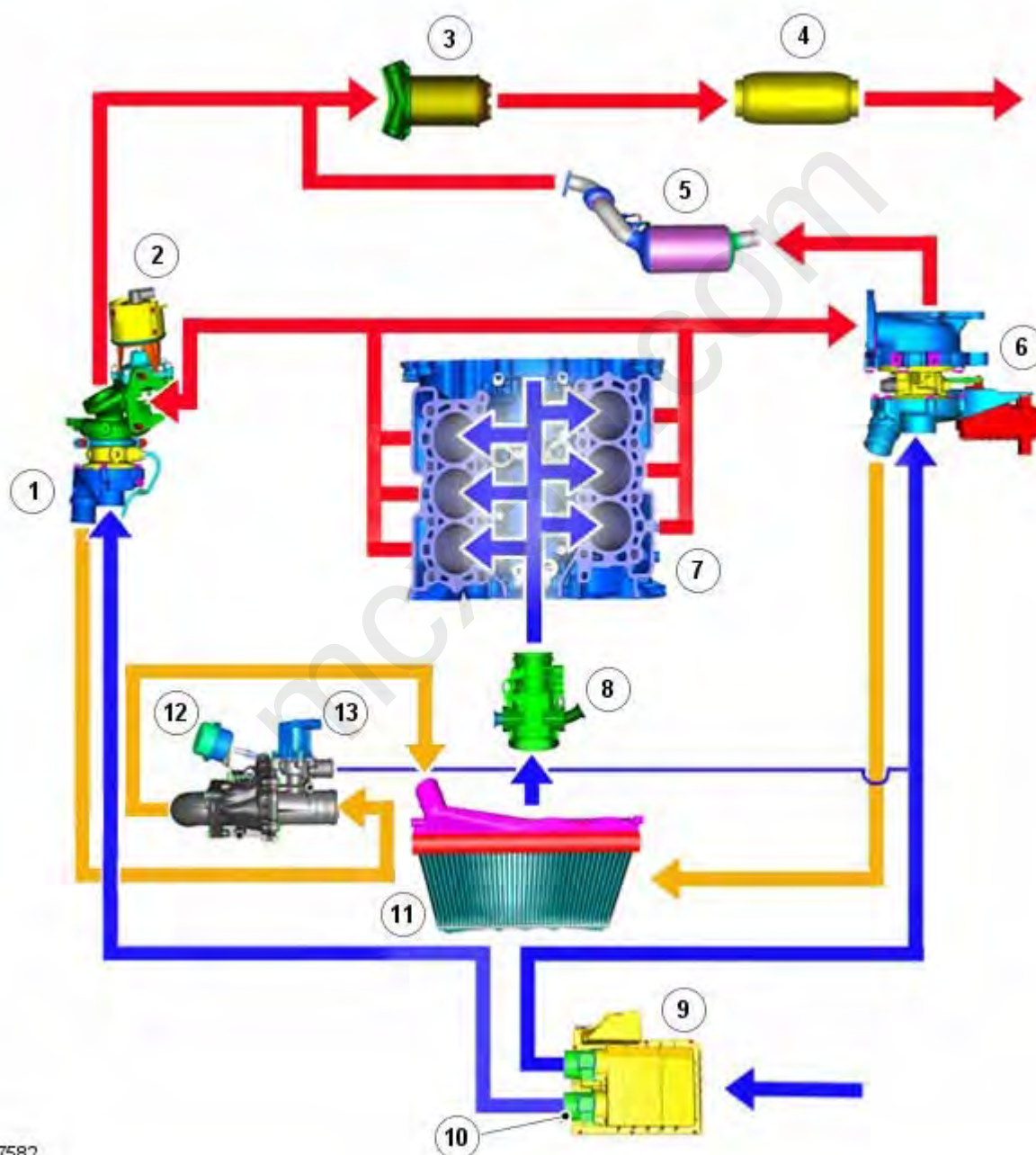
Item	Description
1	Fixed vane turbine
2	Turbine shut-off valve
3	DPF
4	Flexible center resonators
5	Catalytic Converter
6	Variable vane turbocharger
7	Engine
8	Throttle

Air filter
10 MAF meter
11 Charge air cooler
12 Compressor shut-off valve
13 Recirculation valve

When the engine operating parameters approach the limits (approximately 2800 rpm under load) of the primary turbocharger, dual mode boosting control software within the [ECM](#) begins the switch to parallel bi-turbocharger operation. The secondary turbocharger is brought into operation by the opening of the turbine shut-off valve which allows exhaust gasses to flow through the turbine.

Initially, the secondary turbocharger does not produce a boost pressure to equal that of the primary turbocharger. Therefore, the initial boost pressure from the secondary turbocharger is fed via the recirculation valve into the clean air inlet for the primary turbocharger. As the secondary turbocharger boost pressure output increases, the recirculation valve is then closed and the compressor shut-off valve opened to increase the boost pressure from the secondary turbocharger which is directed into the charge air cooler.

Bi-Turbocharger Schematic Diagram



E107582

Item	Description
1	Fixed vane turbine
2	Turbine shut-off valve
3	DPF
4	Flexible center resonators
5	

Catalytic Converter
6 Variable vane turbocharger
7 Engine
8 Throttle
9 Air filter
10 MAF meter
11 Charge air cooler
12 Compressor shut-off valve
13 Recirculation valve

When the secondary turbocharger has reached the required operating parameters, the recirculation valve is closed and the compressor shut-off valve is opened. The [ECM](#) will maintain the engine operating in bi-turbocharger operation with both primary and secondary turbochargers contributing to the air charge induction. When the dual mode boosting software determines that the engine operating parameters no longer require the use of dual mode boosting, the system switches back to mono turbocharger operation.

If the engine idles for more than 3 minutes, the secondary turbocharger is actuated to ensure correct lubrication. This is achieved by pressurizing the turbine shaft bearing cavities through a pipe, which is connected to the air intake system and periodically opening the turbine shut-off valve to operate the turbocharger.

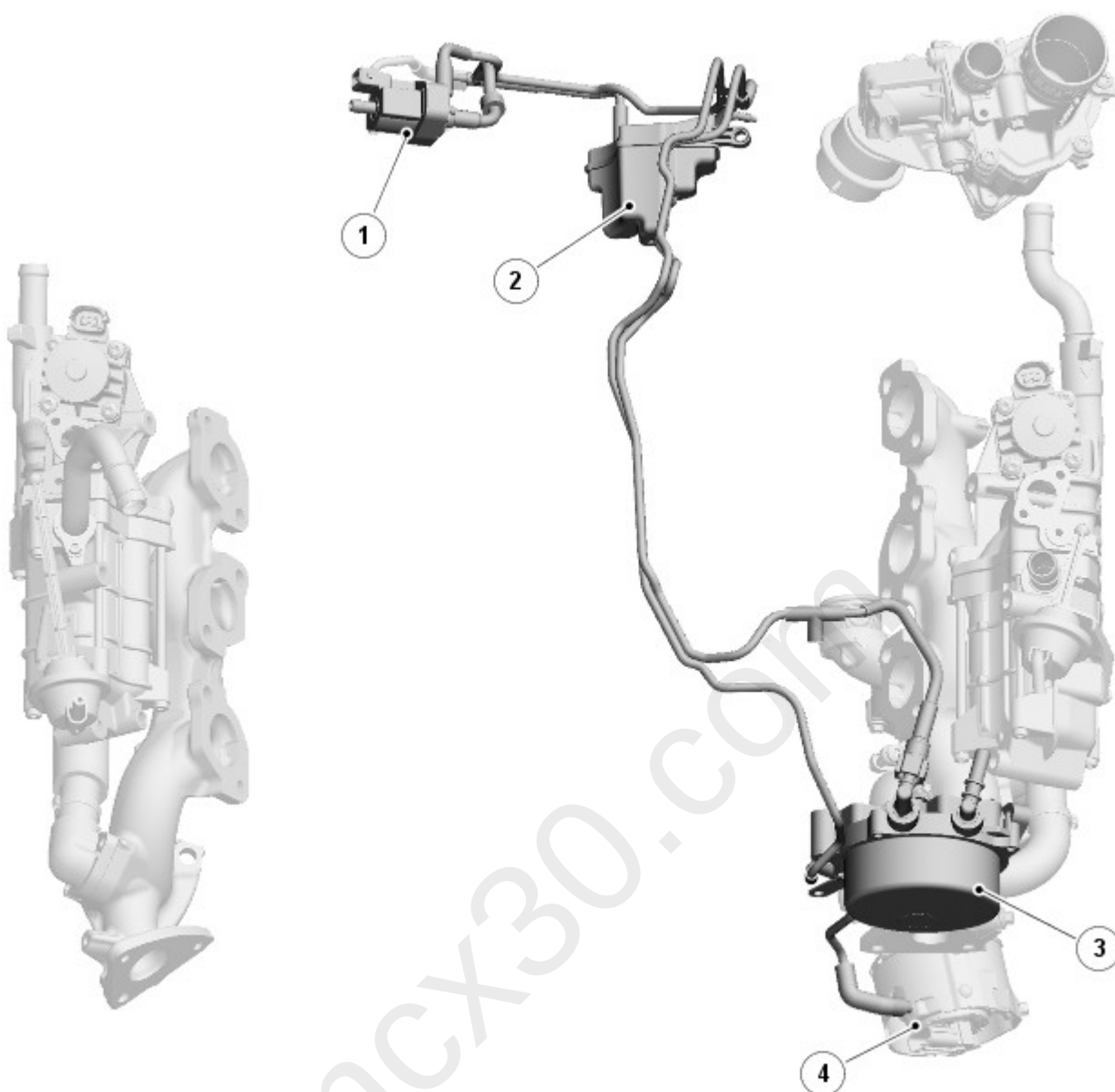


CAUTION: Ensure both ends of the pipe are securely connected to the secondary turbo and the air intake system to prevent damage to the turbo components.

