Step 3. Subtract the total of step 1 by total of step 2.

Step 5. Divide the total of step 3 by the current coolant concentration mix %.

Drain the coolant quantity given by the calculations and replace with distilled water.

20.

Correct installation of the coolant expansion tank cap can be obtained by tightening the cap until 3 audible clicks are heard.

Install the coolant expansion tank pressure cap.

ENGINE COOLING - TDV6 3.0L DIESEL

COOLING SYSTEM DRAINING, FILLING AND BLEEDING [G1269227]

DRAINING

1.

> Make sure to support the vehicle with axle stands.

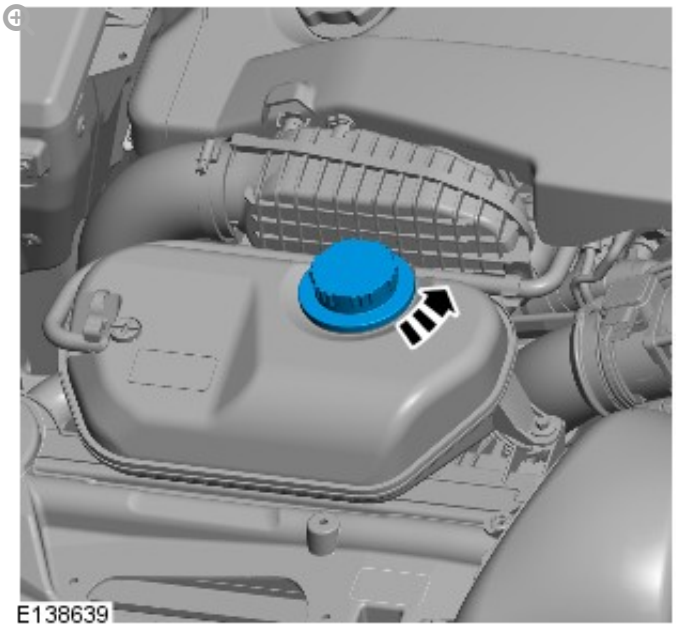
Raise and support the vehicle.

2. Refer to: Radiator Splash Shield (501-02 Front End Body Panels, Removal and Installation).

3.

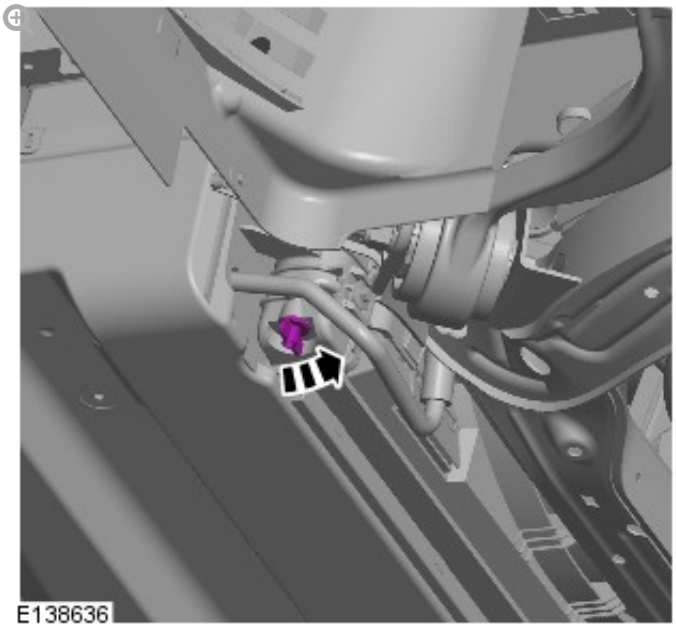
> When releasing the cooling system pressure, cover the coolant expansion tank cap with a thick cloth.

Since injury such as scalding could be caused by escaping steam or coolant, make sure the vehicle cooling system is cool prior to carrying out this procedure.



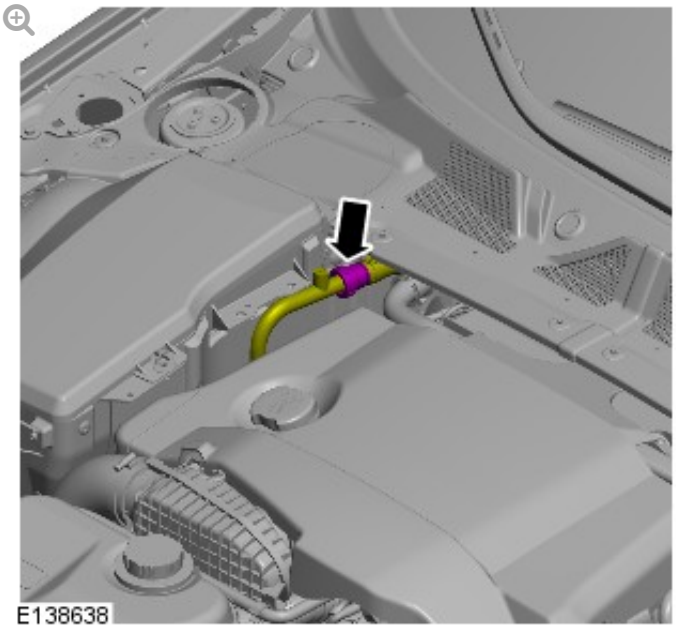
4.

Be prepared to collect escaping coolant.



5.

Be prepared to collect escaping coolant.

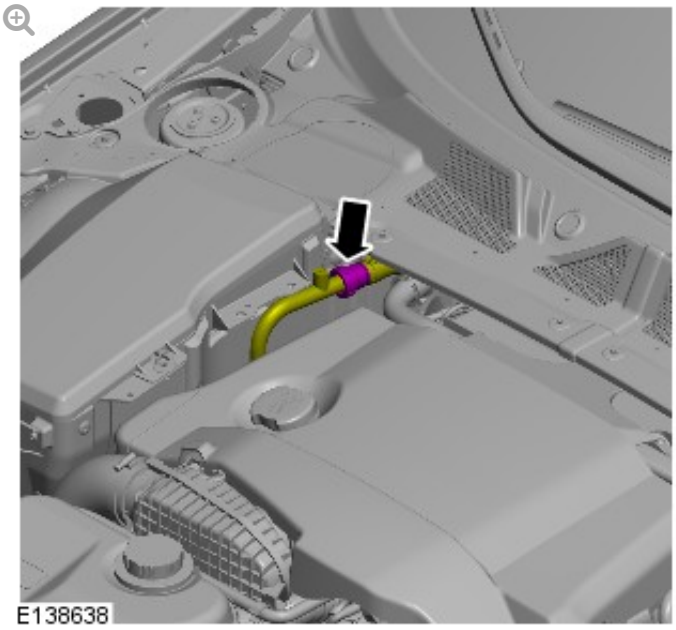


6. Carry out the procedure up to step 1 in the filling section three times, filling the cooling system with clean water at the first two drains. At the third refill, use a suitable measuring tool to make sure that the

cooling system maintains a 50% mix.

FILLING

7.



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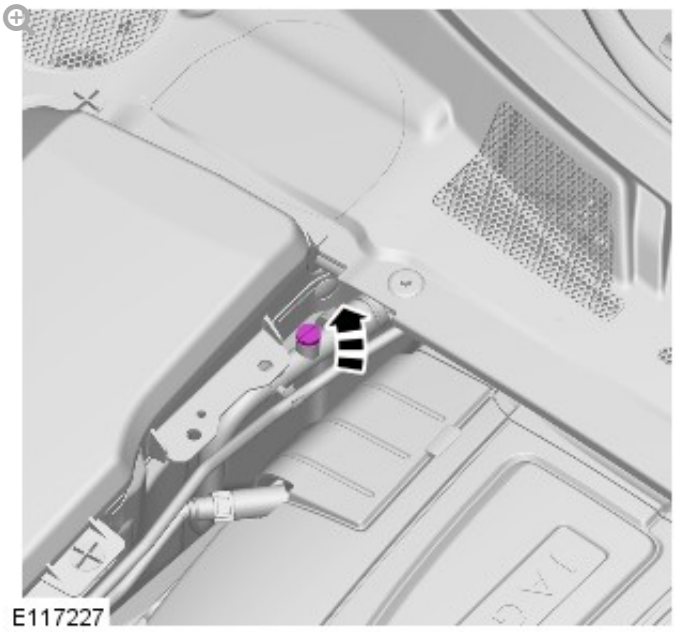

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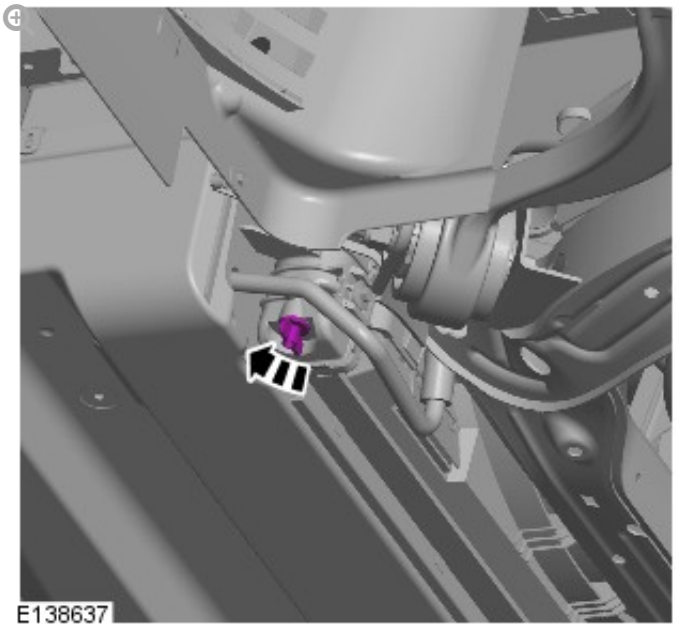
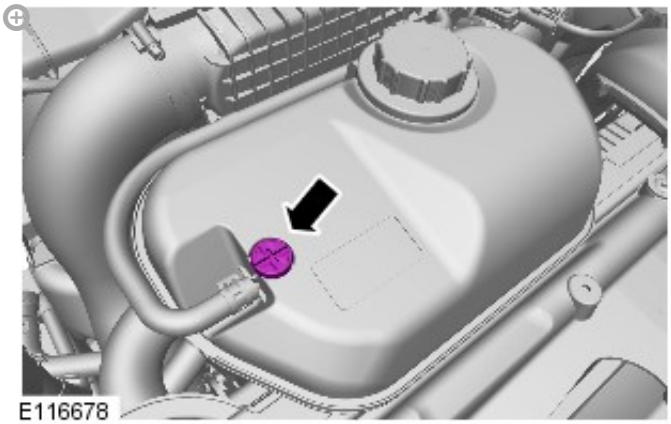
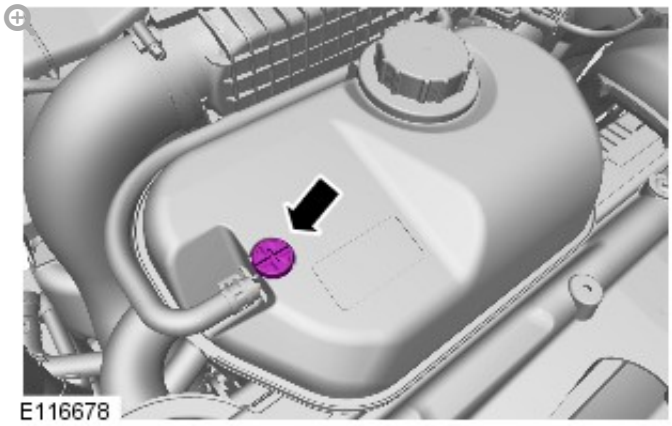


10.

