

This TSI Service Bulletin replaces TSI Service Bulletin 215-001, "Camshaft, D12, D12A, D12B" (11.2001), publication no. PV776-TSP160576.

Date	Group	No.	Supp.	Page
8.2003	<b>215</b>	<b>001</b>		1(21)

Camshaft  
D12, D12A, D12B

## Camshaft

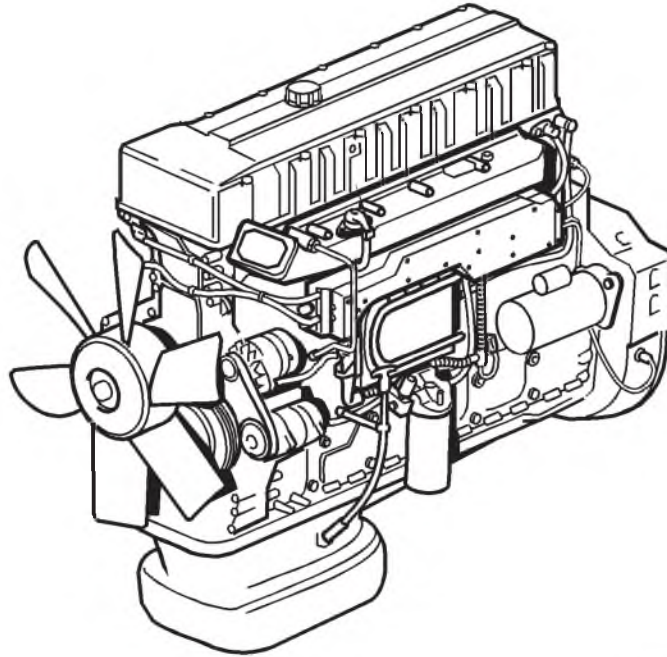


Fig. 1: VOLVO D12B Engine

W2002853

This information covers procedures for camshaft repair on VOLVO D12, D12A, and D12B engines.

### Contents

- "Special Tools" page 2
- "Camshaft Timing, Checking" page 12
- "Camshaft Timing, Check and Adjust" page 18
- "Camshaft, Replacement" page 3

## Tools

### Special Tools

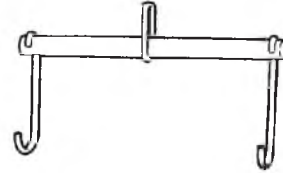
The following special tools are used to replace or repair components. The tools can be ordered from Volvo. Please use the specified part number when ordering.



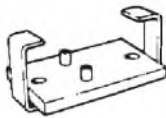
**9996956**  
Flywheel Turning Tool



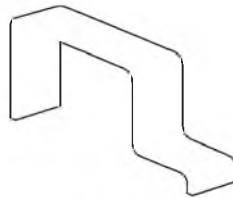
**9998255**  
Rocker Arm Bridge Lifting Tool



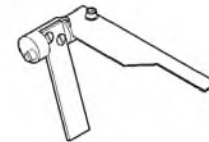
**9998264**  
Camshaft Removal Tool



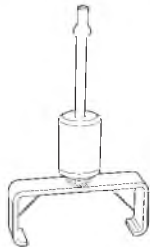
**9998270**  
Counterhold



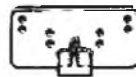
**J-41272**  
Front Cover Tool



**J-42773**  
Camshaft Alignment Tool



**J-44457**  
Camshaft Bearing Cap Removal Tool



**9996950**  
Flywheel Stop Tool

# Service Procedures

## 2154-03-02-01

### Camshaft, Replacement

(With EPG or VEB)

You must read and understand the precautions and guidelines in Service Information, Group 20, "General Safety Practices, Engine" before performing this procedure. If you are not properly trained and certified in this procedure, ask your supervisor for training before you perform it.

#### CAUTION

Observe the greatest possible cleanliness when working on the cylinder head. Dirt particles in the fuel and oil channels can cause the unit injectors to malfunction, and can cause the VEB (if equipped) to fail.

*Special tools: 9996956, 9998255, 9998264, 9998270, J-44457*

#### Removal

1

#### WARNING

Use a hoist or get assistance when lifting components that weigh 23 kg (50 lb.) or more. Make sure all lifting devices such as chains, hooks, or slings are in good condition and are of the correct capacity. Make sure hooks are positioned correctly. Always use a spreader bar when necessary. The lifting hooks **MUST NOT** be side loaded. Failure to follow these warnings may result in personal injury.

Remove the valve cover (valve cover should be removed from the exhaust side of the engine).

**Note:** On WIA, bring the valve cover towards the radiator to remove. On WG, it is necessary to remove the engine cover (doghouse).

**Note:** Be careful that the stud bolts do not loosen. Otherwise, the unit injector wiring harness can be damaged.

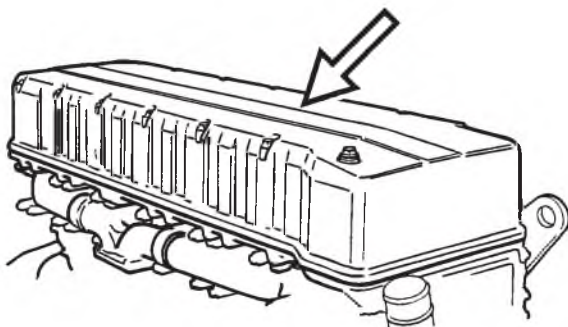


Fig. 2: Valve cover

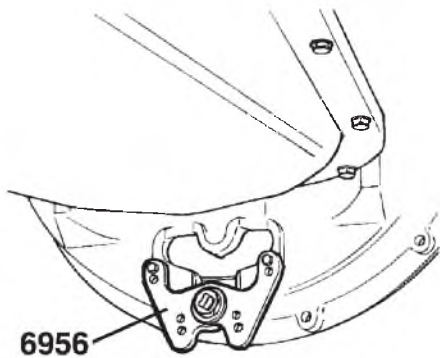
T2006731

2

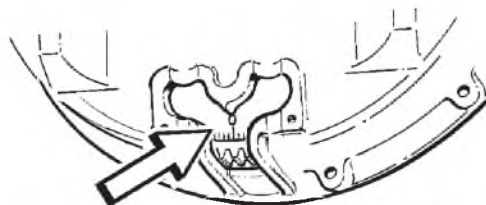
Disconnect the connector for the electrical wires on the upper timing gear cover. Remove the clamp and the cover.

**3**  
Remove the upper timing gear cover.

**4**



T2006672

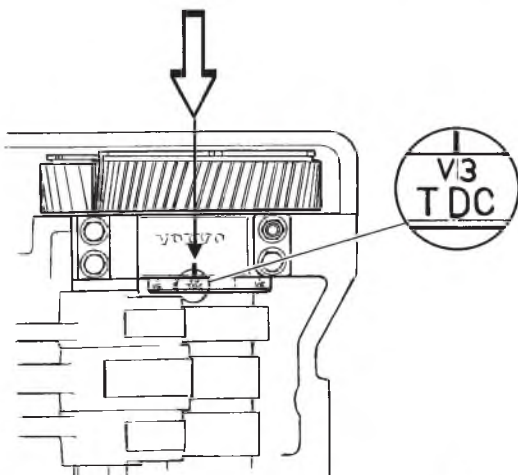


T2008251

Remove the inspection cover from underneath the flywheel housing and install turning tool 9996956.

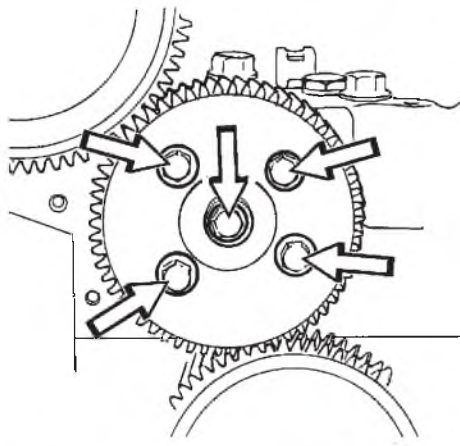
9996956

**5**  
Turn the flywheel around until the piston in cylinder number 1 is in the Top Dead Center position ( $0^{\circ}$ ) on the flywheel and the camshaft marking (TDC) is opposite the marking on the bearing cap.



T2008250



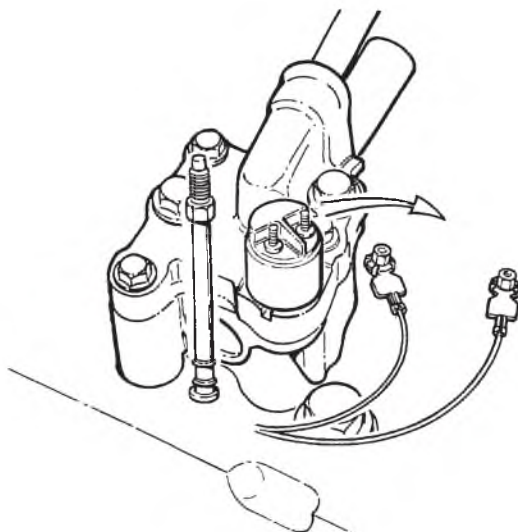


T2007095

Fig. 3: Bolts holding the idler gear in place

**6**

Remove the adjustable idler gear.



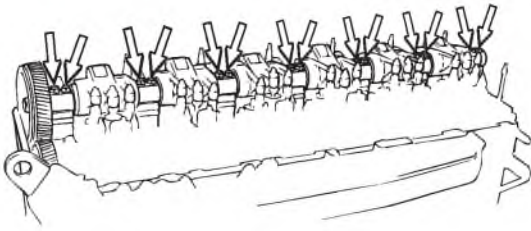
T2008812

**7**

If the engine is equipped with VEB, remove the control valve and pipe. Plug the ports and place it in a plastic bag to avoid it being subjected to dirt and contamination. To facilitate removal, remove the valve cover stud bolt.

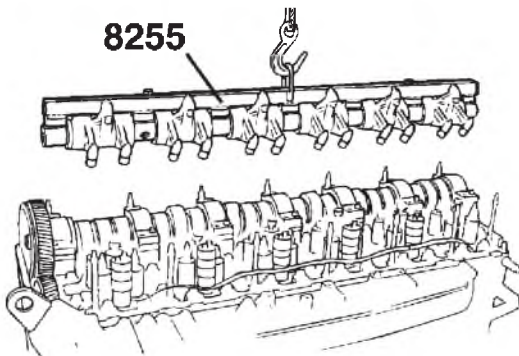
**Note:** Failure to remove the control valve before removing the rocker arm shaft assembly may result in damage to the control valve and/or the pipe.

8



T2006777

Fig. 4: Removing the rocker arm shaft assembly bolts



W2000937

Fig. 5: Removing the rocker arm shaft assembly

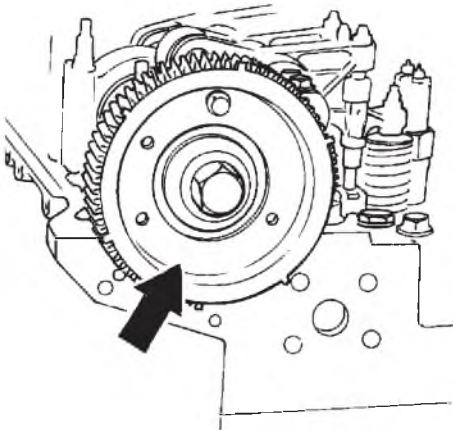
Loosen the rocker arm shaft bolts gradually to avoid bending the arm shaft assembly. Remove the bolts, install tool 9998255 and lift off the rocker arm shaft assembly.

**Note:** On engines equipped with VEB, wrap a rubber band around each exhaust rocker lever and slave piston. This is to prevent the VEB slave pistons from falling out of their rocker arm bore.

9998255

9

Remove the cam sensor wheel from the camshaft drive gear.



T2007096

Fig. 6: Cam sensor wheel

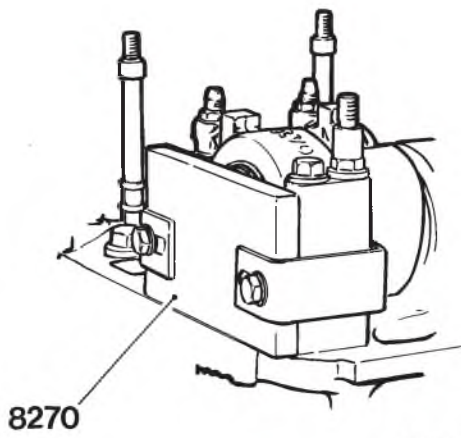


Fig. 7: Tool 9998270 installed

**10**

Install camshaft counterhold tool 9998270 on the rear of the camshaft. Loosen and remove the camshaft drive gear center bolt and the cam gear.

9998270

**11**

Remove the camshaft cap bolts. Mark the caps for the respective bearing housings, and remove.

**Note:** To facilitate the removal of the camshaft bearing caps, use tool J-44457.

**Note:** Failure to match the correct camshaft cap with the respective bearing housing will cause engine damage.

J-44457

**12**

Carefully lift off the camshaft using tool 9998264.

9998264

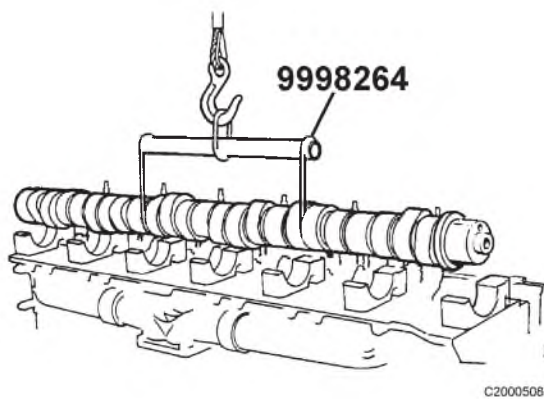


Fig. 8: Lifting the camshaft

**13**

Remove the bearing shells from the bearing housings.

**14**

Inspect the bearings and housings for damage.

**Note:** When replacing the camshaft on the D12 engine, remember that the bearing shells are available in different sizes. Refer to Group 20, Specifications.

## Installation

### 15

Position the camshaft bearing housings on the cylinder head by observing the factory marks 1–7.

**Note:** Check that the mating surface is clean under the bearing housings and that the guide pins are in good condition. If installing a new cylinder head, also use the bearing housings supplied with the cylinder head.

### 16

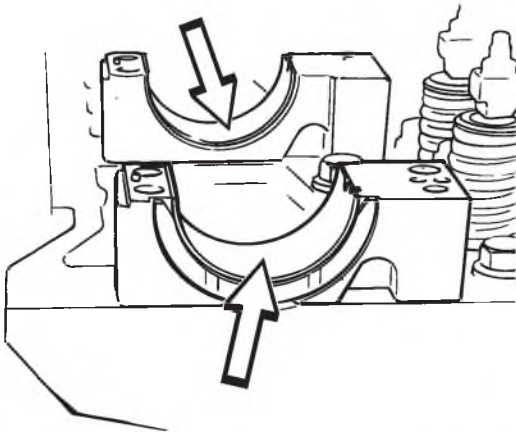


Fig. 9: Bearing shell halves

T2007126

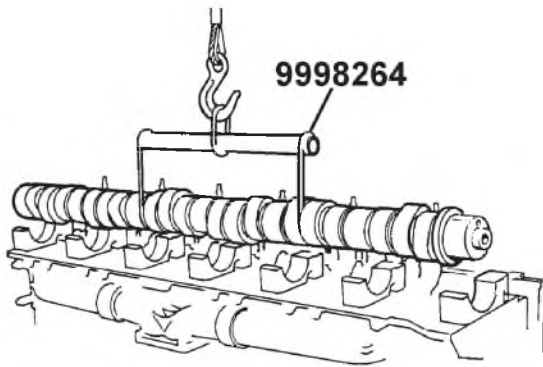


Fig. 10: Installing the camshaft

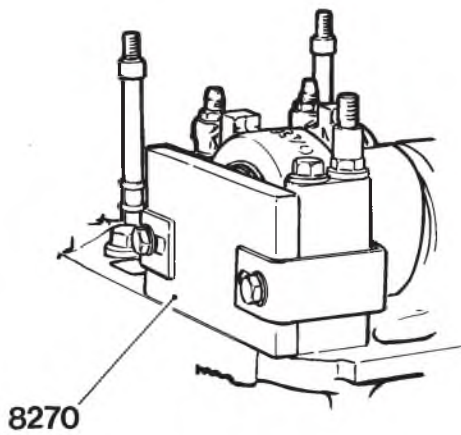
C2000508

Coat the bearing shell halves with clean engine oil and install them in the bearing housings. Carefully lower the camshaft into place.

**Note:** Make sure that bearing shells of the correct size are installed and correctly positioned in the bearing housing.

### 17

Coat the bearing shell halves with clean engine oil and install them in the camshaft caps. Install the caps on their respective bearing housings. Hand-tighten the bolts.



T2007148  
Fig. 11: Installing the camshaft drive gear

**18**

Install the camshaft drive gear. Use tool 9998270 to lock the camshaft into place. Torque-tighten to  $645 \pm 25$  Nm ( $475 \pm 18$  ft-lb).

**Note:** Do NOT install the bolts for the rocker arm shaft.

$645 \pm 25$  Nm  
( $475 \pm 18$  ft-lb)  
9998270

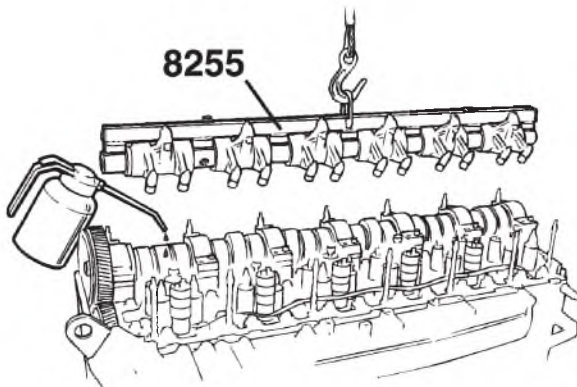
**19**

Adjust the camshaft timing; refer to "Camshaft Timing, Check and Adjust" page 18.

**20**

Apply clean engine oil to the valve bridges and camshaft lobes. Using tool 9998255, lift the rocker arm shaft assembly into place. Make sure that the valve bridges and the rocker arms are correctly positioned in relation to each other.

9998255



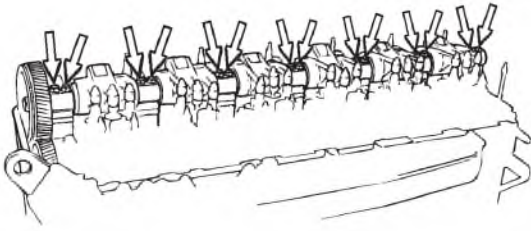
T2006820  
Fig. 12: Installing the rocker arm bridge

**21**

Hand-tighten the rocker arm shaft with the bolts until it bottoms against the bearing housings.

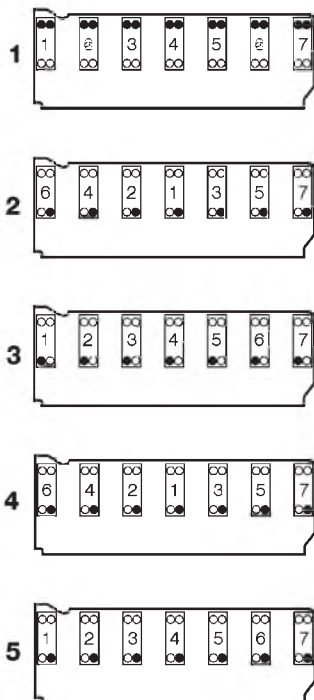
**Note:** Tighten the rocker arm shaft bolts gradually so that no distortions occur on the shaft. Do NOT torque.

22



T2006777

Fig. 13: Tightening rocker arm shaft and camshaft together



W2003520

Fig. 14: Bearing caps and camshaft/rocker shaft, tightening sequence

Tighten the rocker arm shaft **together** with the camshaft, using the 5-step sequence and torques shown:

**D12, D12A, D12B:**

- 1  $15 \pm 5$  Nm ( $11 \pm 4$  ft-lb);  
 $+90 \pm 5^\circ$
- 2 45 Nm (33 ft-lb)
- 3  $15 \pm 5$  Nm ( $11 \pm 4$  ft-lb);  
 $+90 \pm 5^\circ$
- 4 45 Nm (33 ft-lb);  
loosen to 0 Nm (0 ft-lb)
- 5  $15 \pm 5$  Nm ( $11 \pm 4$  ft-lb);  
 $+90 \pm 5^\circ$

When reinstalling a rocker arm shaft that has been loosened or removed, torque only the bolts that hold the rocker arm shaft.

23

**Note: (Engines with VEB:)** Reinstall the VEB control valve Reconnect sliding valve and pipe into the rocker arm shaft as a unit. Apply Loctite to threads and torque tighten the bolts to  $33 \pm 4$  Nm ( $24 \pm 3$  ft-lb).

$33 \pm 4$  Nm  
( $24 \pm 3$  ft-lb)

24

Install the cam sensor wheel and mounting bolts. Turn the cam sensor wheel clockwise (as viewed from the front of the engine) against the mounting bolts; torque bolts to 25 Nm (19 ft-lb).

25 Nm  
(19 ft-lb)

**25**

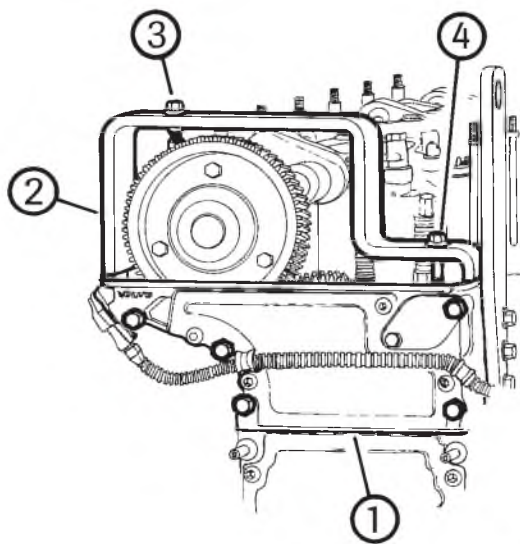
Clean the contact surfaces for the upper timing gear cover. Install a new rubber seal.

**26**

Apply an even bead of sealant around the timing gear cover. Install the cover.

**CAUTION**

Do not allow sealant to harden before installing the cover. The bolts must be torque-tightened within 20 minutes.



W2002163

Fig. 15: Installing alignment tool J-41272

- 1 Upper gear cover
- 2 Alignment tool
- 3 Valve cover nut
- 4 Bolt supplied with J-41272

**27**

Install the alignment tool J-41272 on the forward right-hand valve cover stud using an existing valve cover nut. To attach the left-hand side, thread the bolt (supplied with the tool) into the hole in the cylinder head. The top of the cover must be flush with the top of the cylinder head. Otherwise, oil leaks may result.

J-41272

**28**

Draw the cover down evenly until the cylinder head and cover are aligned. Tighten cover mounting bolts in the proper sequence and torque to  $33 \pm 3$  Nm ( $24 \pm 3$  ft-lb).

$33 \pm 3$  Nm  
( $24 \pm 3$  ft-lb)



**29**

Rotate the camshaft until the cam sensor wheel tooth aligns with the cam sensor. Verify that the air gap is between 0.3 – 0.7 mm (0.012 – 0.028 in.). Adjust if needed by removing or adding shims between the sensor and the cover. Relocate the timing cover, before the sealant hardens, if necessary to aid in obtaining the proper air gap.

**Note:** Make sure the air gap is between 0.3 – 0.7 mm (0.011 – 0.028 in.).

0.3 – 0.7 mm  
(0.012 – 0.028 in.)

**30**

Connect the electrical cable to the cam sensor on the cover.

**31**

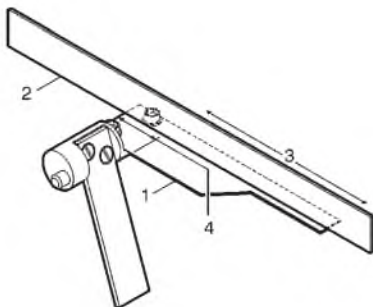
After installing the camshaft, adjust the valves and unit injectors; refer to Service Information, Group 21.

## 2154-06-03-01 Camshaft Timing, Checking

(See also "Camshaft Timing, Check and Adjust" page 18.)

You must read and understand the precautions and guidelines in Service Information, Group 20, "General Safety Practices, Engine" before performing this procedure. If you are not properly trained and certified in this procedure, ask your supervisor for training before you perform it.

**Note:** Before using the cam gear timing tool J-42773, always make sure that the pointer is straight. To check the straightness (refer to numbers in accompanying illustration):



W0002186

- Hold the tool with the pointer horizontal (1).
- Place a straight edge 90 degrees to the pointer along its entire length (2).
- If light can be seen between the straight edge and the pointer, bend the pointer and recheck for straightness (3).

- Use the portion of the pointer that is fastened to the tool shaft as a reference surface since this part is protected from being bent (4).

*Special tools: 9996956, J-41272, J-42773*

**1**

Steam clean around the valve cover and the upper front cover.

**2**

Disconnect the negative battery lead.

**3**

**VN model only**

Drain coolant and then remove the top right fan ring support and the top radiator neck from the thermostat housing.

**All other models**

Remove the fan ring support bracket, remove the fan belt and then remove the fan, the fan hub and bracket as one assembly. Relocate in the fan shroud area while making sure not to damage the radiator.

**4**

Remove the intake pipe that spans from the air filter to the turbo and then cover the turbo.

**5**

Remove the valve cover.

**6**

Remove the VEB and cam sensor harness connections to the upper front cover.

**7**

Disconnect the internal wiring harness to the VEB control solenoid.

**8**

Remove the upper front cover.

**9**

Slightly loosen the cam sensor wheel and note the position of the wheel in relation to its mounting bolts, i.e. clockwise against the mounting bolts, in the center, or counter-clockwise against the mounting bolts.

**10**

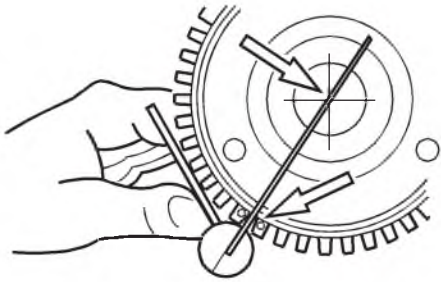
Remove the cam sensor wheel.

**11**

Remove the inspection cover on the flywheel housing. Install the engine turning tool 9996956.

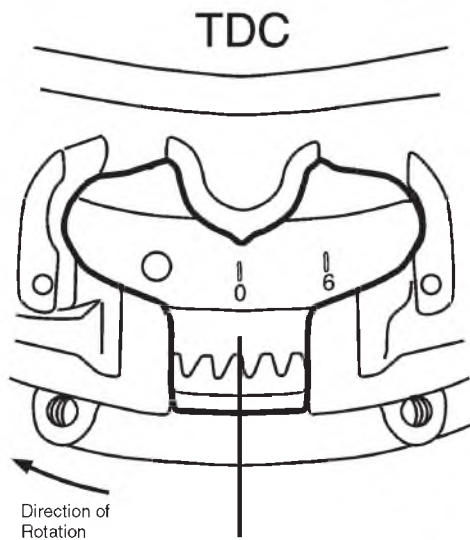
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9996956



T2012262

Fig. 16: Installing camshaft alignment tool



W2004266

Fig. 17: Flywheel direction of rotation

**12**

Install camshaft alignment tool J-42773 by inserting the guide pin into the hole under the camshaft drive gear. Rotate the tool to position the lever against the drive gear teeth to ensure that the tool is positioned correctly. Rotate engine in the direction of rotation until the 2 dots on the camshaft gear are equally spaced on both sides of the camshaft alignment tool.

J-42773

**13**

Assure that the 0° mark aligns with the flywheel pointer.

**14**

**Re-assemble**

Install the cam sensor wheel and mounting bolts. Turn the cam sensor wheel clockwise (as viewed from the front of the engine) against the mounting bolts; torque bolts to 25 Nm (19 ft-lb).

25 Nm  
(19 ft-lb)

**15**

Clean all sealant from the upper front cover.

**16**

Apply a bead of silicone sealant around the upper cover along with a new rubber gasket.

**17**

Position the upper front cover and install the mounting bolts; hand tighten only.

**18**

Install the front cover positioning tool, J-41272. Tighten bolts to align front cover. Torque the cover mounting bolts to  $33 \pm 4$  Nm ( $24 \pm 3$  ft-lb). Verify that the cover is flush with the head.

**Note:** Tighten positioning tool, J-41272 until upper front cover is flush with cylinder head on both sides.

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J-41272  
 $33 \pm 4$  Nm  
( $24 \pm 3$  ft-lb)

**19**

Remove tool, J-41272.

**Note:** Remove any sealant that gets on the cam sensor wheel to prevent any sensor signal faults.

**20**

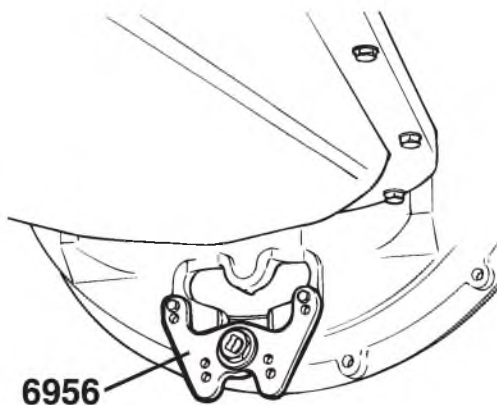
Rotate the camshaft until the cam sensor wheel tooth aligns with the cam sensor. Verify that the air gap is between 0.3 – 0.7 mm (0.012 – 0.028 in.). Adjust if needed by removing or adding shims between the sensor and the cover. Relocate the timing cover, before the sealant hardens, if necessary to aid in obtaining the proper air gap.

**21**

Remove the engine turning tool and reinstall the cover.

---

9996956



T2006672

**22**

Install the VEB solenoid harness and torque nuts to 1.4 Nm (1 ft-lb). Fasten all clips. Connect the external harness to the front cover.

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1.4 Nm  
(1 ft-lb)

**23**

Clean the valve cover and gasket contact surface.

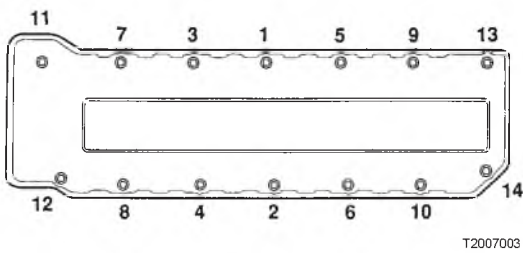


Fig. 18: Valve cover tightening sequence

**24**

Install the valve cover and torque-tighten the bolts to specifications using the proper sequence (see Fig. 18: Valve cover tightening sequence, page 16).

**Note:** Tighten the valve cover nuts according to the proper sequence and torque. This is to prevent the valve cover from cracking and also to keep the studs in the cylinder head from loosening. If any of the valve cover stud bolts loosened from the cylinder head when the nuts were removed, the cable harness for the unit injectors should be checked. There is a risk that the cable holder on the stud bolt may have followed with the rotation of the bolt and possibly damaged the cable harness.

Engine Serial Number	Torque
Below 25748	20 ± 2 Nm (15 ± 1 ft-lb)
Above 25748	30 ± 3 Nm (22 ± 2 ft-lb)

**25**


Install the intake piping.

**26**

Reassemble depending on the model.

**27**

Connect negative battery cable.

 <b>WARNING</b>
<p>Always wear safety glasses when working around batteries. Failure to do so could result in serious personal injury.</p>

**28**

Steam clean the engine, around the valve cover, timing cover, and transmission bellhousing.

**29**

Check for any active fault codes and clear any inactive fault codes.

**30**

Run the engine until the coolant reaches operating temperature. Allow to idle for approximately 10 minutes for cylinder balancing. For cylinder balancing to take place, the following conditions must be satisfied:

- Idling speed must be below 650 RPM.
- Fuel requirement must be below a specific rating.
- Idling adjustment function must not be active.
- Constant engine speed mode (PTO) not active.
- Cruise control mode not active.
- Accelerator pedal in idling position (0%).
- Coolant temperature must be above 50 °C (122 °F).
- Vehicle must be at a standstill (vehicle speed sensor value of 0).
- No fault codes present.

**31**

Check for leaks.

## 2154-06-03-02 Camshaft Timing, Check and Adjust

You must read and understand the precautions and guidelines in Service Information, Group 20, "General Safety Practices, Engine" before performing this procedure. If you are not properly trained and certified in this procedure, ask your supervisor for training before you perform it.

### CAUTION

Failure to properly set the camshaft timing to the crankshaft may result in loss of performance, poor fuel economy, or in extreme cases, engine damage.

*Special tools: 9996956, J-41272, J-42773*

**1**

Install the camshaft alignment tool J-42773 by inserting the guide pin into the hole under the camshaft drive gear. Rotate the tool to position the lever against the drive gear teeth to ensure correct positioning of the camshaft alignment tool.

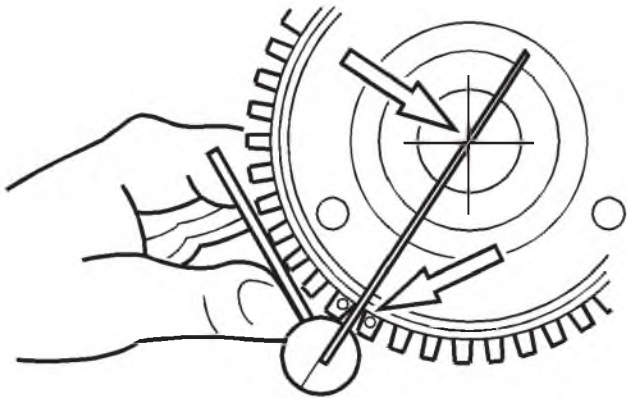
J-42773

**2**

Position the camshaft using the flywheel turning tool 9996956.

**Note:** The camshaft setting must be exactly as illustrated in the figure. It is important that the camshaft gear marking is positioned precisely on both sides of the tool in a line extending from the center of the camshaft.

9996956



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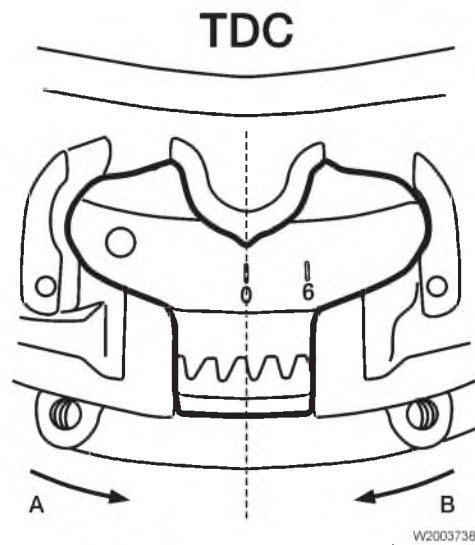


Fig. 19: Rotating the flywheel to 0° TDC

- A Opposite direction of engine rotation
- B Direction of engine rotation

**3**

Using flywheel turning tool 9996956, turn the flywheel opposite to the direction of engine rotation (A) approximately 15° BTDC. Then turn the flywheel in direction of engine rotation (B) until the 0° mark on the flywheel lines up exactly with the pointer on the flywheel housing without passing the 0° mark.



**CAUTION**

If the flywheel is turned past 0° TDC, repeat the above step, completely. Do not just back up the flywheel. Turning the flywheel in the opposite direction of normal rotation will result in an incorrect setting due to improper gear train lash.

**4**

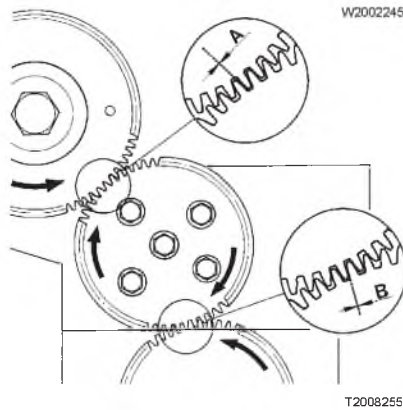
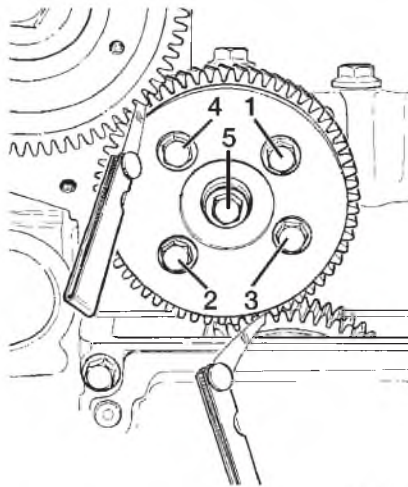
Clean all sealant from the front of the head.

**5**

Install the adjustable idler gear assembly.

**Note:** The bolts are the single-use “stretch” type and should not be reused. Pipe sealant should be used on the center bolt.

6



Insert two 0.10 mm (0.004 in.) feeler gauges on the load sides of the (A and B) gear.

7

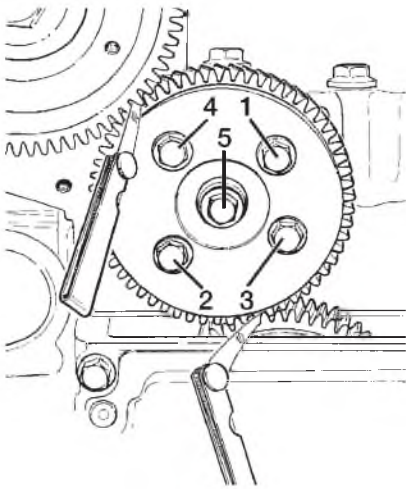
Torque the bolts to an initial torque of  $5 \pm 3$  Nm ( $11 \pm 2$  ft-lb).

**Note:** An additional  $120 \pm 5^\circ$  is required after the correct backlash is confirmed.

$15 \pm 3$  Nm  
( $11 \pm 2$  ft-lb)

8

Check that both feeler gauges have the same resistance when inserting them and pulling them out. The correct backlash is 0.05 - 0.17 mm (0.002 - 0.007 in.).



W2002245

**9**

Tighten the bolts an additional  $120 \pm 5^\circ$  per the torque sequence shown.

**10**

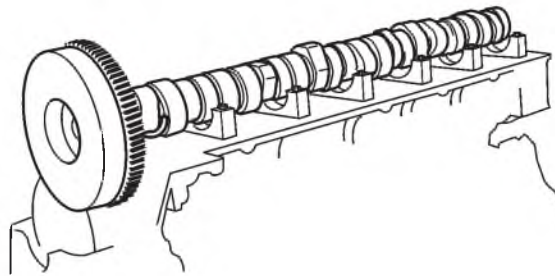
Re-check camshaft timing; refer to "Camshaft Timing, Checking" page 12. For information on valve adjustment and injector installation, also refer to Service Information, Group 21.

This TSI Service Bulletin replaces TSI Service Bulletin 215-002, "Camshaft Wear, D12, D12A, D12B, D12C" (11.2001), publication no. PV776-TSP160575.

Date	Group	No.	Supp.	Page
3.2004	<b>215</b>	<b>002</b>		1(2)

## Camshaft Wear, Check D12, D12A, D12B, D12C

### Camshaft Wear



W2004342

Fig. 1: Camshaft

This information covers procedures for checking camshaft wear in VOLVO D12, D12A, D12B, and D12C engines.

### Contents

- ["Camshaft, Wear Check" page 2](#)

## General

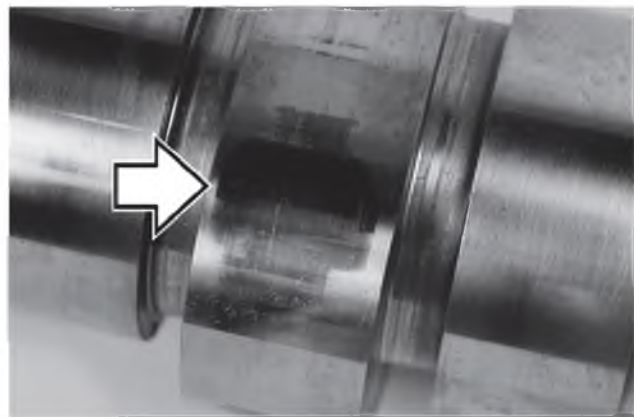
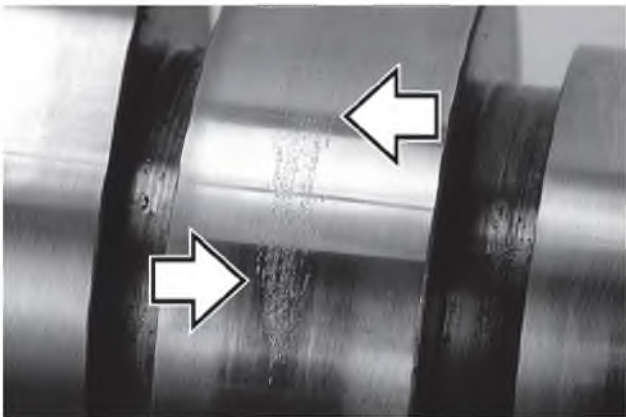
### Camshaft, Wear Check

Surface irregularities may appear on VOLVO engine camshaft lobes in normal operation. This does not mean that the camshaft must be replaced. These marks do not adversely affect the engine's performance nor the durability of the engine or any of its components.

Fig. 2: Camshafts with acceptable wear, page 2 provides examples of camshaft lobes exhibiting this condition. These camshafts may be reused.

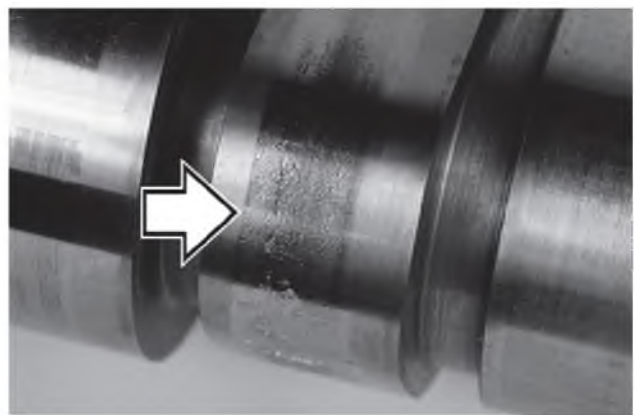
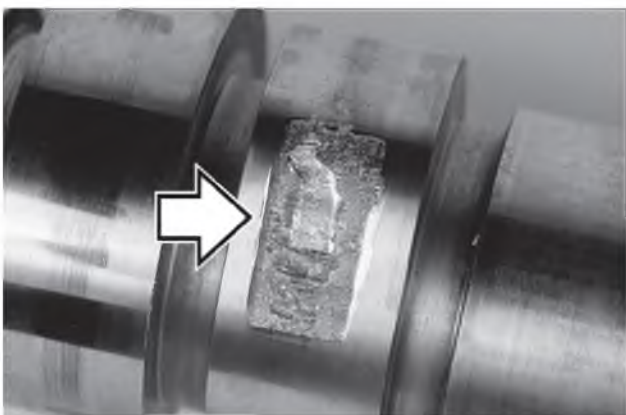
Fig. 3: Camshafts with unacceptable wear, page 2 provides examples of lobes exhibiting unacceptable wear and deterioration. These camshafts and the rocker arms corresponding to the worn lobes must be replaced.

**Note:** If there is any measurable wear, such as shown in Fig. 3: Camshafts with unacceptable wear, page 2, the camshaft should be replaced.



W2002216

Fig. 2: Camshafts with acceptable wear



W2002221

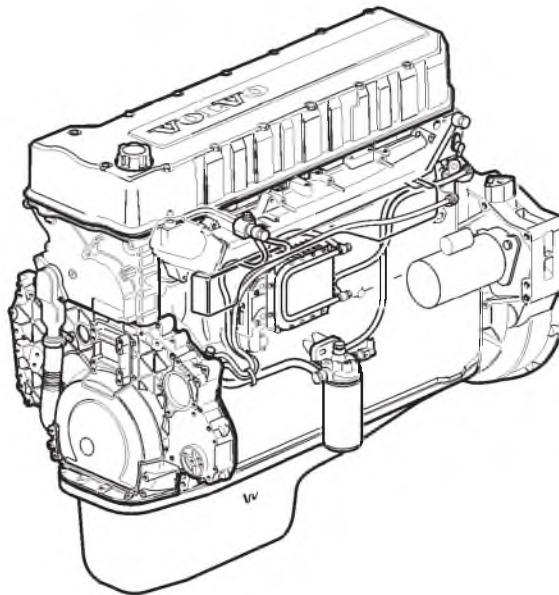
Fig. 3: Camshafts with unacceptable wear

This TSI Service Bulletin replaces TSI Service Bulletin 211-008, "Cylinder Head, D12C" (11.01), publication no. PV776-TSP160569.

Date	Group	No.	Supp.	Page
8.2003	<b>211</b>	<b>008</b>		1(32)

Cylinder Head  
Replacement  
D12C  
VN

## Cylinder Head Replacement



W2003244

Fig. 1: VOLVO D12C Engine

This information covers procedures for replacing the cylinder head of VOLVO D12C engines in VN vehicles.

### Contents

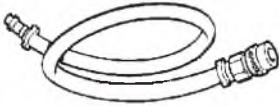
- ["Special Tools" page 2](#)
- ["Cylinder Head, Removal" page 4](#)
- ["Cylinder Head, Installation" page 13](#)

**Note:** Information is subject to change without notice. Illustrations are used for reference only, and may differ slightly from the actual engine version. However, key components addressed in this information are represented as accurately as possible.

## Tools

### Special Tools

For special tools ordering instructions, refer to Tools Information, group 08.



**9996049**  
Drain Hose



**9996956**  
Flywheel Turning Tool



**9996966**  
Cylinder Liner Press Tool



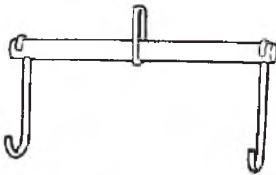
**9998249**  
Unit Injector Protective Sleeve



**9998251**  
Cylinder Head Sealing Plug



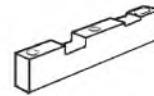
**9998255**  
Rocker Arm Bridge Lifting Tool



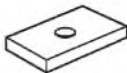
**9998264**  
Camshaft Removal Tool



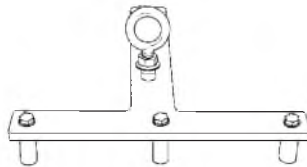
**9998511**  
Lever Tool



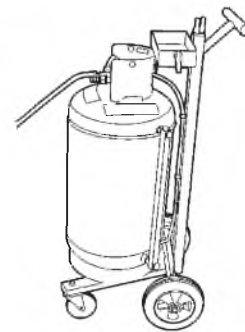
**9998601**  
Cylinder Head Alignment Tool



**9998624**  
Cylinder Head Alignment Tool

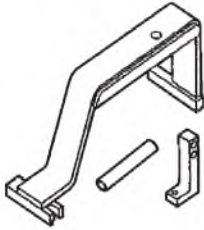


**J41503**  
Cylinder Head Lifting Fixture

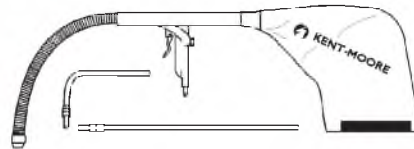


**DBT2V700**  
Coolant Extractor





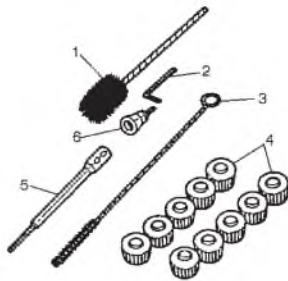
**9998602-6/2**  
Upper Front Cover Alignment Tool



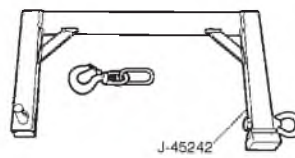
**PT-2900**  
Chip Vacuum Tool



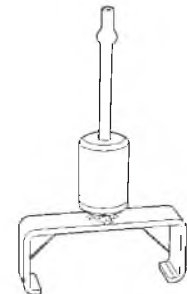
**J-44514-25**  
Camshaft Alignment Tool Kit



**J-42885**  
Injector Bore Cleaning Tool



**J-45242**  
Lifting Bracket



**J-44457**  
Camshaft Bearing Cap Puller

# Service Procedures

## 2111-01-01-01 Cylinder Head, Removal

(With VEB or EPG)

You must read and understand the precautions and guidelines in Service Information, group 20, "General Safety Practices, Engine" before performing this procedure. If you are not properly trained and certified in this procedure, ask your supervisor for training before you perform it.

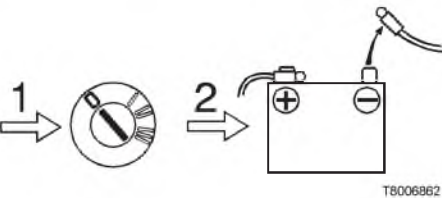
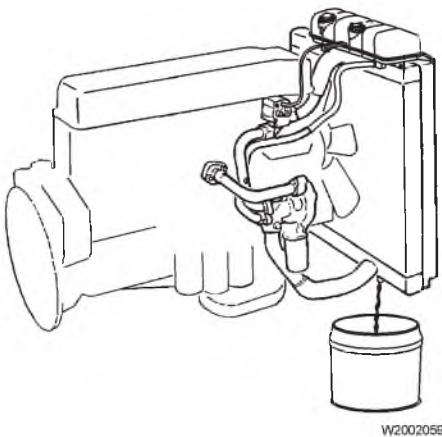
**Note:** The exhaust manifold may remain in place when removing the cylinder head.

*Special tools:* 9996966, 9998249, 9998251, 9998255, 9998264, 9998511

**1**

Drain coolant into approved container using drain hose 9996049 or coolant extractor DBT2V700.

9996049, DBT2V700



**2**

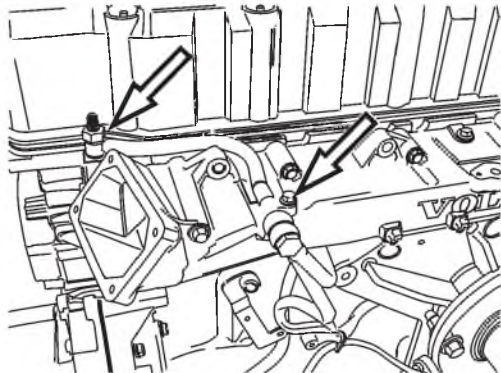
Disconnect batteries; refer to Service Information, Group 33.

**3**

Disconnect the B+ cable and switch wires from the preheater. Remove any harness restraints as needed from the preheater element.

**4**

Connect a 5/16 drain hose onto the drain nipple at the fuel filter. Open the drain; also open the bleed nipple at the front of the head. Drain fuel into appropriate container.



W2003422

**5**

Disconnect fuel lines at the intake manifold and at the rear end of the cylinder head.

**6**

Remove the 2 bolts mounting the boost pressure sensor to the intake manifold. Remove the sensor.

**7**

Remove the driver side upper fan ring support bracket.

**8**

Disconnect the upper charge air cooler hose.

**9**

Disconnect the intake air sensor.

**10**

Disconnect the intake air hose from the air compressor and remove the intake air pipe between the turbocharger and air filter housing.

**11**

Remove the air cleaner housing.

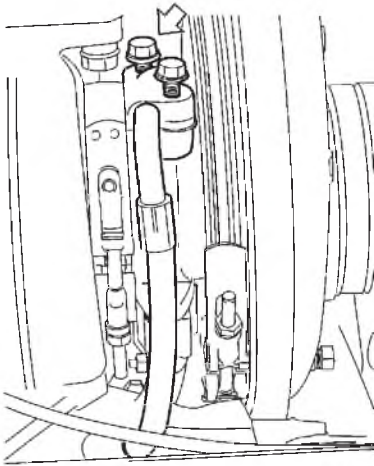
**12**

Disconnect the air discharge pipe from the air compressor. Unbolt the air discharge pipe and the wiring harness brackets from the cylinder head.

**13**

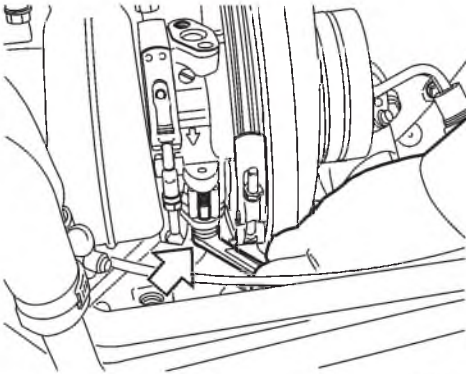
Remove the heat shield at the turbocharger.

- 14**  
Disconnect the oil supply line.



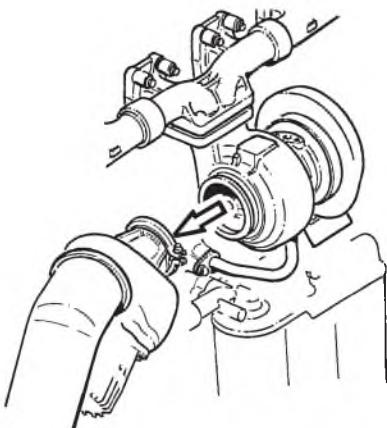
W2003864

- 15**  
Disconnect the oil return line.



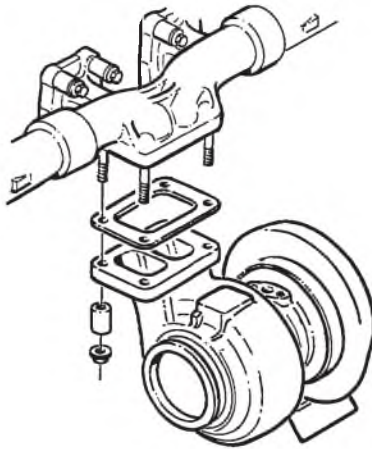
W2003865

- 16**  
Remove the clamp bolt fastening the EPG housing to the turbocharger.



T2009066

- 17**  
Remove the charge air pipe between the turbo and the charge air cooler.



T2009067

**18**

Remove the turbo mounting nuts and lift out turbo.

**19**

Remove the passenger side upper fan ring support bolt.

**20**

Disconnect the static fill hose at the expansion tank and move the hose and pipe to the side.

**21**

Disconnect the top radiator hose and remove the top radiator hose neck from the cylinder head.

**22**

Disconnect the heater return tube from the thermostat housing.

**23**

Remove the air bleed pipe between cylinder head and expansion tank.

**24**

Disconnect the coolant hose between the air compressor and the cylinder head.

**25**

Remove the valve cover retaining nuts and lift off the valve cover.

**26**

Remove the VCB control valve and pipe (if equipped) and place valve in a clean plastic bag to prevent it from being contaminated.

**27**  
Disconnect the injector wires.



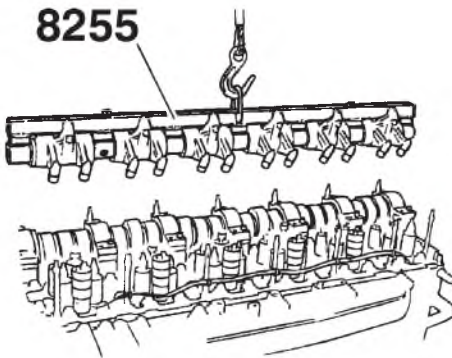
T2008818

**28**  
Disconnect the injector wiring harness at the rear of the cylinder head at the pass-through connector and pull the harness through and lay over to the side.

**29**  
Loosen the bolts to the rocker arm shaft uniformly over the complete assembly to avoid distorting the shaft. Remove the bolts and install lifting tool 9998255. Carefully lift off the rocker arm bridge assembly.

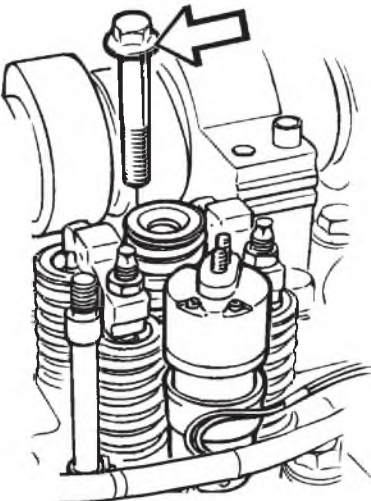
**Note:** On engines installed with VEB, hold the pistons in the rocker arms with rubber bands so that the pistons do not drop out when the rocker arm bridge is lifted up. Pistons and rocker arms are clasped together.

9998255



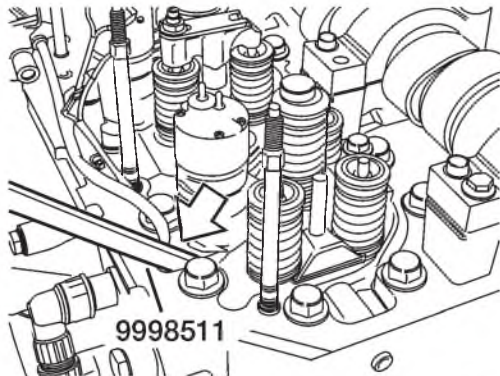
T2014964

**30**  
Remove the 6 injector retainer bolts.



W2000718





W2003392

**31**

Using lever tool 9998511, remove unit injectors **one** at a time.

9998511

**32**

Install protective sleeve 9998249 on the unit injectors as they are removed.

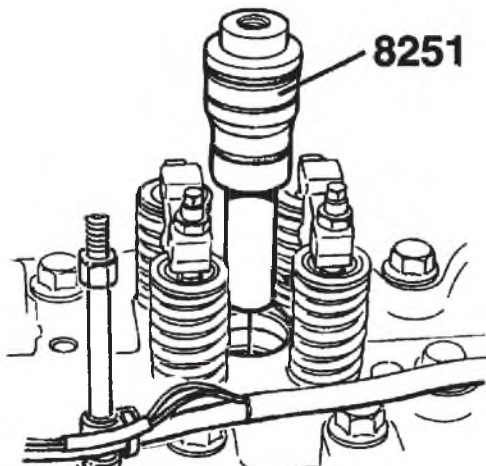
**Note:** Keep the unit injectors in the order in which they were removed, so that each injector can be returned to its corresponding cylinder.

9998249

**33**

Put protective plug 9998251 in the cylinder head at each injector bore and secure using the unit injector's retainer yoke.

9998251



T2008847

**34**

Remove the crankcase ventilation tube to the upper front cover bolts. Move the tube to the side.

**35**

Remove camshaft position sensor harness and sensor from upper front cover.

**36**

Remove the upper front cover (9 mounting bolts).

**Note:** The fan ring must be pushed forward for added clearance when lifting out the upper cover.



**37**

Remove the cam drive gear and vibration damper (6 bolts). Remove the outer camshaft cap bolts.

**38**

Using tool J-44457, remove the upper camshaft bearing caps.

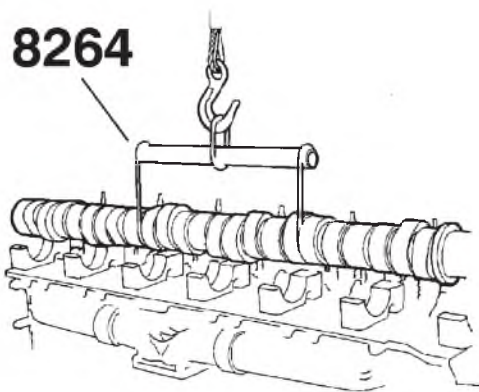
**Note:** Using a felt tip pen, mark each camshaft cap and its respective bearing housing so that each cap will be reinstalled to the same housing.

J-44457

**39**

Using lifting tool 9998264, carefully lift off the camshaft.

9998264



T2015006

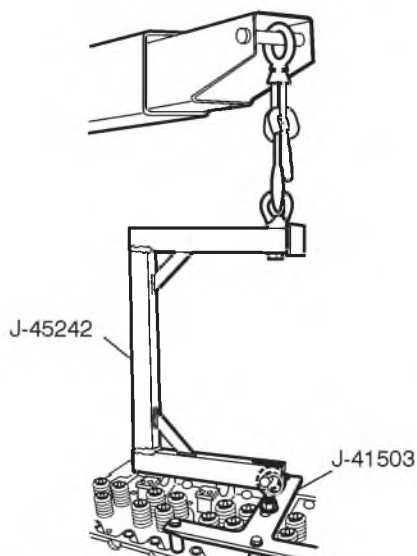
**40**

Remove the 38 cylinder head bolts.

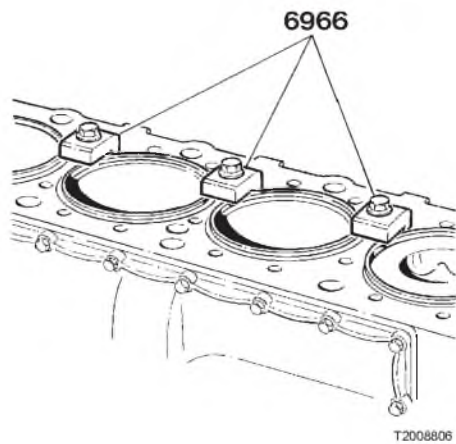
**41**

Remove the #4 lower camshaft cap, then install lifting bracket J-41503 onto the cylinder head. Carefully lift off the cylinder head. While lifting the cylinder head, verify that the coolant pipe behind the air compressor disconnects from the cylinder head.

J-41503



W0002015



**42**

Remove the cylinder head gasket.

**43**

If the engine is to be turned, install fixtures 9996966 to hold the cylinder liners in place.

9996966

**44**

Remove the coolant line from the compressor to the engine oil cooler cover.

**45**

Disconnect the oil supply line from the compressor.

**46**

Remove the air compressor mounting bolts and lift the compressor from the engine.

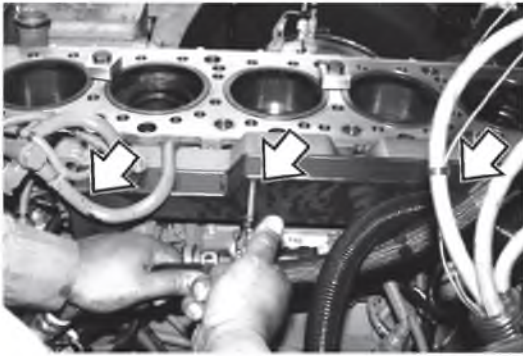
**47**

Remove the coolant pipe from the water pump to the head (2 bolts) that is located behind the air compressor.

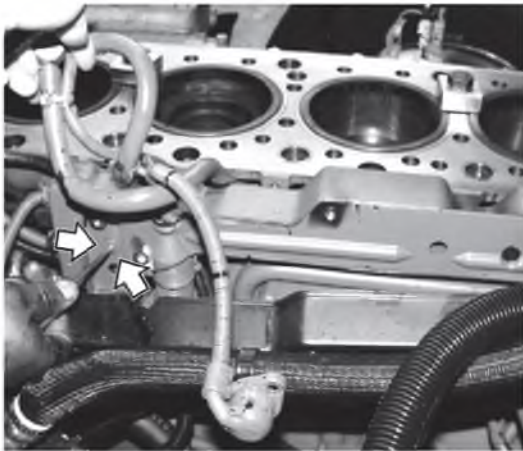
**Note:** The air compressor and coolant pipe are removed to aid in reinstalling the cylinder head.

**Note:** Place a rag over the opening to prevent debris from falling into the cooling system passages.

48



Remove the cable harness box outer cover.



W2003987

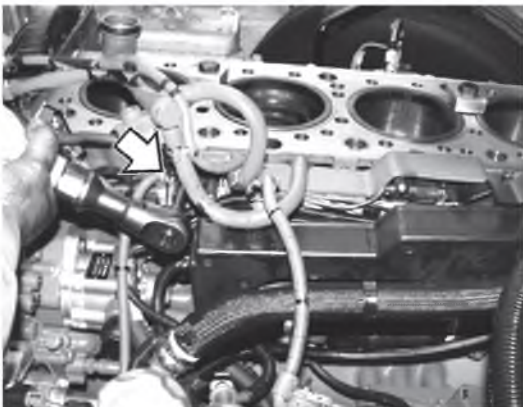
49

Remove the cable harness box intermediate cover.

50

Loosen mounting bolts and pull cable harness box away from cylinder block.

**Note:** The harness box may need to be secured against the frame rail to be kept out of the way.



W2003988

51

Remove the intake manifold from the cylinder head (if not previously removed).

## 2111-02-01-01 Cylinder Head, Installation

(With VEB or EPG)

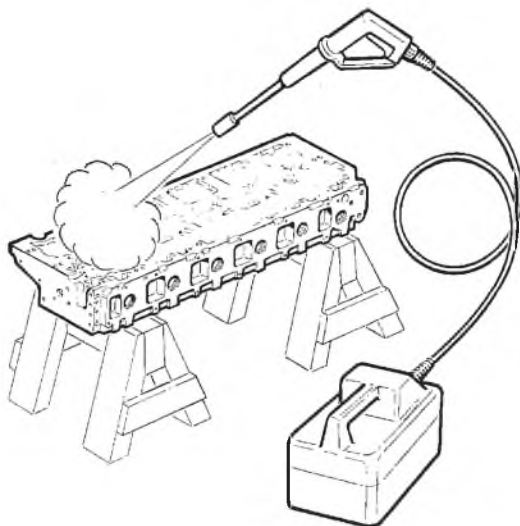
You must read and understand the precautions and guidelines in Service Information, Group 20, "General Safety Practices, Engine" before performing this procedure. If you are not properly trained and certified in this procedure, ask your supervisor for training before you perform it.

### CAUTION

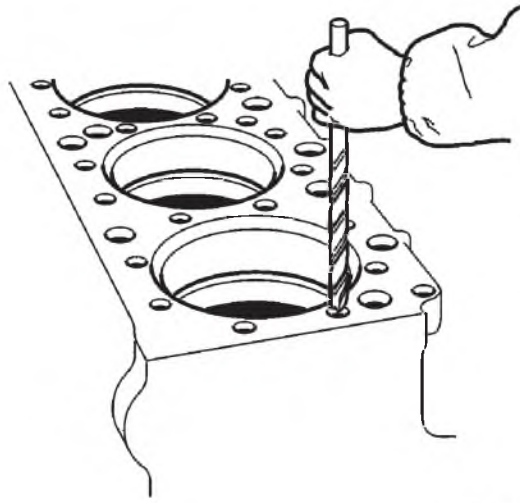
All new and exchange D12C cylinder heads supplied from Volvo have the same part number and are installed with a plug in the oil channel to the VEB system's control valve. When replacing the cylinder head on engines installed with VEB, the plug must be removed before installing the control valve. Failure to remove the oil supply plug on a D12 with Volvo Engine Brake (VEB) exchange cylinder head will cause camshaft seizure. Severe engine damage will result. Engines with Exhaust Pressure Governor (EPG) only, the plug must remain in place.

*Special tools: 9998624, 9998601, 9998264, 9998602, 9998255, 9996956, 9996966, 9998628*

- 1 Clean the gasket and O-ring surfaces of the cylinder block and head. Make sure all bolt holes in the cylinder head and block are free of oil or debris.



T2009056



C2001734

**2**

If debris or carbon is in the cylinder head bolt holes, clean the top of the hole above the thread by using a 17 mm drill bit. Turn it manually into the hole.



C2002611

**3**

If required, clean the cylinder head bolt hole threads with an M16 x 2 thread tap.

**Note:** Remove residue from bolt holes using chip vacuum tool PT-2900.

PT-2900

**4**

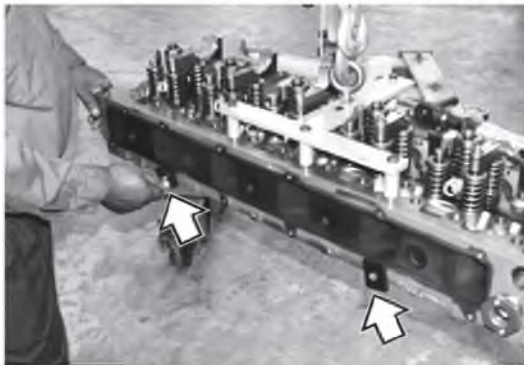
Using injector bore cleaning kit J-42885, clean the injector copper sleeves; refer to Service Information, Group 23.

J-42885

**5**

Clean the contact surfaces on the cylinder head and block to prepare for the alignment blocks.

**Note:** Remove any paint or silicone on all mating surfaces of the alignment blocks.



W2003999

**6**

Install alignment blocks 9998624 on the head at cylinders 3 and 6.

 **CAUTION**

Before installing the alignment blocks, check the flatness of the surface. If the tools are not flush with the cylinder head and block, the head will not be installed correctly, with the risk of serious engine damage.

9998624

**7**

Remove all cylinder liner hold-down tools 9996966.

**8**

Carefully place new cylinder head gasket on the engine block and a new rubber seal on the intermediate gear plate.

**Note:** Make sure the contact surfaces are clean before gasket and seal installation.

**9**

Using lifting tool J-41503, lift the cylinder head and position it onto the cylinder block, letting the alignment blocks position the cylinder head.

**Note:** Push the cylinder head so that the alignment blocks are in contact with the alignment surface on the cylinder block.

J-41503

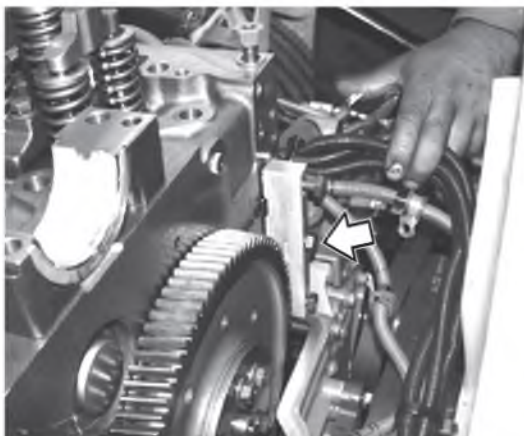
**10**

Check that the rubber seal on the intermediate plate is positioned correctly after the cylinder head is in place.

**11**

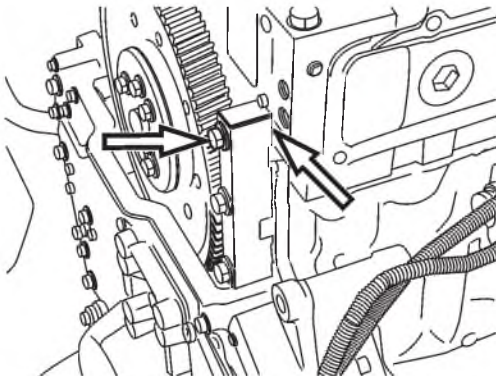
Install the front alignment block 9998601 onto the front of the engine.

9998601



W2004001

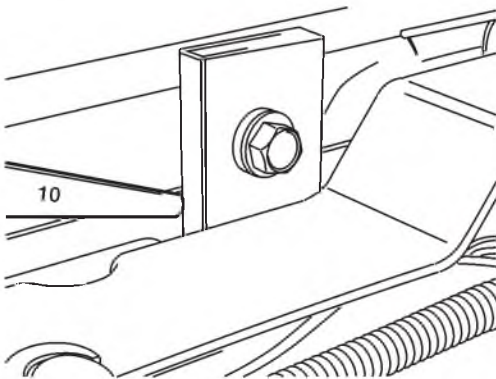




W2003423

**12**

Tighten upper bolt of front alignment block 9998601 to properly align front of head.



W2003424

**13**

Place a 0.10 mm (0.004 in.) feeler gauge between side alignment block and cylinder block to check that the cylinder head is positioned correctly. The feeler gauge should **not** be able to fit between tool and cylinder block.

**Note:** A gap of 0 – 0.10 mm is acceptable.

**14**

Remove cylinder head lifting fixture J-41503.

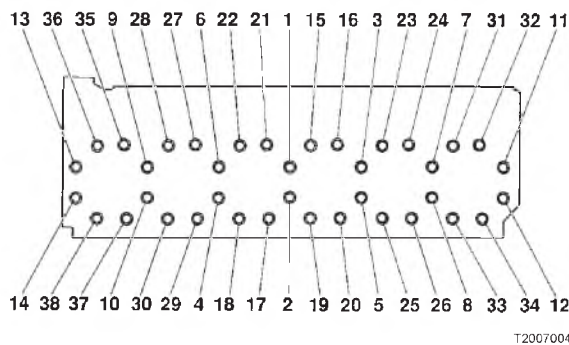


Fig. 2: Cylinder head tightening sequence

**15**

Lubricate cylinder head bolts with clean engine oil. Install the cylinder bolts and torque-tighten using the sequence illustrated (see Fig. 2: Cylinder head tightening sequence, page 17) and the following steps:

- 1  $60 \pm 10$  Nm ( $44 \pm 7$  ft-lb).
- 2 Check tighten  $60 \pm 10$  Nm ( $44 \pm 7$  ft-lb).
- 3 Turn bolt  $90 \pm 5^\circ$ . Make diagonal mark across bolt head w/ felt-tip pen after turning or use angle gauge.
- 4 Repeat check in step 13 before the final torque is applied to the cylinder head bolts. If a gap greater than 0.10 mm exists, loosen the bolts and reposition the cylinder head.
- 5 Turn additional  $90 \pm 5^\circ$ . Make another diagonal mark across bolt head with felt-tip pen after turning.

**Note:** Marking diagonal lines across the bolt heads will help to identify which bolts have been torqued.

**Note:** O-rings may be included in cylinder head gasket kits for D12 engines. However, these O-rings may be cut by the cylinder head during installation of the cylinder head bolts. Therefore, these O-rings are no longer recommended for use when installing cylinder head bolts into the cylinder head.

**16**

Remove alignment blocks 9998624 and 9998601.

**17**

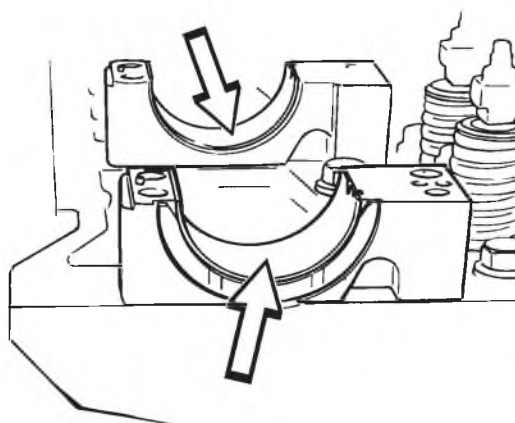
Clean the camshaft and inspect for wear or damage (See service literature "Camshaft Inspection").

**18**

Install number 4 lower camshaft bearing support to the cylinder head and carefully tap into place with a nonmarring hammer.

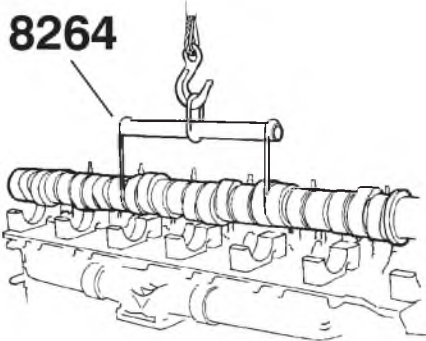
**19**

Install lower camshaft bearings into lower bearing caps. Lubricate with clean engine oil.



T2008859





T2015006

**20**

Using lifting tool 9998264, carefully lower the camshaft (without gear attached) into position.

9998264

**21**

Install the bearings into their corresponding upper camshaft bearing caps.

**22**

Install all 7 upper camshaft bearing caps to their respective positions. Gently tap into place using a nonmarring hammer.

**Note:** Each upper and lower bearing cap assembly is a matched pair and must be assembled accordingly. The upper and lower bearing caps are numbered 1 to 7 to identify the position on the cylinder head where they are to be installed, and also to prevent mixing of the upper and lower housing assemblies.

**23**

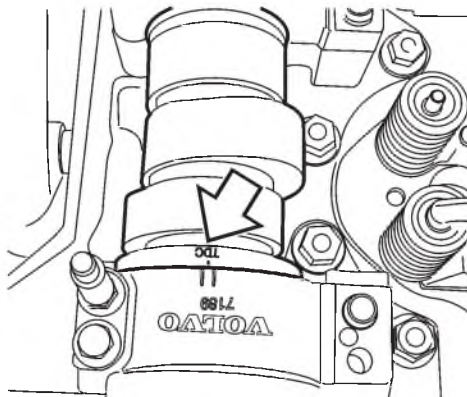
Install outer camshaft bearing cap bolts and studs. Hand-tighten only.

**24**

Using a rag to protect the camshaft, hand-turn the camshaft to make sure that it rotates freely. It should not bind. Axial play should be no more than 0.35 mm (0.014 in.).

**25**

Remove flywheel inspection cover.

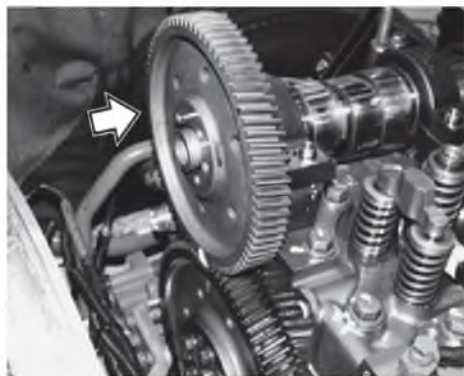


W2003493

**26**

Install flywheel turning tool 9996956 and rotate engine to 0° TDC.

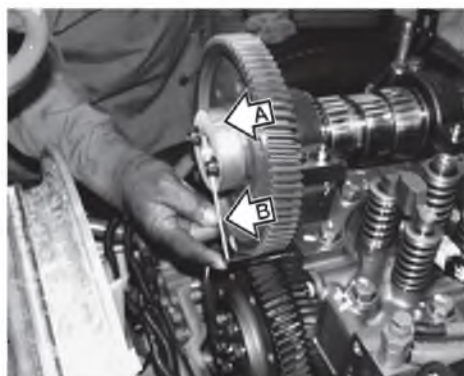
**Note:** Make sure TDC mark on camshaft is between the two hash marks on front cam bearing cap before gear is installed.



W2004022

**27**

Install camshaft gear onto camshaft.



W2004023

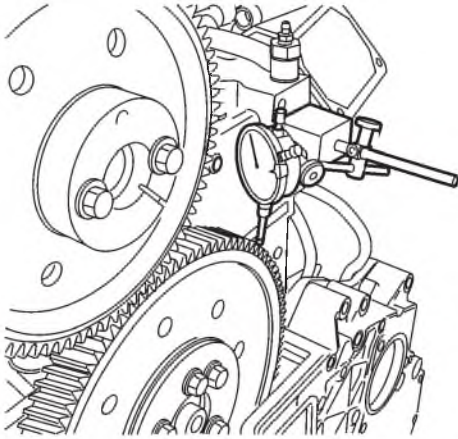
**28**

Using alignment kit J-44514, install camshaft alignment collar (A) to front of gear. Install camshaft alignment tool (B) to verify that camshaft is aligned at TDC.

J44514

**29**

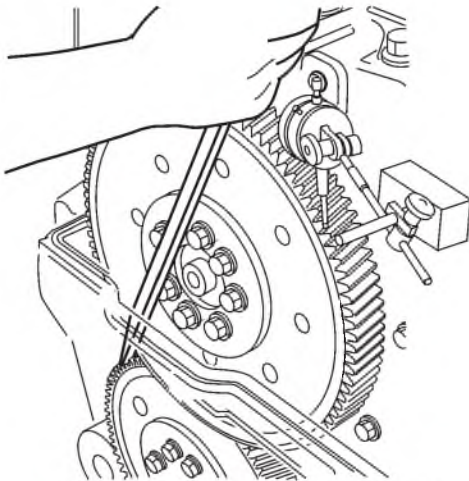
Set up a dial indicator on the adjustable idler gear.



W2003495

**30**

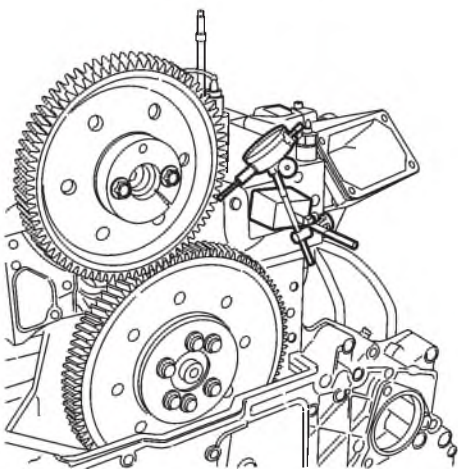
Use a pry bar or long screwdriver to hold the intermediate idler gear in place. Measure the gearlash between the intermediate-to-adjustable idler gears by rocking the adjustable idler gear back and forth. Acceptable gear backlash is 0.05 – 0.17 mm (0.002 – 0.007 in.).



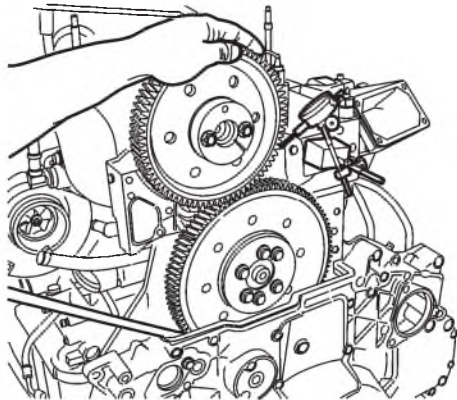
W2004075

**31**

Set up a dial indicator on the camshaft gear; use a pry bar or long screwdriver to hold the adjustable idler gear in place.



W2003497



W2003486

**32**

Measure the gearlash between the camshaft gear and adjustable idler gear by rocking the camshaft gear back and forth. Acceptable gear backlash is 0.05 – 0.17 mm (0.002 – 0.007 in.).

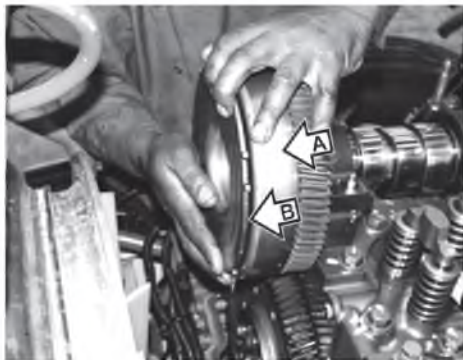
**Note:** If either backlash is out of specification, the adjustable idler gear must be adjusted; refer to Service Information, Group 21.

**33**

Remove the camshaft alignment collar and flywheel turning tool 9996956.

**34**

Install camshaft damper (A) and cam sensor tooth wheel (B).



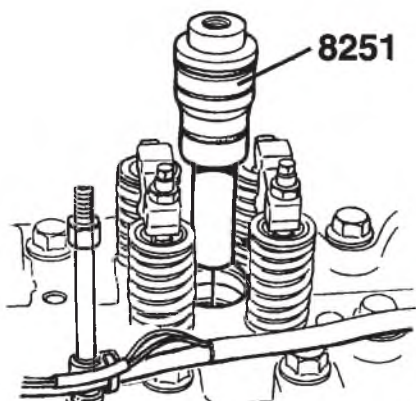
W2004024

**35**

Install spacer and new bolts. Using proper sequence, torque-tighten bolts to  $35 \pm 3$  Nm ( $26 \pm 2$  ft-lb), then turn additional  $90 \pm 5^\circ$ .

**Note:** Camshaft gear retaining bolts are one-time use only.

$35 \pm 3$  Nm  
( $26 \pm 2$  ft-lb);  
then  $90 \pm 5^\circ$

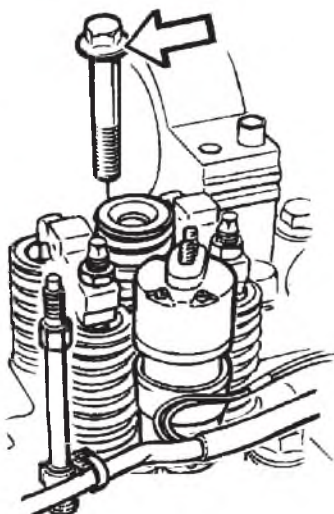


T2008847

**36**

Remove protective plugs 9998251 from each injector bore. Install new O-rings on the injectors. Lubricate the seals with clean engine oil.