Turbine and Compressor Shut-off Valve Control

The secondary turbocharger turbine shut-off valve and compressor shut-off valve are controlled by the [ECM](#) through a vacuum system. The secondary turbo turbine shut-off valve also incorporates a position sensor.

Secondary Turbocharger Turbine Shut-off Valve Vacuum Control



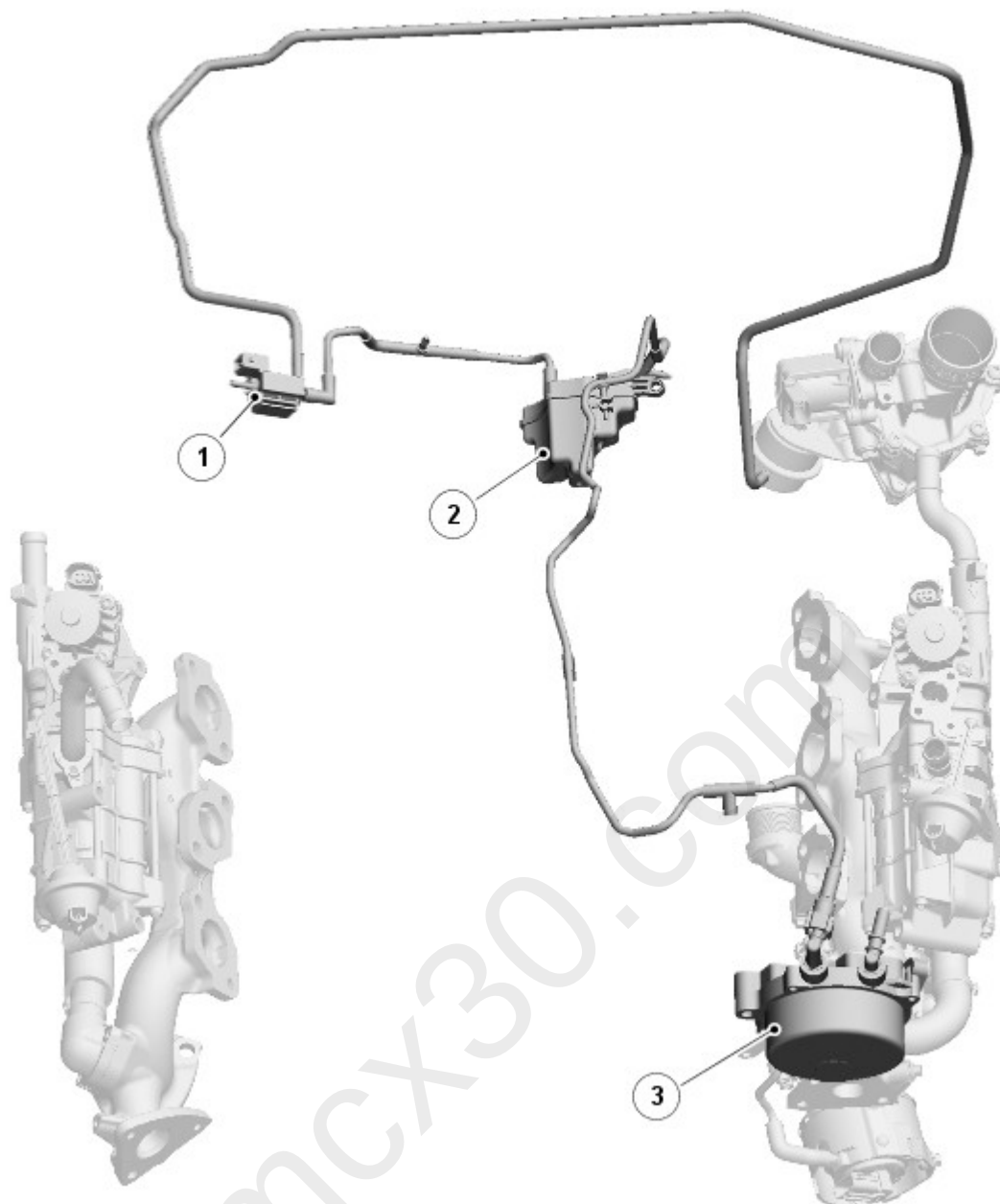
E117413

ItemDescription

1	Secondary turbine shut-off solenoid valve
2	Vacuum reservoir
3	Vacuum pump
4	Secondary turbine shut-off valve

If vacuum is lost to the shut-off valve it will default to the closed position. The position sensor will inform the [ECM](#), which will initiate mono-turbo mode, restricted performance and record [DTC \(diagnostic trouble code\)](#).

Compressor Shut-off Valve Vacuum Control



E117414

ItemDescription

1	Compressor shut-off valve solenoid valve
2	Vacuum reservoir
3	Vacuum pump

If the system develops a fault, for example an air leak, the compressor shut-off valve will default to the closed position. In the default position, mono-turbo operation and restricted engine torque is initiated.

• **NOTE:** When fault finding the vacuum system, always check for trapped/split/disconnected pipework. Any vacuum fault will cause the engine to default to limited torque mode.

Component Description

Each turbocharger consists of two turbo elements, a turbine wheel and compressor wheel, enclosed separately in cast housings and mounted on a common shaft, which rotates in two semi-floating bearings.

VARIABLE VANE TURBOCHARGER (PRIMARY)

The variable vane turbocharger is attached to the [LH \(left-hand\)](#) exhaust manifold and secured to 3 studs on a flange on the manifold with nuts. On production, no gasket is used to seal the joint between turbocharger and the manifold. In-service vehicles will require a service gasket to be fitted if the joint between the turbocharger and the manifold is disturbed.

A second flange on the turbocharger has 3 integral studs and provides for the attachment of the [LH](#) catalytic converter inlet pipe. Three nuts secure the inlet pipe to the flange studs and a gasket seals the joint between the components.

The compressor end of the turbocharger has two hose connections. The central connection provides a clean air supply from the air filter to the compressor. The second connection on the outside of the housing provides for a pipe connection from

the turbocharger to the charge air cooler

The turbocharger is a conventional design with both the turbine wheel and the compressor wheel sharing a common shaft which is supported on bearings. The turbocharger receives an engine oil feed via a pipe from the cylinder block. The pipe supplies both turbochargers with an oil supply for lubrication purposes. An oil drain pipe from the turbocharger allows oil to drain from the turbocharger into the cylinder block.

An integral bracket houses the variable vane electronic rotary actuator. The rotary actuator is connected to an eccentric lever which moves the turbine housing to adjust the position of the vanes. When the rotary actuator operates a boss is rotated, which in turn moves the lever and changes rotary motion into linear motion. The lever is connected to the outside of the turbine housing and the linear motion is converted back to rotary motion of the housing. Operation of the electronic rotary actuator is controlled by the [ECM](#).

FIXED VANE TURBOCHARGER (SECONDARY)

The fixed vane turbocharger is attached to the [RH \(right-hand\)](#) exhaust manifold and is secured to 3 studs on a flange on the manifold with nuts. On production, no gasket is used to seal the joint between turbocharger and the manifold. In-service vehicles will require a service gasket to be fitted if the joint between the turbocharger and the manifold is disturbed.

A second flange on the turbocharger has 2 integral studs and provides for the attachment of the [RH](#) exhaust system downpipe. Two nuts secure the downpipe to the flange studs and a gasket seals the joint between the downpipe and the turbocharger.

The compressor end of the turbocharger has two hose connections; the central connection provides the clean air supply from the air filter. The second connection on the outside of the turbocharger housing allows the connection from the turbocharger to the charge air cooler.

Attached to the rear of the turbocharger is a turbine shut-off valve. The valve is vacuum operated and electronically controlled by the [ECM](#). The valve is closed when the system is operating in mono-turbocharger mode, diverting exhaust gasses from the [RH](#) exhaust manifold, via the exhaust cross-over duct to the [LH](#) exhaust manifold. When bi-turbocharger operation is required, the [ECM](#) electronically operates the valve allow vacuum to open the shut-off valve allowing exhaust gasses from the [RH](#) exhaust manifold to drive the turbine of the fixed vane turbocharger.

Fuel Charging and Controls - Turbocharger - TDV6 3.0L Diesel -

Turbocharger

Diagnosis and Testing

Principles of Operation

For a detailed description of the fuel charging and controls system and operation, refer to the relevant Description and Operation section of the workshop manual. REFER to: (303-04D Fuel Charging and Controls - Turbocharger - TDV6 3.0L Diesel)

[Turbocharger](#) (Description and Operation),

[Turbocharger](#) (Description and Operation),

[Turbocharger](#) (Description and Operation).

Inspection and Verification



WARNING: The following tests may involve working in close proximity to hot components. Make sure adequate protection is used. Failure to follow this instruction may result in personal injury.



CAUTION: Diagnosis by substitution from a donor vehicle is **NOT** acceptable. Substitution of control modules does not guarantee confirmation of a fault and may also cause additional faults in the vehicle being checked and/or the donor vehicle.

- **NOTE:** Check and rectify basic faults before beginning diagnostic routines involving pinpoint tests.

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection

Mechanical	Electrical
● Intake air system ● Hose(s)/hose connections ● General engine condition.	● Circuit(s) ● Engine control module (ECM) ● Electrical connections and harnesses

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step
4. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart, alternatively check for Diagnostic Trouble Codes (DTCs) and refer to the DTC Index.