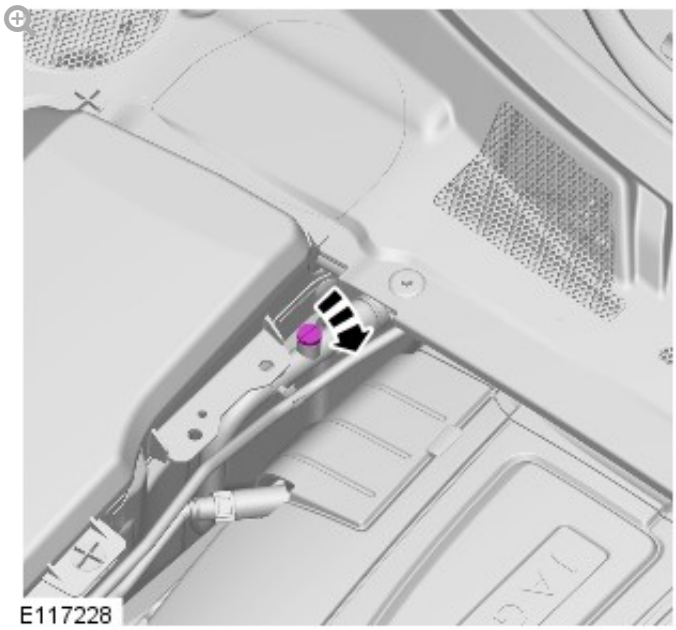


11.

Anti-freeze concentration must be maintained at 50%.



Fill the cooling system, keeping coolant to the upper level mark of the expansion tank until a steady stream of coolant is seen running from the coolant hose bleed point. Tighten the bleed screw.

12. 

13. Set the heating to the HOT position.

14. Start and run the engine.

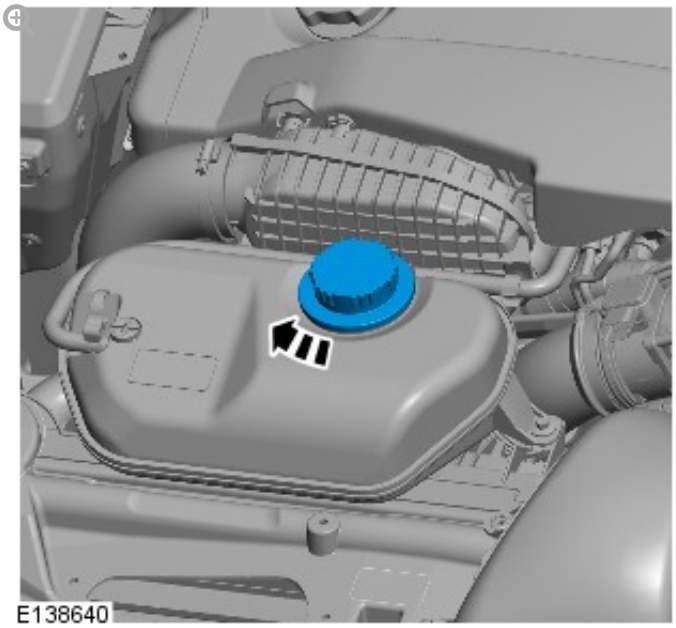
15. Raise the engine to 2500 RPM for 30 seconds.

16. Continue to top-up with coolant with engine idling until hot air is emitted from face vents.

When the coolant stops dropping, continue to fill the coolant untill the maximum level is reached.

17.

> Correct installation of the coolant expansion tank cap can be obtained by tightening the cap until 3 audible clicks are heard.



18. Increase the engine speed to 3000rpm.

19. When hot air is emitted from the vents, switch the heater off.

    Hold the engine speed at 3000 RPM for a further 2 minutes.

20. When the thermostat is opened increase the engine speed from idle to 4000 RPM for 5 times.

    Hold the engine at 3000 rpm for 1 minute.

21. Allow the engine to idle for 2 minutes.

22. Switch the engine off and allow to cool.

23. Check and top up the cooling system as required when cool.

24. Visually check the engine and cooling system for signs of coolant leakage.

25. Refer to: Radiator Splash Shield (501-02 Front End Body Panels, Removal and Installation).

ENGINE COOLING - TDV6 3.0L DIESEL

COOLING SYSTEM PARTIAL DRAINING AND VACUUM FILLING [G1816935]

SPECIAL TOOL[S]

HU-919

Coolant System
Vacuum Refill Kit

DRAINING

Since injury such as scalding could be caused by escaping steam or coolant, do not remove the filler cap from the coolant expansion tank while the system is hot.

- The engine cooling system must be maintained with the correct concentration and type of anti-freeze solution to prevent corrosion and frost damage. Failure to follow this instruction may result in damage to the engine.
- Engine coolant will damage the paint finished surfaces. If spilt, immediately remove the coolant and clean the area with water.

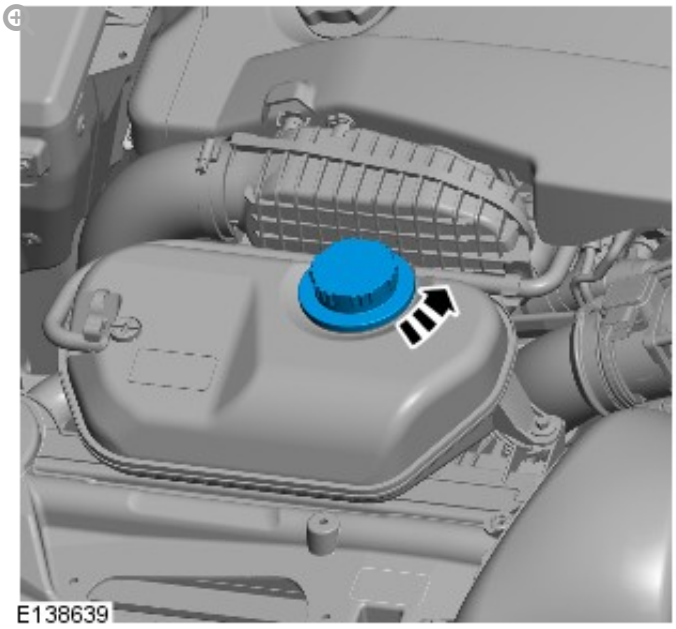
1.

Make sure to support the vehicle with axle stands.

Raise and support the vehicle.

2.

- Release the cooling system pressure by slowly turning the coolant expansion tank cap a quarter of a turn. Cover the expansion tank cap with a thick cloth to prevent the possibility of scalding. Failure to follow this instruction may result in personal injury.
- Be prepared to collect escaping fluids.
- Since injury such as scalding could be caused by escaping steam or coolant, make sure the vehicle cooling system is cool prior to carrying out this procedure.

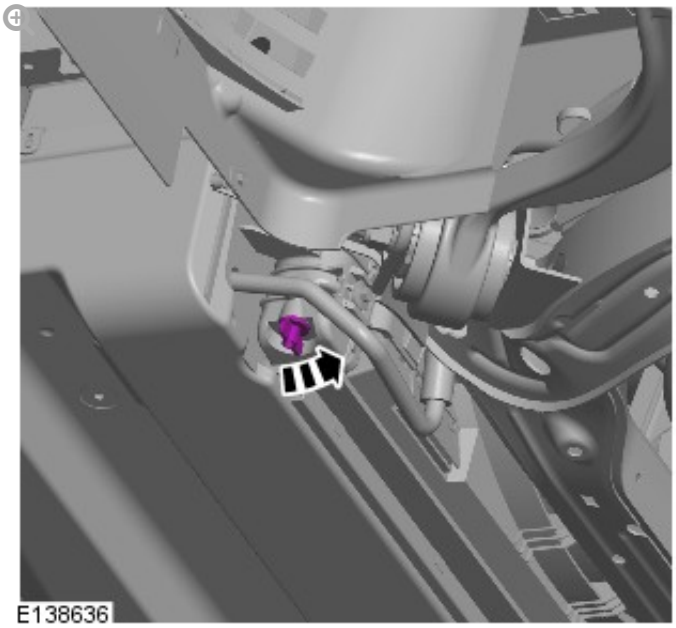


3. Refer to: Radiator Splash Shield (501-02 Front End Body Panels, Removal and Installation).

4.

Be prepared to collect escaping fluids.

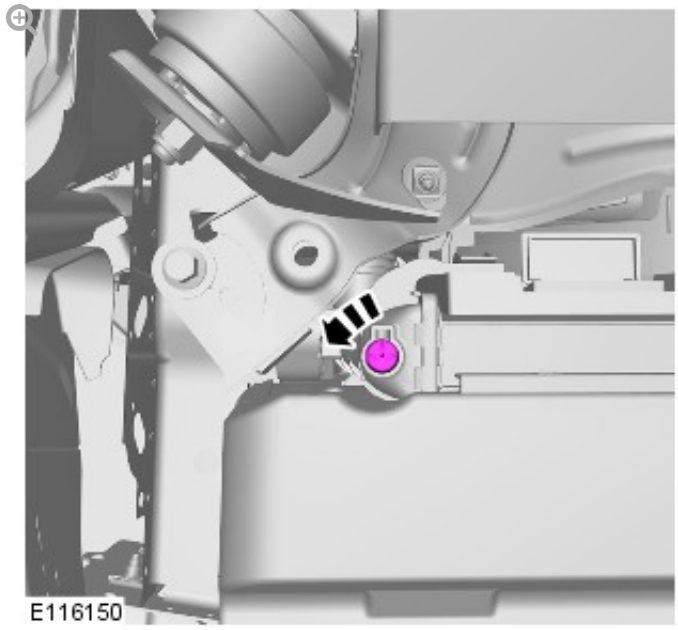
- Collect the coolant in a clean container and reuse.
- If equipped.



5.

Be prepared to collect escaping fluids.

- Collect the coolant in a clean container and reuse.
- If equipped.