9998251



T2008956

Fig. 3: Unit injector retaining bolt

**37**

Install each injector, centering it between the valve springs. Torque-tighten unit injector locator yoke screw as follows:

• **If using new copper sleeve:**

- 1 Tighten to  $20 \pm 5$  Nm ( $15 \pm 4$  ft-lb).
- 2 Turn bolt  $180 \pm 5^\circ$ .
- 3 Loosen to 0 Nm.
- 4 Tighten  $20 \pm 5$  Nm ( $15 \pm 4$  ft-lb).
- 5 Turn bolt  $60 \pm 5^\circ$ .

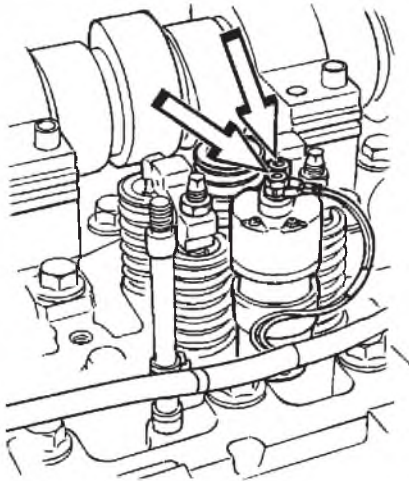
• **If using old copper sleeve:**

- 1 Tighten to  $20 \pm 5$  Nm ( $15 \pm 4$  ft-lb).
- 2 Turn bolt  $60 \pm 5^\circ$ .

**38**

Install the injector electrical wires and route wires to the outside of the valve cover studs.





W2000690

Fig. 4: Unit injector cable connections

39

 **CAUTION**

DO NOT OVERTIGHTEN. Hold wires while tightening. If the screws break, the unit injector must be replaced.

Connect the unit injector electrical wires to the injectors. Using tool 9999708, torque-tighten the nut to 1.4 Nm (12 in-lb).

1.4 Nm  
(12 in-lb)

40

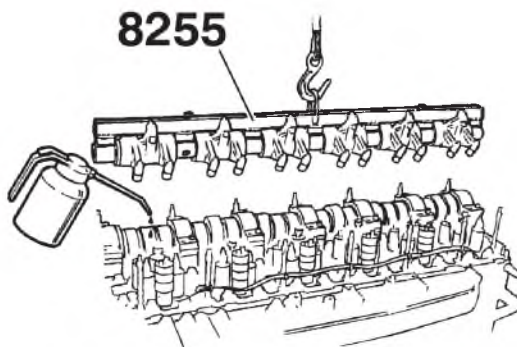
Lubricate valve bridges and install on intake and exhaust guides.

41

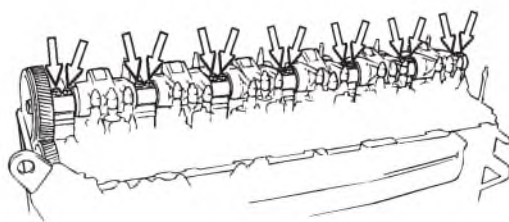
Using lifting tool 9998255, install the rocker shaft.

**Note:** The bolt holes must be free of oil or debris.

9998255



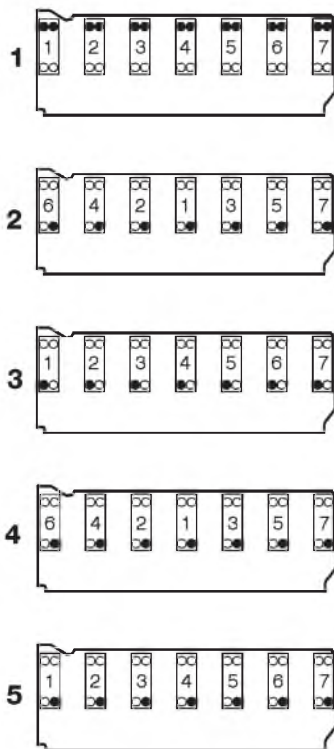
T2014966



T2006777

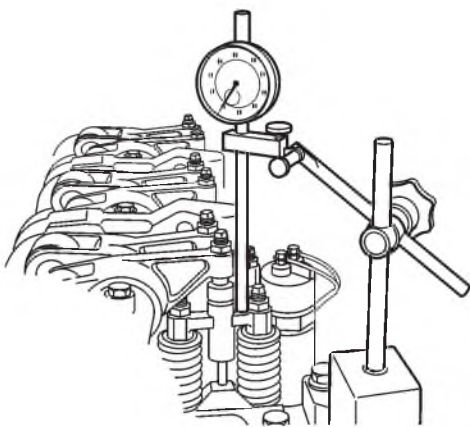
42

Loosely install the rocker shaft mounting bolts.



W2003520

Fig. 5: Bearing caps and camshaft/rocker shaft, tightening sequence, D12C



T2019068

#### 43

Tighten the rocker arm shaft mounting bolts, a little at a time, over the entire rocker arm shaft to avoid bending the shaft and to make sure that it is positioned correctly in the camshaft brackets. When all bolts are hand tight, torque-tighten using proper sequence (see Fig. 5: Bearing caps and camshaft/rocker shaft, tightening sequence, D12C, page 24) and the following steps:

- 1  $15 \pm 5$  Nm ( $11 \pm 4$  ft-lb);  $+90 \pm 5^\circ$
- 2  $60 \pm 5$  Nm ( $44 \pm 4$  ft-lb)
- 3  $15 \pm 5$  Nm ( $11 \pm 4$  ft-lb);  $+120 \pm 5^\circ$
- 4  $60 \pm 5$  Nm ( $44 \pm 4$  ft-lb); loosen to 0 Nm (0 ft-lb)
- 5  $15 \pm 5$  Nm ( $11 \pm 4$  ft-lb);  $+120 \pm 5^\circ$

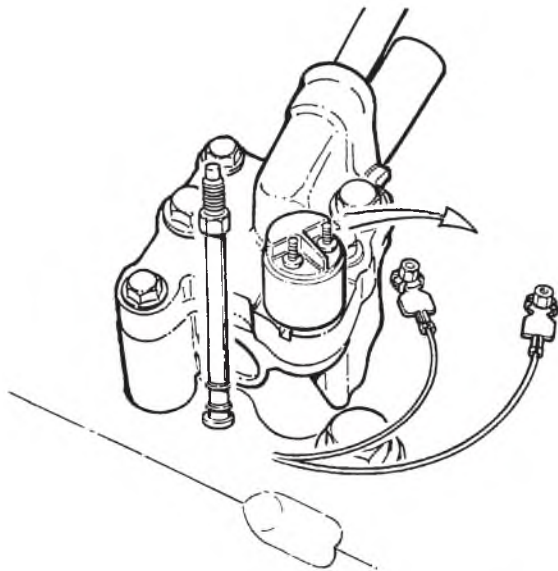
#### 44

If needed, verify camshaft timing. Check camshaft settings with cold engine and no. 1 intake valve = 0.

Intake valve for cylinder 1 for flywheel position  $6^\circ$  after TDC must be open  $1.6 \pm 0.3$  mm ( $0.063 \pm 0.001$  in.). When checking, timing gears must be turned ONLY in the correct direction (clockwise from the front) to eliminate any backlash. For more information, refer to Service Information, Group 21.

#### 45

Adjust the injector and valve clearance according to specifications. Shims are used to adjust the exhaust valve clearance on engines equipped with VEB; refer to Service Information, Group 21.

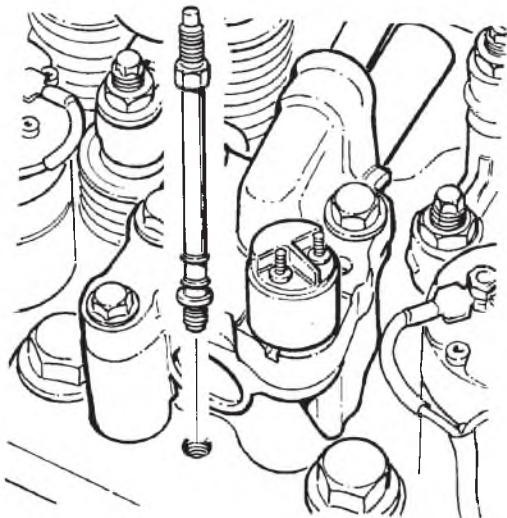


T2008612

**46**

Install the VEB control valve (if equipped) and oil supply pipe with new O-rings; connect the wires. Torque-tighten mounting bolts to  $20 \pm 3$  Nm ( $15 \pm 2$  ft-lb) and electrical connection nut to  $1.5 \pm 0.5$  Nm ( $1.5 \pm 0.4$  ft-lb).

$20 \pm 3$  Nm ( $15 \pm 2$  ft-lb),  
 $1.5 \pm 0.5$  Nm ( $1 \pm 0.4$  ft-lb)



T2008813

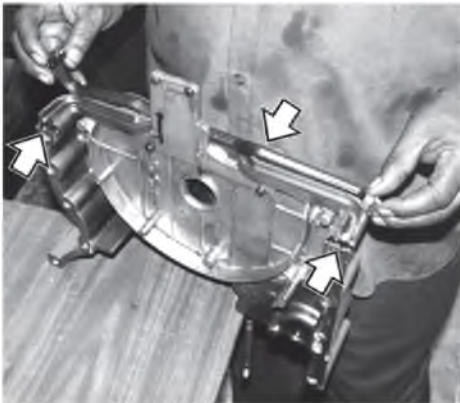
**47**

Install the valve cover studs.

**48**

Clean sealing surface of upper front cover. Using pressurized air, blow off any debris.



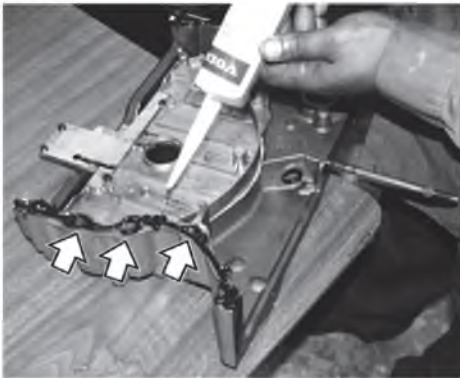


W2004027

**49**

Install gasket between upper and lower front covers.

**Note:** To prevent leaks, sealant must be placed at front corners of upper cover and at indentation along side of cover.



W2004028

**50**

Apply a 2 mm bead of sealant to the upper front cover where it contacts the cylinder head. Make sure that the sealant completely surrounds the bolt holes.

**Note:** Cover should be torque-tightened within 20 minutes after applying sealant.

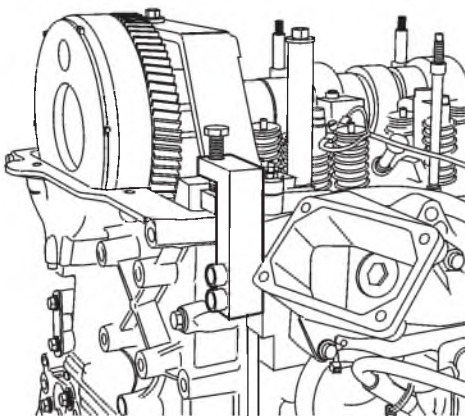
**51**

Install the upper front cover. Hand-tighten bolts, only.

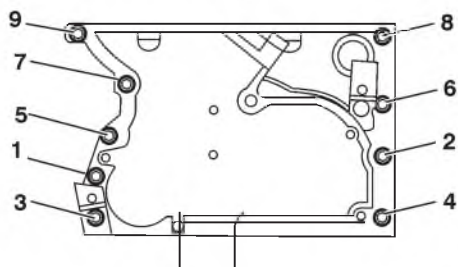
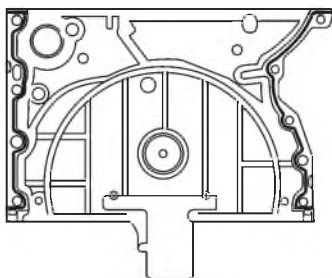
**52**

Install front cover alignment tool 9998602-6/2. Tighten bolts to align front cover.

**Note:** Tighten until upper front cover is flush with cylinder head on both sides.



W2003432



T2019925

**53**

Torque-tighten upper front cover bolts as follows, using the sequence illustrated:

**M8:**  $24 \pm 4$  Nm ( $18 \pm 3$  ft-lb)

**M10:**  $48 \pm 8$  Nm ( $36 \pm 6$  ft-lb)

**54**

Remove upper front cover alignment tool 9998602-6/2.

**55**

Install camshaft sensor to upper front cover.

**Note:** The distance between sensor and sensor tooth wheel should be 0.3 – 1.0 mm (0.012 – 0.039 in.).

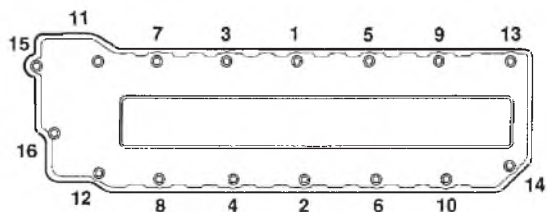
**56**

Install wiring harness and clamps to upper front cover.

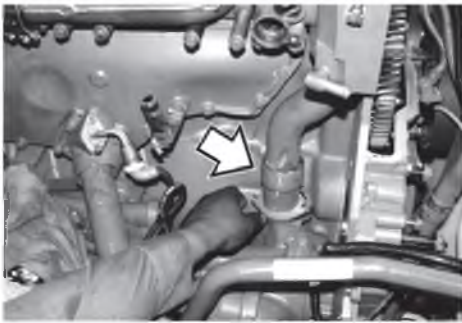
**57**

Install the valve cover on the engine. Using pattern illustrated, torque-tighten to  $20 \pm 2$  Nm ( $15 \pm 2$  ft-lb).

$20 \pm 2$  Nm  
( $15 \pm 2$  ft-lb)



T2012645



W2004009

**58**

Install coolant tube from water pump to cylinder head.

**Note:** Use new O-rings and gasket.

**59**

Install air compressor with new mounting O-ring. Torque-tighten mounting bolts to  $85 \pm 15$  Nm ( $63 \pm 11$  ft-lb).

---

$85 \pm 15$  Nm  
( $63 \pm 11$  ft-lb)

**60**

Install oil supply line to air compressor.

**61**

Connect air compressor coolant hoses to cylinder head and oil cooler cover. Tighten hose clamps.



W2004011

**62**

Connect air lines to the air compressor and install line supports to cylinder head.

**63**

Clean the intake manifold and install new sealant.

**64**

Install intake manifold. Using cross-over pattern, torque-tighten bolts to  $24 \pm 4$  Nm ( $18 \pm 3$  ft-lb).

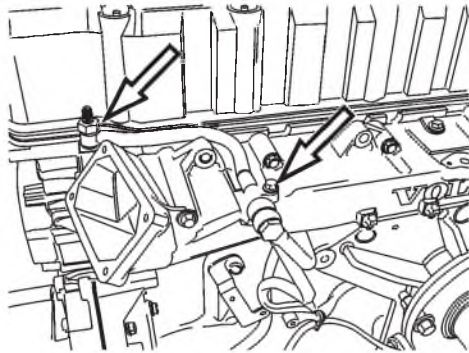
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$24 \pm 4$  Nm  
( $18 \pm 3$  ft-lb)

**65**

Install the cable box to the cylinder block.

**Note:** Do not install the cover at this time.



W2003422

**66**

Install the fuel line at the front of the head.

**67**

Install the intake manifold pressure/temperature sensor.

**68**

Install the cable box intermediate cover.

**69**

Install the cable box outer cover.

**70**

Install the bracket between the preheater and the fan ring; connect the upper charge air cooler pipe.

**71**

Loosen the alternator and pull down to install the front intake bolt. Torque-tighten to specifications.

**72**

Reposition and tighten the alternator bolts.

**73**

Fit new O-ring seal on the coolant temperature sensor and install in cylinder head.

**74**

Install the transmission oil cooler water hose at the back of the cylinder head.

**75**

Install the fuel line at the rear of the cylinder head using new copper washers.

**76**

Connect the preheater B+ and switch wires. Install wire restraints.

**77**

Connect the AC line support to the intake manifold.

**78**

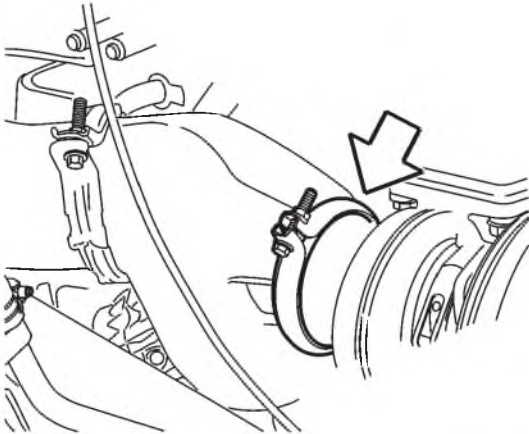
Install the heater pipe at the thermostat housing using new O-ring.

**79**

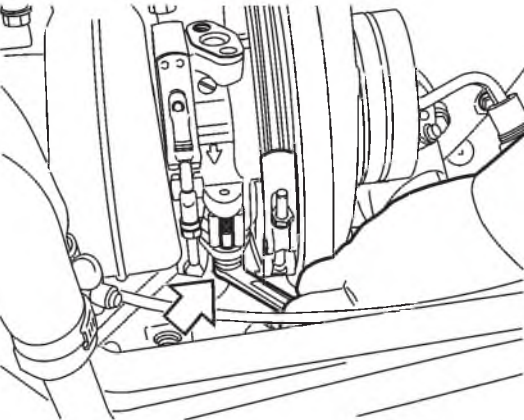
Using a new gasket, lift turbo into position and tighten mounting nuts.

**80**

Install the EPG housing onto the turbocharger and tighten the clamp bolt.



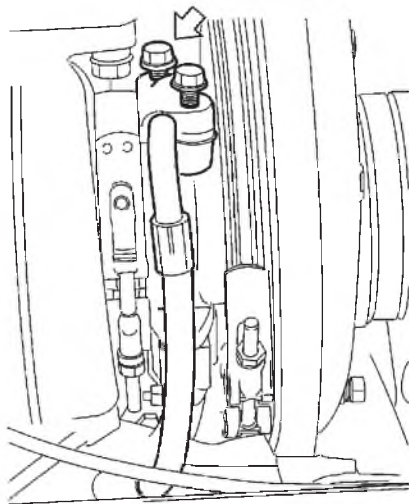
W2004314



W2003865

**81**

Install the turbocharger oil return pipe using new gasket and O-ring.



W2003864

**82**

Install the turbo oil supply line to the turbocharger.

**83**

Install the charge air pipe to the turbo.

**84**

Install the upper radiator coolant neck and connect the fan ring to the coolant neck.

**85**

Connect the upper radiator coolant hose and static fill pipe.

**86**

Install the breather pipe to the upper front cover.

**87**

Install the oil filler pipe to the upper front cover.

**88**

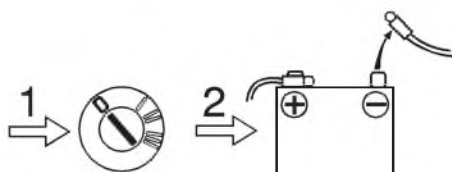
Install the coolant in the engine.

**89**

Install the air filter housing and piping.

**90**

Connect batteries; refer to Service Information, group 33.



T8006962

**91**

Prime the fuel system.

**92**

Crank the engine. Check for leaks and any wires or hoses that require service.

**93**

Road test the truck and recheck for leaks.



# Service Manual Trucks

Group **260–600**

Cooling System

D12, D12A, D12B, D12C



# Foreword

The descriptions and service procedures contained in this manual are based on designs and methods studies carried out up to August 2000.

The products are under continuous development. Vehicles and components produced after the above date may therefore have different specifications and repair methods. When this is believed to have a significant bearing on this manual, supplementary service bulletins will be issued to cover the changes.

The new edition of this manual will update the changes.

In service procedures where the title incorporates an operation number, this is a reference to an S.R.T. (Standard Repair Time).

Service procedures which do not include an operation number in the title are for general information and no reference is made to an S.R.T.

The following levels of observations, cautions and warnings are used in this Service Documentation:

**Note:** Indicates a procedure, practice, or condition that must be followed in order to have the vehicle or component function in the manner intended.

**Caution:** Indicates an unsafe practice where damage to the product could occur.

**Warning:** Indicates an unsafe practice where personal injury or severe damage to the product could occur.

**Danger:** Indicates an unsafe practice where serious personal injury or death could occur.

**Volvo Trucks North America, Inc.**  
Greensboro, NC USA

**Order number: PV776-TSP142854**

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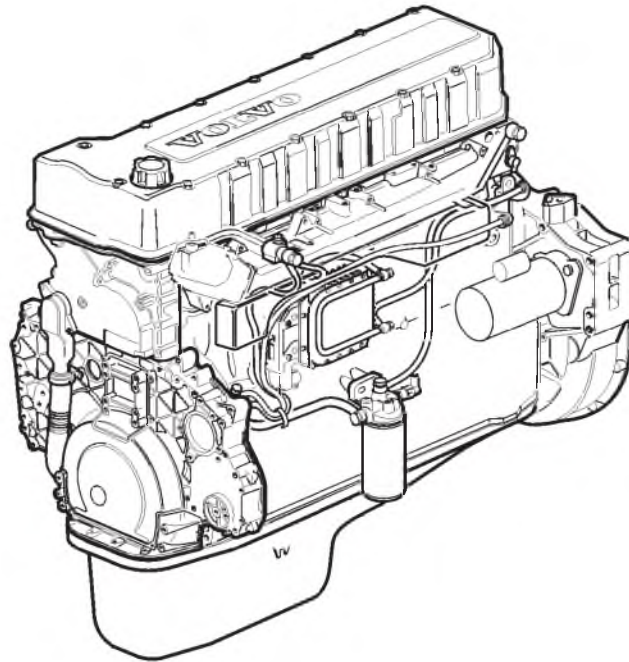
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**Feedback**

**Operation Numbers**

## General



W2003244

This information covers the Cooling System for the D12, D12A, D12B, and D12C engines.



# Tools

## Special Tools

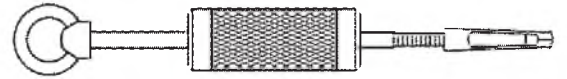
The following special tools are required to work on the cooling system of the D12 engine. The tools are available from the Parts Department of Volvo Trucks North America, Inc.

Please specify the complete part number when ordering.



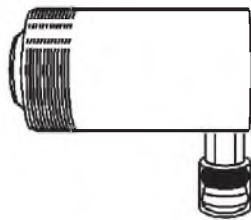
W0001739

**9992071** Drift for Overhauling Coolant Pump



W0001745

**9994090** Puller for Coolant Pump Seal



W0001743

**9992671** Hydraulic Cylinder



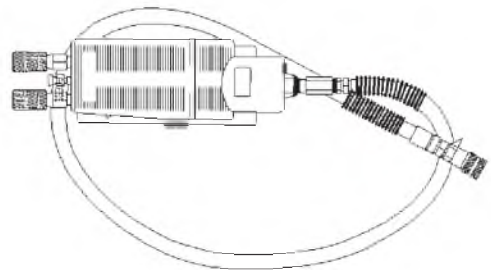
W0001746

**9996049** Drain Hose for coolant



W0001744

**9994034** Hollow Drift for Overhauling Coolant Pump



W0001747

**9996222** Air Powered Hydraulic Pump





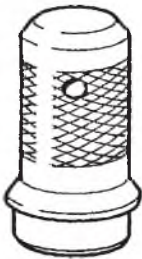
W0001748

**9996315** Spindle for Overhauling Coolant Pump



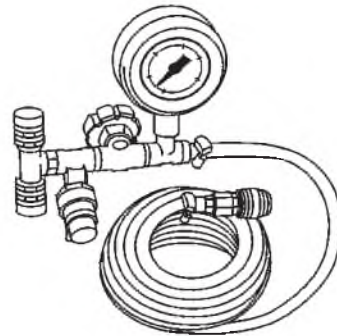
W0001750

**9996626** Hollow Drift for Overhauling Coolant Pump



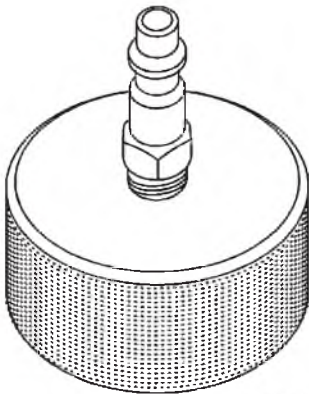
W0001763

**9996383** Hollow Drift for Overhauling Coolant Pump



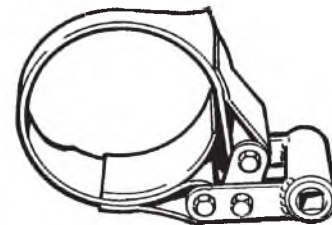
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**9996662** Pressure Gauge



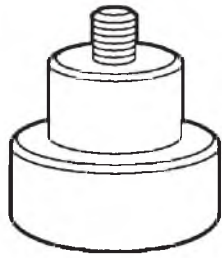
W0001261

**9996441** Expansion Tank Cap-VN



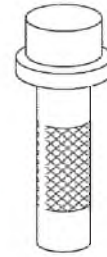
W0001766

**9996671** Filter Wrench for Coolant Filter



W0001754

**9996883** Adapter for Overhauling Coolant Pump



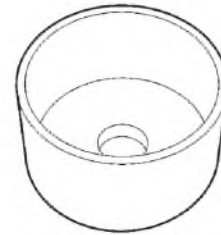
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**9998113** Drift for Overhauling Coolant Pump



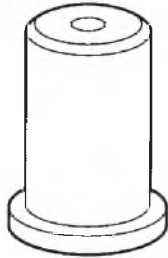
W0001755

**9996884** Drift for Overhauling Coolant Pump



W0001764

**9998244** Sleeve for Overhauling Coolant Pump



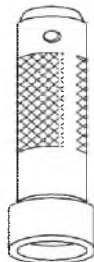
W0001762

**9998012** Hollow Drift for Overhauling Coolant Pump



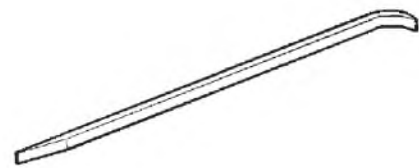
W0001760

**9998291** Drift for Installing Thermostat Sealing Ring on the D12 A & B engine



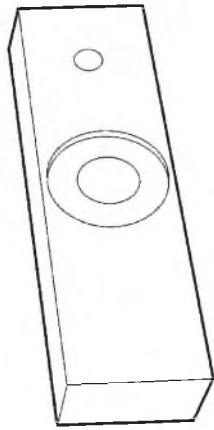
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**9998039** Drift for Overhauling Coolant Pump



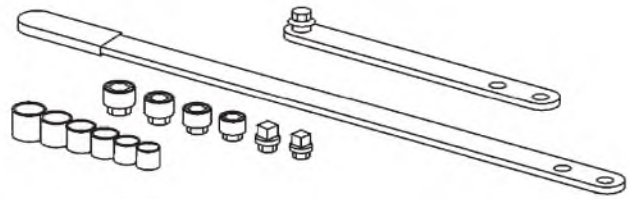
W0001802

**9998511** Drift for Installing Thermostat Sealing Ring on the D12 A & B engine



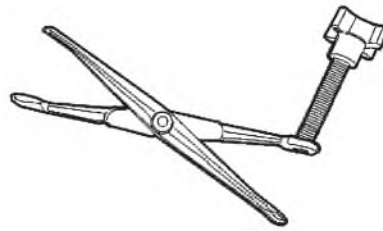
W0001765

**9998541** Tool for Pressing Impeller onto Coolant Pump Shaft



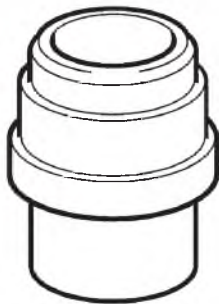
W2003340

**J-44392** Belt Tensioner Release Tool (Kent Moore)



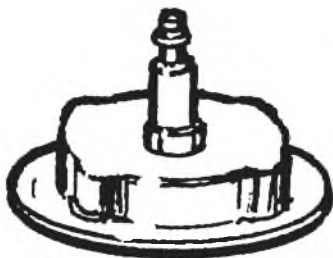
W0001929

**J-44772** Thermostat Housing Install Tool



W0001806

**9998619** Drift for Installing Thermostat Sealing Ring on the D12C engine



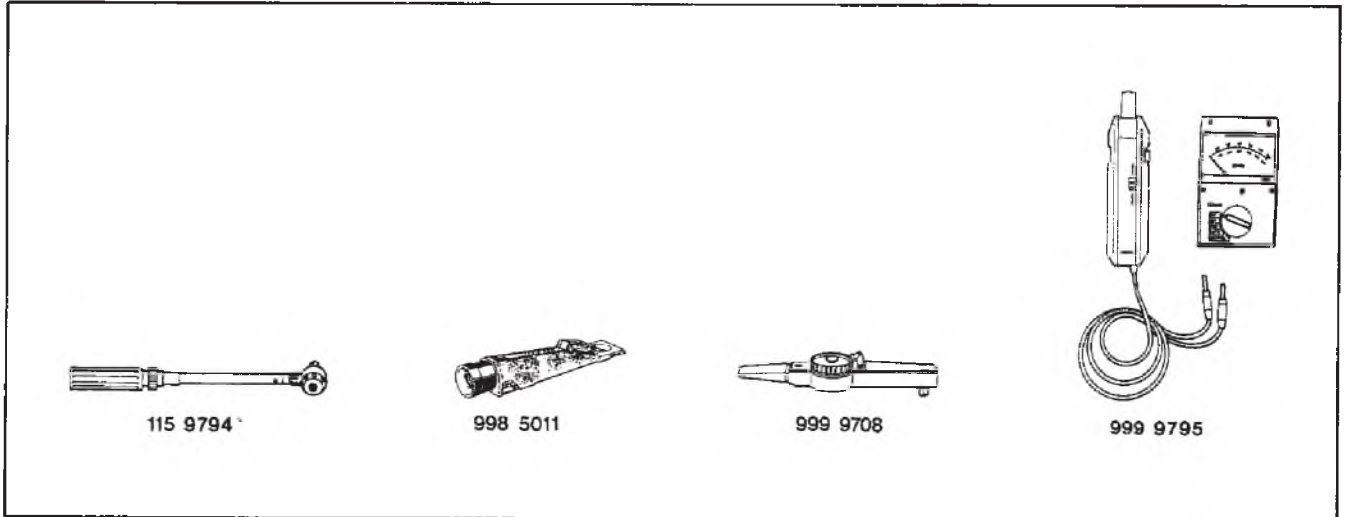
C0000353

**J-42397-A** Expansion Tank Cap-VHD

## Special Equipment

Like the special tools, the following are also available from the Parts Department of Volvo Trucks North America, Inc.

Please specify the complete part number when ordering.



- 1159794** Torque wrench 10-100 Nm (7-74 ft-lb)
- 9985011** Hydrometer for antifreeze
- 9999708** Torque wrench 0-17.5 Nm (0-13 ft-lb)

- 9999795** Tachometer

T2007271



# Design and Function

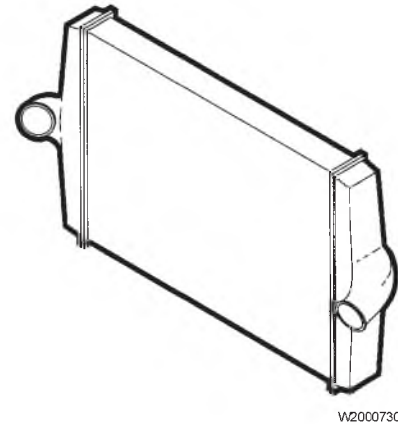
## Cooling System

### Charge Air Cooler

Charge Air Cooler Systems are essential today to meet emissions regulations. However, they also improve power density, lower fuel consumption, and reduce thermal stresses on the engine by cooling the turbocharged air before it enters the engine. The turbocharged air is heated up to 200° C (400° F) or even higher as it enters the charge cooler, and is cooled to around 40° C (100° F) when it leaves for the engine.

Accumulation of bugs and dirt in the finned areas of a Charge Air Cooler are known problems. If there is a build up of any debris like road film, bugs, etc. in just a section of a charge air cooler, that section overheats and torsional (twisting) stresses develop in the charge air cooler core. The fin passage cleanliness may not be as critical in an over-the-highway vehicle, but in construction, logging and mining equipment, it can be.

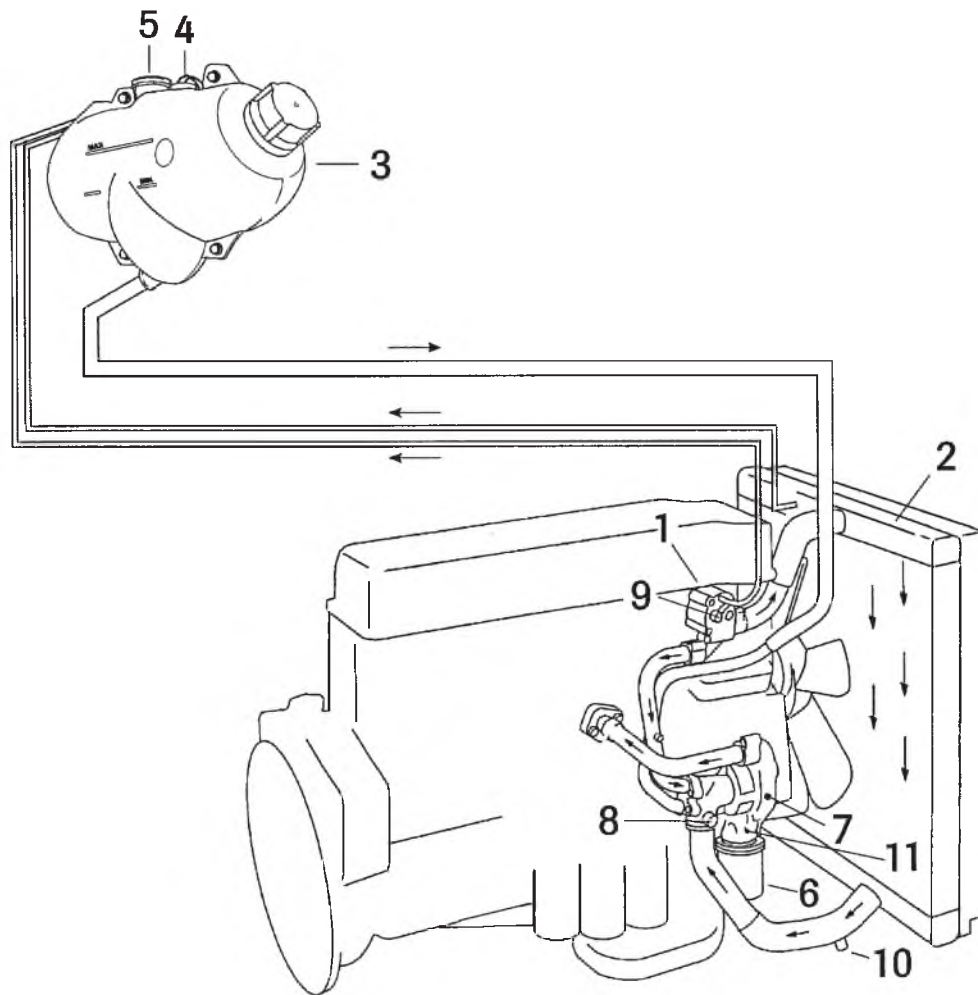
Before performing the actual leak test, make sure the pressure regulator is functioning properly; see "Cooling System, Flow" page 12.



W2000730

Fig. 1: Charge air cooler

## Cooling System, Flow



W2003323

Fig. 2: Cooling system

- |   |                    |    |                             |
|---|--------------------|----|-----------------------------|
| 1 | Thermostat housing | 7  | Coolant pump                |
| 2 | Radiator           | 8  | Heater return               |
| 3 | Expansion tank     | 9  | Heater supply               |
| 4 | Level sensor       | 10 | Radiator drain valve        |
| 5 | Pressure cap       | 11 | Shut-off valve—coolant pump |
| 6 | Coolant filter     |    |                             |

### Coolant Circulation in Engine

The coolant is forced through the system by a gear-driven pump. The coolant enters the cylinder block through a pipe and first passes the area where the oil cooler is installed. The coolant is then distributed through galleries in the cylinder block and cylinder head to reach the cylinder liners and other parts of the engine before leaving the cylinder head through the thermostat housing. The illustration shows the engine during the warm-up period. The thermostat is closed and the coolant is flowing back to the coolant pump.

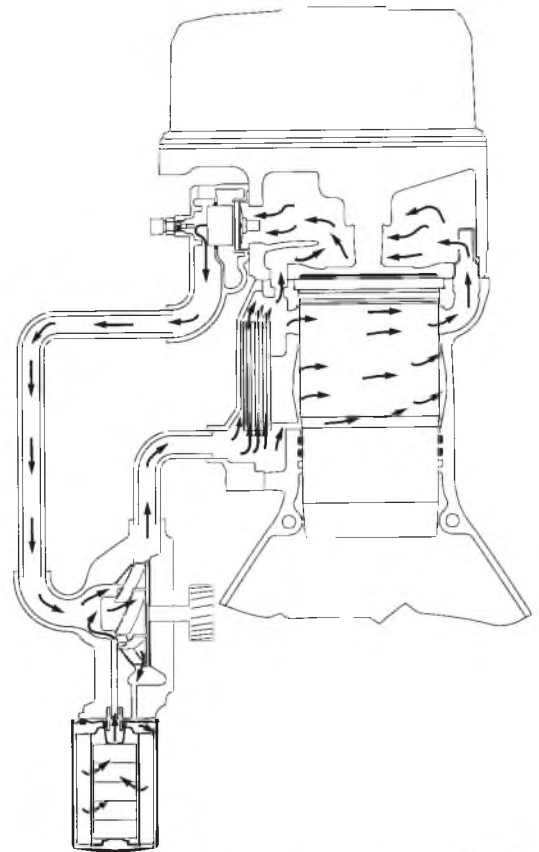


Fig. 3: Coolant circulation

T2007265



## Thermostat

The engine is equipped with a thermostat. The thermostat housing incorporates a sensor for coolant temperature. During engine warm-up, the thermostat is closed, (see Fig. 4: Thermostat closed , page 14) and coolant flows from the cylinder head through the outer section of the thermostat back to the coolant pump.

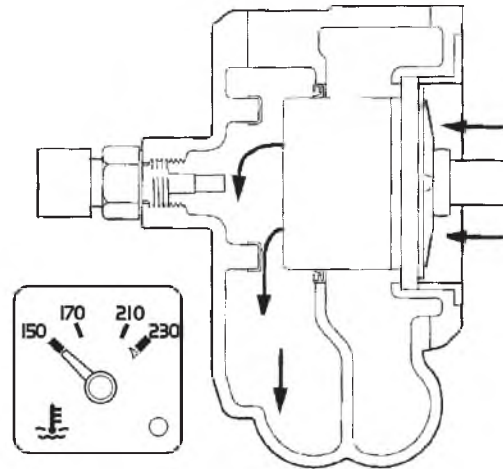


Fig. 4: Thermostat closed

W2003283

When the engine has reached operating temperature and the thermostat is open (see Fig. 5: Thermostat open, page 14) , the outlet to the coolant pump is gradually closed. The coolant now passes through the inner section of the thermostat housing and then to the radiator.

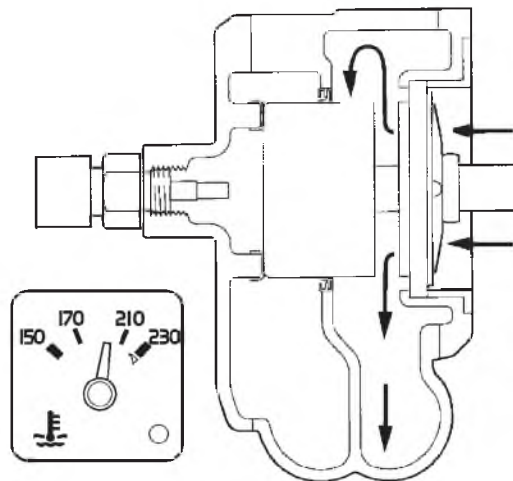


Fig. 5: Thermostat open

W2003284

## Thermostat Housing

### D12C

The thermostat housing has been integrated into the cylinder head.

The thermostat (1) is located at the right front side of the cylinder head and its seal ring (2) is accessible once the connection housing (3) and thermostat have been removed (see illustration, Fig. 6: Thermostat Housing, D12C, page 15).

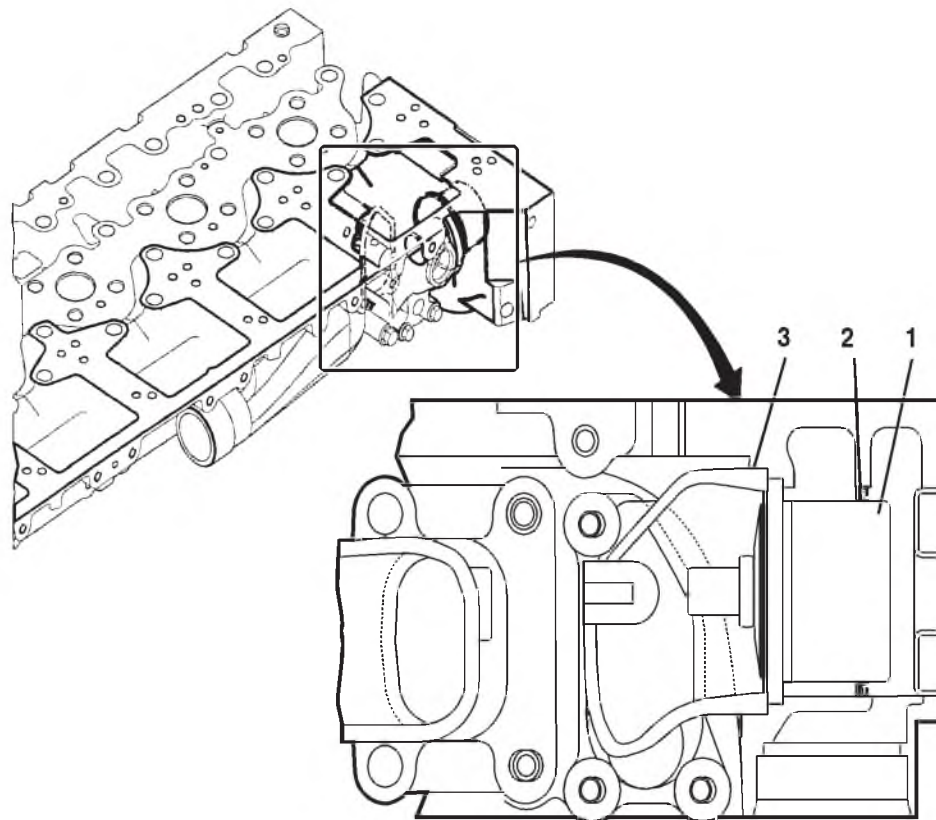


Fig. 6: Thermostat Housing, D12C

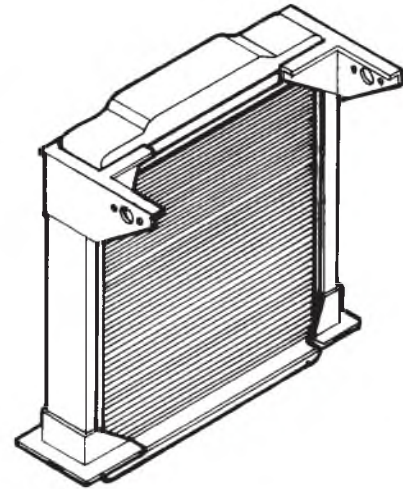
T2012790

## Radiator

### AC, WG

There are two (2) sizes of radiators furnished for use with the D12 engines in different applications:

Vehicle Type	Radiator Area	System Capacity
Autocar	84 dm <sup>2</sup> (1300 in <sup>2</sup> )	43 (52 qts)
WG	67 dm <sup>2</sup> (1032 in <sup>2</sup> )	50 (52 qts)



W2003214

Fig. 7: Radiator, AC, WG

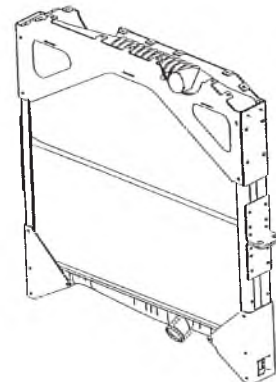
### VN/VHD

Due to the unique design of the radiator, do not attempt to replace any of the components on the VN/VHD radiator, including tanks, seals or core.

Specialized tooling is needed to perform quality repairs when crimping the tanks and seals to the core. Therefore, you should:

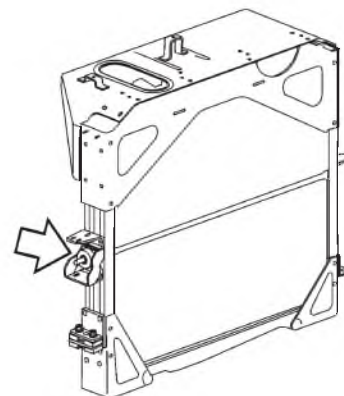
- have the radiator repaired by an authorized radiator service center; or
- replace the complete unit

Vehicle Type	Radiator Area	System Capacity
VN	124 n <sup>2</sup>	39
VHD	849 n <sup>2</sup>	39



W2003376

Fig. 8: Radiator, VN



W2003472

Fig. 9: Radiator, VHD (with unique mounting bracket)


## Coolant Mixture


Always mix water and antifreeze to the correct concentration before filling the cooling system.

The recommended mixture is 50% antifreeze/coolant in the water.

**Note:** Mixing concentrated coolants of a different type can result in a loss of anti-corrosion properties with damage to the engine as a result.

At the factory, the cooling system is normally filled with a mixture of tap water and concentrated coolant which gives protection down to minimum  $-29^{\circ}\text{C}$  ( $-20^{\circ}\text{F}$ ). If the vehicle is destined for climates colder than this, the antifreeze level of the coolant should be adjusted; see approximate values in the following table.

 <b>CAUTION</b>
60% antifreeze in the mixture gives optimum freeze protection. Increasing the antifreeze content beyond that will only decrease the freeze protection.

 <b>CAUTION</b>
Never use a mixture weaker than 40% antifreeze to 60% water. Ignoring this increases the risk of corrosion in the cooling system and cylinder liner pitting leading to damage of the engine.

For more detailed information on Coolants, refer to:

**TSI**                    184–001  
*Coolant Requirements, Volvo Engines*

**IMPACT**            Function Group 184  
Information Type: Service and Maintenance  
"Coolant Requirements"

### Freeze Protection

down to:	Amount concentrated antifreeze, WG	Amount concentrated antifreeze, WI and AC	Percentage of antifreeze in mixture
$-25^{\circ}\text{C}$ ( $-13^{\circ}\text{F}$ )	17 liters	20 liters	40%
$-30^{\circ}\text{C}$ ( $-22^{\circ}\text{F}$ )	20 liters	23 liters	46%
$-38^{\circ}\text{C}$ ( $-36^{\circ}\text{F}$ )	21 liters	25 liters	50%
$-46^{\circ}\text{C}$ ( $-51^{\circ}\text{F}$ )	26 liters	30 liters	60%

## Flushing Cooling System

The cooling system should always be cleaned when the coolant is replaced.



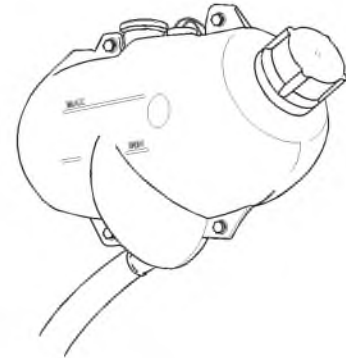
**DANGER**

Coolant is toxic; risk of poisoning. Do not drink coolant. Use proper hand protection when handling. Keep coolant out of reach of children and animals. Failure to follow these precautions can cause serious illness or death.

**Note:** Always dispose of coolant according to Federal or local regulations. Take all used coolant to a recycling or waste collection center.

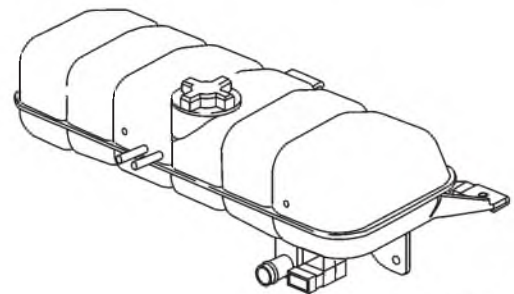
## Expansion Tank

The expansion tank includes a pressure valve and a coolant level sensor. The tank material is clear and has maximum (MAX) and minimum (MIN) markings to allow visual fluid level checks.



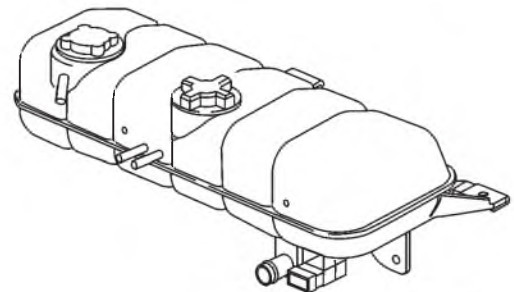
W2000749

Fig. 10: Expansion tank for WG and AC



W2003514

Fig. 11: Expansion tank for VHD



W2003515

Fig. 12: Expansion tank for VN

## Draining Points

To drain the cooling system, all drain points should be opened. In addition, the expansion tank cap should be removed while the system is draining.

Draining points:

- Radiator
- Cylinder block
- Oil cooler, transmission (when installed)
- Coolant pump

**Note:** In some locations the draining point consists of a quick-connect valve (1) covered with a rubber cap; see Fig. 13: Quick-connect drain valve in bottom of radiator, page 20. In this case use tool 9996049 for draining. This is a quick-connect hose needed for draining.

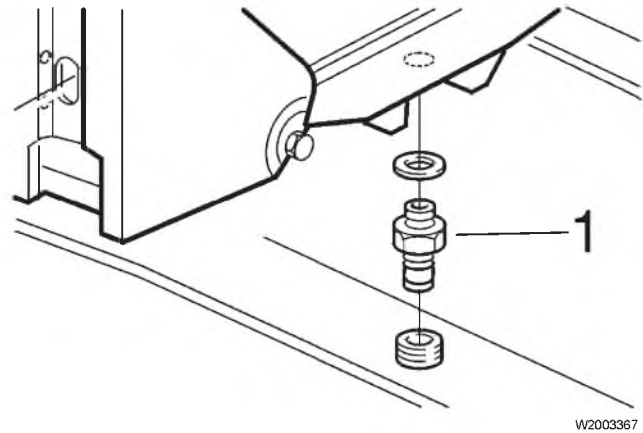


Fig. 13: Quick-connect drain valve in bottom of radiator

## Coolant Pump

The coolant pump is mounted to the timing gear plate and is driven by the timing gears. The coolant pump includes a one-piece carbon/ceramic seal and a double ball bearing for the pump shaft. The pump is equipped with a shut-off valve (1) which prevents coolant from draining out when changing the coolant filter; see Fig. 14: Coolant pump, page 20. To close the valve, the handle is turned to the horizontal position.

**Note:** The shut-off valve must always be in the open position. That is, the handle should point vertically, except when replacing the lines.

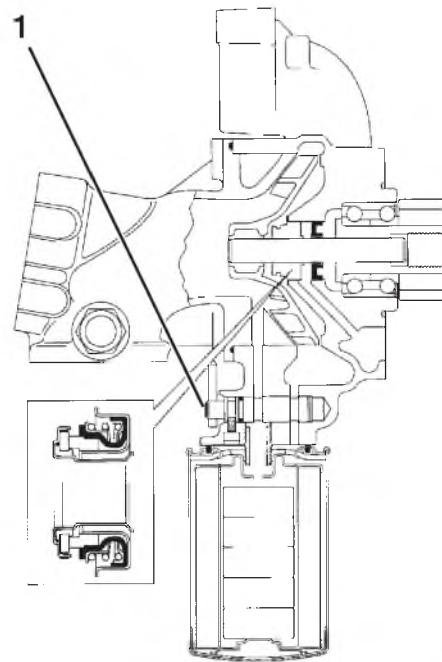


Fig. 14: Coolant pump

## Coolant Filter

A coolant filter is mounted to the coolant pump. On D12 engines and an adapter is mounted to the pump with lines to a remote-mounted coolant filter situated on the right side of the engine.

Coolant filters used with standard coolant include an anti-corrosive agent, SCA (Supplemental Coolant Additive), which is added to the standard coolant during filtration.

Coolant filters used with Extended Life Coolant, ELC, are "blanks" and do not contain any SCA.

**Note:** The valve must always be in the open position, i.e. the handle should point vertically, except when changing the filter.

For more detailed information on coolants, refer to

**TSI** 184-001  
*Coolant Requirements, Volvo Engines*

**IMPACT** Function Group 184  
Information Type: Service and Maintenance  
"Coolant Requirements"



## Winterfront

Volvo Trucks North America, Inc. does not recommend the use of winterfronts, shutters or any other shield in front of the grille or radiator package under normal circumstances. These devices, if not used properly, can cause higher exhaust temperatures, power loss, excessive fan usage and a reduction in fuel economy.

Today's electronically controlled engines are designed to operate in temperatures without a winterfront. Volvo Trucks North America, Inc. does not recommend the use of a winterfront while the vehicle is being driven. If a winterfront is used, it must conform to these specifications:

**Note:** Please see your local Volvo Truck Dealer for Volvo recommended winterfronts. If there is engine or related damage that can be followed back to an improperly used winterfront, the warranty is no longer valid for those parts.

**VHD-**Failure to remove the winterfront when temperatures go above 15° F (-25° C.) could cause severe damage to engine, charge-air-cooler and/or loss of fuel economy. The grille cover should be able to let airflow through to the charge-air-cooler at a uniform rate over the entire area. This means that a single, small opening in the winterfront is not acceptable. Air passage must be distributed evenly across the grille and no more than 85% can be covered.

**VN-**Winterfronts are properly used for overnight parking in the winter or very cold temperatures (below-5° F[-20° C]). In these cases, coolant and inlet manifold temperatures must be carefully monitored and controlled.

## Viscous Fan

The Viscous fan consists of a fan section and a drive section connected by a visco-static clutch. The clutch consists of a drive plate (6) which is mounted in a housing (7); see Fig. 17: Fan, cross-section, page 23.

On each side of the drive plate (6) is an air gap. When the fan is engaged, these gaps are filled with fluid. With the fan in operation, the flow of fluid in the fan hub takes place in two different ways. The temperature around the bimetallic plate (2) determines which path the fluid takes and thereby the degree to which the fan is engaged.

The control device regulates the amount of fluid reaching the drive chamber to meet the cooling requirements. The more fluid in the drive chamber, the less "slip," thus resulting in higher fan speed. The fluid circulates between the storage and drive chambers. When the engine and fan stop, the fluid runs out into the drive chamber, which is why the fan is generally engaged during the first minutes after starting the engine.

### A. Disengagement

The valve (1) closes and fluid is pumped out into the storage chamber (5).

### B. Engagement

The valve (1) opens and fluid can enter the drive chamber (8).

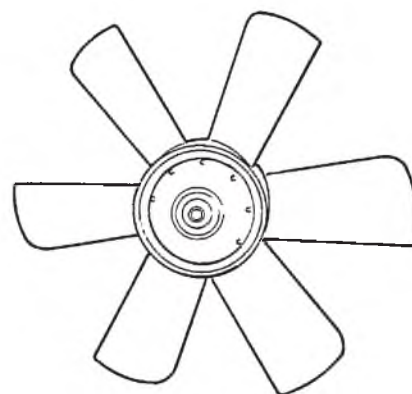


Fig. 15: Cooling fan

T2006863

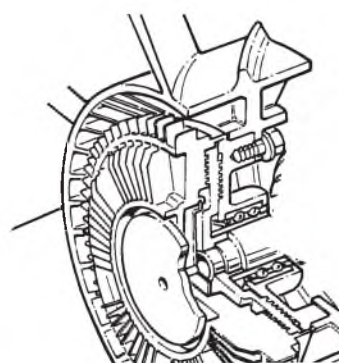


Fig. 16: Sensor, bimetallic plate

T2007216

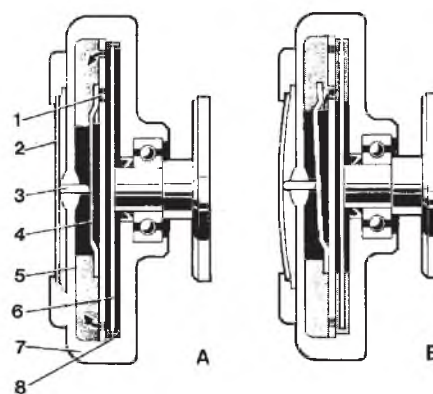


Fig. 17: Fan, cross-section

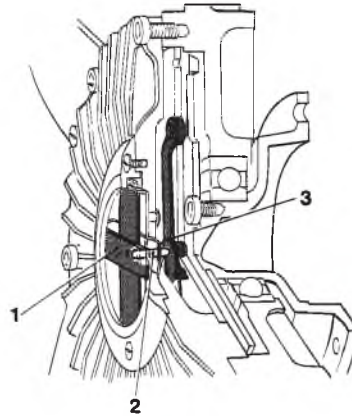
T2007217

Fan, cross section shows valve disengaged (B) and engaged (A)

- 1 Valve
- 2 Bimetallic plate
- 3 Control pin
- 4 Valve lever
- 5 Fluid storage chamber
- 6 Drive plate
- 7 Housing
- 8 Drive chamber

## Control Device

The fan rotates at reduced speed. The bimetallic plate (1) presses against the control pin (2) moving it towards the valve lever (3).



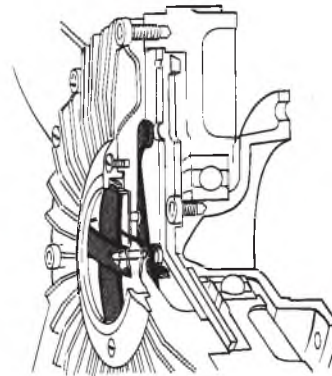
T2007218

Fig. 18: Control valve closed

- 1 Bimetallic plate
- 2 Control pin
- 3 Valve lever

The fan is fully engaged. The bimetallic plate flexes outwards due to the temperature increase in the ambient air.

For function check, see "Viscous Fan, Checking" page 68.



T2007219

Fig. 19: Control valve open

# Troubleshooting

## Cooling System Troubleshooting

### Coolant Temperature Too High

Excessively high coolant temperature can be due to:

- Blocked radiator (low airflow)
- Blocked cooling system
- Contaminated coolant
- Low coolant level
- Broken fan belt
- Faulty temperature gauge
- Poor grounding between engine and chassis
- Faulty thermostat
- Faulty temperature-controlled cooling fan
- Leaking cylinder head gasket, lower liner seals
- Leaking coolant hoses

### Coolant Temperature Too Low

- Faulty thermostat
- Faulty temperature gauge

### Loss of Coolant

#### *External Leaks*

- Leaks in hoses or connections
- Leaks in radiator and/or expansion tank
- Leaks in cab heater
- Leaks in coolant pump
- Cylinder head gasket leakage

#### *Internal Leaks—Engine*

- Leak at injector copper sleeve
- Defective liner seals
- Liners pitted or cracked
- Cylinder head gasket leakage
- Crack(s) in cylinder head
- Crack(s) in cylinder block

### *Coolant Leaks Through Overflow*

- Faulty pressure cap/relief valve
- Engine running too hot
- Expansion tank installed incorrectly
- Cylinder head gasket leakage
- Cylinder block cracked
- Liners pitted or cracked
- Coolant losses, warm engine switched off

Coolant losses after having switched off a warm engine are generally due to heavy load operation and subsequent stopping without allowing the engine first to run at idling speed to cool down, or a faulty pressure cap valve.

### **Temperature Gauge, Checking**

Remove the temperature sensor from the thermostat housing and reconnect the electric connector. Connect a ground between the temperature sensor and the cylinder block. Submerge the temperature sensor in heated water. Using a thermometer, read off the temperature. Compare this reading with the reading of the temperature gauge.

### **Air Flow-through, Checking**

Should higher than normal coolant temperatures be observed, the passage of air through the charge air cooler, A/C condenser and radiator must always be checked and cleaned if necessary. Any obstruction must be removed.

In cases of more serious blockage, the radiator/charge air cooler and A/C condenser must be removed entirely and thoroughly cleaned, especially if the pollutant is oil based.

If the fins of the radiator have been bent by flying stones etc., straighten them with a fin comb.

Check that the rubber seals between the fan shroud and the radiator, and in some cases between the radiator and the front shroud, have not loosened or for any other reason are not providing a good seal.

### **Polluted Coolant**

If the coolant is polluted it could mean that there is an internal leak (oil) or that the cooling system is clogged (deposits). Check for leaks.

A clogged system is usually a result of not changing the coolant according to the specific change intervals or using the wrong mixture of coolant and water, or that polluted water has been used.

### Speed Check

**DANGER**

Coolant is toxic; risk of poisoning. Do not drink coolant. Use proper hand protection when handling. Keep coolant out of reach of children and animals. Failure to follow these precautions can cause serious illness or death.

**DANGER**

Keep your hand, clothing, and the measuring instrument at a safe distance from the blades of the fan when checking RPM. Contact may cause personal injury or death.

**WARNING**

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

**WARNING**

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

### Fan Disengaged

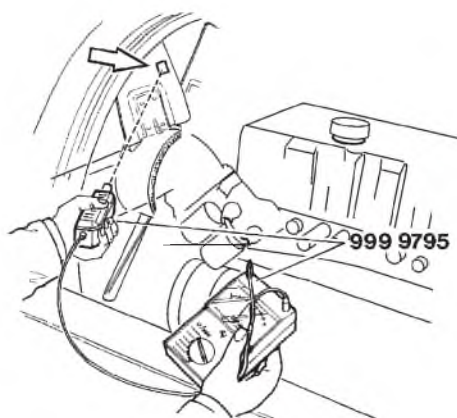


Fig. 20: Using hand-held tachometer

1 Run the engine at idling speed for approximately 5 minutes. Air temperature in front of the fan must not exceed 30° C (85° F). The silicone fluid, which drains into the drive chamber when the engine is switched off, is now pumped back to the storage chamber.

1 Increase engine speed to maximum RPM and measure fan speed with special tool 9999795. Fan speed should be **less than half engine speed** when the fan is fully disengaged.

### Fan Engaged

Air temperature around the sensor should be approximately 85° C (185° F) for the fan to be fully engaged.

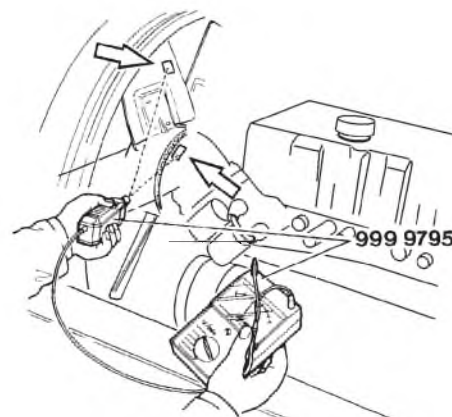


Fig. 21: Measuring fan speed

1 Run the engine at maximum output RPM and measure the fan speed and fan drive pulley speed using tool 9999795. Fan speed must **not be less than 90% of pulley speed** when the fan is fully engaged.





## Service Procedures

### 2611-03-02-01 Radiator, Replacement

#### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

#### WARNING

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

#### WARNING

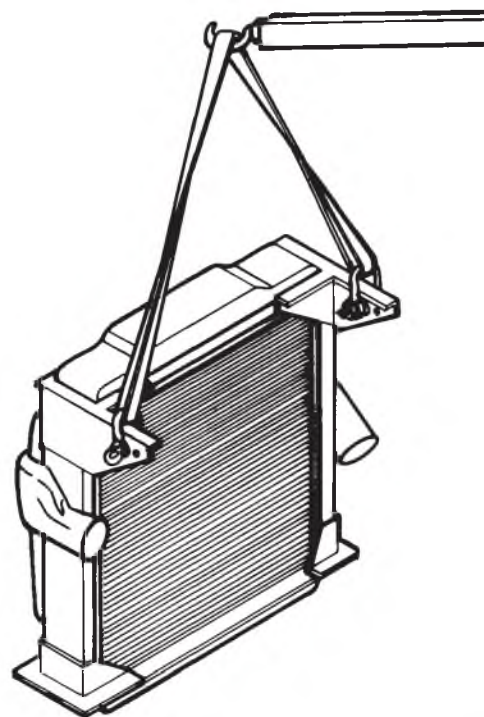
Never remove the cap on the expansion tank while the engine is still hot. Wait until the coolant temperature is below 50° C (120° F). Scalding steam and fluid under pressure may escape and cause serious personal injuries.

#### WARNING

Do not work near the fan with the engine running. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured. Before turning on the ignition, be sure that no one is near the fan.

#### WARNING

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.



W2002101

Fig. 22: Lifting radiator and charge air cooler assembly

#### **Note:** WG, AC

The radiator and charge air cooler are removed and installed as an assembly. Use of a lifting strap during removal and installation will help to prevent damage to the radiator/charge air cooler assembly.

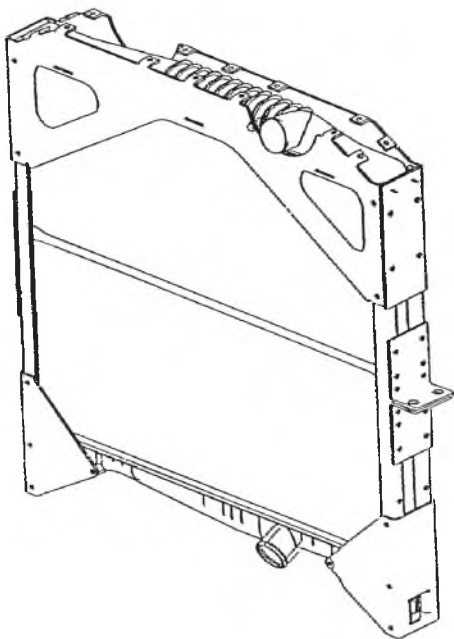


Fig. 23: VN radiator

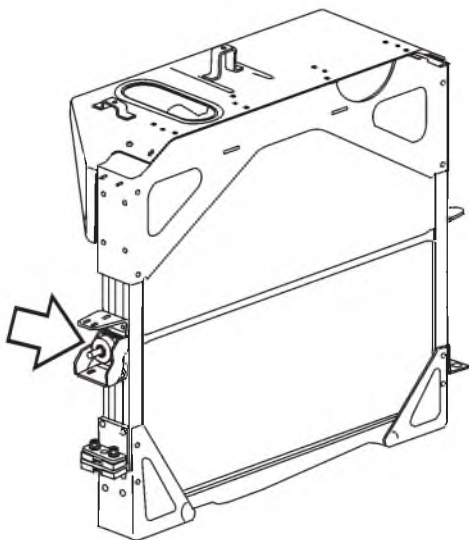


Fig. 24: VHD radiator

**Important:** Do not attempt to replace any of the components on the VN/VHD radiator, including tanks, seals, or core.

Specialized tooling is needed to perform quality repairs when crimping the tanks and seals to the core. Therefore, you should:

- have the radiator repaired by an authorized radiator service center; or
- replace the complete unit.

## Removal

- 1 • **(VHD only)** For removal of the grille in a VHD model truck refer to procedure: T25 Torx bit  
8 mm wrench

**TSI** 820–500  
"Hood, VHD"

**Impact** Function Group  
82  
Information Type:  
Repair  
Hood, VHD

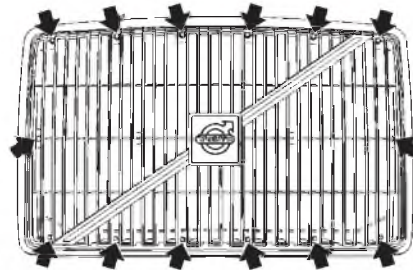


Fig. 25: VN model- screw fasteners

**(VN only)**

Remove the 14 Torx screws fastening the grille to the hood, and set the grille aside.

2

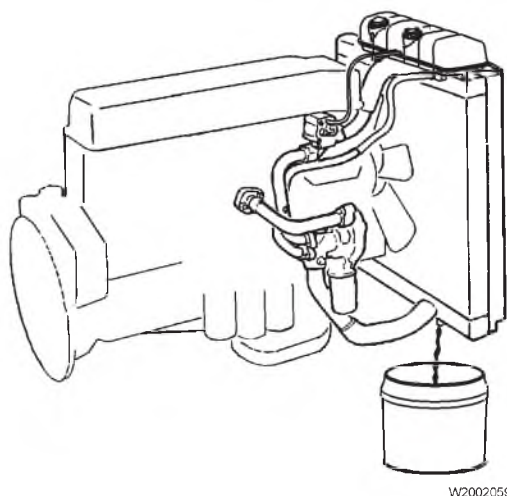


Fig. 26: Drain the cooling system

**DANGER**

Risk of poisoning. Coolant is toxic. Do not drink coolant. Use proper eye and hand protection when handling. Keep coolant out of reach from children. Personal injury or death could result.

Drain the cooling system. Open the drain on the bottom of the radiator and drain into a suitable container.

**Note:** On most older models, use tool 9996049 to drain radiator or engine.

3

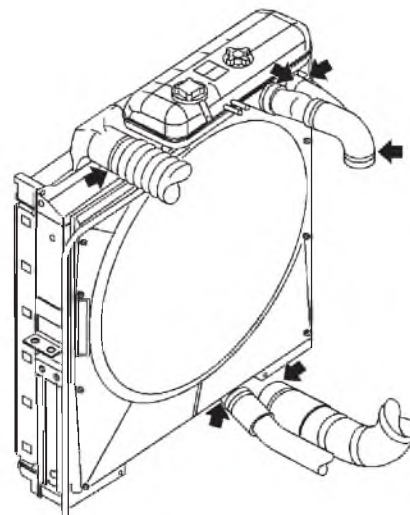


Fig. 27: Disconnect radiator hoses

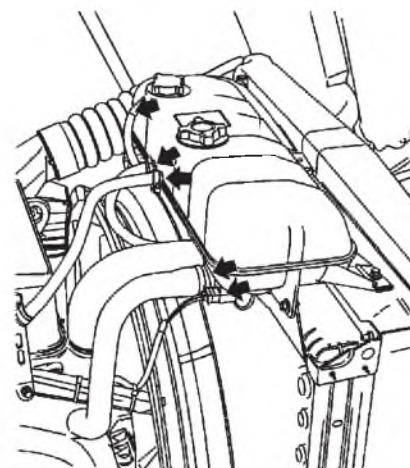
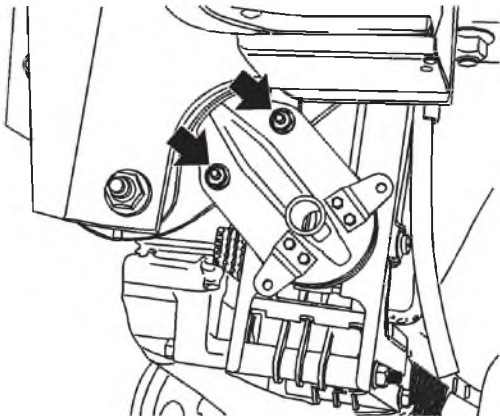


Fig. 28: Disconnect wires/hoses for coolant sensor

Disconnect the hoses to the radiator      10 mm socket  
and the charge air cooler assembly:      7 mm socket

- Top radiator hose
- Bottom radiator hose
- Fill hose from the water pump to the expansion tank
- Top charge air cooler hose
- Bottom charge air cooler hose
- Wires for the low coolant sensor

4

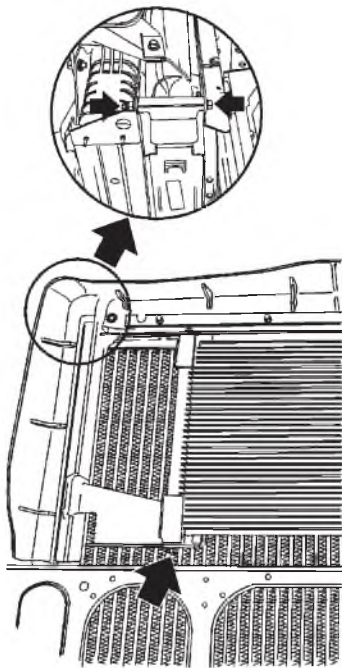


W2002065

Fig. 29: Remove radiator mounts

Remove the four bolts fastening the lower radiator mounts. 13 mm socket

5



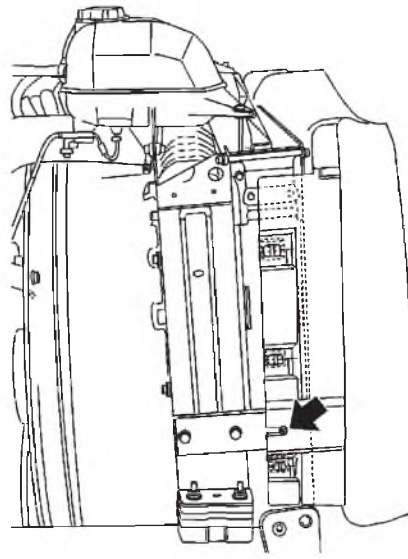
W2002078

Fig. 30: Remove bolts for support bracket

Remove the two upper bolts that fasten the air conditioning condenser upper support bracket to the charge air cooler assembly. 12 mm wrench  
12 mm socket  
13 mm wrench

**Note:** These bolts also mount the upper CAC to the radiator.  
Remove the lower two bolts that fasten the condenser itself to its lower support brackets.

6

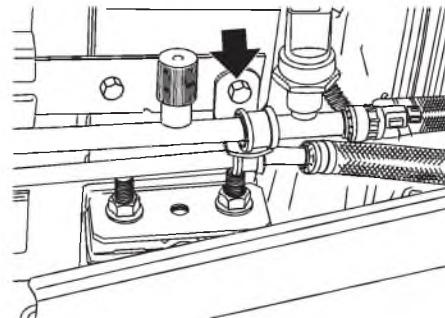


W2002075

Fig. 31: Remove head screws

Remove the two torx head screws fastening the side shroud to the radiator. T25 torx bit

7



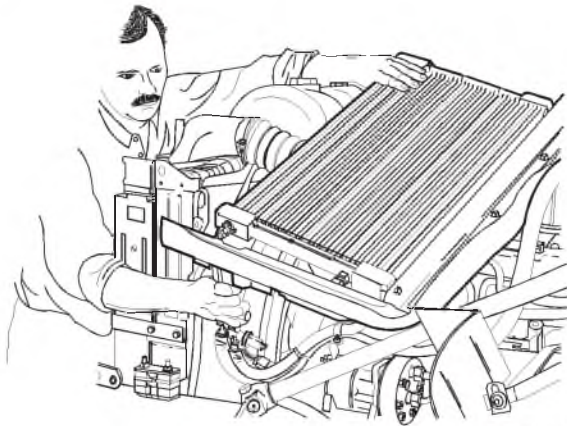
W2002066

Fig. 32: Remove radiator fastener

Remove the one bolt that fastens the air conditioning lines to the radiator. 12 mm wrench



8

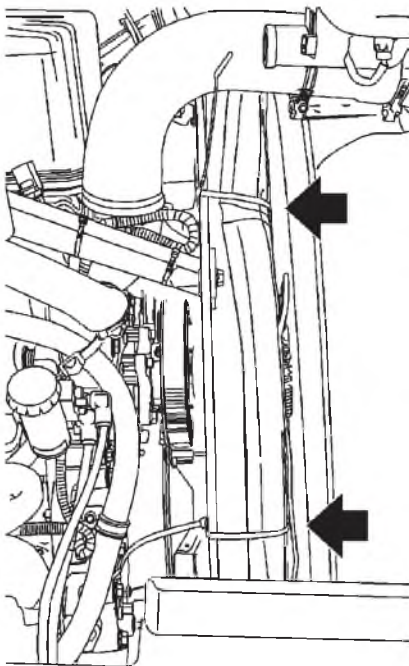


W2002071

Fig. 33: Lift out the condenser

Lift out the condenser, raise across the top of the radiator and let rest on top of the engine valve cover.

9

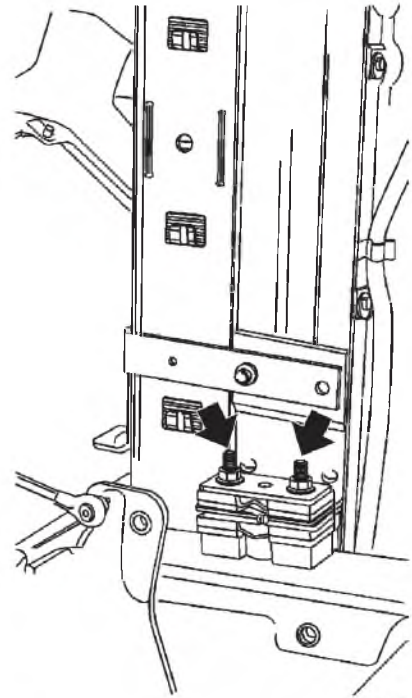


W2002072

Fig. 34: Plastic tie placement

Using plastic ties, tie the rubber part of the fan ring back away from the fan shroud.

10



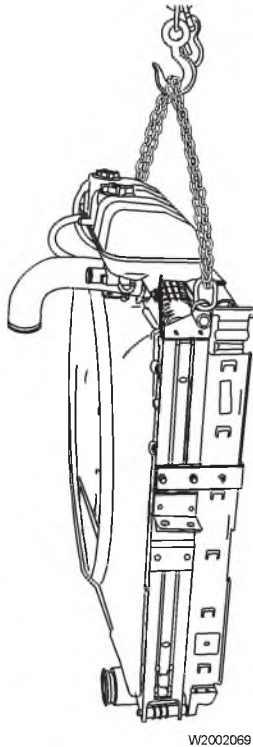
W2002105

Fig. 35: Remove mounting bolts

Remove the four upper radiator mounting bolts.

15 mm deep socket

11



W2002069

Fig. 36: Radiator removal

Fasten an acceptable lifting device to the top of the radiator in the holes that are provided. Lift out the radiator and the charge air cooler assembly.

OEM 4129

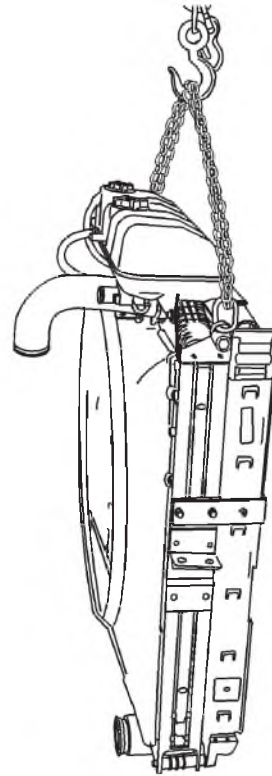


**CAUTION**

Be careful not to damage the radiator assembly when removing. Damage to the radiator and/or engine could result in severe damage to the engine.

## Installation

1



W2002069

Fig. 37: Lowering radiator

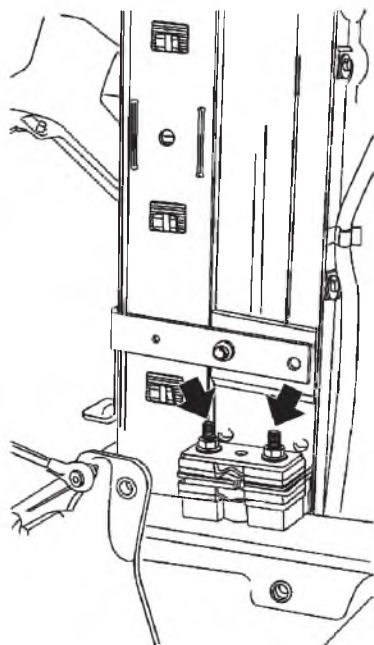
Position the radiator into the truck.

**Note:** Be very careful when lowering the radiator into the truck. Watch for any hoses or wires that might interfere or be damaged. Make sure the fan does not damage the radiator core assembly.

2

Remove the lifting device from the radiator.

3

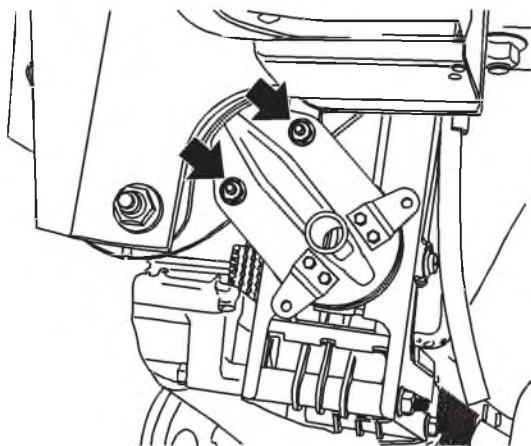


W2002105

Fig. 38: Install the radiator mounts

Install the upper radiator mounts and nuts. Torque to  $48 \pm 8$  Nm ( $36 \pm 6$  ft-lb).  $15$  mm socket  
 $48 \pm 8$  Nm  
( $18 \pm 3$  ft-lb)

4

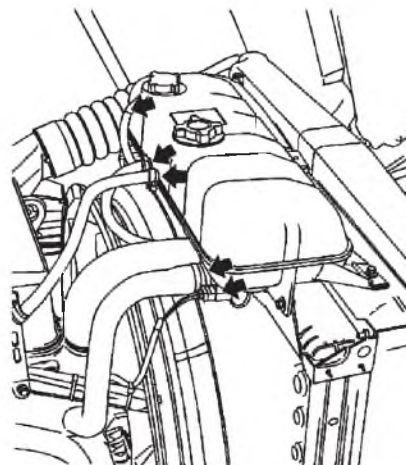


W2002065

Fig. 39: Install the supports and ties

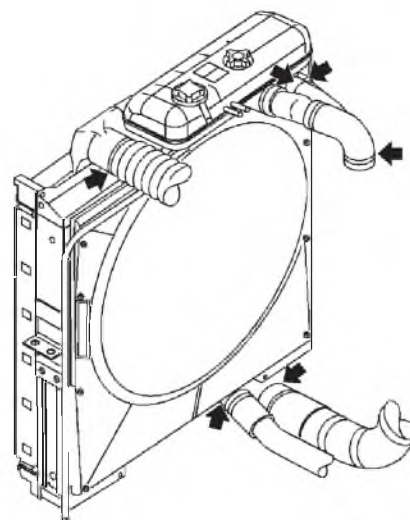
Install the lower radiator supports and nuts. Torque to  $24 \pm 4$  Nm ( $18 \pm 3$  ft-lb).  $13$  mm socket  
 $24 \pm 4$  Nm  
( $18 \pm 3$  ft-lb)

5



W2002060

Fig. 40: Install expansion tank hoses



W2002063

Fig. 41: Connect top hose clamps

Install all coolant hoses on the top side of the radiator. Connect the following:

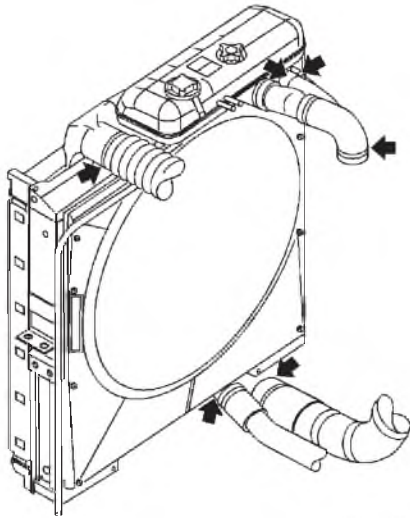
- charge air cooler hose  $7$  mm socket
- low coolant sensor harness  $10$ mm socket

Torque the hose clamps as follows:

- top radiator hose  $5.5 \pm 0.8$  Nm ( $35 \pm 5$  in-lb)
- fill hose clamp  $4 \pm 0.6$  Nm ( $2.3 \pm 0.3$  in-lb)
- small bleed hose clamp  $2.3 \pm 0.3$  Nm ( $20 \pm 3$  nibble)
- charge air cooler hose clamp to  $10 \pm 1.5$  Nm ( $90 \pm 3$  in-lb).