Symptom Chart

Symptom	Possible Causes	Action
Poor performance	● Low/Contaminated fuel ● Restricted air intake system ● General engine condition ● Engine control module failure	Check the fuel level and condition. Check the air intake for restriction. Check the engine condition, compressions, etc. Refer to the relevant section of the workshop manual. Check for DTCs. Refer to the warranty policy and procedures manual if an engine control module is suspect.
No boost	● Electrical connections and harnesses ● Restricted air intake system ● Charge air cooler restricted/leaking ● Engine control module failure	Check the electrical connections and harnesses. Check the air intake for restriction/leakage (see visual inspection). Refer to the relevant section of the workshop manual. Refer to the warranty policy and procedures manual if an engine control module is suspect.

DTC Index

For a list of Diagnostic Trouble Codes (DTCs) that could be logged on this vehicle, please refer to Section 100-00. REFER to: Diagnostic Trouble Code (DTC) Index - DTC: Engine Control Module (PCM) 3.0L TdV6 (100-00, Description and Operation).

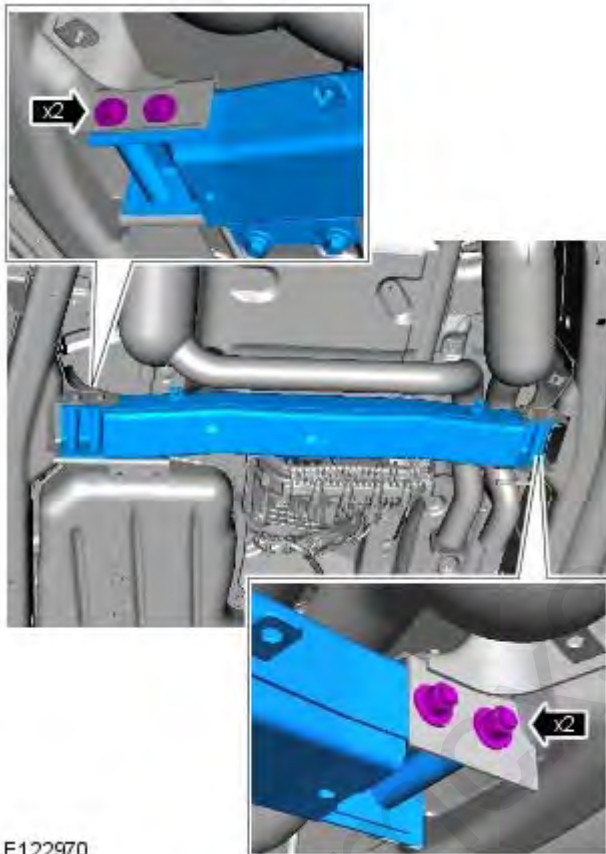
Fuel Charging and Controls - Turbocharger - TDV6 3.0L Diesel - Turbocharger LH

Removal and Installation

Removal

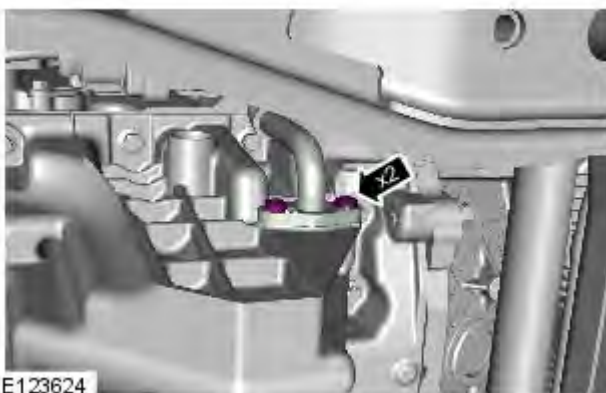
- NOTE: Some variation in the illustrations may occur, but the essential information is always correct.
- NOTE: Removal steps in this procedure may contain installation details.

1. Refer to: [Exhaust System](#) (309-00B Exhaust System - TDV6 3.0L Diesel, Removal and Installation).



E122970

2.  CAUTION: Only tighten the bolts finger tight at this stage.



E123624

3. 3. CAUTIONS:

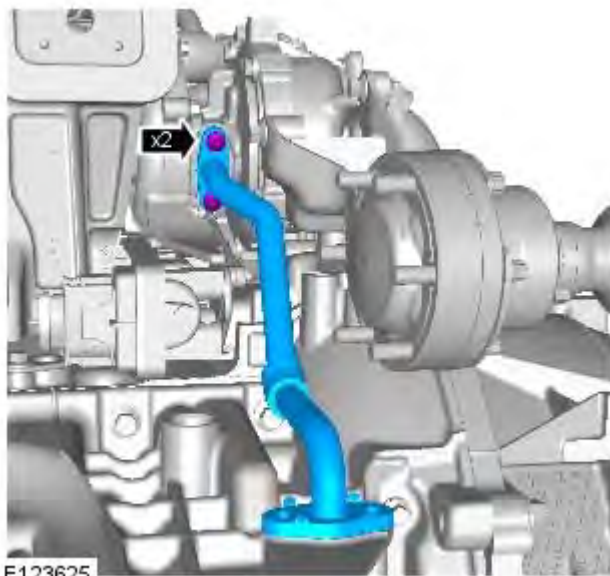


Make sure that all openings are sealed. Use new blanking caps.



Make sure that the area around the component is clean and free of foreign material.

Torque: 9 Nm



E123625

4. **4. CAUTIONS:**



Make sure that the area around the component is clean and free of foreign material.

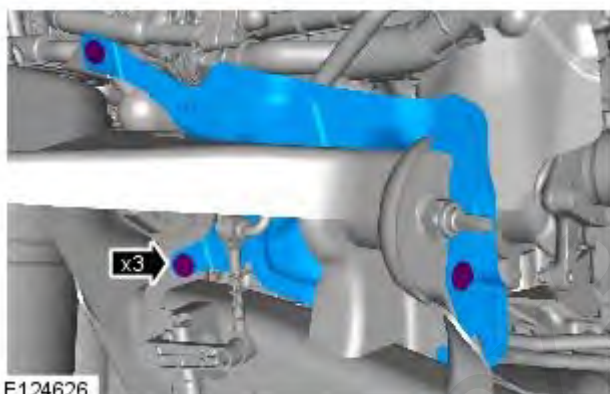


Make sure that all openings are sealed. Use new blanking caps.

• **NOTE:** Engine shown removed for clarity.

Torque: 9 Nm

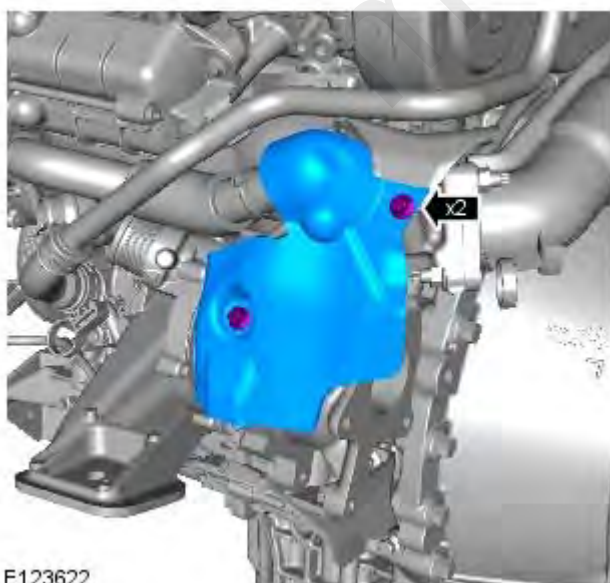
5. Refer to: [Body - TDV6 3.0L Diesel/TDV6 2.7L Diesel](#) (502-02 Full Frame and Body Mounting, Removal and Installation).



E124626

6. **6. NOTE:** The heatshield consists of 3 parts.

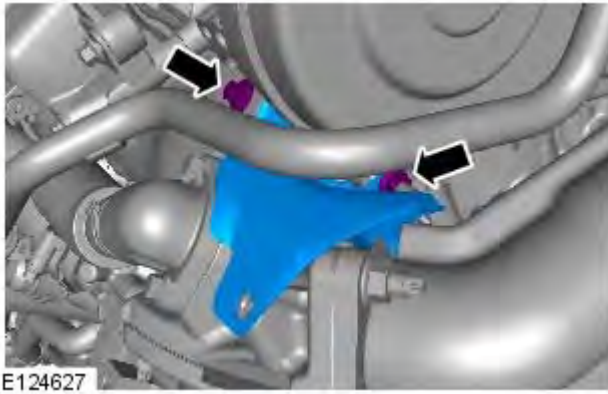
Torque: 9 Nm



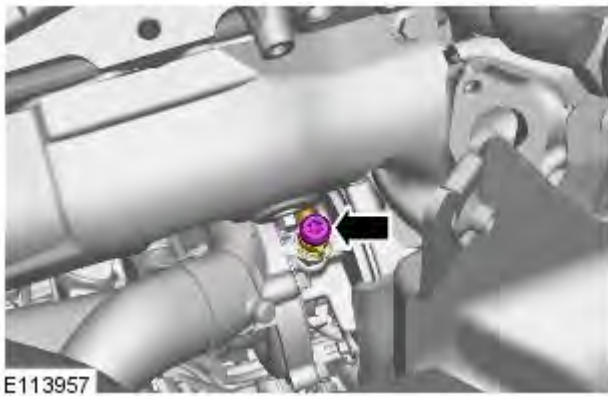
E123622

7. **7. NOTE:** Engine shown removed for clarity.