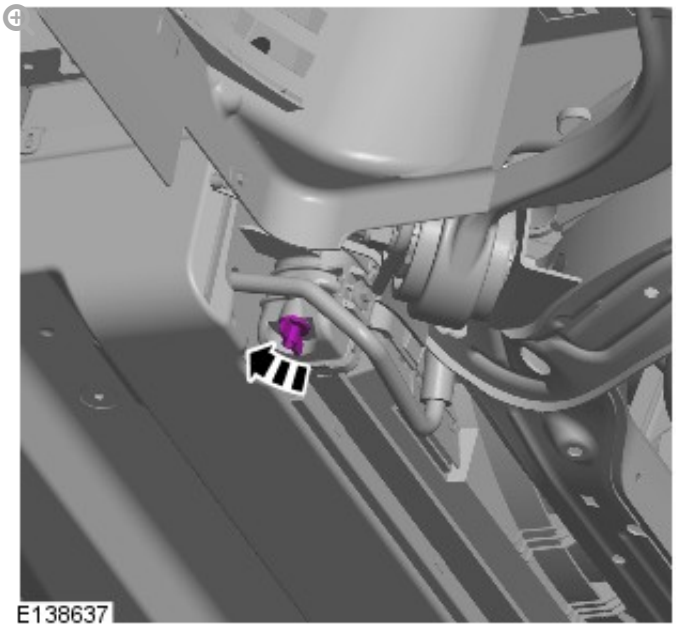
FILLING

Since injury such as scalding could be caused by escaping steam or coolant, do not remove the filler cap from the coolant expansion tank while the system is hot.

- The engine cooling system must be maintained with the correct concentration and type of anti-freeze solution to prevent corrosion and frost damage. Failure to follow this instruction may result in damage to the engine.
- Engine coolant will damage the paint finished surfaces. If spilt, immediately remove the coolant and clean the area with water.

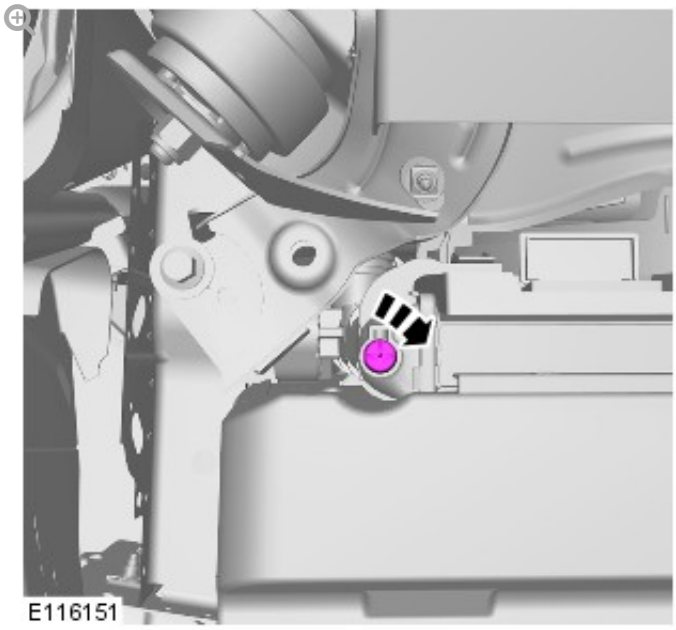
6.

If equipped.



7.

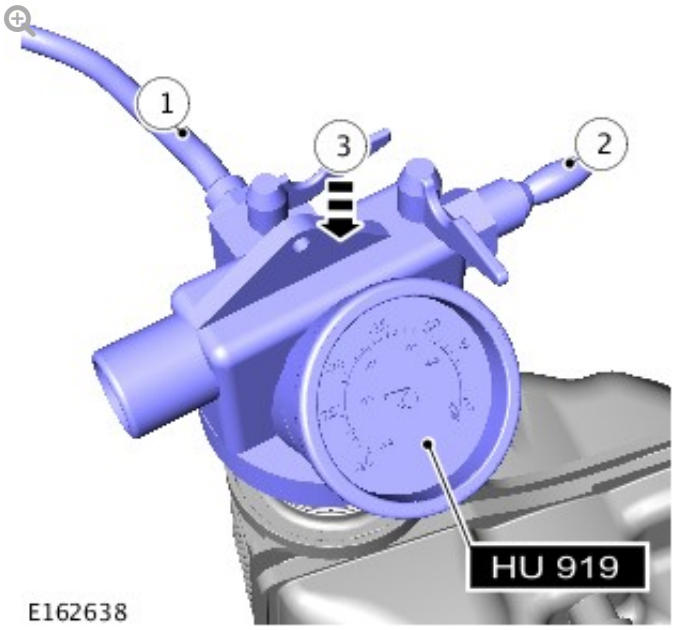
If equipped.



Torque: **2 Nm**

8. Refer to: Radiator Splash Shield (501-02 Front End Body Panels, Removal and Installation).

9. Prepare a sufficient amount of coolant to the specified concentration.

10. 

-

  - Make sure the coolant supply valve is in the closed position on the special tool.
  - The special tool needs an air pressure of 6 to 8 bar (87 to 116 psi) to operate correctly.
  - Small diameter or long airlines may restrict airflow to the coolant vacuum fill tool.

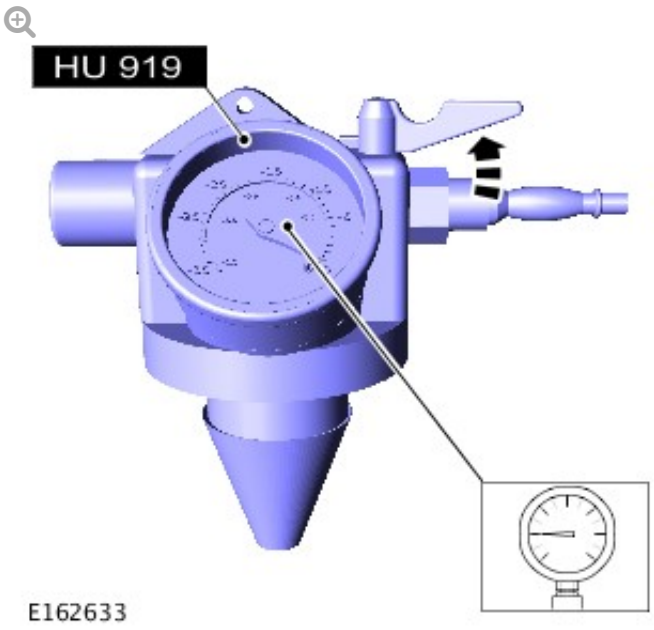
  Position the hose from the special tool into a container of clean coolant.

  Connect a regulated compressed air supply to the special tool.

  Move the special tool to the expansion tank.
  Special Tool(s): HU-919

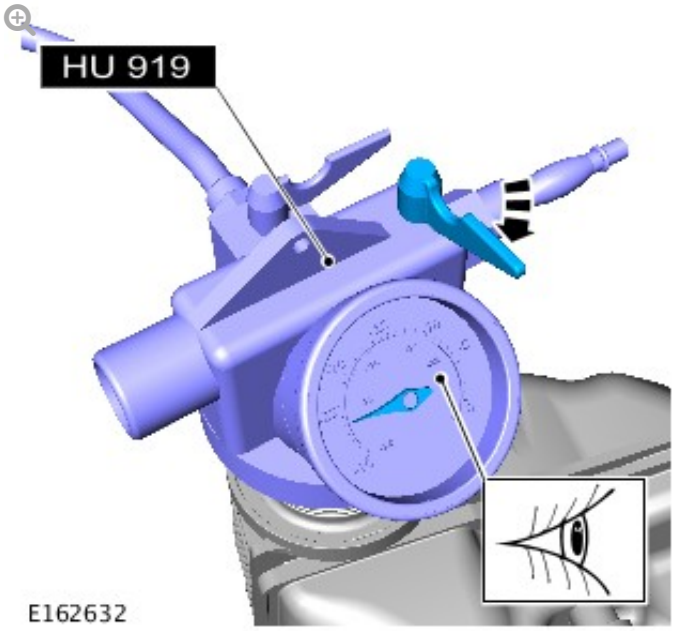
11.

- Make sure the coolant supply valve is in the closed position on the special tool.
- The special tool needs an air pressure of 6 to 8 bar (87 to 116 psi) to operate correctly.
- Small diameter or long airlines may restrict airflow to the coolant vacuum fill tool.



Open the air supply valve until -0.8 (-12 psi) Bar is shown on the gauge.
Special Tool(s): HU-919

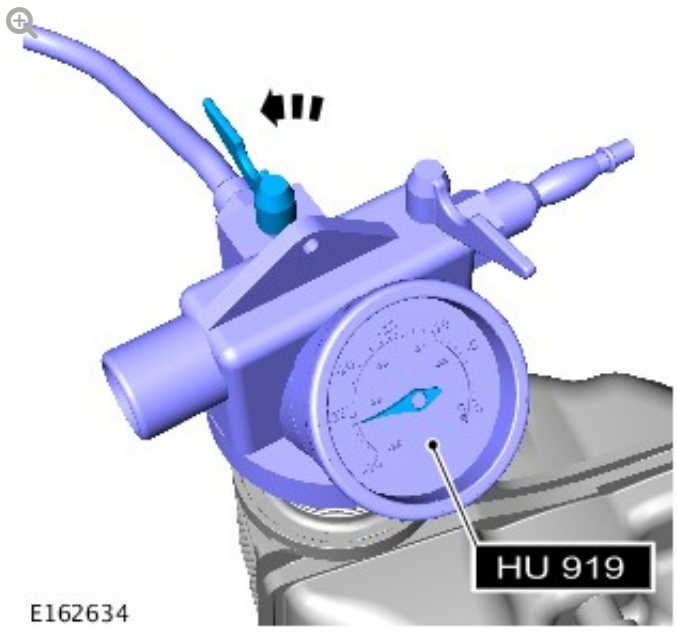
12.



- Close the air supply valve.
- Allow 1 minute to check the vacuum is held.
  Special Tool(s): HU-919

13.

- The coolant is to be reused.
- Close the coolant supply valve when the coolant expansion tank MAX mark is reached or coolant movement has stopped.



Open the coolant supply valve and allow the coolant to be drawn into the system.
Special Tool(s): HU-919

14. Remove the special tool.

15. Connect exhaust extraction hoses to the tail pipes.

16. Start and run the engine.

17.

> Correct installation of the coolant expansion tank cap can be obtained by tightening the cap until 3 audible clicks are heard.

Install the coolant expansion tank cap.

18. Hold the engine speed at 2000 revolutions per minute (RPM) until warm air is expelled from the heater.

19. Switch the engine off and allow to cool.

20. Clean any spilt or excess coolant from the vehicle.

21.

> Since injury such as scalding could be caused by escaping steam or coolant, allow the vehicle cooling system to cool prior to carrying out this procedure.

Check and top-up the coolant if required.

ENGINE COOLING - TDV6 3.0L DIESEL

COOLING SYSTEM PARTIAL DRAINING, FILLING AND BLEEDING [G1447428]

DRAINING

1.