6



W2002063

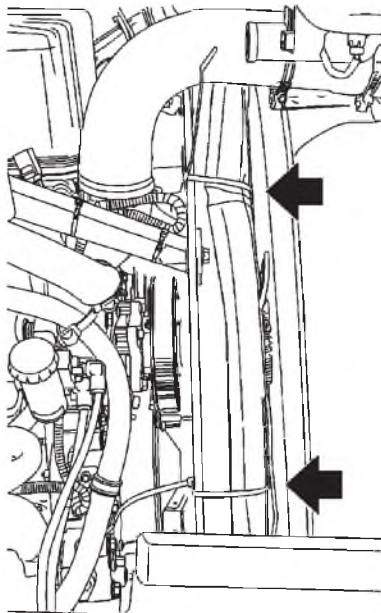
Fig. 42: Connect bottom hose clamps

Install the bottom radiator hose and the lower charge air cooler hose. Torque the hose clamps as follows:

- bottom radiator hose clamp  $5.5 \pm 0.8$  Nm ( $50 \pm 8$  in-lb).
- lower charge air cooler hose clamp  $10 \pm 1.5$  Nm ( $90 \pm 13$  in-lb).

7 mm socket  
10 mm socket torque wrench  
 $5.5 \pm 0.8$  Nm ( $50 \pm 8$  in-lb)  
 $10 \pm 1.5$  Nm ( $90 \pm 13$  in-lb)

7

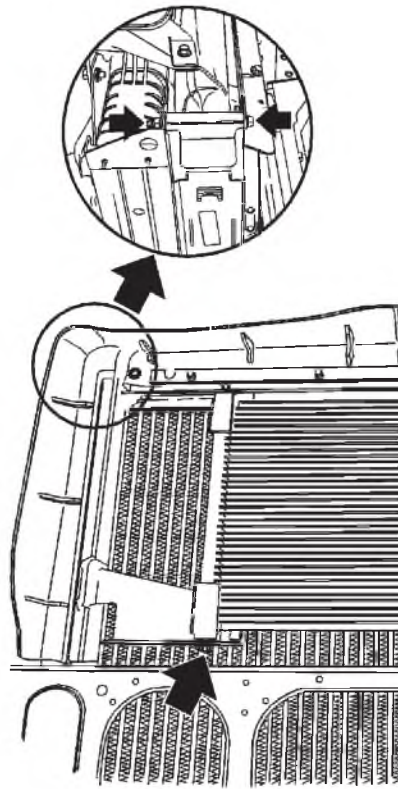


W2002072

Fig. 43: Tie removal

Cut the four ties holding the rubber shrouding away from the radiator.

8



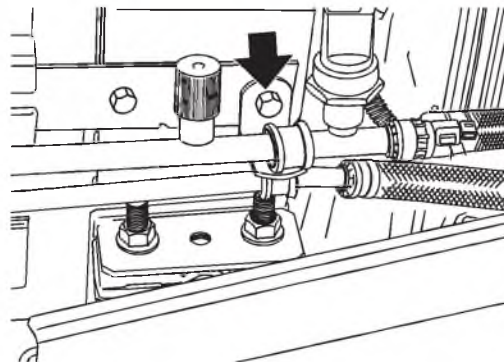
W2002078

Fig. 44: Install mounting brackets

Position the condenser onto the lower mounting brackets. Install the condenser mounting bolts and torque to  $24 \pm 4$  Nm ( $18 \pm 3$  ft-lb). Torque the lower condenser mounting bracket bolts (previously hand tight) to  $24 \pm 4$  Nm ( $18 \pm 3$  ft-lb).

12 mm socket  
 $24 \pm 4$  Nm ( $18 \pm 3$  ft-lb)  
 $24 \pm 4$  Nm ( $18 \pm 3$  ft-lb)

9



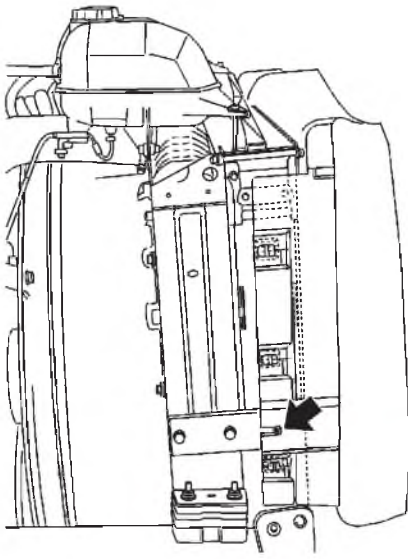
W2002066

Fig. 45: Install air conditioner line clamp

Install the bolt supporting the air conditioner line clamp. Torque the line clamp bolt to  $24 \pm 4$  Nm ( $18 \pm 3$  ft-lb).

12mm wrench  
 $24 \pm 4$  Nm ( $18 \pm 3$  ft-lb)

10

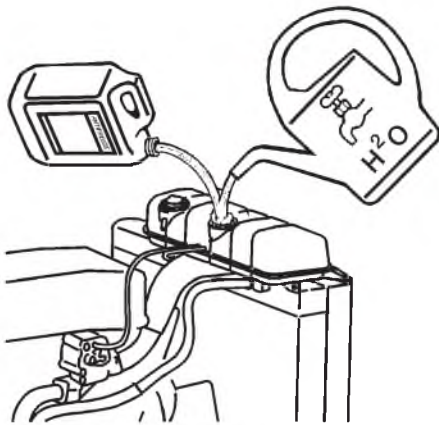


W2002075

Fig. 46: Install head screws

Position the side shroud into place, install two torx head screws and hand tighten. T25 torx bit

11



W2002058

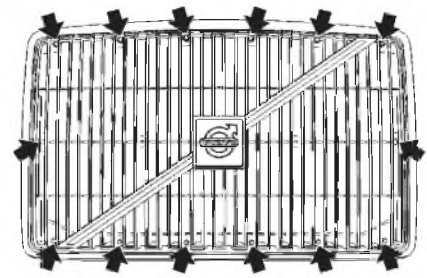
Fig. 47: Add coolant

Add the drained coolant. Maximum fill rate of 9.5 liter per minute (2.5 gallons per minute). For more detailed information on Coolants, refer to;

**TSI** 184-001  
*Coolant Requirements, Volvo Engines*

**IMPACT** Function Group 184  
Information Type: Service and Maintenance  
"Coolant Requirements"

12



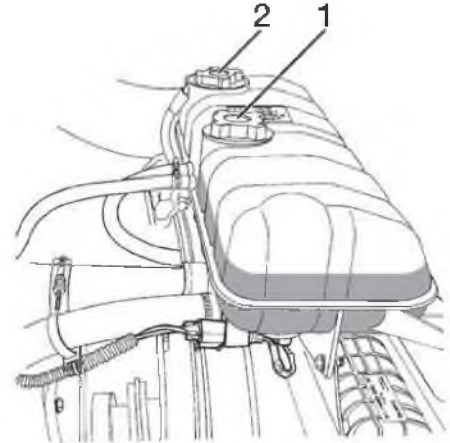
W2002077

Fig. 48: Install grille

Install grille and torque the 14 Torx head screws to 5 Nm (44 in-lb).

T25 Torx bit  
8mm wrench  
5 Nm  
(44 in-lb)

13



W2002104

Fig. 49: Cap replacement

- 1 Fill cap
- 2 Pressure cap (do not remove)

Start engine and check for leaks. Run the engine to operating temperature. After the engine has reached operating temperature, move the heater controls to warm and run the engine an additional 10 minutes.

14

Shut off engine and re-check coolant level.

**Note:** To pressure test the system, see "Cooling System Leak Test, Checking" page 41.

## 2611-06-02-01 Radiator, Checking

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### WARNING

HOT ENGINE! Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

### WARNING

Never remove the cap on the expansion tank while the engine is still hot. Wait until the coolant temperature is below 50° C (120° F). Scalding steam and fluid under pressure may escape and cause serious personal injuries.

### WARNING

Do not work near the fan with the engine running. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured. Before turning on the ignition, be sure that no one is near the fan.

### WARNING

Always wear eye protection when working around batteries to prevent the risk of injury due to contact with sulfuric acid or an explosion.

### *(Checking CAC and Radiator Air Flow-Through)*

**1**  
If coolant temperatures are higher than normal, check the passage of air through the charge air cooler, A/C condenser and radiator. Clean if necessary.

**2**  
Check the radiator to make sure that its external sections are not blocked by insects or other foreign objects which can obstruct airflow. If obstructions are found, use a mild detergent and water to clean them off. If the fins of the pipe system have been bent (by flying stones, etc.), straighten them out.

**3**  
Make sure that the sealing moldings between the fan shroud and the radiator are not loose or for any reason are not providing a good seal. Check the condition of the recirculation shield. Also make sure it is properly installed.

## 2612-03-02-01 Radiator Surge Tank, Replacement

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### WARNING

HOT ENGINE! Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

### WARNING

Never remove the cap on the expansion tank while the engine is still hot. Wait until the coolant temperature is below 50° C (120° F). Scalding steam and fluid under pressure may escape and cause serious personal injuries.

### WARNING

Do not work near the fan with the engine running. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured. Before turning on the ignition, be sure that no one is near the fan.

**WARNING**

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

**Removal**

1

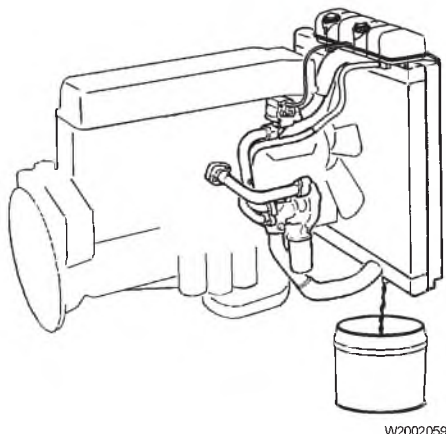


Fig. 50: Draining the coolant system

Open the drain on the bottom of the radiator and drain into a suitable container. Drain coolant below the expansion tank level.

**DANGER**

Risk of poisoning. Coolant is toxic. Do not drink coolant. Use proper eye and hand protection when handling. Keep coolant out of reach of children. Personal injury or death could result.

2

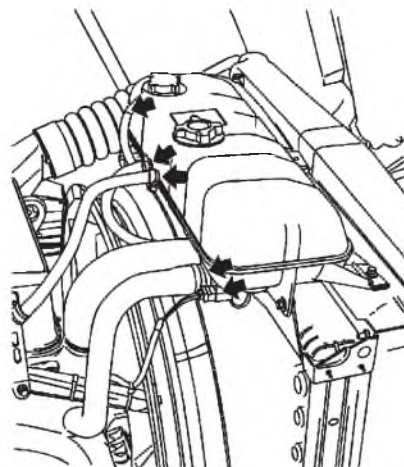


Fig. 51: Remove expansion tank hoses

Remove the four expansion tank hoses: 12 mm socket  
6 in. extension

- overfill tube
- fill line
- air bleed hose (to thermostat housing)
- hose from expansion tank to radiator top tank

Unplug the wire harness to the low coolant sensor.



3

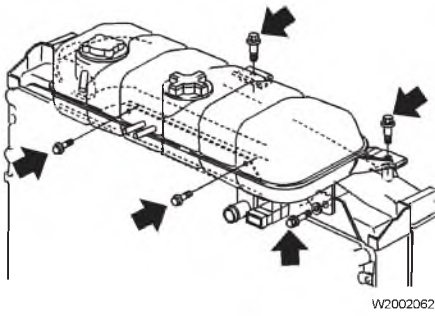


Fig. 52: Remove mounting bolts

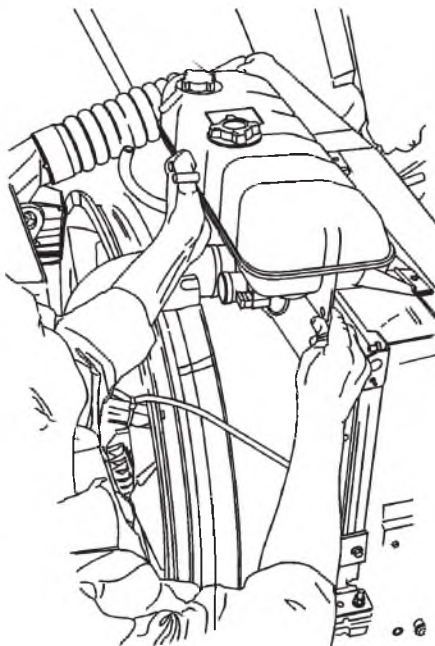


Fig. 53: Lift the expansion tank

Remove the expansion tank mounting bolts (two in the front, three in the rear). Lift away the expansion tank.

12 mm socket

**Installation**

4

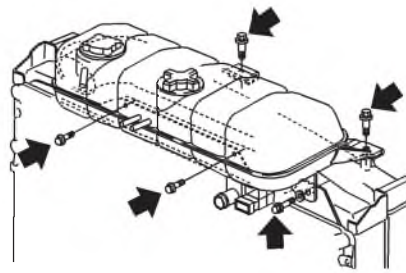


Fig. 54: Install mounting bolts

Position the expansion tank into place and install the five mounting bolts. Torque to 24 ± 4 Nm (18 ± 3 ft-lb).

12 mm socket  
24 ± 4 Nm  
(18 ± 3 ft-lb)

5

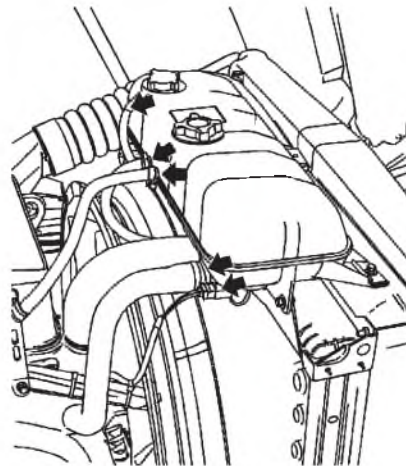


Fig. 55: Connect expansion tank hoses

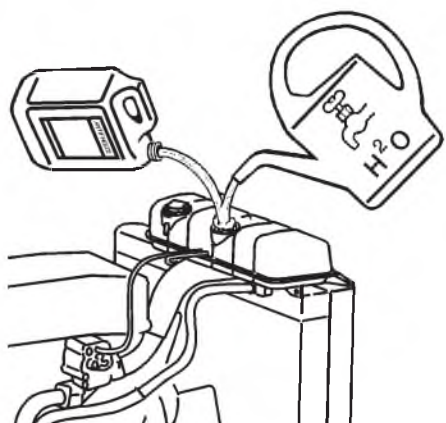
Connect the four expansion tank hoses:

7 mm socket  
screwdriver

- overfill tube
- fill line
- air bleed hose (to thermostat housing)
- hose from expansion tank to radiator top tank

Connect the wire harness to the low coolant sensor.

6



W2002058

Fig. 56: Add coolant

Install the drained coolant. Maximum fill rate of 9.5 l/min (2.5 gpm).

**Note:** For current coolant requirements;

**Service Bulletin** 184-001  
*Coolant Requirements, Volvo Engines*

**IMPACT** Function group 184  
Information type:  
Maintenance  
"Coolant Requirements"

7

Start engine and check for leaks. Run the engine to operating temperature. After the engine has reached operating temperature, move the heater controls to warm and run the engine an additional 10 minutes.

8

Shut off engine and recheck coolant level.

**Note:** To pressure test the system, see "Cooling System Leak Test, Checking" page 41.

## 2619-06-02-01 Cooling System Leak Test, Checking

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### WARNING

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

### WARNING

Never remove the cap on the expansion tank while the engine is still hot. Wait until the coolant temperature is below 50° C (120° F). Scalding steam and fluid under pressure may escape and cause serious personal injuries.

### WARNING

Do not work near the fan with the engine running. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured. Before turning on the ignition, be sure that no one is near the fan.

### WARNING

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

**To be carried out in the vehicle**

**Note:** Before using pressure gauge 9996662, check its operation. Do this by attaching it to an air supply and setting the pressure to 100 kPa (14 psi) with the regulator valve.

**DANGER**

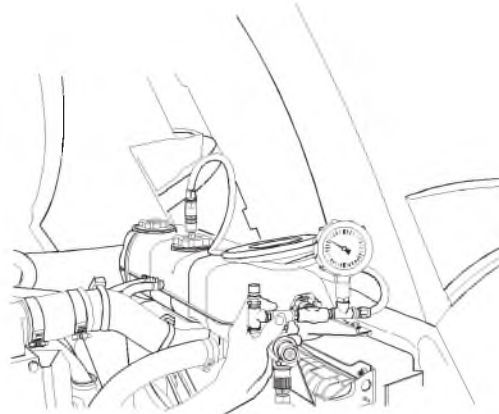
Check that the pressure on the gauge never exceeds 100 kPa (14 psi). Excessive pressure may cause air supply to burst which can cause personal injury or death.

**Procedure**

*Special tools:* 9996049, 9996662

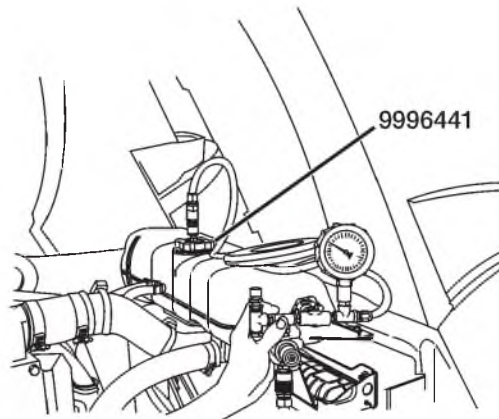
**1**

Check the hoses and connections of the cooling system for leaks and to make sure they are in good working condition.

**2**

W2001430

Fig. 57: Remove fill cap –VN Model



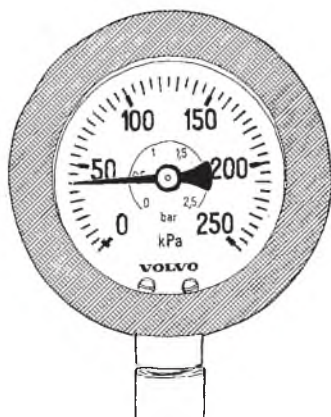
W2003473

Fig. 58: Remove fill cap –VHD Model

Remove the fill cap and install 9996662 pressure regulator, gauge and cap assembly. J-42397

**Note:** Make sure the cooling system is full of coolant before performing this test.

3

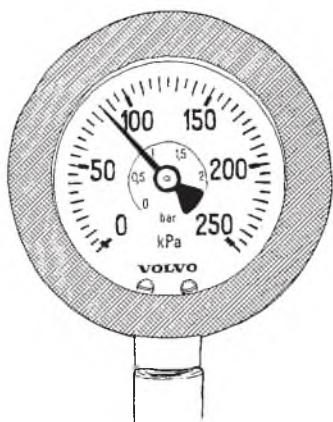


T2007258

Fig. 59: Increase pressure to 40 kPa (6 psi)

Using the knob of the reduction valve, slowly increase pressure to 40 kPa (6 psi). Maintain this pressure for approximately 5 minutes. Look over the entire engine, radiator, and coolant hoses for any leaks and then perform a leakage check on the radiator, hoses, connections, and the coolant pump.

4



T2007257

Fig. 60: Increase pressure to 100 kPa (14 psi)

Slowly increase the pressure to 100 kPa (14 psi) and check that the valve opens. At this pressure, the air flow should be continuous. End this test after approximately 10 seconds.

5

Slowly release the pressure from the cooling system. Remove the cap assembly and replace the fill cap.

## 2621-03-02-01 Coolant Pump, Replacement

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### WARNING

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

### WARNING

Never remove the cap on the expansion tank while the engine is still hot. Wait until the coolant temperature is below 50° C (120° F). Scalding steam and fluid under pressure may escape and cause serious personal injuries.

### WARNING

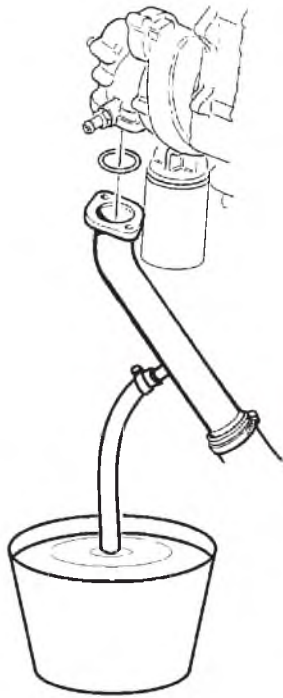
Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

*Special tools: 9996049*



## Removal

1



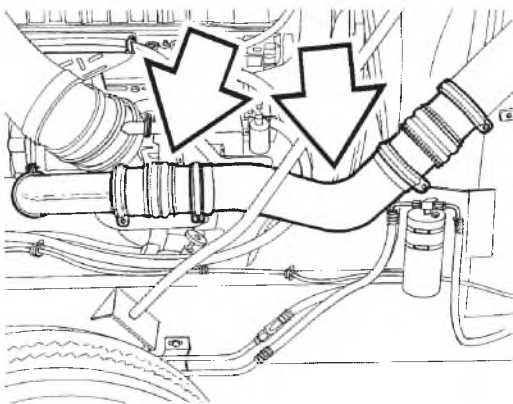
W2003324

Fig. 61: Draining the coolant

Attach hose 9996049 to lower coolant pipe and drain the coolant into a suitable container. 9996049

**Note:** If the coolant is not reusable, dispose of used coolant in a proper and responsible manner according to EPA and local environmental regulations

2



W2003334

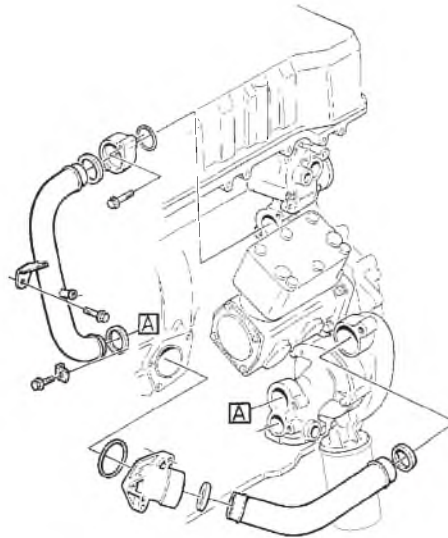
Fig. 62: Charge air cooler piping

Remove charge air cooler pipe and mounting brackets.

3

Remove the elbow outlet from the turbocharger.

4



W2003328

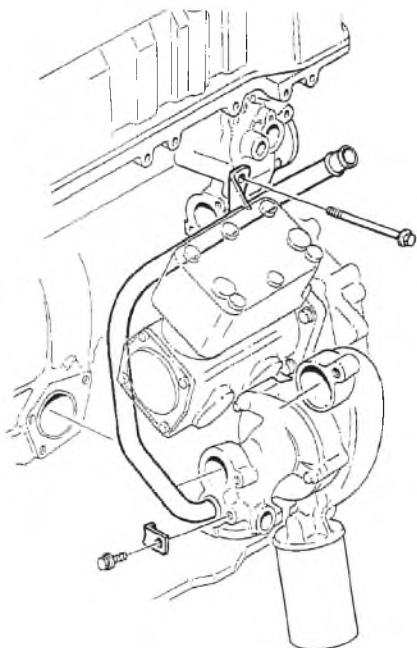
Fig. 63: Removing coolant pipes

Remove the pipe between the coolant pump and the cover over the oil cooler.

5

Remove the pipe between the pump and the thermostat housing.

6



W2003329

Fig. 64: Bolt location

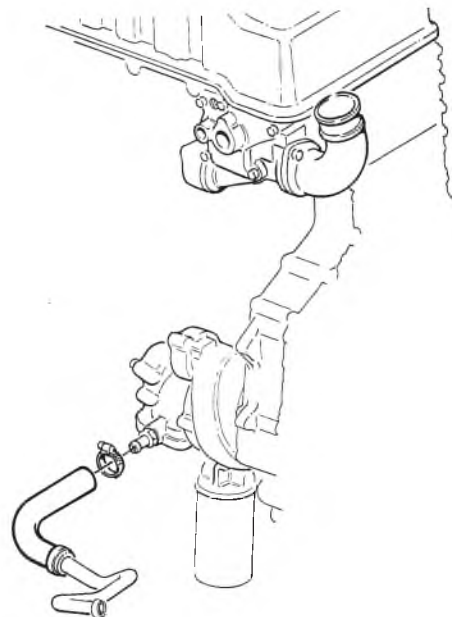
Remove the bolt beside the thermostat housing holding the pipe between coolant pump and the expansion tank.

7

Remove the bolt from the coolant pump and pull the pipe out of the pump.

**Note:** The bolt beside the thermostat housing runs through a bracket on the pipe. With the air compressor in position, the pipe cannot be removed.

8



T2007246

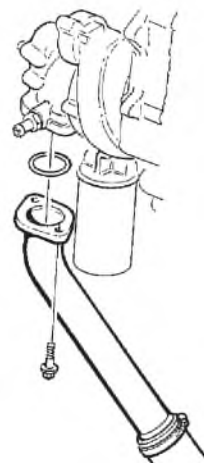
Fig. 65: Heater hose location

Remove the heater hose from the coolant pump.

9

Remove the drain hose from the lower coolant pipe.

10



W2003330

Fig. 66: Lower radiator pipe location

Remove the bolts holding the lower coolant pipe to the pump.

**Note:** Leave the pipe attached to the lower radiator hose.

**11**  
Remove the coolant filter hoses.

**12**

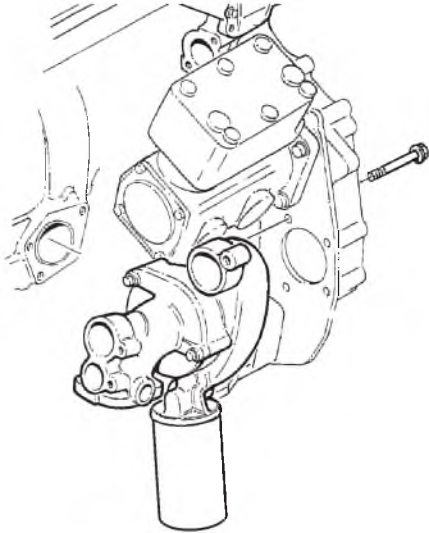


Fig. 67: Removing coolant pump W2003332

Remove the bolts and lift off the coolant pump.

**13**  
Remove the adapter for the remote coolant filter from the bottom of the coolant pump.

**Installation**

**1**  
Clean all sealing surfaces.

**2**

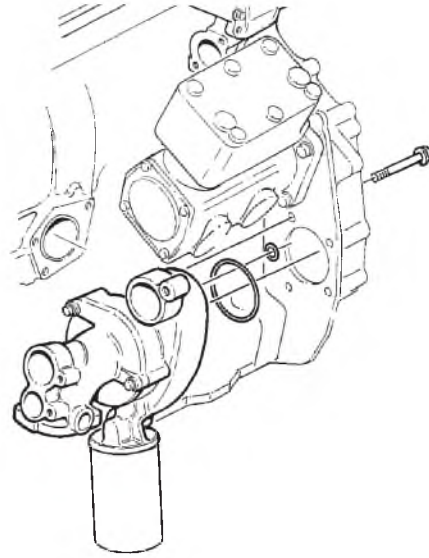


Fig. 68: Installing coolant pump W2003331

Install the new coolant pump using new seals. Tighten the bolts to  $48 \pm 8$  Nm ( $35 \pm 6$  ft-lb).

**3**

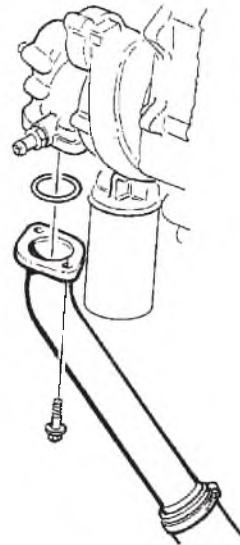
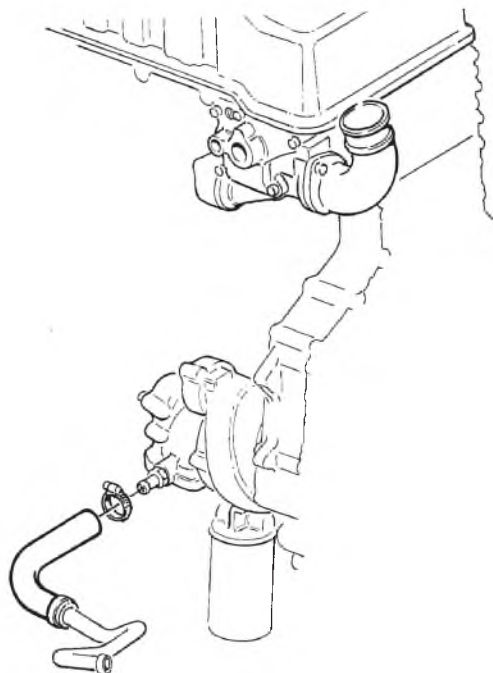


Fig. 69: Pipe from radiator to coolant pump W2003330

Install the pipe from the radiator to the coolant pump using a new sealing ring.

4



T2007246

Fig. 70: Heater hose connection

Connect the heater hose to the coolant pump and tighten the hose clamp.

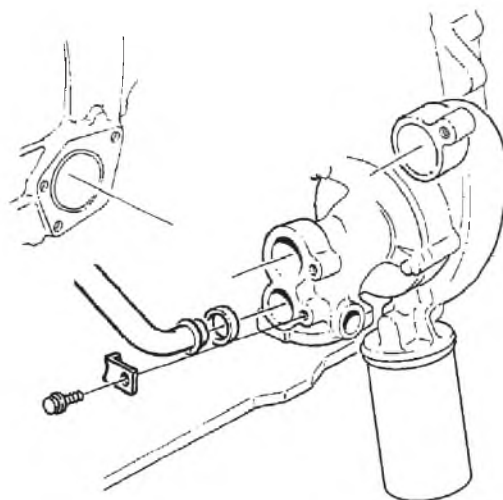
5

Reinstall the coolant filter.

6

Connect the remote-mounted coolant filter hoses to the adapter and tighten the hose clamps.

7



W2003333

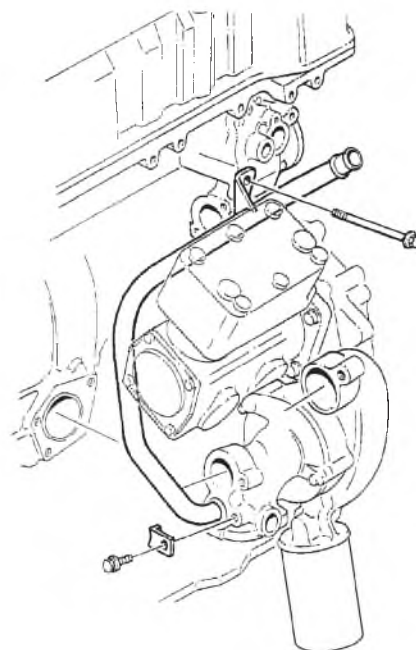
Fig. 71: Install sealing ring

Install a new sealing ring to the pipe from the expansion tank and bolt the pipe to the coolant pump.

8

Coat the sealing ring with soapy water to make installing the pipe into the coolant pump easier.

9

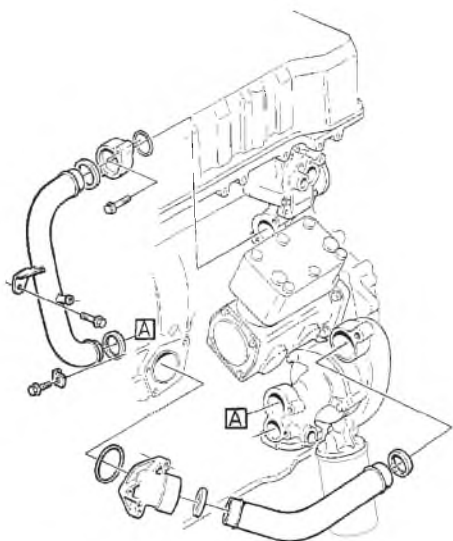


W2003329

Fig. 72: Bolt location

Install the bolt holding the pipe beside the thermostat housing.

10



W2003328

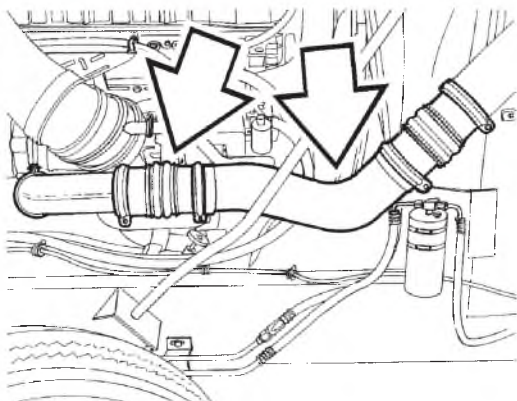
Fig. 73: Installing coolant pipe

Using new sealing rings, install the pipe between the coolant pump and the thermostat housing and the pipe between the coolant pump and the oil cooler cover.

11

Coat the sealing rings with soapy water.

12



W2003334

Fig. 74: Charge air cooler piping

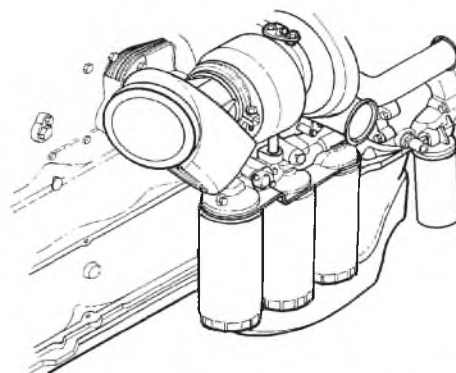
Reinstall the charge air cooler pipe and mounting brackets.

13

Reinstall the elbow outlet on the turbocharger.

48

14



W2003335

Fig. 75: Coolant filter

Install a new coolant filter on the coolant pump.

15

Fill the system with coolant.

16

Start the engine and check the cooling system for leaks.

## 2621-04-04-01 Coolant Pump, Overhaul

### (Unit Removed)

**⚠ DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**⚠ WARNING**

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

**⚠ WARNING**

Never remove the cap on the expansion tank while the engine is still hot. Wait until the coolant temperature is below 50° C (120° F). Scalding steam and fluid under pressure may escape and cause serious personal injuries.



**! WARNING**

Do not work near the fan with the engine running. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured. Before turning on the ignition, be sure that no one is near the fan.

**! WARNING**

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

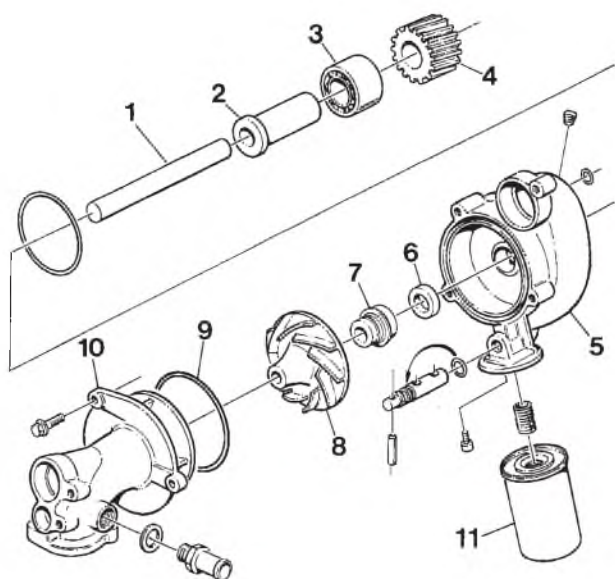


Fig. 76: Exploded view of coolant pump

**Note:** Reference is made in the text to component positions as shown in picture.

- 1 Shaft
- 2 Shaft sleeve
- 3 Ball Bearing
- 4 Gear
- 5 Pump Housing
- 6 Oil Sealing Ring
- 7 Coolant Sealing Ring
- 8 Impeller
- 9 O-ring
- 10 Rear Cover
- 11 Coolant Filter

**Special tools:** 9992071, 9992671, 9994034, 9994090, 9996222, 9996315, 9996383,

9996626, 9996883, 9996884, 9998012, 9998039, 9998113, 9996671

## Disassembly

**1**  
Remove the coolant filter (11), using filter wrench 9996671. Remove the rear cover (10); see Fig. 76: Exploded view of coolant pump, page 49.

**2**

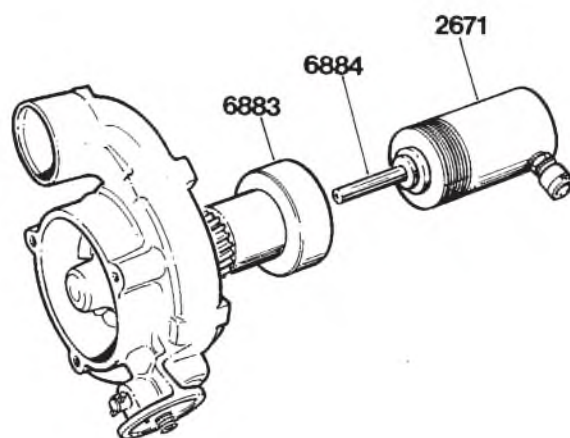


Fig. 77: Attaching tools to coolant pump

Screw adapter 9996883 into the shaft sleeve (2) of the coolant pump and thread drift 9996884 onto hydraulic cylinder 9992671; see Fig. 76: Exploded view of coolant pump, page 49.

**3**

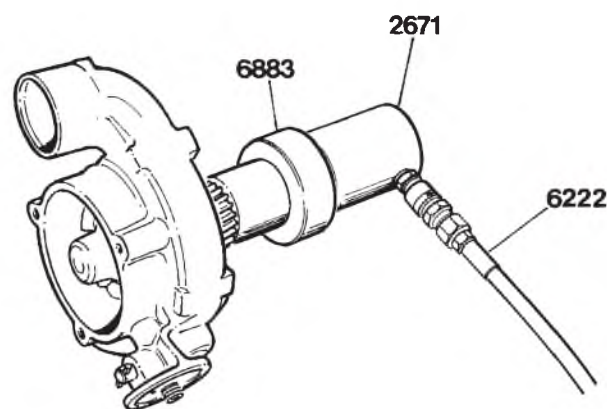


Fig. 78: Removing the shaft

Assemble the hydraulic cylinder and the adapter. Using hydraulic pump 9996222, press out the shaft (1) the impeller (8) and the seal (7); see Fig. 76: Exploded view of coolant pump, page 49.

4

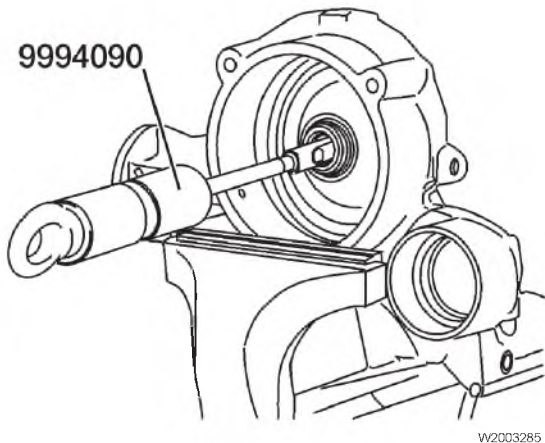


Fig. 79: Coolant seal, removal

If parts of the coolant seal do not come out with the shaft when pressing this out, use puller 9994090 to remove the rest of the sealing ring.

9994090

5

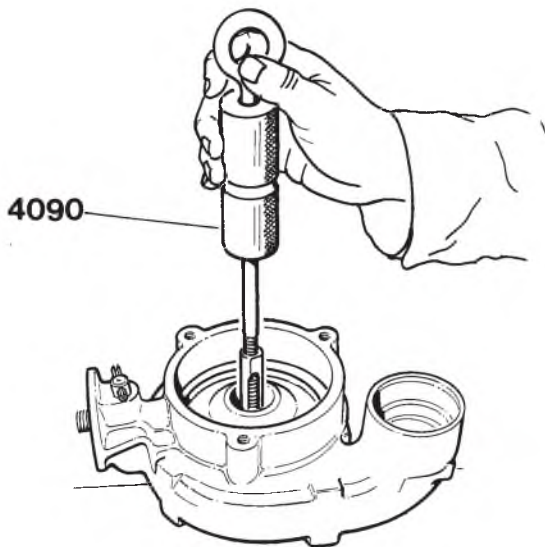


Fig. 80: Removing the oil sealing ring

Remove the seal (6) using tool 9994090; see Fig. 76: Exploded view of coolant pump, page 49.

9994090

6

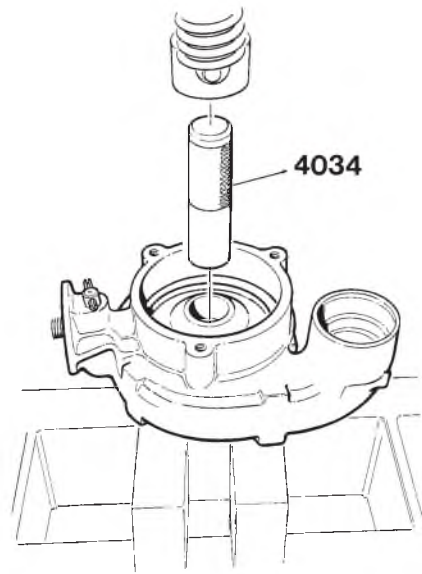


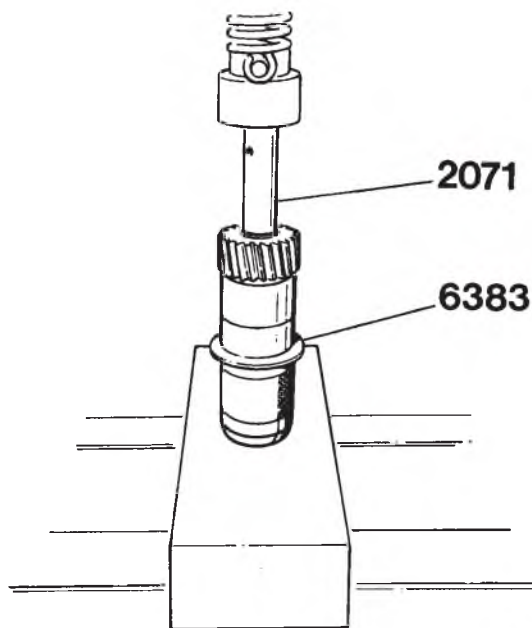
Fig. 81: Removing shaft sleeve, drive gear and bearing

Place the pump housing in a press. Using 9994034, carefully press out the shaft sleeve (2) together with the drive gear (4) and bearing (3); see Fig. 76: Exploded view of coolant pump, page 49.

T2007109

9994034

7

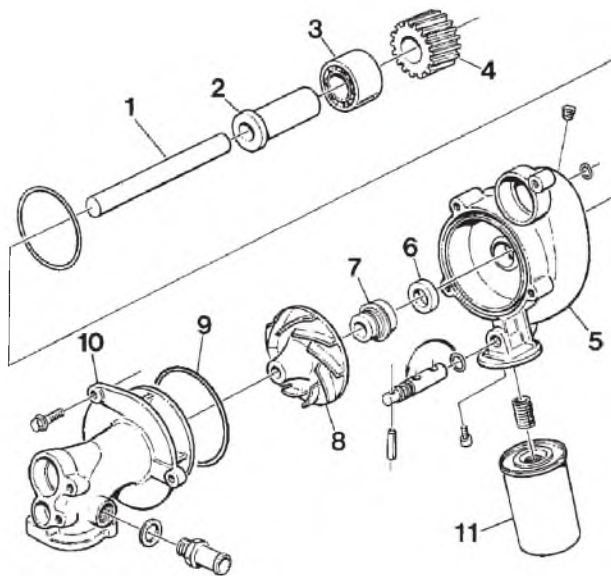


T2007248

Fig. 82: Removing the shaft sleeve from drive gear

Using 9992071 and 9996383, press the shaft sleeve (2) out of the drive gear (4); see Fig. 76: Exploded view of coolant pump, page 49.

## Cleaning and Inspection



T2007117

Fig. 83: Exploded view of coolant pump

**1**  
Clean all parts which are to be reused.

**2**  
The seals and bearing must always be changed. Check the fit of the bearing races to the pump housing and shaft sleeve.

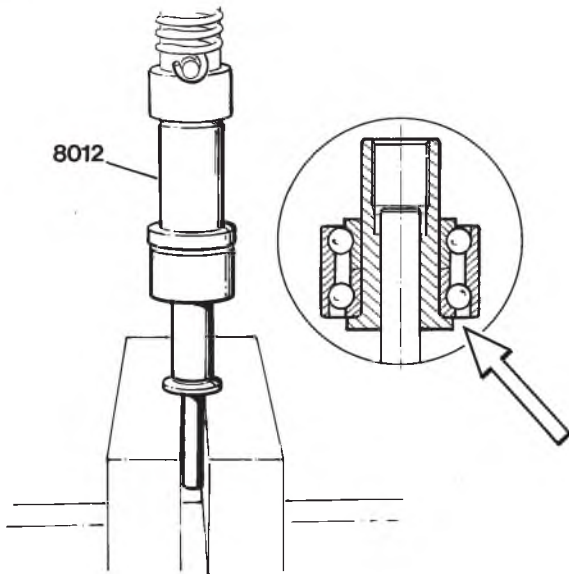
**Note:** If the impeller is damaged, it must be replaced.

**Note:** If the pump housing or rear cover is to be replaced, transfer pipe fittings to the replacement unit, etc.



## Assembly

1



T2007111

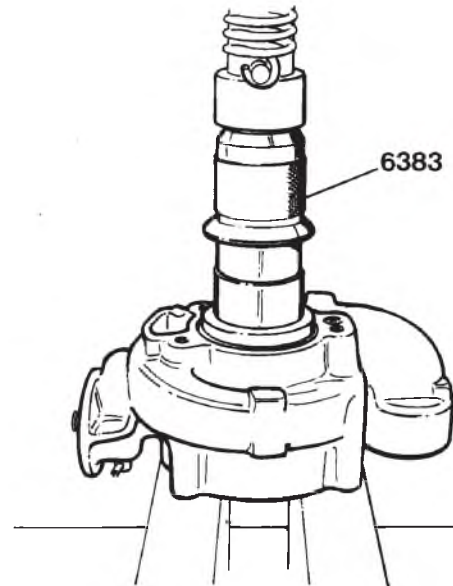
Fig. 84: Installing bearing to shaft sleeve

Install the new bearing (3) to the shaft sleeve (2) and, using hollow drift 9998012, carefully press down on the inner race of the bearing until it lies up against the flange of the shaft sleeve; see Fig. 83: Exploded view of coolant pump, page 51.

9998012

**Note:** Install the bearing with the side at which the outer and inner races are level facing the flange of the shaft sleeve. The shaft (1) and the shaft sleeve (2) are supplied as a single spare part unit; see Fig. 83: Exploded view of coolant pump, page 51.

2



T2007112

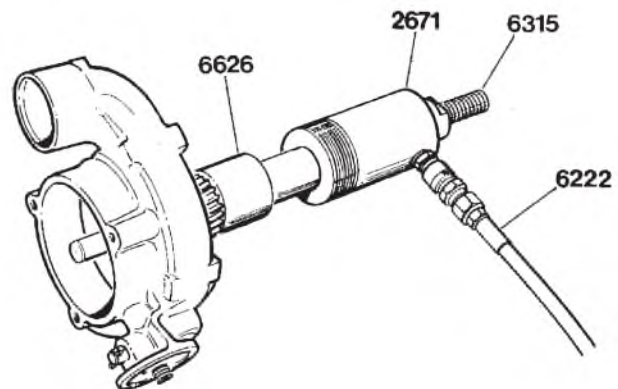
Fig. 85: Installing bearing and shaft into pump

Place the pump housing (5) in a press. Using hollow drift 9996383, carefully press in the bearing and shaft until the bearing bottoms out in the pump housing; see Fig. 83: Exploded view of coolant pump, page 51.

9996383

**Note:** Press on the outer race of the bearing and check to make sure that the shaft does not hit the press table.

3



T2007119

Fig. 86: Press drive gear onto shaft

Screw the shorter threaded section of spindle 9996315 into the shaft sleeve (2); see Fig. 83: Exploded view of coolant pump, page 51.

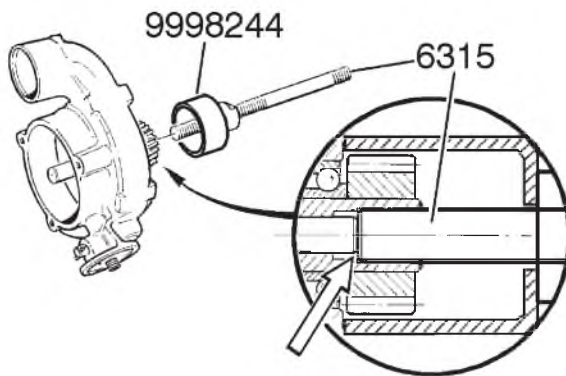
9996315

**4**  
Place the drive gear (4), hollow drift 9996266 and hydraulic cylinder 9992671 on the spindle and install the nut; see Fig. 83: Exploded view of coolant pump, page 51.

**5**  
Using hydraulic pump 9996222, carefully press the drive gear down until it bottoms out against the bearing. 9996222

**6**  
Remove the tools

**7**



T2012619

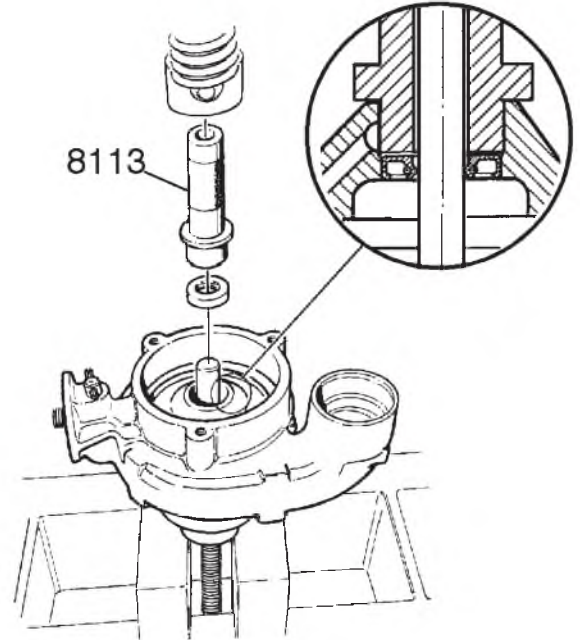
Fig. 87: Using tool 9996315

Insert the spindle 9996315 through the hole of sleeve 9998244 and screw the long threaded end of the spindle into the shaft until it bottoms out against the shaft. Tighten the nut by hand. 9996315 9998244

**Note:** Make sure that the spindle 9996315 is threaded in until it bottoms out against the shaft before tightening the nut.

**8**  
Install the pump in a press so that the spindle's nut rests flat against the surface of the press.

**9**



T2012620

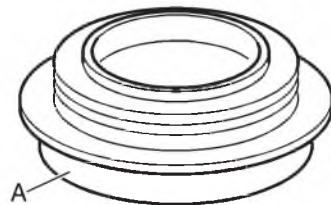
Fig. 88: Installing the oil seal

Install the oil seal (6) with the sealing lip against the drive gear; see Fig. 83: Exploded view of coolant pump, page 51.

**10**  
Using drift 9998113, carefully press the seal into position until it is level with the edge of the pump housing. 9998113

**Note:** Do not press in the drift until it hits the pump housing.

**11**

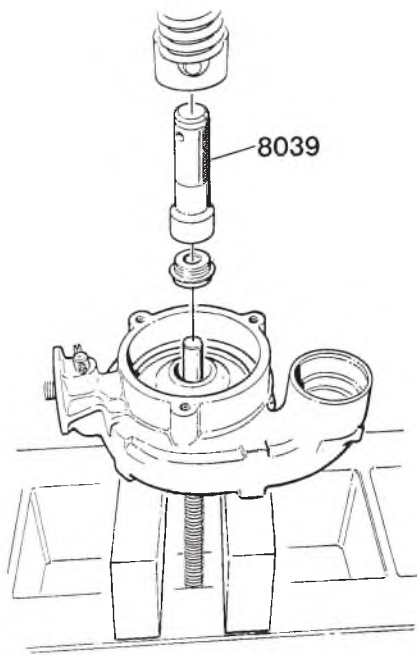


T2012621<sub>M</sub>

Fig. 89: Coolant seal, applying Loc-Tite

Apply Loc-Tite™ locking fluid to the coolant seal's contact surface (A) against the housing.

12



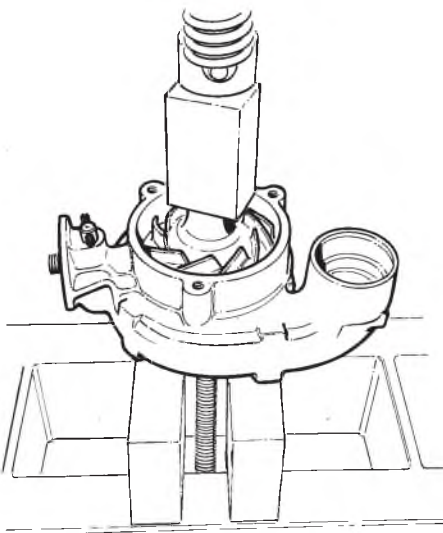
T2007262

Fig. 90: Installing the coolant seal

Carefully press in the coolant seal using the drift 9998039.

**Note:** To prevent damage due to excessive pressing force, pressure should be removed when the seal flanges out against the housing.

13



T2007115

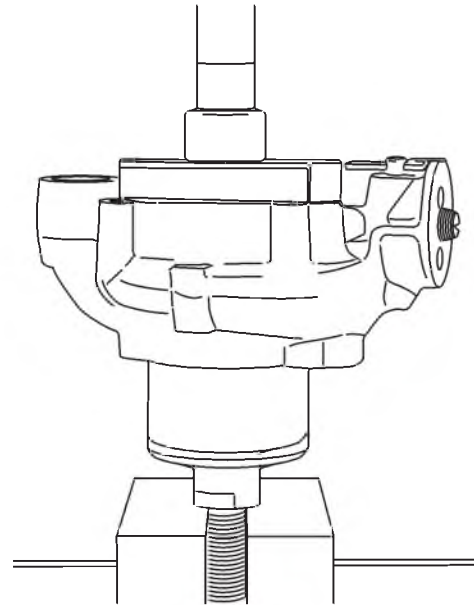
Fig. 91: Installing new impeller

Place the pump with the spindle nut resting on a flat surface.

14

Press the impeller approximately 10 mm (1/2 in.) on to the shaft.

15



W2003286

Fig. 92: Pressing on the impeller

Install the tool 9998541 on the impeller and carefully press it down until the tool rests against the pump housing.

16

Remove the spindle 9996315 from the shaft sleeve.

17

Install the rear cover using a new O-ring in the pump housing.

**Note:** Turn the drive gear and check that it rotates easily. Bearing noise or axial play is not permitted.

18

Install a new coolant filter. Coat the filter gasket with a light film of grease and hand tighten only.

## 2627-03-02-01 Thermostat, Replacement D12, D12A, D12B

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### WARNING

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

### WARNING

Never remove the cap on the expansion tank while the engine is still hot. Wait until the coolant temperature is below 50° C (120° F). Scalding steam and fluid under pressure may escape and cause serious personal injuries.

### WARNING

Do not work near the fan with the engine running. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured. Before turning on the ignition, be sure that no one is near the fan.

### WARNING

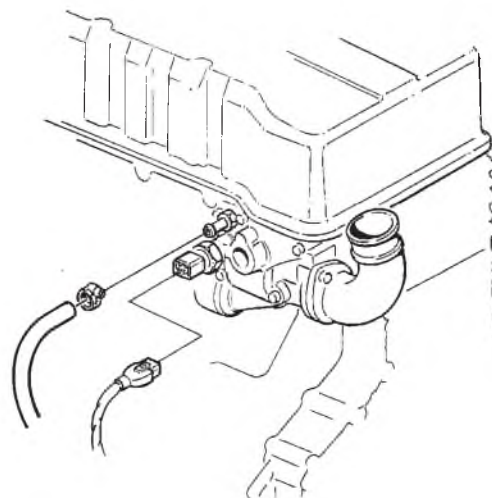
Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

*Special tools: 9996049 , 9998291*

**1**  
Using drain hose 9996049, drain the coolant into suitable container.

**2**  
Remove the pipe between the air cleaner housing and the turbo-compressor.

**3**



T2007264

Fig. 93: Removing hoses from thermostat housing

Remove the expansion tank hose and the connector for the temperature sensor from the thermostat housing.

**4**

Remove the fan ring stay bolt holding the upper radiator cooling pipe.

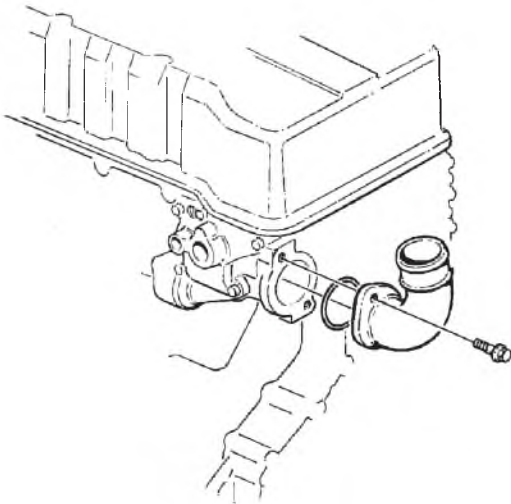
**5**

Remove the bolt from the thermostat housing and timing gear cover which hold the pipe to the cab heat exchanger.

**6**

Loosen the cooling coil nut from the air compressor. Remove the bolt holding the cooling coil bracket to the timing gear cover and push the coil to one side.

7



T2007234

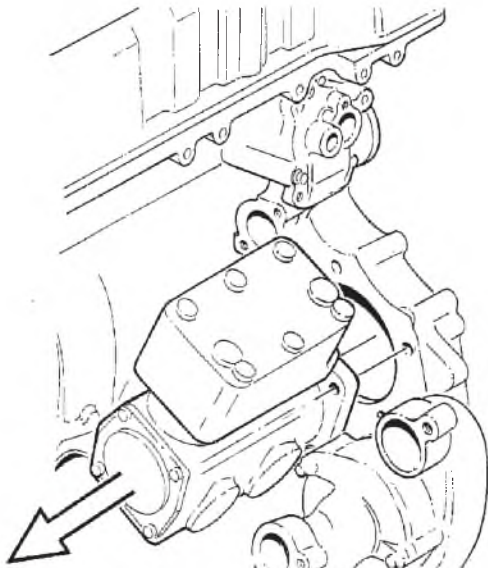
Fig. 94: Removing the upper radiator hose elbow

Remove the upper radiator hose connecting pipe from the thermostat housing.

8

Remove all of the coolant/air/oil lines from the air compressor.

9



T2007250

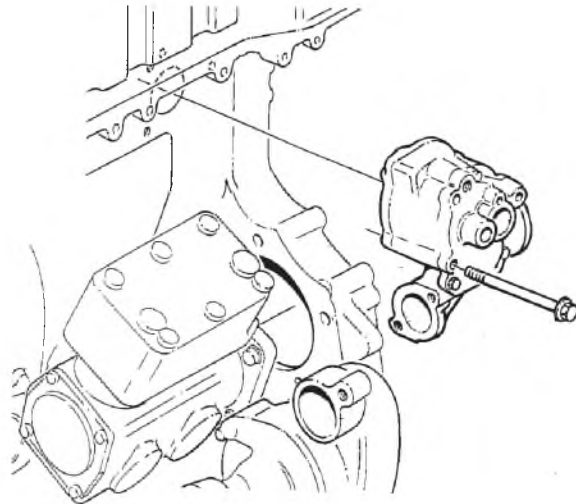
Fig. 95: Rotate the air compressor

Remove the air compressor attaching bolts and rotate the compressor out far enough to allow clearance to remove the thermostat housing.

10

Remove retaining bolts holding "C" shaped cooling pipe attached to rear of thermostat housing.

11

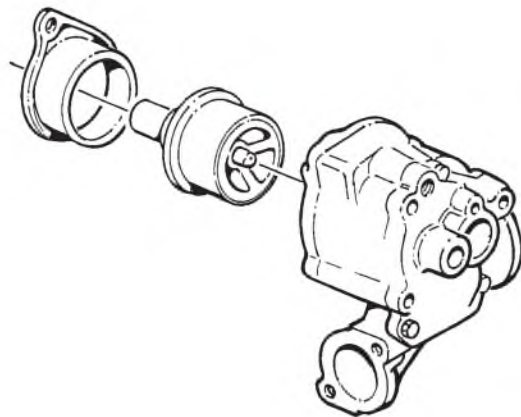


T2007235

Fig. 96: Removing the housing

Remove the bolts and the thermostat housing.

12



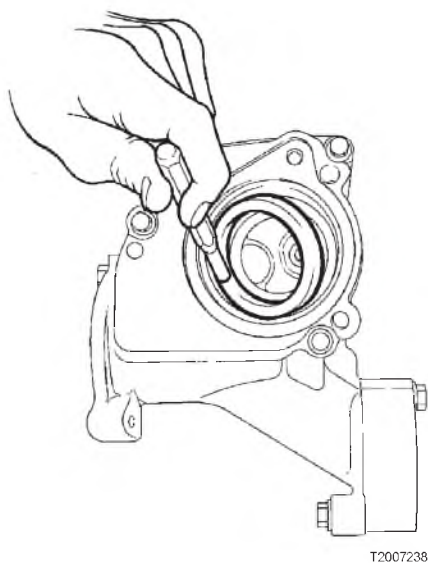
T2007236

Fig. 97: Removing the thermostat

Remove the thermostat from the thermostat housing.



13



T2007238

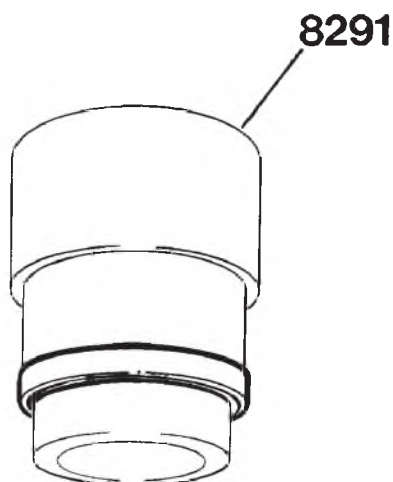
Fig. 98: Removing the sealing ring

Remove the sealing ring from the thermostat housing by tapping with a drift until it tips over and can be removed.

14

Clean the sealing surfaces of the thermostat housing and the sealing surfaces of the cylinder head and pipe connections.

15



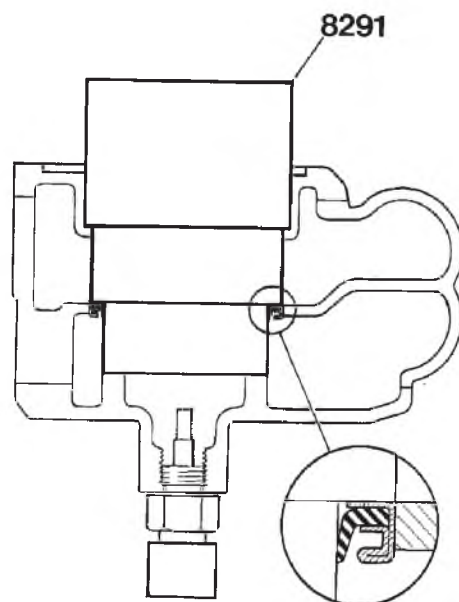
T2007243

Fig. 99: Installing a new sealing ring

Install a new sealing ring to drift 9998291.

**Note:** The sealing ring must be installed with the broad metal plate facing the ledge on the drift.

16

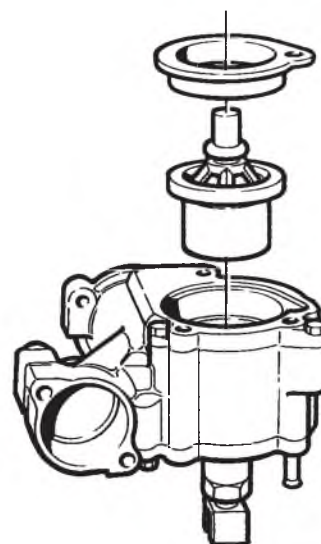


T2007242

Fig. 100: Installing a new sealing ring

Using drift 9998291, carefully tap the sealing ring in until it bottoms out in the housing.

17



T2007237

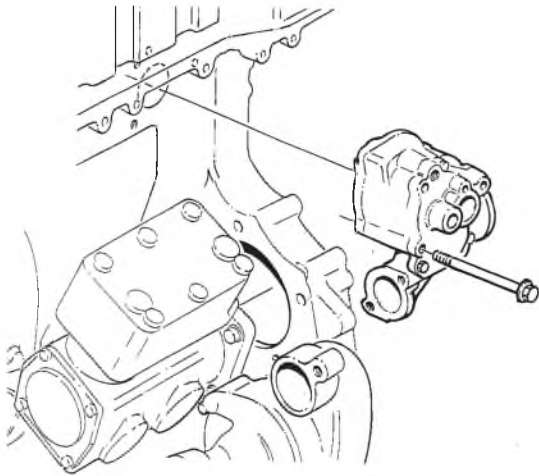
Fig. 101: New thermostat and seal

Install a new thermostat and a new seal into the housing.

18

Remove the bolts holding the spacer between the coolant pump and the thermostat housing. Install a new sealing ring to the spacer and coat it with grease.

19



T2007235

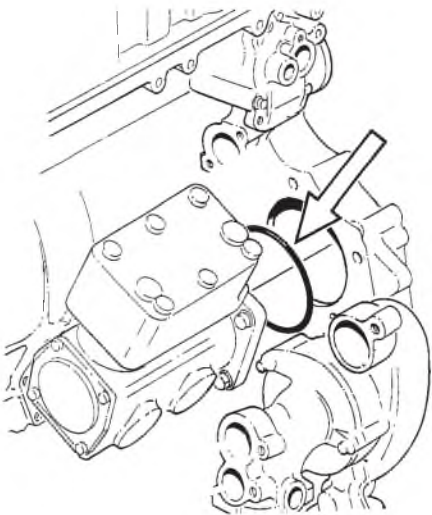
Fig. 102: Reattaching the thermostat housing

Install and attach the thermostat housing to the cylinder head.

20

Push the pipe from the coolant pump into the thermostat housing entry and install the bolts holding the pipe.

21



T2007240

Fig. 103: New air compressor seal

Install a new seal between the air compressor and the timing gear plate. Attach the air compressor.

22

Reinstall all of the coolant/air/oil lines to the air compressor.

23

Install the pipe between the radiator and the thermostat housing. Use a new sealing ring.

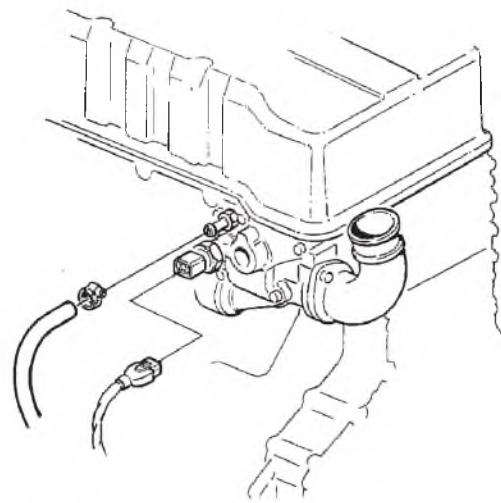
24

Attach the cab heater pipe to the thermostat housing. Install a new sealing ring.

25

Attach the fan ring stay.

26



T2007264

Fig. 104: Reattaching the hoses to thermostat housing

Plug in the temperature sensor connector and attach the expansion tank hose.

27

Fill with coolant and carry out a leakage check.

## 2627-03-02-01 Thermostat, Replacement

### D12C

#### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

#### WARNING

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

#### WARNING

Never remove the cap on the expansion tank while the engine is still hot. Wait until the coolant temperature is below 50° C (120° F). Scalding steam and fluid under pressure may escape and cause serious personal injuries.

#### WARNING

Do not work near the fan with the engine running. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured. Before turning on the ignition, be sure that no one is near the fan.

#### WARNING

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

*Special tools: 9996049, 9998619, 9998511  
Other special equipment: 945408, 946173,  
949873, 955894*

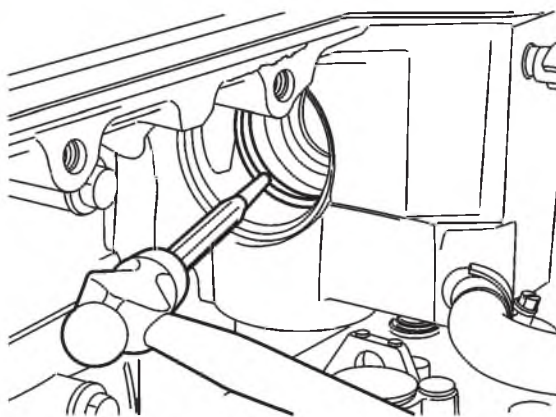
**1**  
Drain off the coolant with drain hose 9996049.

**2**  
Remove the two bolts for the exhaust collector pipe located next to the thermostat housing.

**3**  
Remove the thermostat housing from the engine.

**4**  
Remove piston thermostat from the cylinder head.

**5**



WZ003428

Fig. 105: Remove the sealing ring

Remove the sealing ring from the cylinder head, tapping the sealing ring with a drift so that it is lifted up and can be removed.

**6**  
Clean all the sealing surfaces and pipe connections.



7

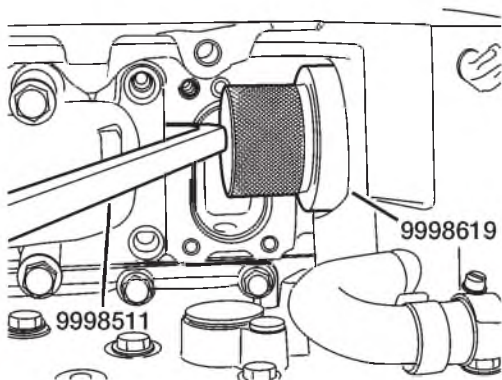


Fig. 106: Checking that the sealing ring is correctly positioned

Place a new sealing ring on drift 9998619 9998619.

**Note:** The ring should be turned with the wide plate edge facing the shoulder of the drift.

8

Install the thermostat housing and tighten the bolts by hand.

9

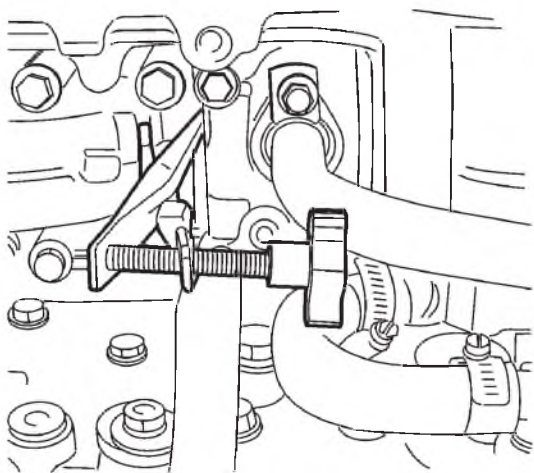


Fig. 107: Thermostat housing remove tool

Press drift J-44772 into the cylinder head until the drift reaches the bottom of the cylinder head. J-44772

10

Install the new piston thermostat. Lubricate the seal on the piston thermostat with soapy water.

11

Install the thermostat housing and tighten the bolts by hand.

**Note:** Make sure that the gasket to the cylinder head is correctly positioned. Use a new gasket.

12

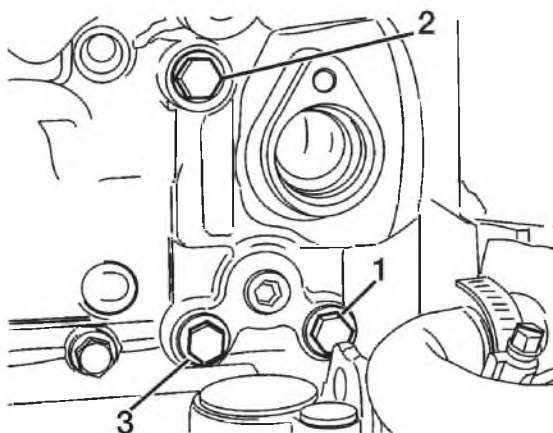


Fig. 108: Tighten the thermostat housing bolts in the sequence shown

Tighten the thermostat housing's bolts in the sequence shown in the illustration (1-2-3). Tighten to a torque as per the specifications for standard bolts.

**Note:** Remember to remove the tensioning bolt (M8x20).

13

Install the bolts between the exhaust manifold and the thermostat housing until they push against the seal. Tighten to the specified torque.

14

Connect the remaining coolant line.

15

Fill with approved coolant.

16

Start the engine.

Run the engine until it is at operating temperature. Then run at 1800 rpm and check for leaks.

## 2627-06-05-01 Thermostat, Checking

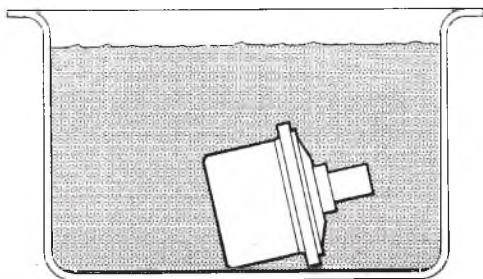
### WARNING

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

A function check must be carried out before installing a new thermostat.

**Note:** Check to be sure that the thermostat closes fully. This can be done by holding it up to the light to check that there is no visible gap at the opening point. If the thermostat does not close properly, replace it.

1



T2007256

Fig. 109: Checking the thermostat

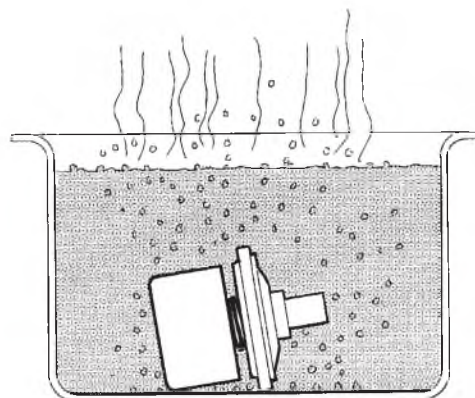
Warm up water in a receptacle to 75 °C (167° F) and immerse the thermostat in the water as illustrated.

Use a piece of wire attached to the thermostat.

2

After at least 30 seconds, check that the thermostat is still closed.

3



T2007255

Fig. 110: Checking the thermostat

Now warm the water to 100° C (212° F). After at least 30 seconds at boiling point, check that the thermostat has opened at least 7 mm (9/32 in). If the thermostat has not opened, it must be replaced. A good thermostat starts to close at 95° C (203° F) and is fully closed at approximately 85° C (185° F).

## 2631-03-02-01 Viscous Fan, Replacement

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### WARNING

HOT ENGINE! Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

### WARNING

Never remove the cap on the expansion tank while the engine is still hot. Wait until the coolant temperature is below 50° C (120° F). Scalding steam and fluid under pressure may escape and cause serious personal injuries.

**⚠ WARNING**

Do not work near the fan with the engine running. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured. Before turning on the ignition, be sure that no one is near the fan.

**⚠ WARNING**

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

**(Includes removal and installation of fan blade.)**

**Note:** Before replacing the fan, carry out a function check. See "Viscous Fan, Checking" page 68.

**Removal**

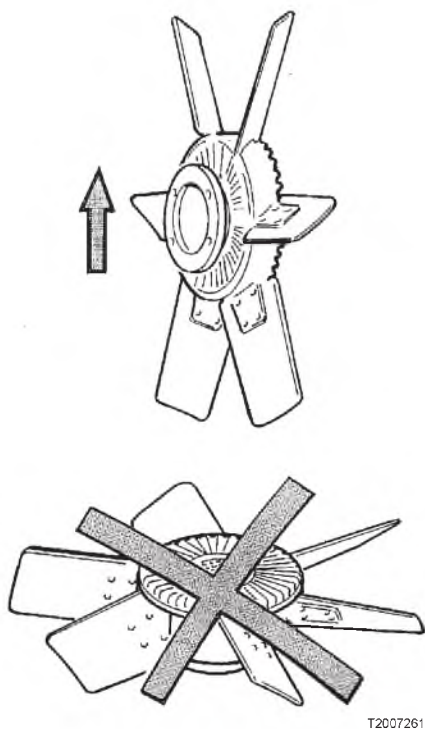


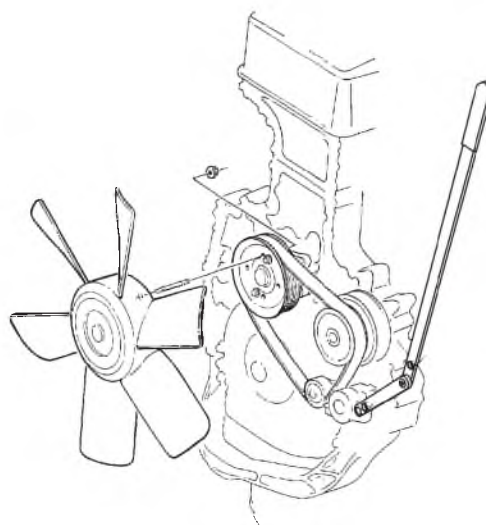
Fig. 111: Proper storage of fan

The temperature controlled fan is filled with a precise amount of silicone fluid; this determines its functional properties. When out of the vehicle, the temperature controlled fan must always be stood vertically. If placed horizontally, leakage will occur and the fan will lose its properties. Before replacing a fan, always make sure that the new fan has not leaked fluid. If fluid has leaked out, special instruments are required to check both engagement temperature and fan speed.

**Special tools:** J-44392

- 1** Remove the charge air hose between the charge air cooler and inlet pipe, or where applicable, between the charge air cooler and starting heater.
- 2** Remove the bolts holding the fan ring.

**3**



W2003337

Fig. 112: Removing the fan

Using the Belt Tensioner Release Tool, J-44392, loosen the drive belt. Remove the fan nuts and lower the fan carefully into the fan shroud.

**Note:** Some engines may have the belt tensioner mounted on the other side, compared to shown picture

- 4** Remove the studs from the fan hub and carefully lift the fan out. Stand the fan vertically to avoid leakage of fluid.

## Installation

**1**  
Place the new fan in the fan shroud.  
Install the studs.

**2**

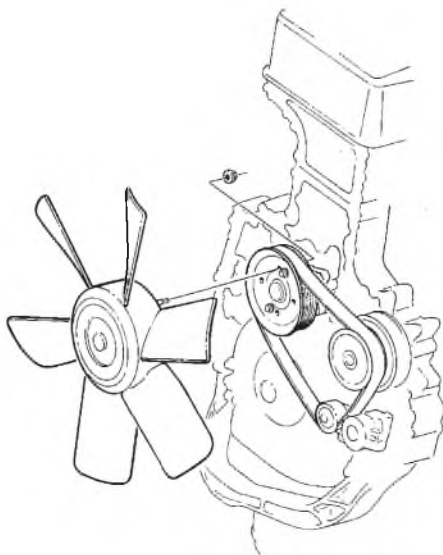


Fig. 113: Installing the fan

Lift the fan into position. Install and tighten the nuts. Make sure that the drive belt runs properly in the pulleys. Remove the lever.

**3**  
Install the bolts for the fan ring.

**4**  
Install the charge air hose using new seals.

## 2634-03-02-01 Fan Belt Tensioner, Replacement

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### WARNING

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

### WARNING

Never remove the cap on the expansion tank while the engine is still hot. Wait until the coolant temperature is below 50° C (120° F). Scalding steam and fluid under pressure may escape and cause serious personal injuries.

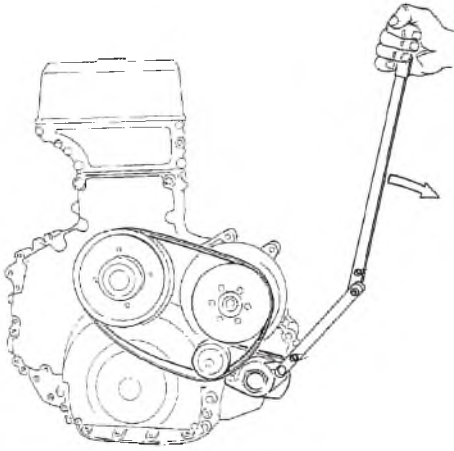
### WARNING

Do not work near the fan with the engine running. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured. Before turning on the ignition, be sure that no one is near the fan.

### WARNING

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

## Removal



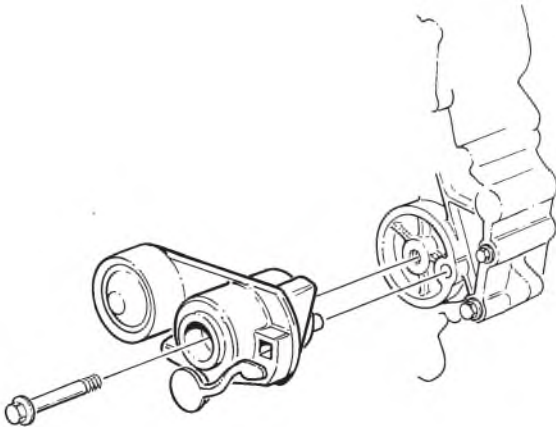
W2003336

Fig. 114: Loosening fan belt tension

**1**

Apply special tool J-44392, to the belt tensioner to loosen and remove the belt.

**2**



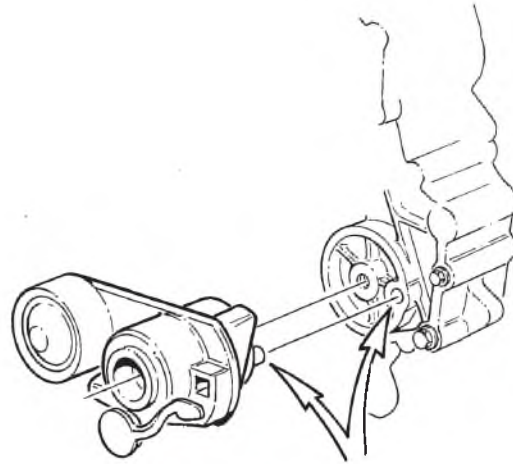
T2007223

Fig. 115: Removing the belt tensioner

Remove the protective cover. Remove the bolt and the belt tensioner.

## Installation

**1**



T2007224

Fig. 116: Installing the belt tensioner

Install the belt tensioner, making sure that the stud in the tensioner fits correctly into the hole in the timing gear cover.

**2**

Tighten the bolt to  $24 \pm 4$  Nm ( $18 \pm 3$  ft-lb) and install the cover.

$24 \pm 4$  Nm  
( $18 \pm 3$  ft-lb)

**3**

Check that the fan belt is not damaged and does not need to be changed before installing it into the correct grooves of the pulleys.

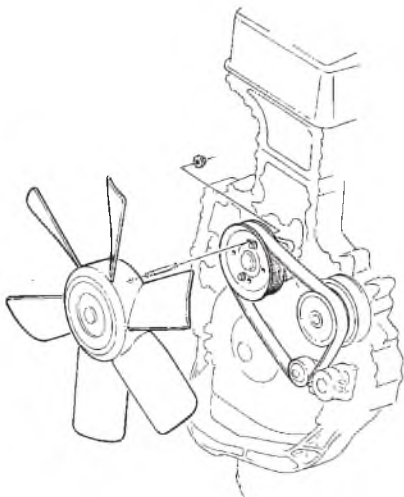
**4**

Remove the lever from the belt tensioner.