Torque: 9 Nm

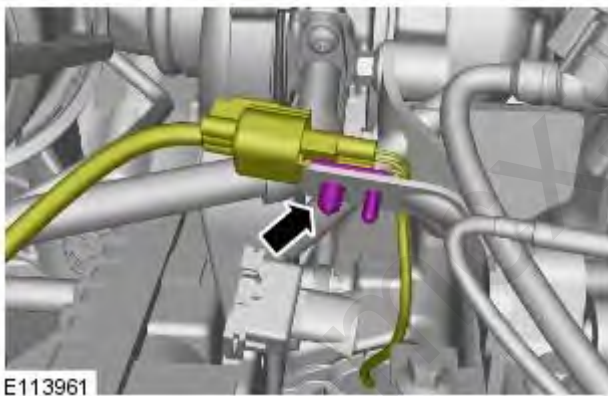


8. Torque: 9 Nm

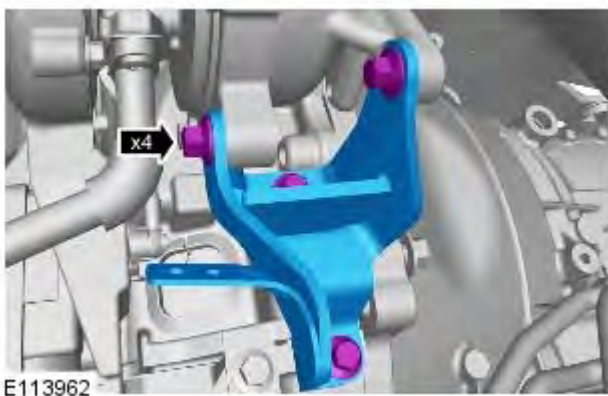


9.  CAUTION: Make sure that all openings are sealed. Use new blanking caps.

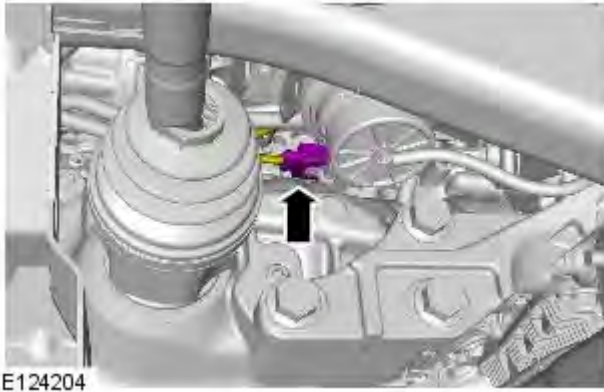
Torque: 30 Nm



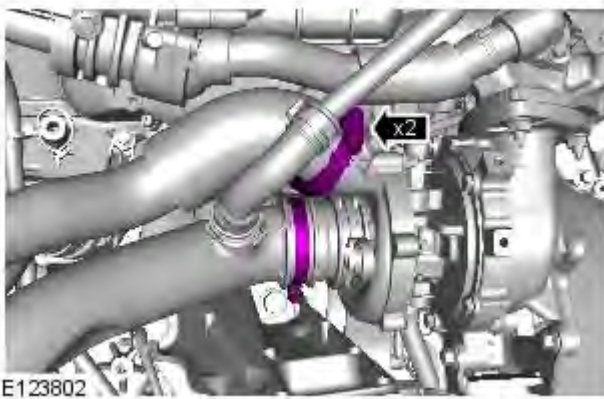
10.



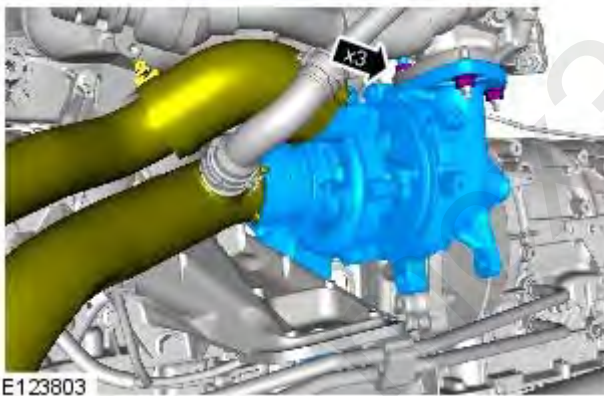
11. Torque: 32 Nm



12.



13. **13.** NOTE: Engine shown removed for clarity.



14. **14.**  WARNING: Make sure that new nuts are installed.

• CAUTIONS:

 Make sure that the area around the component is clean and free of foreign material.

 Discard the nuts.

 Make sure that all openings are sealed. Use new blanking caps.

 Install a new turbocharger to exhaust manifold gasket every time the turbocharger is removed.

• NOTE: Remove and discard the gasket.

• NOTE: Engine shown removed for clarity.

Torque: 24 Nm

Installation

1. To install reverse the removal procedure.

Fuel Charging and Controls - Turbocharger - TDV6 3.0L Diesel - Turbocharger RH

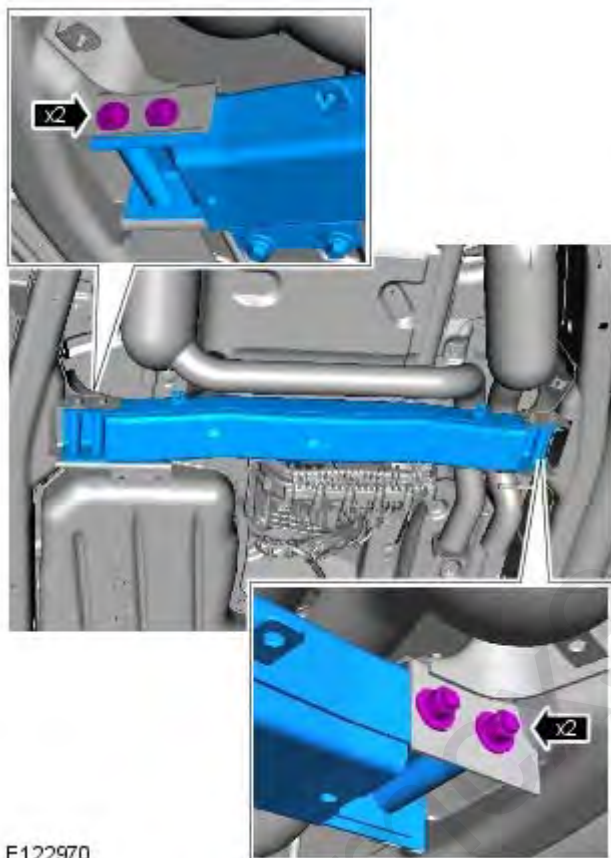
Removal and Installation

Removal

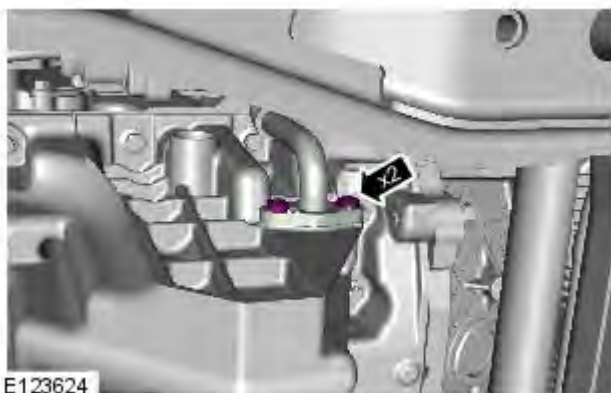
- NOTE: Some variation in the illustrations may occur, but the essential information is always correct.
- NOTE: Removal steps in this procedure may contain installation details.

1. Refer to: [Exhaust System](#) (309-00B Exhaust System - TDV6 3.0L Diesel, Removal and Installation).

2.  CAUTION: Only tighten the bolts finger tight at this stage.



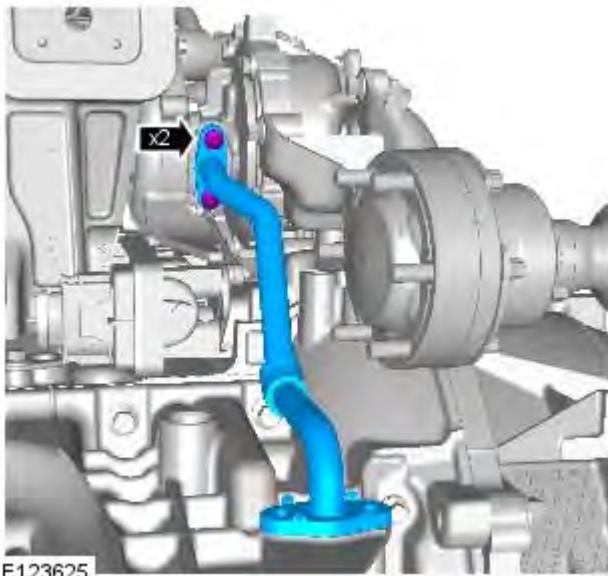
E122970



E123624

3.  CAUTION: LH illustration shown, RH is similar.

Torque: 9 Nm

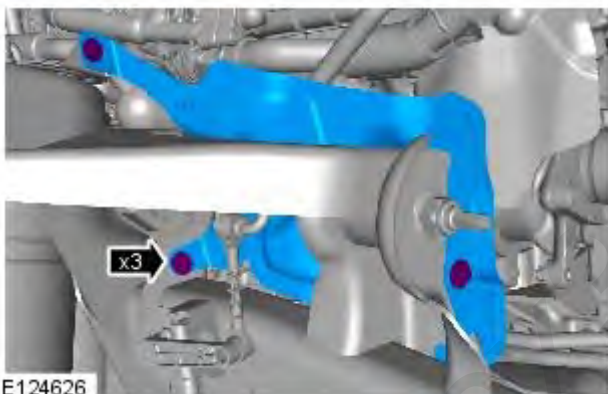


E123625

4.  CAUTION: LH illustration shown, RH is similar.
- NOTE: Engine shown removed for clarity.
 - NOTE: Install new gaskets.