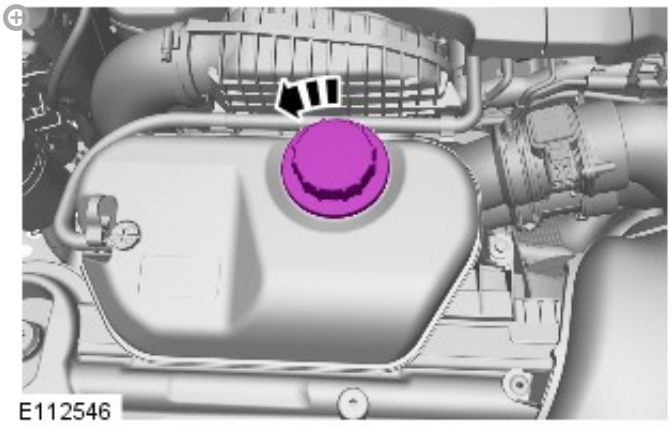
> Make sure to support the vehicle with axle stands.

Raise and support the vehicle.

2.

When releasing the cooling system pressure, cover the coolant expansion tank cap with a thick cloth.

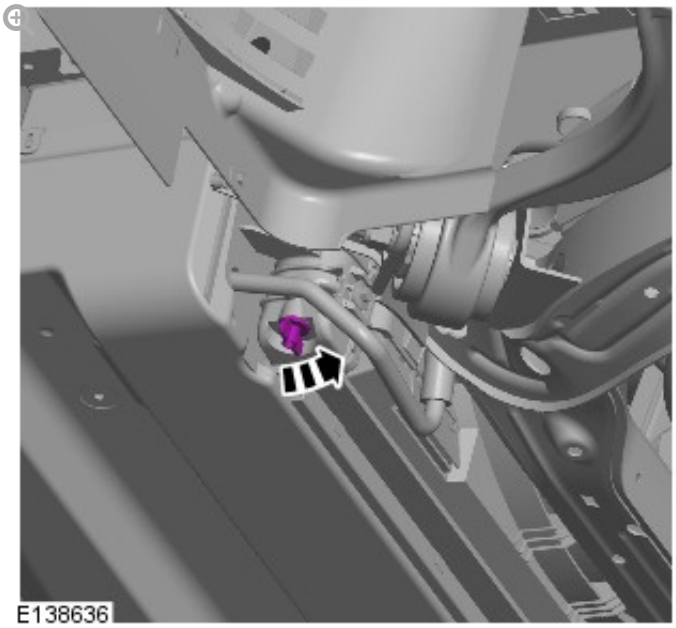
Since injury such as scalding could be caused by escaping steam or coolant, make sure the vehicle cooling system is cool prior to carrying out this procedure.



3. Refer to: Radiator Splash Shield (501-02 Front End Body Panels, Removal and Installation).

4.

Allow at least 15 minutes for the coolant to drain from the radiator drain plug.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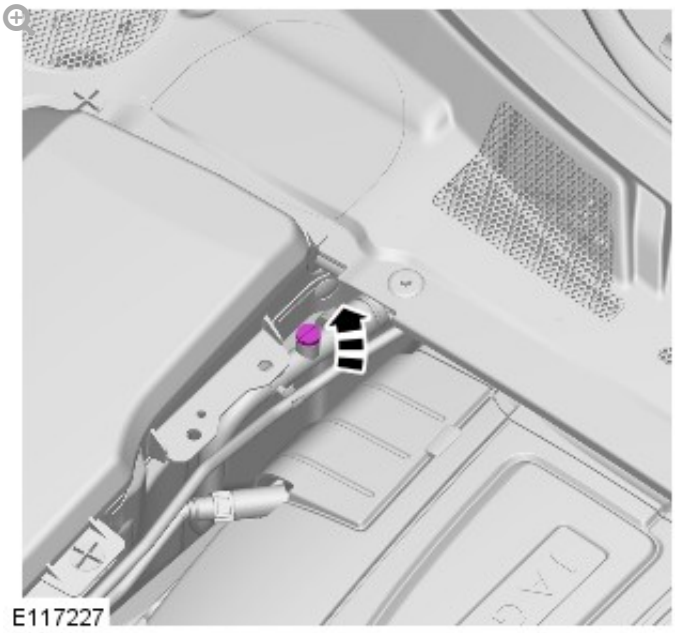
FILLING

5.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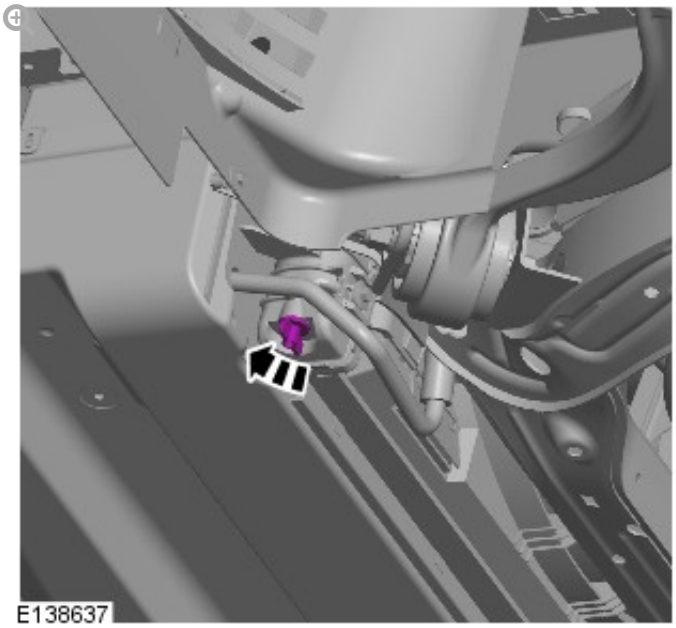
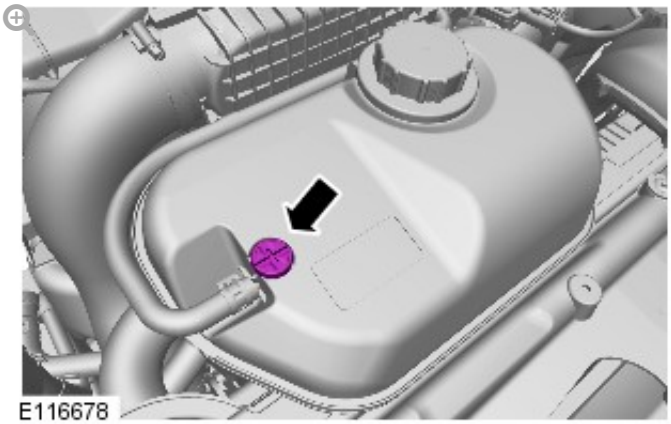
6.

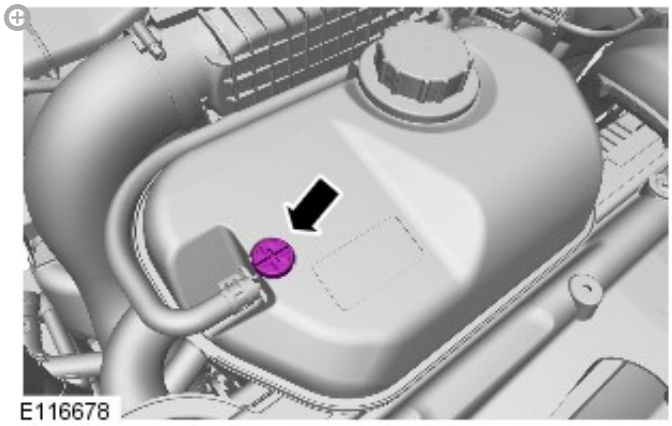


7.

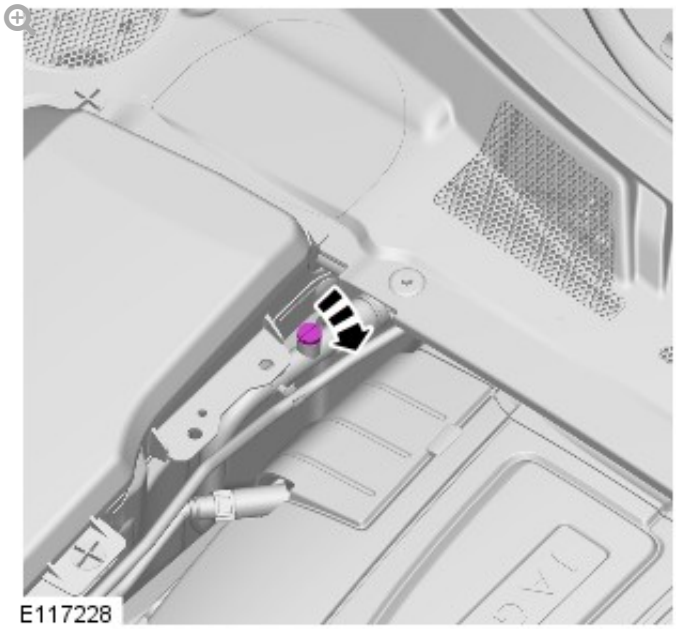


8.

Anti-freeze concentration must be maintained at 50%.



Fill the cooling system, keeping coolant to the upper level mark of the expansion tank until a steady stream of coolant is seen running from the coolant hose bleed point. Tighten the bleed screw.

9. 

10. Continue to fill the coolant until the maximum level is reached.

11. Set the heating to the HOT position.

12. Start and run the engine.

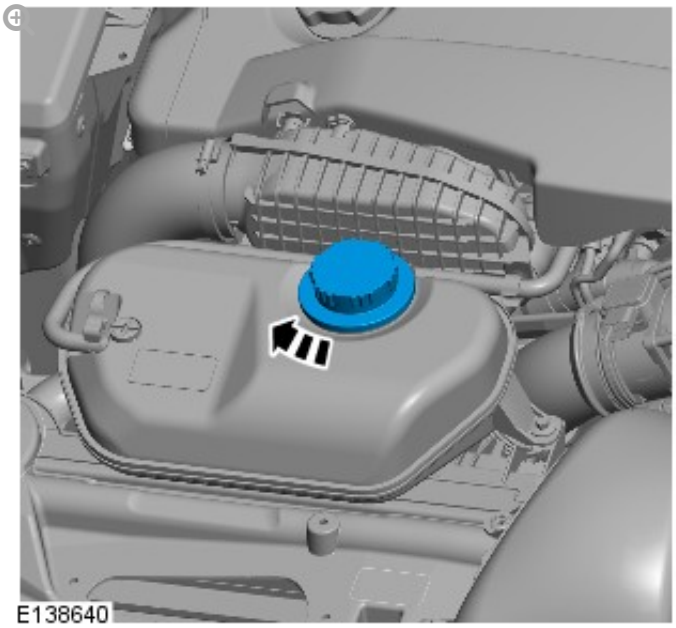
13. Raise the engine to 2500 RPM for 30 seconds.

14. Continue to top-up with coolant with engine idling until hot air is emitted from face vents.

    When the coolant stops dropping, continue to fill the coolant untill the maximum level is reached.

15.

> Correct installation of the coolant expansion tank cap can be obtained by tightening the cap until 3 audible clicks are heard.



16. Increase the engine speed to 3000rpm.

17. When hot air is emitted from the vents, switch the heater off.

    Hold the engine speed at 3000 RPM for a further 2 minutes.