## 2634-03-02-04 Cooling Fan Drive Belt, Re- placement

1

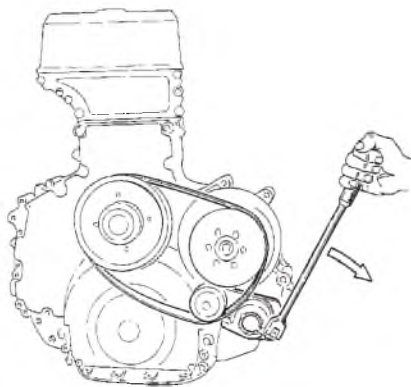


T2007253

Fig. 117: Removing the fan assembly

Remove the nuts holding the fan to the pulley. Lift off the fan and lower it into the fan shroud.

2



T2007222

Fig. 118: Loosening fan belt tension

Apply a breaker bar to the belt tensioner to loosen and remove the belt.

3

Install the new belt making sure that it runs properly in the pulley grooves.

4

Install the fan and bolts. Remove the breaker bar from the belt tensioner.

## 2634-04-02-01 Fan Belt Tensioner, Overhaul

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### WARNING

HOT ENGINE! Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

### WARNING

Never remove the cap on the expansion tank while the engine is still hot. Wait until the coolant temperature is below 50° C (120° F). Scalding steam and fluid under pressure may escape and cause serious personal injuries.

### WARNING

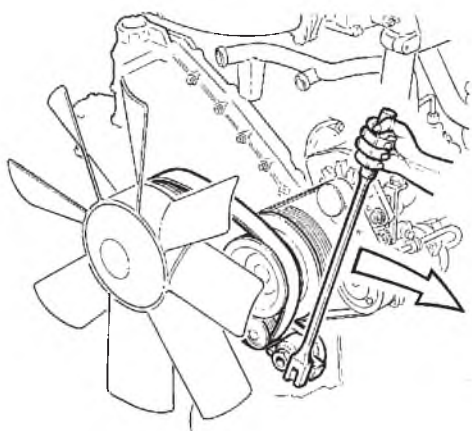
Do not work near the fan with the engine running. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured. Before turning on the ignition, be sure that no one is near the fan.

### WARNING

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

**Removal**


1



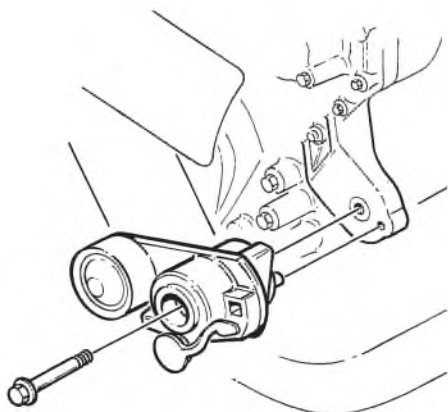
T2008291

Fig. 119: Remove belt tensioner

Use a 1/2 in. drive ratchet to move the belt tensioner to a position that will allow the fan belt to be removed from its pulleys.

 <b>WARNING</b>
<p>Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.</p>

2



T2008345

Fig. 120: Remove protective cap

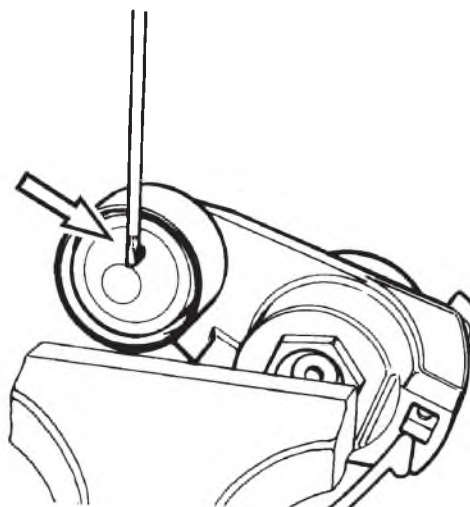
Remove the protective cap from the belt tensioner. Remove the bolt and lift off the belt tensioner from the timing cover.

**Overhaul**

3

Place the tensioner in a vice.

4



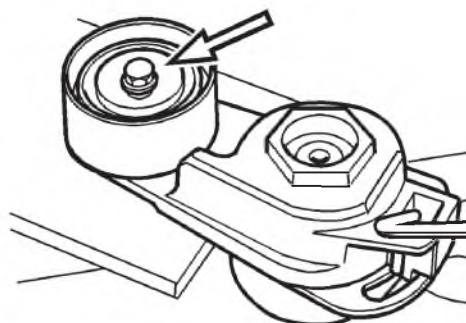
T2008723

Fig. 121: Remove protective cover

Remove the protective cover from the pulley. Make a hole in the protective cover with a screwdriver or punch and carefully pry the cover off the pulley.

**Note:** Make sure you do not damage the pulley if it will be reused

5



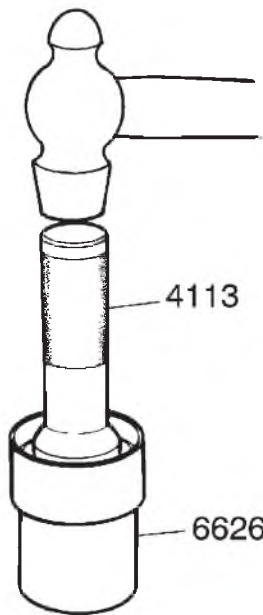
T2008724

Fig. 122: Remove center bolt

Remove the center bolt and lift off the pulley and bearing.



6



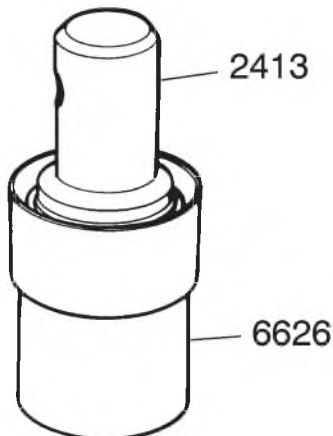
T2008725

Fig. 123: Remove the belt tensioner

Remove the belt tensioner from the vice. Place sleeve 9996626 under the pulley and tap out the bearing using drift 9994113.

7  
Clean and inspect the parts.

8

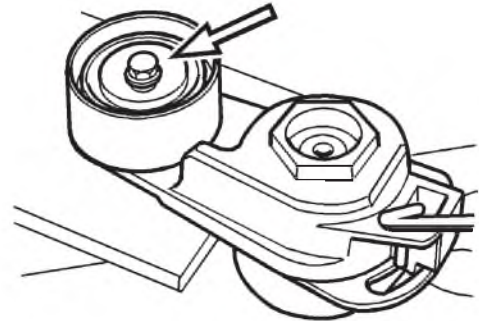


T2008726

Fig. 124: Sleeve placement in pulley

Place sleeve 9996626 under the pulley and press on the bearing using drift 9992413. Make sure that the bearing bottoms in the pulley.

9

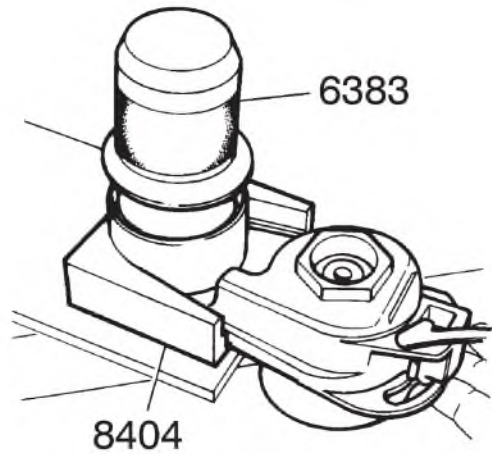


T2008724

Fig. 125: Install the pulley on the belt tensioner

Install the pulley on the belt tensioner and tighten the center bolt. Check that the pulley rotates easily.

10



T2008727

Fig. 126: Install a new protective cover

Install a new protective cover using drift 9996383 and counter-hold 9998404. Check that the pulley rotates easily.

**Note:** It is important that the counter-hold is used, otherwise there is a risk that the bearing will not seat properly in the pulley.

**Installation**

11

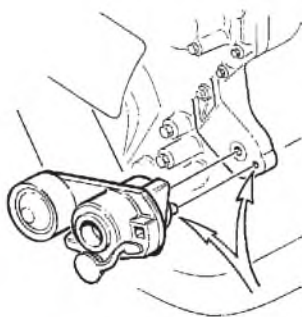


Fig. 127: Install the belt tensioner

Install the belt tensioner, make sure that the mounting bolt on the tensioner correctly enters the hole in the timing gear cover. Torque the mounting bolt to  $24 \pm 4$  Nm ( $18 \pm 3$  ft-lb). Install the protective cap.

12

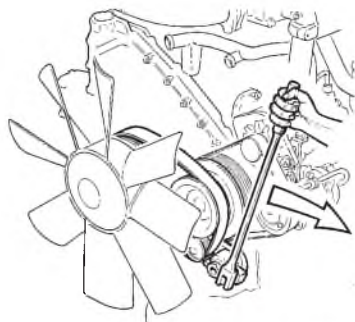


Fig. 128: Adjust the belt tensioner

Use a 1/2 in. drive ratchet to move the belt tensioner to a position that will allow the fan belt to be installed on its pulleys.

13

Check the fan belt, if cracks or chafing marks are present, replace the fan belt. Check that the belt is correctly positioned in the grooves on the pulleys. Remove the lever from the belt tensioner and check fan belt tension with Kent-Moore tool J-23600-B.

**2631-06-02-01**

**Viscous Fan, Checking**

**! DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**! DANGER**

Never work under or around a vehicle unless it is supported on jack stands of adequate rating. Failure to use adequate jack stands can result in the vehicle falling, which can cause serious injury or death to anyone under the vehicle.

**! WARNING**

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

**! WARNING**

Never remove the cap on the expansion tank while the engine is still hot. Wait until the coolant temperature is below  $50^{\circ}$  C ( $120^{\circ}$  F). Scalding steam and fluid under pressure may escape and cause serious personal injuries.

**! WARNING**

Do not work near the fan with the engine running. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured. Before turning on the ignition, be sure that no one is near the fan.

**! WARNING**

Always wear eye protection when working around batteries to prevent the risk of injury due to contact with sulfuric acid or an explosion.

If any of the following characteristics are observed, it is possible that the fan could be faulty. However, be sure to go through the **check list** below:

- 1 The fan does not engage, i.e. low fan speed despite high engine load. This will result in high coolant temperature and thereby a drop in engine output.
- 2 The fan does not disengage despite low engine load.

**Check the following before measuring fan speed:**

- That the radiators are not blocked by insects or leaves etc.
- Coolant level is between MIN and MAX.
- Fan drive belt is not loose or cracked.
- The radiator is not blocked by insects or leaves etc.
- The coolant temperature gauge sensor is functioning properly.
- The cooling system is not blocked.
- The fan is clean and undamaged.
- Fluid has not leaked out of the fan hub.
- The bimetallic spring/plate of the fan is not damaged or blocked.

**Note:** Operational disturbances concerning the fan can also be due to wear in the control mechanism.

**Note:** If the thermostat in the cooling system is faulty, this will also result in faulty fan operation.

**Note:** The fan drive or clutch is an exchange unit and cannot be repaired since special instruments are required for adjustment and checking of the engagement temperature and speed.

**Note:** If fluid has leaked out of the fan drive or clutch, no attempt must be made to refill with silicone fluid since a precise amount of fluid is required to give the fan its properties.

**Note:** The fan should be stored upright or to a maximum angle of 45°. If the angle is higher or if lying flat on the ground, the silicone fluid will drain out of the fan.

## 2651-03-04-01 Charge Air Cooler, Replacement

(Radiator Removed)



**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.



**WARNING**

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.



**WARNING**

Never remove the cap on the expansion tank while the engine is still hot. Wait until the coolant temperature is below 50° C (120° F). Scalding steam and fluid under pressure may escape and cause serious personal injuries.



**WARNING**

Do not work near the fan with the engine running. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured. Before turning on the ignition, be sure that no one is near the fan.

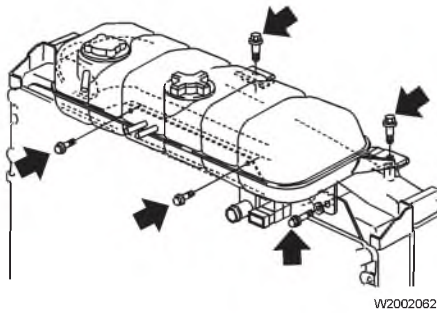


**WARNING**

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

# Removal

1



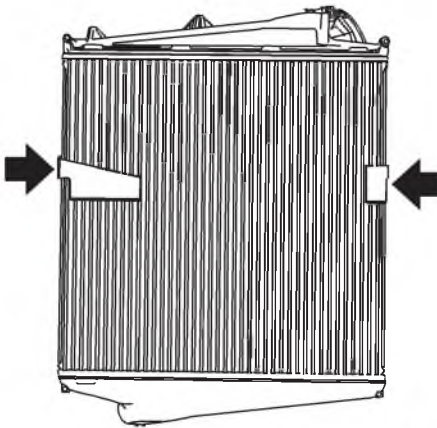
W2002062

Fig. 129: Remove expansion tank from radiator

Remove the five bolts fastening the expansion tank to the radiator. Disconnect the hose from expansion tank to the radiator top tank. Lift off the expansion tank and set aside.

12 mm socket  
screwdriver

2



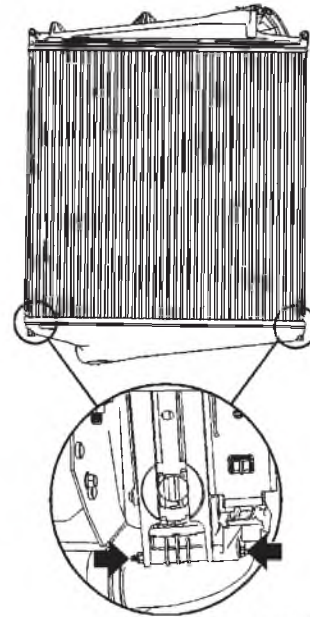
W2002124

Fig. 130: Remove support brackets

Remove the four bolts holding the two lower air conditioning condenser support brackets to the radiator assembly.

12 mm socket

3



W2002125

Fig. 131: Remove charge air cooler

Remove the remaining bolts fastening the charge air cooler to the radiator, and set the charge air cooler aside.

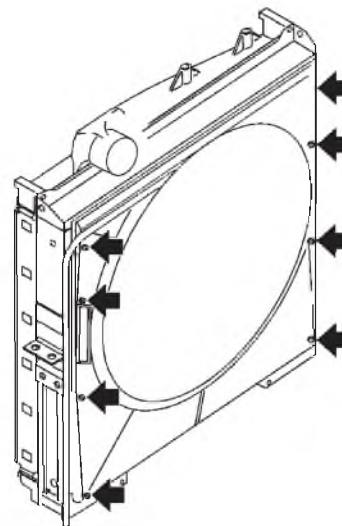
13 mm socket  
12 mm wrench

4

Remove the one bolt holding the overflow tube to the radiator assembly.

12 mm socket

5



W2002126

Fig. 132: Remove head screws from shroud

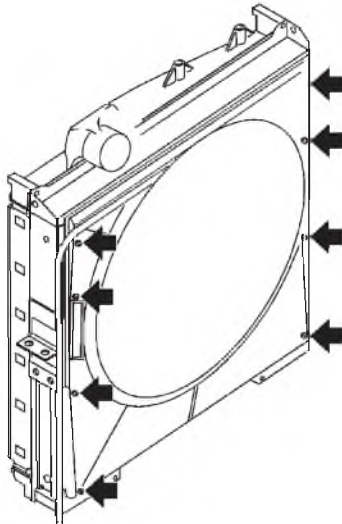
Remove the eight torx head screws fastening the shroud to the radiator, and set the shroud aside.

T 30 torx bit

## Installation

**1**  
Install the overflow hose and bracket, the top radiator hose and the bleed hose to the radiator. 7 mm socket  
screwdriver

**2**

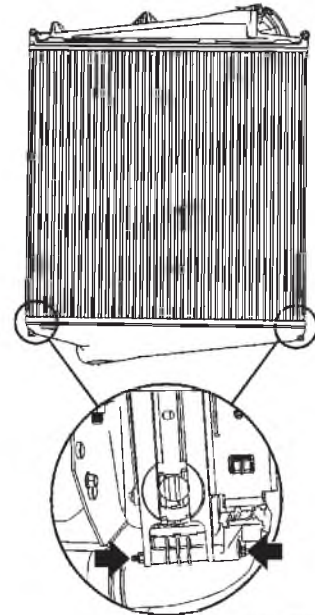


W2002126

Fig. 133: Position the shroud into place, install head screws

Position the shroud into place, install eight torx head screws and hand tighten. T 30 torx bit

**3**

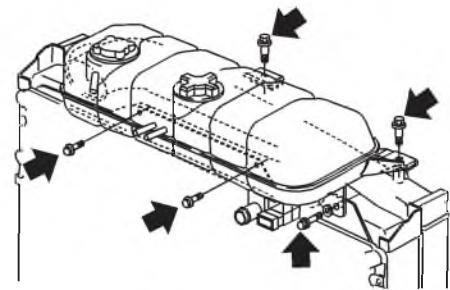


W2002125

Fig. 134: Install mounting bolts

Position the charge air cooler onto the radiator. Install the four mounting bolts leaving the upper two hand tight. 13 mm socket  
12 mm wrench  
Torque the lower bolts to  $24 \pm 4$  Nm  $24 \pm 4$  Nm  
( $18 \pm 3$  ft-lb)  
( $18 \pm 3$  ft-lb).

**4**



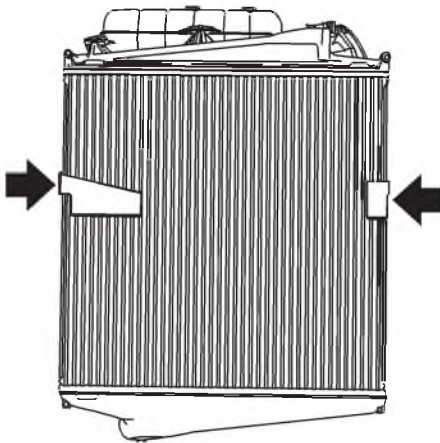
W2002062

Fig. 135: Install expansion tank bolts

Position the expansion tank into place and install the five mounting bolts. 12mm socket  
Torque to  $24 \pm 4$  Nm ( $18 \pm 3$  ft-lb).  $24 \pm 4$  Nm  
( $18 \pm 3$  ft-lb)



5



W2002102

Fig. 136: Install support brackets

Position the air conditioning condenser 12 mm socket mounting brackets. Install the four mounting bolts hand tight.

## 3821-06-02-01 Coolant Temperature Gauge, Checking

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### WARNING

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

### WARNING

Never remove the cap on the expansion tank while the engine is still hot. Wait until the coolant temperature is below 50° C (120° F). Scalding steam and fluid under pressure may escape and cause serious personal injuries.

### WARNING

Do not work near the fan with the engine running. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured. Before turning on the ignition, be sure that no one is near the fan.

### WARNING

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

- 1 Remove the temperature sensor from the thermostat housing and connect the electric cable.
- 2 Connect a ground between the temperature sensor and the cylinder block.
- 3 Submerge the temperature sensor in heated water.
- 4 Using a thermometer, measure the temperature. Compare this reading with the temperature gauge reading.



## 2611-11-04-01 Radiator, Cleaning

### (Unit Removed)



#### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.



#### WARNING

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.



#### WARNING

Never remove the cap on the expansion tank while the engine is still hot. Wait until the coolant temperature is below 50° C (120° F). Scalding steam and fluid under pressure may escape and cause serious personal injuries.



#### WARNING

Do not work near the fan with the engine running. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured. Before turning on the ignition, be sure that no one is near the fan.



#### WARNING

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

If you see or suspect that the cell packages of the charge air cooler or radiator cell packages are dirty, these components should be cleaned. Depending on the installation, it may be necessary to completely remove the components from the vehicle; see "Radiator, Replacement" page 29.

**Note:** Regardless of cleaning method, extreme caution should be observed so as not to damage the radiator fins.

#### External Cleaning

**1**

Separate the radiator and the charge air cooler if they have been removed from the vehicle as a single unit. This ensures proper cleaning of each component.

**2**

Cover the inlet and outlet pipes to prevent degreasing agents or dirt to enter.

**3**

Clean the radiator with compressed air if it is clogged with dust.

**Note:** Air pressure should not exceed 210 kPa (30 psi) for the radiator and should not exceed 170 kPa (25 psi) for the condenser.

**4**

When rinsing, start with the back of the radiator and then turn it around and rinse from the front. Use hot water and make sure that the cells get clean.

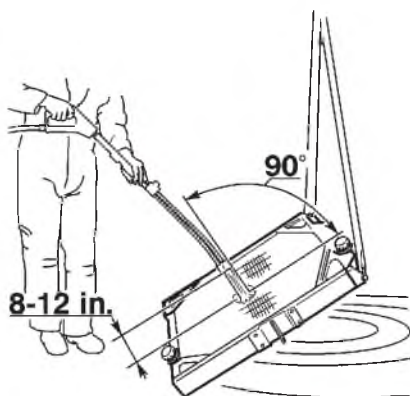
**5**

Gummed up dirt can be removed by using CALCLEAN cleaners, either in regular or heavy-duty strength. These cleaners can be sprayed on the cores using a hand pump sprayer and rinsed off. They will not harm the core materials.

**6**

In case a degreasing agent is used, be sure to thoroughly clean plastic and rubber parts if these get covered with degreasing agent.

7



W2003373

Fig. 137: Correct positioning of high pressure car wash.

A high pressure car wash with a max working pressure of 100–120 bar (1450–1750 psi) may be used, but with extreme caution. Make sure that the nozzle is held perpendicular to cell package at all times and that it is moved from side to side. The nozzle should always be positioned at a distance of 8–12 inches from the cell package.

**Note:** Using a high pressure car wash will necessitate the removal of the radiator(s) from the vehicle in order to correctly clean the radiator without the risk of damaging the fins with the high pressure.

8

Rinse the radiator starting with the back and then turn it around and rinse from the front.

## 2651-11-02-01 Charge Air Cooler, Cleaning

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### WARNING

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

### WARNING

Never remove the cap on the expansion tank while the engine is still hot. Wait until the coolant temperature is below 50° C (120° F). Scalding steam and fluid under pressure may escape and cause serious personal injuries.

### WARNING

Do not work near the fan with the engine running. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured. Before turning on the ignition, be sure that no one is near the fan.

### WARNING

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

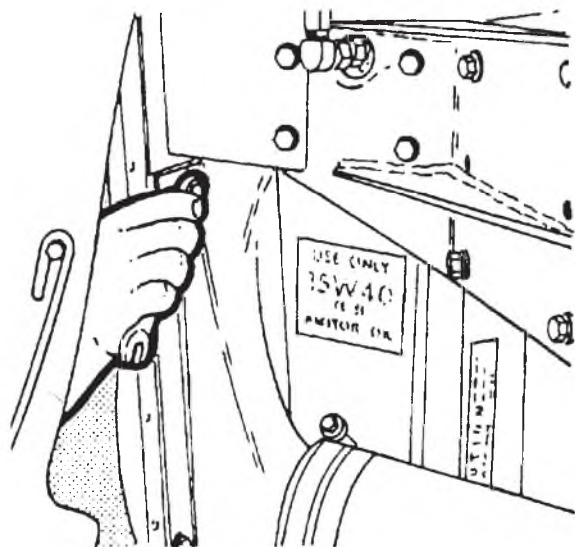
1

Remove the grille

2

Tilt the hood. Support the hood to allow removal of the safety cables.

3

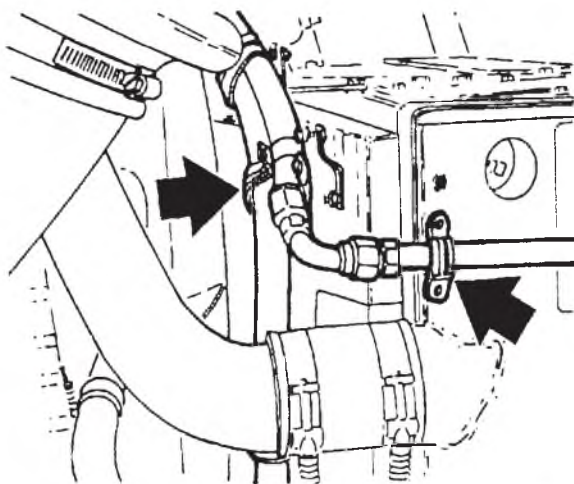


W2000460

Fig. 138: Loosening charge air cooler clamps.

Loosen the charge air cooler clamps on the side of the charge air cooler.

4

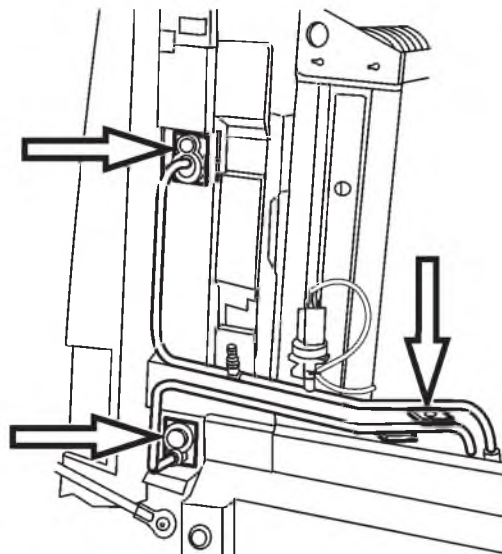


W2000461

Fig. 139: Unfasten A/C lines

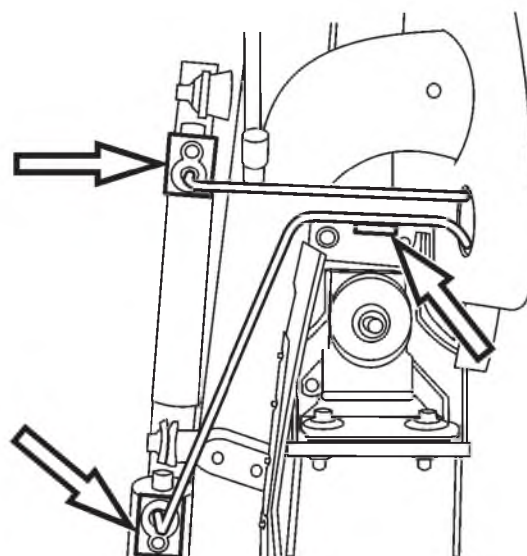
Unfasten the A/C lines from the right side of the radiator.

5



W2003523

Fig. 140: Removing A/C condenser mounting bolts on VN model



W2003524

Fig. 141: Removing A/C condenser mounting bolts on VHD model

After removing the A/C condenser line clamps and the A/C condenser mounting bolts, the condenser can be laid aside.

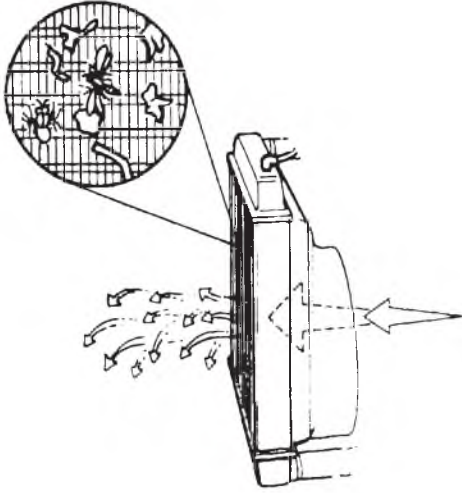
**Note:** All A/C lines on the VN/VHD are locted on the left side of the cooling package. When removing the A/C condenser line clamps make sure not to loosen the A/C lines.

6

Remove the clamps from the charge air cooler hoses on both sides. Remove the left side radiator shield.

7  
Remove the charge air cooler.

8



W2000462

Fig. 142: Direction of air pressure

Clean dirt and debris from the cores by using air pressure. This should be done from the backside of the core. The use of a radiator fin comb will also loosen dirt and debris from the fins.

**Note:** The air pressure should not exceed 30 psi (210kPa) for charge air cooler core.

**Note:** The air pressure should not exceed 25 psi(170 kPa) for the condenser.

9

Hard to remove gummed up dirt can be removed by using Calgon cleaners CALCLEAN, either in regular or heavy duty strengths. These cleaners can be sprayed on the cores using a hand pump sprayer, rinsed off and will not harm the core materials.

10

Reassemble the charge air cooler and condenser. Remember to install the isolators and teflon pads on the charge air cooler.

11

Install the radiator recirculation shields on the top, bottom and both sides of the radiator. These shields will help reduce the contaminations that get between the components.

**Note:** VN/NVHD model trucks are equipped with air deflectors mounted on the sides of the radiator.

# System Check

## 2619-09-02-01 Cooling System, Servicing

(Flush — includes draining and re-filling coolant)



### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.



### DANGER

Coolant is toxic; risk of poisoning. Do not drink coolant. Use proper hand protection when handling. Keep coolant out of reach of children and animals. Failure to follow these precautions can cause serious illness or death.



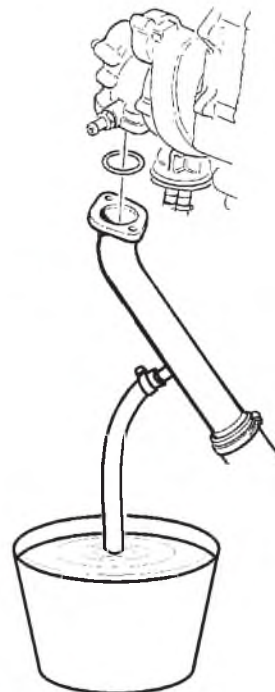
### WARNING

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

**Note:** Should the cooling system have substantial rust and sludge deposits, the following cleaning method is recommended:

### Draining and Flushing

1



W2000751

Draining the coolant

Drain the cooling system into suitable container. Open all drain points. In addition, remove the expansion tank cap before draining the system.

#### Draining points:

- Radiator
- Cylinder block
- Oil cooler, transmission (when installed)
- Water pump (remove water filter and leave drain valve open)

2

Drain the cooling and heating systems and flush them with a good commercial cooling system cleaner (flush). Follow the instructions provided on the cleaner (flush) packaging.

**3**

Drain the cooling and heating systems and flush through with clean water. For quick, efficient draining, remove the lower and upper radiator hoses and the drain valves. Do not forget to drain the heater element and the engine heater.

**4**

Run the engine for 10–15 minutes at normal working temperature and then repeat the flushing procedure.

**5**

The heating system must be flushed separately with hoses disconnected to ensure removal of any impurities left in the system. Also remove the expansion tank cap. For effective cleaning, flush the expansion tank from below with the cap removed.

**6**

When the system is entirely free from impurities, it is ready to be refilled with new coolant, see table page 17

**7**

If the system is cleaned on a regular basis (for example, when the concentrated coolant is drained or filled) or when the system is relatively free from deposits, a smaller amount of cleaner additive or simply flushing with clean water may be sufficient.

**Note:** Chemicals for cleaning the cooling system are not marketed by Volvo Trucks North America and must be obtained elsewhere. Dispose of all cleaner's and coolant fluids according to local and state regulations.

**Filling****8**

The cooling system is filled through the expansion tank. The engine must be switched off and the heater controls set at WARM.

**9**

Fill with coolant to the maximum level on the expansion tank. The cooling system will vent itself automatically.

**10**

Place shift lever in neutral and apply parking brake.

**11**

After running the engine warm and then allowing it to cool, check the coolant level again.



# Feedback

One of our objectives is that workshop personnel should have access to correct and appropriate service manuals where it concerns fault tracing, repairs and maintenance of Volvo trucks.  
In order to maintain the high standards of our literature, your opinions and experience when using this manual would be greatly appreciated.  
If you have any comments or suggestions, make a copy of this page, write down your comments and send them to us, either via telefax or mailing directly to the address listed below.

To

From

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7825 National Service Road

P.O. Box 26115

Greensboro, NC 27402-6115

USA

Fax (336) 393-3170

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Comments/proposals

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Concerns Service Manual: .....



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**VOLVO**

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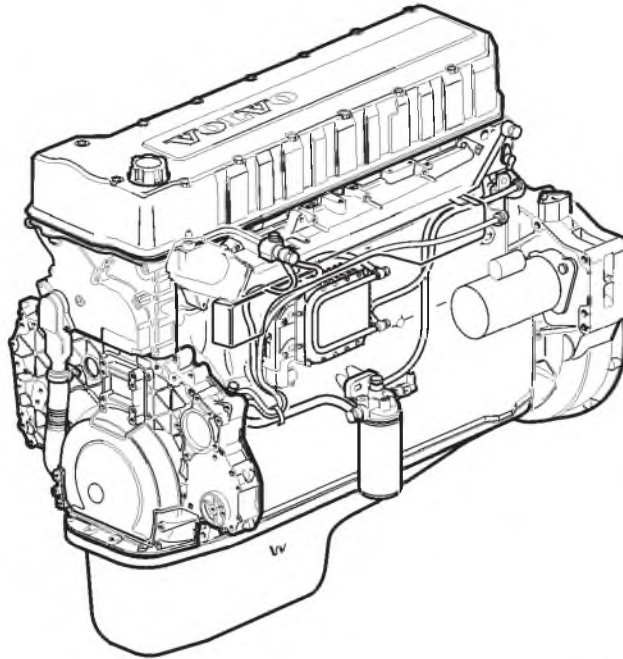
<http://www.volvotrucks.volvo.com>

This TSI Service Bulletin replaces TSI Service Bulletin 216-003, "Rear Crankshaft Seal, D12, D12A, D12B, D12C" (11.2001), publication no. PV776-TSP160567.

Date	Group	No.	Supp.	Page
8.2003	<b>216</b>	<b>003</b>		1(4)

Rear Crankshaft Seal  
D12, D12A, D12B, D12C

## Rear Crankshaft Seal



W2003244

VOLVO D12C Engine

This information covers service procedures for replacing rear crankshaft seals on VOLVO D12, D12A, D12B, and D12C engines.

### Contents

- ["Special Tools" page 2](#)
- ["Crankshaft Seal, Replacement \(Rear\)" page 3](#)

## Tools

### Special Tools

The following special tools are used to replace or repair components. The tools can be ordered from Volvo; please use the specified part number when ordering.



**9992000**  
Handle



**9998238**  
Drift



**9996950**  
Stop Tool for Flywheel



## Service Procedures

### 2167-03-03-01

### Crankshaft Seal, Replacement (Rear)

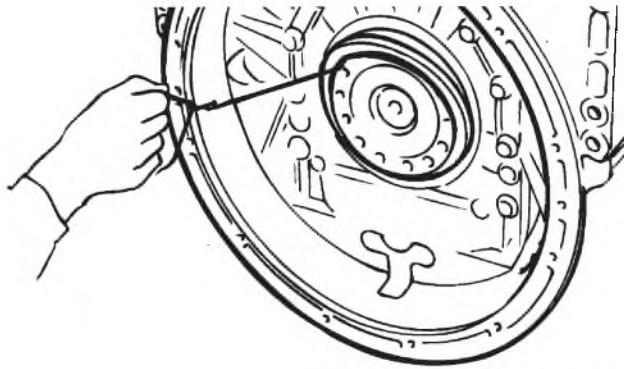
(In vehicle — transmission, clutch, and flywheel removed)

You must read and understand the precautions and guidelines in Service Information, Group 20, "General Safety Practices, Engine" before performing this procedure. If you are not properly trained and certified in this procedure, ask your supervisor for training before you perform it.

*Special tools: 9992000, 9998238*

**1**

Rotate the sealing ring outward using a drift and hammer. As the seal rotates outward, remove the old sealing ring with the help of a hook.

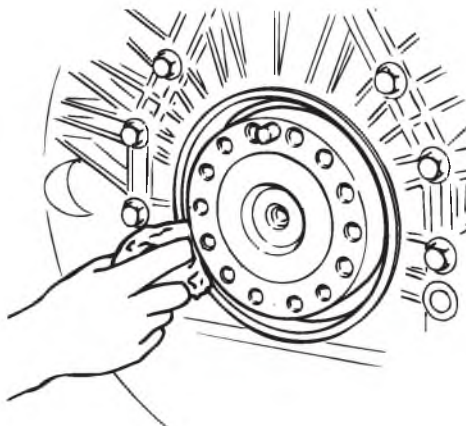


T2007129

Removing old sealing ring

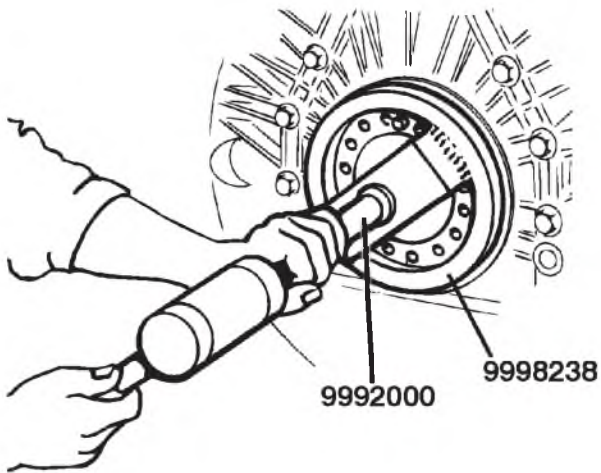
**2**

Clean the sealing surface in the flywheel housing.



T2006662

Clean sealing ring seat



**3**

Apply clean engine oil to the edge of the new sealing ring and fit seal on drift 9998238. Carefully tap seal into the flywheel housing using handle 9992000 and drift 9998238 until the drift evenly contacts the crankshaft.

**Note:** Position Drift 9998238 so that it does not interfere with the alignment dowel during installation.

9992000, 9998238

Installing sealing ring

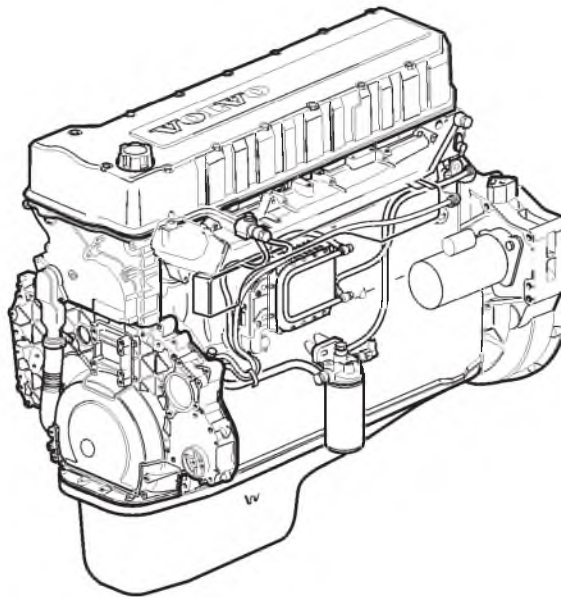
W2004278

This TSI Service Bulletin and others in Groups 21 and 33 replace TSI Service Manual 210-600, "Basic Engine, D12, D12A, D12B, D12C" (8.2000), publication no. PV776-TSP142853.

Date	Group	No.	Supp.	Page
11.2001	<b>210</b>	<b>004</b>		1(18)

## Cylinder Compression D12, D12A, D12B, D12C

### Cylinder Compression



W2003244

Fig. 1: VOLVO D12C Engine

This information covers the procedure for checking cylinder compression on VOLVO D12 engines.

### Contents

- "Special Tools" page 2
- "Cylinder Compression, Checking" page 3

# Tools

## Special Tools

The following special tools are used to replace or repair components. The tools can be ordered from Volvo; please use the specified part number when ordering.



**3949521**  
VEB Shim Kit



**9808570**  
Brush



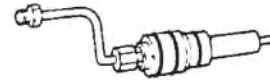
**9808616**  
Handle



**9988539**  
Compression gauge



**9996956**  
Cranking tool



**9998248**  
Adapter



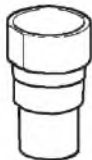
**9998249**  
Protection cap



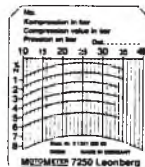
**9998255**  
Elevation tool



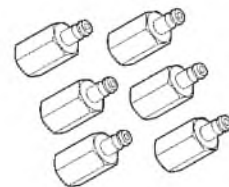
**9998511**  
Lever



**9998580**  
Seal tool



**9999693**  
Graphic Card (used with 9988539)



**J-44621**  
Compression Gauge Adapter Set

## 2103-06-02-01 Cylinder Compression, Check- ing

(With EPG or VEB)

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### DANGER

Do not service any part of the fuel system while smoking or in the presence of flames, sparks, or hot surfaces. Failure to follow these precautions can result in fire, which can cause serious injury or death.

### WARNING

HOT ENGINE! Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

### WARNING

Do not work near the fan with the engine running. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured. Before turning on the ignition, be sure that no one is near the fan.

**Note:** A diagnostic test can identify possible variations between cylinders; refer to VCADS Pro tool.

**Note:** When performing a compression test on the D12 engine, install all six adapters (9998248) at the same time. This eliminates the need to remove and reinstall the rocker arm bridge between each cylinder test. It is also unnecessary to remove and adjust the unit injector between each cylinder test.

**Note:** Before removing the unit injectors, make sure that their surrounding areas are clean.

**Special tools:** 9808570, 9808616, 9988539, 9996956, 9998248, 9998249, 9998255, 9998511, 9998580, 9998583, 9999696

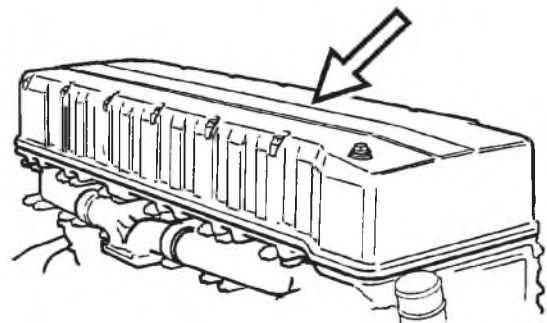
1

### WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. Clean up fuel spills immediately.

Clean around the drain plug in the fuel filter bracket. Connect a pipe to the plug and direct the other end of the pipe to a suitable container. Open the plug and let the fuel in the cylinder head drain into the container.

2



C2001719

Remove the valve cover.

**Note:** Do not use an impact wrench, or the studs may loosen from the cylinder head and damage the electrical installation and the valve cover.

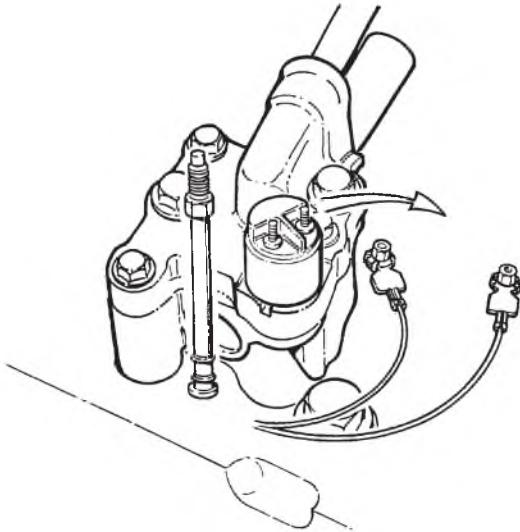
3



T2008818

Disconnect the electrical connections from the unit injectors.

4



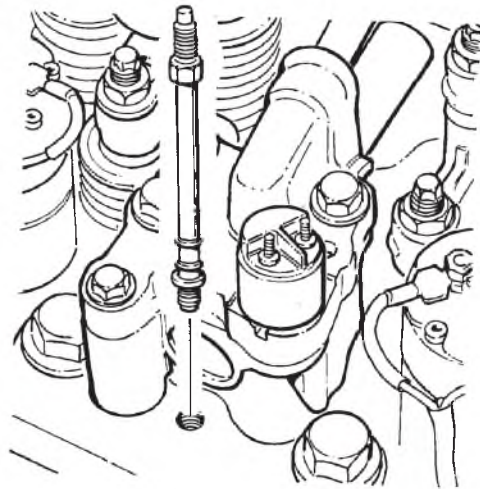
T2008812

Disconnect the electrical connections from the unit injectors and from the VEB control valve. Carefully pull the electrical installation out of the cylinder head.

5

Clean around the VEB control valve.

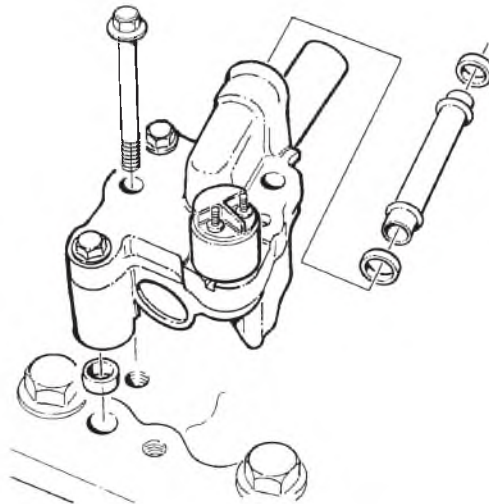
6



T2008813

Remove the valve cover stud located in front of the VEB control valve.

7



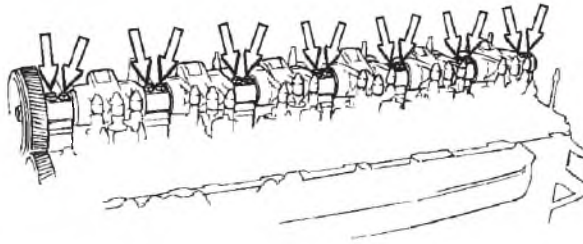
T2008814

Remove the bolts from the VEB control valve and then remove the valve. Also remove the pipe between the control valve and the rocker arm shaft.

**Note:** Save the valve in a place free from dust. Place a cover over the cylinder head oil hole.



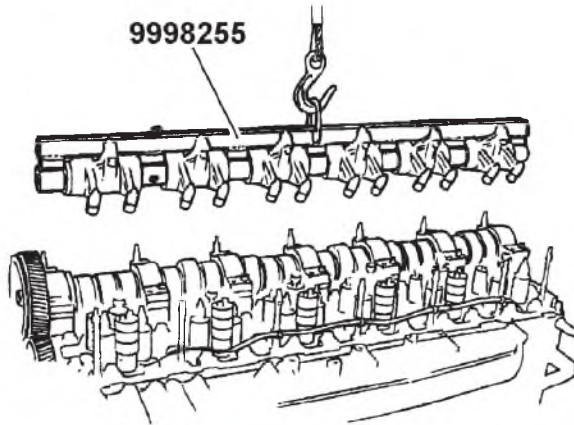
8



C200172C

Loosen the bolts in the rocker arm shaft support uniformly along the entire shaft, so that it is not strained and risk being warped.

9



C2001721

Remove the bolts, attach lifting tool 9998255, and raise the entire rocker arm assembly.

**Note:** In engines equipped with the VEB engine brake, fasten the rocker pistons with a rubber band or another suitable device to prevent the pistons from dropping when the rocker arm assembly is lifted.

Rocker pistons are classified in packages (2, 3, or 4 points are stamped on the rocker arms and pistons) and should be kept as an assembly.

10

Remove the bolts fastening the levers of all unit injectors.

11

Clean around the unit injectors.

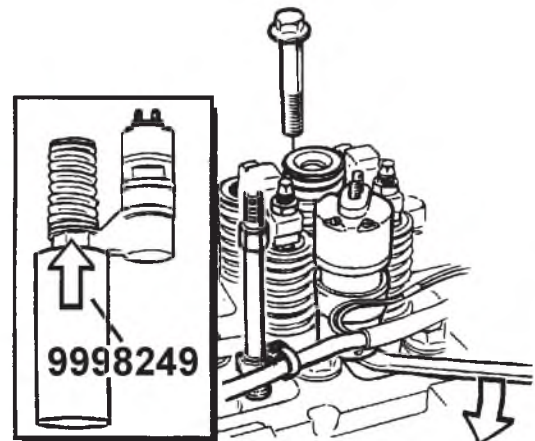
12



T2012632

Remove the unit injector with lever 9998511.

13



C2000425

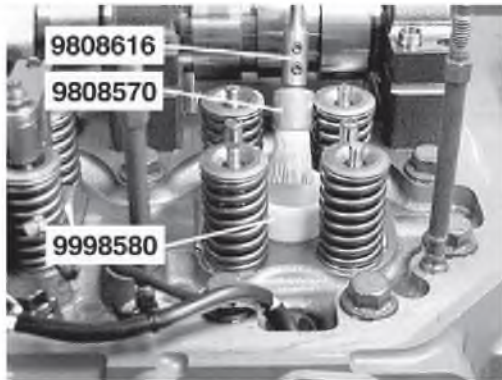
Install dust covers 9998249 on the unit injector to protect them from dirt or possible damage.

14

Use the same procedure to remove the other unit injectors, one at a time.

**Note:** Arrange the unit injectors on a support so they can easily be reinstalled in their original cylinders.

15



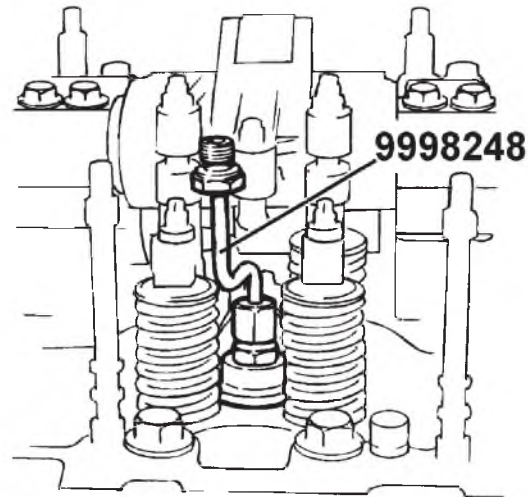
T2014131

Clean the copper sleeves in the unit injectors using tools 9808616, 9808570, and 9998580.

**⚠ CAUTION**

While cleaning the copper sleeves for the unit injectors, never use spatulas, steel brushes, or any other steel objects. Do not clean the injector nozzles, as this can damage them or obstruct the nozzle holes, which can reduce engine power or bind piston rings.

16



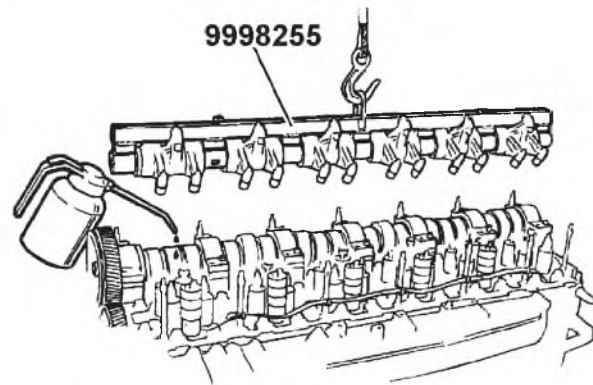
C2000411

Install the 6 compression test adapters 9998248 in the cylinder head.

**⚠ CAUTION**

DO NOT leave unit injector tubes opened. If not installing 9998248 adapters, install 9998251 protective plugs to protect tubes from contaminants.

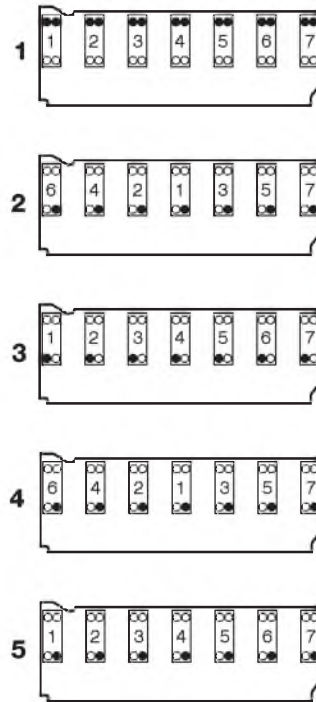
17



C2001726

Lubricate the valve bridges and camshaft lobes with engine oil. Using lifting tool 9998255, install the rocker arm bridge.

18



W2003E20

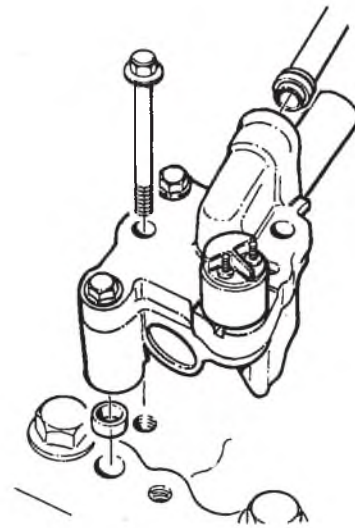
Fig. 2: Bearing caps and camshaft/rocker shaft, tightening sequence

Gradually tighten the bolts so that the rocker arm shaft does not bend or warp (also check that the guide pins  $\text{\AA}$  correctly in the camshaft supports). Tighten the shaft until it lies against the camshaft lobes, then torque-tighten using the proper bolt sequence (see Fig. 2: Bearing caps and camshaft/rocker shaft, tightening sequence, page 7) and the following 5-step process:

- D12C:**
- 1  $15 \pm 5$  Nm  
( $11 \pm 4$  ft-lb);  
 $+90 \pm 5^\circ$
  - 2  $60 \pm 5$  Nm  
( $44 \pm 4$  ft-lb)
  - 3  $15 \pm 5$  Nm  
( $11 \pm 4$  ft-lb);  
 $+120 \pm 5^\circ$
  - 4  $60 \pm 5$  Nm  
( $44 \pm 4$  ft-lb);  
loosen to 0 Nm  
(0 ft-lb)
  - 5  $15 \pm 5$  Nm  
( $11 \pm 4$  ft-lb);  
 $+120 \pm 5^\circ$

- D12, D12A,  
D12B:**
- 1  $15 \pm 5$  Nm  
( $11 \pm 4$  ft-lb);  
 $+90 \pm 5^\circ$
  - 2 45 Nm  
(33 ft-lb)
  - 3  $15 \pm 5$  Nm  
( $11 \pm 4$  ft-lb);  
 $+90 \pm 5^\circ$
  - 4 45 Nm (33 ft-lb);  
loosen to 0 Nm  
(0 ft-lb)
  - 5  $15 \pm 5$  Nm  
( $11 \pm 4$  ft-lb);  
 $+90 \pm 5^\circ$

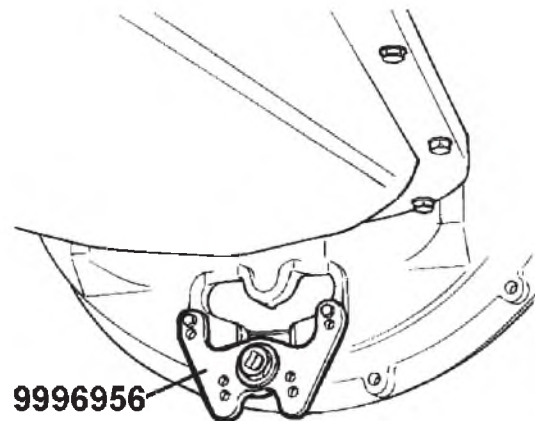
19



T2008958

In VEB engines, install the control valve.

20



**9996956**

C2000183

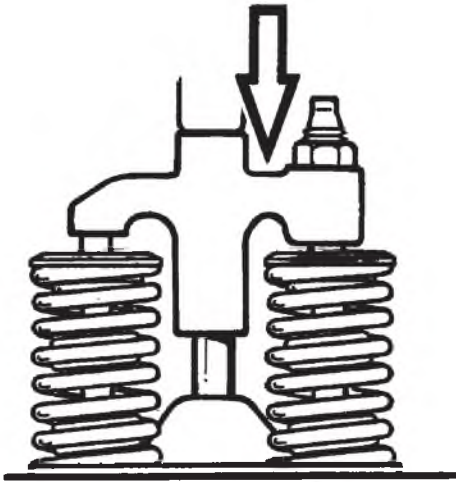
Install  $\varnothing$ wheel turning tool 9996956.

9996956

21

Turn the engine to the next marking on the camshaft for the valve adjustment.

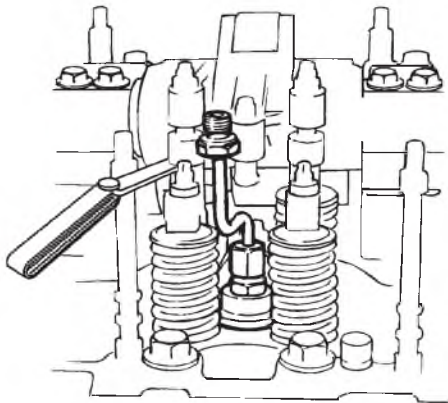
22



T2009075

Loosen the screw in the valve bridge until the bridge stops contacting the valve stems. Put pressure on the valve bridge and hand-tighten the screw to 0 lash. Turn an additional 60° and torque-tighten the retaining nut to  $38 \pm 4 \text{ Nm}$  ( $28 \pm 3 \text{ ft-lb}$ ).

23



W2003733

Checking intake valve play with tool 9998248 installed

Check the intake valve play and adjust if the play is not within specifications:

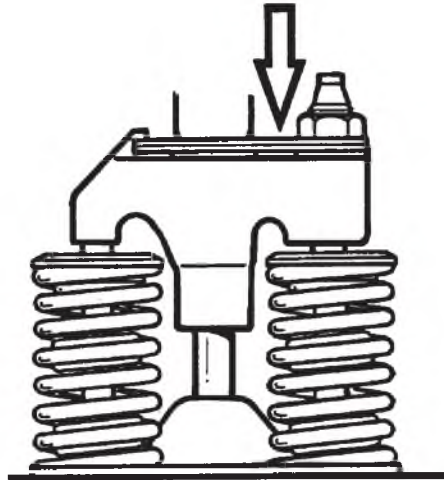
- Intake valves:  $0.20 \pm 0.05 \text{ mm}$  ( $0.008 \pm 0.002 \text{ in.}$ )

**Note:** Mark each valve with a felt marker pen as you adjust them so as to know which valves are already adjusted.

24

Turn the engine to the next marking on the camshaft for the exhaust valve adjustment.

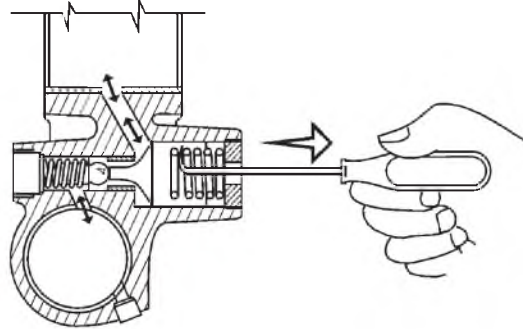
25



T2009073

To adjust the valve bridge, use the same procedure described for the intake valve, but do not tighten the nut.

26

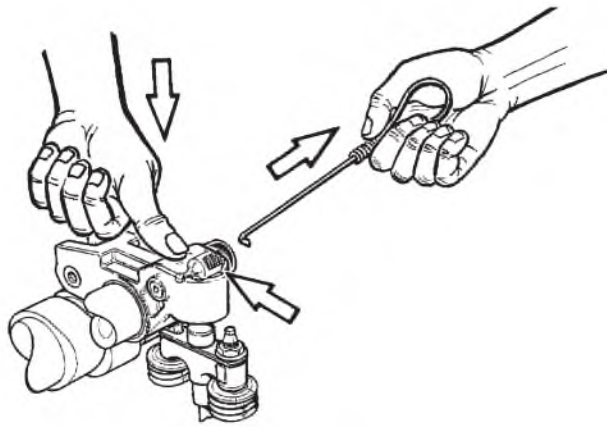


W2002165

Using a cotter pin removal tool or similar instrument, compress the coil spring of the rocker piston.



27

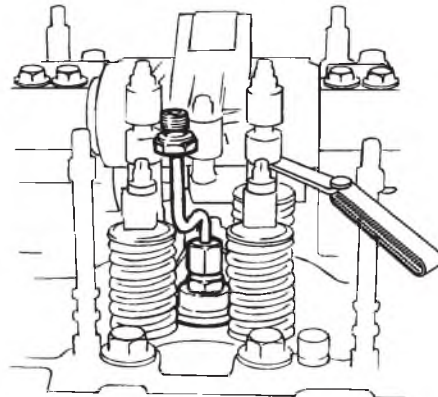


T2009009

While compressing the coil spring, press down firmly on the exhaust rocker arm. This will force out any oil and properly seat the power piston to its innermost position in the rocker arm.

**Note:** Be sure there is no oil on the rocker arm preventing the piston from reaching the end of its stroke. This can act as a hydraulic wedge and prevent correct adjustment.

28



W2003734

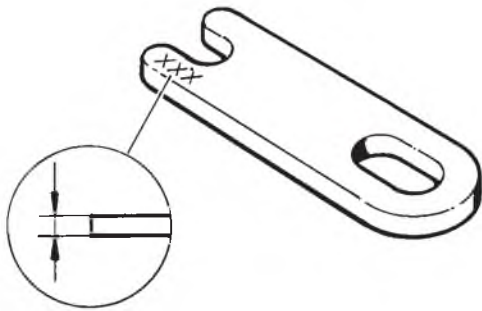
Checking exhaust valve play with tool 9998248 installed

Insert a feeler gauge, with the specified measure, between the valve bridge and the rocker piston end. Turn the piston to prevent it from tilting.

Acceptable valve clearance (play)	
Exhaust	0.50 ± 0.05 mm (0.0196 ± 0.0019 in.)
Exhaust with VEB	1.60 ± 0.05 mm (0.063 ± 0.002 in.)

**Note: If there is play:** try with different feeler gauges until the play disappears. That makes it possible to find out which shim measure will be used in step 29. If unable to insert the feeler gauge, try a thinner gauge until one fits or until there is no longer any play.

29



T2009008

Calculate the thickness for the new shims using "A-B" (below). **A maximum of two shims may be used.** (If two shims are needed, select the shims so they are both about the same thickness.)

<b>A - B = shims required</b>
A = Measured play
B = Specified play tolerance

**Note:** Shims are available in thickness intervals of 0.05 mm (0.002 in.). Sizes range from 2.0 – 2.4 mm (0.08 – 0.094 in.), and from 3.2 – 3.95 mm (0.126 – 0.156 in.). The thickness is stamped on the shims.

30

Carefully clean the shims and valve bridge. Install the shims and tighten the adjustment screw lock nut to  $38 \pm 4$  Nm ( $28 \pm 3$  ft-lb).

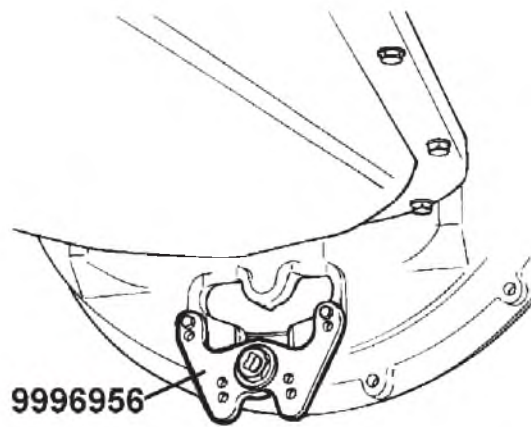
$38 \pm 4$  Nm  
( $28 \pm 3$  ft-lb)

**Note:** Make sure that the adjustment screw does not move out of position when tightening the nut.

31

Use the same procedure to check the play of the other valves.

32



C2000183

Remove the wheel turning tool 9996956.

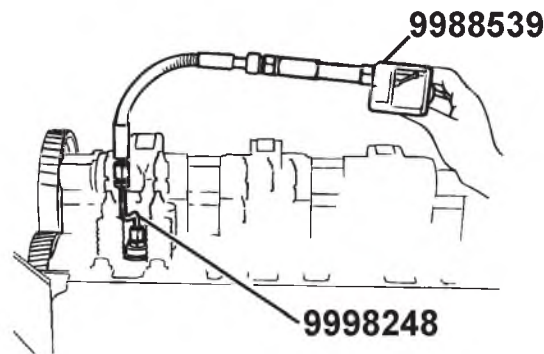
33

<b>CAUTION</b>
<p>Before running the engine with the starter motor, remove the voltage supply fuse for the engine ECU (fuse 43) to prevent the engine from starting accidentally.</p>

Connect a contact switch to the starter motor or ask another person to help you run the engine with the contact switch.



34



C2000412

Fig. 3: Connecting the compression tester to adapter

Using adapter 9998248, connect compression tester 9988539 to cylinder number 1 and perform the test. Note that compression gauge adapter J-44621 must be installed on 9998248 before connecting it to the compression tester.

Run the engine with the starter motor until the compression gauge needle stops (compression maximum value). Write down the maximum value for the cylinder compression.

**Note:** Do not run the starter motor for more than 15 seconds in time intervals of 60 seconds.

35

Repeat the test for all cylinders.

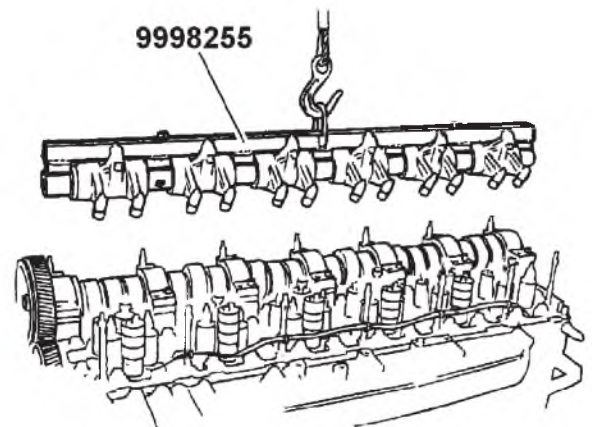
**Note:** No cylinder should be more than 20% below the maximum cylinder. Make necessary repairs, if required, before reassembly. Refer to Service Information, Group 21.

### Reassembly

36

Remove the bolts and remove the VEB control valve.

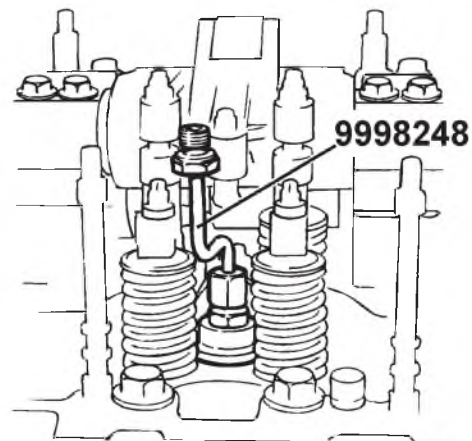
37



C2001721

Remove the complete rocker arm shaft using lifting tool 9998255.

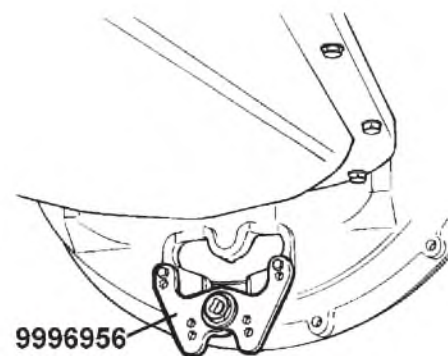
38



C2000411

Remove adapters 9998248 from all cylinders.

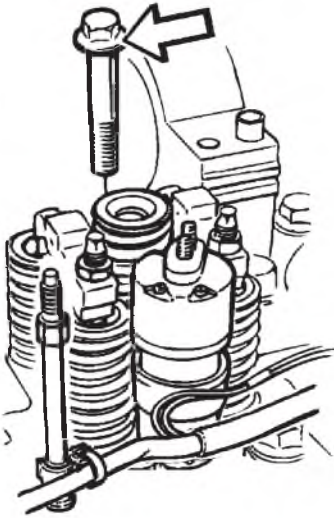
39



C2000183

Reinstall wheel turning tool 9996956.

40



T2008956

Install new O-rings in the unit injectors. (For D12C, choose the two thickest violet rings in the O-ring set.) Lubricate the O-rings with clean engine oil. Install the unit injector and align it between the valve springs. Torque-tighten the lock nut to  $52 \pm 4$  Nm ( $38 \pm 3$  ft-lb).

41

Use the same procedure to install the other unit injectors.

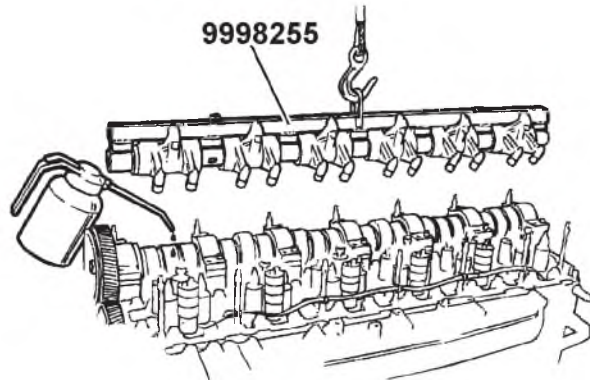
42

Connect the wire to the unit injector terminal. Torque-tighten the nut to 1.4 Nm (1.0 ft-lb).

 **CAUTION**

Do not over-tighten. Over-tightened nuts may permanently damage the unit injector.

43

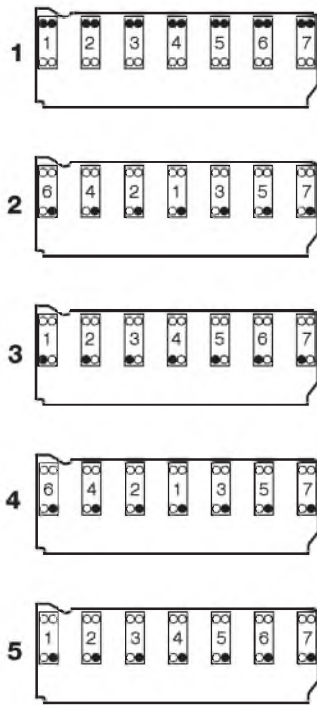


C2001726

9998255

Lubricate the valve bridges and camshaft lobes with engine oil. Using lifting tool 9998255, install the rocker arm assembly.

44



w2003520

Fig. 4: Bearing caps and camshaft/rocker shaft, tightening sequence

Gradually tighten the bolts so that the rocker arm shaft does not bend or warp (also check that the guide pins  $\text{\AA}$  correctly in the camshaft supports). Tighten the shaft until it lies against the camshaft lobes, then torque-tighten using the following 5-step torque sequence (see also Fig. 4: Bearing caps and camshaft/rocker shaft, tightening sequence, page 13):

D12C:

- 1  $15 \pm 5$  Nm  
( $11 \pm 4$  ft-lb);  
 $+90 \pm 5^\circ$
- 2  $60 \pm 5$  Nm  
( $44 \pm 4$  ft-lb)
- 3  $15 \pm 5$  Nm  
( $11 \pm 4$  ft-lb);  
 $+120 \pm 5^\circ$
- 4  $60 \pm 5$  Nm  
( $44 \pm 4$  ft-lb);  
loosen to 0 Nm  
(0 ft-lb)
- 5  $15 \pm 5$  Nm  
( $11 \pm 4$  ft-lb);  
 $+120 \pm 5^\circ$

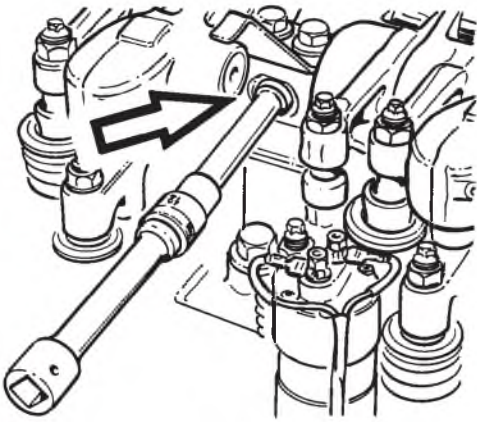
D12, D12A,  
D12B:

- 1  $15 \pm 5$  Nm  
( $11 \pm 4$  ft-lb);  
 $+90 \pm 5^\circ$
- 2 45 Nm  
(33 ft-lb)
- 3  $15 \pm 5$  Nm  
( $11 \pm 4$  ft-lb);  
 $+90 \pm 5^\circ$
- 4 45 Nm (33 ft-lb);  
loosen to 0 Nm  
(0 ft-lb)
- 5  $15 \pm 5$  Nm  
( $11 \pm 4$  ft-lb);  
 $+90 \pm 5^\circ$

45

Remove the rubber bands holding the VEB rocker pistons.

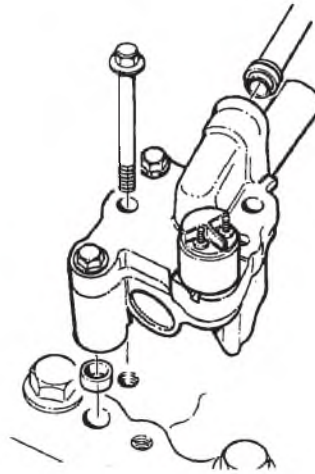
46



T2009070

Thoroughly clean the VEB control valve pipe. Lubricate the rocker arm shaft hole. Using a 1/2±inch extension and a socket, connect the pipe to the socket and install a new sealing ring on the other end of the pipe. Connect the pipe to the rocker shaft and check that the seal ring is properly positioned.

47



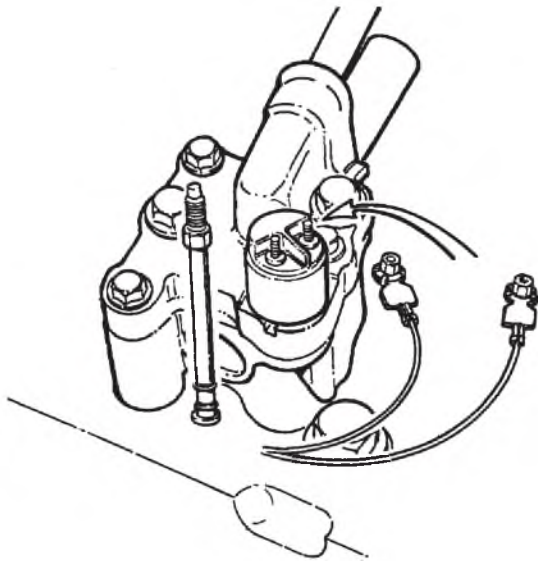
T2008958

Install a sealing ring to the pipe and install the VEB control valve.

**Note:** Check that the cylinder head oil channel cover has been removed.

**Note:** Use a new seal ring between the VEB control valve and the engine cylinder head. Check that the ring is properly positioned before tightening the bolts for the VEB control valve.

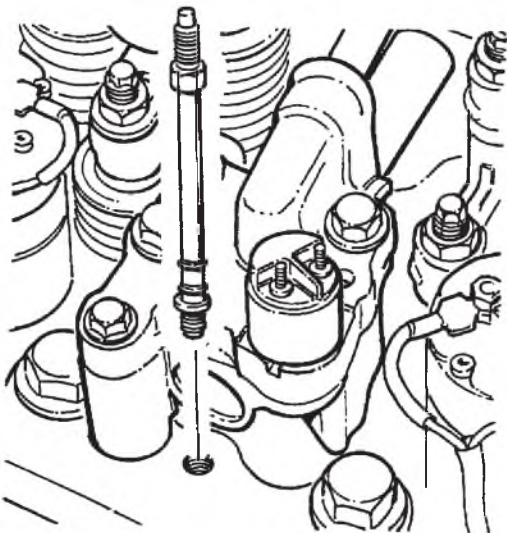
48



T2008960

Connect the electrical installation for the VEB solenoid valve to the control valve and carefully tighten the terminals so that the valve is not damaged.

49



T2008956

Install the stud in front of the VEB control valve.

**Note:** Use loctite to lock the thread.

50

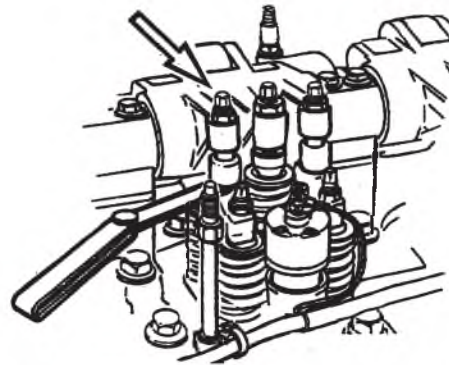
Turn the engine until the next marking on the camshaft for the valve adjustment.

51

To set the play to zero in the valve bridge, loosen the bolt until valve bridge stops contacting the valve stems. Then, hand-tighten the bolt until it contacts the support. Turn the bolt an additional 60° and torque-tighten the bolt nut to 38 ± 4 Nm (28 ± 3 ft-lb).

38 ± 4 Nm  
(28 ± 3 ft-lb)

52



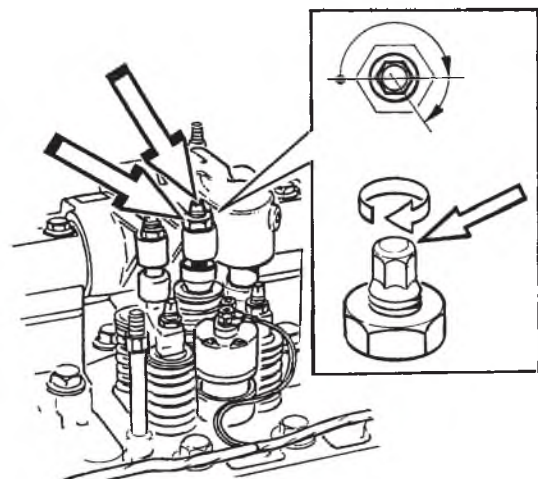
T2008968

Adjust the correct intake valve play:

∑ Intake valves: 0.15 ± 0.25 mm  
(0.006 ± 0.010 in.)

**Note:** Mark each valve with a felt marker pen as you adjust them so as to know which valves are already adjusted.

53



T2008845

Adjust the rocker arm for the unit injector until the play in the camshaft is zero. Turn the adjusting bolt 3 or 4 turns and then torque-tighten to 52 ± 4 Nm (38 ± 3 ft-lb).

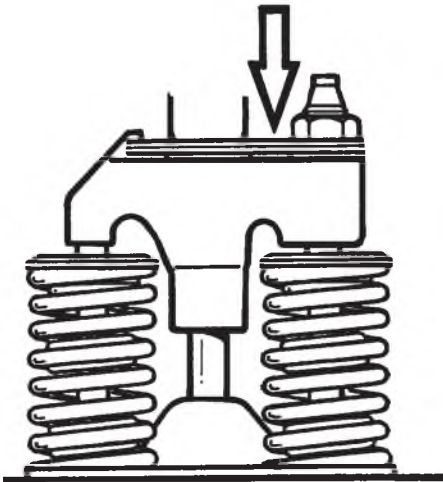
52 ± 4 Nm  
(38 ± 3 ft-lb)



**54**  
Use the same procedure to adjust the other unit injectors.

**55**  
Turn the engine until the next marking on the camshaft for the exhaust valve adjustment.

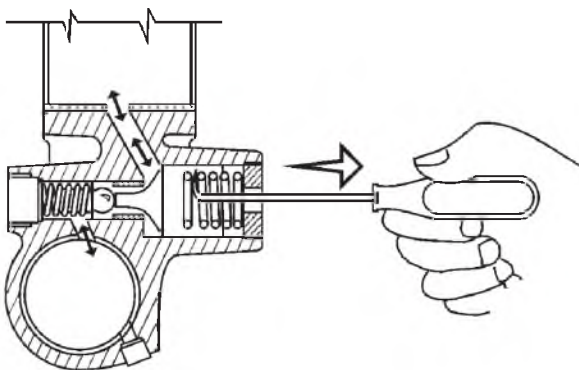
**56**



T2009073

To adjust the valve bridge, use the same procedure described for the intake valve, but do not tighten the nut.

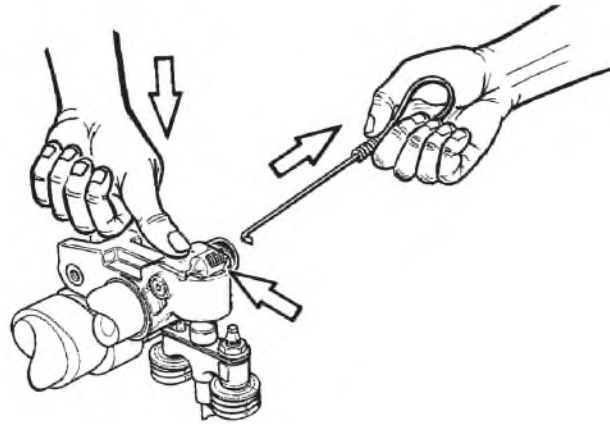
**57**



VW2002165

Using a cotter pin removal tool or similar instrument, compress the coil spring of the rocker piston.

**58**



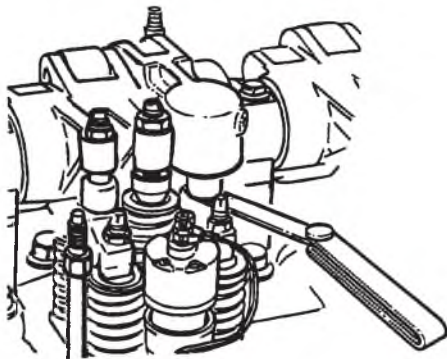
T20090C9

While compressing the coil spring, press down firmly on the exhaust rocker arm. This will force out any oil and properly seat the power piston to its innermost position in the rocker arm.

**Note:** Be sure there is no oil on the rocker arm preventing the piston from reaching the end of its stroke. This can act as a hydraulic wedge and prevent correct adjustment.



59



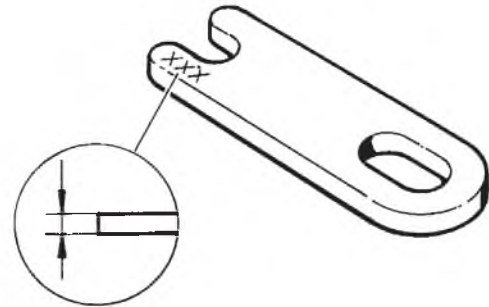
T2008966

Insert a feeler gauge, with the specified measure, between the valve bridge and the rocker piston end. Turn the piston to prevent it from tilting.

Acceptable valve clearance (play)	
Exhaust	0.50 ± 0.05 mm (0.0196 ± 0.0019 in.)
Exhaust with VEB	1.60 ± 0.05 mm (0.063 ± 0.002 in.)

**Note:** If there is play: try with different feeler gauges until the play disappears. That makes it possible to find out which shim measure will be used in step 60. If unable to insert the feeler gauge, try a thinner gauge until one fits or until there is no longer any play.

60



T2009008

Calculate the thickness for the new shims using  $A - B$  (below). **A maximum of two shims may be used.** (If two shims are needed, select the shims so they are both about the same thickness.)

$A - B =$ shims required
A = Measured play
B = Specified play tolerance

**Note:** Shims are available in thickness intervals of 0.05 mm (0.002 in). Sizes range from  $2.0 \pm 2.4$  mm (0.08 ± 0.094 in.), and from  $3.2 \pm 3.95$  mm (0.126 ± 0.156 in.). The thickness is stamped on the shims.

61

Carefully clean the shims and valve bridge. Install the shims and tighten the adjustment screw lock nut to  $38 \pm 4$  Nm ( $28 \pm 3$  ft-lb).

$38 \pm 4$  Nm  
( $28 \pm 3$  ft-lb)

**Note:** Make sure that the adjustment screw does not move out of position when tightening the nut.

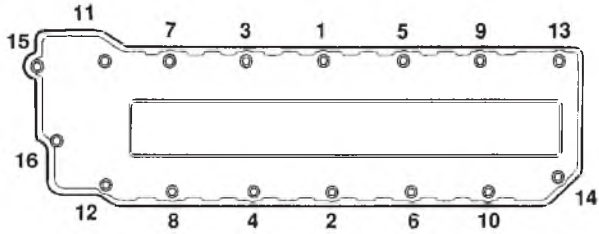
62

Use the same procedure to check the play of the other valves and unit injectors.