Torque: 9 Nm

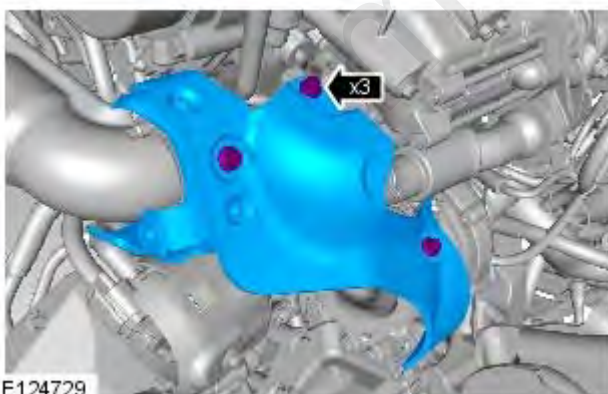
5. Refer to: [Body - TDV6 3.0L Diesel/TDV6 2.7L Diesel](#) (502-02 Full Frame and Body Mounting, Removal and Installation).



E124626

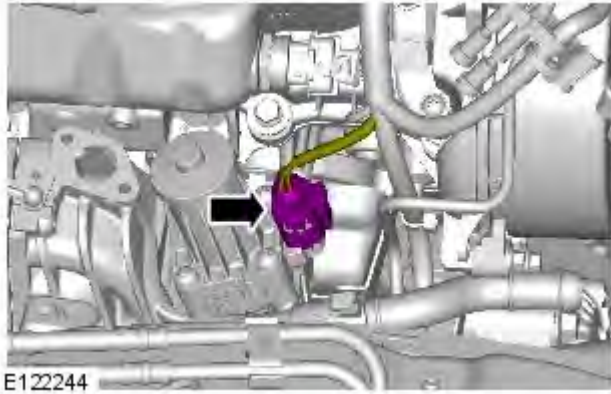
6.  CAUTION: LH illustration shown, RH is similar.
- NOTE: The heatshield consists of 3 parts.

Torque: 9 Nm

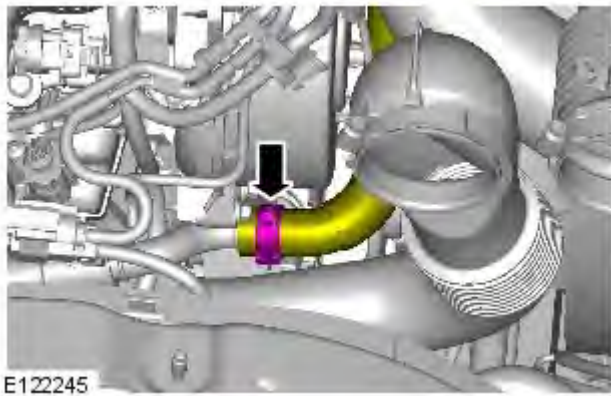


E124729

7. Torque: 9 Nm



8.



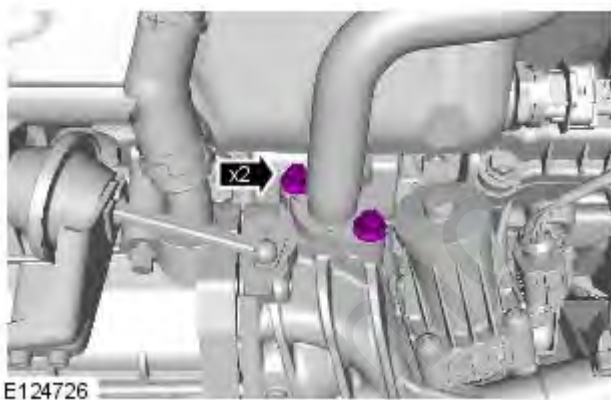
9. **9. CAUTIONS:**



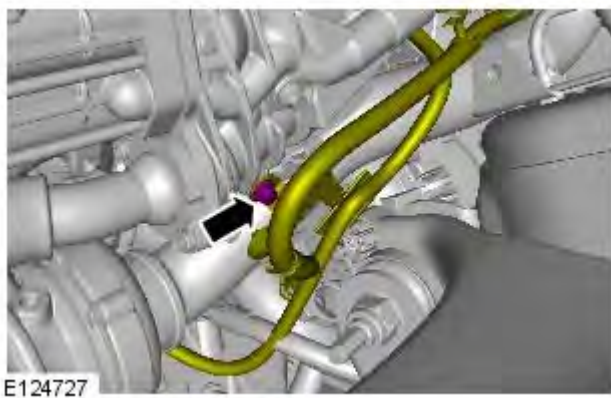
Be prepared to collect escaping coolant.



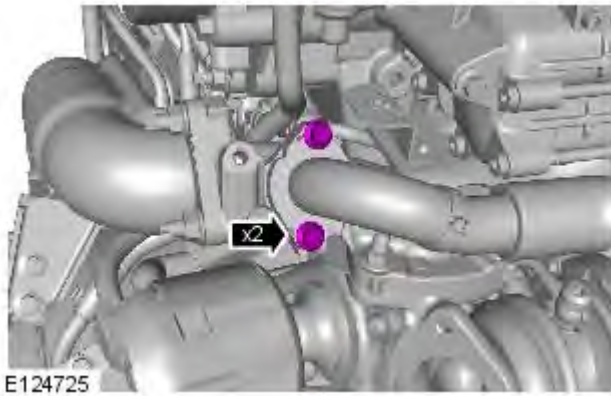
Make sure that all openings are sealed. Use new blanking caps.



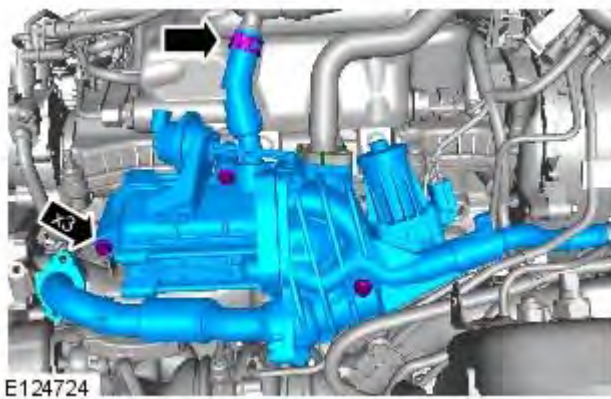
10. Torque: 10 Nm



11. Torque: 10 Nm



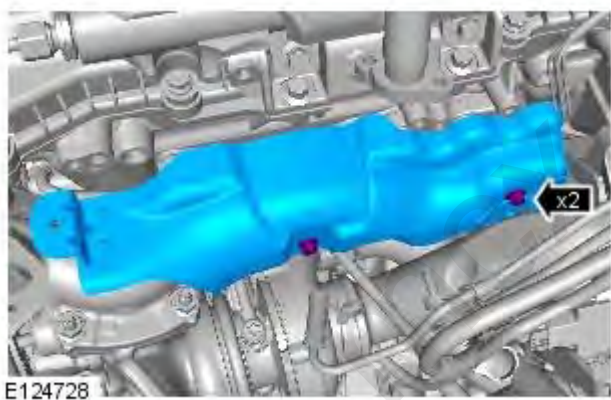
12. Torque: 10 Nm



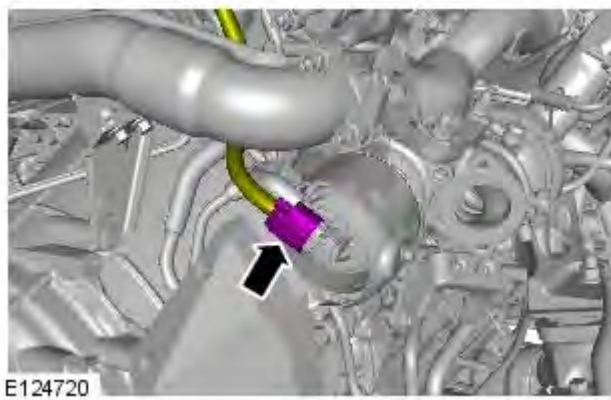
13. **13.**  CAUTION: Be prepared to collect escaping coolant.

- NOTE: Install new gaskets.

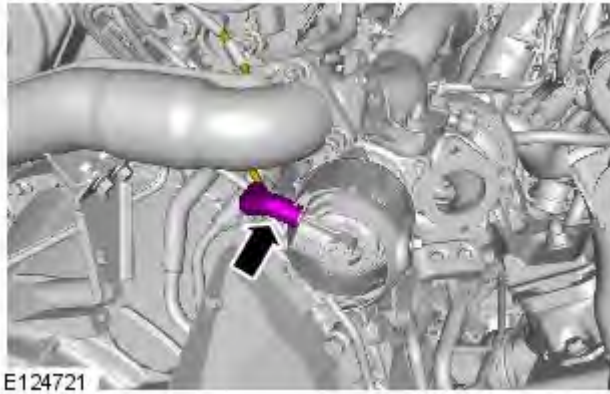
Torque: 10 Nm



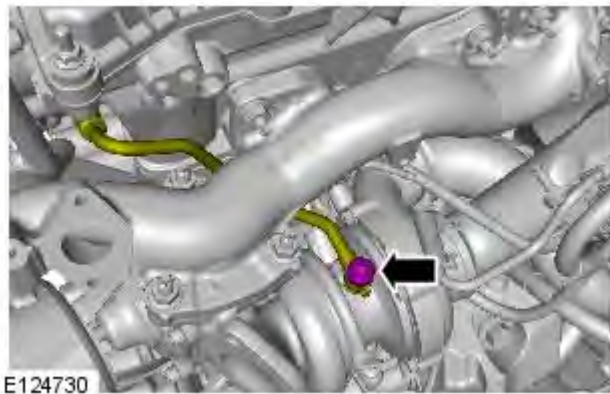
14. Torque: 11 Nm



15.