18. When the thermostat is opened increase the engine speed from idle to 4000 RPM for 5 times.

    Hold the engine at 3000 rpm for 1 minute.

19. Allow the engine to idle for 2 minutes.

20. Switch the engine off and allow to cool.

21. Check and top up the cooling system as required when cool.

22. Visually check the engine and cooling system for signs of coolant leakage.

23. Refer to: Radiator Splash Shield (501-02 Front End Body Panels, Removal and Installation).

ENGINE COOLING - TDV6 3.0L DIESEL

COOLING SYSTEM PRESSURE TEST [G1898875]

GENERAL EQUIPMENT

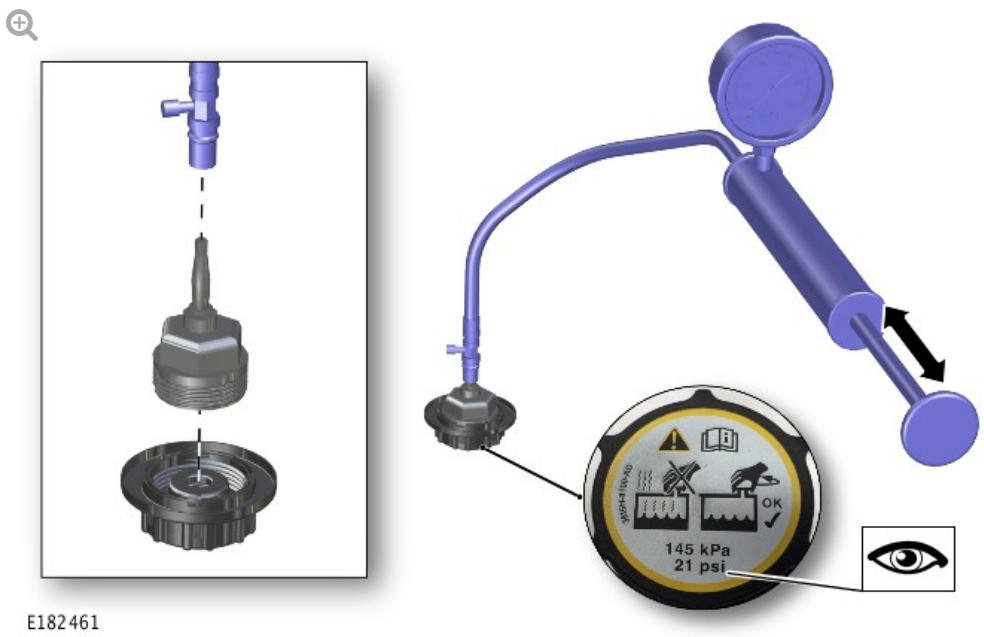
System pressure tester

ACTIVATION

Since injury such as scalding could be caused by escaping steam or coolant, allow the vehicle cooling system to cool prior to carrying out this procedure.

- The following procedure will enable the cooling system to be pressure tested for condition and leaks. Stage 1 will check the expansion tank cap register seal and the cap for leaks. Stage 2 will check the entire cooling system.
- This procedure contains some variation in the illustrations depending on the vehicle specification, but the essential information is always correct.
- This procedure contains illustrations showing certain components removed to provide extra clarity.

1. Examine the coolant hoses for signs of cracking, distortion and security of the hose connections. Inspect the coolant system for any visible leaks and replace any damaged or leaking components.

2. 

   - Remove the expansion tank cap, using the correct adaptor connect the cooling system pressure test kit to the cap.
     General Equipment: System pressure tester

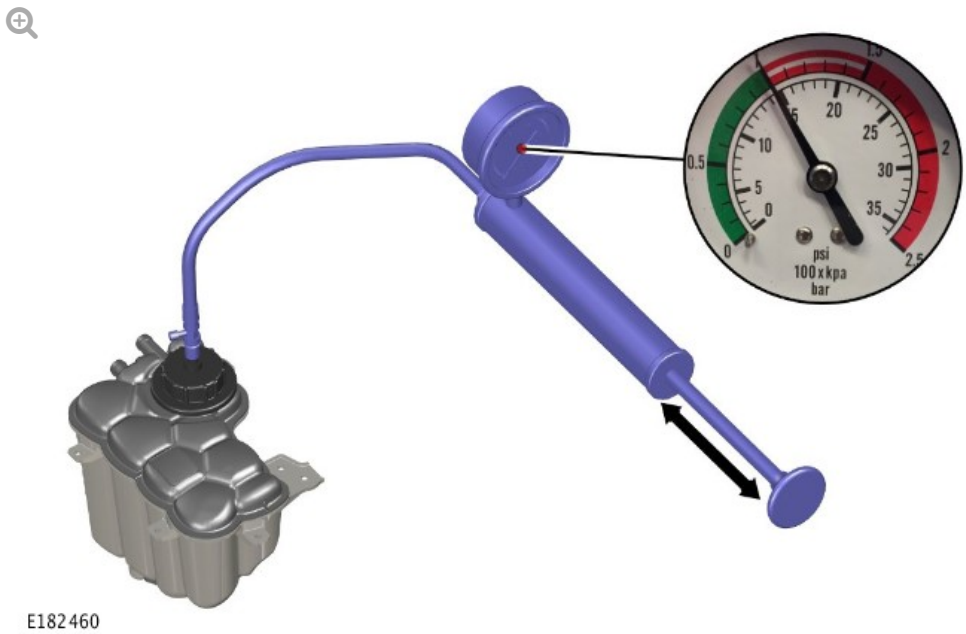
- Note the release pressure displayed on the expansion tank cap before applying pressure.
- Slowly pressurize the expansion tank cap checking for leaks. Once the noted cap pressure is reached the pressure will be released through the cap.

3. Depressurize and remove the cooling system pressure test kit.

4.

- Make sure that the mating faces are clean and free of foreign material.
- Do not exceed 1.0 bar (15 psi) whilst pressurizing the cooling system.

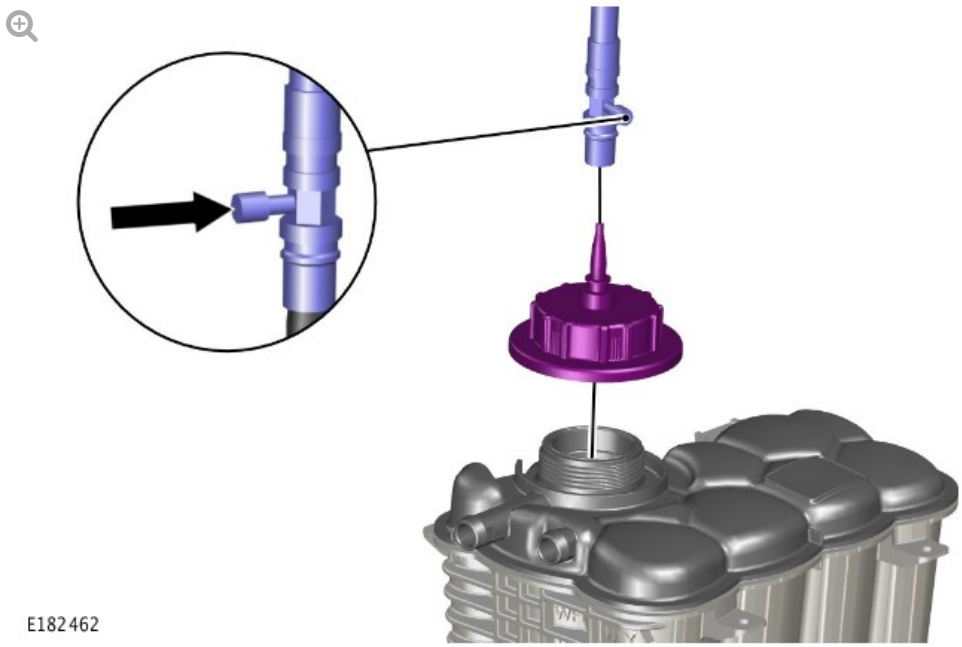
If the pressure continues to drop after the initial tolerance, there is a coolant leak.



E182460

- Using the correct adaptor connect the cooling system pressure test kit to the vehicle expansion tank.
  General Equipment: System pressure tester
- Slowly pressurize the cooling system until the pressure gauge reads 1.0 bar (15 psi).
- Make sure the cooling system holds pressure for 5 minutes, note that a small pressure decay of approximately 0.15 bar (1 psi) over the first minute is normal.

5.



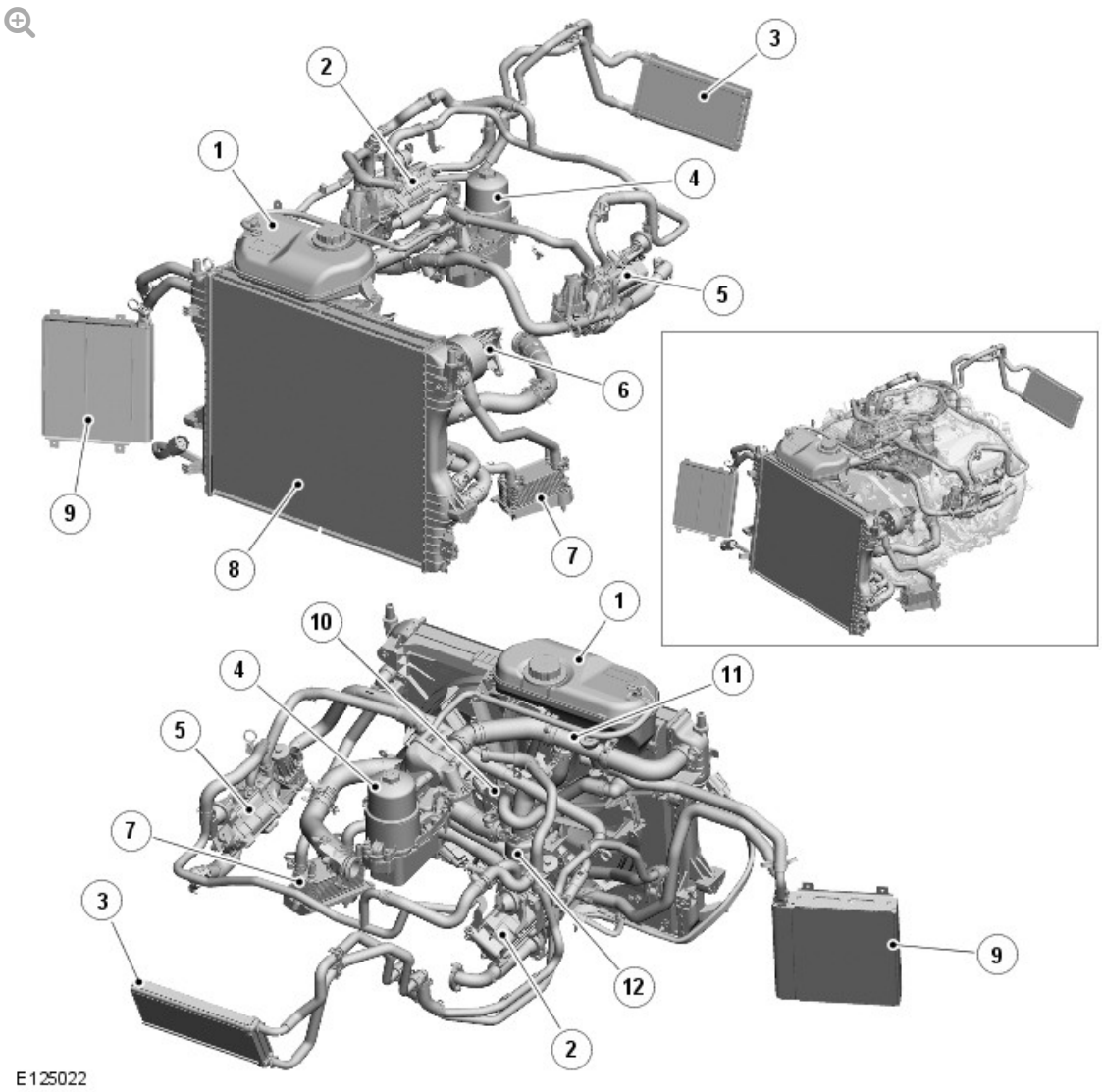
Depressurize and remove the cooling system pressure test kit.