63

Install the engine ECU fuse.

64

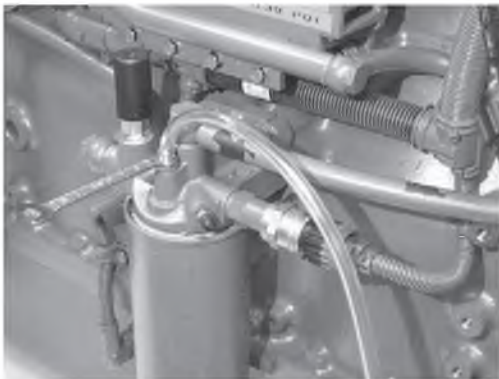


T2012845

Install the valve cover and torque-tighten the bolts to  $20 \pm 2$  Nm ( $15 \pm 1$  ft-lb) following the sequence shown.

**Note:** Check that the nut washers and rubber rings properly fit the valve cover holes to avoid damage to the valve cover.

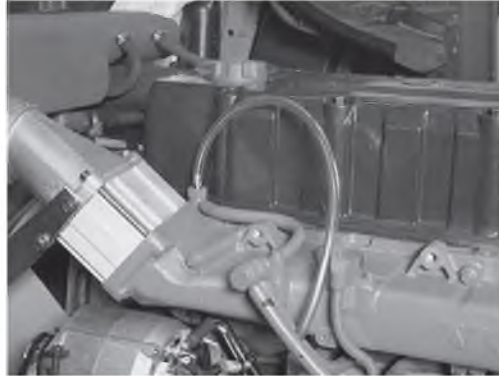
65



T2012934

Connect a hose to the air bleed nipple in the fuel filter bracket. Open the drain plug and pump fuel with the manual pump until the fuel comes out with no air bubbles through the hose. Tighten the drain plug in the fuel filter bracket, remove the hose, and place the protection cap on the drain plug.

66



T2012797

Connect the hose to the air drain nipple on the cylinder head front and drain the air by pumping fuel with the manual pump until the fuel comes out with no air bubbles through the hose. Tighten the air drain nipple, remove the hose, and place the protection cap on the nipple.

67

Start the engine and keep it running at idling speed for approximately 10 minutes to purge any air remaining in the fuel system. Check the seals in all fuel pipe connections.

68

Check that the engine reaches the normal operating temperature and let it run for another 5 minutes at idling speed. When the idle speed stabilizes, the cylinder balancing is finished and the correct amount of fuel the unit injector should inject in each cylinder is determined.

**Note:** Disconnect all power-consumption components, such as power take-off, air conditioning, etc., to allow the cylinder balancing to occur.

# Service Manual Trucks

Group **230–600**

Fuel System  
D12, D12A, D12B, D12C



# Foreword

The descriptions and service procedures contained in this manual are based on designs and methods studies carried out up to August 2000.

The products are under continuous development. Vehicles and components produced after the above date may therefore have different specifications and repair methods. When this is believed to have a significant bearing on this manual, supplementary service bulletins will be issued to cover the changes.

The new edition of this manual will update the changes.

In service procedures where the title incorporates an operation number, this is a reference to an S.R.T. (Standard Repair Time).

Service procedures which do not include an operation number in the title are for general information and no reference is made to an S.R.T.

The following levels of observations, cautions and warnings are used in this Service Documentation:

**Note:** Indicates a procedure, practice, or condition that must be followed in order to have the vehicle or component function in the manner intended.

**Caution:** Indicates an unsafe practice where damage to the product could occur.

**Warning:** Indicates an unsafe practice where personal injury or severe damage to the product could occur.

**Danger:** Indicates an unsafe practice where serious personal injury or death could occur.

**Volvo Trucks North America, Inc.**  
Greensboro, NC USA

**Order number: PV776-TSP142867**

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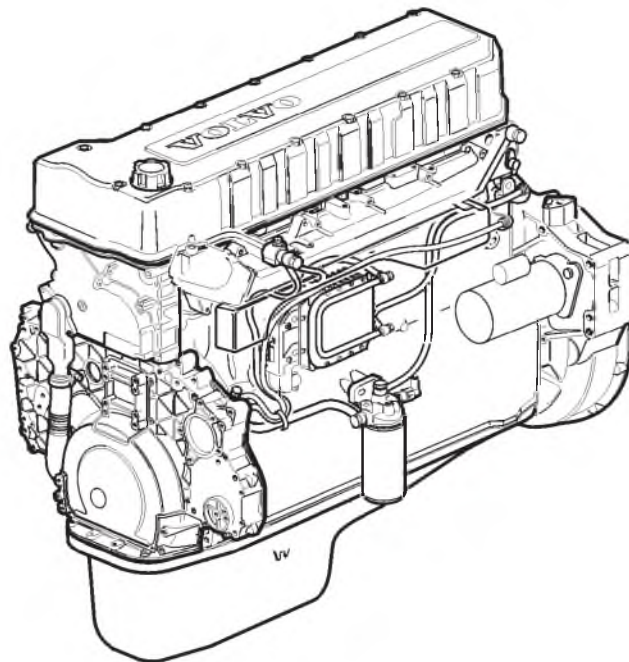
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## **Feedback**

## **Operation Numbers**



## General



V2003244

This information covers the fuel system of the Volvo D12 engine and includes engine versions D12, D12A, D12B, and D12C.



# Specifications

## Fuel System

Component	Nm	ft-lb
Retainer bolt unit injector w/ NEW COPPER SLEEVE		
First tightening Step 1	20 ± 5	15 ± 4
First tightening Step 2	Turn an additional 180 ± 5°	
Loosen the retainer bolt for the unit injector prior to the second tightening.		
Second tightening Step 1	20 ± 5	15 ± 4
Second tightening Step 2	Turn an additional 60 ± 5°	
Component	Nm	ft-lb
Retainer bolt unit injector w/ OLD COPPER SLEEVE		
Step 1	20 ± 5	15 ± 4
Step 2	Turn an additional 60 ± 5°	

## Fuel Supply Pump and Overflow Valve

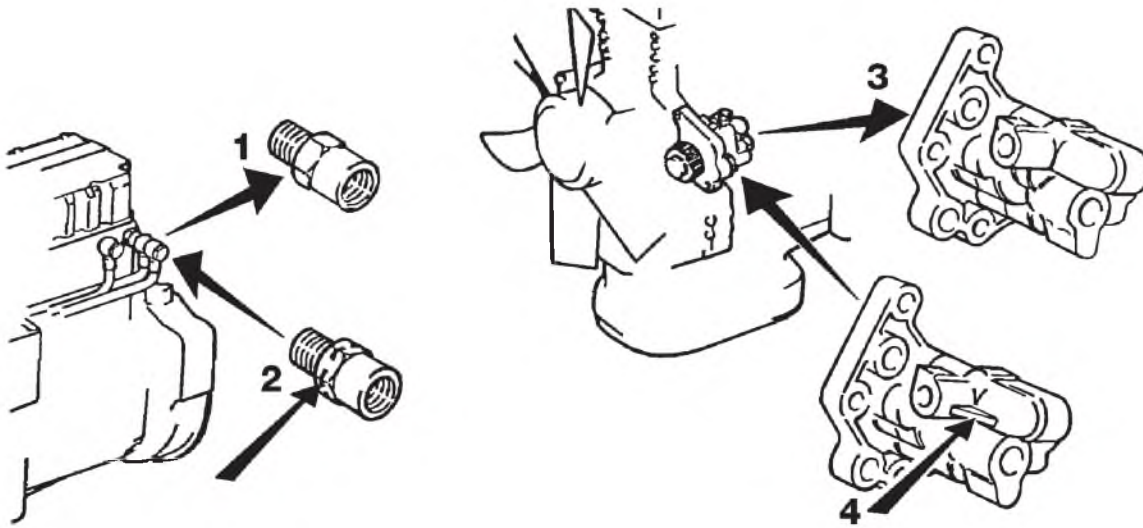
### Fuel Supply Pressure

Engine number .....	up to 98799	from 98800
Minimum supply pressure at full load .....	250 kPa (36 psi)	350 kPa (51 psi)

### Overflow Valve

Engine number .....	up to 98799	from 98800
Opening pressure .....	300-350 kPa (44-51 psi)	340-450 kPa (50-65 psi)

## Identifying 450 kPa (65 psi) Fuel System Components

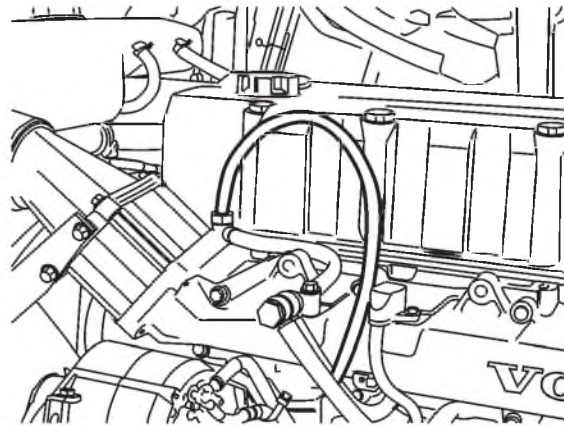


W2003117

Fig. 1: Fuel System Components

- 1 350 kPa (51 psi) overflow valve\*
- 2 New 450 kPa (65 psi) overflow valve can be identified by the groove cut into the hex portion of the valve as shown above.\*
- 3 350 kPa (51 psi) fuel pump.
- 4 New 450 kPa (65 psi) fuel pump can be identified by the additional web in the casting as shown above.  
(\*D12A/B location shown.)

**Important:** When changing an overflow valve to the new 450 kPa (65 psi) bar version, the fuel pump must also be changed to the 450 kPa (65 psi) version. However, when changing a fuel supply pump to the 450 kPa (65 psi) version, you are not required to change the overflow valve.



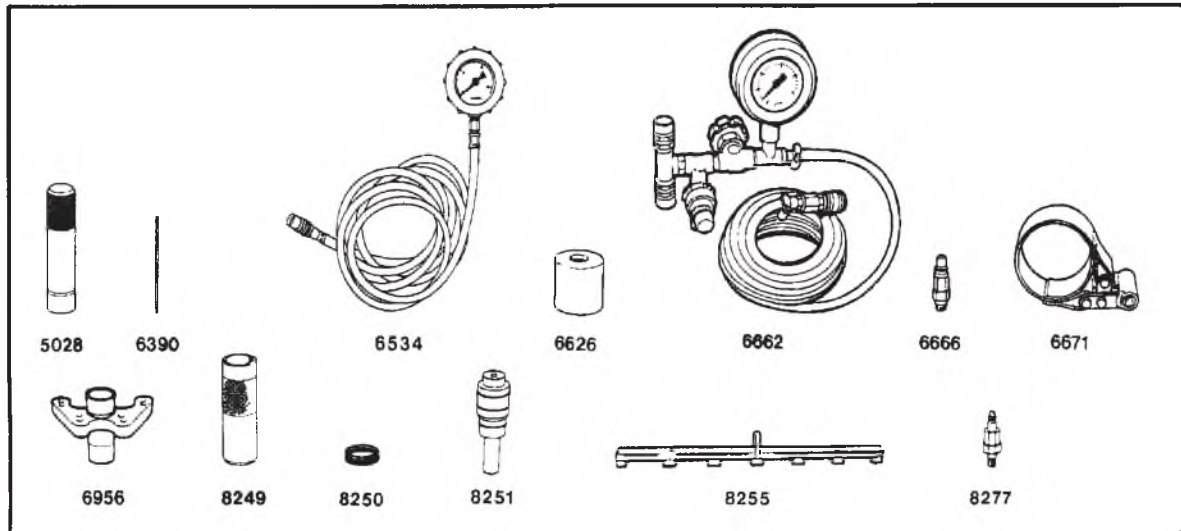
W2003394

Fig. 2: Overflow valve location, D12C

## Tools

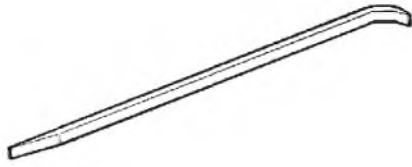
### Special Tools

The following special tools are used to replace or repair components. The tools can be ordered from Volvo Parts North America; please use the specified part number when ordering. Tools with part numbers beginning with "J" are available directly from Kent-Moore (telephone: 1-800-328-6657).



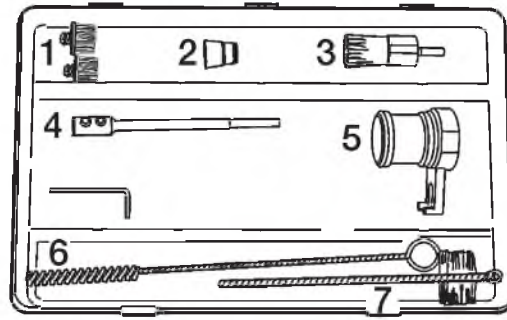
W0000404

9996390	Drift indicator extension for setting electronic unit injector
9996534	Gauge for checking fuel feed pressure
9996662	Pressure gauge
9996666	Union for checking fuel feed pressure
9996671	Fuel filter removal tool
9996956	Cranking tool for flywheel
9998249	Protective sleeve for electronic unit injector
9998250	Sealing rings for the fuel gallery (2)
9998251	Sealing plug for cylinder head
9998277	Union for draining fuel system
9812546	Cleaning brush
J-41603	Socket
J-41196	Dial indicator



**9998511** Lever tool

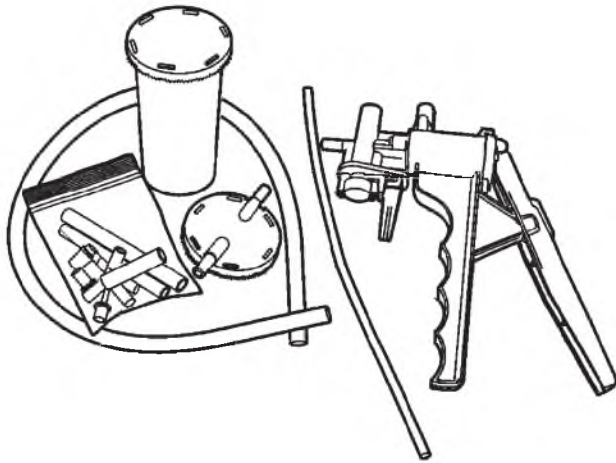
W0001802



W2003530

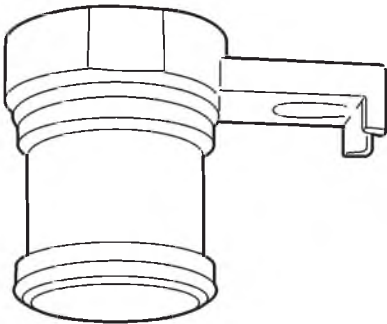
**9998599** Cleaning kit

- 1 9808614 — brush
- 2 9808615 — holder
- 3 9808613 — holder
- 4 9808616 — handle
- 5 J-42885-25 — protecting sleeve
- 6 9808617 — brush
- 7 9808618 — brush



**J-44515** Fuel vacuum tool

W0001837



W2003529

**J-42885-25** Injector bore protecting sleeve



## Special Equipment

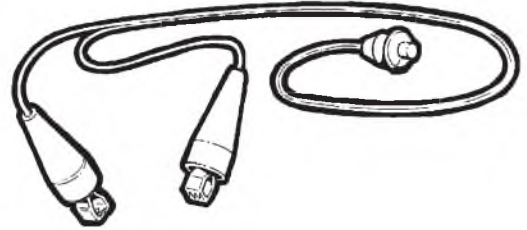
Like the special tools, the following equipment will aid in servicing the D12 engine. When ordering equipment, specify the appropriate number.



**1159794**

Torque wrench, 10 – 100 Nm (7 – 70 ft-lb)

W0001840



**MT302A**

SNAP-ON Remote Starter Cable Switch

W0000399



# Design and Function

## Fuel System

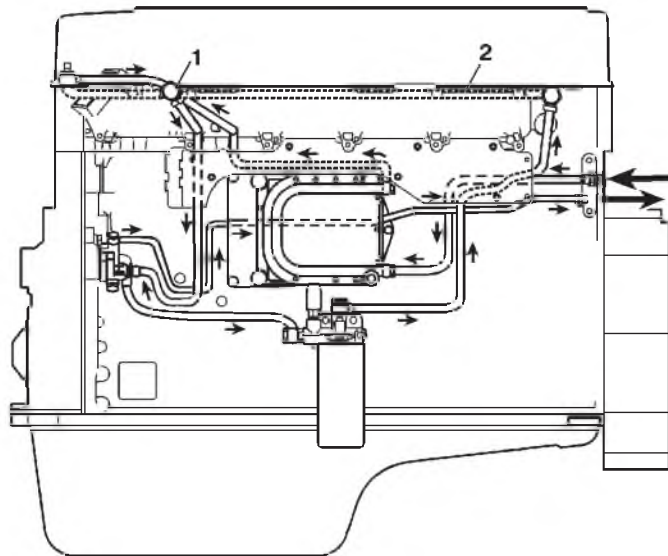


Fig. 3: Fuel system, D12C

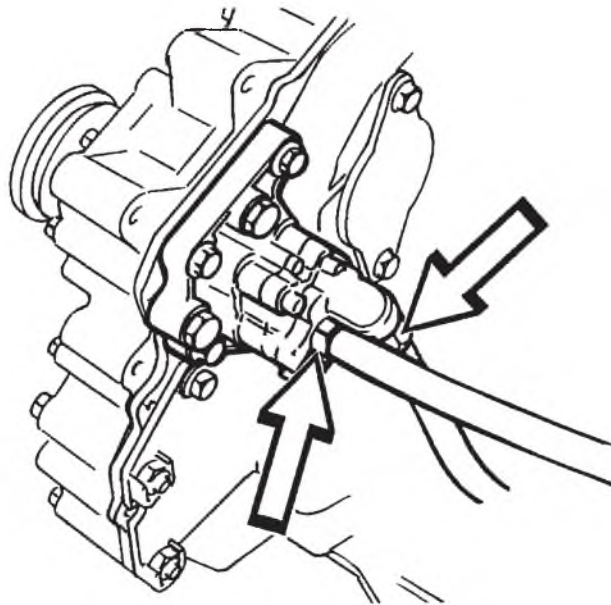
W2003243

The Volvo D12 is an electronic engine designed to meet today's high environmental standards. Meeting these standards requires optimum combustion. This demands, among other things, injecting the exact amount of fuel into the combustion chamber under very high pressure, at precisely the correct time, depending on engine speed, load, temperature and other conditions.

Because totally mechanical injection systems cannot meet these demands, the engine is equipped with an electronically controlled injection system. An **engine electronic control unit (EECU)** receives impulses from the accelerator pedal and a number of sensors on the engine. The sensors read signals which govern the injection procedure and send these signals to the EECU. The fuel system has a built-in diagnostic system, which electronically detects and traces any faults in the system.

Each cylinder has four valves. Individual differences always occur between the cylinders in an internal combustion engine. The engine has a cylinder balancing system, the purpose of which is to even out the amounts of fuel between the cylinders. Cylinder balancing takes place with the engine running at idle speed, providing certain preconditions have been met.

## Fuel Line O-Rings

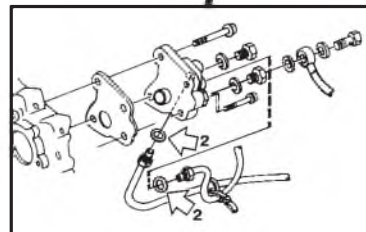
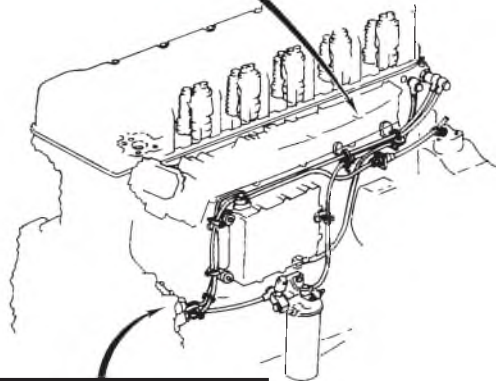
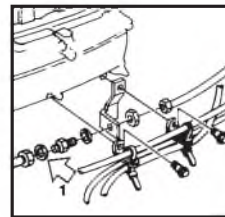


W2002168

Fig. 4: Removing fuel lines

**Always replace the fuel line O-rings when:**

- troubleshooting for fuel aeration and/or
- performing any Service Procedure that requires the removal of VE D12 engine fuel lines.



W2002169

Fig. 5: Fuel line O-ring locations

- 1 976020
- 2 955984

## Unit Injectors

The fuel injection system of the D12 engine uses electronically-governed unit injectors that are electrically activated and mechanically driven via roller rocker arms from the camshaft lobe. They are vertically located in the center between the four valves in the cylinder head for each cylinder.

The electronic unit injector (EUI) combines an injection pump and an injector. An EUI can operate at considerably higher injection pressure than a conventional injector. The EUI consists of three main components:

- **Pump** containing a cylinder and piston; this corresponds to the pump assembly in an injection pump.
- **Injector** with nozzle body, nozzle needle and spring.
- **Valve housing** with an electro-magnetically controlled fuel valve.

The upper part of the electronic unit injector, which includes the compression spring and valve housing, lies above the cylinder head.

The center part of the electronic unit injector, where the intake and outlet holes for the fuel are located, lies in the cylinder head fuel gallery. The electronic unit injector takes in fuel directly from the fuel gallery.

The lower part of the EUI is located in a copper sleeve against the bottom of the cylinder head, similar to a standard injector.

The EECU calculates injection timing and the amount of fuel to inject into the cylinder and transmits signals to the electromagnetically controlled fuel valve in the valve housing. The length of the injection time determines the amount of fuel injected into the cylinder.

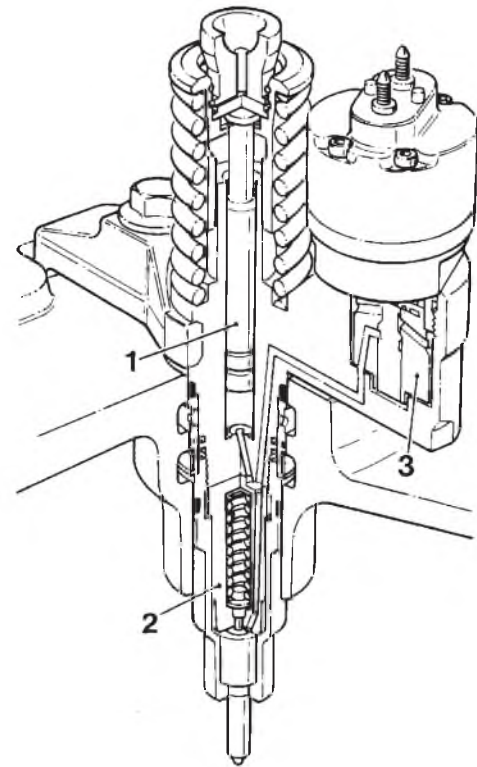


Fig. 6: Electronic unit injector (EUI)

T2006848

- 1 Pump part
- 2 Injector part
- 3 Valve housing

## Injector Operational Phases

### Fill Phase

During the filling phase, the pump plunger (2) is on its way up, the camshaft lobe is passing its highest point, and the rocker arm is on its way toward the camshaft basic circle.

The fuel valve (1) is open, allowing fuel to flow into the EUI from the lower fuel gallery (4). It flows into the cylinder head and the EUI pump cylinder. Filling continues until the pump plunger reaches its upper position.

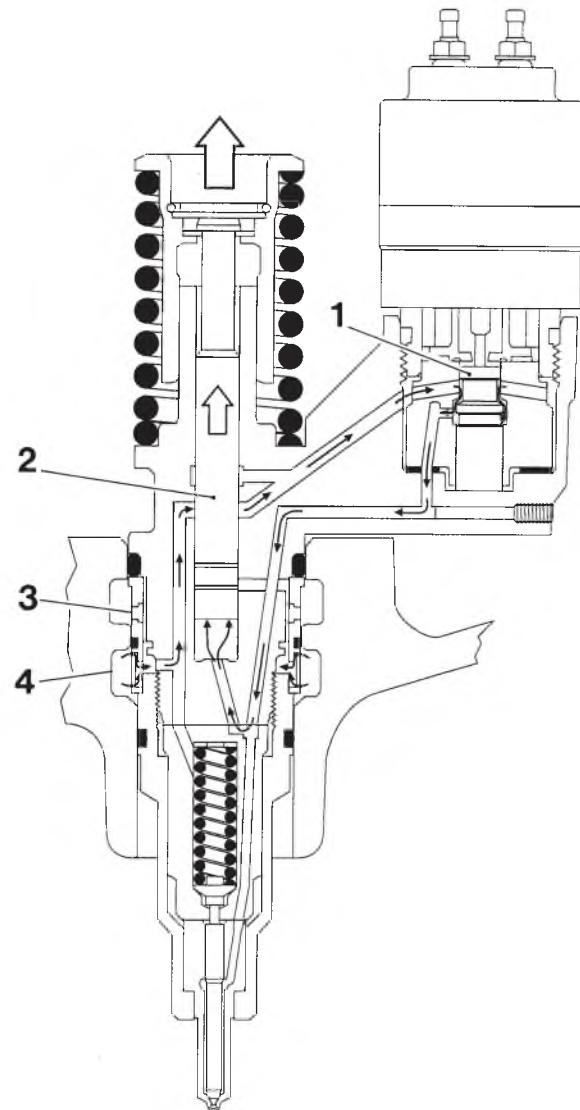


Fig. 7: Filling phase

T2006813

- 1 Fuel valve
- 2 Pump plunger
- 3 Fuel outlet (overflow)
- 4 Fuel gallery (inlet and outlet)



### Spill Phase

The spill phase begins when the camshaft turns to the position at which the camshaft lobe forces the rocker arm to push the pump plunger (2) down.

The fuel can now flow through the fuel valve (1), through the holes in the EUI and out through the fuel gallery (4). The spill phase continues as long as the fuel valve (1) is open.

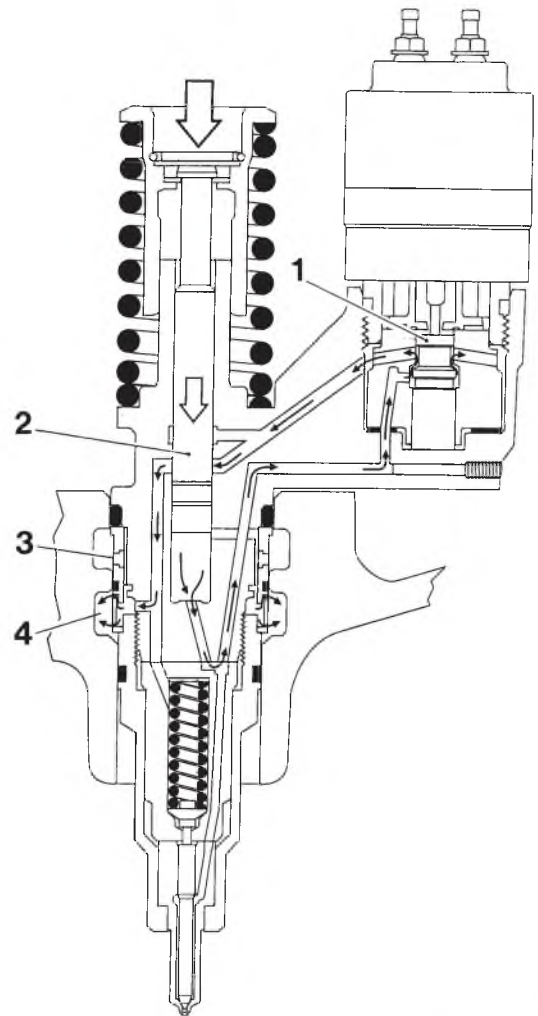


Fig. 8: Spill phase

T2006B14

- 1 Fuel valve
- 2 Pump plunger
- 3 Fuel outlet (overflow)
- 4 Fuel gallery (inlet and outlet)

### *Injection Phase*

The injection phase begins when the fuel valve (1) closes. The camshaft lobe and rocker arm continue to press down the pump plunger (2) and injection occurs as the route through the fuel valve closes. The injection phase continues as long as the fuel valve (1) is closed.

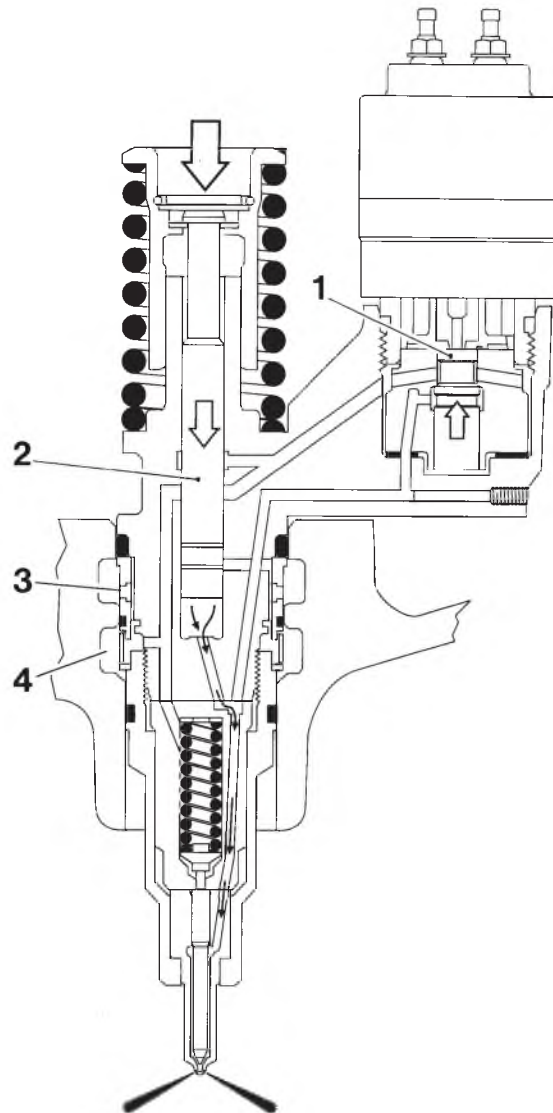


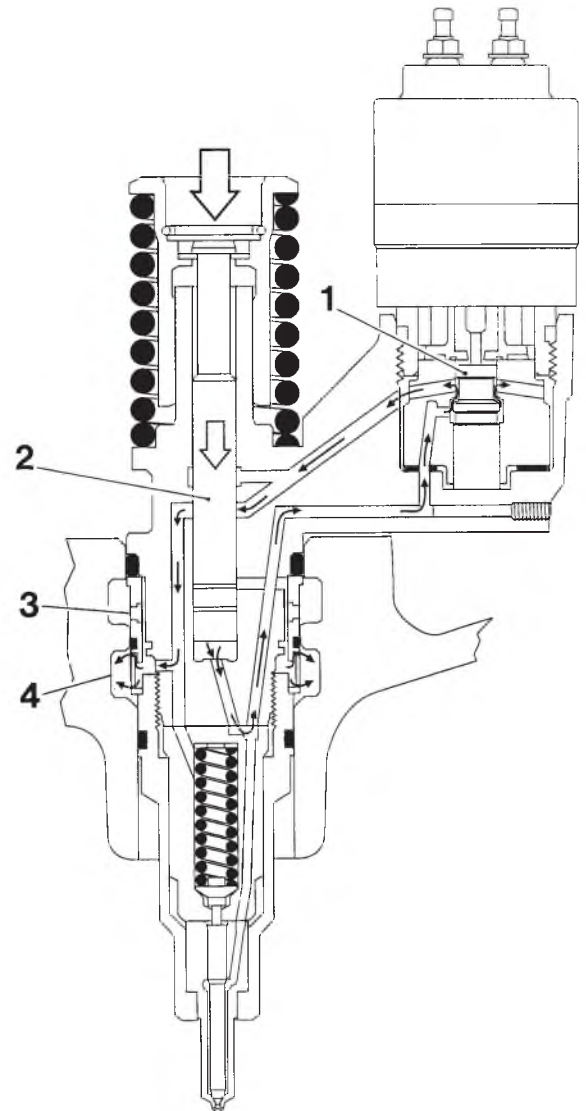
Fig. 9: Injection phase

T2006815

- 1 Fuel valve
- 2 Pump plunger
- 3 Fuel outlet (overflow)
- 4 Fuel gallery (inlet and outlet)

### *Pressure Drop Phase*

The injection phase ends when the fuel valve (1) opens and pressure in the EUI drops below the nozzle opening pressure. The fuel flows through the open fuel valve (1), through the electronic unit injector holes and out through the fuel gallery (4). Note that the fuel valve position (closed or open) determines when the injection phase begins and ends. The time during which the fuel valve is closed determines the amount of fuel injected at each pump stroke.



T2006816

Fig. 10: Pressure drop phase

- 1 Fuel valve
- 2 Pump plunger
- 3 Fuel outlet (overflow)
- 4 Fuel gallery (inlet and outlet)

## D12A

One unit injector is used for the 345, 385, and 425 horsepower variants. The spray angle has been modified. These injectors are **NOT** interchangeable with the D12 injectors.

## D12B

**The unit injectors on the D12B have a longer pump stroke length than earlier injectors on the D12A. They are not interchangeable with other engine versions.**

The engine electronic control unit (EECU) receives signals both from the engine's own sensors and from the vehicle control unit. The EECU then controls the unit injectors and determines the timing of the injection as well as the amount of fuel to be injected into the cylinders.

With the adaptation to the new vehicle electronics, the throttle position sensor signal on the D12B is now linked to the engine control unit via the vehicle control unit.



### CAUTION

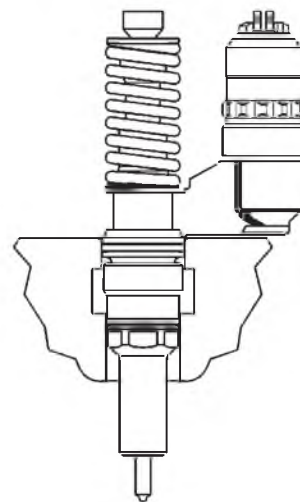
Using incorrect injectors (i.e. D12A injectors in a D12B engine) can cause engine damage and/or poor performance. Injector identification can only be made using the injector part number located on the injector solenoid valve.

## D12C

The D12C has new unit injectors, with 17 mm pump stroke and higher injection pressure. The injector nozzles are new, and have a different orifice pattern.

Unlike the D12A and D12B engines, the D12C cylinder head only has one fuel galley for the unit injectors. This means that only two sealing rings are needed for each unit injector (the D12A and D12B use three rings).

Fuel enters at the rear of the cylinder head and exits out the front.

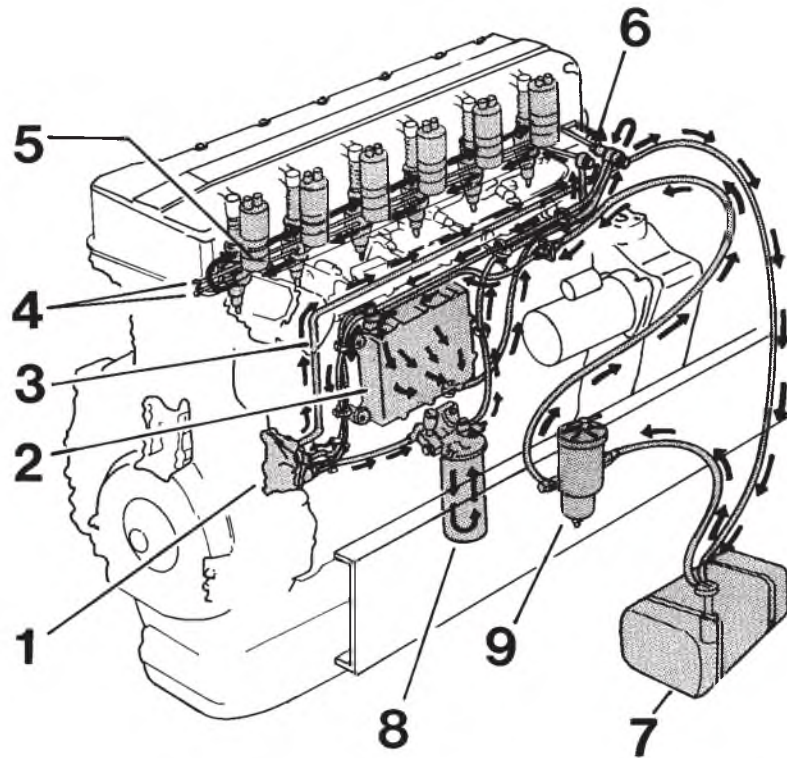


T2012782

Fig. 11: Unit Injector, D12C

## Fuel Flow

### D12A



W2000680

Fig. 12: Fuel flow, D12A

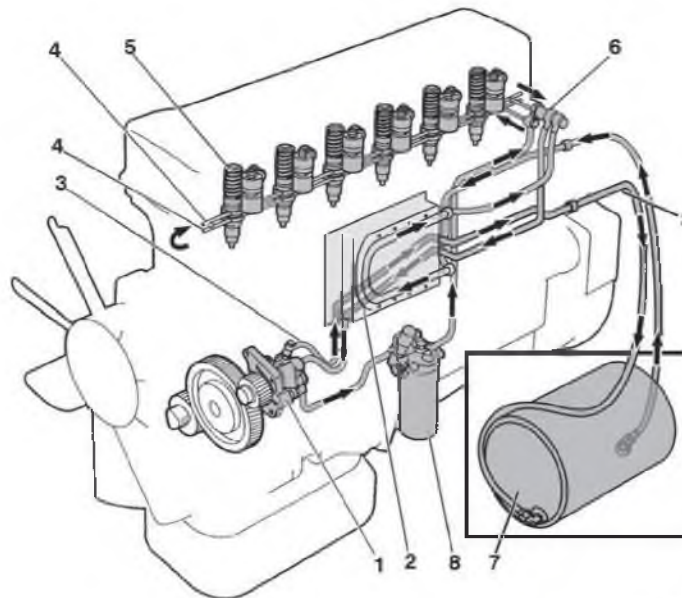
- |   |                                       |   |                                |
|---|---------------------------------------|---|--------------------------------|
| 1 | Fuel feed pump                        | 5 | Electronic unit injector (EUI) |
| 2 | Engine electronic control unit (EECU) | 6 | Overflow valve                 |
| 3 | Bleed line                            | 7 | Fuel tank                      |
| 4 | Fuel gallery                          | 8 | Fuel filter                    |

The fuel feed pump (1) is mounted on the timing gear plate and driven through a recess in the pump shaft by the engine timing gears. It picks up fuel from the fuel tank (7) through the fuel system EECU (2). Return fuel from the cylinder head is also routed into the fuel feed pump. A bleed line (3) goes from the fuel feed pump back to the fuel tank, and is designed to continuously bleed the system. From the fuel feed pump, fuel first passes through the filter (8) and then into the cylinder head fuel gallery (4). The fuel gallery surrounds the part of the EUI (5) where the fuel holes are placed. The system overflow valve (6) is located in the fuel gallery outlet connection.

Leak-off fuel flows from the EUI back to the fuel gallery, eliminating the need for an external fuel return.

## D12B

Unlike the D12A, the EECU on the D12B is fitted with an external fuel cooling coil.



W200262B

Fig. 13: D12B, Fuel flow

- |               |                 |                  |
|---------------|-----------------|------------------|
| 1 Supply pump | 4 Fuel gallery  | 6 Overflow valve |
| 2 EECU        | 5 Unit injector | 7 Fuel tank      |
| 3 Bleed line  |                 | 8 Fuel filter    |

The fuel system's supply pump (1) is attached to the timing gear plate and is driven via a groove in the pump shaft from the engine's timing gears.

The supply pump pulls fuel from the tank (7) through the EECU's cooling coil, which cools the EECU. The return fuel from the cylinder head is then blended with this fuel and enters the supply pump. From the supply pump (1), a bleed line (3) leads back to the fuel tank to provide continuous venting for the system.

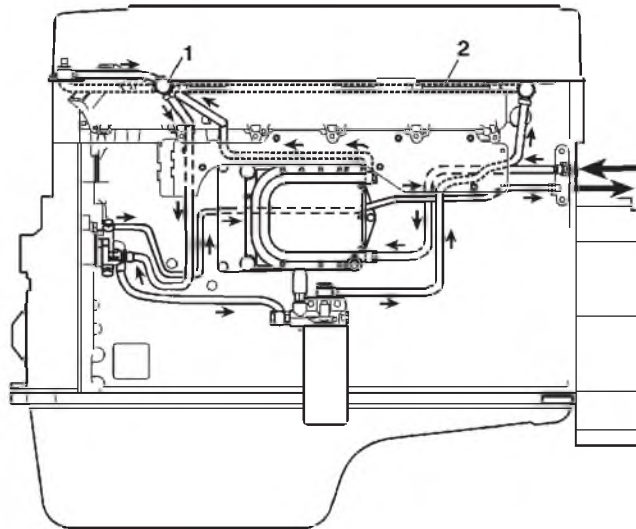
With the bleed line (3) as the only return line to the tank, the only fuel passing through the EECU's cooling coil is the amount consumed by the engine.

From the supply pump (1), the fuel is forced through the fuel filter (8) and then into the cylinder head fuel gallery (4). The fuel gallery is designed so that it surrounds that part of the unit injectors (5) where the fuel holes are located.

The system's overflow valve (6) is located in the fuel gallery's outlet connection. The overflow valve regulates the fuel system's supply pressure. All fuel that exits the overflow valve (leak-off fuel) is then blended with the fuel entering the supply pump.



## D12C



W2003243

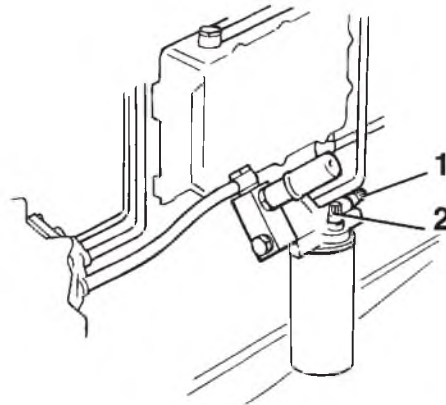
Fig. 14: External fuel line installation and fuel flow, D12C.

- 1 Bypass valve
- 2 Fuel passage in cylinder head

The D12C uses a fuel line through the cylinder head. The bypass valve is also located toward the front of the cylinder head.

## Fuel Filter

The system is equipped with a large fuel filter located on the left-hand side of the engine. The filter insert consists of a special corrugated filter paper with a high resistance to water and very good filtering properties. In addition, a fine-gauge net filter on the fuel suction line in the fuel tank separates any possible solid impurities before the fuel is pumped up into the system.



T2006726

Fig. 15: Fuel filter

- 1 Drain nipple
- 2 Bleed nipple

## D12C

The D12C uses a new fuel filter base, with hand pump mounted directly on the base.

The base has a port for a fuel pressure sensor.

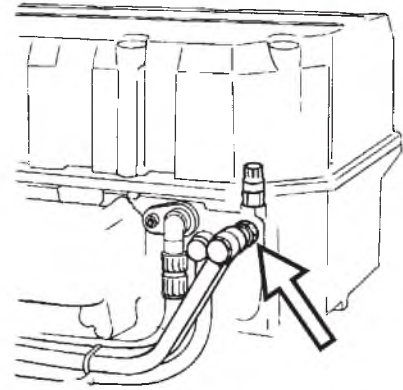


T2012783

Fig. 16: Fuel Filter, D12C

## Overflow Valve

The overflow valve, located in the outlet from the cylinder head fuel gallery, regulates the fuel system feed pressure. Opening pressure is about 345 kPa (50 psi). The high feed pressure ensures that the injectors are filled with fuel.

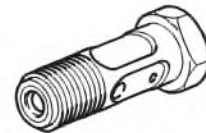


W2000581

Fig. 17: Overflow Valve Location, D12A/B

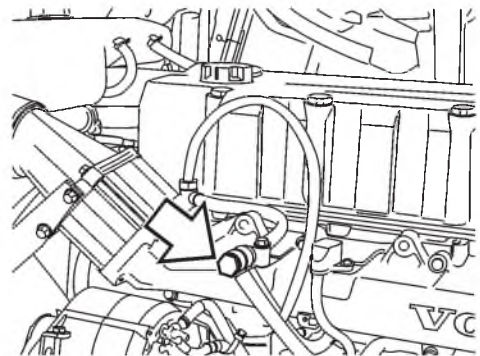
## D12C

The D12C has a new overflow valve. The valve is integrated with the hollow screw in the fuel outlet at the front of the cylinder head.



T2012784

Fig. 18: Overflow Valve, D12C

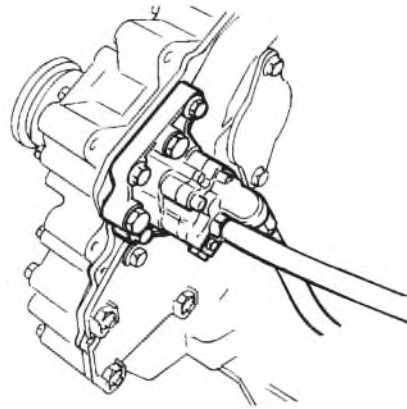


W2003527

Fig. 19: Overflow Valve location, D12C

## Fuel Feed Pump

The capacity of the pump has been adapted to give the correct pressure and flow to the EUI. Filling the EUIs requires relatively high pressure. The flow must be large enough to even out any fuel temperature differences in the cylinder head fuel gallery.



T2006725

Fig. 20: Fuel Feed Pump

## Fuel Feed Pump Replacement

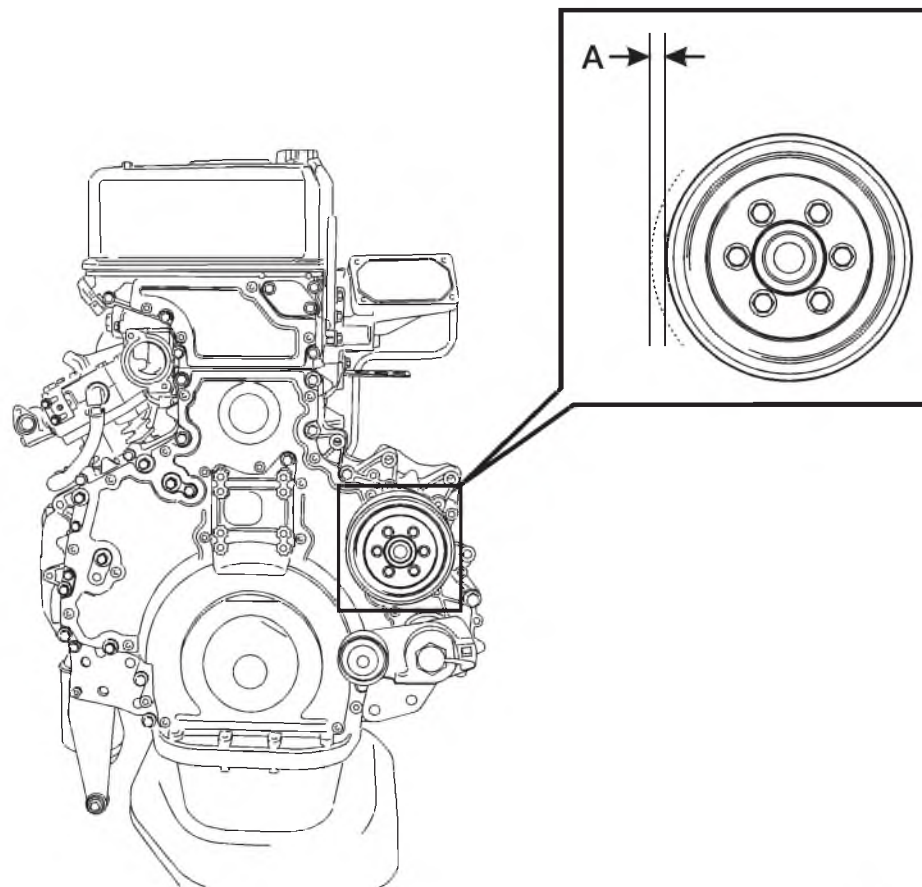


Fig. 21: A = Radial Play

W2002891

When replacing a D12 fuel supply pump for any reason, the accessory drive must also be inspected. There should be no radial or axial play in the accessory drive shaft. Radial play is movement parallel (side to side) to the face of the pulley. Do not confuse with backlash which is measured by turning the pulley. Axial play is movement perpendicular (in and out) to the face of the pulley. Release the tension on the alternator and fan belts before checking. This test is done by simply attempting to move the accessory drive pulley by hand.



### CAUTION

Radial or axial play in the accessory drive shaft may cause premature failure of the fuel feed pump.

## Hand Primer

The hand primer is situated on the fuel filter bracket. It is used to pump the fuel and bleed the system when the engine is not running.

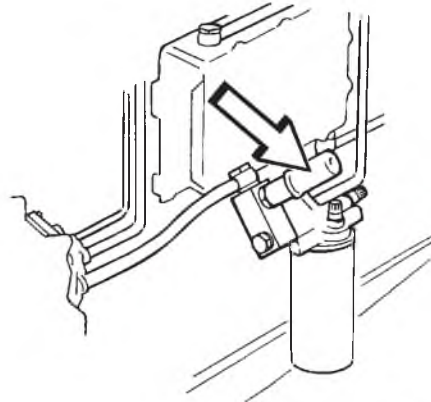


Fig. 22: Hand primer

## Engine Electronic Control Unit (EECU)

The electronic control module is the central part of the injection system. It is located on the left-hand side of the engine. The EECU receives continuous information from the accelerator pedal and from several sensors on the engine. It calculates the amount and the time to inject fuel into the cylinders. Electrical wiring to the EUI fuel valves transmits control signals to the injectors.

The EECU uses the flywheel sensor to monitor engine rotation and engine speed variations during a revolution. This allows the EECU to ensure that each EUI receives exactly the correct amount of fuel. The EECU stores information when a fault occurs or if something in the system is abnormal. Occasional faults are also stored and can be traced at a later stage.

For information about the EECU, EECU sensors, and their functions, refer to:

**Service Information** 280–600  
*Control Systems, D12*

**IMPACT** Function Group: 284  
Information Type: Design and Function  
"Sensors"



# Troubleshooting

## Fuel System, Fault Tracing

Correct fault diagnosis is essential to accurate engine repair. The complex design of the engine (that is, with a cylinder head that covers all the cylinders, overhead gear wheel-driven camshaft, and EUI) makes the cylinder head removal on the D12 a comprehensive work operation. Fault tracing in the fuel system requires thorough knowledge on how the system functions, as one does not have the opportunity as with a conventional fuel system of seeing and checking directly on the engine.

As the EECU receives all the information electronically from the different sensors, the EECU must gather all the information when the engine is started and then check that the information is correct. This means the D12 engine does not start on the first crankshaft revolution, but requires two revolutions in order for the control unit to set the correct values. It is important that the starter motor revolutions are not too slow, as slow starter motor speed is interpreted by the control unit that the crankshaft does not rotate and, as a result, the injector fuel valves do not receive the appropriate signals to release fuel.

The crankshaft must rotate at a minimum of 75 rpm to ensure that the engine starts. To facilitate fault tracing in the fuel system, D12 is equipped with a diagnostic system which makes it possible to localize faults in the fuel system without having to perform extensive dismantling work.

With the fault codes stored in the control unit, it is possible, through the diagnostic system, to quickly establish which fault or faults have occurred.

## Fault Codes

It is important to delete a fault code from the diagnostic system after the fault code has been corrected and **before the truck leaves the workshop. Fault codes remain in the system until they are removed. They do not automatically clear when the fault has been corrected.**

## Unit Injector Troubleshooting

The following information will aid in troubleshooting of Electronic Unit Injector (EUI) fault codes.

## Read and Document Fault Codes

Connect the MPSI tool to the vehicle's diagnostic connector to determine whether any active or inactive fault codes are set. Document all set fault codes below:

Code #	Occurred counts	Active/Inactive	PID	SID	FMI
Description .....					

Code #	Occurred counts	Active/Inactive	PID	SID	FMI
Description .....					

Code #	Occurred counts	Active/Inactive	PID	SID	FMI
Description .....					

Code #	Occurred counts	Active/Inactive	PID	SID	FMI
Description .....					

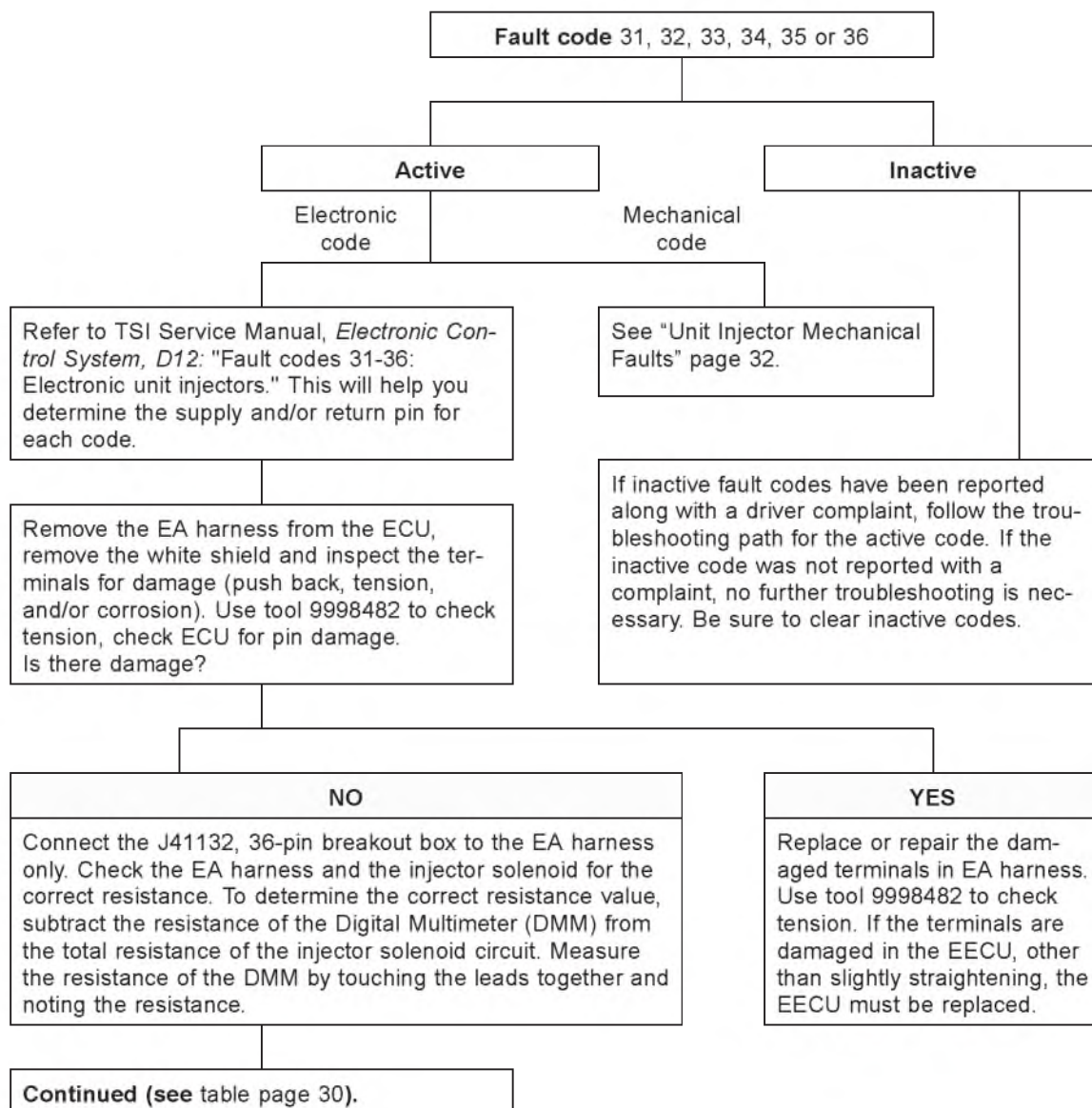
## Troubleshooting Flow Path

### Active fault codes

Troubleshoot the active fault codes first.

### Inactive fault codes with high counts

If inactive fault codes are recorded, follow the troubleshooting path for that same active code. This should be done; however, only when there is a driver complaint in conjunction with the inactive fault code.



Continued from table page 29

Measure the circuit resistance between the injector supply and return pins into the EA harness and note the reading. Subtract the DMM lead resistance from the injector circuit resistance. This will give you the true circuit resistance. Compare to the specifications below.

**Note:** The ECU must **NOT** be connected to the breakout harness during these checks.

Specifications:

* Solenoid circuit to ground .....	OL (open circuit)
* Solenoid circuit resistance .....	1.3-3.5 Ω
* Return circuit to block .....	OL (open circuit)
* Supply circuit to block .....	OL (open circuit)

Record the values.

Remove the valve cover, check the harness to solenoid connection.  
Is connection tight?

**YES**

Remove the supply and return wiring from the injector solenoid and test the solenoid for open or short circuit to ground. Does the solenoid check within specifications?

**NO**

Tighten the connection, re-assemble and check for active code.

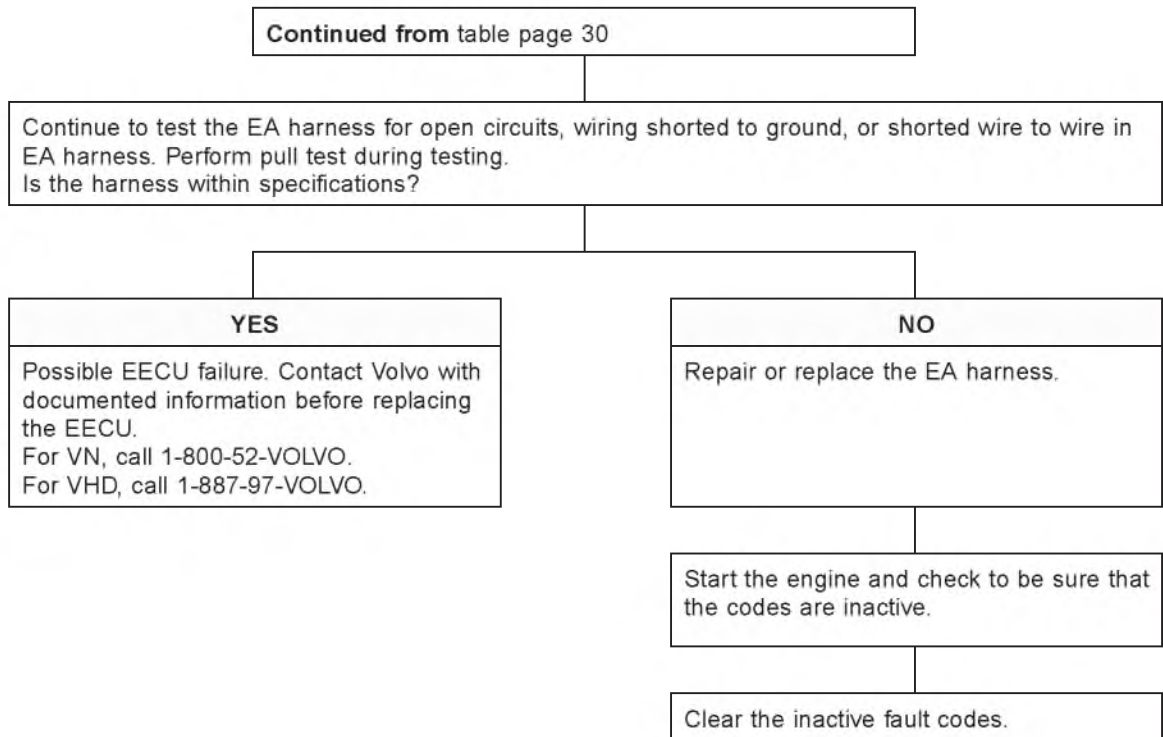
**YES**

The injector is good. Do **not** replace the injector.

**NO**

Replace the injector.

Continued (see table page 31)



## Unit Injector Mechanical Faults

**Note:** A mechanical fault indicates low performance of that cylinder, not just the injector.

Determine the correct troubleshooting flow path.

Fault codes: 31, 32, 33, 34, 35, 36.

### 1. Active code or misfiring occur immediately after start-up

Cause	Corrective action
<ul style="list-style-type: none"> <li>• Incorrect valve or injector adjustment</li> <li>• Injector problem</li> <li>• Base engine problem</li> </ul>	<ul style="list-style-type: none"> <li>• Check the valve and injector adjustment as required.</li> <li>• Perform cylinder balancing or manual compression test before replacing the injector; refer to appropriate service literature or diagnostics checklists for information.</li> <li>• Visual inspection of the camshaft and high crankcase pressure. Perform cylinder balancing or manual compression test before replacing the injector for piston and valve condition. Repair as required.</li> </ul>

### 2. Active code at normal operating temperature and high idle

Cause	Corrective action
<ul style="list-style-type: none"> <li>• Incorrect valve or injector adjustment</li> <li>• Poor quality fuel or excessive fuel additives</li> <li>• Aeration</li> <li>• Injector problem</li> <li>• Base engine problem</li> </ul>	<ul style="list-style-type: none"> <li>• Check the valve and injector adjustment as required.</li> <li>• Test with auxiliary fuel and retest.</li> <li>• Check for fuel restriction, air or compression introduced into the fuel system and repair as required.</li> <li>• Perform cylinder balancing test or manual compression test. If within specifications, replace injector.</li> <li>• Visual inspection of camshaft and high crankcase pressure. Perform cylinder balancing or manual compression test before replacing injector for piston and valve condition. Repair as required.</li> </ul>

### 3. Active code and misfiring at BASE IDLE ONLY

Cause	Corrective action
-------	-------------------

- Incorrect camshaft to crankshaft static timing
- Refer to Camshaft Timing procedure, Group 21.

**If the answer to any of the following is yes, static timing may be the cause of the fault.**

- Have previous repairs been made to the engine that required removing the camshaft?
- Can you clear the fault code, unplug the camshaft sensor, start the engine, and the fault code does not return?
- Can you clear the fault code, start the engine, set the idle above the base idle, and the fault code does not return?



## Locating Air in the Fuel System

Air in the fuel being supplied to the engine can cause a number of problems including hard starting, poor performance, and excessive smoke. Air can enter the fuel system at several points:

- suction side fuel supply lines
- pick-up in the fuel tank
- primary fuel filter
- copper sleeve to injector seat
- injector tip
- fuel supply pump seals

Locating the point of entry can be troublesome and time consuming. A kit has been developed to aid in this process. The kit (J-42753) consists of:

- two fuel line sight glass assemblies
- two transparent hose assemblies
- a clamp
- a washer
- a hollow screw
- copper gaskets
- O-rings

## Determining Whether There is Air in the Fuel



### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.



### DANGER

Do not service any part of the fuel system while smoking or in the presence of flames, sparks, or hot surfaces. Failure to follow these precautions can result in fire, which can cause serious injury or death.



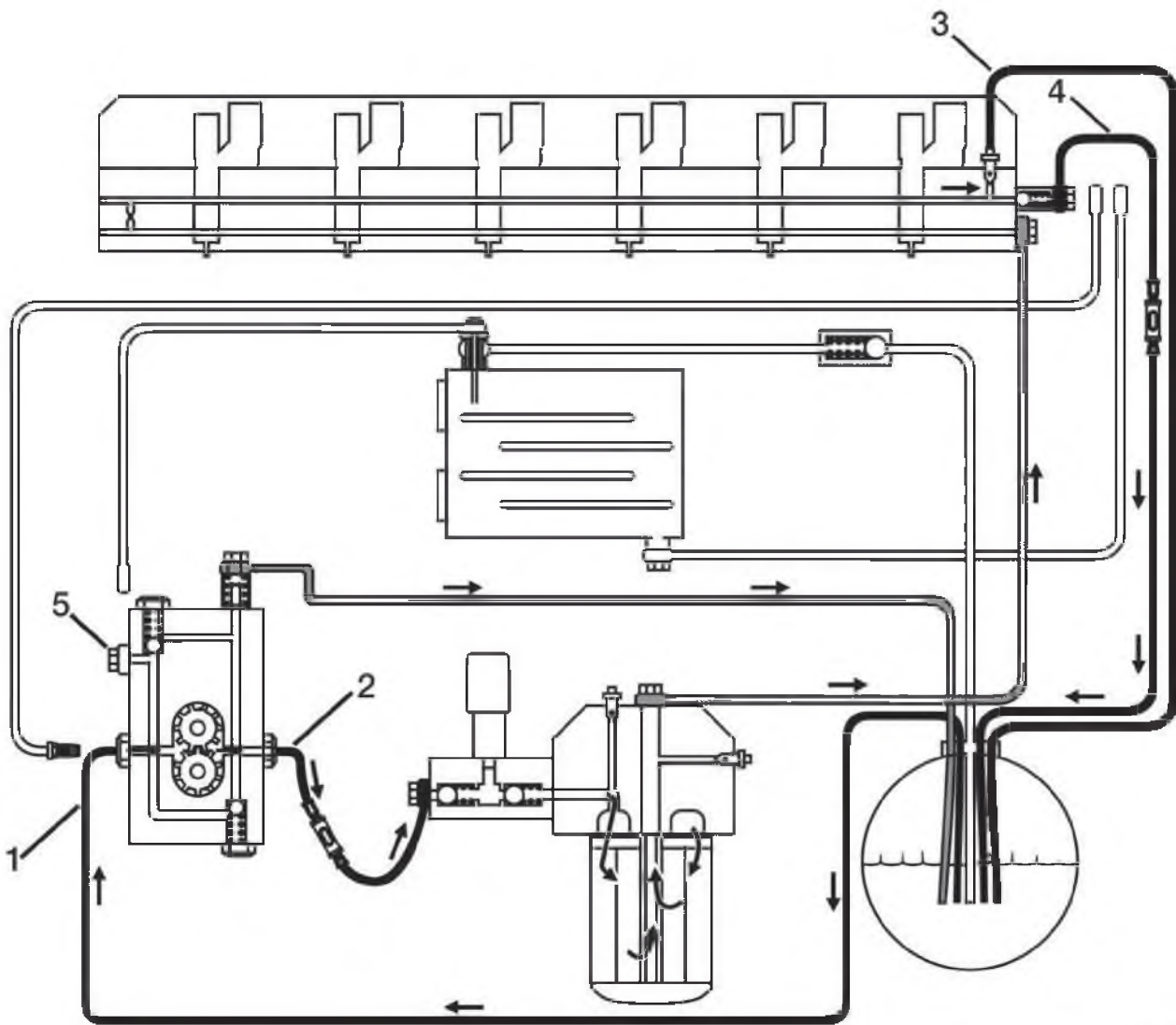
### WARNING

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.



### CAUTION

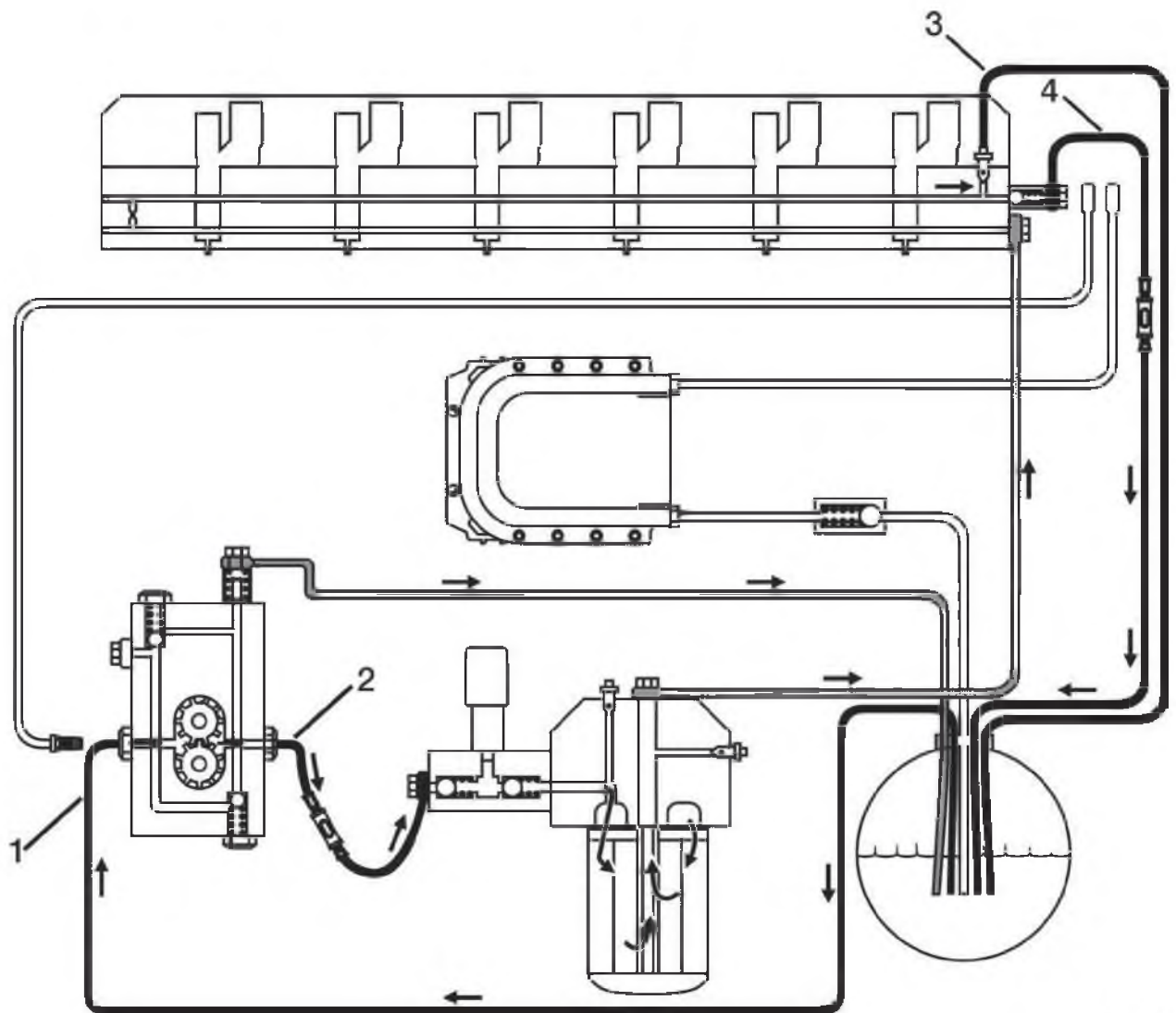
After using the fuel aeration test kit, thoroughly drain all remaining fuel from the test hoses, then install plugs, end caps and washers. This will prevent accidental spillage which could result in fuel contamination.



W2003008

Fig. 23: D12, D12A Fuel System Diagram with Fuel Line Kit Installed

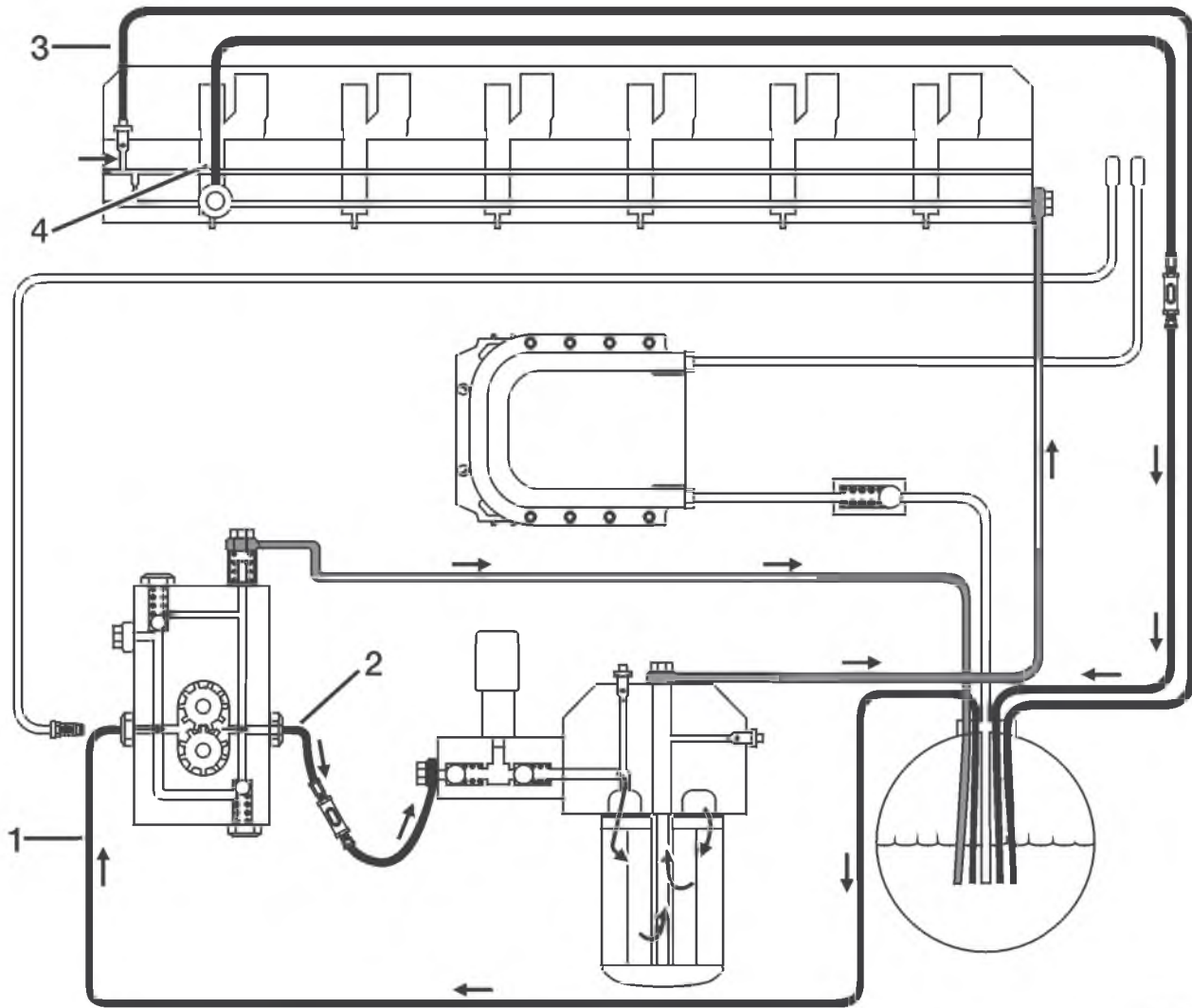
- 1 3/8 in. I.D. Transparent Suction Hose/Alternate Fuel Supply
- 2 Sight Glass Hose Assembly (S)
- 3 3/16 in. I.D. Transparent Hose
- 4 Sight Glass Hose Assembly (R)
- 5 Vent Line Port Washer (949873)



W2003009

Fig. 24: D12B Fuel System Diagram with Fuel Line Kit Installed

- 1 3/8 in. I.D. Transparent Suction Hose/Alternate Fuel Supply
- 2 Sight Glass Hose Assembly (S)
- 3 3/16 in. I.D. Transparent Hose
- 4 Sight Glass Hose Assembly (R)



W2003500

Fig. 25: D12C Fuel System Diagram with Fuel Line Kit Installed

- 1 3/8 in. I.D. Transparent Suction Hose/Alternate Fuel Supply
- 2 Sight Glass Hose Assembly (S)
- 3 3/16 in. I.D. Transparent Hose
- 4 Sight Glass Hose Assembly (R)

**Note:** The numbers within parentheses in the following steps correspond to the accompanying figures:

<b>D12, D12A</b>	See Fig. 23: D12, D12A Fuel System Diagram with Fuel Line Kit Installed, page 37
<b>D12B</b>	See Fig. 24: D12B Fuel System Diagram with Fuel Line Kit Installed, page 38
<b>D12C</b>	See Fig. 25: D12C Fuel System Diagram with Fuel Line Kit Installed, page 39

### 1

Connect the 3/16 in. I.D. transparent hose (3) to the bleed nipple located at the rear of the cylinder head and secure onto the bleed nipple with the clamp provided in the fuel line kit. Route the line back to the fuel tank and secure to prevent it from moving out of the tank. Open the bleed nipple 1 1/2 turns and pump the hand primer pump until the transparent hose is free of air. If the fuel system can be bled free of air continue to step 3.

### 2

If air continues to exist in the fuel, check the following:

- that there is ample fuel in both tanks.
- connections from the fuel tank to the fuel supply pump for suction leaks.
- fuel/water separator for restrictions, suction side leaks or an incorrect micron element.
- that the hand primer pump is capable of pumping fuel.
- the fuel supply pump seal for failure.

### 3

Close the fuel bleed nipple and start the engine.

**Note:** It may be necessary to continue to pump the hand primer during cranking to start the engine. If the engine does not start then the fuel system is most likely filling with air during cranking; skip to step 5.

### 4

Once the engine starts, open the fuel bleed nipple, located at the rear of the cylinder head, 1 1/2 turns with the transparent hose connected. Monitor for air in the fuel for 3 to 5 minutes. If air is present continue to step 5, if not then there is a possibility that air is entering the fuel system only under loaded conditions. If it is suspected that air is entering under loaded conditions continue to step 5. If not, stop here, no further testing is required.

### 5

If the engine would not start in step 3, continues aeration during cranking, or if air is noted in the transparent hose while the engine is running then install the following hoses and sight glasses to determine where the air is entering the fuel system.

### 6

Install sight glass hose assembly (2) between the outlet port of the fuel supply pump and the fuel filter.

### 7

Remove the fuel supply (suction) line from the fuel supply pump and install the alternate transparent fuel supply line (1) and route back to the fuel tank.

### 8

Remove the two fuel lines at the overflow valve and install sight glass assembly (4) onto the overflow valve using hollow screw (941686) from the kit, and route the line to the fuel tank.

### 9

**Remove** the transparent hose (3) from the bleed nipple at the rear of the cylinder head to the fuel tank and close the bleed nipple. Secure all three lines to prevent them from moving out of the fuel inside the tank.

**Note:** For engines equipped with the small line located between the fuel supply pump and the top of the engine electronic control unit (EECU), this line must be disconnected from the fuel supply pump and the port from which the line was removed (5) must be plugged using two copper gaskets and washer (949873) supplied in the fuel line kit.

**10**

Using the hand primer pump attempt to purge all air from the fuel system and start the engine.

**Note:** Purging time may vary.

**11**

Repeat the conditions in which aeration was previously noted or test under loaded conditions, i.e. dyno test.

**12**

Monitor the two sight glasses and transparent hose for aeration allowing 3 to 5 minutes for the sight glasses to clear.

**Note:** Shining a flashlight into the **backside** of the sight glass will improve visibility.

**13**

If no air is noted in either sight glass and air was noted in previous steps, the air entry is most likely in the suction lines between the fuel supply pump and the fuel tank including the primary fuel filter, copper washers, O-rings and pick-up inside of the fuel tanks.

**14**

If air is noted in sight glass (2) between the fuel supply pump and fuel filter, and the alternate fuel supply is supplying the fuel supply pump with a good flow of air free fuel, the problem is most likely in the fuel pump seals.

**Note:** The fuel in sight glass (2) is under pressure. This compresses the air bubbles and they will appear to be small.

**15**

If air is noted in the sight glass (4), at the rear of the cylinder head, but not in sight glass (2) at the outlet of the fuel supply pump (with no engine load), the problem is most likely within the cylinder head, i.e. copper sleeve to injector seat or injector tip leakage. See "Determining which Cylinder is Introducing Air into the Fuel" page 41.

**Note:** Sight glass (4) will show small bubbles due to the turbulence created by the opening and closing of the overflow valve. To determine whether normal or abnormal aeration is occurring, use the transparent hose (3) at the bleed nipple at the rear of the cylinder head. Open the bleed nipple 1 1/2 turns and monitor for air. If the line is clear then the aeration in the sight glass (4) is normal. If the transparent hose indicates aeration then the aeration in sight glass (4) is abnormal.

**16**

If air is noted only under loaded conditions, remove all six injectors and inspect the copper sleeve to the injector seat for signs of leakage.



## Determining which Cylinder is Introducing Air into the Fuel

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### DANGER

Do not service any part of the fuel system while smoking or in the presence of flames, sparks, or hot surfaces. Failure to follow these precautions can result in fire, which can cause serious injury or death.

### WARNING

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

### CAUTION

After using the fuel aeration test kit, thoroughly drain all remaining fuel from the test hoses, then install plugs, end caps and washers. This will prevent accidental spillage which could result in fuel contamination.

**Note:** The numbers within parentheses in the following steps correspond to the accompanying figures:

- D12, D12A** See Fig. 23: D12, D12A Fuel System Diagram with Fuel Line Kit Installed, page 37
- D12B** See Fig. 24: D12B Fuel System Diagram with Fuel Line Kit Installed, page 38
- D12C** See Fig. 25: D12C Fuel System Diagram with Fuel Line Kit Installed, page 39

**1**  
Disconnect the two fuel lines from the overflow valve at the rear of the cylinder head and install the sight glass (4) and line assembly onto the overflow valve using hollow screw (941686), from the kit, and route into the fuel tank. Tie down the line to prevent it from moving out of the tank.

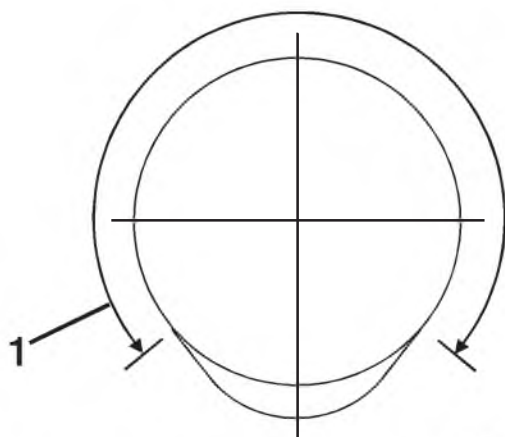
**2**  
Remove the fuel supply line from the fuel supply pump and install the alternate fuel supply line onto the feed pump. Route the line back to the fuel tank. Tie down the line to prevent it from moving out of the fuel level inside the tank.

**Note:** For engines equipped with the small line located between the fuel supply pump and the top of the engine electronic control unit (ECU), this line must be disconnected from the fuel supply pump. The port from which the line was removed (5) must be plugged using two copper gaskets and washer (949873) supplied in the fuel line kit.

**3**  
Start the engine and allow 3 minutes for the sight glass to clear. Take note of the air present in the fuel sight glass (4).

**4**  
Stop the engine and remove the valve cover.


5



W2003027


Fig. 26: 1 base circle of camshaft

Rotate the engine by hand until the rocker arm for the intake valve for number 1 cylinder is on the base circle of the cam, (in other words, in position to be adjusted). Turn the adjusting screw down (clockwise) until all clearance has been removed then turn it down an additional 1/4 turn (90°). Install the valve cover and secure with 4 nuts.

 <b>CAUTION</b>
Do not turn the adjusting screw down more than 1/4 turn (90°) after all clearance has been removed. Engine damage will result.

6

Using the hand primer pump, purge all air from the fuel system.

 <b>CAUTION</b>
Run the engine only at idle speed with no load for this test. High engine speed or load could cause engine damage.

7

Restart the engine and monitor the sight glass (4) in the rear of the cylinder head. If the air that was noted in step 3 is gone then the problem is most likely in the number 1 cylinder (injector tip or injector to copper sleeve seat). Remove the number 1 injector and inspect the injector to the copper sleeve seat. If the seat appears to be OK, replace the injector and perform the test again.

8

If the air that was noted in step 3 is not gone, stop the engine, remove the valve cover, back out (counterclockwise) the adjusting screw for the intake valve at the number 1 cylinder 1/2 round (180°), and repeat the procedure (starting with step 5) on the number 2 cylinder.

9

Continue the procedure until the cylinder that is introducing air into the fuel system has been determined.

10

When the cylinder that is introducing air into the fuel system has been located, remove that injector and inspect the injector to copper sleeve seat. If the seat appears to be O.K., replace the injector and perform the test again. If the seat and injector O-rings show signs of combustion leakage, clean the injector and replace the injector copper sleeve. Reinstall the injector with new O-rings and adjust all valves and injectors.