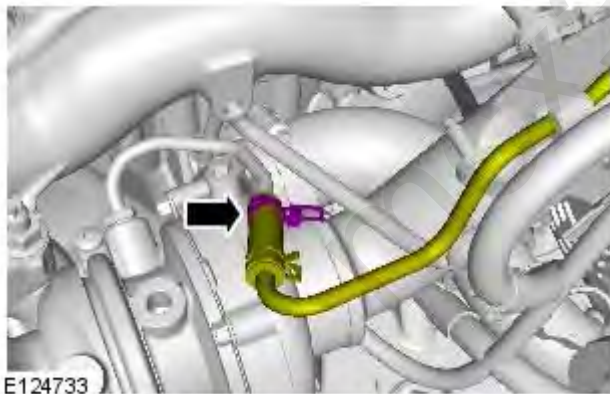
16.



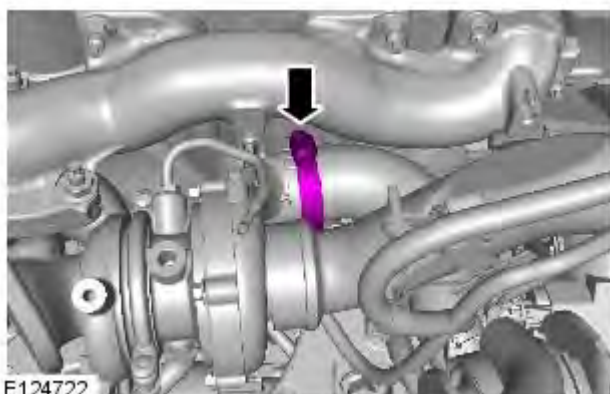
17. **17. CAUTIONS:**

-  Be prepared to collect escaping oil.
-  Make sure that all openings are sealed. Use new blanking caps.
-  Make sure that the area around the component is clean and free of foreign material.
-  Make sure that new sealing washers are installed.
-  Make sure that a new bolt is installed.

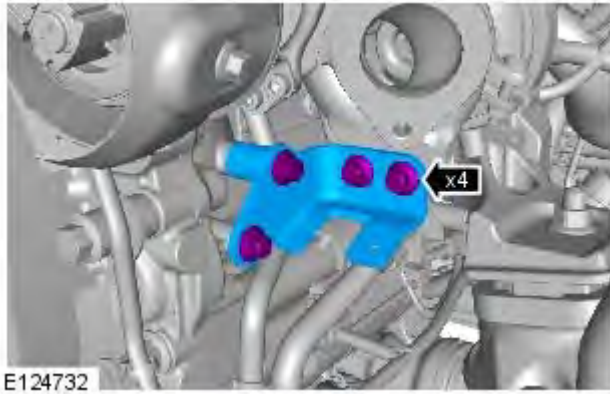
Torque: 30 Nm



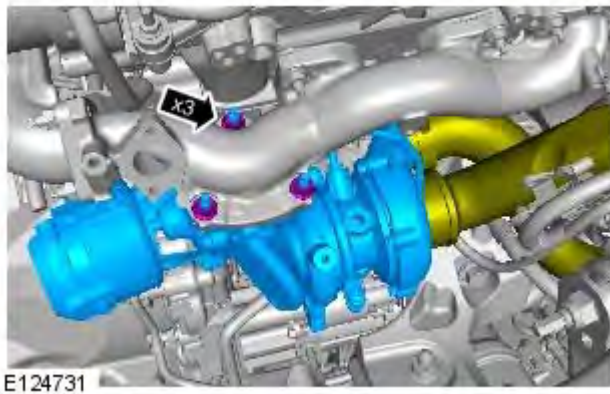
18. **18.  CAUTION:** Make sure that all openings are sealed. Use new blanking caps.



19.



20. Torque: 32 Nm



21. **21.**  **WARNING:** Make sure that new nuts are installed.

• **CAUTIONS:**



Discard the nuts.



Make sure that all openings are sealed. Use new blanking caps.



Make sure that the area around the component is clean and free of foreign material.



Install a new turbocharger to exhaust manifold gasket every time the turbocharger is removed.

• **NOTE:** Remove and discard the gasket.

Torque: 24 Nm

Installation

1. To install, reverse the removal procedure.
2. If a new unit is installed, configure the fixed vane turbocharger actuator using the approved diagnostic tool.

Fuel Charging and Controls - Turbocharger - TDV6 3.0L Diesel - Fixed Vane Turbocharger Actuator

Removal and Installation

Removal

- NOTE: Some variation in the illustrations may occur, but the essential information is always correct.

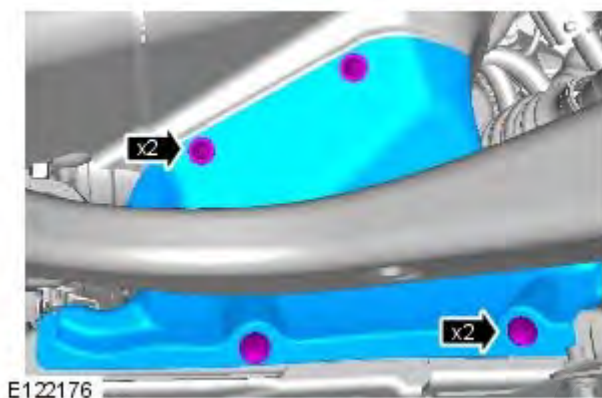
1.  **WARNING:** Make sure to support the vehicle with axle stands.

Raise and support the vehicle.

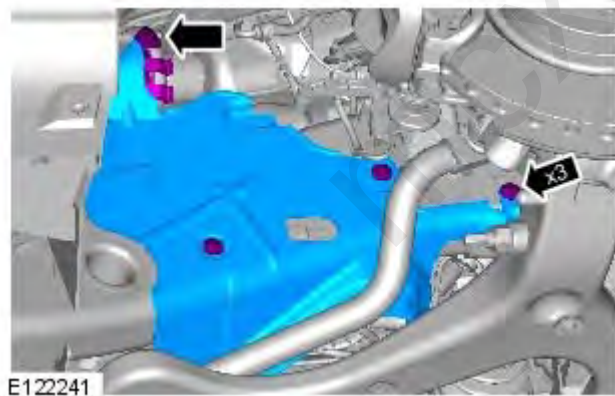
2. Refer to: [Exhaust System](#) (309-00B Exhaust System - TDV6 3.0L Diesel, Removal and Installation).

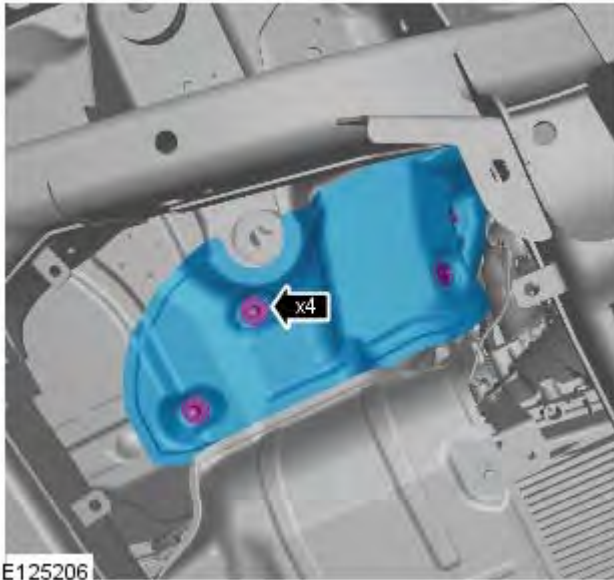
3. Remove the RH front wheel and tire.

4.

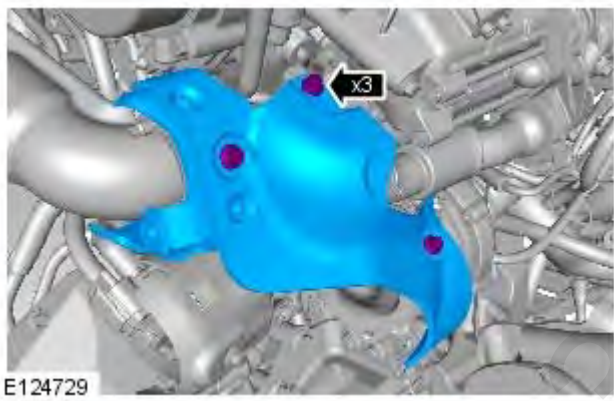


5.