6.

Correct installation of the coolant expansion tank cap can be obtained by tightening the cap until 3 audible clicks are heard.

Install the expansion tank cap.

ENGINE COOLING - COMPONENT LOCATION [G1245362]



1	Expansion tank
2	RH (right-hand)EGR (exhaust gas recirculation) cooler
3	Heater core
4	Engine oil cooler
5	LH (left-hand)EGR cooler
6	Coolant pump
7	Transmission oil cooler
8	Radiator
9	Auxiliary radiator
10	Cooling fan
11	5 Way connector
12	Pressure relief thermostat

ENGINE COOLING - OVERVIEW [G1245363]

OVERVIEW

The engine cooling system maintains the engine within an optimum temperature range under changing ambient and engine operating conditions. It also provides:

- Heating for the passenger compartment. For additional information refer to Heating and Ventilation 412-01.
- Cooling for:
  - The engine oil
  - The fuel
  - The EGR (exhaust gas recirculation) system -
    Refer to: Engine Emission Control (303-08A Engine Emission Control - TDV6 3.0L Diesel, Description and Operation).
  - The transmission fluid.

ENGINE COOLING - TDV6 3.0L DIESEL

ENGINE COOLING - SYSTEM OPERATION AND COMPONENT DESCRIPTION

[G1245364]

SYSTEM OPERATION

COOLANT CIRCUIT FLOW

When the engine is running the coolant is circulated around the engine cooling system by the coolant pump. From the coolant pump, coolant flows through the cylinder block and the cylinder heads. Some of the coolant in the cylinder block is diverted through the engine oil cooler before returning to the 5-way connector via the water outlet.

From the 5-way connector, the majority of the coolant flows to the pressure relief thermostat, either directly or via the radiator, depending on the temperature of the coolant. Some of the coolant is also directed through the auxiliary cooling radiators returning the cooled coolant to the Pressure Relief Thermostat (PRT) via the radiator bottom hose. From the outlet of the thermostat the coolant flows to the inlet of the coolant pump.

A separate hose from the radiator allows extra-cooled coolant from the radiator to flow through the transmission oil cooler. The coolant from the cooler is returned to the system via a branch in the bottom radiator hose.

Coolant from the water outlet also flows through the EGR (exhaust gas recirculation) coolers and then to the heater core. From the heater core outlet, the coolant flows to the outlet zone of the pressure relief thermostat.

The expansion tank allows expansion of coolant due to temperature increases to pass excess coolant back to the expansion tank. A small hose is connected from the water outlet to the expansion tank for this purpose. As the coolant cools, the coolant is allowed back into the system from the tank via a hose from the expansion tank into the radiator bottom hose.

PRESSURE RELIEF THERMOSTAT (PRT)

The thermostat is closed at temperatures below approximately 82°C (179°F). When the coolant temperature reaches approximately 82°C the thermostat starts to open and is fully open at approximately 96°C (204°F). In this condition the full flow of coolant is directed through the radiator. The thermostat is exposed to 90% hot coolant from the engine on one side and 10% cold coolant returning from the radiator bottom hose on the other side. Hot coolant from the engine passes from the by-pass pipe through four sensing holes in the flow valve into a tube surrounding 90% of the thermostat sensitive area. Cold coolant returning from the engine, cooled by the radiator, conducts through 10% of the sensitive area.

In cold ambient temperatures, the engine temperature is raised by approximately 10°C (50°F) to compensate for the heat loss of 10% exposure to the cold coolant returning from the bottom hose.

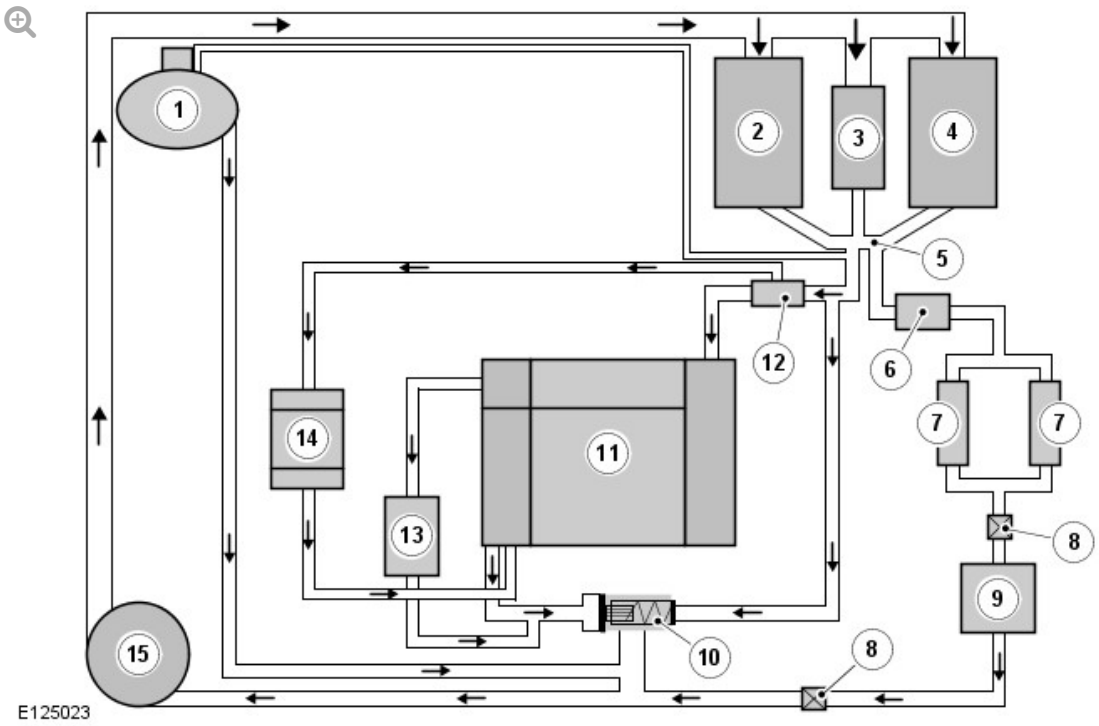
The by-pass flow valve is held closed by a light spring. It operates to further aid heater warm-up. When the main valve is closed and the engine speed is at idle, the coolant pump does not produce sufficient flow and pressure to open the valve. In this condition the valve prevents coolant circulating through the by-pass circuit and forces the coolant through the heater matrix only. This provides a higher flow of coolant through the heater matrix to improve passenger comfort in cold conditions. When the engine speed increases above idle, the coolant pump produces a greater flow and pressure than the

heater circuit can take. The pressure acts on the by-pass flow valve and overcomes the valve spring pressure, opening the valve and limiting the pressure in the heater circuit. The valve modulates to provide maximum coolant flow through the heater core and yet allowing excess coolant to flow into the by-pass circuit to provide the engine's cooling needs at higher engine speeds.

COOLING FAN

The cooling fan is operated by a fan control module integrated into the cooling fan motor. The fan control module regulates the voltage, and subsequently the speed, of the cooling fan motor in response to a PWM (pulse width modulation) signal from the ECM (engine control module). The ECM calculates the required fan speed from the engine temperature, A/C (air conditioning) system pressure and transmission oil temperature. Under hot operating conditions, the fan may continue to operate for up to four minutes after the engine has been switched off.
Refer to: Electronic Engine Controls (303-14A Electronic Engine Controls - TDV6 3.0L Diesel, Description and Operation).

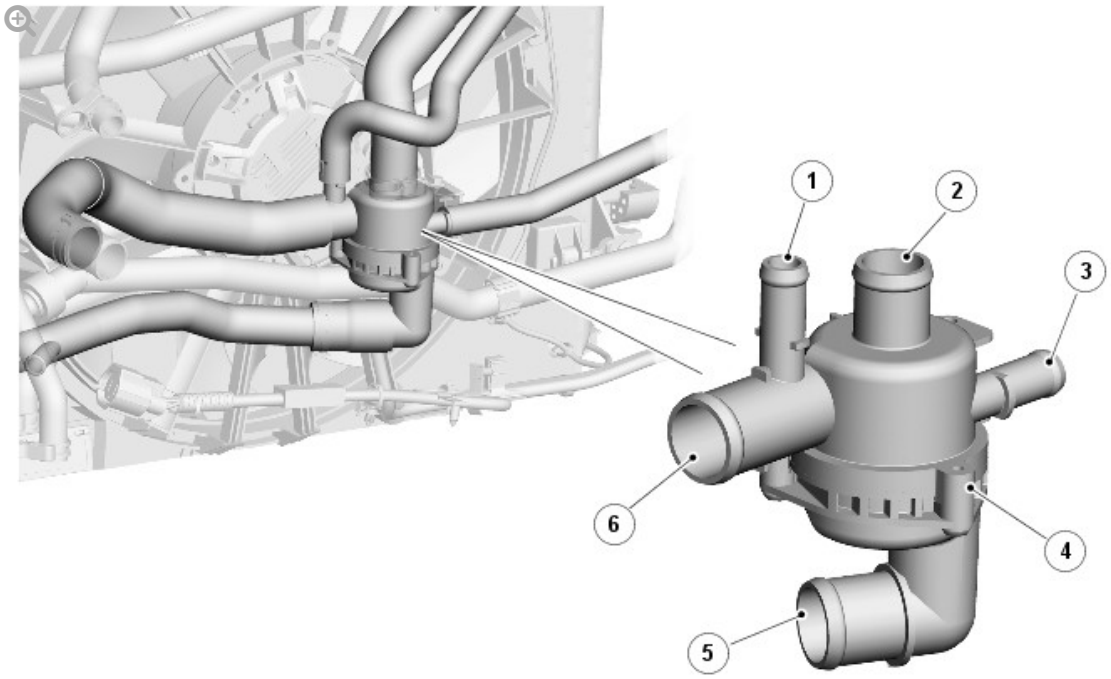
ENGINE COOLING - SCHEMATIC FLOW DIAGRAM



1	Expansion tank
2	Engine LH (left-hand) cylinder bank
3	Engine oil and fuel cooler
4	Engine RH (right-hand) cylinder bank
5	Engine water outlet
6	ECT (engine coolant temperature) sensor
7	EGR coolers
8	Bleed screw
9	Heater core
10	Pressure Relief Thermostat
11	Radiator
12	5 Way connector
13	Transmission fluid cooler
14	Auxiliary radiator
15	Coolant pump