11

Start the engine and monitor the sight glass for air. If no air is present then stop. If air is present then test again as required.

## Service Procedures

### General Work Practices



#### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.



#### DANGER

The D12 engine uses high voltage (up to 90 V) to the electronic unit injectors. Do not come in contact with the injector terminals while the engine is running as there could be as much as 90V going to the electronic injectors. Contact may result in electrical shock. Personal injury or death can occur.



#### CAUTION

Extreme cleanliness must be observed when working on the fuel system and the **Volvo Engine Brake (VEB)**. Always clean the engine before beginning repairs. To prevent dirt from entering the fuel system, install protective plugs whenever connections are removed. Store components in sealed plastic bags (when feasible) until they are to be reinstalled. The same procedures apply for VEB components. The oil channels for the VEB control system should also be plugged. Dirt in the fuel system and in the VEB system can affect engine operation.

**Note:** After removing or replacing any EUI, or after adjusting preload, start the engine and allow it to reach normal operation temperature. Then let the engine idle for an additional five minutes. This will enable the ECM (through the cylinder-balancing system) to set the correct amount of fuel for delivery to the EUI. No power-consuming components, for example, a PTO should be engaged. The exhaust pressure governor must not be activated. (Remove wire **636K** from the solenoid valve and apply the parking brake to ensure that the truck cannot move.) When the engine runs evenly at idle speed, the cylinder-balancing function has been carried out.

**Note:** If the engine is turned over with the starter motor (for example, when adjusting the valves) the fuse for the engine control system (**B6**) must first be removed and the ignition key must be in the **OFF** position in order to eliminate any risk of the engine starting unintentionally. Also check that the gear lever is in neutral and the parking brake is applied.

- Never remove the EECU connectors or any other electrical wires from the sensors while the engine is running. The ignition key must be in the **OFF** position and the engine stopped.
- Never turn the battery master switch **OFF** or disconnect the battery cables while the engine is running.
- When performing electric welding work on the truck, the EECU connectors must be disconnected from the EECU.

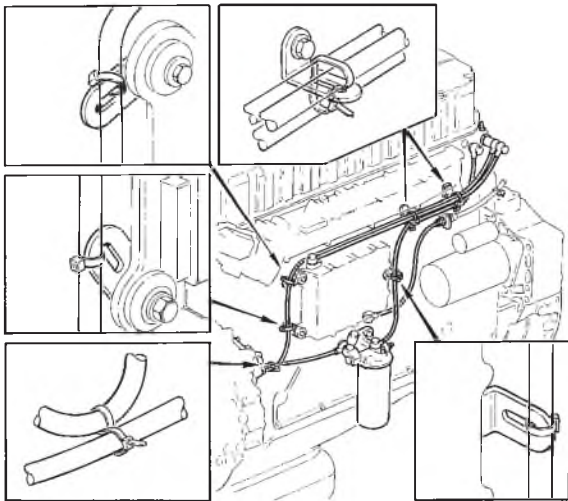
**Note:** Before disconnecting the connectors, the key switch must be turned to the **OFF** position.

- When oven-drying spray-paint work, any ECUs must be removed from the truck. The maximum allowable drying temperature, with the control unit in the vehicle, is 80°C (176°F).
- Use only batteries for auxiliary starting. Using a starting unit can induce peak voltages that can damage the electronic components.
- When charging batteries with a rapid charger, battery cables must be disconnected. (Normal trickle charging does not require this procedure.)
- If a connector is removed, make sure it is reinstalled correctly and is not covered with oil or other fluids which can result in a poor connection.
- For maintenance intervals, refer to:

**Service Bulletin** 175-001  
*Oil and Filter Change Intervals*

**IMPACT** Function Group 175  
Information Type: Maintenance  
*Engine Maintenance*

## Clamping the Fuel Lines



W2000654

Fig. 27: Fuel line routing and securing

To avoid damage and operational disturbances in the fuel system, the fuel lines should be rerouted and secured with plastic cable ties.

**Note:** Always check the fuel lines for cuts, abrasions, chafing or leakage. Diesel fuel that comes in contact with a hot surface can start a fire.

**Note:** Refer to Service Bulletin, Group 23, for oil-cooler thermostat plate leak repair.

**Note:** Refer to Service Bulletin, Group 23, for accessory drive pulley information.

**Note:** Refer to Service Bulletin, Group 23, for fuel line information.

## Turning the Engine Over with the Starter Motor

1

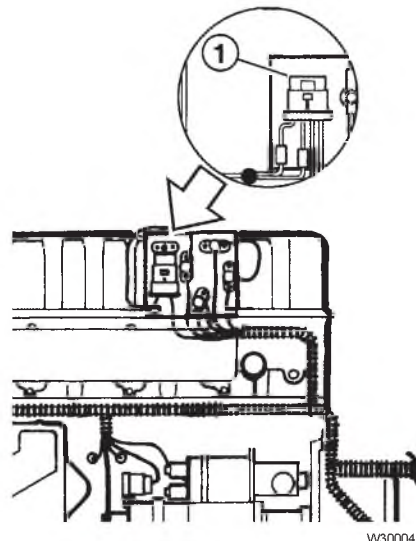


**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

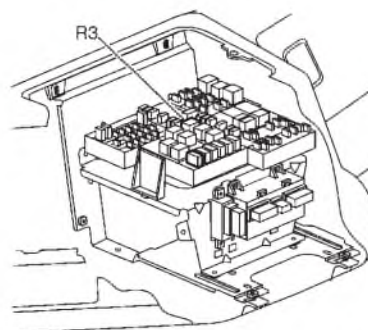
Apply the parking brake, block the wheels, and place the gear lever in neutral. Make sure that the ignition key is in the OFF position.

2



W3000459

Fig. 28: EECU power supply relay, D12A/B



W5001141

Fig. 29: R3 relay location (TEC Panel), D12C

For D12/A/B only, disconnect the EECU power supply relay (1); for D12C (and later versions of D12B), disconnect the R3 relay (located in the TEC panel).

3

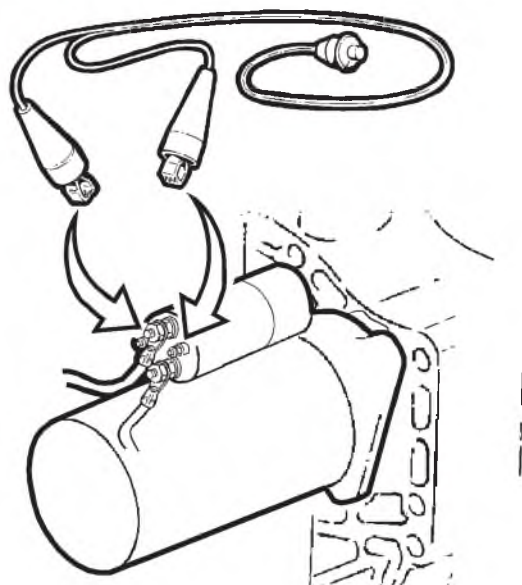


Fig. 30: Remote starter switch and wiring

Connect a switch between the battery positive (+) and the positive (+) connection on the starter solenoid.

4

Do not run the starter for more than 15 seconds at any one time. However, if the starter is run for 15 seconds or longer, wait at least one minute before reusing the starter motor.

## 2309-06-02-03

### Fuel System Pressure, Checking

**Note:** Before beginning this service procedure, please review "General Work Practices" page 43.

#### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

#### DANGER

Do not service any part of the fuel system while smoking or in the presence of flames, sparks, or hot surfaces. Failure to follow these precautions can result in fire, which can cause serious injury or death.

#### WARNING

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

#### WARNING

Fuel, oil, or coolant leaked/spilled onto hot surfaces or electrical components can cause a fire. Clean up spills immediately.

#### WARNING

Do not work near the fan with the engine running or the ignition in the ON position. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured.

*Special tools:* 9996666, 9998496, J-39200



1

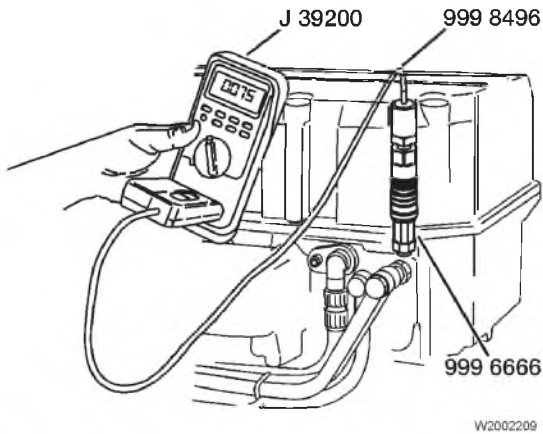


Fig. 31: Bleed nipple, D12A/B

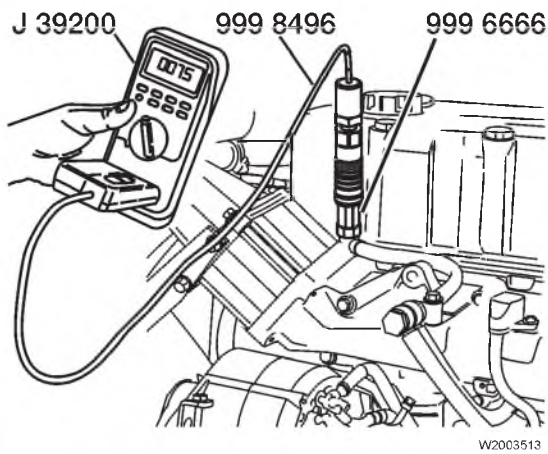


Fig. 32: Bleed nipple, D12C

Remove the bleed nipple at the rear of the head on the D12A/B, or at the front of the head on the D12C; install adapter 9996666 and pressure transducer 9998496. Connect the transducer to multimeter J-39200.

**Note:** The pressure transducer measurement scale is in kPa.

2

**⚠ DANGER**

When operating a vehicle on streets and highways, during a data collection procedure, it is mandatory to have a second person drive while a technician collects the data.

Monitor fuel pressure under full load, i.e. Dyno test or road test with load.

3

Compare measurements with specifications found in "Fuel Supply Pump and Overflow Valve" page 5.

**Note:** If measurements are found to be within specifications, no further testing is required. However, if measurements do not meet specifications, refer to the Diagnostics Checklist B, "Fuel System."

## 2309-11-03-01 Fuel System, Draining

**Note:** Before beginning this service procedure, please review "General Work Practices" page 43.

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### DANGER

Do not service any part of the fuel system while smoking or in the presence of flames, sparks, or hot surfaces. Failure to follow these precautions can result in fire, which can cause serious injury or death.

### WARNING

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

### WARNING

Fuel, oil, or coolant leaked/spilled onto hot surfaces or electrical components can cause a fire. Clean up spills immediately.

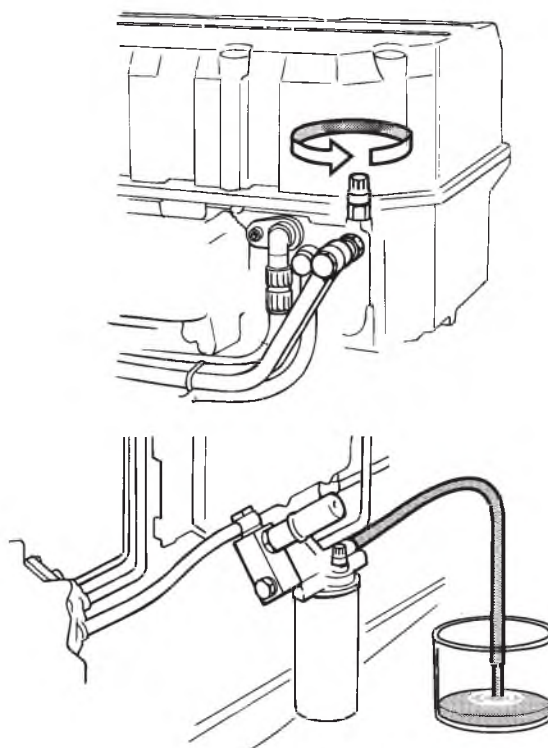
### WARNING

Make sure that gauge pressure never exceeds 50 kPa (7.25 psi). Excessive pressure may cause personal injury.

**Note:** Before using, check the function of pressure gauge 6662 by attaching it to an air supply and setting the pressure to 50 kPa (7.25 psi) with the regulator valve.

**Special tools:** 9996662, 9998277

1



T2006719

Fig. 33: Draining the fuel system (D12A/B bleed nipple location shown)

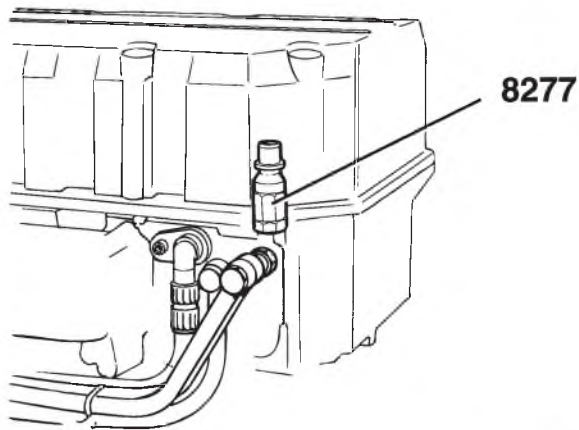
Carefully clean around the cylinder head bleed nipple and the fuel filter bracket drain union located on the right side of the filter housing.

2

Connect a 7.9 mm (5/16 in.) drain hose and open the fuel filter bracket drain union. Remove the bleed nipple from the cylinder head.

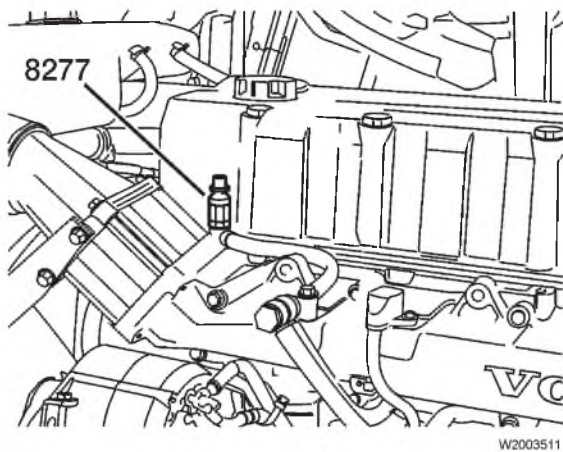


3



T2006715

Fig. 34: Tool installation, D12A/B

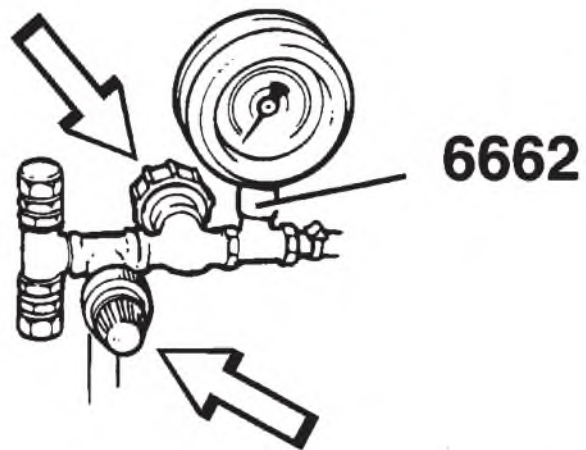


W2003511

Fig. 35: Tool installation, D12C

When the fuel has completely drained out of the cylinder head, install union 9998277 into the bleed nipple hole.

4



T2006716

Check the pressure gauge assembly

- 1 Reduction valve
- 2 Air supply shut-off

Make sure the reduction valve knob is completely open (rotate counterclockwise). Open the shut-off tap. Connect pressure gauge 9996662 assembly to the shop air supply.

9996662

5

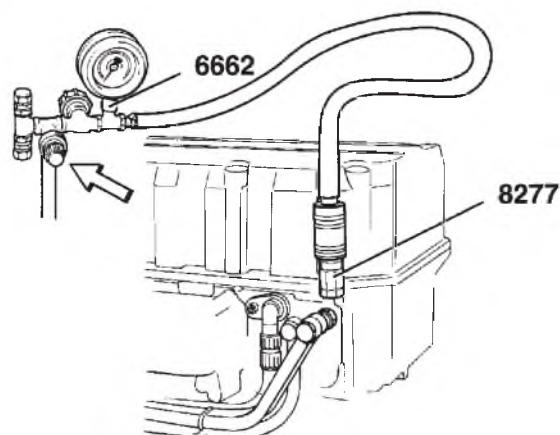


Fig. 36: Pressure gauge assembly connected to union, D12A/B

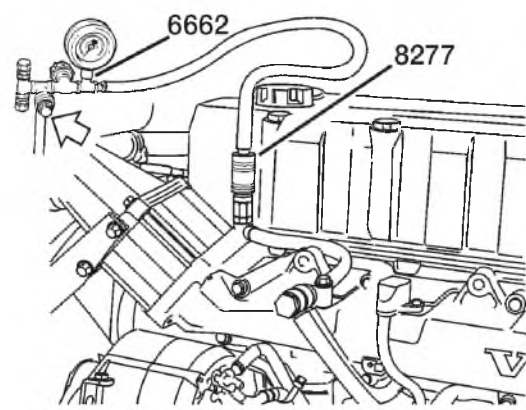


Fig. 37: Pressure gauge assembly connected to union, D12C

Check that the pressure gauge indicator is at "0" (zero) and connect the gauge to union 9998277.

6

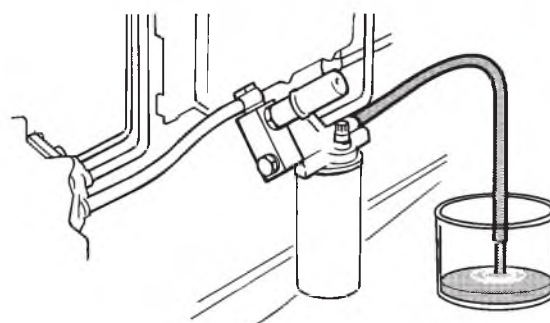
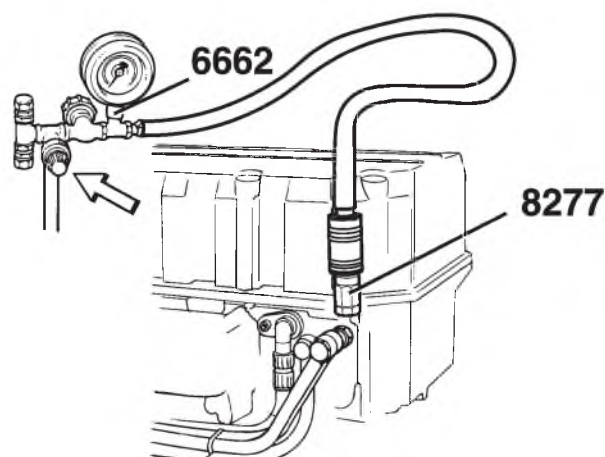


Fig. 38: Draining the remainder of the fuel, D12A/B

Blow the remaining fuel out of the cylinder head by carefully increasing the pressure with the knob on the pressure gauge reduction valve. DO NOT EXCEED 50 kPa (7.25 psi).

7

When all fuel has been drained:

- Remove the pressure gauge assembly, union and the drain hose.
- Reinstall the bleed nipple and the protective cap onto the cylinder head. Do not replace the nipple, as the original nipple is fitted to the seating in the cylinder head. A new nipple can result in leakage.
- Tighten the drain union on the fuel filter bracket and install the protective cap.

## 2309-05-03-01 Fuel System, Bleeding

**Note:** Before beginning this service procedure, please review "General Work Practices" page 43.

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### DANGER

Do not service any part of the fuel system while smoking or in the presence of flames, sparks, or hot surfaces. Failure to follow these precautions can result in fire, which can cause serious injury or death.

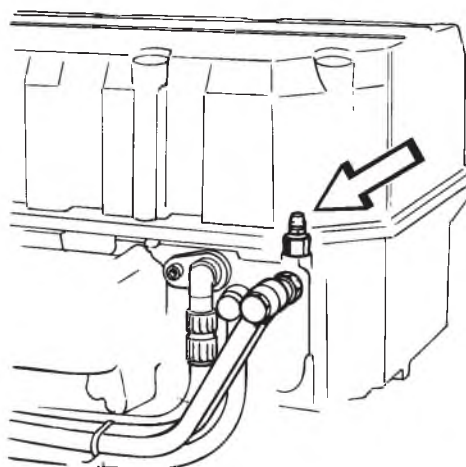
### WARNING

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

### WARNING

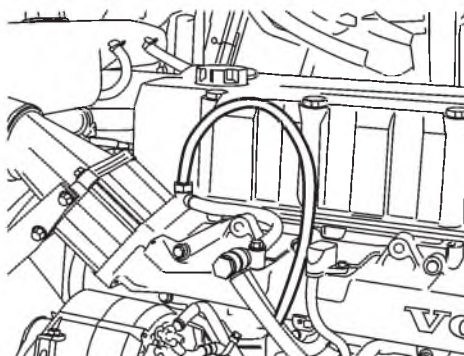
Fuel, oil, or coolant leaked/spilled onto hot surfaces or electrical components can cause a fire. Clean up spills immediately.

1



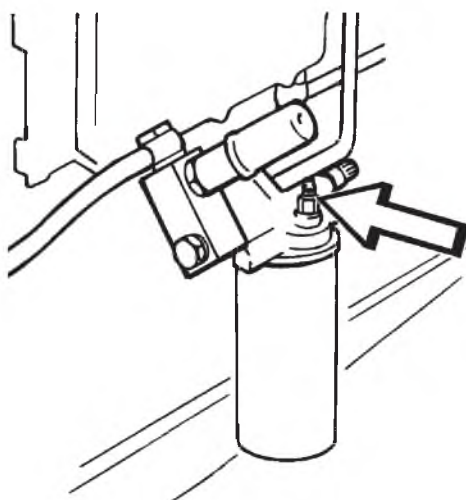
T2006713

Fig. 39: Cylinder head bleed nipple, D12A/B location



W2003394

Fig. 40: Cylinder head bleed nipple, D12C location



T2006712

Fig. 41: Fuel filter bleed nipple

Clean around the bleed nipples on the fuel filter housing and cylinder head.

2

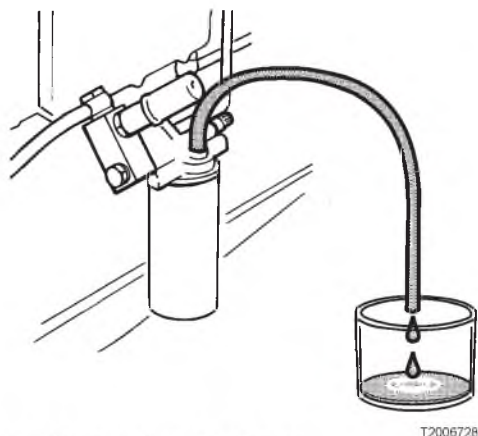


Fig. 42: Installing bleed line

Connect a transparent plastic hose to the fuel filter housing bleed nipple. Open the bleed nipple and pump the hand primer until clean fuel runs out of the hose. Tighten the bleed nipple while fuel is still running out.

3

Remove the hose and install the protection plug on the bleed nipple.

4

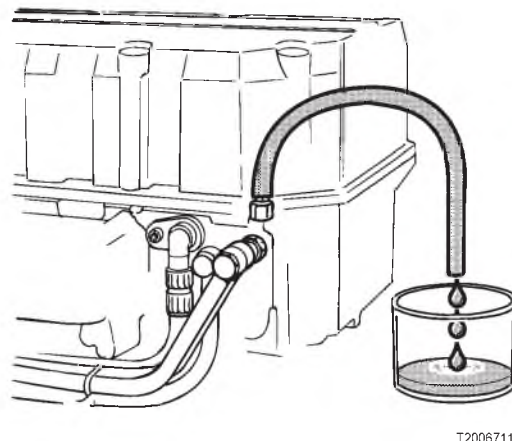


Fig. 43: Bleeding the cylinder head, D12A/B

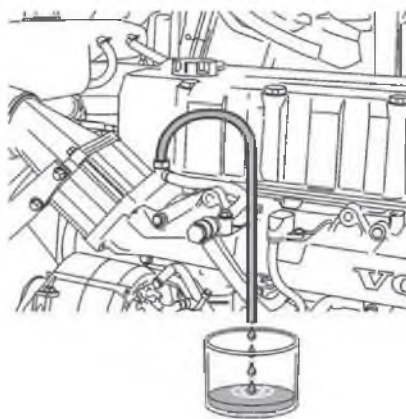


Fig. 44: Bleeding the cylinder head, D12C

Move the hose over to the cylinder-head bleed nipple and bleed the system in the same way as with the fuel filter housing.

5

Apply parking brake and place gear lever into neutral.

6

Start the engine and allow it to run at fast idle, or with the PTO engaged, for about five minutes to remove air from the system. Check for leaks.



# 2331-03-02-01 Fuel Feed Pump, Replacement

## D12, D12A, D12B

**Note:** Before beginning this service procedure, please review "General Work Practices" page 43.

**⚠ DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**⚠ DANGER**

Do not service any part of the fuel system while smoking or in the presence of flames, sparks, or hot surfaces. Failure to follow these precautions can result in fire, which can cause serious injury or death.

**⚠ WARNING**

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

**⚠ WARNING**

Do not work near the fan with the engine running or the ignition in the ON position. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured.

**⚠ WARNING**

Fuel, oil, or coolant leaked/spilled onto hot surfaces or electrical components can cause a fire. Clean up spills immediately.

**1**  
Clean the area around the fuel feed pump area and remove the bleed line.

**2**

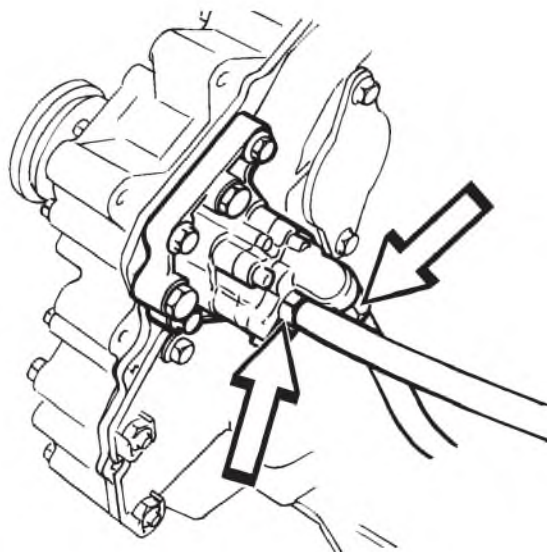


Fig. 45: Removing fuel line

T2006724

Remove the plastic straps securing the fuel line on the ECM and cylinder block. Remove the lines at the unions from the fuel feed pump, as indicated by arrows in figure Fig. 46: Removing fuel pump, page 52.

**3**



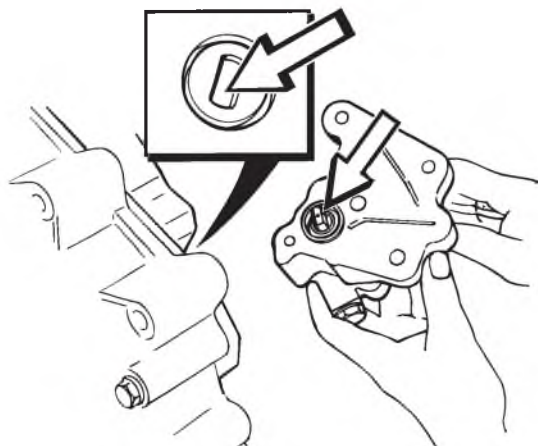
Fig. 46: Removing fuel pump

T2006723

Remove the bolts indicated by arrows in figure Fig. 46: Removing fuel pump, page 52 and lift out the fuel-feed pump.

**4**  
Clean the contact surface on the timing gear plate.

5



T2006722

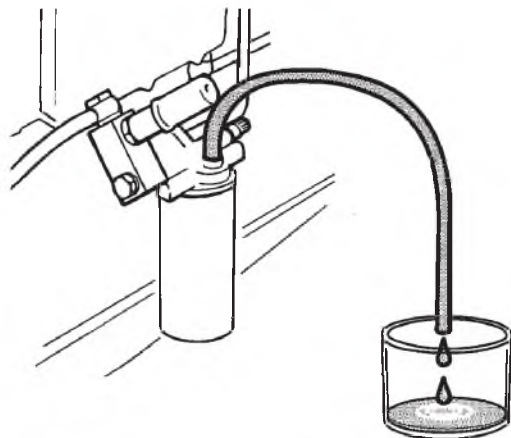
Fig. 47: Install fuel-feed pump

Check to make sure that the fuel-feed pump drive engages in the drive slot. Install a new gasket and tighten the fuel-feed pump mounting bolts.

6

Connect the fuel lines and the bleed line. Use new sealing washers. Secure the fuel lines with plastic tie straps.

7



T2006728

Fig. 48: Bleeding fuel system

Bleed the fuel system at the fuel filter as shown in illustration, Fig. 48: Bleeding fuel system, page 53. See also "Fuel System, Bleeding" page 50.

8

Apply parking brake and place gear lever into neutral.

9

Start the engine. Allow it to run at fast idle, or with the PTO engaged, for about five minutes to remove air from the system. Check for leaks.

## 2331-03-02-01 Fuel Feed Pump, Replacement D12C

**Note:** Before beginning this service procedure, please review "General Work Practices" page 43.

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### DANGER

Do not service any part of the fuel system while smoking or in the presence of flames, sparks, or hot surfaces. Failure to follow these precautions can result in fire, which can cause serious injury or death.

### WARNING

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

### WARNING

Fuel, oil, or coolant leaked/spilled onto hot surfaces or electrical components can cause a fire. Clean up spills immediately.

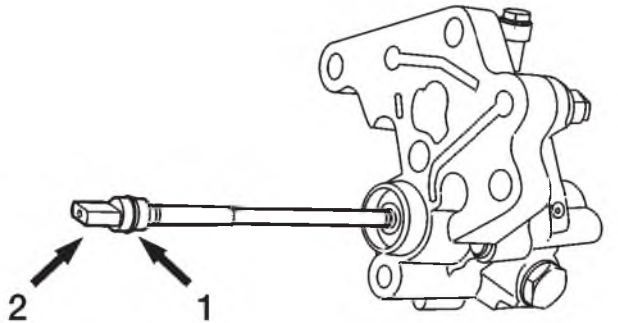
### WARNING

Do not work near the fan with the engine running or the ignition in the ON position. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured.

## Types

There are two types of feed pump on the D12C engine:

1

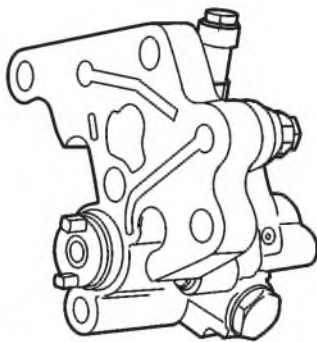


W2003386

Fig. 49: Feed pump, type 1 (older version, with long drive shaft).

- 1 Seal
- 2 Shaft journal

2



W2003385

Fig. 50: Feed pump, type 2 (newer version, available with one or two drive heads; available on newer and replacement engines).

Feed pumps as spare parts are available in both versions.

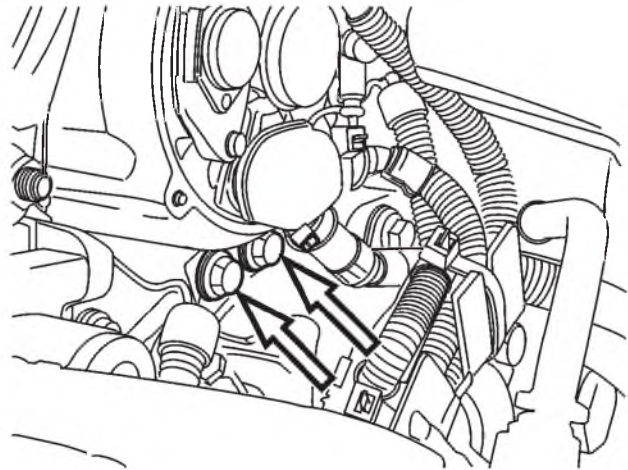
**Note:** Both types of feed pumps are interchangeable, i.e. feed pump type 1 can be replaced with feed pump type 2 and vice versa.

## CAUTION

When replacing feed pump **Type 1**, great care must be taken with the long drive shaft. Any damage to the drive shaft can damage the feed pump; if it is installed on the engine, serious engine damage can result.

## Removal

1



W2003384

Cut the plastic clamps for the cabling and remove the bracket under the alternator.

2

Carefully clean round the feed pump and the fuel connections.

3

Remove all fuel pipes from the feed pump.

4

Remove the hold-down bolts for the feed pump. Carefully pull the drive shaft from the drive exhaust and remove the pump from the engine.

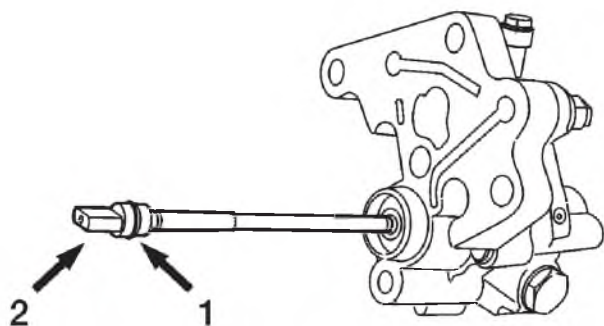
5

Clean the sealing surface on timing gears plate. Check that the gasket for the feed pump is in good condition. If necessary, replace with new gasket.



## Installation

1



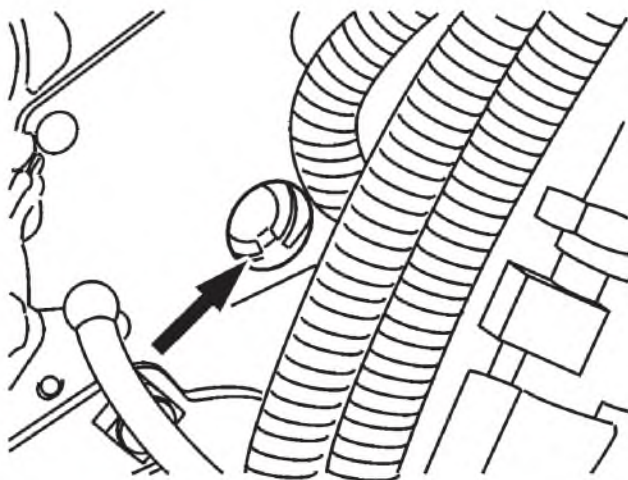
W2003386

Fig. 51: Feed Pump Type 1

- 1 Seal
- 2 Shaft journal

**(Feed Pump Type 1 only:)** Check that the seal (1) is in good condition and correctly positioned. Also check that the shaft journal (2) is lubricated with graphite grease.

2



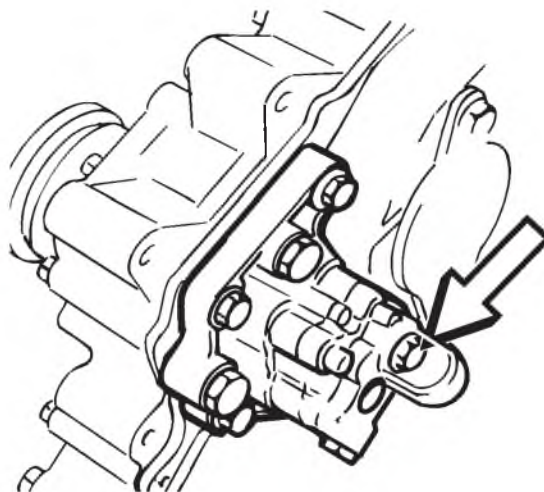
W2003387

Fig. 52: Feed pump drive shaft groove

Check that the feed pump's drive installs in the groove on the feed pump's drive shaft.

The groove in the shaft shows which position the feed pump's shaft journal should have when installing ( applies to both type 1 and 2).

3



T2014660

Fig. 53: M8-bolt with sealant

Install the seal on the feed pump and install the feed pump on the engine.

### CAUTION

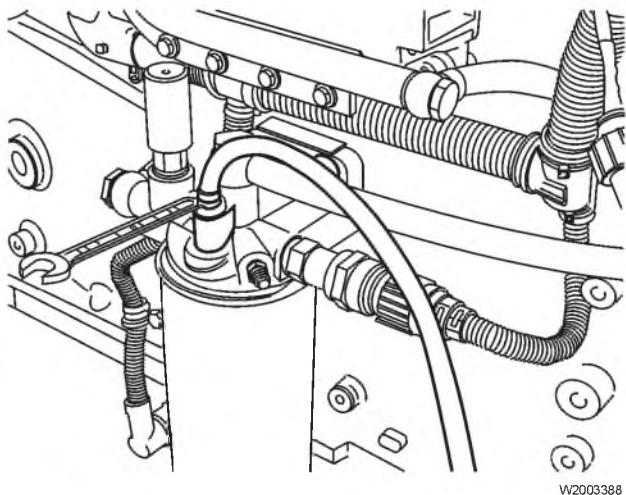
(Feed Pump Type 2:) Observe great care with the feed pump's drive shaft. Damage to the feed pump's drive shaft can permanently damage the engine.

**Note.** The M8-bolt should be reinstalled with sealant to seal any oil leakage. Do not install the old bolt without sealant or leakage can occur.

4

Check the seals on the fuel lines. The sealing washers for the return line should always be replaced. Replace other seals if necessary. Install the fuel lines on the feed pump.

5



Vent the fuel system.

6

Start the engine and run it at high revs (**approx. 800 – 1000 rpm**) for **approx. 10 min.** to evacuate any remaining air in the fuel system. 800 – 1000 rpm approx. 10 min

7

Conduct leakage check.

8

Check that no fault codes exist.

## 2331-03-02-02 Hand-Primer Pump, Replacement

**Note:** Before beginning this service procedure, please review "General Work Practices" page 43.



**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.



**DANGER**

Do not service any part of the fuel system while smoking or in the presence of flames, sparks, or hot surfaces. Failure to follow these precautions can result in fire, which can cause serious injury or death.



**WARNING**

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.



**WARNING**

Fuel, oil, or coolant leaked/spilled onto hot surfaces or electrical components can cause a fire. Clean up spills immediately.

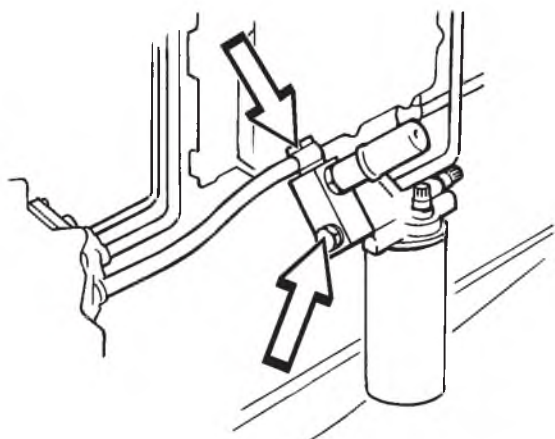
1

Open the fuel tank cap to release any pressure in the fuel tank.

2

Clean around the hand-primer fuel fittings.

3



T2006720

Fig. 54: Removing hand-primer pump

Remove the hand-primer pump fuel lines at the unions.

4

Remove the hand-primer pump mounting bolts.

5

Install the new hand-primer pump using new sealing washers.

6

Reconnect the mounting bolts and fuel lines.

7

Bleed the fuel system (see "Fuel System, Bleeding" page 50).

8

Apply parking brake and place the gear lever into neutral.

9

Start the engine. Allow it to run at fast idle, or with the PTO engaged, for about five minutes to remove air from the system and check for leaks.

## 2334-03-02-01 Fuel Filter, Replacement

### Prerequisite:

- Container for fuel under filter.

**Note:** Before beginning this service procedure, please review "General Work Practices" page 43.



Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.



Do not service any part of the fuel system while smoking or in the presence of flames, sparks, or hot surfaces. Failure to follow these precautions can result in fire, which can cause serious injury or death.



**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.



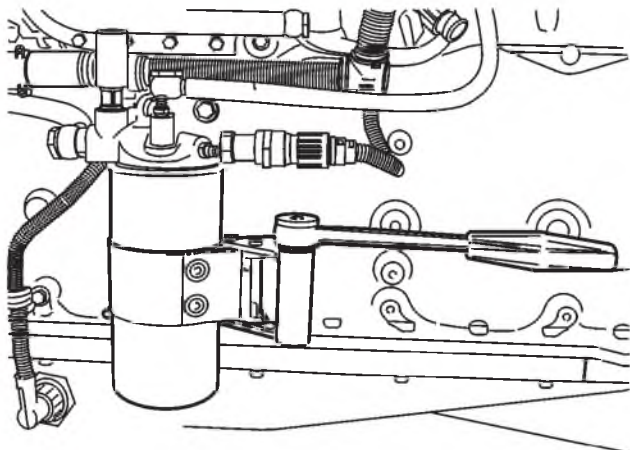
Fuel, oil, or coolant leaked/spilled onto hot surfaces or electrical components can cause a fire. Clean up spills immediately.

### Special tools: 9996671

1

Clean the area around the fuel filter area.

2



W2003389

Remove the fuel filter.

3

Clean the sealing surface, making sure that there is no residual gasket.

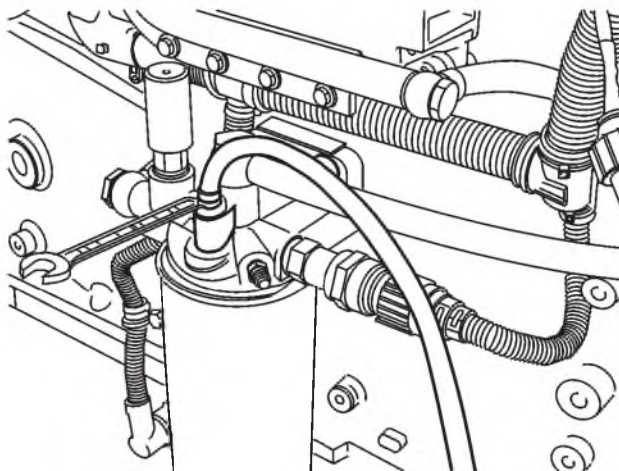
4

Install the new fuel filter, following the instructions on the filter.

**CAUTION**

Do not fill the new fuel filter with fuel before installing. Doing so may allow foreign objects to get into the fuel, and can cause the injectors to malfunction.

5



W2003388

Bleed (vent) the fuel system at the fuel filter. Connect a transparent plastic hose to the bleed nipple. Open the bleed nipple and pump the hand primer until clean fuel runs out of the hose. Tighten the bleed nipple while fuel is still running out (see "Fuel System, Bleeding" page 50).

6

Remove the hose and reinstall the protection plug on the bleed nipple.

7

Apply parking brake and shift lever into neutral.

8

Start the engine. Allow it to run at fast idle, or with the PTO engaged, for about 10 minutes to evacuate any residual air in the fuel system.



## 2339-06-02-02 Overflow Valve, Checking

### D12, D12A, D12B

**Note:** Before beginning this service procedure, please review "General Work Practices" page 43.

**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**DANGER**

Do not service any part of the fuel system while smoking or in the presence of flames, sparks, or hot surfaces. Failure to follow these precautions can result in fire, which can cause serious injury or death.

**WARNING**

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

**WARNING**

Fuel, oil, or coolant leaked/spilled onto hot surfaces or electrical components can cause a fire. Clean up spills immediately.

*Special tools: 9996666, 9998496, J-39200*

1

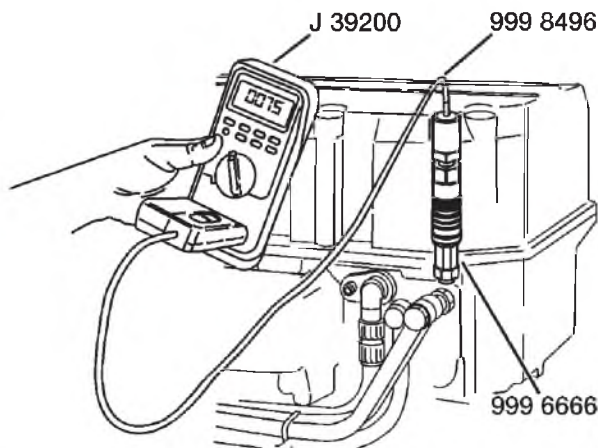


Fig. 55: Bleed nipple, D12A/B

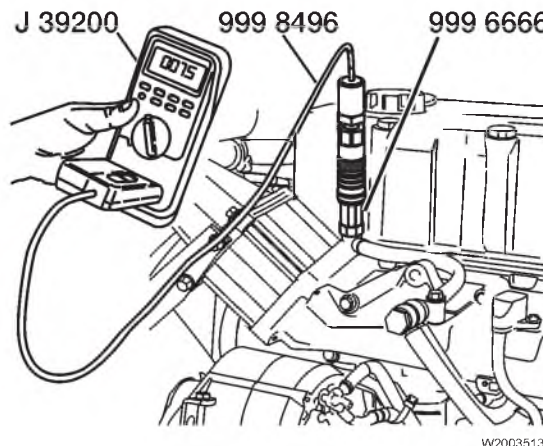


Fig. 56: Bleed nipple, D12C

Remove the bleed nipple at the rear of the head, install adapter 9996666 and pressure transducer 9998496. Connect the transducer to the multimeter J-39200.

**Note:** The pressure transducer measurement scale is in kPa.

2

Slowly pump the hand pump while monitoring the fuel pressure. The pressure should rise to a point determined by the opening of the overflow valve then drop quickly. Recheck several times to get an accurate reading.

**3**

The opening pressure should correspond to specifications found in "Fuel Supply Pump and Overflow Valve" page 5.

**Note:** If the overflow valve opens at a pressure that is less than that given in the specification, low fuel pressure will result. The valve must be replaced.

**4**

Replace the valve if necessary.

## 2339-03-02-02 Overflow Valve, Replacement

### D12, D12A, D12B

**Note:** Before beginning this service procedure, please review "General Work Practices" page 43.

**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**DANGER**

Do not service any part of the fuel system while smoking or in the presence of flames, sparks, or hot surfaces. Failure to follow these precautions can result in fire, which can cause serious injury or death.

**WARNING**

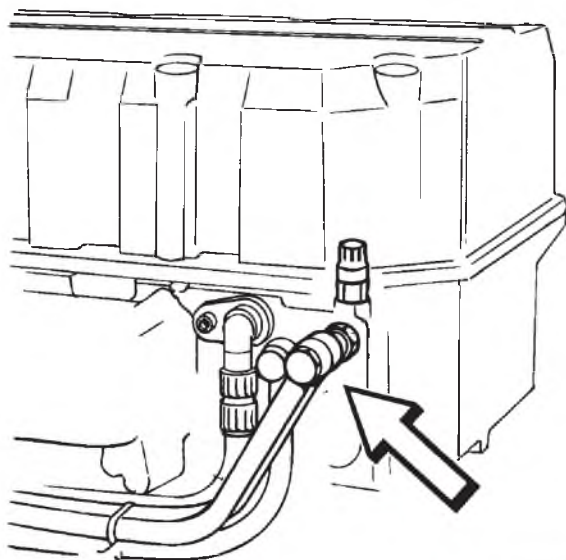
**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

**WARNING**

Fuel, oil, or coolant leaked/spilled onto hot surfaces or electrical components can cause a fire. Clean up spills immediately.



1

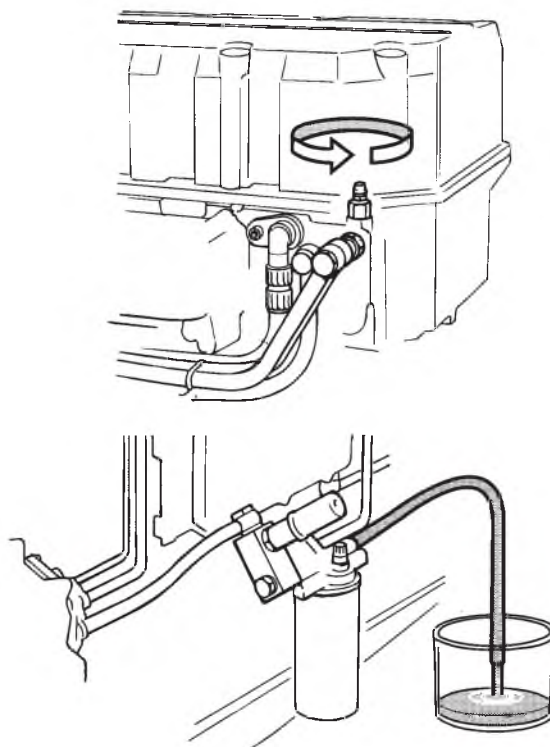


T2006730

Overflow valve

Carefully clean the area around the overflow valve area.

2

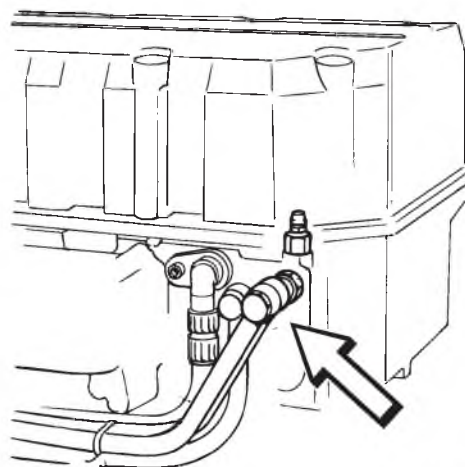


T2006710

Draining fuel

Drain the fuel by connecting a hose to the fuel filter housing drain nipple. Remove the protection plug and open the bleed nipple on the cylinder head. Route the fuel from the fuel filter housing into a suitable container.

3



T2006714

Removing fuel lines

Remove the fuel line from the overflow valve.

- 4 Remove the overflow valve.
- 5 Clean the contact surface on the cylinder head and install a new overflow valve. Use a new sealing washer.
- 6 Reconnect the fuel line. Use new sealing washer.
- 7 Bleed the fuel system.
- 8 Apply parking brake and place the gear lever into neutral.
- 9 Start the engine and allow it to run at fast idle, or with the PTO engaged, for about ten minutes to remove air from the system.
- 10 Perform leak and operation checks.

## 2339-03-02-02 Overflow Valve, Replacement

### D12C

**Note:** Before beginning this service procedure, please review "General Work Practices" page 43.



#### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.



#### DANGER

Do not service any part of the fuel system while smoking or in the presence of flames, sparks, or hot surfaces. Failure to follow these precautions can result in fire, which can cause serious injury or death.



#### WARNING

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

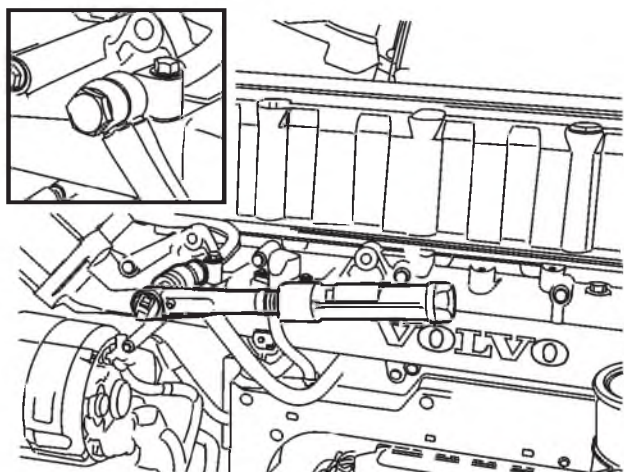


#### WARNING

Fuel, oil, or coolant leaked/spilled onto hot surfaces or electrical components can cause a fire. Clean up spills immediately.

- 1 Remove the overflow valve from the intake pipe.
- 2 Clean the sealing surfaces.

3



W2003390

Install a new overflow valve with new copper washers and tighten the overflow valve to 55 ± 5 Nm (40 ± 4 ft-lb).

## 2371-03-02-02 Unit Injector, Replacement (One)

Not Included:

- "Unit Injector, Adjustment" page 67

**Note:** Before beginning this service procedure, please review "General Work Practices" page 43.

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### DANGER

Do not service any part of the fuel system while smoking or in the presence of flames, sparks, or hot surfaces. Failure to follow these precautions can result in fire, which can cause serious injury or death.

### WARNING

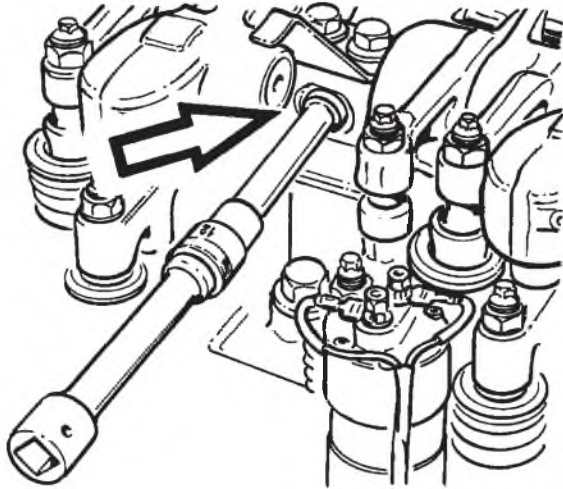
**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

### WARNING

Fuel, oil, or coolant leaked/spilled onto hot surfaces or electrical components can cause a fire. Clean up spills immediately.

**Special tools:** 9998249, 9998511, 9998599, J-44515

1

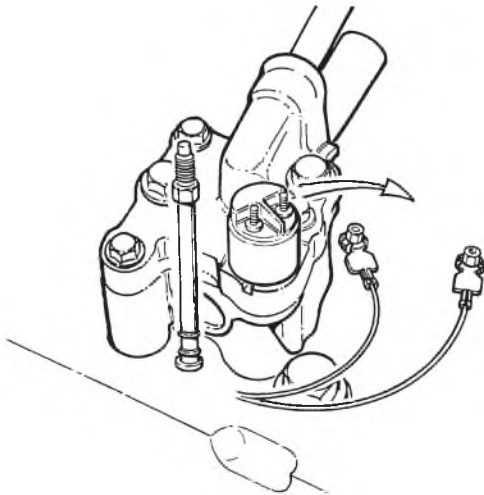


T2009070

**Prerequisites:**

- Valve cover removed.
- Control valve removed.
- Pipe removed between control valve and rocker arm shaft.

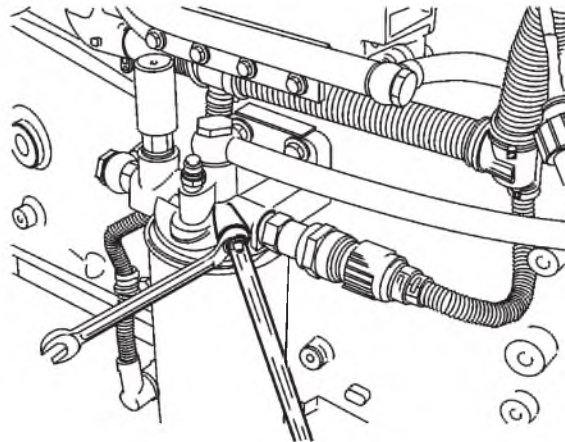
2



T2008812

Release the rocker arm bridge as per the specifications.

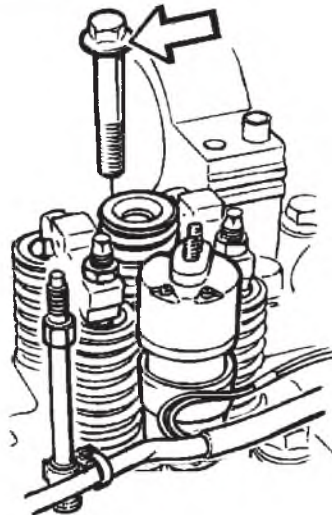
3



W2003391

Drain the fuel out of the system to prevent fuel running down into the cylinder when a unit injector is dismantled.

4



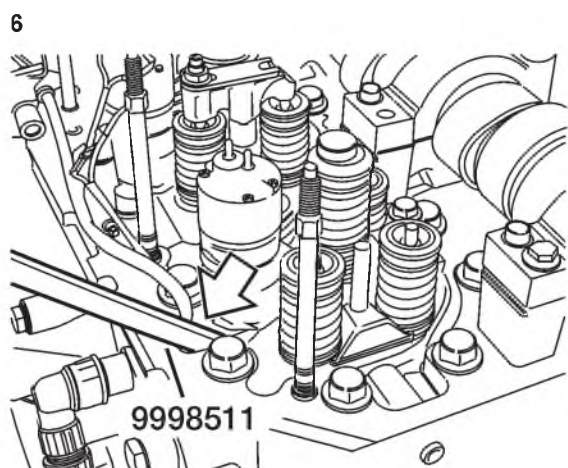
T2008956

Remove the injector hold-down bolt.

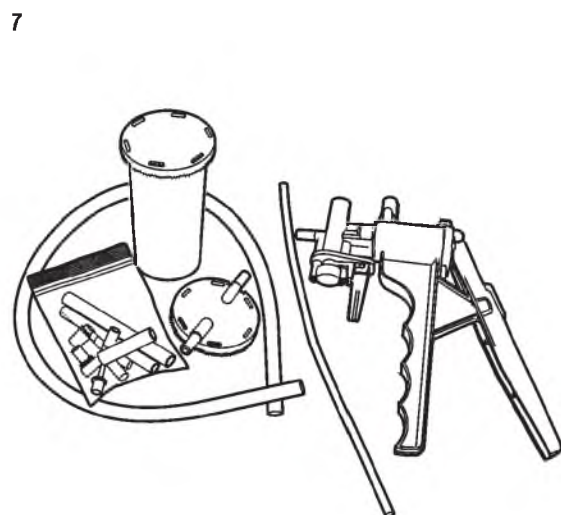
5

Clean very carefully round the unit injector to be changed.



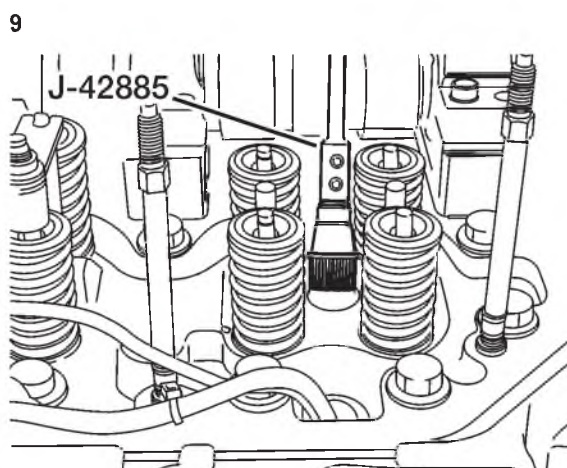


6  
 Remove the electrical cables from the unit injector and the bolt for the unit injector's attachment yoke.  
 Remove the unit injector with tool 9998511.



7  
 Fig. 57: Vacuum pump J-44515  
 Remove fuel from the top of the piston using vacuum pump J-44515.

8  
 Install protective sleeve J-42885-25 on the unit injector.



9  
 Fig. 58: Cleaning the copper sleeve  
 Install cleaning sleeve 9998580 in the injector well and carefully clean the copper sleeve.

Leave cleaning sleeve 9998580 on the cylinder head until the dirt is removed from the injector well.

**Note:** If the unit injector is not installed immediately, install the protective plug 9998251 in the cylinder head.

10  
 Check the sealing rings on the unit injector. Install the unit injector and centre it between the valve springs. Tighten with a torque as per the specifications.

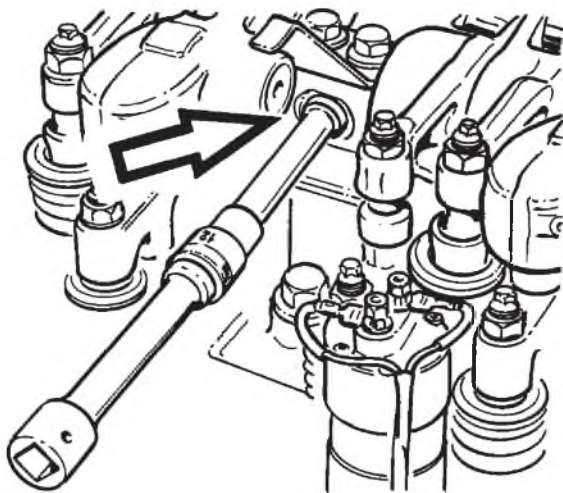
**11**  
 Connect the electric cables to the injector. 1.4 ± 0.1 Nm  
 (3.5 ± 0.88 in-lb)

**Note:** Tighten the nuts with a torque of 1.4 ± 0.1 Nm (3.5 ± 0.88 in-lb).

 <b>CAUTION</b>
Do not overtorque. This will break the stud.

**12**  
 Install the rocker arm bridge and tighten with a torque as per the specifications.

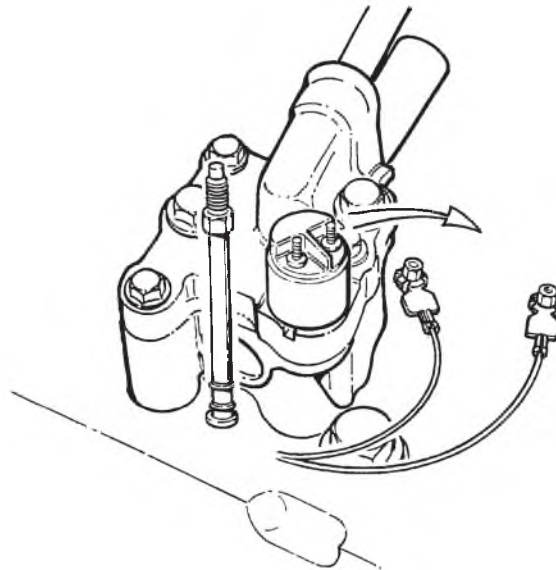
**13**



T2009070

Install the pipe between the rocker arm shaft and control valve.

**14**



T2008812

Install the control valve.

**15**  
 Connect the cables on the solenoid valve. 1.4 ± 0.1 Nm  
 (3.5 ± 0.88 in-lb)

**Note:** Tighten the nuts with a torque of 1.4 ± 0.1 Nm (3.5 ± 0.88 in-lb).

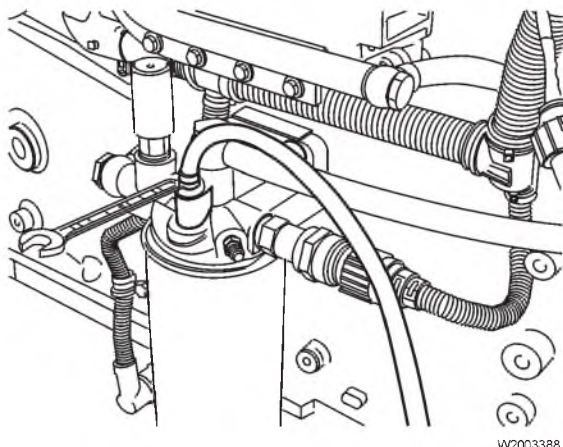
 <b>CAUTION</b>
Do not overtorque. This will break the stud.

**16**  
 Adjust the valves.

**17**  
 Install the valve cover and tighten according to the tightening schedule in the specifications.

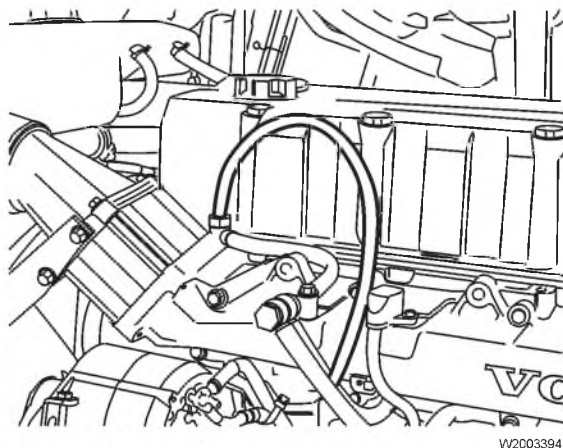


18



Vent the fuel system at the fuel filter.

19



Vent the fuel system on the cylinder head.

20

Start the engine and run for approx. 10 minutes to evacuate any residual air in the fuel system.

21

Check that the engine has reached normal working temperature and then run for another 5 minutes.

22

Check to make sure the fuel system is operating properly. Check for leaks.

## 2371-05-02-01 Unit Injector, Adjustment

(Adjusting pre-load)

**Note:** Before beginning this service procedure, please review "General Work Practices" page 43.

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### DANGER

Do not service any part of the fuel system while smoking or in the presence of flames, sparks, or hot surfaces. Failure to follow these precautions can result in fire, which can cause serious injury or death.

### WARNING

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

**! WARNING**

Fuel, oil, or coolant leaked/spilled onto hot surfaces or electrical components can cause a fire. Clean up spills immediately.

**! WARNING**

Do not work near the fan with the engine running or the ignition in the ON position. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured.

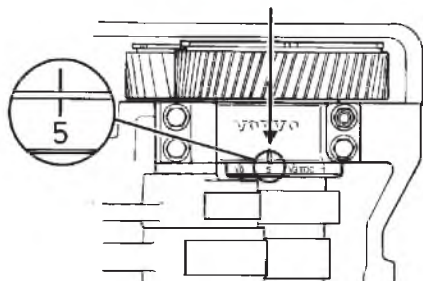
**! CAUTION**

Observe the greatest possible cleanliness when working on the cylinder head. Dirt particles in the fuel and oil channels can cause the unit injectors to malfunction, and can cause the VEB (if equipped) to fail.

*Special tools: 9996956*

**Unit Injector, Adjusting Pre-load**

1



T2006936

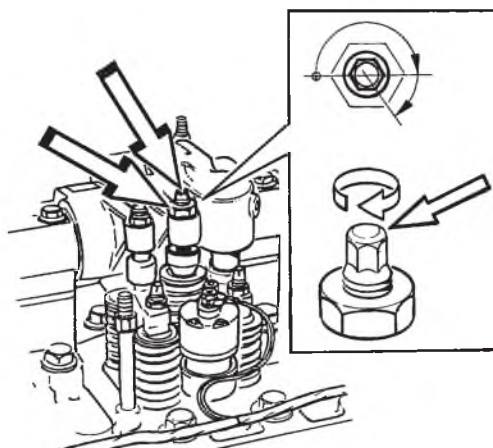
Check that the camshaft line marking for adjusting the intake valves and unit injector are opposite the marking on the bearing cap, tolerance  $\pm 2$  mm (alternatively between the marks). Check, via the number marking on the camshaft on which cylinder unit injector pre-loading is to be adjusted.

**Important:** If tool 6956 is used to crank the flywheel, make sure that the tool is removed if the engine is to be turned over with the starter motor.

2

Loosen the adjustment screw and adjust the unit injector rocker arm to zero clearance against the camshaft. Tighten the adjustment screw one full turn and then loosen again. Then return the rocker arm to zero clearance.

3



T2008845

Preload the unit injector by screwing down the adjustment screw **3-4 flats**, (180°- 240°). Torque-tighten the lock nut according to the specifications.

**3-4 flats**  
(180°- 240°)

## 2379-03-02-02 Unit Injector Copper Sleeve, Replacement

**Note:** Before beginning this service procedure, please review "General Work Practices" page 43.

**⚠ DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**⚠ DANGER**

Do not service any part of the fuel system while smoking or in the presence of flames, sparks, or hot surfaces. Failure to follow these precautions can result in fire, which can cause serious injury or death.

**⚠ WARNING**

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

**⚠ WARNING**

Fuel, oil, or coolant leaked/spilled onto hot surfaces or electrical components can cause a fire. Clean up spills immediately.

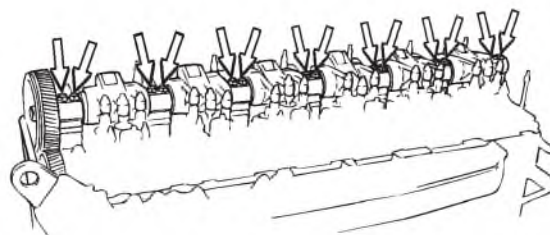
**⚠ WARNING**

Do not work near the fan with the engine running or the ignition in the ON position. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured.

### Removal

**1**  
Connect a drain hose 9996049 to the engine coolant drain nipple and drain the coolant into a suitable container.

**2**



T2006777

Remove the rocker arm bridge bolts.

**Note:** Loosen the bolts in three equal stages to avoid bending the rocker arm shaft.

**3**

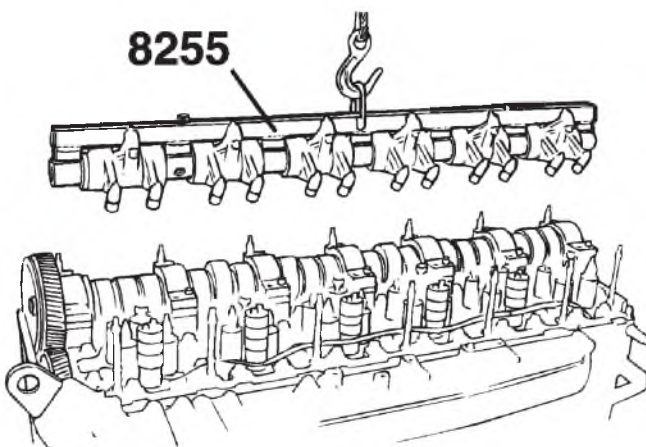
**⚠ CAUTION**

Failure to remove the control valve before removing the rocker arm bridge may result in damage to the control valve and/or the pipe.

If the engine is equipped with a VEB (Volvo Engine Brake), remove the control valve and the pipe. Plug the ports and place the valve in a plastic bag to prevent it from being subjected to dirt and contamination. To facilitate removal, remove the valve cover stud bolt.

**Note:** On engines equipped with a VEB (Volvo Engine Brake), secure the rocker arm plungers with rubber bands so that the plungers do not fall out of the rocker arms.

**4**

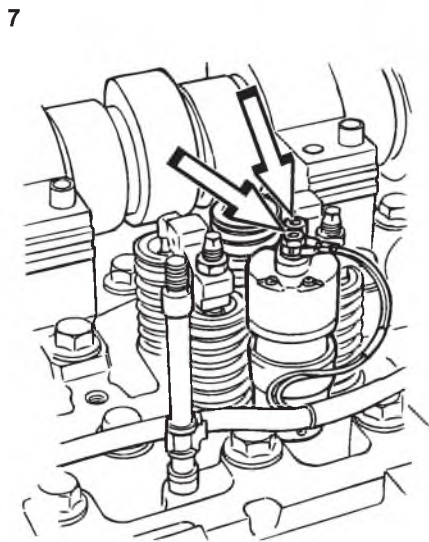


T2006776

Lift the rocker arm bridge using lifting tool 9998255.

**5**  
 Drain the fuel from the cylinder head. Refer to the procedure, "Fuel System Draining," the service manual 210-600, Basic Engine D12.

**6**  
 Carefully clean around the electronic unit injector (EUI) to be removed.

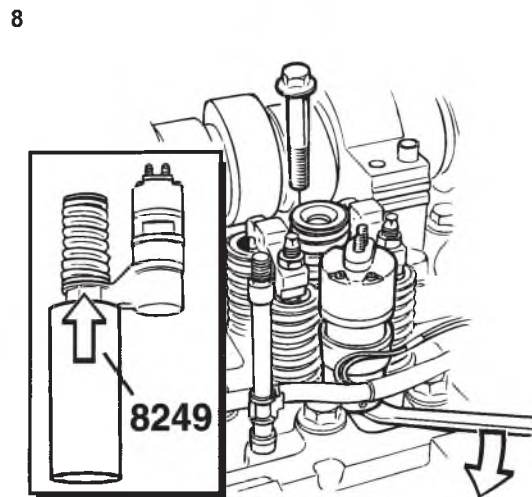


T2006709

Disconnect the electrical wires from the EUI.

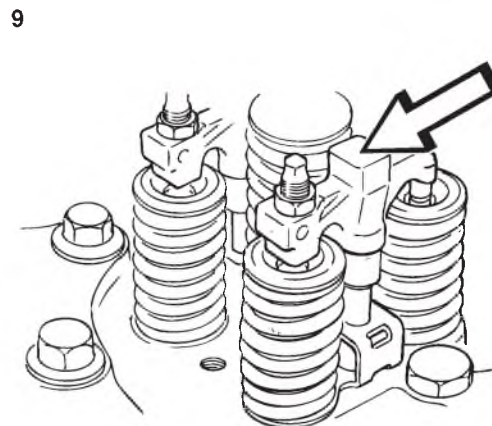
**! CAUTION**

Pay close attention to the wire terminals. If one breaks, remove the broken pieces. Failure to do so may result in pieces falling into the cylinder, which can cause component damage.



T2006708

Remove the EUI and check that no dirt enters the injector well in the cylinder head. Install a dust cover on the EUI, and install protective plug 9998249 in the injector well in the cylinder head.



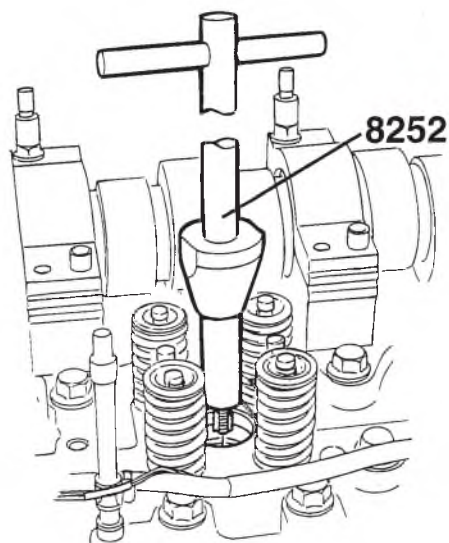
T2007050

Remove the valve bridges at the copper sleeve that is to be changed, and make note of location for reassembly.

**10**  
 Make sure that the piston corresponding to the copper sleeve being removed is in the down position.



11



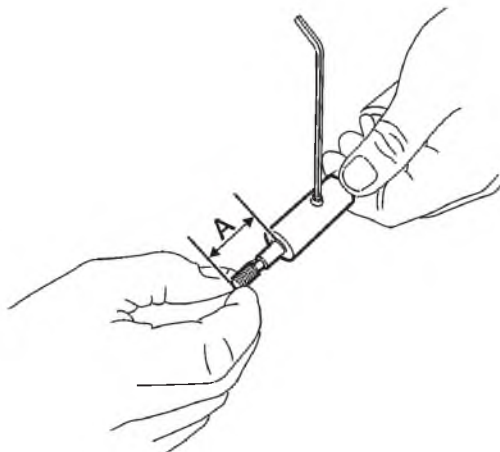
T2007157

**(This step is for D12C only)** Check whether the copper sleeve has an 8 mm or 9 mm hole in the tip. Install the 8 mm tap in tool 9998252 and try threading the copper sleeve. If it turns too easily, replace the 8 mm tap with the 9 mm tap and continue with the procedure.

**12** Using tool 9998252 turn tap approximately 1/4 of a turn, then back off at least a full turn to remove shavings. Turn forward again until you feel tension, then repeat this step. Continue until the tap has passed through the bottom of the copper sleeve.

**Note:** Apply grease to the tap to prevent shavings from falling down into the cylinder.

13



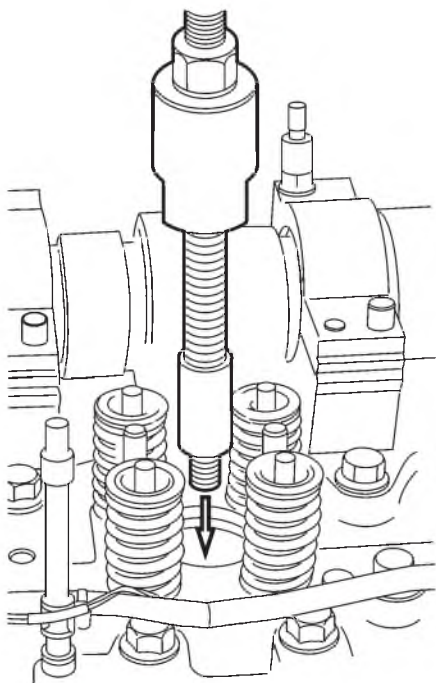
W2003433

Using the Allen wrench, loosen the Allen set-screw on the extractor tool 9998253.

**14** Adjust the bolt in the end of the tool until the bolt extends approximately 22 mm (0.875 in.) beyond the end of the tool(A).

**15** Tighten the Allen set-screw and make sure that the screw is seated against the flat part of the extractor bolt.

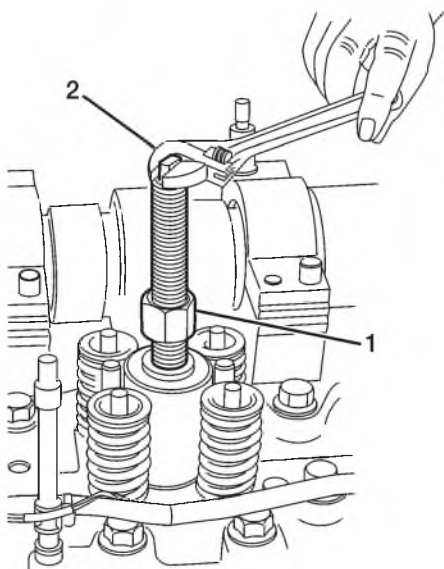
16



W2003434

Install the extractor tool into the copper sleeve and hand tighten until it bottoms out in the sleeve.

17

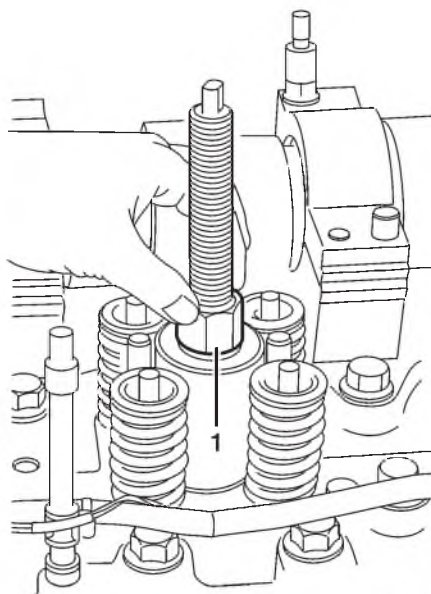


W2003435

Back off the retaining nut (1) and turn the extractor bolt (2) so that the threaded end passes completely through the copper sleeve tip.

**Note:** If the threaded end does not pass completely through the copper sleeve, the tip of the sleeve may break off as it is removed.

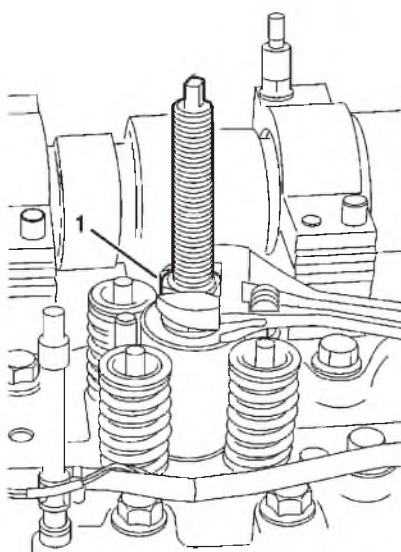
18



W2003436

Hand turn the retaining nut clockwise (1) until it is firmly seated against the bottom of the extracting cup.

19



W2003437

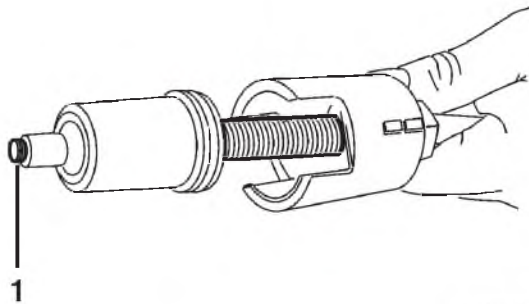
**CAUTION**

Do not use air tools to remove the copper sleeve. Use of air tools can damage engine components.

Using a wrench, turn the retaining nut (1) clockwise until the copper sleeve is removed.



20



W2003438

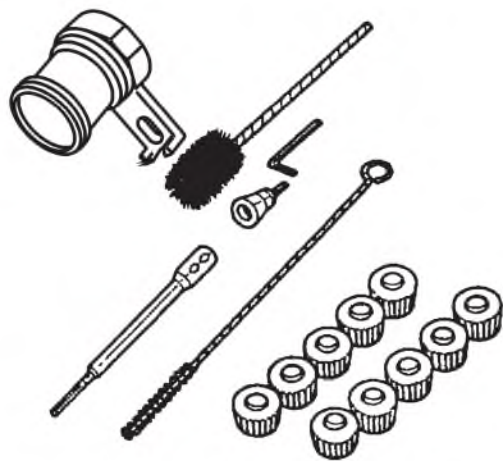
**CAUTION**

Pieces of the copper sleeve that fall into the cylinder can seriously damage the piston and/or turbocharger.

When the sleeve is removed, the extractor tool should be extended beyond the copper sleeve at least 3 mm (0.125 in); see (1). If it is not, check to make sure that a piece of the copper sleeve has not broken off and fallen into the cylinder.

**Cleaning the Copper Sleeve Bore**

21



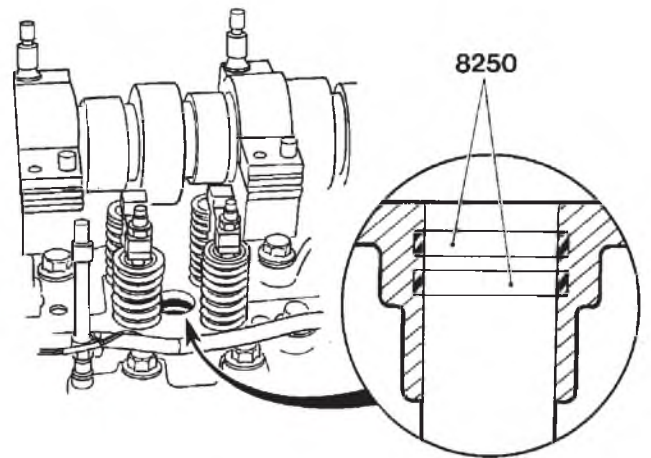
W2003537

Fig. 59: Cleaning kit J-42885

When replacing the injector copper sleeves in the cylinder head, it is important that the sleeve bore in the head is free from any carbon deposits and any other residue (i.e. pieces of the O-ring, etc.) before installing the new sleeve. Use the cleaning kit J-42885 in the following steps.

J-42885

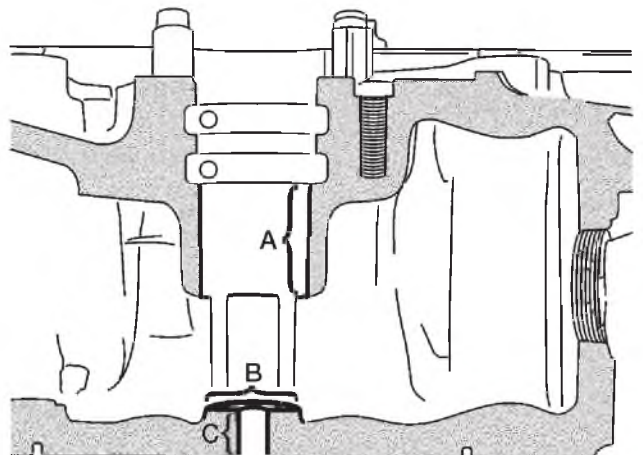
22



T2006521

Install the 2 sealing clamps 9998250 9998250 in the cylinder head fuel gallery.