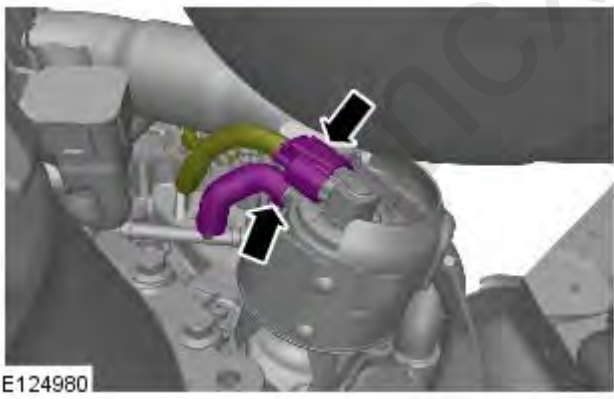




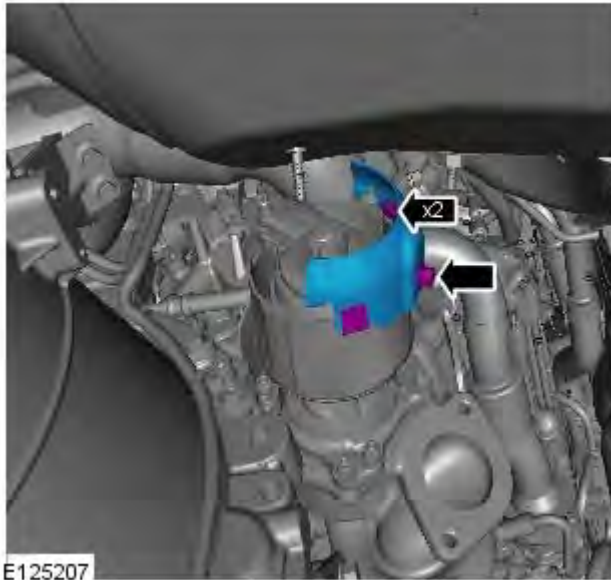
6.



7. **7.** NOTE: Engine shown removed for clarity.

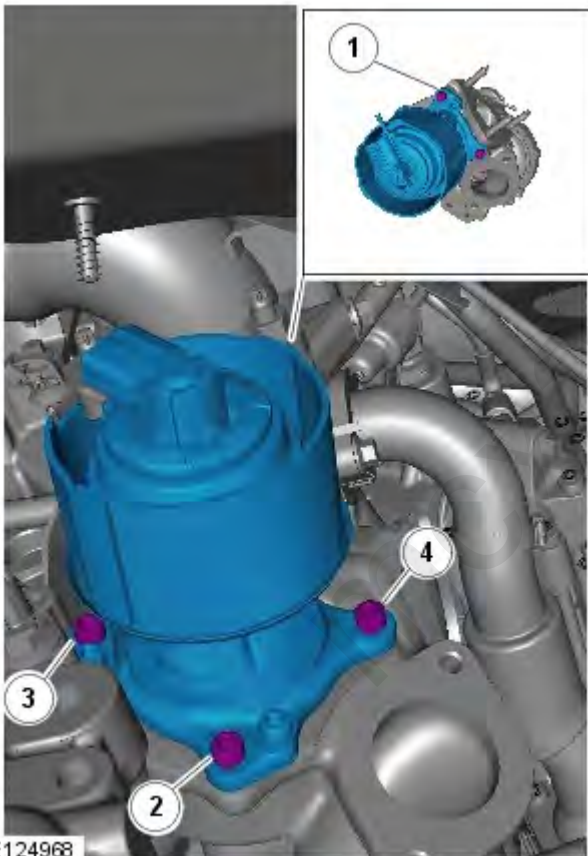


8.



E125207

9.



E124968

10. 10. CAUTIONS:



Remove the Torx screws evenly and progressively.



Make sure component mating faces are not damaged during removal.

Using a suitable 130mm T30 Torx socket, remove the retaining bolts.



E124969

11. 11. NOTE: Make a note of the orientation of the gasket tang.

- NOTE: Remove and discard the gasket using the gasket tang.



E124972

12. **12.** NOTE: Remove and discard the gasket.

- NOTE: Turbocharger shown removed for clarity.

Installation



E124969

1. **1.**  CAUTION: Make sure that the mating faces are clean and free of corrosion and foreign material.

- NOTE: Install a new gasket.

- NOTE: Make sure that the gasket tang is installed in the correct orientation as noted in the removal step.

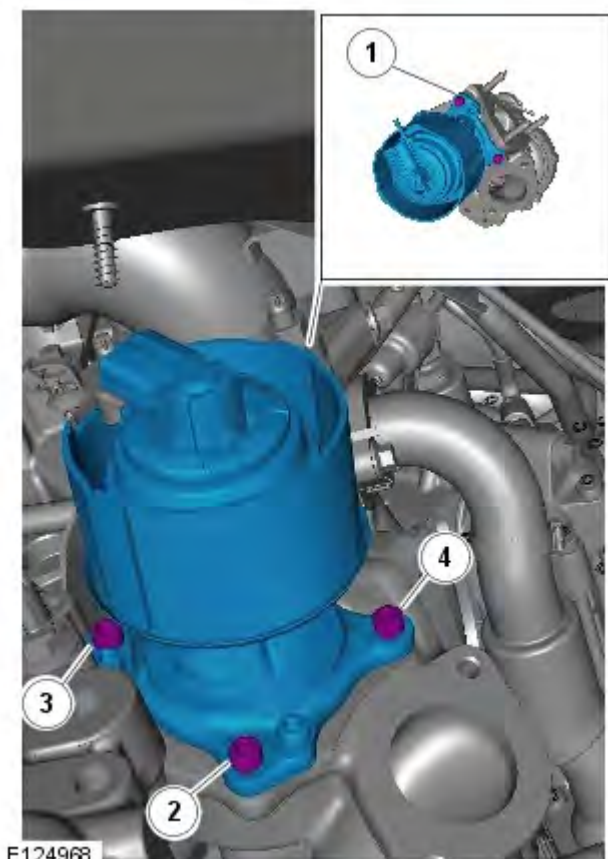


E124970

2. **2.**  CAUTION: Make sure that the mating faces are clean and free of corrosion and foreign material.

- NOTE: Install a new gasket.

- NOTE: Apply a small amount of grease in the areas indicated to allow the gasket to remain in the position for installation.



3. CAUTIONS:

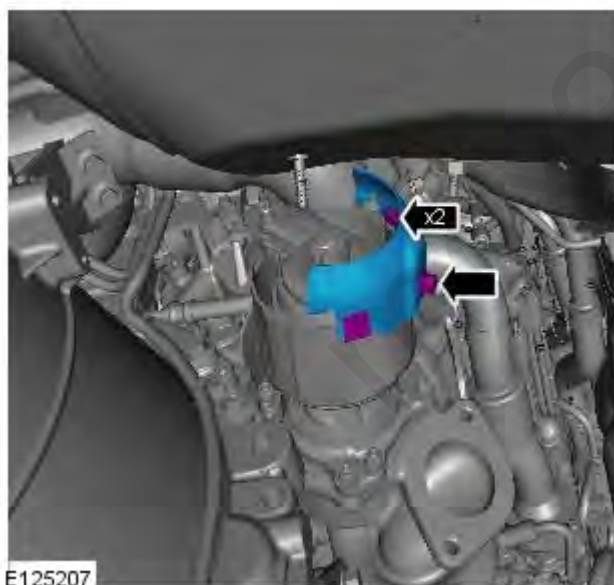


Install all the bolts finger tight before final tightening.

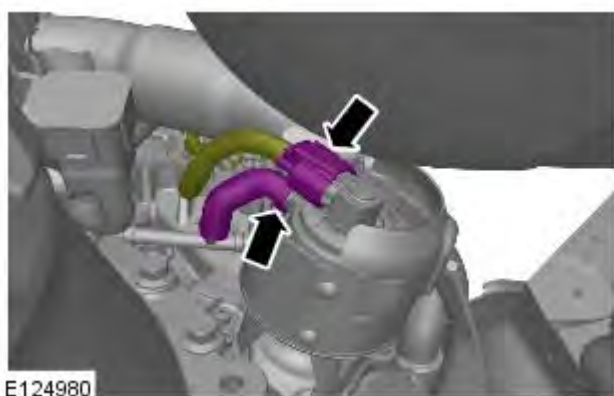


Tighten the Torx screws evenly and progressively.

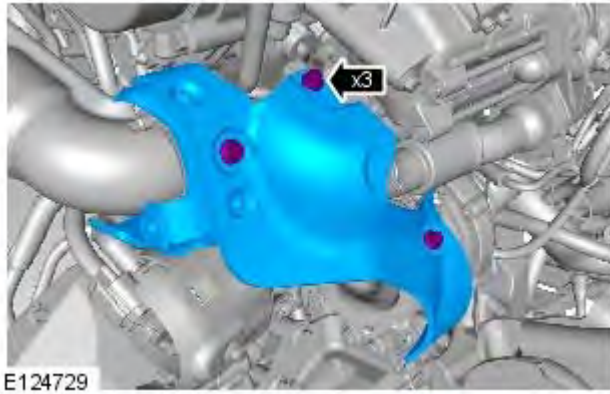
Using a suitable 130mm T30 Torx socket, Install the retaining bolts.