COMPONENT DESCRIPTION

PRESSURE RELIEF THERMOSTAT (PRT)

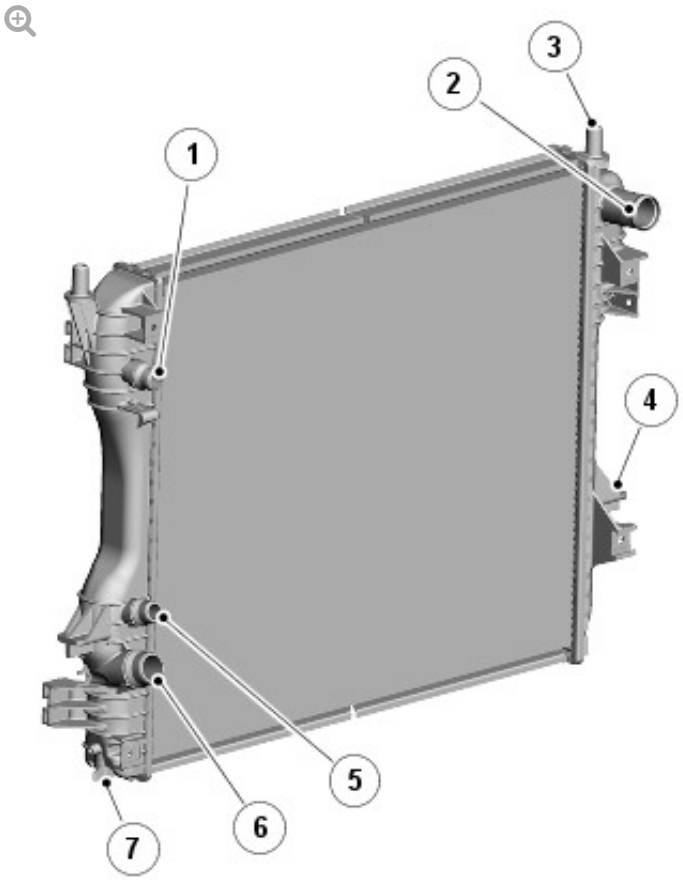


1	Connection to expansion tank
2	Connection to radiator top hose
3	Heater core return connection
4	PRT body
5	Connection from radiator bottom hose
6	Connection to cylinder block water inlet

A plastic thermostat housing is located behind the radiator. The housing has 5 connections which locate the radiator bottom hose, top hose from the 5-way connector, coolant pump feed hose to the cylinder block and return feed from the heater core. The housing contains a wax element and a spring loaded by-pass flow valve.

The thermostat is used to maintain the coolant at the optimum temperature for efficient combustion and to aid engine warm-up.

RADIATOR



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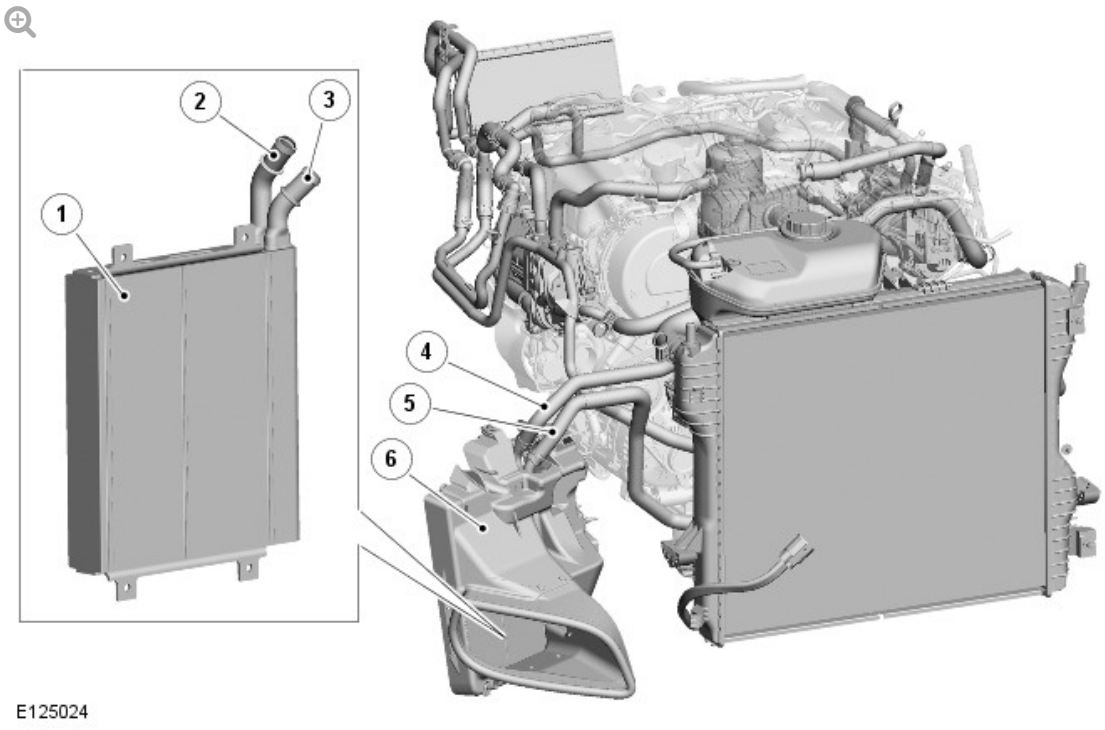
1	Coolant outlet to transmission fluid cooler
2	Coolant inlet
3	Locating spigot (2 off)
4	Support (2 off)
5	Coolant inlet from auxiliary coolers
6	Coolant outlet to pressure relief thermostat
7	Drain plug

The radiator is a cross-flow type with an aluminum core and plastic end tanks. The radiator is located in the vehicle by locating spigots and supports integrated into the end tanks. The supports are installed in rubber bushes in the upper chassis rails. The locating spigots are installed in rubber bushes in the front end carrier. A drain plug is integrated into the LH end tank. Coolant inlet and outlet connections are incorporated into the RH and LH end tanks respectively.

The LH end tank also has connections for coolant inlet from the auxiliary coolers and a coolant outlet to the transmission fluid cooler.

AUXILIARY COOLING RADIATOR



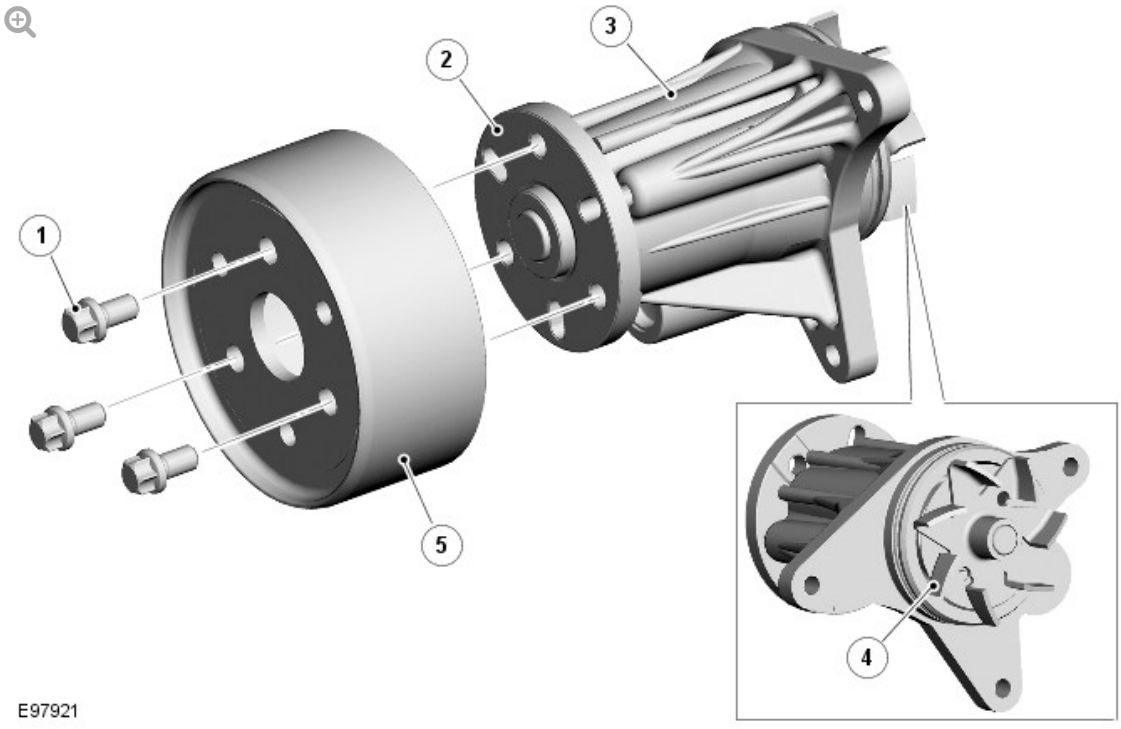
1	Auxiliary cooling radiator
2	Coolant outlet
3	Coolant inlet
4	Coolant outlet hose to radiator
5	Coolant inlet hose from 5 way connector

6	Ducting from front bumper

One auxiliary cooling radiator is used to maintain the optimum engine coolant temperature for performance driving.

The radiator is located behind the RH side of the front bumper and ducting provides are flow to the radiator via an aperture in the bumper. The auxiliary radiator is connected to the main radiator with flow through the system controlled by the PRT.