23



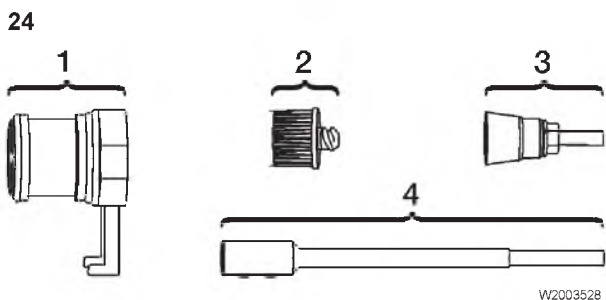
W2003148

**WARNING**

Wear safety glasses while using cleaning brushes or compressed air. Failure to do so could cause eye injury from flying debris.

Use the "7/16 in. diameter" brush inside bore (C). Move the brush up and down while turning it at the same time.

J-42885



**24**  
Place the injector bore sleeve protector into injector bore. Assemble the Roloc® brush (2), the holder (3), and the extension (4). Install the assembly into a drill and clean the sleeve seal (B); see illustration page 73.

**25**  
Install the 1.5 in. diameter brush into the drill and clean bore (A); see illustration page 73.

**26**  
Use the chip vacuum PT-2900 to remove all debris from the copper sleeve bore.

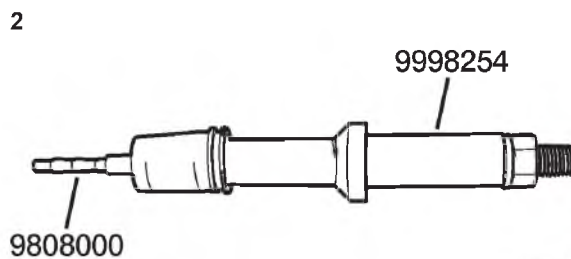
**27**  
Inspect the copper sleeve bore for any remaining debris. Pay close attention to the O-ring area of the bore for any remaining pieces of the O-ring that may require scraping with a pocket knife to remove. Reclean if needed.

**28**  
Remove the 2 sealing clamps 9998250 from the cylinder head fuel gallery, and remove any remaining debris using chip vacuum PT-2900.

**Installation**



**1**  
Lubricate the new sealing ring with engine oil and install it on the new copper sleeve. Lubricate the sealing ring again with engine oil.



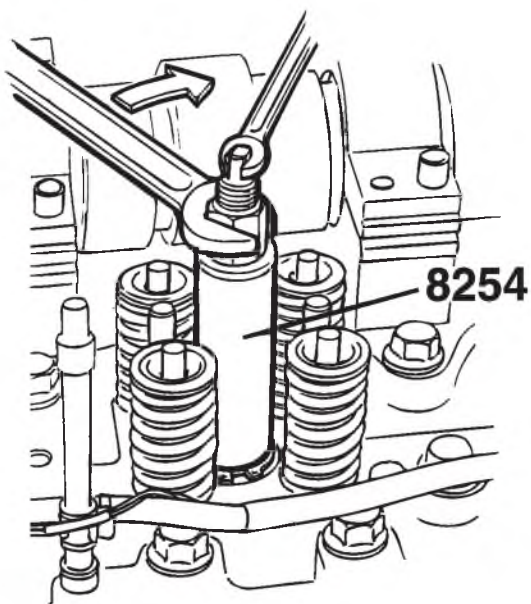
**2**  
Install the copper sleeve on the flaring tool 9998254, and lubricate the flaring pin 9808000 with engine oil. Thread the flaring tool 9998000 to the flaring tool 9998254 until it bottoms. Then, loosen the flaring pin approximately 180°.

**Note:** Failure to loosen the flaring tool 180° can result in the pin being twisted or broken.

**3**  
Check that the piston is not at T.D.C. (if the piston is at T.D.C., the flywheel must be turned). Carefully tap down the copper sleeve until it bottoms out against the sleeve seal in the cylinder head.

**4**  
Install and tighten the retainer for the electronic unit injector.

5



T2007089  
9998254

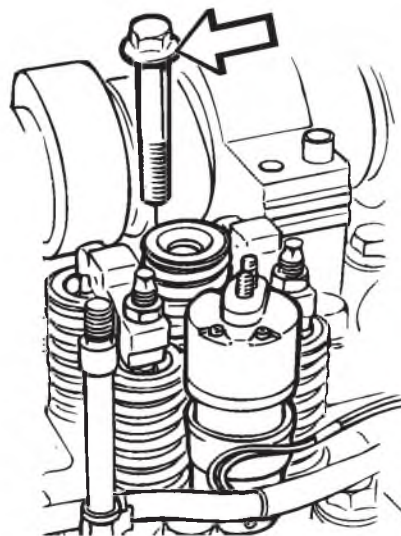
Flare the copper sleeve. Do this by turning the nut while counterholding the spindle until the flaring pin, 9998254 has been completely pulled through the copper sleeve.

**Note:** Failure to counterhold the spindle will result in a twisted or broken flaring pin.

6

Remove the flaring tool 9998254 and pin 9808000. 9998254  
9808000

7



T2006707

Install the new sealing rings on the electronic unit injector (EUI). Lubricate the sealing rings with grease and install the electronic unit injector.

8

**CAUTION**

Remove all oil from the injector retainer bolt holes to prevent a hydraulic lock that may result in damage to the cylinder head.

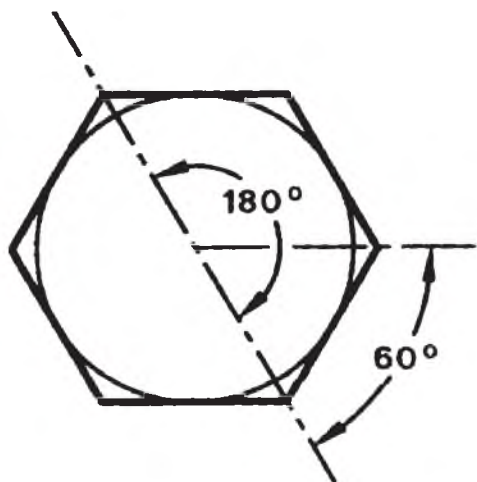
Tighten the electronic unit injector.

**New Copper Sleeve:**

9

Tighten retainer bolt to a torque of 20 ± 5 Nm (15 ± 4 ft-lb). 20 ± 5 Nm  
(15 ± 4 ft-lb)

10



Turn the retainer bolt an additional  $180 \pm 5^\circ$ .

W2003181  
 $180 \pm 5^\circ$

11

Loosen the retainer bolt for the unit injector prior to the second tightening.

12

Tighten bolt to a torque of  $20 \pm 5$  Nm ( $15 \pm 4$  ft-lb).

$20 \pm 5$  Nm  
( $15 \pm 4$  ft-lb)

13

Turn the retainer bolt an additional  $60 \pm 5^\circ$ .

$60 \pm 5^\circ$

**Old Copper Sleeve:**

14

Tighten the retainer bolt to a torque of  $20 \pm 5$  Nm ( $15 \pm 4$  ft-lb).

$20 \pm 5$  Nm  
( $15 \pm 4$  ft-lb)

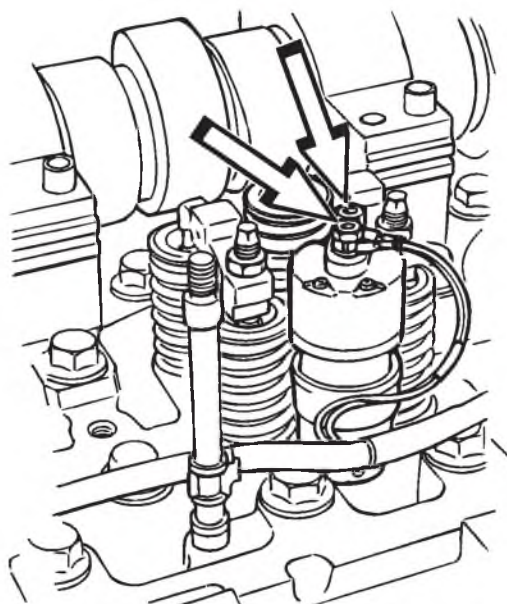
**Note:** If the injector is not to be installed at once, install a protective plug in the cylinder head.

15

Turn the retainer bolt an additional  $60 \pm 5^\circ$ .

$60 \pm 5^\circ$

16



Connect the electronic unit injector (EUI) electrical wires and tighten the nut to a torque of 1.4 Nm (1 ft-lb). The EUI electrical wires should be routed to the outside of the valve cover bolts.

T2006709  
 $1.4$  Nm  
(1 ft-lb)  
 $33 \pm 4$  Nm  
( $24 \pm 3$  ft-lb)

Pay close attention to the cable holders. If one breaks, remove the broken pieces to prevent clogging or damage to any components.

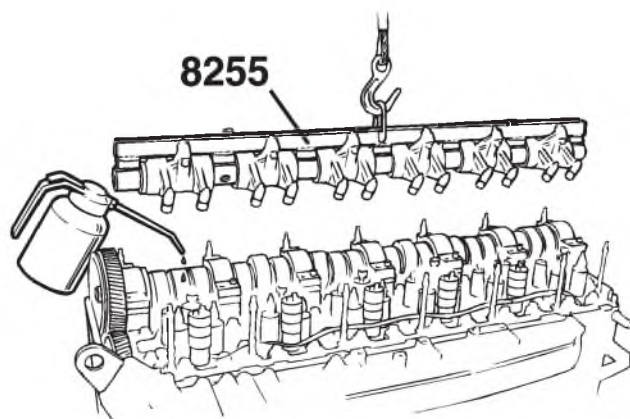
**Note:** Be careful not to pinch the EUI wiring cable harness when installing the valve cover.

**Note:** Hold the wires while tightening. If the screw gets damaged, the complete electronic unit injector must be replaced.

**Note:** Applies to engines equipped with VEB (Volvo Engine Brake). The VEB control valve should be reinstalled at this time. Reconnect sliding valve and pipe into the rocker arm shaft as a unit. Apply Loctite® 242 to threads and tighten the bolts to a torque of  $33 \pm 4$  Nm ( $24 \pm 3$  ft-lb).



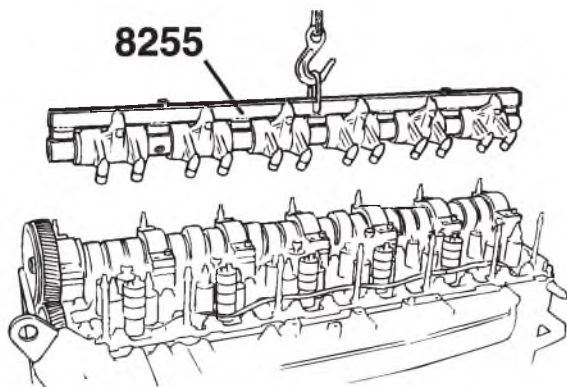
17




T2006820

Coat the valve bridges and camshaft lobes with engine oil.

18



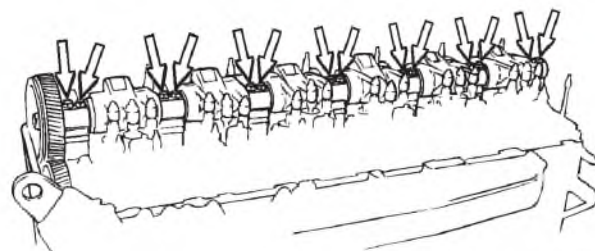
T2006776

 <b>CAUTION</b>
<p>Remove all oil from the rocker arm bridge bolt holes to prevent a hydraulic lock that may result in damage to the cylinder head.</p>

Install the rocker arm bridge, using lifting tool 9998255.

9998255

19

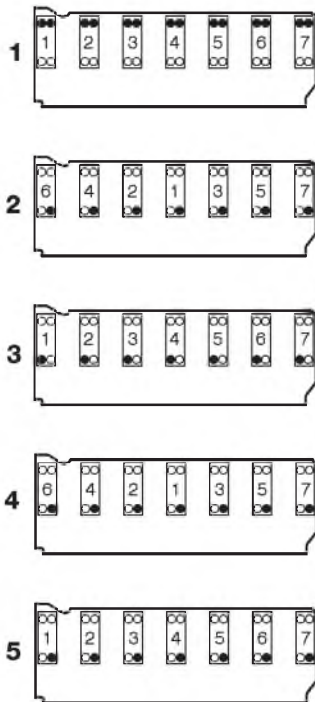


T2006777

Install all rocker arm shaft bolts, making sure they are hand tight before continuing.

**Note:** When reinstalling a rocker arm shaft which has been removed or loosened, only the bolts which hold the rocker arm shaft should be tightened.

20



W2003520

Fig. 60: Bearing caps and camshaft/rocker shaft, tightening sequence

D12C:

- 1  $15 \pm 5$  Nm ( $11 \pm 4$  ft-lb);  $+90 \pm 5^\circ$
- 2  $60 \pm 5$  Nm ( $44 \pm 4$  ft-lb)
- 3  $15 \pm 5$  Nm ( $11 \pm 4$  ft-lb);  $+120 \pm 5^\circ$
- 4  $60 \pm 5$  Nm ( $44 \pm 4$  ft-lb); loosen to 0 Nm (0 ft-lb)
- 5  $15 \pm 5$  Nm ( $11 \pm 4$  ft-lb);  $+120 \pm 5^\circ$

D12, D12A, D12B:

- 1  $15 \pm 5$  Nm ( $11 \pm 4$  ft-lb);  $+90 \pm 5^\circ$
- 2 45 Nm (33 ft-lb)
- 3  $15 \pm 5$  Nm ( $11 \pm 4$  ft-lb);  $+90 \pm 5^\circ$
- 4 45 Nm (33 ft-lb); loosen to 0 Nm (0 ft-lb)
- 5  $15 \pm 5$  Nm ( $11 \pm 4$  ft-lb);  $+90 \pm 5^\circ$

Gradually tighten the bolts so that the rocker arm shaft does not bend or warp. Tighten the shaft until it lies against the camshaft lobes, then torque tighten using the 5-step torque sequence shown.

21

Adjust the valves and the electronic unit injector (EUI).



# Feedback

One of our objectives is that workshop personnel should have access to correct and appropriate service manuals where it concerns fault tracing, repairs and maintenance of Volvo trucks.

In order to maintain the high standards of our literature, your opinions and experience when using this manual would be greatly appreciated.

If you have any comments or suggestions, make a copy of this page, write down your comments and send them to us, either via telefax or mailing directly to the address listed below.

To

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Greensboro, NC 27402-6115

USA

Fax (336) 393-3170

From

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Comments/proposals

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Concerns Service Manual: .....



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This TSI Service Bulletin and others in Groups 21 and 33 replace TSI Service Manual 210–600, “Basic Engine, D12, D12A, D12B, D12C” (8.2000), publication no. PV776–TSP142853.

Date

11.2001

Group

**215**

No.

**007**

Supp.

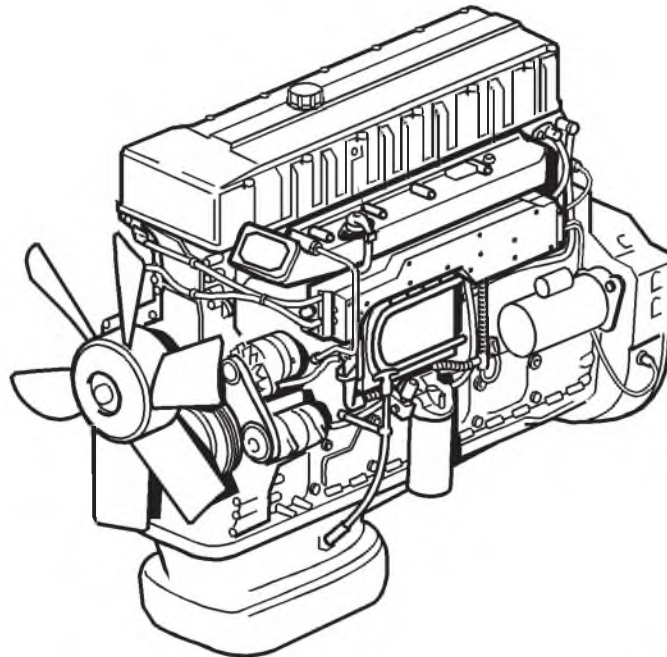
Page

1(4)

Idler Gear Assembly

D12, D12A, D12B

## Idler Gear Assembly



W2002853

Fig. 1: VOLVO D12C Engine

This information covers procedures for overhauling the idler gear assembly on VOLVO D12, D12A, and D12B engines.

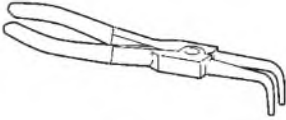
### Contents

- [“Special Tools” page 2](#)
- [“Idler Gear Assembly, Overhaul” page 3](#)

## Tools

### Special Tools

The following special tools are used to replace or repair components. The tools can be ordered from Volvo; please use the specified part number when ordering.



**9988183**  
Snap Ring Pliers



**9992267**  
Puller



**9992584**  
Hollow Drift



**9998244**  
Hollow Drift



## Service Procedures

### 2153-04-05-01 Idler Gear Assembly, Overhaul

(Unit removed.)

#### **WARNING**

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with debris.

*Special tools:* 9988183, 9992267, 9992584, 9998244

- 1  
Clamp the idler gear assembly securely in a vise.

#### Disassembly

2

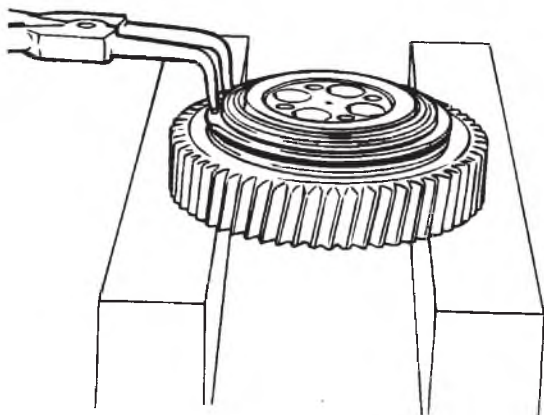
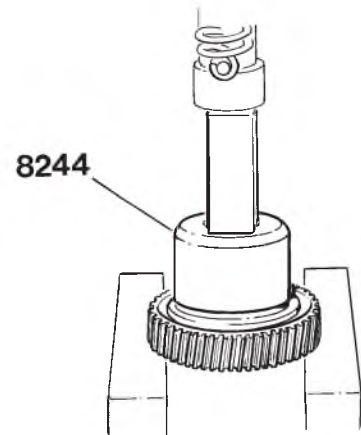


Fig. 2: Removing the snap ring

Using snap ring pliers 9988183, remove the snap ring at the front of the idler gears equipped with roller bearings.

3

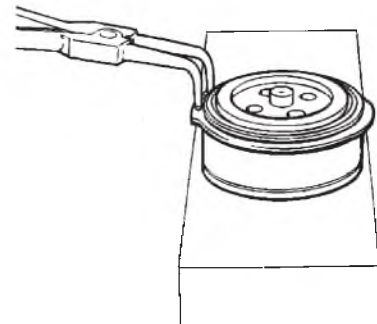


T2007174

Fig. 3: Removing the shaft and the bearing together

Using tool 9998244, press the shafts and bearings out of both the idler gears.

4

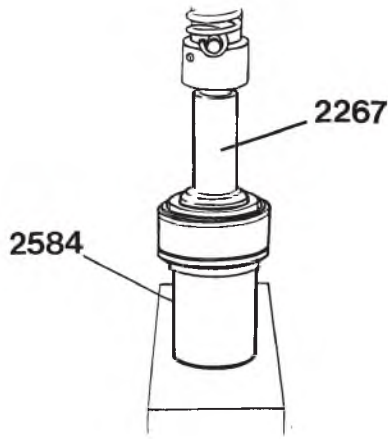


T2007077

Fig. 4: Removing the snap ring

Using snap ring pliers 9988183, remove the snap rings on the other side of the idler gears.

5



T2007141

Fig. 5: Removing the shaft from the bearing

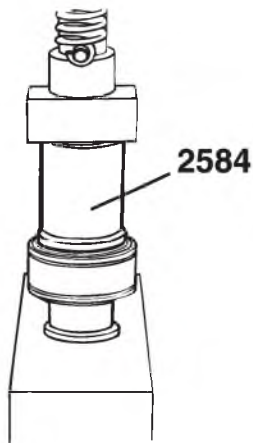
Using puller 9992584 and drift 9992584  
9992267, press the shafts out of the 9992267  
bearings.

### Assembly

6

Place the shaft and the bearing lock washer into a press.

7



T2007094

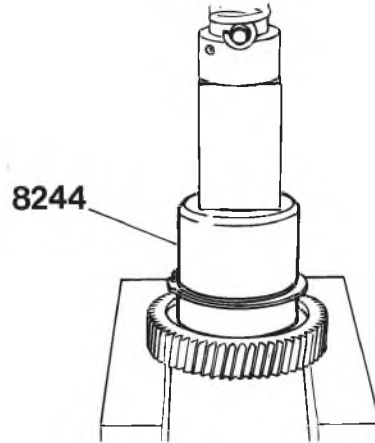
Fig. 6: Installing a new bearing

Using tool 9992584, press the new 9992584  
bearing onto the shaft until it bottoms 9992584  
against the washer.

8

Install the snap ring onto the side of the bearing that faces the timing gear plate.

9



T2007140

Fig. 7: Installing the shaft and bearing assembly

Using tool 9998244, carefully press 9998244  
the shaft and the bearing into the idler 9998244  
gear until the bearing lies up against  
the snap ring.

**Note:** Do not press too hard against  
the snap ring.

10

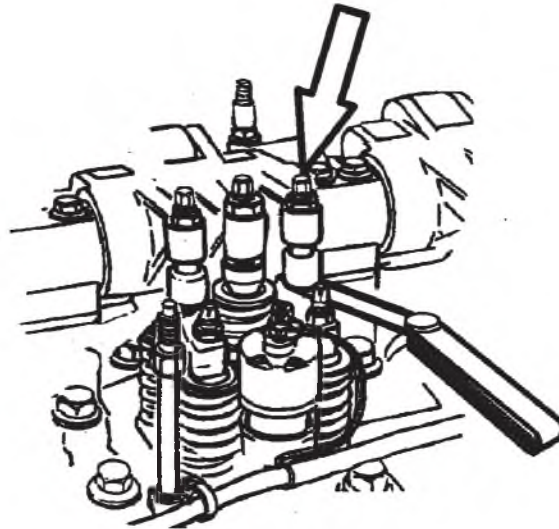
Install the other snap ring and remove  
the washer.

This TSI Service Bulletin replaces TSI Service Bulletin 214-013, "Valves, D12C" (11.2001), publication no. PV776-TSP160587.

Date	Group	No.	Supp.	Page
7.2004	<b>214</b>	<b>020</b>		1(9)

## Valve and Injector Adjustment with EPG D12, D12A, D12B, D12C

### Valve and Injector Adjustment with EPG



W2003805

This information covers procedures for adjusting valves and injectors on VOLVO D12, D12A, D12B, and D12C engines.

#### Contents

- ["Special Tools" page 2](#)
- ["Valves and Unit Injectors, Adjustment" page 3](#)

**Note:** Information is subject to change without notice. Illustrations are used for reference only and may differ slightly from the actual vehicle being serviced. However, key components addressed in this information are represented as accurately as possible.

## Tools

### Special Tools

The following special tools are used to replace or repair components. The tools can be ordered from Volvo. Please use the specified part number when ordering.



C0000220  
**9996956**  
Cranking tool



W0000416  
**J41610**  
Feeler Gauge Set

### Other Special Equipment

Like special tools, the following items can be ordered directly from Volvo. Please refer to the specific tool number when ordering.



C2001260  
**1159794**  
Torque Wrench

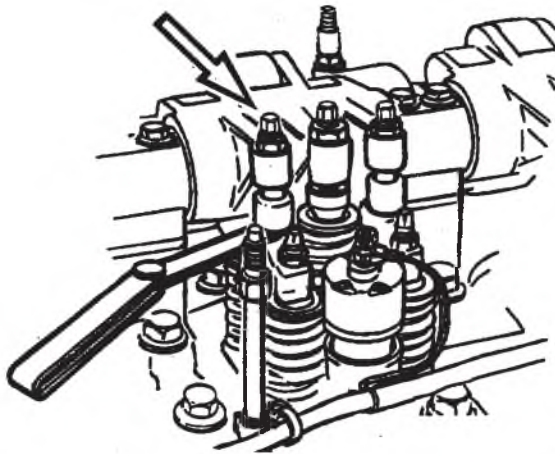
# Service Procedures

## 2140-05-03-01

### Valves and Unit Injectors, Adjustment

(Valve cover removed.)

You must read and understand the precautions and guidelines in Service Information, group 20, "General Safety Practices" before performing this procedure. If you are not properly trained and certified in this procedure, ask your supervisor for training before you perform it.



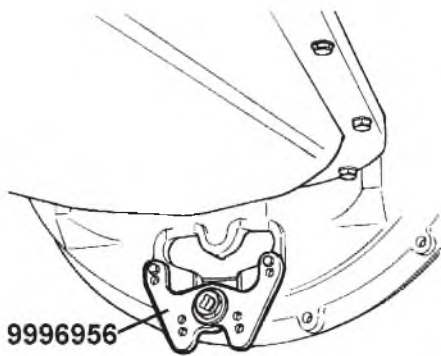
T2008968

**Note:** Variant abbreviations are used to identify an engine equipped with the following components:

EPG                      Exhaust Pressure Governor

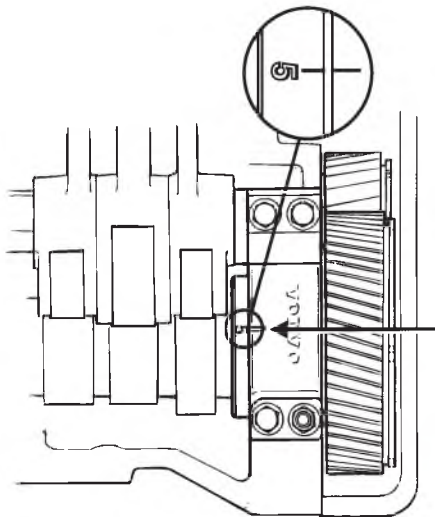
*Special tools: 9996956, J41610*

*Other special equipment: 1159794*



**1**  
Remove the flywheel inspection cover located under the engine flywheel housing. Install engine turning tool 9996956.

9996956



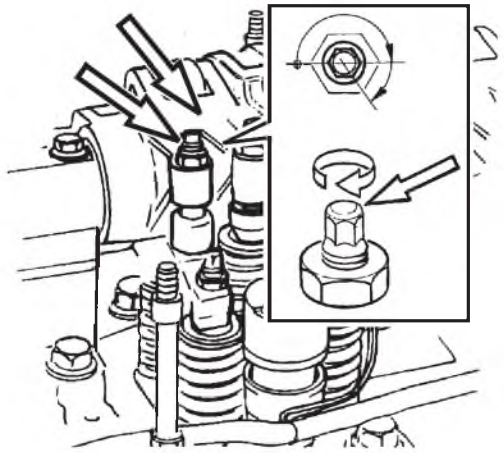
**2**  
Turn the engine to the camshaft marking to adjust the corresponding valve (for example, no. 5, as shown in illustration), as indicated below:

- Marking 1 – 6: Apply to adjustment of valve bridge intake valves, exhaust valves, and unit injector.

Example:

Adjustments for no. 5 intake clearances, no. 5 injector preload, and no. 5 exhaust valve clearances would be made in this engine position.





W2004460

### Valve and Unit injector, adjustment

#### 3

Loosen lock nut and back off adjusting screw until it no longer makes contact with the injector socket.

**Note:** Adjust injector before adjusting intake and exhaust valves.

#### Valve and Injector Settings

Cam Position	Injector	Intake	Exhaust
1	X	X	X
5	X	X	X
3	X	X	X
6	X	X	X
2	X	X	X
4	X	X	X

#### 4

Adjust the unit injector's adjusting screw to zero clearance.

#### 5

Tighten the adjusting screw 4 flats or 240°.

#### 6

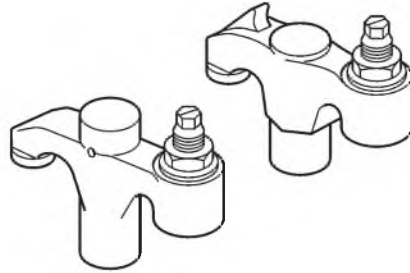
Torque-tighten the adjusting screw lock nut to 52 ± 4 Nm (38 ± 3 ft-lb).

**Note:** Mark the rocker arm and injector rocker when each valve has been adjusted.

52 ± 4 Nm  
(38 ± 3 ft-lb)

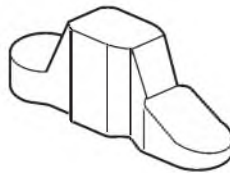
## Intake and Exhaust Valve Bridge Adjustment

7



T2019496

Valve bridge with guide



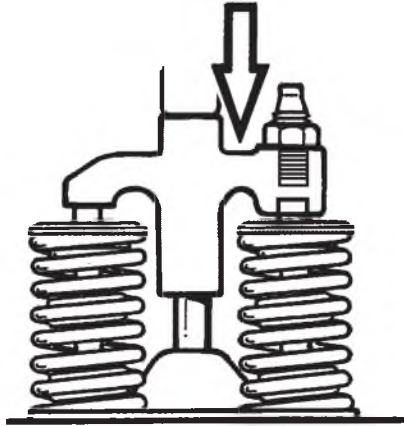
W2004467

Valve bridge without guide

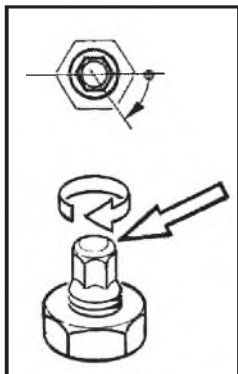
**Note:** A valve bridge design (without guide pin) is used in D12 engines. These may be installed in combination with the current valve bridge design with guide pin. The procedure for adjusting valves remains the same, except that the valve bridge without guide pin does not need adjusting. Valve clearances are also unchanged. For intake valves, the valve bridge without guide pin may be installed facing either direction. A valve bridge with guide pin must always be installed as a replacement component.

## Intake and Exhaust Valve Bridge Adjustment

8



W2004433



W2004468

### CAUTION

The valve bridge must be adjusted prior to the valve clearance adjustment that is related to it. Failure to do this can result in breakage or damage to the valve bridge guide.

**Note:** The valve bridge adjustment can only be made when there is clearance between the valve bridge and the rockerarm.

Adjust the valve bridge clearance:

- Loosen the adjusting screw lock nut.
- Loosen adjusting screw until it no longer contacts valve stem.
- Press valve bridge downward toward the valve stem.
- Tighten adjusting screw until it makes contact, then turn an additional 1 flat or 60°.
- Hold adjusting screw in place and torque-tighten nut to 38 ± 3 Nm (28 ± 2 ft-lb).

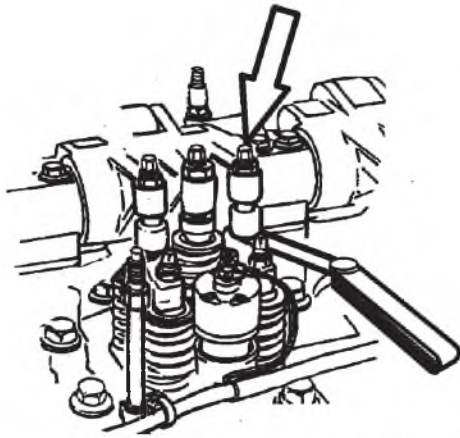
38 ± 3 Nm  
(28 ± 2 ft-lb)

9

Recheck valve clearance after nut is torque-tightened.

10

Rotate the engine to the next cylinder mark on the camshaft. Adjust unit injector, valve bridges, intake and exhaust valves on that cylinder.



W2003805

**11**

With engine cold ( $140^{\circ}\text{F}$  or less), adjust the valve clearance for exhaust to 0.5 mm (0.020 in.). Hold adjusting screw in place and torque-tighten lock nut to  $38 \pm 3 \text{ Nm}$  ( $28 \pm 2 \text{ ft-lb}$ ).

**Note:** Mark each valve rocker lever as you adjust it to know which valves have already been adjusted.

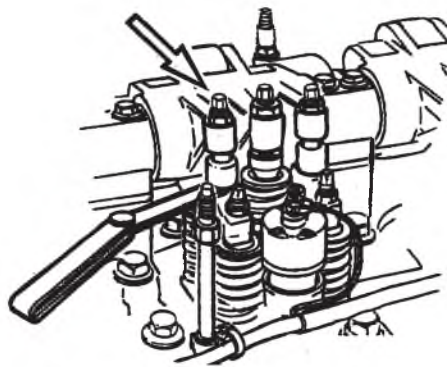
**Intake Valves, adjustment**

**12**

With engine cold ( $140^{\circ}\text{F}$  or less), adjust valve clearance to 0.2 mm (0.008 in.). Hold adjusting screw in place and torque-tighten lock nut to  $38 \pm 3 \text{ Nm}$  ( $28 \pm 2 \text{ ft-lb}$ ).

**Note:** Mark each valve rocker lever as you adjust it to know which valves have already been adjusted.

$38 \pm 3 \text{ Nm}$   
( $28 \pm 2 \text{ ft-lb}$ )



T2008968

**13**

Use steps 3 - 13 to adjust the injectors and valves.

**Valve Clearance, Cold Engine Setting Valve**

Inlet	0.2 mm (0.008 in.)
Exhaust	0.5 mm (0.020 in.)

**Valve Clearance, Cold Engine Check Valve**

Inlet	0.15 – 0.25 mm (0.006 – 0.010 in.)
Exhaust	0.45 – 0.55 mm (0.018 – 0.22 in.)

**Valve and Injector Settings**

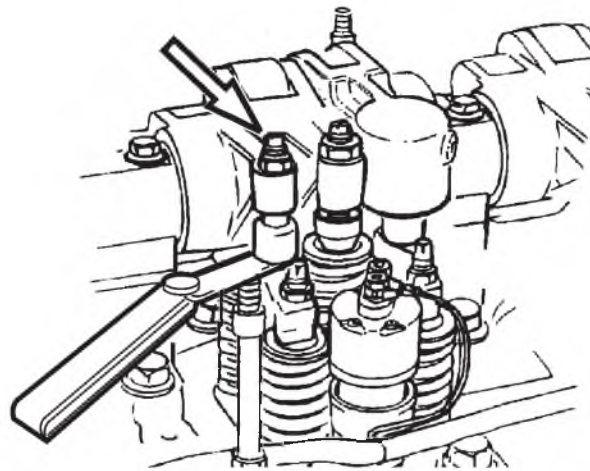
Cam Position	Injector	Intake	Exhaust
1	X	X	X
5	X	X	X
3	X	X	X
6	X	X	X
2	X	X	X
4	X	X	X

This TSI Service Bulletin replaces TSI Service Bulletin 214-013, "Valves, D12C" (11.2001), publication no. PV776-TSP160587.

Date	Group	No.	Supp.	Page
7.2004	<b>214</b>	<b>019</b>		1(11)

## Valve and Injector Adjustment with VEB D12, D12A, D12B, D12C

### Valve and Injector Adjustment with VEB



W2004459

This information covers procedures for adjusting valves and injectors on VOLVO D12, D12A, D12B, and D12C engines.

#### Contents

- ["Special Tools" page 2](#)
- ["Valves and Unit Injectors, Adjustment" page 3](#)

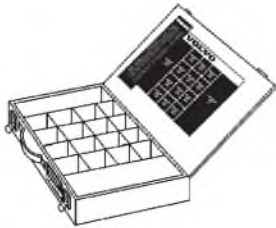
**Note:** Information is subject to change without notice. Illustrations are used for reference only and may differ slightly from the actual vehicle being serviced. However, key components addressed in this information are represented as accurately as possible.



## Tools

### Special Tools

For special tools ordering instructions, refer to Tool Information, group 08.



W0001924  
**3949521**  
VEB shim kit



W0001774  
**9996956**  
Engine turning tool



W0000416  
**J41610**  
Feeler gauge set

### Other Special Equipment

Like special tools, the following items can be ordered directly from Volvo. Please refer to the specific tool number when ordering.



C2001260  
**1159794**  
Torque Wrench

# Service Procedures

## 2140-05-03-01

### Valves and Unit Injectors, Adjustment

(Valve cover removed.)

You must read and understand the precautions and guidelines in Service Information, group 20, "General Safety Practices, Engine" before performing this procedure. If you are not properly trained and certified in this procedure, ask your supervisor for training before you perform it.

**Note:** Variant abbreviations are used to identify an engine equipped with the following components:

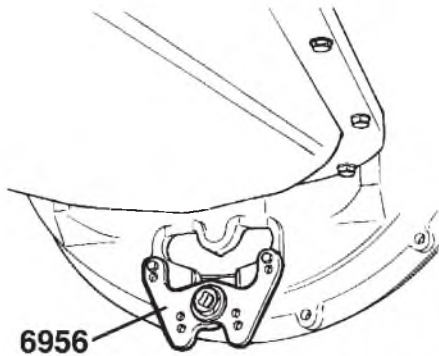
**VEB** Volvo Engine Brake

*Special tools: 3949521, 9996956, J41610*  
*Other special equipment: 1159794*

**1**

Remove the flywheel inspection cover from the flywheel housing. Install engine turning tool 9996956.

9996956

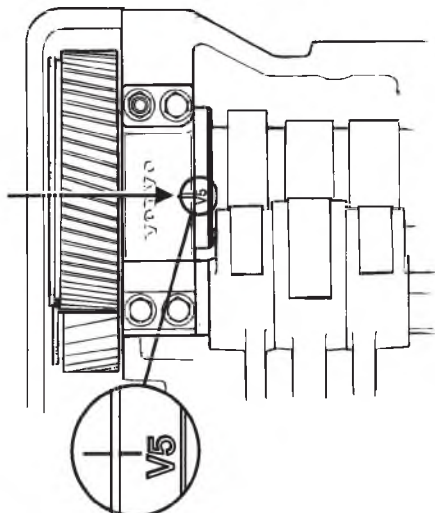


T2006672

**2**

**Camshaft markings for setting of valves and unit injectors:**

- Markings 1–6, apply to adjustment of intake valves and unit injector.
- Markings V1–V6, apply to adjustment of exhaust valves only.



W2004440

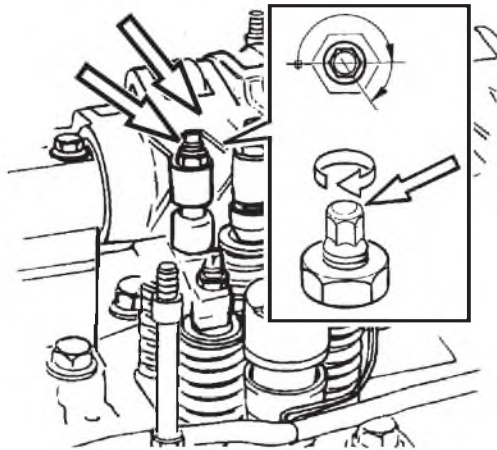
### Valve and Unit injector, adjustment

#### 3

Loosen lock nut and back off adjusting screw until it no longer makes contact with the injector socket.

#### Valve and Injector Settings

Cam Position	Injector	Intake	Exhaust
5	X	X	
V6			X
3	X	X	
V2			X
6	X	X	
V4			X
2	X	X	
V1			X
4	X	X	
V5			X
1	X	X	
V3			X



W2004460

#### 4

Adjust the unit injector's adjusting screw to zero clearance.

#### 5

Tighten the adjusting screw 4 flats or 240°.

#### 6

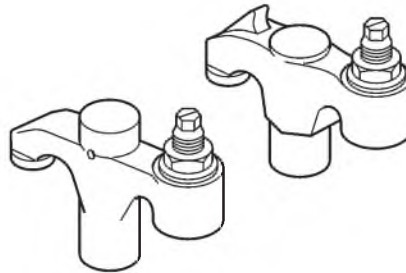
Torque-tighten the adjusting screw lock nut to 52 ± 4 Nm (38 ± 3 ft-lb).

**Note:** Mark the rocker arm and injector rocker when each valve has been adjusted.

52 ± 4 Nm  
(38 ± 3 ft-lb)

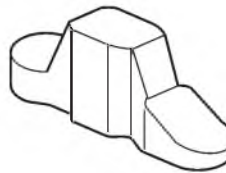
## Intake and Exhaust Valve Bridge Adjustment

7



T2019496

Valve bridge with guide

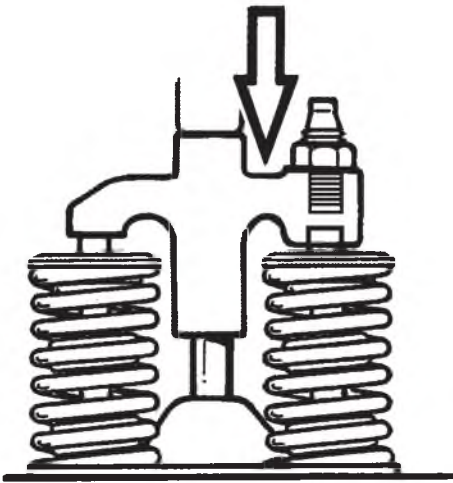


W2004467

Valve bridge without guide

**Note:** A valve bridge design (without guide pin) is used in D12 engines. These may be installed in combination with the current valve bridge design with guide pin. The procedure for adjusting valves remains the same, except that the valve bridge without guide pin does not need adjusting. Valve clearances are also unchanged. For intake valves, the valve bridge without guide pin may be installed facing either direction. A valve bridge with guide pin must always be installed as a replacement component.

8



W2004433



### CAUTION

The valve bridge must be adjusted prior to the valve clearance adjustment that is related to it. Failure to do this can result in breakage or damage to the valve bridge guide.

**Note:** The valve bridge adjustment can only be made when there is clearance between the valve bridge and the rockerarm.

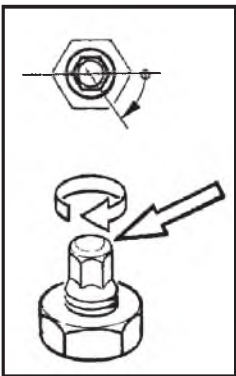
Adjust the valve bridge clearance:

- Loosen the adjusting screw lock nut.
- Loosen adjusting screw until it no longer contacts valve stem.
- Press valve bridge downward toward the valve stem.
- Tighten adjusting screw until it makes contact, then turn an additional 1 flat or 60°.
- Hold adjusting screw in place and torque-tighten nut to 38 ± 3 Nm (28 ± 2 ft-lb).

38 ± 3 Nm  
(28 ± 2 ft-lb)

9

Recheck valve clearance after nut is torque-tightened.



W2004468

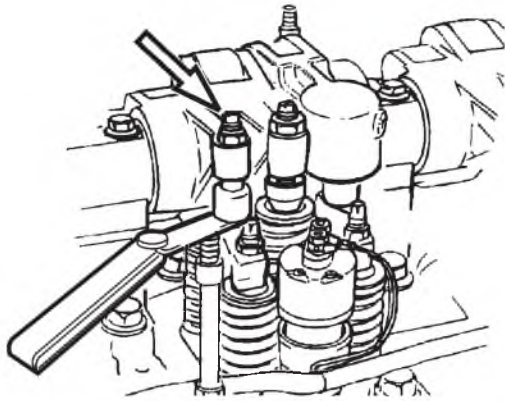
### Intake Valves, adjustment

#### 10

With engine cold (140°F or less), adjust valve clearance to 0.2 mm (0.008 in.). Hold adjusting screw in place and torque-tighten lock nut to 38 ± 3 Nm (28 ± 2 ft-lb).

**Note:** Mark each valve rocker lever as you adjust it to know which valves have already been adjusted.

38 ± 3 Nm  
(28 ± 2 ft-lb)



W2004459

#### 11

Turn the engine to the next camshaft marking before adjusting another cylinder.

**Note:** Engine temperature at 140°F or less.

#### Valve Clearance, Cold Engine Setting Valve

Inlet	0.2 mm (0.008 in.)
Exhaust VEB	1.6 mm (0.063 in.)

#### Valve Clearance, Cold Engine Check Valve

Inlet	0.15 – 0.25 mm (0.006 – 0.010 in.)
Exhaust VEB	1.55 – 1.65 mm (0.061 – 0.065 in.)



### Exhaust valves (VEB), adjustment

#### 12

Turn the engine to the next camshaft marking ("V" plus number) for the adjustment of exhaust valves.

#### 13

Loosen the adjusting screw until the valve bridge does not make contact with the valve stem.

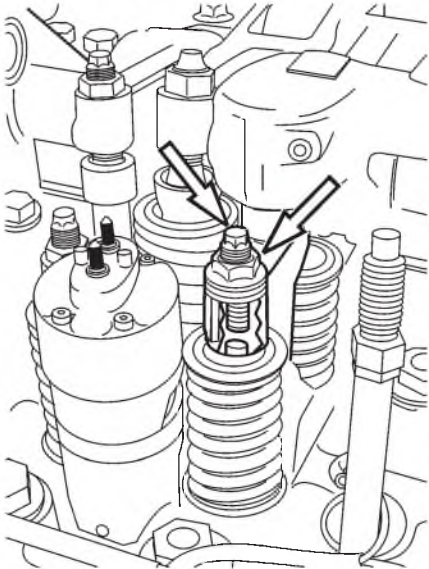
#### Valve and Injector Settings

Cam Position	Injector	Intake	Exhaust
5	X	X	
V6			X
3	X	X	
V2			X
6	X	X	
V4			X
2	X	X	
V1			X
4	X	X	
V5			X
1	X	X	
V3			X

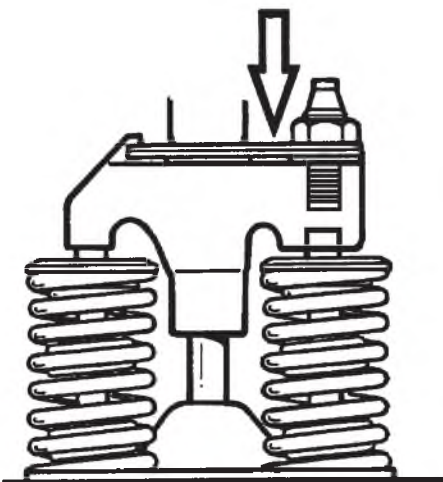
#### 14

Tighten the adjusting screw until it makes contact (zero clearance) against the valve stem. Turn an additional 1 flat or 60°. Do not tighten the adjusting screw lock nut at this point.

**Note:** When the adjusting screw is screwed down, the valve bridge must be pushed down at the same time until it makes contact with the valve stems.

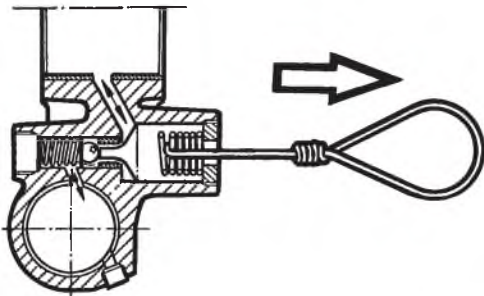


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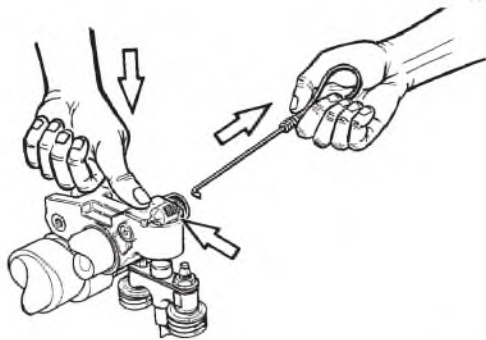


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15



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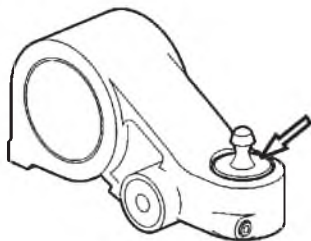


T2009009

Push the rocker arm down as shown. If the rocker arm "springs," the rocker arm piston's spring should be pulled outward while the rocker arm is pushed down until the piston makes contact with the VEB housing.

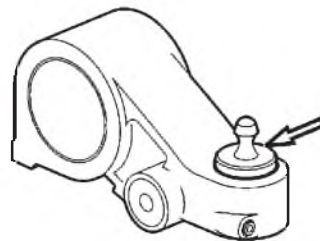
**Note:** Use a strong wire or a bent screwdriver to pull out the spring.

**Note:** For correct reading or measurement, make sure that the wire or the screwdriver has been well cleaned before they are used. Impurities between the rocker arm piston and the rocker arm can lead to the piston seizing and the brake function on the cylinder failing to work. Make sure that the piston's sliding surface in the rocker arm is not damaged.



W2004447

VEB Compressed Piston in Housing  
(Correct valve lash adjustment)



W2004446

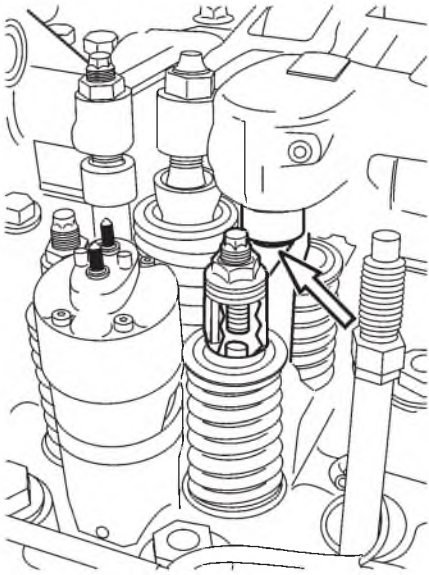
VEB Plunger Piston with oil trapped  
(Incorrect valve lash adjustment)

16

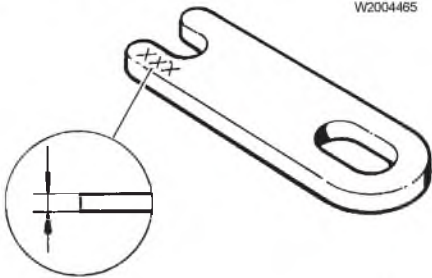
Measure the clearance between the rocker arm's piston and the valve bridge. Acceptable clearance is 1.55 – 1.65 mm (0.061 – 0.065 in.).

1.55 – 1.65 mm (0.061 – 0.065 in.)

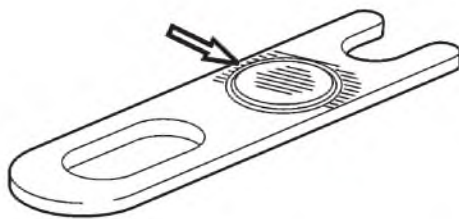
17



W2004465



T2009008



W2004423

**Note:** The exhaust valve rockers do not have adjusting screws. The exhaust valve clearance is adjusted by adding and/or removing the correct VEB shims.

**Note:** Shims are available in intervals of 0.05 mm. The thickness is stamped on the shim. VEB shim kit is tool no. 3945921.

If the valve clearance needs to be adjusted, remove the lock nut **without moving the adjusting screw.**

**Note:** If the shim is wearing on one side, turn it over and reuse.

**Note:** If the adjusting screw turns while removing the lock nut, repeat steps for Valve Bridge Adjustment.

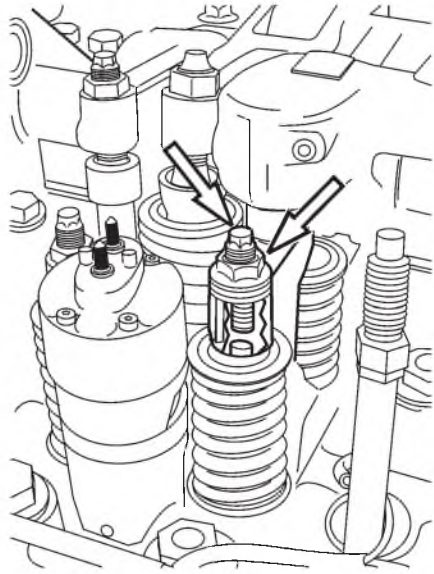
3945921

18

Use the measured value to calculate the thickness of the new shims.

If two shims must be used, select shims of approximately the same thickness.

**Note:** A maximum of two shims can be used.



W2004464

**19**

Make sure that the shim(s) and the valve bridge have been properly cleaned. Install shims and torque-tighten the adjusting screw lock nut to  $38 \pm 4$  Nm ( $28 \pm 3$  ft-lb).

**Note:** The adjusting screw must not be moved on the valve bridge when the lock nut is tightened.

$38 \pm 4$  Nm ( $28 \pm 3$  ft-lb).

**20**

After tightening the adjusting screw, recheck the valve clearance.

**Note:** Mark the rocker arm when the valve has been adjusted.

**21**

After work has been completed, start the engine and check for incorrect valve adjustment and leaks.

**22**

Bring engine to normal operating temperature. Let engine idle for approximately 5 minutes; the system performs its own cylinder balancing in order to attain smooth idling.

**Note:** During cylinder balancing, do not use any form of power-consuming equipment, such as power take-off or air conditioning.

# Service Manual Trucks

Group **250–600**

Intake and Exhaust System

D12, D12A, D12B, D12C



# Foreword

The descriptions and service procedures contained in this manual are based on designs and methods studies carried out up to August 2000.

The products are under continuous development. Vehicles and components produced after the above date may therefore have different specifications and repair methods. When this is believed to have a significant bearing on this manual, supplementary service bulletins will be issued to cover the changes.

The new edition of this manual will update the changes.

In service procedures where the title incorporates an operation number, this is a reference to an S.R.T. (Standard Repair Time).

Service procedures which do not include an operation number in the title are for general information and no reference is made to an S.R.T.

The following levels of observations, cautions and warnings are used in this Service Documentation:

**Note:** Indicates a procedure, practice, or condition that must be followed in order to have the vehicle or component function in the manner intended.

**Caution:** Indicates an unsafe practice where damage to the product could occur.

**Warning:** Indicates an unsafe practice where personal injury or severe damage to the product could occur.

**Danger:** Indicates an unsafe practice where serious personal injury or death could occur.

**Volvo Trucks North America, Inc.**  
Greensboro, NC USA

**Order number: PV776-TSP144524**

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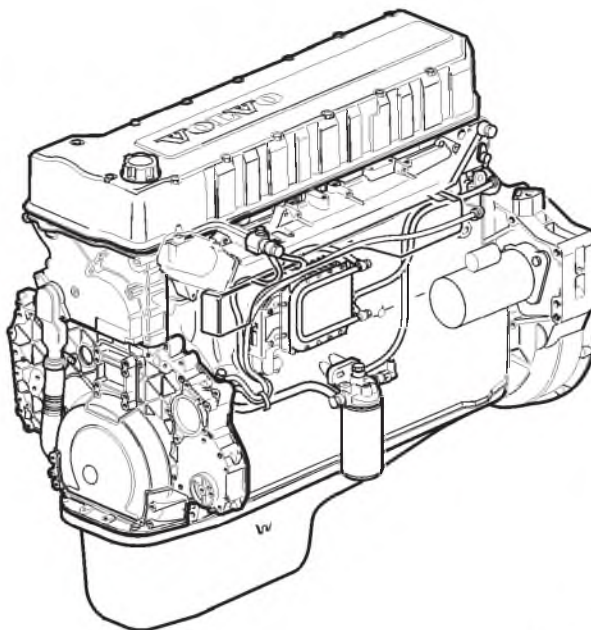


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## General



D12C Engine

W2003244

This information covers the Intake and Exhaust System for the D12, D12A, D12B, and D12C engines.



# Specifications

## Intake and Exhaust System

Maximum Restriction (Rated speed full load) ..... 6.2 kPa (H<sub>2</sub>O) (25 in.)

### *Air Cleaner torque*

Plastic ..... 9 ± 2 Nm (7 ± 2 ft-lbs)

Metal ..... 20 ± 2 Nm (15 ± 2 ft-lbs)

For Specifications, including torques, refer to:

**Service Manuals**            200–890, Specifications, D12C  
                                      200–850, Specifications, D12B  
                                      200–820, Specifications, D12A

**IMPACT**                      Function Group 25  
                                      Info Type: Specifications

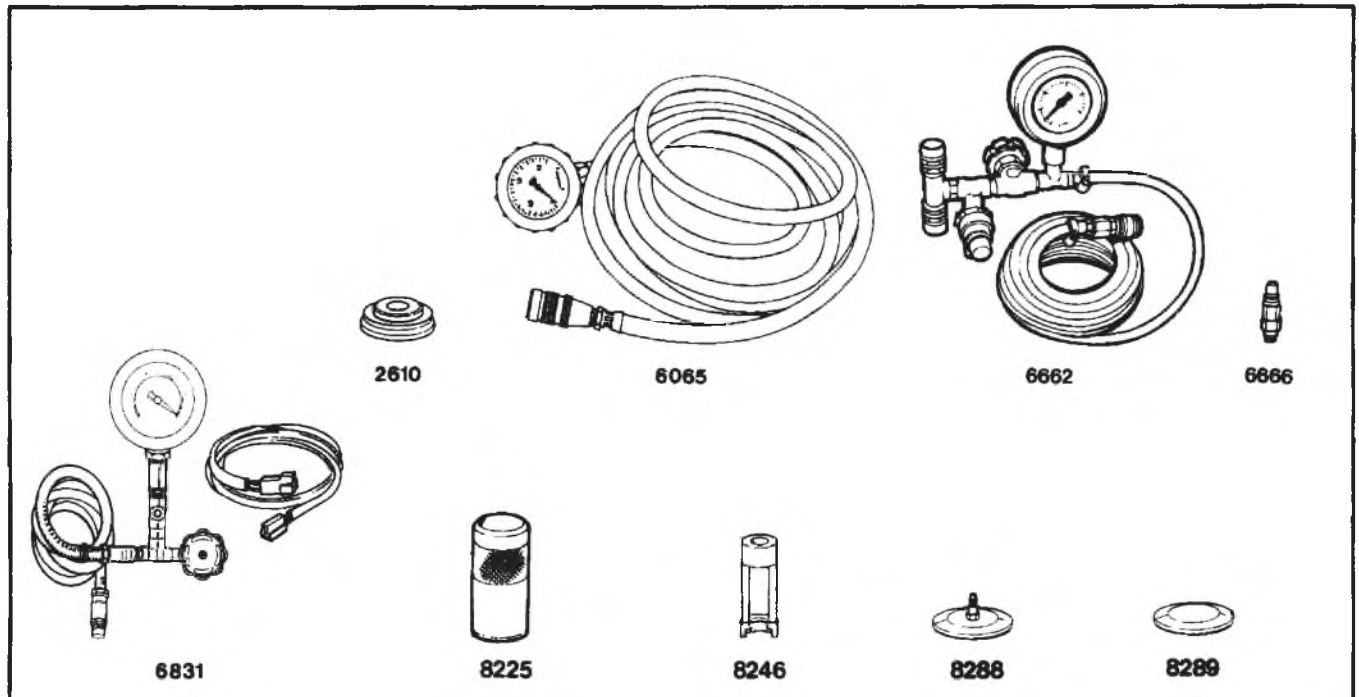




# Tools

## Special Tools

Servicing the VE D12 intake and exhaust systems requires the following special tools. The tools are available from parts departments of Volvo Trucks North America, Inc. When requesting tools, provide the appropriate number, preceded by "999", for example, 9992610.



<b>9992610</b>	Drift for overhauling exhaust pressure governor	<b>9998225</b>	Hollow drift for overhauling exhaust pressure governor
<b>9996065</b>	Gauge for checking boost pressure	<b>9998246</b>	Drift for overhauling exhaust pressure governor
<b>9996666</b>	Union for checking boost pressure	<b>9998288</b>	Connecting washer for leakage test of charge air cooler
<b>9996662</b>	Pressure gauge	<b>9998289</b>	Sealing washer for leakage test of charge air cooler
<b>9996831</b>	Vacuum gauge for checking pressure drop indicator		

W0000405

## Special Equipment

Like the special tools, the following are available from the parts department of Volvo Trucks North America, Inc.. When requesting tools, provide the appropriate part number.



W0001840

**1159794** Torque wrench 10–100 Nm (7–73 ft-lb)



W0001841

**1159795** Torque wrench 40–340 Nm (30–250 ft-lb)



W0001842

**1159796** Torque wrench 150–800 Nm (110–590 ft-lb)

## Design and Function

### Intake and Exhaust System

#### Preheater

Selected versions of the D12 are equipped with a preheater. Its purpose is to warm air in the intake manifold when starting the engine. This heated air eases starting at very low temperatures and reduces engine smoking when starting a cold engine. The following conditions are required to engage the preheater:

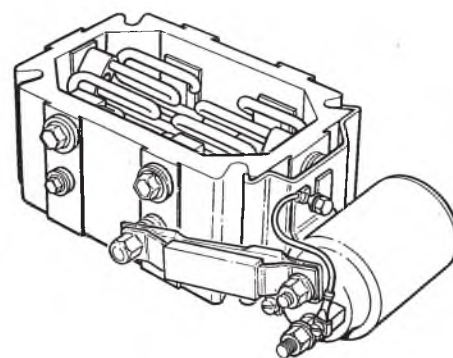
- The parking brake must be applied.
- The power take-off must not be engaged.

The preheater does not engage at coolant temperatures over  $10^{\circ}\text{C}$  ( $50^{\circ}\text{F}$ ). At a coolant temperature of  $10^{\circ}\text{C}$  ( $50^{\circ}\text{F}$ ), the preheating time is 25 seconds. At coolant temperatures below  $-15^{\circ}\text{C}$  ( $5^{\circ}\text{F}$ ), the preheating time is 55 seconds. Preheating time increases linearly between  $10^{\circ}\text{C}$  ( $50^{\circ}\text{F}$ ) and  $-15^{\circ}\text{C}$  ( $5^{\circ}\text{F}$ ).

The post-heating time is always the same as the pre-heating time.

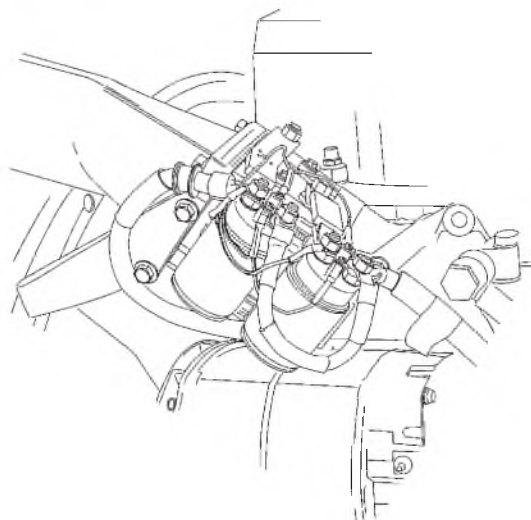
#### D12C

The D12C is equipped with a new preheater. The function of the starting heater is similar for both vehicle variants, but the location of the relay differs. The preheater on both engine variants is grounded to the engine block through the intake manifold.



T2006975

Fig. 1: Preheater



W2003281

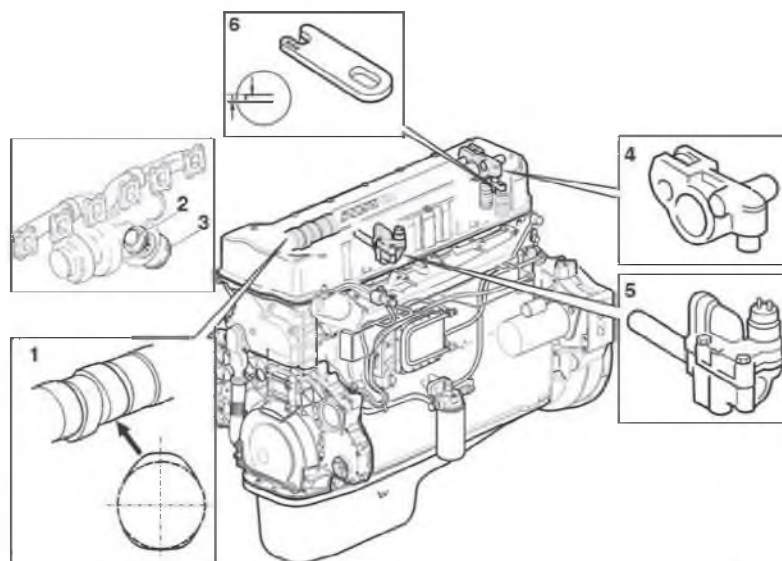
Fig. 2: Preheater, D12C

## Engines without Preheater

On engines not equipped with a preheater, engine coolant temperature determines the point at which fuel injection begins while starting. The crankshaft rotates an extra number of turns to increase cylinder temperature before fuel injection begins. This gives more reliable starting and reduces exhaust emissions during cold starts down to about  $-15^{\circ}\text{C}$  ( $5^{\circ}\text{F}$ ). This means that the crankshaft may need to rotate about 3–4 rotations before fuel injection begins and the engine fires.

An exhaust pressure governor is activated during start-up.

## Engine Brake



W2003501

Fig. 3: D12 Engine

- |   |                           |   |               |
|---|---------------------------|---|---------------|
| 1 | Camshaft                  | 4 | Rocker arm    |
| 2 | Shutter                   | 5 | Control valve |
| 3 | Exhaust pressure governor | 6 | Shim          |

The Volvo Engine Brake (VEB) is a combination of two brake systems: the exhaust brake and the compression brake.

### Exhaust brake

The exhaust pressure governor uses a shutter mounted in the exhaust outlet from the turbocharger. This shutter, connected to the exhaust pressure governor plunger, can restrict the exhaust gas flow. This creates a braking effect during the exhaust stroke when the exhaust gases cannot evacuate freely and create an overpressure between the pistons and the shutter.

### Compression brake

During the engine compression stroke and combustion (operating) stroke, the controlled opening of the exhaust valves creates an overpressure in the combustion chamber. This, in turn, produces a braking effect on the crankshaft.

The camshaft on an engine with a compression brake has two extra lobes on each exhaust cam profile. The lifting height of the extra lobes is very low when compared to the normal exhaust lobes. To enable the extra lobes to open the exhaust valves, the exhaust rocker arms are arranged in a manner by which the valve clearance can be reduced during the braking sequence.

**Shim** Shims are available in thickness intervals of 0.05 mm (0.002 in). Sizes range from 2.0–2.4 mm (0.08–0.094 in) and from 3.2–3.95 mm (0.126–0.156 in). Thickness is stamped on the shims.

## D12C

The VEB solenoid has been moved to the center of the rocker shaft. The oil supply is internal, rather than having the external piping visible.

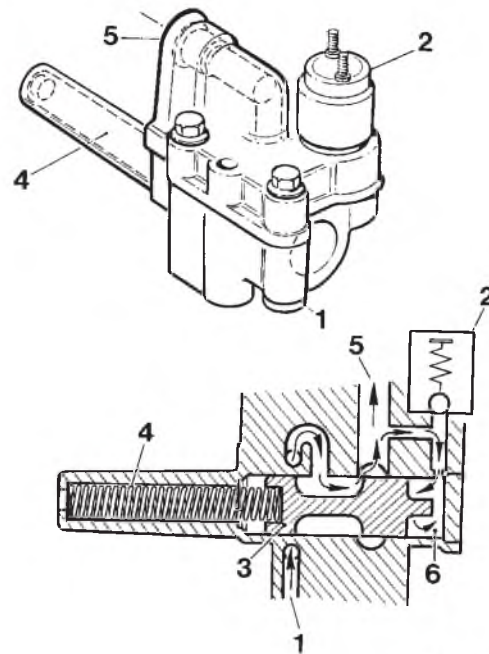
### Control Valve

The control valve is mounted on the cylinder head under the valve cover, and is connected to the oil system ahead of the rocker arm shaft. Its purpose is to reduce the oil pressure to the rocker arms while the engine is operating (compression brake not activated).

There is always full system oil pressure to the control valve intake (1) because the intake is connected via a pipe to the lube oil gallery in the cylinder block. The oil pressure to the rocker arm shaft can be increased via a solenoid valve (2) mounted on the control valve, from approximately 100 kPa (14.5 psi) while the engine is operating, to more than 200 kPa (29 psi) during compression braking.

While the engine is operating, the oil pressure is reduced after the control valve by the plunger (3) being held in balance by the force of a spring (4) and the oil pressure in the oil chamber (6) on the opposite side of the plunger.

When the solenoid valve is activated, the oil chamber (6) is drained and the spring (4) presses the plunger (3) to its end position. The plunger completely opens the oil outlet (5) to increase oil pressure to the rocker arm shaft.



T2006835

Fig. 4: Control Valve

- 1 Oil inlet
- 2 Solenoid valve
- 3 Plunger
- 4 Spring
- 5 Oil outlet
- 6 Oil chamber

### *Camshaft on Engine with Compression Brake*

The camshaft on an engine with a compression brake has an induction lobe (1) and a decompression lobe (2) — in addition to the normal exhaust lobe (3) — on each cam profile for the exhaust valves.

The induction and decompression lobe lifting height is 0.8 mm (0.032 in.) above the basic circle, which is equivalent to approximately 1.1 mm (0.043 in.) at the valve bridge.

The induction lobe is positioned so that it opens the exhaust valves at the end of the intake stroke and holds them open until the beginning of the compression stroke.

The decompression lobe is positioned so that it opens the exhaust valves at the end of the compression stroke.

In order for the induction and decompression lobes to open the exhaust valves, the valve clearance must be reduced to zero by the activation of the non-return valve and plunger located in the rocker arm for the exhaust valves.

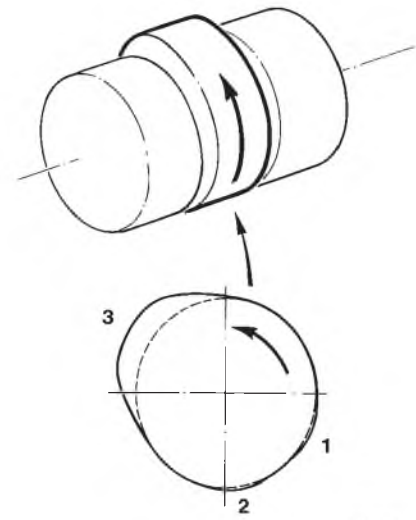


Fig. 5: Cam Shaft Profile

- 1 Induction lobe
- 2 Decompression lobe
- 3 Exhaust lobe



### Exhaust Rocker Arms

The exhaust rocker arms on an engine with a compression brake are larger than those on a conventional engine.

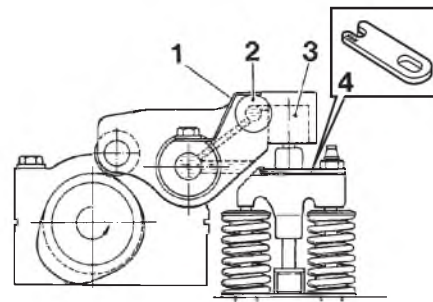
The rocker arm includes a non-return valve (2) and a plunger (3) with a pressure limiting valve, the purpose of which is to regulate the oil flow during compression braking.

The rocker arm is held in its position against the valve bridge with the help of a spring tab (1).

The valve clearance is greater than that on an engine without a compression brake, because the induction and decompression lobes must not open the exhaust valves while the engine is in normal operating mode (compression brake not activated).

Valve adjustment is carried out with shims which are placed on the valve bridge.

**Note:** A maximum of two shims are allowed to obtain proper valve clearance.



WZ003502

Fig. 6: Rocker arm assembly, side view:

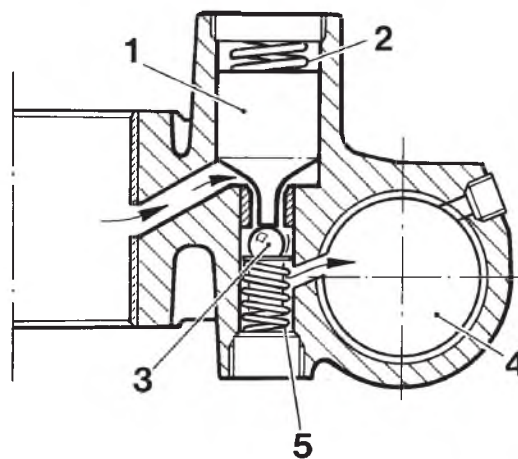
- 1 Spring tab
- 2 Non-return valve
- 3 Rocker arm plunger
- 4 Shims

### Non-Return Valve

The engine brake has a non-return valve, consisting of a plunger (1), spring (2) and a ball (3) in the rocker arm. When oil from the rocker arm shaft enters the valve, the movement of the plunger is determined by the spring force and the oil pressure.

When the oil pressure is low — approximately 100 kPa (14.5 psi); the control valve is in its normal engine operating position — the plunger (1) will not move out of its rest position because the oil pressure is not sufficient to overcome the spring force. The plunger pin prevents the ball (3) from entering the seating area, and the oil can then flow freely through the valve in both directions.

When the control valve takes up the position for compression braking, the oil pressure increases to the non-return valve. The spring force in the non-return valve is such that when the oil pressure exceeds approximately 200 kPa (29 psi), the spring force is overcome and the plunger (1) moves so that it no longer influences the ball (3). The spring (5) presses the ball (3) against the seat and prevents the oil contained above the plunger (4) from flowing past the ball (3). This forms high oil pressure above the plunger (4).



T2006834

Fig. 7: Rocker arm assembly, top view:

- 1 Plunger
- 2 Spring
- 3 Ball
- 4 Rocker arm plunger
- 5 Spring

### Rocker Arm Plunger

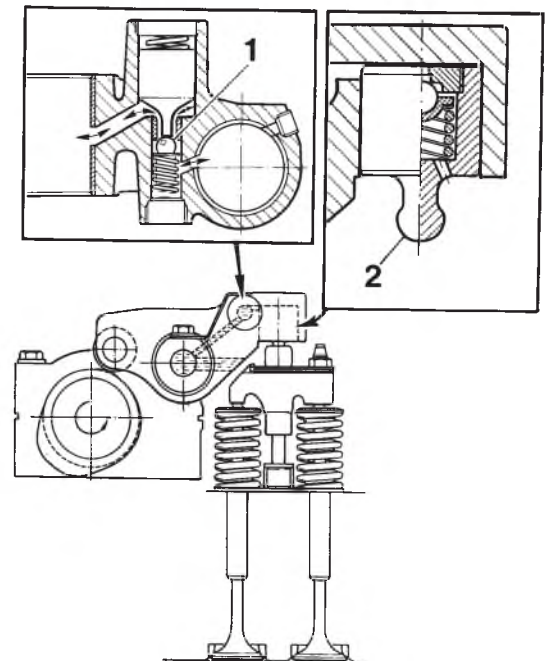
The purpose of the rocker arm plunger is to eliminate all valve clearance during the compression braking.

#### Engine Operation

When the engine is operating (compression brake not activated), there is reduced oil pressure — approx. 100 kPa (14.5 psi) — via the control valve to the rocker arm shaft and the rocker arm non-return valve (1) is open. Oil can flow freely through the non-return valve in both directions. As a result, no oil pressure is built up between the rocker arm plunger (2) and the rocker arm.

The set valve clearance is great enough to prevent the camshaft induction and decompression lobes from opening the exhaust valves.

The valve mechanism operates the same as on an engine without a compression brake; in other words, only the exhaust lobe opens the exhaust valves.



T2006828

Fig. 8: Rocker Arm Plunger

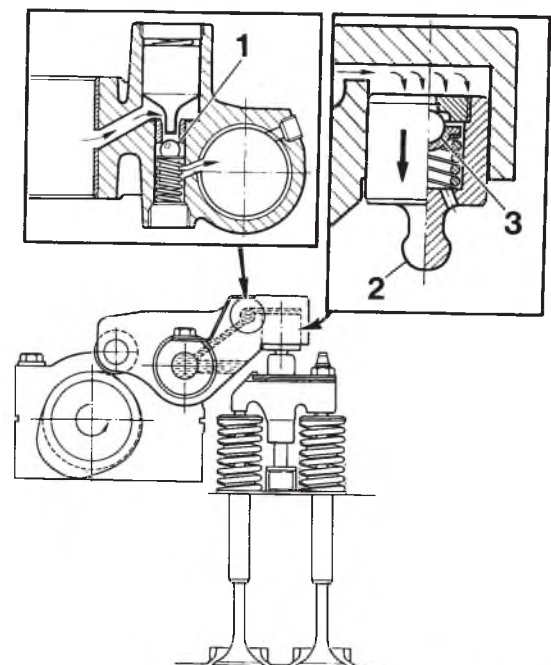
- 1 Non-return valve
- 2 Rocker arm plunger

### Compression Braking

During compression braking, the control valve does not reduce the oil pressure, so an oil pressure of at least 200 kPa (29 psi) is delivered to the rocker arm shaft.

The pressure in the rocker arm non-return valve (1) becomes so great that the plunger in the non-return valve is moved out of its rest position, and the ball now functions as a non-return valve. Pressure is built up between the rocker arm plunger (2) and the rocker arm. The plunger is pressed out and presses the rocker arm roller against the lobes on the camshaft. In this way, the valve clearance is eliminated and the lifting height on the induction and decompression lobes is sufficient to open the exhaust valves.

The rocker arm plunger is fitted with a pressure limiting valve (3). When the oil pressure between the rocker arm plunger and the rocker arm becomes too great, the pressure limiting valve opens and oil can exit through the hole in the bottom of the plunger. The opening pressure of the pressure limiting valve is governed by the force of the valve spring.



T2006836

Fig. 9: Rocker Arm Plunger

- 1 Non-return valve
- 2 Rocker arm plunger
- 3 Pressure limiting valve

### Control System

The engine brake is connected to the throttle pedal and is activated when the pedal is completely released, according to the selection made with the engine brake switch on the instrument panel.

The selection made with this switch also regulates engine braking activated by the cruise control.

**Note:** The engine brake functions as long as the engine control system has received signals from engine sensors indicating that the required preconditions for engine braking have been met. For example, the engine speed must be greater than 1100 rpm, the vehicle speed must be greater than 12 km/h (7.5 mph), and the engine temperature must be above 70° C (160° F).

The switch has three positions:

- 0 No engine brake engaged
- 1 Exhaust brake, EPG
- 2 Exhaust brake and compression brake, VEB



T2006953

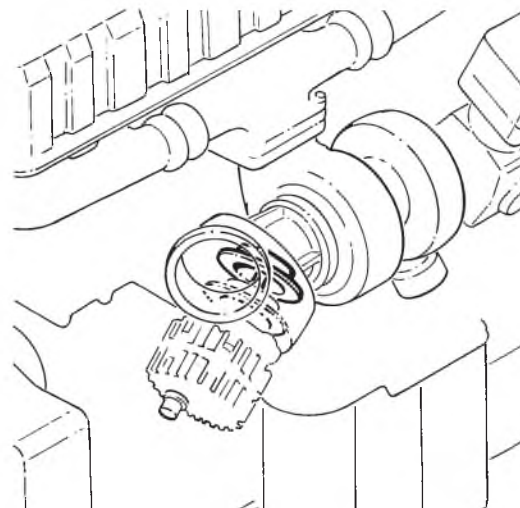
Fig. 10: Switch for engine brake

### Exhaust Brake

When exhaust braking, the exhaust pressure governor (EPG) is activated with a control pressure of approximately 750 kPa (110 psi). At this point, the shutter is forced out of the EPG and into the shutter housing. This restricts the flow of exhaust gases out of the cylinders, as the shutter blocks the outlet from the turbocharger.

Restricting the flow of exhaust gases forms an air cushion between the shutter and the piston crowns. During the exhaust stroke, this air cushion provides a braking effect on the pistons as the exhaust valves are then opened.

The higher the engine speed during the exhaust braking, the greater the braking effect.



T2006832

Fig. 11: Exhaust pressure governor

### Compression Brake

**The exhaust brake is always engaged in conjunction with the compression brake.** In the compression brake induction phase, the exhaust brake creates an overpressure in the exhaust manifold, making the compression brake more efficient.

#### Induction phase

The induction phase begins at the end of the intake stroke and continues slightly into the compression stroke.

The piston travels towards its bottom dead center position and the camshaft induction lobe opens the exhaust valves for the time required to fill the cylinder with the overpressure created by the exhaust brake in the exhaust manifold.

When the induction lobe closes the exhaust valves, the cylinder has an overpressure at the start of the compression stroke.

This overpressure considerably increases the compression during the compression stroke, which in turn creates a powerful braking effect during the upward movement of the piston.

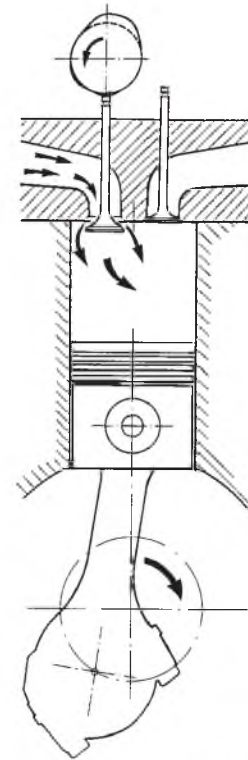


Fig. 12: Charging phase

#### Decompression phase

At the end of the compression stroke, when the piston is nearing its top dead center position, the camshaft decompression lobe opens the exhaust valves and releases the pressure out of the cylinder.

Shortly before the bottom dead center position, the exhaust valves are opened by the ordinary exhaust lobe.

During the exhaust stroke, the counterpressure is created in the exhaust manifold which, in turn, has a braking effect because the exhaust pressure governor shutter is still restricting the flow of exhaust gases out of the turbocharger.

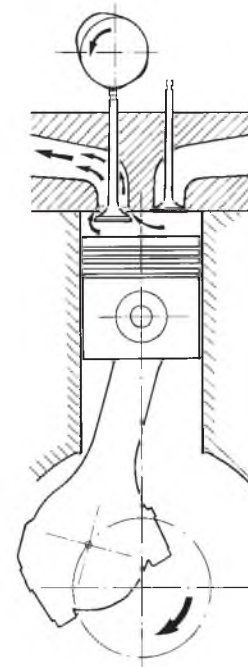


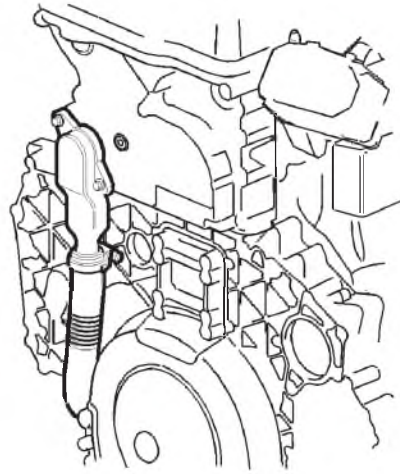
Fig. 13: Decompression phase

## Crankcase Ventilation

### D12C

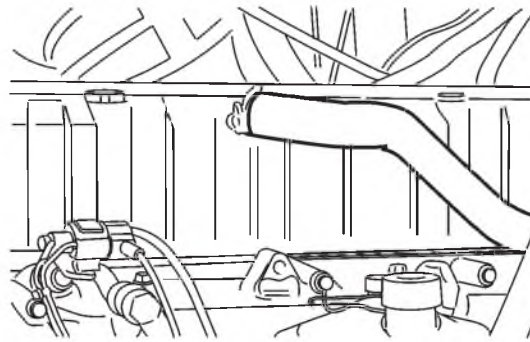
The D12C has new crankcase ventilation with its outlet from the upper timing gear cover.

The timing gear cover is designed with an oil trap to prevent oil from escaping through the ventilation tube.



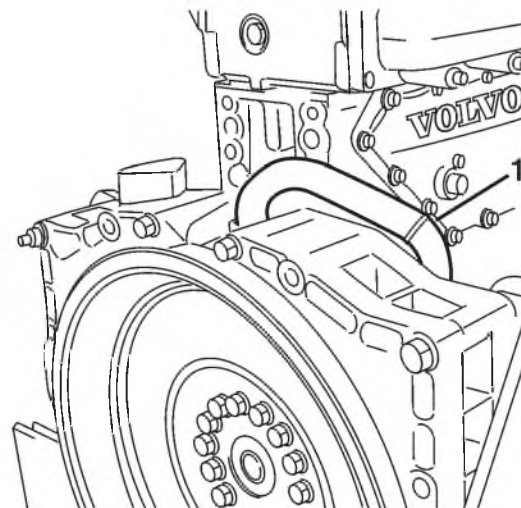
T2012791

Fig. 14: Crankcase Ventilation, D12C



W2003503

Fig. 15: Crankcase Ventilation, D12B and D12C



W2003504

Fig. 16: Crankcase Ventilation, D12A



## Exhaust Pressure Governor

The exhaust pressure governor (EPG) acts as an exhaust brake when slowing the vehicle down. It also speeds engine warm-up by applying a load to the engine during idle and warm-up. Engine load is created by the (EPG) throttling the flow of exhaust gases, causing the engine to work against a backpressure. This increases combustion temperature and shortens the warm-up period.