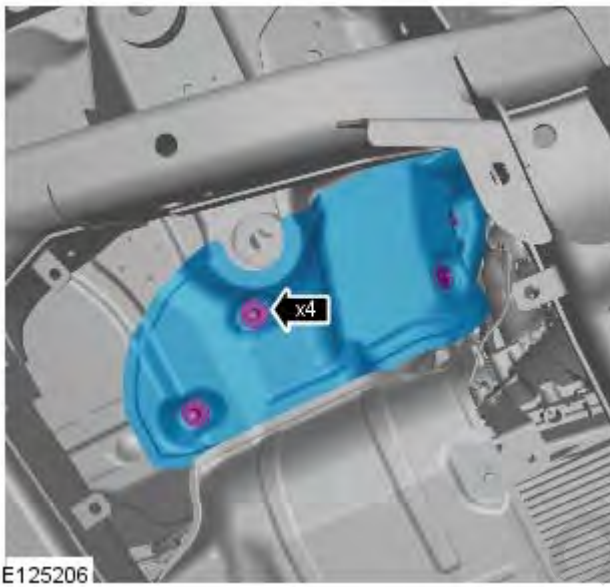
4. Torque: 9 Nm



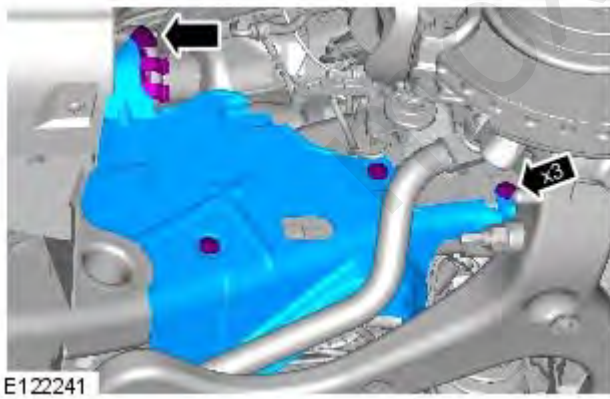
5.



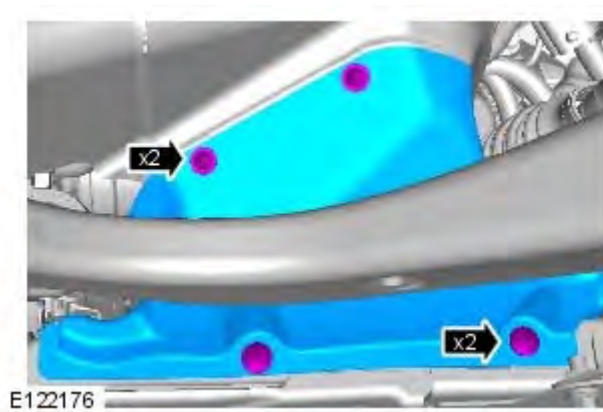
6. Torque: 9 Nm



7. Torque: 10 Nm



8.



9.

10. Install the RH front wheel and tire.

11. Refer to: [Exhaust System](#) (309-00B Exhaust System - TDV6 3.0L Diesel, Removal and Installation).

12. If a new fixed vane turbocharger actuator is installed, carry out the reset procedure for the fixed vane turbocharger actuator using approved diagnostic tool.

Fuel Charging and Controls - Turbocharger - TDV6 3.0L Diesel - Turbocharger Bypass Valve

Removal and Installation

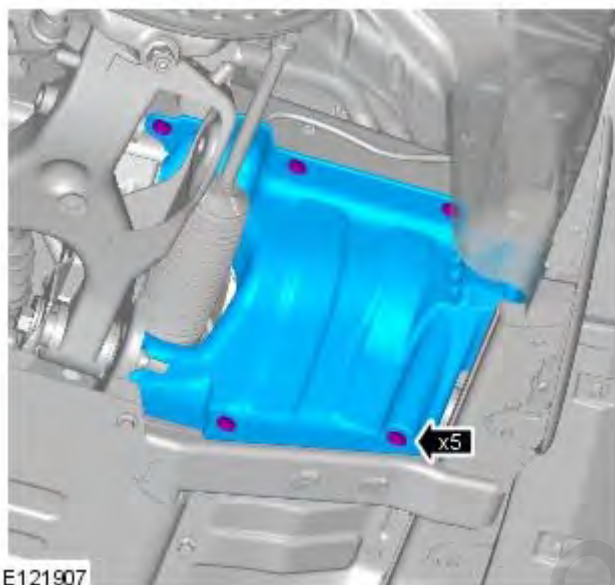
Removal

- NOTE: Removal steps in this procedure may contain installation details.

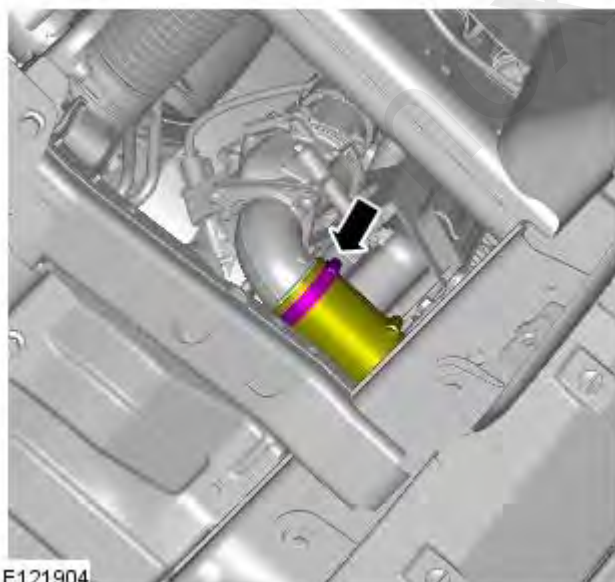
1.  **WARNING:** Make sure to support the vehicle with axle stands.

Raise and support the vehicle.

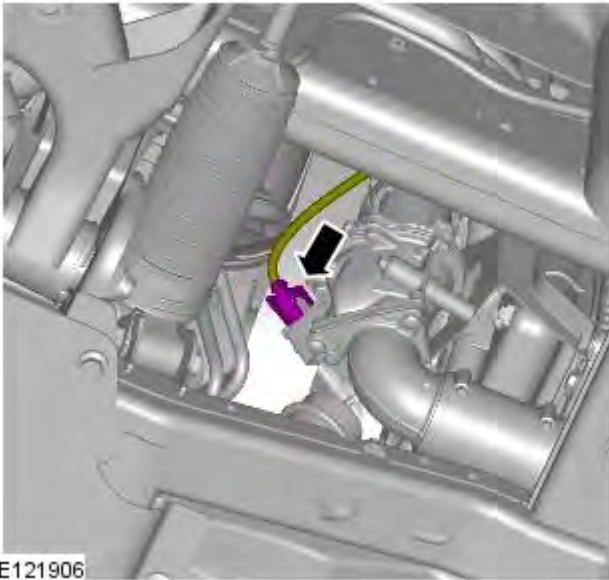
2.



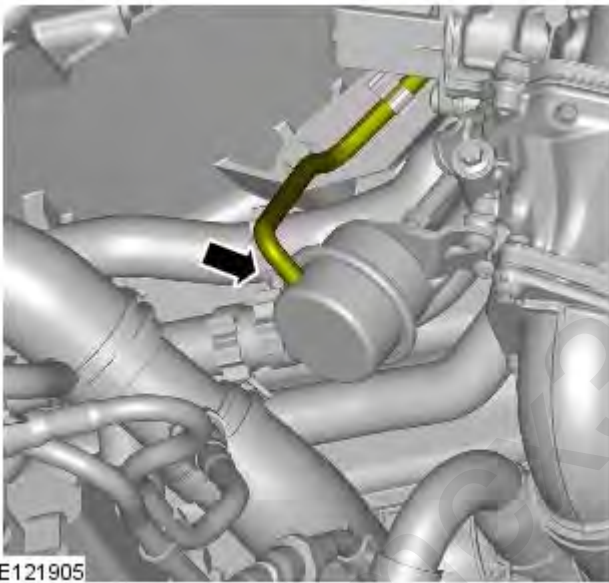
3. Torque: 5 Nm



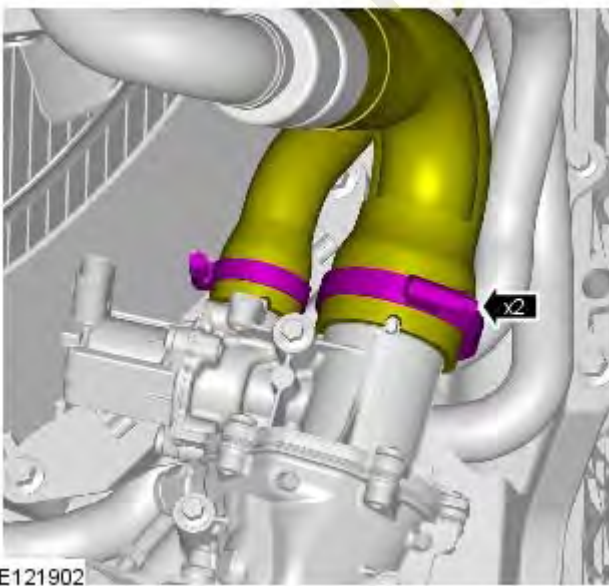
4.

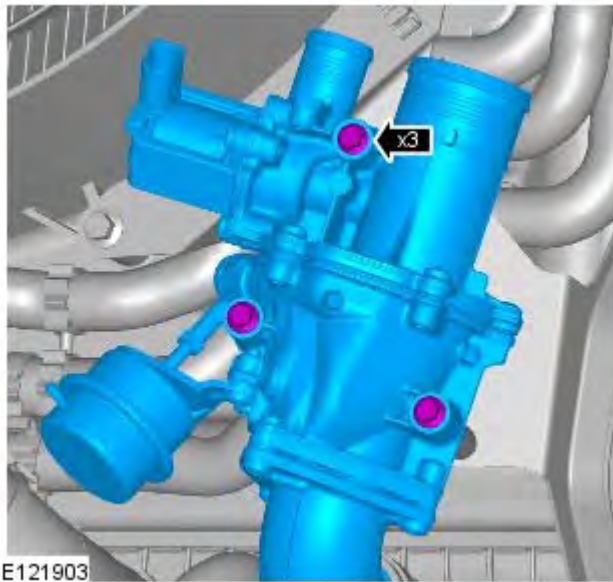


5.



6. Torque: 5 Nm





7. Torque: 10 Nm

Installation

1. To install, reverse the removal procedure.