COOLANT PUMP

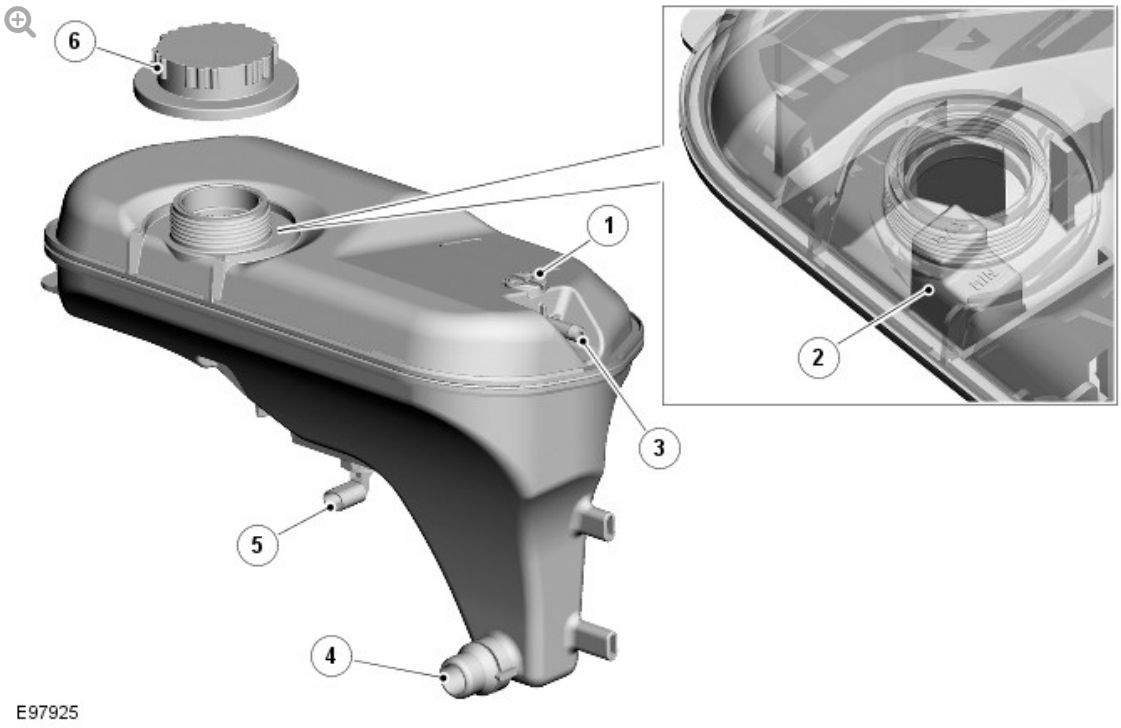


1	Bolt (3 off)
2	Drive hub
3	Housing
4	Impeller
5	Pulley

The coolant pump has a housing that supports a shaft with an impeller attached to one end and a drive hub at the other. The housing is attached to the front of the cylinder block with the impeller located in a pumping chamber. The pump is driven by a pulley attached to the drive hub and driven by the accessory drive belt.

Refer to: Accessory Drive (303-05A Accessory Drive - TDV6 3.0L Diesel, Description and Operation).

EXPANSION TANK



1	Bleed screw
2	Level markings
3	Vent hose connection
4	Expansion hose connection
5	Level sensor
6	Filler cap

A pressurized expansion tank system is used which continuously separates the air from the cooling system and replenishes the system through a hose connected between the expansion tank and the heater return hose. A continuous vent into the expansion tank, through a hose connected to the engine's coolant outlet connector, prevents air locks from forming in the cooling system.

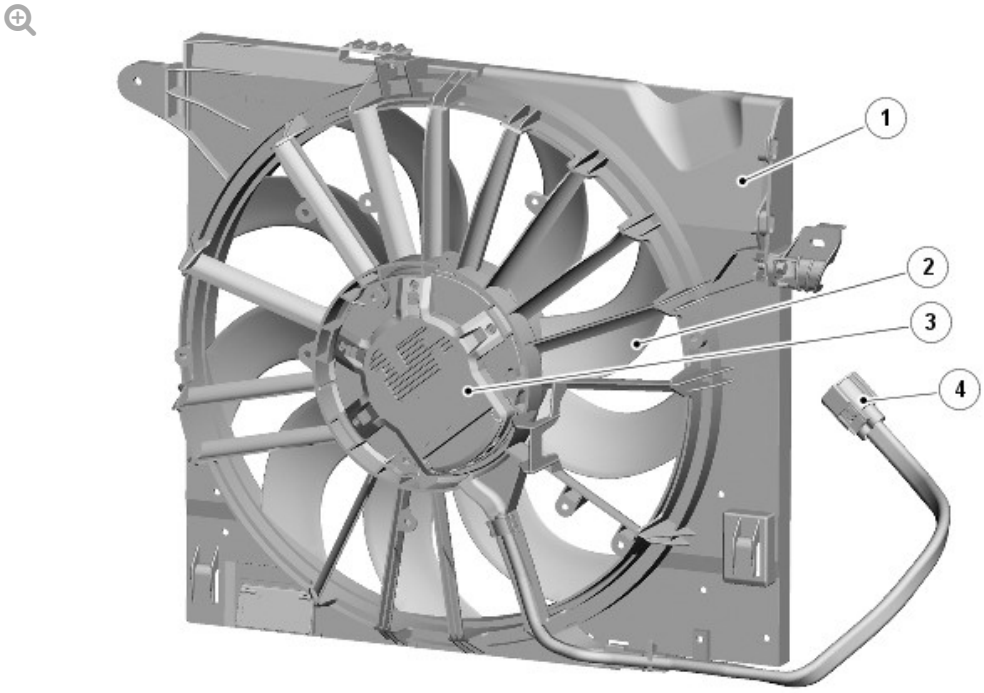
The expansion tank is installed behind the top right corner of the radiator. A filler cap, bleed screw and level sensor are incorporated into the expansion tank. MAX and MIN level markings are molded into the interior of the tank below the filler cap.

The expansion tank provides the following functions:

- Service fill
- Coolant expansion during warm-up
- Air separation during operation
- System pressurization by the filler cap

The expansion tank has an air space of approximately 0.5 to 1 liter (1.06 to 2,11 US pints), above the MAX level, to allow for coolant expansion.

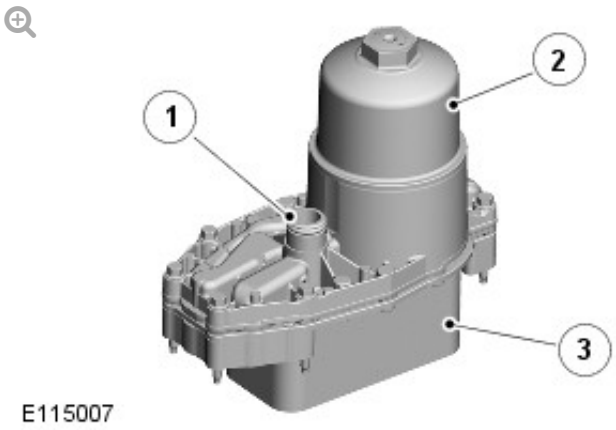
COOLING FAN



1	Shroud
2	Fan
3	Motor and fan control module
4	Electrical connector

An electric, variable speed cooling fan is installed in a shroud attached to the rear of the radiator. The cooling fan is operated by a fan control module, integrated into the electric motor, under the control of the ECM. Electrical connectors at the LH side of the shroud provides the interface between the cooling fan harness and the vehicle wiring.

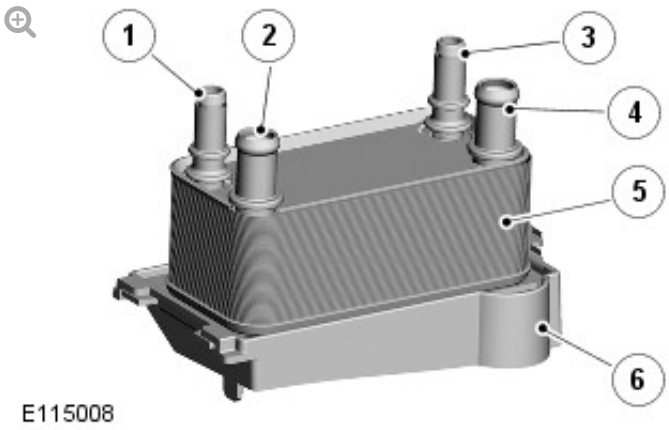
ENGINE OIL COOLER



1	Coolant outlet
2	Engine oil filter
3	Engine oil cooler

The engine oil cooler is attached to a common adapter assembly located in the vee of the cylinder block. Inlet and outlet ports for engine oil, and an inlet port for coolant, are incorporated into the cylinder block mating face of the adapter assembly. A metal gasket seals the joint between the adapter assembly and the cylinder block. From the cylinder block, coolant flows through the adapter assembly and into the cooler. After passing through the cooler, the coolant then flows into the engine coolant water outlet.

TRANSMISSION FLUID COOLER



1	Transmission fluid inlet
2	Coolant outlet to radiator bottom hose
3	Transmission fluid outlet
4	Coolant inlet from radiator
5	Transmission fluid cooler
6	Mounting bracket

The transmission fluid cooler is located near the lower LH corner of the radiator. The cooler is connected to the cooling system with 2 hoses and receives cooled fluid from the upper section of the radiator, which flows through the cooler, reducing the temperature of the transmission fluid.

ENGINE COOLANT

The coolant is silicate free and must not be mixed with conventional engine coolant.

ENGINE COOLING - TDV6 3.0L DIESEL

PRINCIPLES OF OPERATION

For a detailed description of the Engine Cooling system, refer to the relevant Description and Operation section in the workshop manual. REFER to: Engine Cooling (303-03A Engine Cooling - TDV6 3.0L Diesel, Description and Operation).

INSPECTION AND VERIFICATION

DO NOT remove the coolant expansion tank cap when the engine is hot. Failure to follow this instruction may result in personal injury.

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 tested and/or the donor vehicle.

- If a control module or a component is suspect and the vehicle remains under manufacturer warranty, refer to the Warranty Policy and Procedures manual, or determine if any prior approval programme is in operation, prior to the installation of a new module/component.
- When performing voltage or resistance tests, always use a digital multimeter accurate to three decimal places, and with an up-to-date calibration certificate. When testing resistance always take the resistance of the digital multimeter leads into account.
- Check and rectify basic faults before beginning diagnostic routines involving pinpoint tests.

Verify the customer concern

Visually inspect for obvious signs of damage and system integrity

▪ Coolant leaks ▪ Coolant hoses ▪ Coolant expansion tank ▪ Coolant expansion tank cap ▪ Radiator ▪ Heater core ▪ Accessory drive belt ▪ Cooling fan	▪ Fuses ▪ Wiring harnesses and connectors ▪ Powertrain control module ▪ Engine coolant temperature sensor ▪ Radiator outlet temperature sensor ▪ Cooling fan

If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step

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

Check DDW for open campaigns. Refer to the corresponding bulletins and SSMs which may be valid for the specific customer complaint and carry out the recommendations as required

SYMPTOM CHART

Coolant loss	▪ Coolant leak ▪ Coolant hose damaged ▪ Coolant hose clamp loose/damaged ▪ Radiator leaking/damaged ▪ Coolant pump seal failed ▪ Heater core leaking/damaged ▪ Seal/gasket leaking ▪ Engine casting leaking ▪ Engine core plugs leaking	▪ Check for coolant leaks. Perform a cooling system pressure test. Rectify as necessary
Overheating	▪ Coolant level low ▪ Coolant contaminated ▪ Coolant leak ▪ Thermostat stuck closed ▪ Radiator airflow obstructed ▪ Cooling fan inoperative	▪ Check the coolant level. Rectify as necessary ▪ Check the condition of the coolant. Rectify as necessary ▪ Check for coolant leaks. Perform a cooling system pressure test. Rectify as necessary ▪ Check the operation of the thermostat. Rectify as necessary ▪ Check the radiator for obstructions. Rectify as necessary