On engines without a pre-heater, the (EPG) is activated before the starter motor is engaged. For engines with a pre-heater, the (EPG) is activated after pre-heating, start-up and post-heating have taken place.

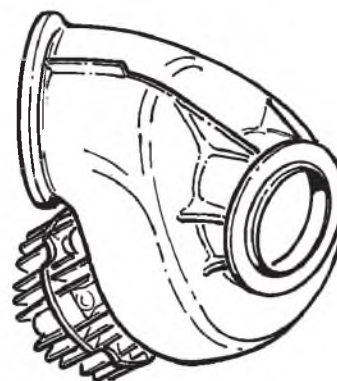
The (EPG) is activated by a control pressure of about 200 kPa (29 psi), by a combi relay when it is used during starting and warm-up. When used for engine braking, the exhaust pressure governor is controlled by a single two-position switch if the engine is equipped with an exhaust brake only, and by dual two-position switches if the engine is equipped with a Volvo Engine Brake, or VEB (both exhaust brake and compression brake).

### *Engines with Exhaust Brake Only*

#### Two-position switch (ON/OFF)

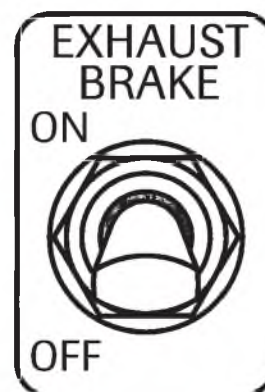
With the switch in the **ON** position, the exhaust pressure governor is activated by a control pressure of approx. 750 kPa (110 psi) subject to the following conditions:

- Accelerator pedal fully up.
- Clutch pedal fully up.
- Engine speed above 1100 rpm.
- Boost pressure below 52 kPa (7.5 psi).
- When using cruise control and preselected road speed is exceeded by 7 km/h (4 mph) (disengagement at 4 km/h (3 mph) over preselected speed).
- ABS not activated (continuous control).



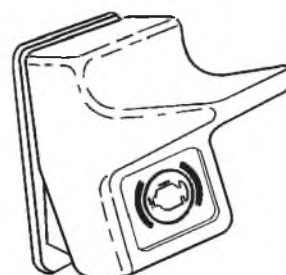
T2006948

Fig. 17: Exhaust pressure governor (EPG)



W2000731

Fig. 18: Exhaust brake switch for WX, WG and AC



W3001324

Fig. 19: Exhaust brake switch for VN/VHD

### Engines with VEB

When the engine brake **ON/OFF** switch is in the **ON** position, the engine brake is activated according to the position of the engine brake **HI/LO** switch.

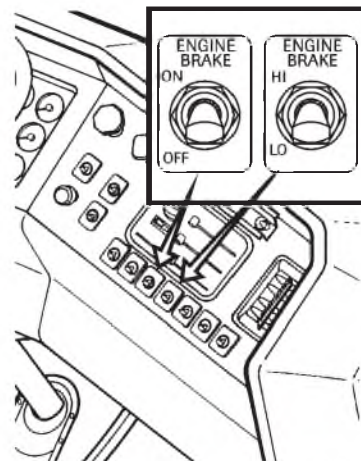
With the **HI/LO** switch in the **LO** position, only the exhaust pressure governor is activated and is subject to the same conditions as for engines with an exhaust brake only.

With the **HI/LO** switch in the **HI** position, the VEB is activated (both the exhaust pressure governor and compression brake are switched on).

In addition to satisfying exhaust brake prerequisites, the following conditions must be met:

- Coolant temperature above 70°C (158°F).
- Vehicle speed must be greater than 12 km/h (7.5 mph).
- Engine temperature must be above 43°C (110°F).

For VN/VHD, engine exhaust brake switches are located on the dash (5); see Fig. 21: Engine brake switches for VN/VHD, page 20.

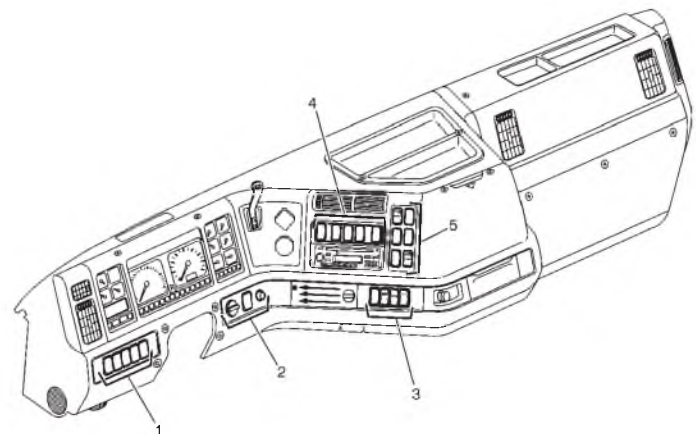


W2001002

Fig. 20: Engine brake switches for WG and AC

Dual two-position switches:

- 1 **ON/OFF**
- 2 **HI (VEB)/LO (exhaust brake)**



W3004361

Fig. 21: Engine brake switches for VN/VHD

- 1 Left Dash Switches
- 2 Driving Light Switches
- 3 Pneumatic Switches
- 4 Auxiliary Switches
- 5 Right Dash Switches



## D12C

The EPG on the D12C has a new air valve. The valve is located on the right, rear edge of the engine block and is controlled by current from the EECU. There are two on/off valves and two reduction valves in the valve body.

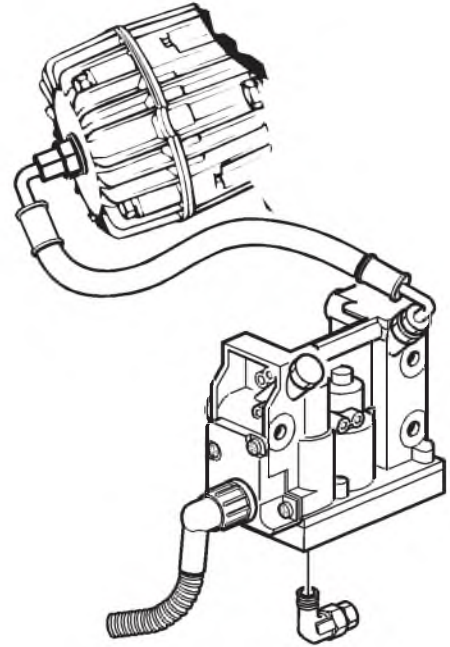


Fig. 22: Exhaust Pressure Governor, D12C <sup>T2012788</sup>

## EPG Control Valve

The exhaust pressure governor is controlled by a valve that regulates air pressure to the EPG.

The exhaust pressure governor operates using two different pressures:

- When the exhaust pressure governor is activated during starting and keeping the engine warm, the control valve provides a control pressure of approximately 200 kPa (29 psi).
- When the exhaust pressure governor is activated for engine braking, the control valve provides a control pressure of approximately 750 kPa (110 psi).

### D12A

The D12A is provided with two solenoid valves, one for controlling the starting and engine warming pressure and one for controlling the pressure for engine braking. Both solenoid valves are located in a bracket on the cylinder head.

### D12B

The D12B is provided with an EPG control valve that controls both the starting and engine warming pressure, and the pressure for engine braking. The valve is located at the lower rear edge on the right-hand side of the cylinder block.

**The EPG control valve on the D12B replaces the two solenoid valves on the D12A to perform the same function.**

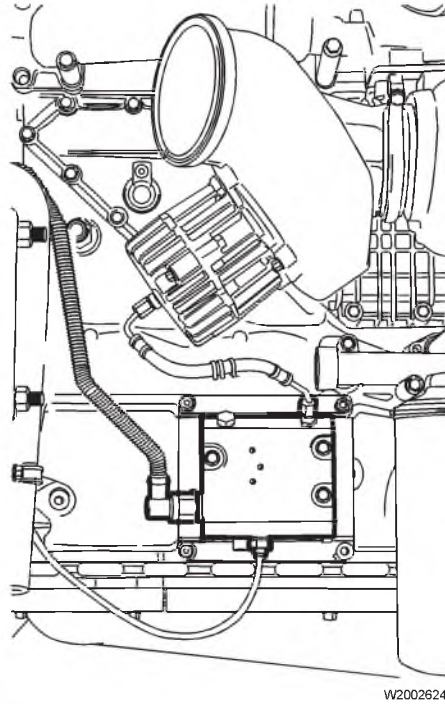
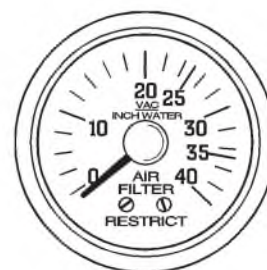


Fig. 23: EPG control valve, D12B

### Air Restriction Indicator

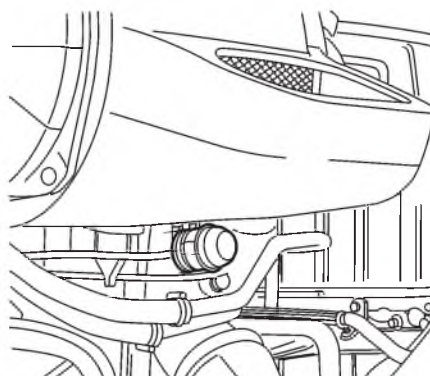
There are several types of restriction indicators which can be mounted in certain locations, such as on the air cleaner duct or on/above the instrument panel. The air restriction indicator mounted on the instrument panel permits continuous monitoring of the gauge.

When either the flag or piston-type restriction gauge is mounted directly on the air cleaner, the piston is usually drawn downward into view as the element loads with dirt. It locks into full view only after the restriction (caused by a dirty element) reaches the rated value of the indicator.



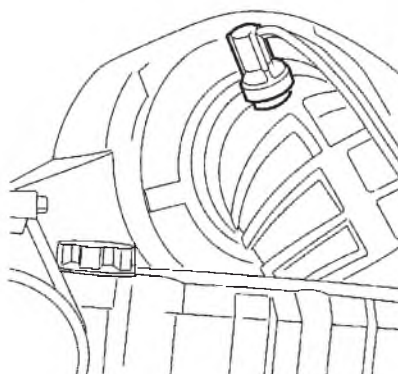
W2000740

Fig. 24: Air restriction indicator WX, WG , AC(dash mounted)



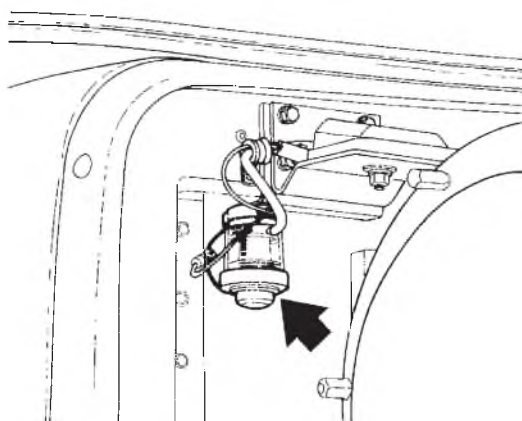
W2003505

Fig. 25: Air restriction indicator VN, VHD, VNM (located beneath the air box)



W2003506

Fig. 26: Air restriction indicator VN, VHD (located on the air pipe)



W2000741

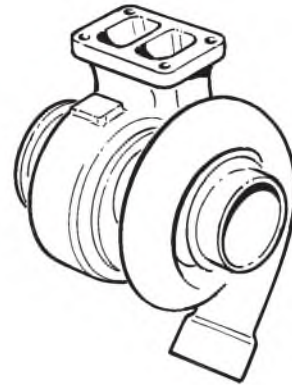
Fig. 27: Piston-type air restriction indicator-WG

## Turbocharger

The turbocharger is driven by the exhaust gases from the engine passing through the turbine housing on their way out into the exhaust system.

The flow of exhaust gases causes the turbine wheel inside the turbine housing to rotate. On the same shaft as the turbine wheel is a compressor wheel. The compressor wheel is mounted in a housing which is connected between the air cleaner and the intake manifold.

When the compressor wheel starts to rotate, air is drawn in from the air cleaner, compressed and forced into the cylinders of the engine — but not before it has been cooled down after passing through the charge air cooler.



T2006949

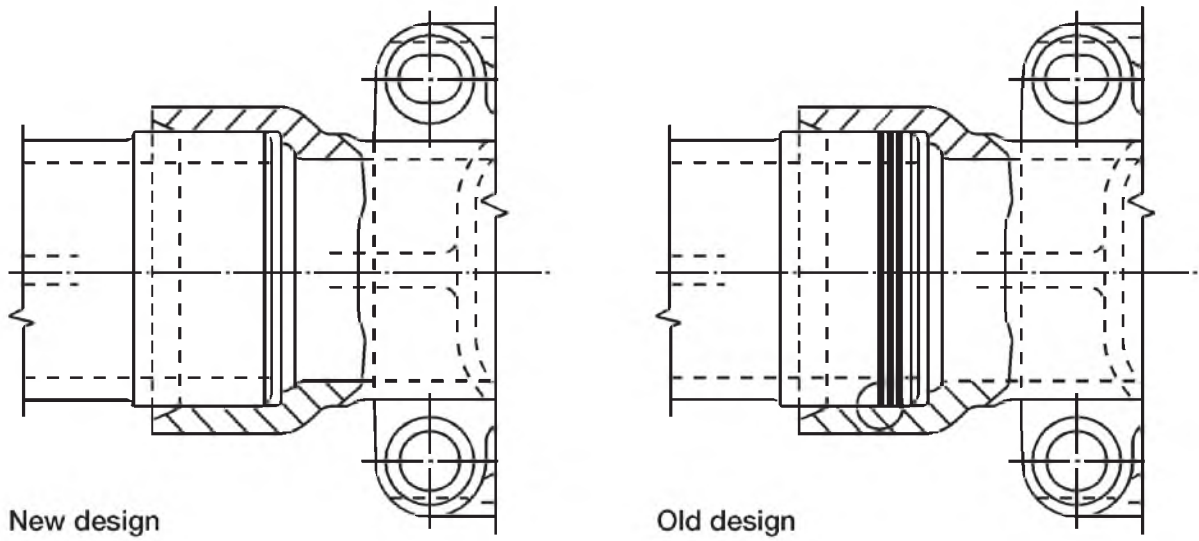
Fig. 28: Turbocharger

## D12A

The turbo used on the D12A engine is **NOT** interchangeable with turbos on other D12 engine versions.

# Exhaust Manifold

## New design of exhaust manifold sections

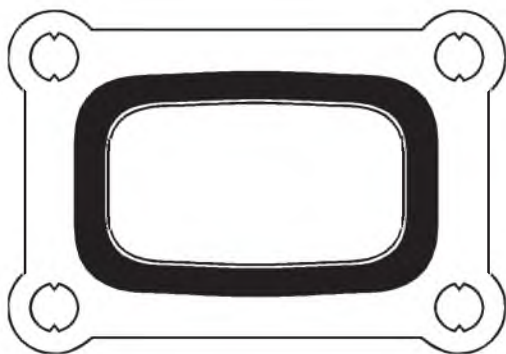


W2002222

Fig. 29: Manifold designs

Description	New design P/N	Qty	Old design P/N	Qty
Side section	3964707	2	1547521	2
Middle section	3964708	1	1547520	1
Complete	3964706	1	1677205	1

## Improved gasket



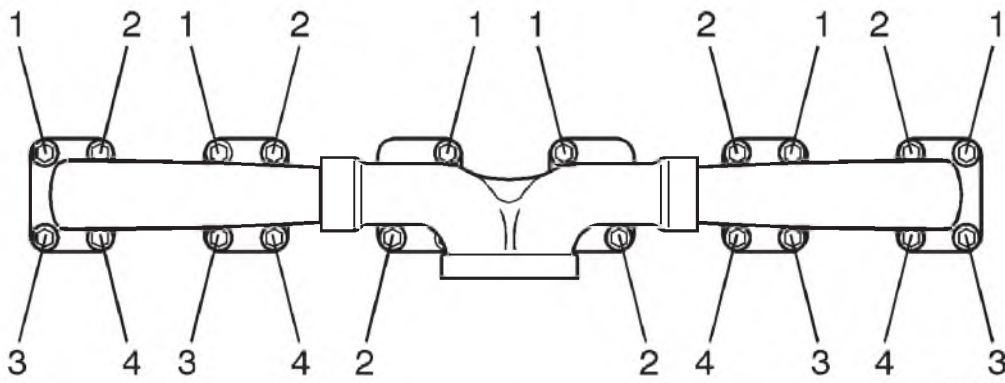
W2002223

Fig. 30: Gasket

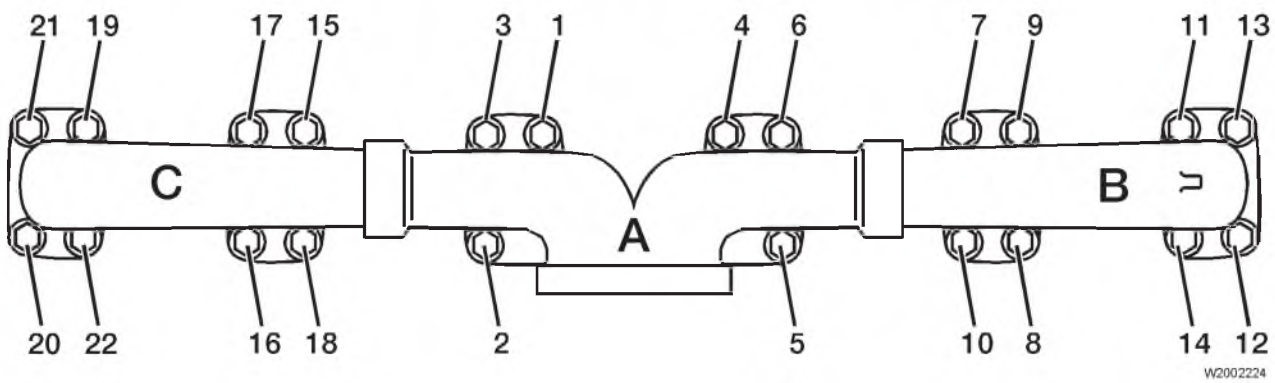
**Note:** The gaskets are marked "MANIFOLD SIDE" to aid in installation.

# Tightening Sequence

Old Style Manifold.



New Style Manifold



## Troubleshooting

### Air Restriction Indicator, Checking

Low restriction readings may be difficult to identify. They can result from a damaged element gasket, ruptured element, incorrectly installed element or a leak in the engine air intake ducts and piping. When servicing the air cleaner, make sure to check for these. A water manometer may also be used to check for service. A maximum of 25 in. of water (20 in. of water measured at air cleaner body outlet) is the limit of element service and indicates a need for replacement.

On turbocharged engines, connect the manometer to the air intake pipe, one to two pipe diameters upstream from the turbocharger inlet, in a straight section of pipe. Turbocharged engines should be under full load long enough to allow the turbocharger to reach maximum speed.

**Note:** Dust conditions and accumulated mileage determine the interval for replacing the air cleaner element. The air cleaner should be inspected every 24,000 km (15,000 miles) and replaced as necessary. The air cleaner element should be replaced at least once a year regardless of service or restriction indicator readings.





## Service Procedures

### 2562-03-02-01

### Air Filter Element, Replacement

#### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

#### WARNING

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

#### CAUTION

When removing and installing the intake manifold on engines equipped with VEB, keep the work area as clean as possible to prevent impurities from entering the oil system. This also applies to the compression brake oil delivery pipe between the cylinder block and intake manifold.

#### Removal

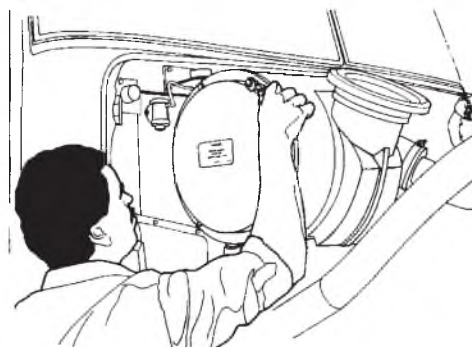
1

Apply parking brakes, make sure the shift lever is in neutral.

2

Tilt hood.

3



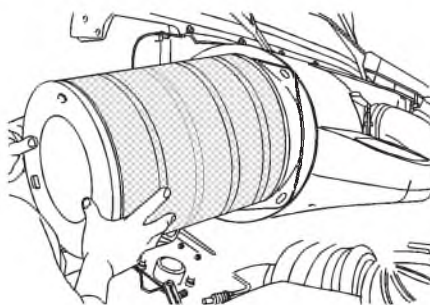
W2000940

Fig. 31: Removing the endcap,(WG, AC)

Remove the endcap by removing the hardware (depending on the type of endcap) that attaches the endcap to the air filter.

**Note:** The type of hardware used to hold the endcap varies, depending on the style of air cleaner and air cleaner assembly.

4

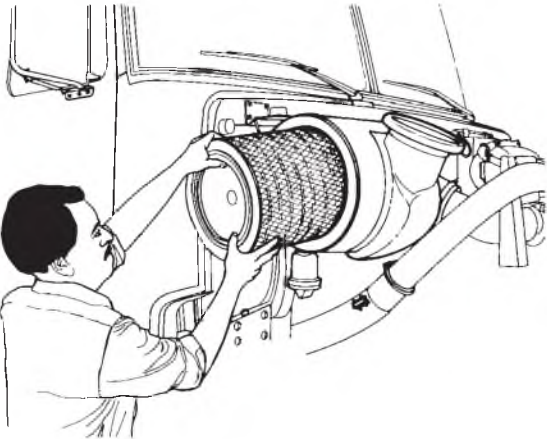


W2002051

Fig. 32: Removing the air filter (VN,VHD and VNM)

Remove the air filter.

5



W2000941

Fig. 33: Remove the air filter (WG, AC)

Remove the element from the canister. If the element is held by a wing nut, remove the wing nut before removing the element.

*Installation*

6

Clean and inspect the inside of the housing and endcap.

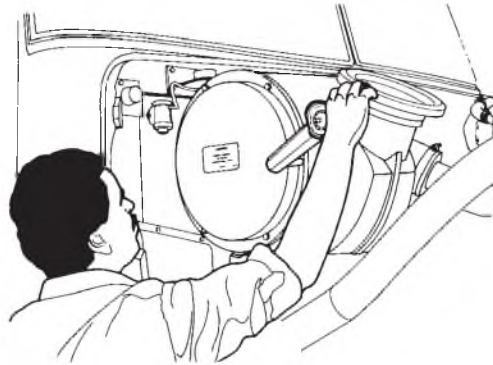
7

Lubricate the rear seal on the new filter with Vaseline or the like.

8

Install the new filter. Make sure that it is correctly positioned in the filter housing.

9



W2000746

Fig. 34: Endcap reinstall

Reinstall the endcap and attach, using the necessary hardware. Tighten to a torque of  $24 \pm 2$  Nm ( $18 \pm 2$  ft-lb).

**Note:** Refer to the label attached inside the endcap on some models.

## 2512-03-02-01 Intake Manifold Gasket(s), Replacement

**! DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**! WARNING**

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

**! CAUTION**

When removing and installing the intake manifold on engines equipped with VEB, keep the work area as clean as possible to prevent impurities from entering the oil system. This also applies to the compression brake oil delivery pipe between the cylinder block and intake manifold.

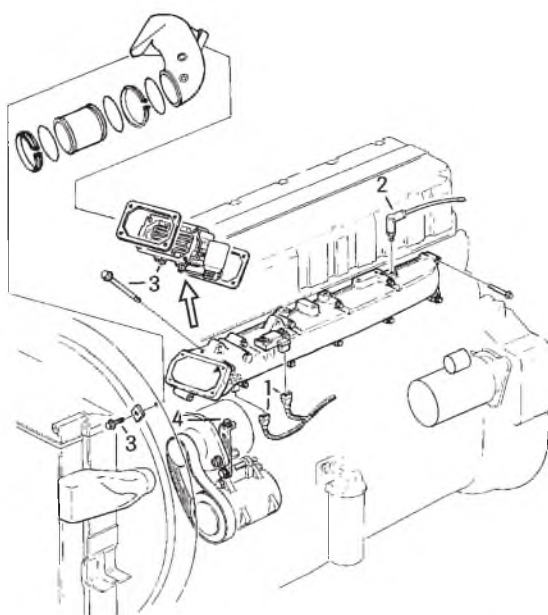


Fig. 35: Replacing intake manifold gasket

### Removal

- 1**  
Remove the plastic ties from the electric cables under the intake manifold. Disconnect the terminals from the sensors for the charge air pressure and the charge air temperature on the intake manifold.
- 2**  
Remove the boost pressure gauge connection from the intake manifold.
- 3**  
Remove the bolt for the pre-heater, or the spacer, from the fan shroud bracket.  
Remove the pre-heater, or the spacer, from the intake manifold and set aside.
- 4**  
Loosen the alternator drive belt and remove the nut for the gear lever bracket. Remove the alternator.

W2000732

5

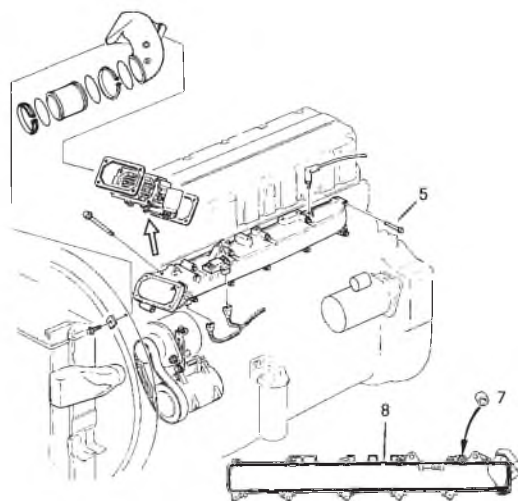


Fig. 36: Replacing intake manifold gasket

Remove the intake manifold bolts and carefully tap the manifold loose, using a plastic-headed mallet.

- 6**  
Clean the sealing surfaces of the intake manifold and the cylinder head. Install a new gasket.

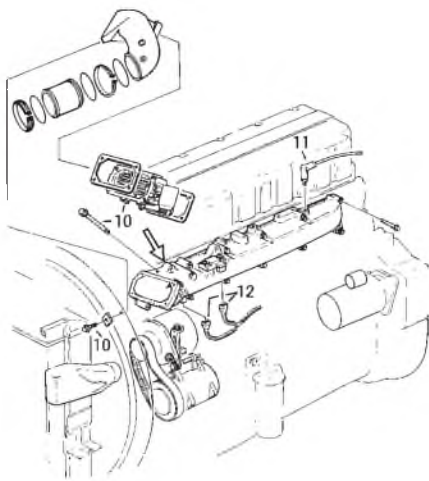
### Installation

- 1**  
Install a new seal on the compression brake oil duct.
- 2**  
Apply a 2 mm (1/16 in.) bead of sealant to the intake manifold. The manifold must be installed and tightened within 20 minutes after applying sealant.

2 mm  
(1/16 in.)

**Note:** Do not allow the sealant to enter the oil duct of the compression brake.

3



W2000734

Fig. 37: Replacing intake manifold gasket

Adjust the alternator, A/C refrigerant compressor, drive belt tension if so equipped.

4

Install the pre-heater (if equipped) or the spacer, using new gaskets, and bolt the mounting to the fan shroud.

5

Install the boost air gauge connections to the intake manifold.

6

Reconnect the terminals to the sensors for the boost air pressure and the boost air temperature on the intake manifold. Tie the electrical cables.

## 2551-03-02-02 Turbocharger, Replacement



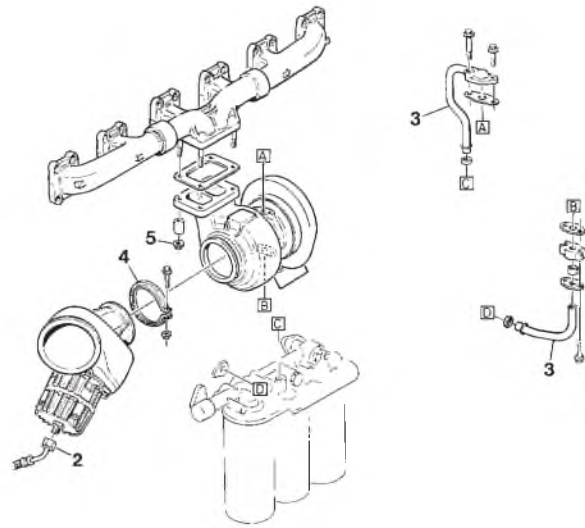
**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.



**WARNING**

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.



W2000943

Fig. 38: Turbocharger assembly

- 1 n/a
- 2 Exhaust pressure governor
- 3 Oil delivery and return pipes
- 4 Clamp
- 5 Nuts

### General Guidelines and Precautions

Always determine the reasons for replacing a turbocharger before making the repair. Correct any noted defects before replacing.

When replacing a turbocharger, always thoroughly read and carefully follow the procedures.

After degreasing, wipe the cooler clean and dry it with compressed air. Also check the air pipes and charge air hose. If contaminated with oil, replace the charge air hose to prevent damage to the rubber.

The engine oil system and intake system must be kept in good condition to ensure proper turbocharger operation. That is, change oil and filters at specified times, use the correct engine oil and properly care for the air cleaner.

When replacing a turbocharger, use compressed air to remove any rust or carbon flakes from the exhaust manifold. Carbon flakes can damage the turbine of the new unit. It is also important to clean the intake pipe from the air filter. Pieces of broken components can remain in the pipe and cause immediate turbocharger failure.

Also, always check to be sure that the injection equipment is in good condition.

**Note:** Once the turbocharger is installed put oil in oil supply port to ensure proper turbo lubrication. Once turbo is sufficiently lubricated you can crank the engine.

### Removal

- 1 Remove the air cleaner hose from the turbocharger.

**2**

Remove the bolts holding the charge air pipe to the mounting bracket. Pull the charge air pipe off the turbocharger.

**3**

Remove the air line from the exhaust pressure governor.

**4**

Remove the turbocharger oil delivery and return pipes. Install a protective plug into the connection for the oil delivery pipe on the oil filter bracket.

**5**

Loosen the clamp between the turbocharger and the shutter housing. Remove the shutter housing from the turbocharger.

**6**

Remove the nuts and lift the turbocharger off.

**7**

Clean the sealing surfaces of the exhaust manifold, shutter housing and oil-pipe connections.

## Installation

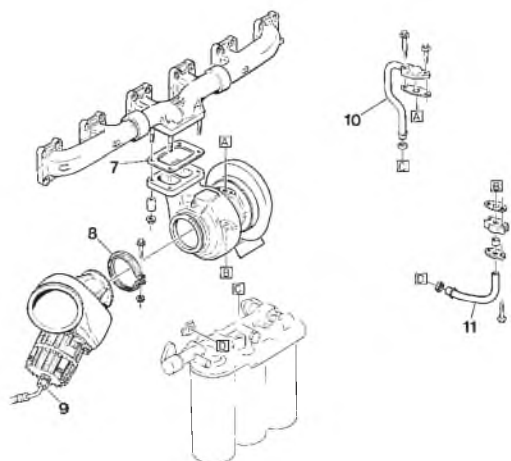


Fig. 39: Turbocharger assembly

- 7 Gasket
- 8 Clamp
- 9 Air line
- 10 Oil delivery pipe
- 11 Oil return pipe

**1**

Before installing the new turbocharger, check the engine oil and change the oil filters, if required. Then, run the engine a few minutes before installing the new turbocharger. When running the engine without a turbocharger, be sure to plug the oil delivery line. As a precaution to prevent the oil from entering the new turbocharger, a strainer can be temporarily installed into the oil entry point. Then run the engine for at least a half hour.

**Note:** After this test, remove the strainer to prevent strainer blockage that may occur if the oil system is not properly maintained.

**2**

Before installing a new turbocharger, pre-lubricate the bearing system. This will ensure adequate lubrication of the turbocharger at start-up. Install a new gasket and install the new turbocharger.

**3**

Apply sealant to the shutter housing sealing surface and install the housing to the turbocharger. Mate the shutter housing flange with the heel of the turbocharger. Retighten the clamp.

**4**

Connect the air line to the exhaust pressure governor.

**5**

Install the turbocharger oil delivery pipe using new seals.

**Note:** Be sure to remove the delivery oil plug if used to run the engine without the turbocharger.

**6**

Install the turbocharger oil return pipe to the cylinder block using a new seal. Do not attach the oil return pipe to the turbocharger at this time.

**7**

Install the charge air pipe into the turbocharger using new sealing rings. Attach the charge air pipe.



**8**  
Reconnect the air cleaner hose to the turbocharger.

**9**  
Attach the turbocharger oil return pipe, using new seals.

**10**  
Apply parking brake and place shift lever in neutral. Start the engine and check for proper operation and leaks.

## 2516-03-04-01 Exhaust Manifold Gasket(s), Replacement

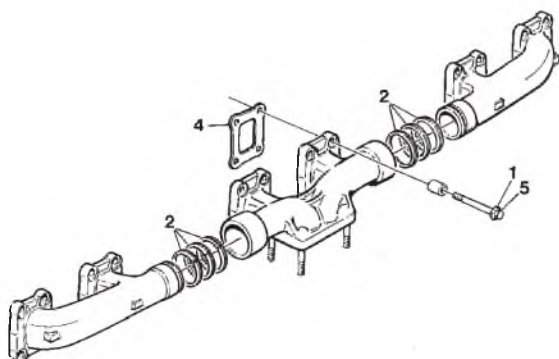
(Turbocharger Removed)

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### WARNING

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.



T2008979

Fig. 40: Exhaust manifold

**Note:** It is easy to get the wrong impression from exhaust manifold leakage (mixture of moisture and soot). This mixture may drip down on the turbo and could easily be mistaken for an oil leak from the turbo.

## Removal

**1**  
Remove the bolts holding the exhaust manifold and lift off the manifold.

**2**  
Disassemble the exhaust manifold and remove all sealing rings. Clean the exhaust manifold and the cylinder head.

## Installation

**3**  
Use compressed air to blow any carbon out of the manifold. Then assemble the manifolds.

### CAUTION

Wear appropriate eye protection.

**Note:** Three sealing rings must be installed at each side. Install the sealing ring with the smallest diameter in the middle.

**4**  
Install the exhaust manifold using new gaskets. Begin by lining up all three manifold sections onto the cylinder head, starting with section A.

**Note:** Make sure that the sleeves fit correctly into the milling of the exhaust manifold and install the gaskets with the graphite surface facing the cylinder head.

**5**  
After applying anti-sieze to the manifold bolts and turbo studs, screw the bolts in by hand, starting with section A and then sections B and C.

**6**  
Tighten the bolts cross-wise starting with section A, and then sections B and C. Torque to 25 Nm (18 ft-lb). See illustration, page 26

25 Nm  
(18 ft-lb)

**7**  
Begin the tightening sequence again; however, raise the torque to 48 ± 8 Nm (35 ± 6 ft-lb).

48 ± 8 Nm  
(35 ± 6 ft-lb)



**8**  
Start the engine and run until it reaches operating temperature.

**9**  
Verify the torque at  $48 \pm 8$  Nm ( $35 \pm 6$  ft-lb).

## 2538-03-02-01 Exhaust Pressure Governor, Replacement

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### WARNING

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

### Removal

**1**

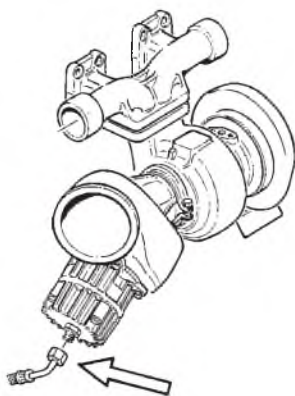
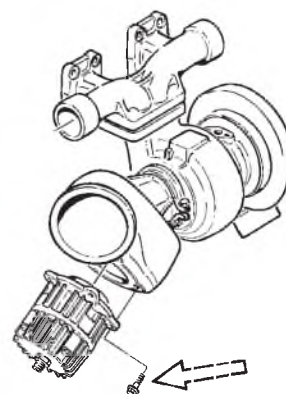


Fig. 41: Removing air line

Remove the air line from the exhaust pressure governor.

**2**



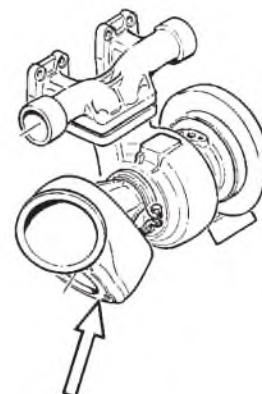
T2006940

Fig. 42: Removing air pressure governor

Remove the bolts and lift off the exhaust pressure governor.

### Installation

**3**



T2006941

Fig. 43: Cleaning shutter housing

Clean the sealing surface of the shutter housing.

**4**

Install the new exhaust pressure governor. Install the air line.

**5**

Apply parking brake and place shift lever in neutral. Start the engine and check for proper operation and leaks.

# 2538-04-04-01 Exhaust Pressure Governor, Overhaul

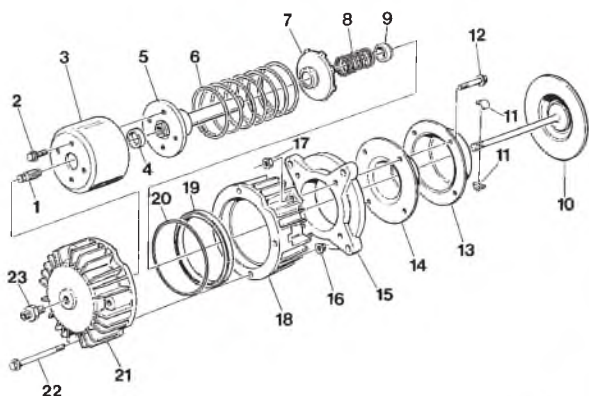
## (Unit Removed)



Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.



**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.



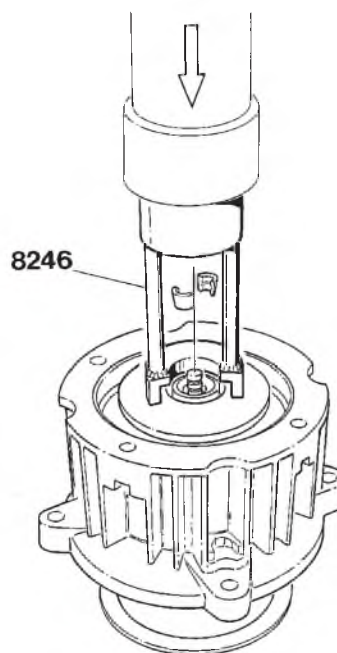
T2006749

Fig. 44: Exhaust pressure governor

- |                 |                    |
|-----------------|--------------------|
| 1-Setscrew      | 11-Valve Collets   |
| 2-Bolts         | 12-Bolts           |
| 3-Plunger       | 13-Cover           |
| 4-Seazls        | 14-Heat shield     |
| 5-Plunger Rod   | 15-Securing flange |
| 6-Spring        | 16-Nut             |
| 7-Spring holder | 17-Nut             |
| 8-Spring        | 18-Housing         |
| 9-Seal          | 19-Seals           |
| 10-Shutter      | 20-Seals           |
|                 | 21-End cover       |

## Disassembly

- 1 Remove the end cover from above the plunger.
- 2 Remove the bolts and take out the plunger.
- 3 Remove the seals (4, 20 and 19, Fig. 44: Exhaust pressure governor, page 36).
- 4 Remove the set screw on the plunger rod.
- 5



T2006747

Fig. 45: Removing collets

Place the exhaust pressure governor into a press. Compress the spring enough to remove the valve collets

**Note:** Do not press more than necessary to remove the collets. Compressing the spring fully can damage the cover.

- 6 Remove the plunger rod, spring and shutter.

*Special tools: 999 2610, 999 8225, 999 8246*

**7**  
Remove the bolts holding the cover, the heat shield and the securing flange.



Fig. 46: Removing spring holder

Carefully tap out the spring holder that secures the spring and the seal (9, Fig. 44: Exhaust pressure governor, page 36).

**9**  
Clean all parts and replace any that are damaged or worn.

### Assembly

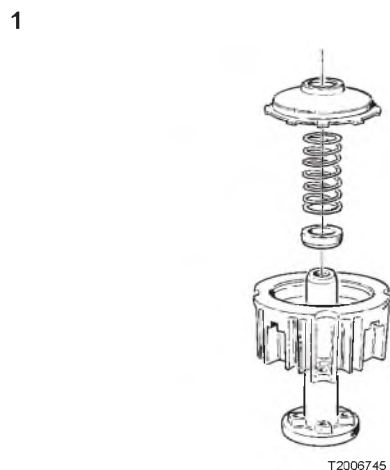


Fig. 47: Assembly

Install the plunger rod into the housing from behind so as to center the spring holder. Install a new seal with the beveled edge facing inside the housing. Install the spring and a new spring holder.

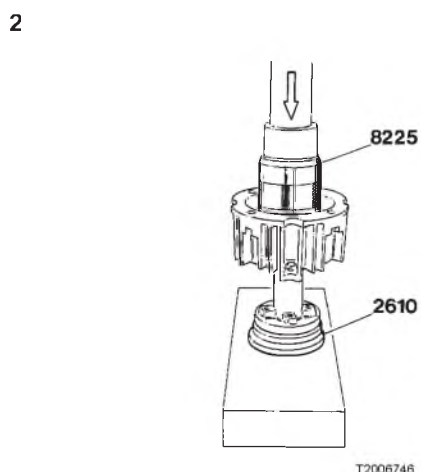


Fig. 48: Plunger rod installation

Put the plunger rod onto drift 9992610 in a press. Using drift 9998225, press on the spring holder until it bottoms in the housing. Remove the plunger rod. Check to make sure that the spring holder is correctly centered.

**3**  
Install the securing flange, the heat shield and the cover. Tighten the bolts to 13 ± 2 Nm (10 ± 2 ft-lb).

**4**  
Install the shutter, spring and plunger rod into the housing.

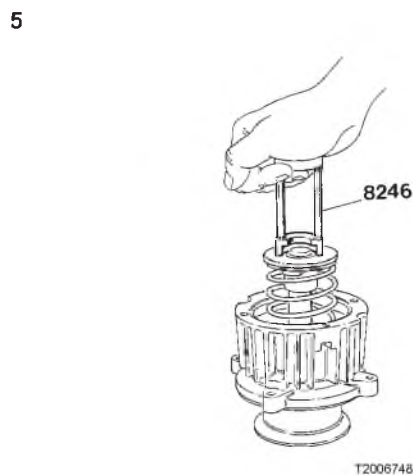


Fig. 49: Depressing spring

Compress the spring by hand, making sure that the shutter shaft and plunger rod fit together and that the plunger rod fits correctly into the seal. Stop applying pressure if undue resistance is felt. Install the valve collets.

**6**  
Install the set screw into the plunger rod. Apply sealant to the set screw before installing. Tighten the set screw to  $40 \pm 5$  Nm ( $30 \pm 4$  ft-lb).  
 $40 \pm 5$  Nm ( $30 \pm 4$  ft-lb).

**7**  
Install a new seal into the plunger rod and install the plunger. Apply sealant to the bolts and tighten them to  $13 \pm 2$  Nm ( $10 \pm 2$  ft-lb).  
 $13 \pm 2$  Nm ( $10 \pm 2$  ft-lb).

**8**  
Install the end cover using new seals. Make sure that the seal bottoms in the housing. Install the seal with the flat side facing the housing. Tighten the bolts (22) to  $24 \pm 2$  Nm ( $18 \pm 2$  ft-lb).  
 $24 \pm 2$  Nm ( $18 \pm 2$  ft-lb).

## 2651-06-04-01 Charge Air Cooler Leak Test, Checking

If the turbocharger fails on an intercooled engine, it is essential to check the charge air cooler. When considerable oil loss or the presence of foreign material (for example, broken compressor wheel parts forced into the charge air cooler) is suspected, take the following measures:

Check the charge air cooler hoses up to the cooler. If there are traces of oil at the charge air cooler, remove the cooler and clean it internally, using a low-aroma, white-spirit type degreasing agent.

If turbocharger failure results in a broken compressor wheel, pressure-test the charge air cooler to see if it has been damaged by broken compressor wheel pieces.

*Special tools: 9996662, 9998288, 9998289*

**Note:** Check the function of pressure gauge 9996662 before using it. Attach it to an air supply and set the pressure to 100 kPa (14.5 psi) with the regulator valve.

**! DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**! WARNING**

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

**! WARNING**

Never disconnect an air system component unless all system pressure has been depleted. Failure to deplete system pressure before disconnecting hoses or components may result in their violent separation and can cause serious bodily injury.

**! WARNING**

Make sure that the gauge pressure never exceeds 100 kPa (14.5 psi). Failure to do so can result in personal injury.

**! WARNING**

—Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

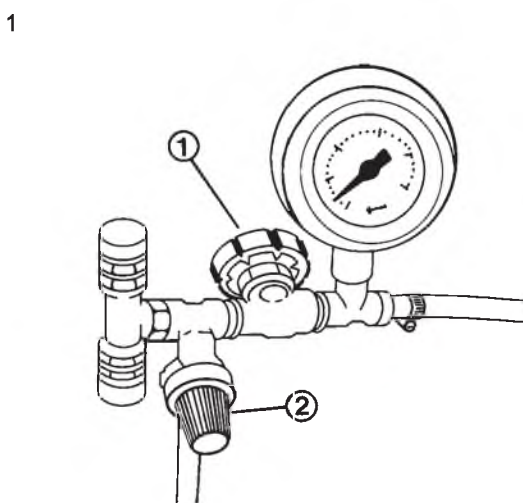


Fig. 50: Pressure gauge W2000715

- 1 Shut-Off Valve
- 2 Reduction Valve

Connect the pressure gauge to outside air source and set the gauge reading to 100 kPa (14.5 psi) using the reduction valve. The knob of the reduction valve is locked by a ring which is engaged by pulling up on the ring, and pushing down to release.

**2**  
Close the shut-off valve. For the pressure gauge to be considered reliable, the pressure reading must not drop during a period of two minutes.

3

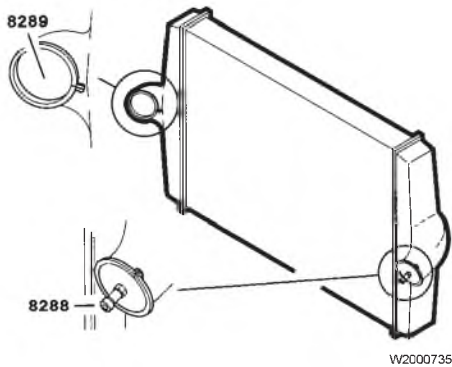


Fig. 51: Removing charge air hoses

Remove the air hoses from the charge air cooler. Install connecting washer 9998288, sealing washer 9998289 and new O-rings.

4

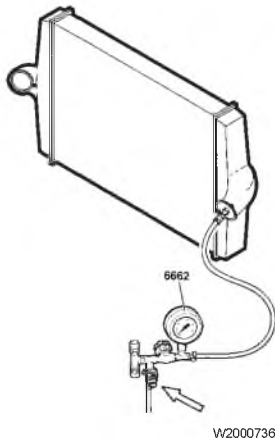


Fig. 52: Connecting pressure gauge

Remove the pressure gauge reduction valve and check that the gauge reading is "0." Connect the pressure gauge to the charge air cooler.

5

Open the shut-off valve and set the pressure gauge to 100 kPa (14.5 psi), using the reduction valve.

6

Close the shut-off valve. For the charge air cooler to be serviceable, the pressure reading must not drop more than 50 kPa (7 psi) during 30 seconds.

7

If a leak is found, repeat the test a few times. Also check pressure gauge hoses and connections.

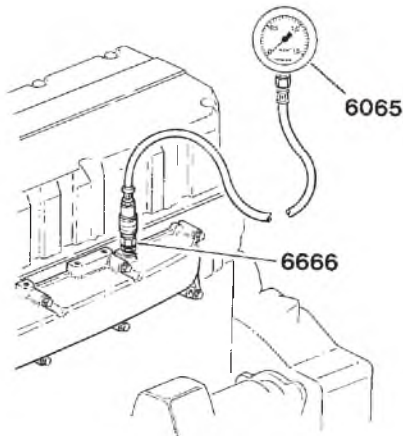
# System Check

## 2559-06-02-02 Boost Pressure, Checking

**Note:** This operation number covers only the installation and removal of test equipment.

**Special tools:** 9996065, 9996666

1



T2006943

Boost pressure gauge installation

Clean around the plug for the boost pressure gauge on the intake manifold. Remove the plug and install union 9996666. Connect pressure gauge 9996065 to the 9996666 union. Make sure the pressure gauge hose is long enough to reach the driver's seat in the cab.

**Note:** Secure the hose so that it does not contact any moving parts.

2

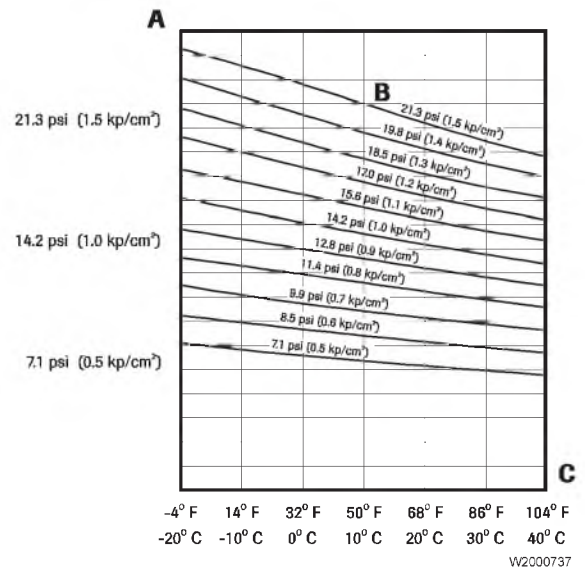
The measurement should be carried out:

- with a fully loaded vehicle
- driving up an incline at full acceleration (full load)
- while engine revs (rpm), slowly pass the speed specified for boost pressure.

**Note:** For a reliable result, engine load must be maintained long enough for the pressure to stabilize. Boost pressure specifications at 28.3 r/s (1700 rpm):

- VE D12-370 125–170 kPa (18–24.7 psi)
- VE D12-415 145–175 kPa ( 21–25.4 psi)

3



W2000737

Boost pressure at various temperatures

A measured boost pressure

B correction curves

C intake air temperature

The specifications state engine speed and boost pressure at +20°C (68°F). If reading at any other temperature, use the chart above to correct the resulting boost pressure.

Example:

A pressure of 80 kPa (12 psi) measured at -10°C (14°F) is equivalent to about 70 kPa (10 psi) +20°C (68°F). That is, pressure drops as temperature rises.

If boost pressure does not reach specified levels, check the following:

- properly tightened bolts on intake and exhaust manifolds
- exhaust brake
- backpressure in exhaust system
- air cleaner element
- fuel pressure



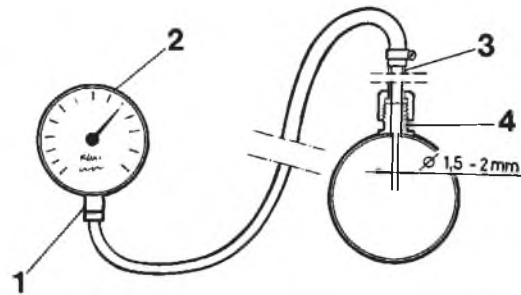
## Exhaust Backpressure, Checking

**Pressure gauge:** Of indicating or U-tube type, graded to 24 kPa or 2,440 mm water column (3.5 psi) and equipped with damper.

**Steel pipe:** About 200 mm (8 in.) long and able to connect to a union.

**Union:** The union must be brazed onto the exhaust pipe as shown. Then drill a 1.5 – 2.0 mm (0.06 – 0.08 in) hole through the center of the union and the side of the exhaust pipe.

**Hose:** The hose is installed between the pressure gauge and steel pipe and must be long enough for the gauge to be read inside the cab.



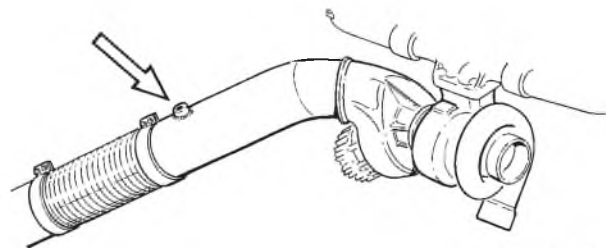
Measuring equipment

- 1 Damper
- 2 Pressure gauge
- 3 Steel pipe
- 4 Union

## Pressure Testing Outlet Location

The pressure-testing fitting should be located on as straight a section of the pipe as possible, two-thirds after and one-third before a bend in the pipe.

The test fitting must not be located on an outer or inner bend of the exhaust pipe.



Outlet location

## Backpressure Measuring Techniques

Using a chassis dynamometer is the best way to measure backpressure. If such equipment is not available, the vehicle can be driven up a long hill. The accelerator pedal must be kept fully floored with the vehicle accelerating up the hill until the engine reaches specified rpm.

Note the highest backpressure reading and compare it with specifications.

After the test, make sure to block off the union in the exhaust pipe with a plug, or in some other suitable manner.

# Feedback

One of our objectives is that workshop personnel should have access to correct and appropriate service manuals where it concerns fault tracing, repairs and maintenance of Volvo trucks.

In order to maintain the high standards of our literature, your opinions and experience when using this manual would be greatly appreciated.

If you have any comments or suggestions, make a copy of this page, write down your comments and send them to us, either via telefax or mailing directly to the address listed below.

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7825 National Service Road

P.O. Box 26115

Greensboro, NC 27402-6115

USA

Fax (336) 393-3170

From

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Comments/proposals

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Concerns Service Manual: .....



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2562-03-02-01 Air Filter Element, Replacement . . . . . 29  
2651-06-04-01 Charge Air Cooler Leak Test, Checking . . . . . 39

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# Service Manual Trucks

Group **220–600**

Lubricating and Oil System

D12, D12A, D12B, D12C



# Foreword

The descriptions and service procedures contained in this manual are based on designs and methods studies carried out up to August 2000.

The products are under continuous development. Vehicles and components produced after the above date may therefore have different specifications and repair methods. When this is believed to have a significant bearing on this manual, supplementary service bulletins will be issued to cover the changes.

The new edition of this manual will update the changes.

In service procedures where the title incorporates an operation number, this is a reference to an S.R.T. (Standard Repair Time).

Service procedures which do not include an operation number in the title are for general information and no reference is made to an S.R.T.

The following levels of observations, cautions and warnings are used in this Service Documentation:

**Note:** Indicates a procedure, practice, or condition that must be followed in order to have the vehicle or component function in the manner intended.

**Caution:** Indicates an unsafe practice where damage to the product could occur.

**Warning:** Indicates an unsafe practice where personal injury or severe damage to the product could occur.

**Danger:** Indicates an unsafe practice where serious personal injury or death could occur.

**Volvo Trucks North America, Inc.**  
Greensboro, NC USA

**Order number: PV776-TSP144525**

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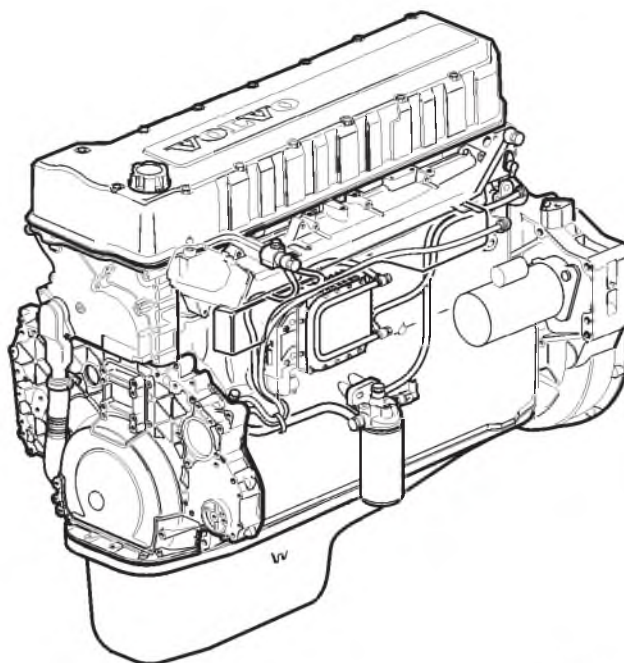


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# General



W2003244

This information covers the Lubricating and Oil System for the D12, D12A, D12B, and D12C engines.



## Specifications

### Torque Chart

Part	Torque
Oil cooler element bolts	27 ± 4 Nm (20 ± 3 ft-lb)
Oil cooler element cover bolts	33 ± 4 Nm (24 ± 3 ft-lb)
Oil pump intermediate gear bolts	24 ± 4 Nm (18 ± 3 ft-lb)
Oil pump main bearing bolts	150 ± 20 Nm (111 ± 14 ft-lb)
Oil pump main bearing cap bolts	24 ± 4 Nm (18 ± 3 ft-lb)
Oil strainer bolts	27 ± 4 Nm (20 ± 3 ft-lb)
Delivery pipe union	10 Nm (7.4 ft-lb)
Oil pan bolts	24 ± 4 Nm (18 ± 3 ft-lb)
Piston cooling nozzle bolts	24 ± 4 Nm (18 ± 3 ft-lb)
Oil filter base	40 ± 5 Nm (30 ± 4 ft-lb)

### Tightening Specifications

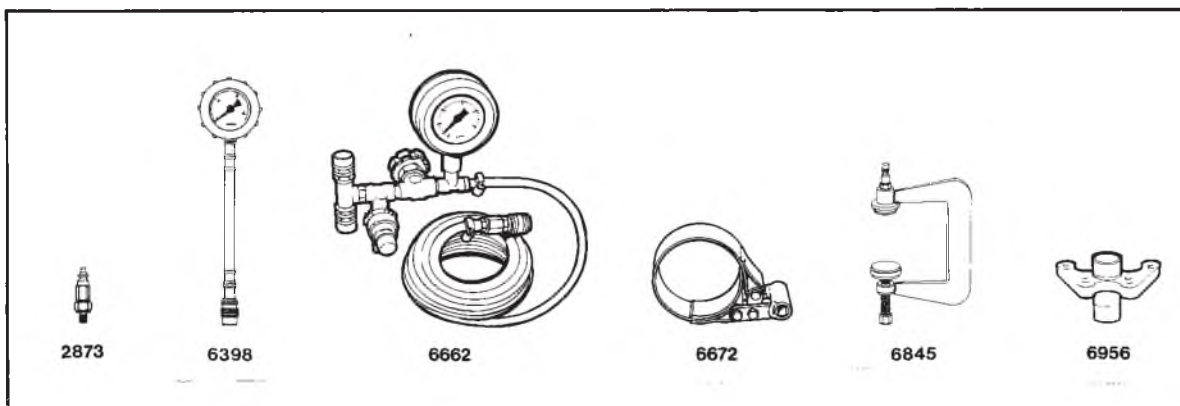
Part	Tighten Until:
Oil filter (full flow)	Seal contacts housing then additional 1/2 - 3/4 turn
Oil filter (bypass)	Seal contacts housing then additional 3/4 -1 turn



# Tools

## Special Tools

The following special tools are required for work on the VE D12 oil system. Tools are available from Volvo Trucks North America, Inc. parts department. Unless otherwise noted, all tool numbers are preceded by "999". When requesting tools, provide the appropriate part number, for example, 9992873.

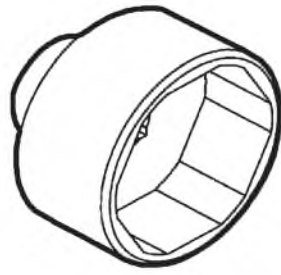


- 9992873** Connection union for checking lube oil pressure
- 9996398** Pressure gauge for checking lube oil pressure
- 9996662** Pressure gauge for leak test, oil cooler element

- 9996672** Removal tool for oil filter
- 9996845** C-clamp for leak test, oil cooler element
- 9996956** Cranking tool for flywheel

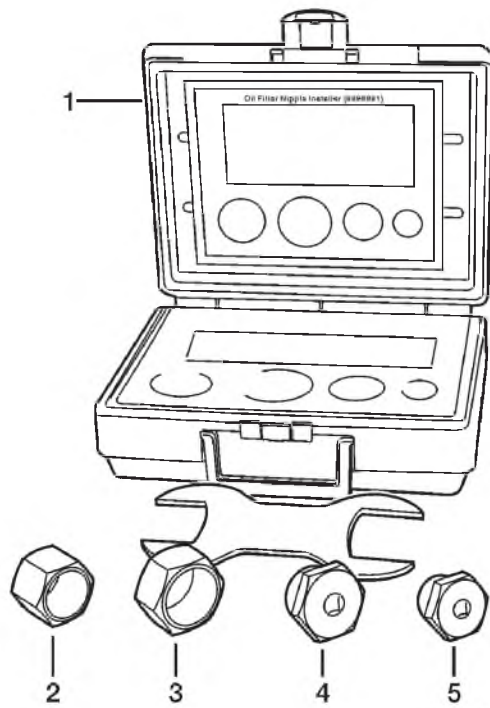
T2006803





W0001809

**J-43051**      Reduction valve cap socket



W2003485

**9998691**      Oil Filter Nipple installation Kit

- 1    9809706
- 2    9809702
- 3    9809703
- 4    9809705
- 5    9809704

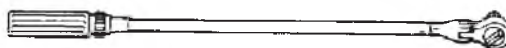
## Special Equipment

Like the special tools, the following are available from the parts department of Volvo Trucks North America, Inc.. When requesting tools, provide the appropriate part number.



W0001840

**1159794** Torque wrench 10–100 Nm (7 – 73 ft-lb)



W0001841

**1159795** Torque wrench 40 – 340 Nm (30 – 250 ft-lb)



W0001842

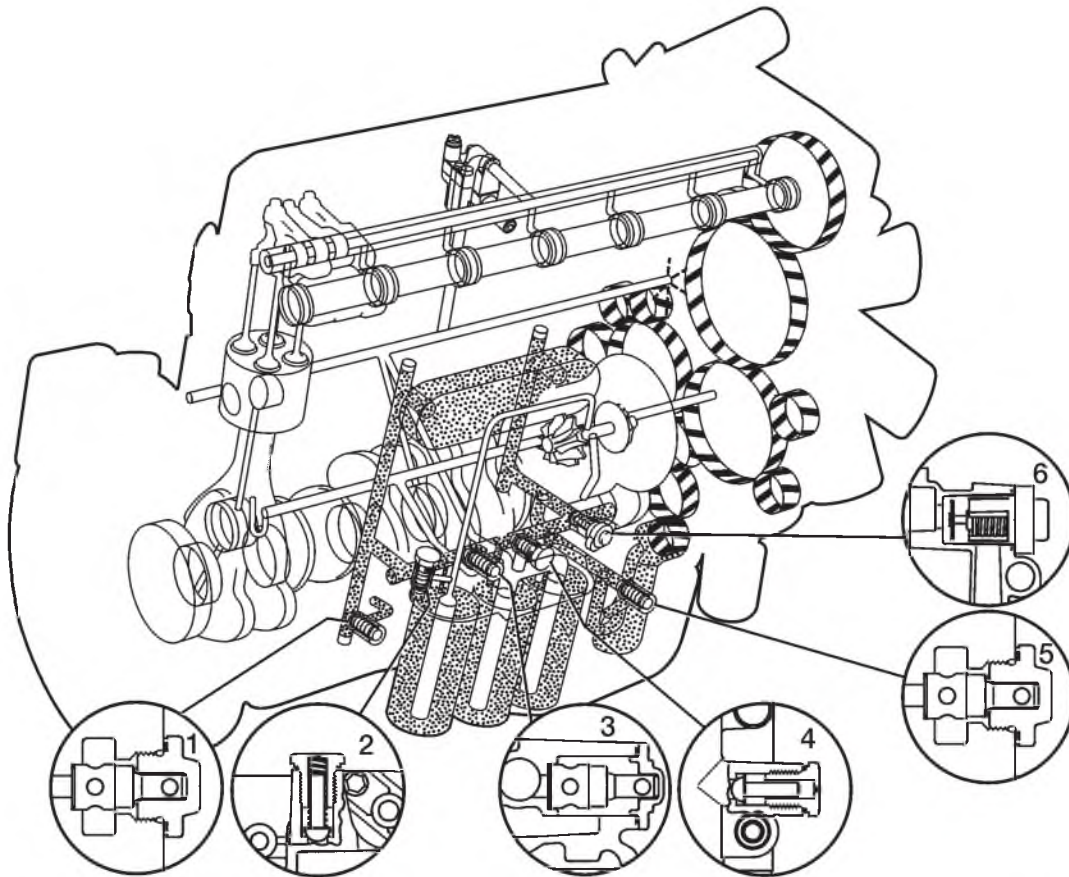
**1159796** Torque wrench 150 – 800 Nm(110 – 590 ft-lb.)



## Design and Function

### Lubricating and Oil System

#### General



W2003516

- 1 Reducing valve
- 2 Overflow valve
- 3 Cooling valve
- 4 Overflow valve
- 5 Safety valve
- 6 Thermostatic valve

The engine has a forced lubrication provided by a gear pump driven by the crankshaft through an intermediate gear. The lubrication system contains two full flow filters and a by-pass filter. The oil flow is adjusted by six valves. Three of these are individual valves and they are identified with color codes to avoid an incorrect installation. This color code may be replaced by a number that represents the valve opening pressure.

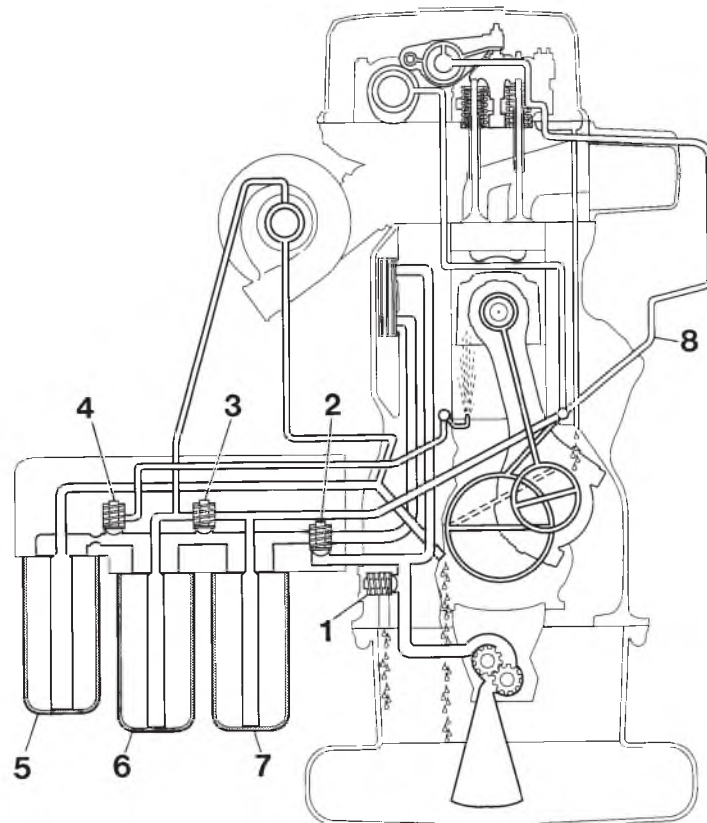
A flat oil cooler is assembled under a cast aluminum cover in the engine block right side.

The lubrication oil pump impels the oil towards the two full flow filters and the by-pass filter. The by-pass filter contains a low oil passageway and a high degree of filtering.

After passing through the full flow filters, the oil moves to the cylinder block, where it is distributed through galleries to engine points in need of lubrication.

The purpose of the lubrication system is to lubricate the engines movable parts in order to keep friction and wearing to a minimum. The oil transports coal and other residues stuck on the cylinder walls after combustion. The oil also functions as a sealer, for the cylinder liners have been projected in such a way that a thin layer of oil is always kept in its walls. This make it easier for the piston rings to seal the combustion chamber. The oil also cool the engine inner and, at the same time, reduces the sounds produced by the engine.

## D12, D12A, D12B



T2006823

- 1 Oil pressure regulator valve
- 2 Oil cooler by-pass valve
- 3 Oil filter by-pass valve
- 4 Piston cooling valve
- 5 By-pass filter
- 6 Full-flow filter
- 7 Full-flow filter
- 8 Oil pipe for engine brake (VEB)

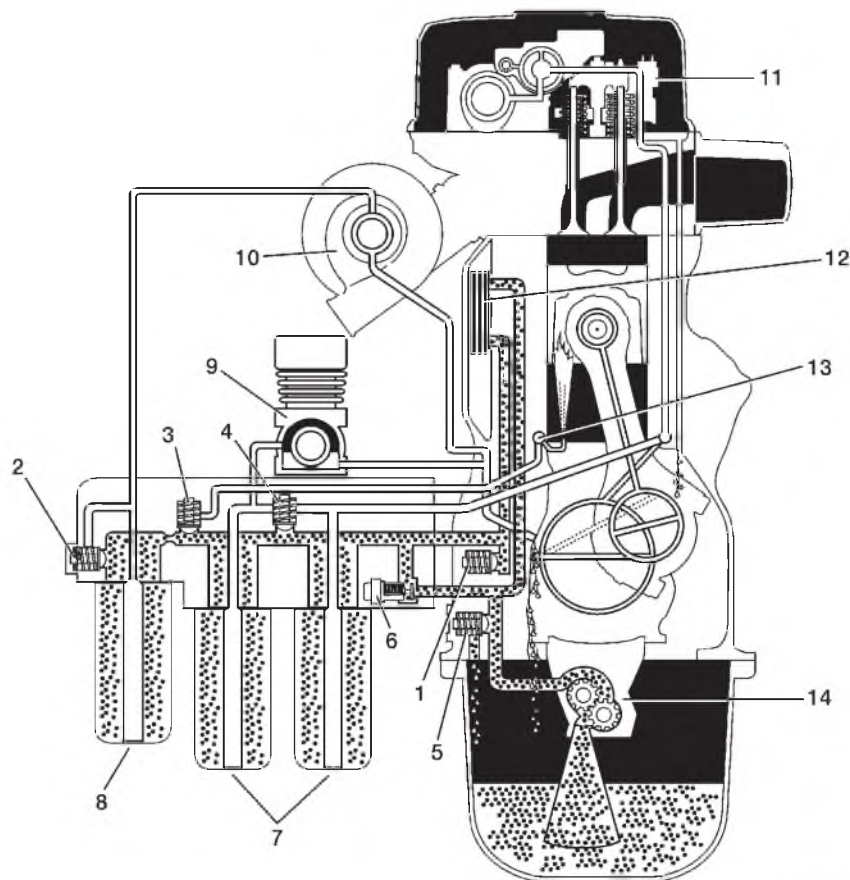
The engine is pressure-lubricated by a gear pump driven by the engine timing gears. The lube oil is cleaned by two full-flow filters and one bypass filter. The flat-type oil cooler is mounted under a cast aluminum cover on the right-hand side of the cylinder block.

The lube oil pump forces the oil to the full-flow filters and the bypass filter. The bypass filter has a low through flow and provides a high degree of filtration. The oil is led from the full-flow filters to the cylinder block where it is distributed by passages to the lubricating points of the engine.

The lubricating system incorporates four valves:

- Oil pressure regulator valve
- Oil cooler bypass valve
- Oil filter bypass valve
- Piston cooling valve

## D12C



W2003517

- 1 Reducing valve
- 2 Overflow valve
- 3 Cooling valve
- 4 Overflow valve
- 5 Safety valve
- 6 Thermostatic valve
- 7 Filter

- 8 Filter
- 9 Compressor
- 10 Turbocompressor
- 11 Regulator valve
- 12 Oil cooler
- 13 Pulverizer nozzle
- 14 Oil pump

The oil pump (14) forces the oil through the coolant element in the oil cooler (12) to the filter casing that contains both the full flow filter (7) and the by-pass filter (8). The oil goes then to the gallery in the engine block where it is distributed through the galleries and all the engine lubrication points. A gallery that passes through the engine block and the cylinder head lubricates the

camshaft and the rocker arm mechanisms. In the VEB engines, the oil passes through the regulator valve (11). The compressor (9) is lubricated through an external pipe that comes from the filter casing. The turbocompressor (10) is lubricated through a pipe that comes from the bypass filter.

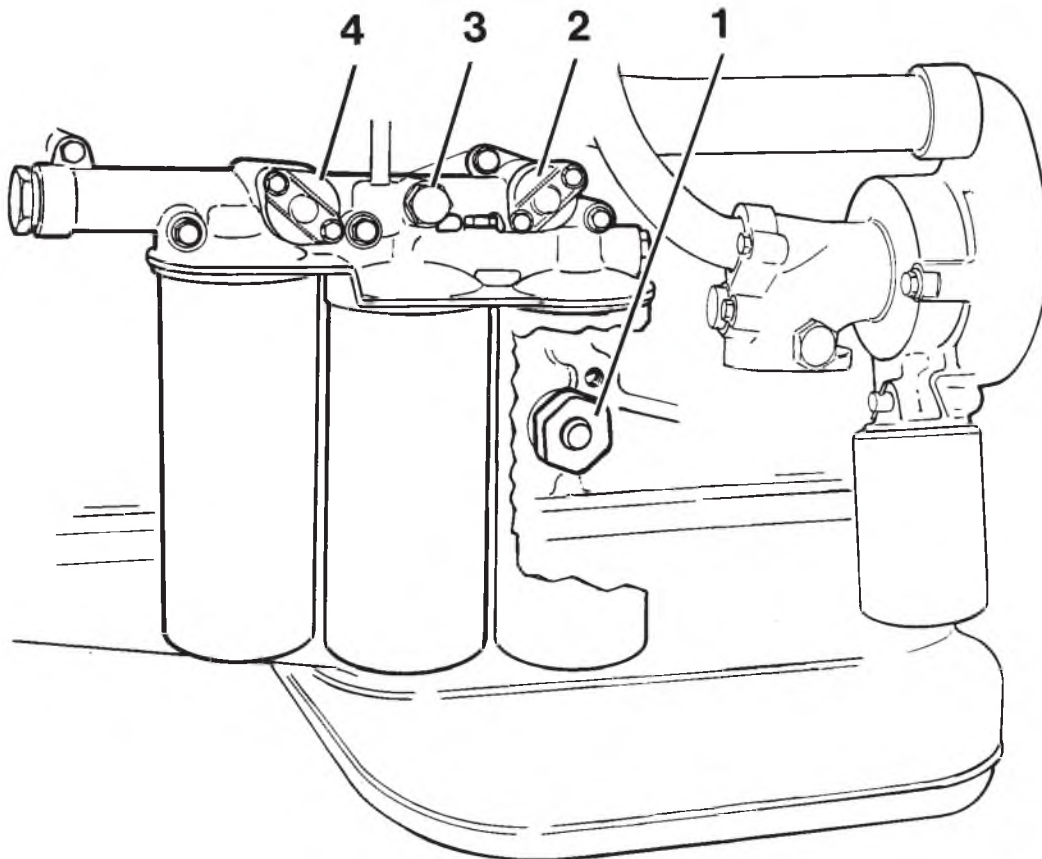
### Valve Functions

- 1 The reducing valve regulates engine oil pressure letting go the oil excess to the oil sump.
- 2 The filter overflow valve (8) opens up if the filters become clogged, assuring the continuity of the turbocompressor lubrication.
- 3 The piston cooling valve is pressure sensible and opens up as soon as the rotates exceeds idling speed pressure.  
The oil is conducted to the longitudinal gallery on the block and pulverized by the pulverizer nozzle (13), one for each piston, on the piston flange bottom side.
- 4 The filter overflow valve (7) opens up if the filters become clogged, assuring the continuity of the engine lubrication.
- 5 The safety valve opens up if the pressure in the lubrication system gets too high.
- 6 The oil cooling thermostatic valve is used to conduct the oil through the outside of the cooler during the engine heating, so that the engine gets a faster lubrication during a cold start and heats faster. This valve is thermostatically controlled and it acts as an oil temperature sensor.



## Oil Valves

### D12, D12A, D12B



T2008673

- 1 Regulator Valve
- 2 Bypass valve for oil cooler

- 3 Overflow valve for oil filters (bypass)
- 4 Reducing valve

**1 Regulator valve** — The regulator valve regulates the oil pressure. It does this by opening when the lube oil pressure becomes too high and letting any surplus oil back to the oil pan.

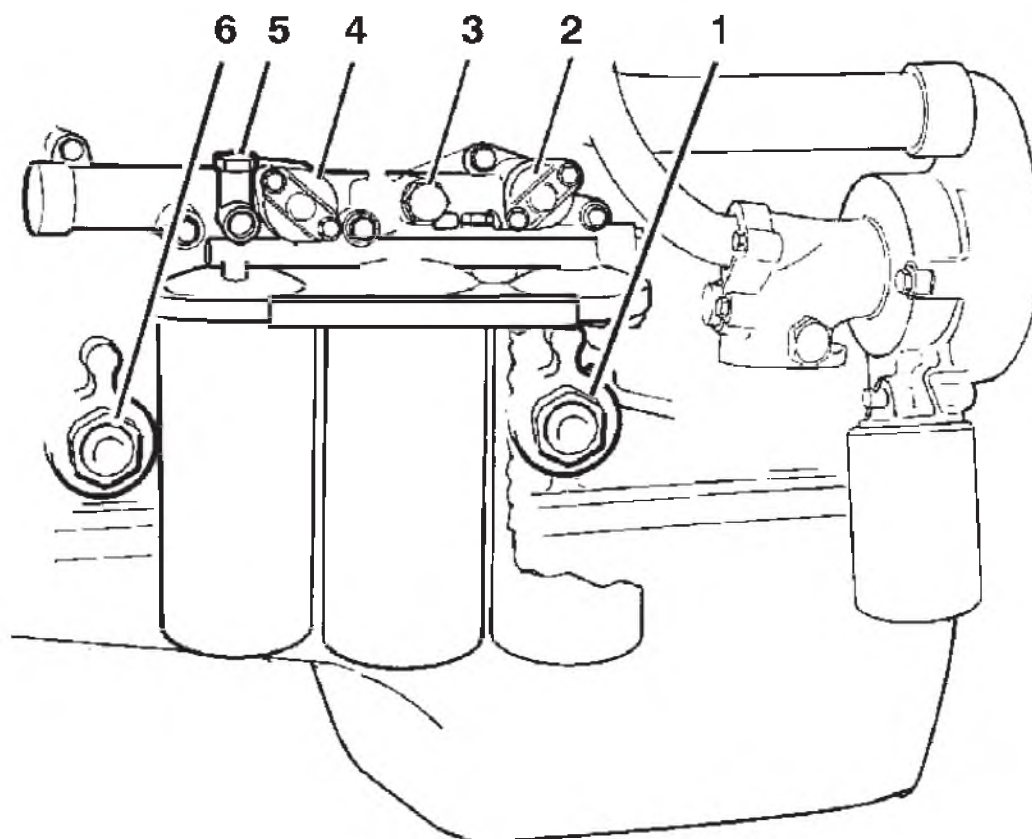
**2 Bypass valve for oil cooler** — The purpose of the bypass valve is to regulate the oil flow through the oil cooler. When the pressure drop across the oil cooler is low, for example, immediately after starting when oil temperature is low, the overflow valve opens and oil is led past the oil cooler. When oil temperature rises and pressure drops across the oil cooler increases, the bypass valve closes, and oil flows through the oil cooler before being pressed out into the lubrication system. The bypass valve is also available with a built-in thermostat. When the oil temperature is under 105–115° C (221–239° F), the by—pass valve opens and oil is led past the oil cooler and directly out into the lubrication system. At higher oil temperatures, the thermostat closes the by-pass valve and the oil passes through the oil cooler before it is forced out into the lubrication system.

**3 By—pass valve for oil filter** — If the filters become blocked, the by—pass valve opens guaranteeing lubrication, but with no filtration.

**4 Piston cooling valve**— The piston cooling valve opens when the engine speed (rpm) has increased to slightly over idling speed. Oil flows through the piston cooling passage to the six piston cooling nozzles which spray oil against the underside of the pistons.



## D12C



T2012843

- 1 Safety valve
- 2 Thermostatic valve
- 3 Overflow valve for oil filters (bypass)

- 4 Oil valve for pistons cooling
- 5 Overflow valve for oil filters (bypass)
- 6 Reducing valve

**1 Safety valve**

The safety valve opens up if the pressure in the lubrication system gets too high, for example, during a cold start in the winter.

**2 Thermostatic valve**

The thermostatic valve function is to regulate the oil flow through the oil cooler.

When the pressure in the oil cooler is too low, for instance, just after a start with a low oil temperature, the thermostatic valve opens up and the oil passes through near to the oil cooler. When the oil temperature increase and the pressure drop in the oil cooler get higher, the thermostatic valve closes and the oil passes through the cooler before being impelled to the lubrication system.

**3 Overflow valve for oil filters (bypass)**

The overflow valve opens up if the filters become clogged, assuring the continuity of the lubrication process.

**4 Oil valve for pistons cooling**

The oil valve for pistons cooling opens up as soon as the rotates exceeds idling speed.

The oil passes through the piston cooling circulation galleries to the six piston cooling oil injectors.

**5 Overflow valve for oil filters (bypass)**

The overflow valve opens up if the filters become clogged, assuring the continuity of the lubrication process.

**6 Reducing valve**

The reducing valve regulates oil pressure, opening up when the pressure exceeds the specified value, letting go the oil excess to the engine oil sump.

## Oil Pump

The oil pump is a gear pump set in motion by an intermediate gear in the synchronized gearing. The pump is made up of two gears that are turned in a well-sealed casing. When gears turn, the oil is transported between its teeth and the walls of the pump casing. When the teeth are geared, the oil is pumped out and inserted in the lubrication system.

## Oil Filter

One of the purposes of the oil lubrication is to clean up impurities on the engine lubrication points and on the bearings surface. The oil, then, accumulates dirt that needs to be cleaned up before it goes back to the lubrication points. The oil is roughly filtered while passing through the oil manifold filter. In order to get rid of the dirt particles, the D12C engine lubrication system is equipped with three filters.

The oil filters are made up of replaceable filtering elements.

All the oil coming through the pump passes through the filters before entering the engine.

## Piston Cooling


When the engine is running, there usually is a buildup of heat in the piston that, in some cases, needs an extra cooling. The piston cooling is set in motion when the oil pressure gets so high that the piston cooling valve in the cylinder block opens up. The oil is then forced through the engine block drilled galleries into the injection nozzles of piston cooling, one for each piston. The oil is then pulverized on the bottom of the piston.

# Troubleshooting

## Lube System Fuel Contamination, Checking

1  
When fuel contamination is suspected in the lube system, use a high-intensity black-light lamp (Kent-Moore part number J 28428 E) along with a fluorescent additive to locate the point at which fuel is entering the system.

## 2231-06-05-01 Oil Cooler Leak Test, Checking

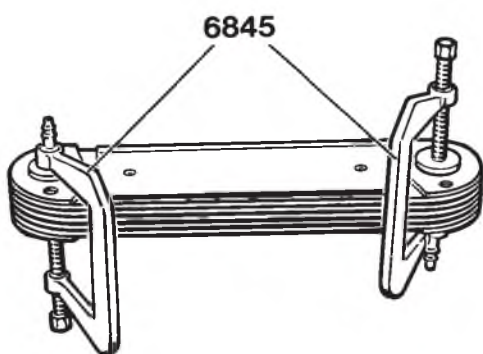

DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

*Special tools:* 9996662, 9996845

1  
Flush the coolant side of the oil cooler element with water-soluble degreasing fluid. Wash the oil side of the cooler element with degreasing solvent.

2



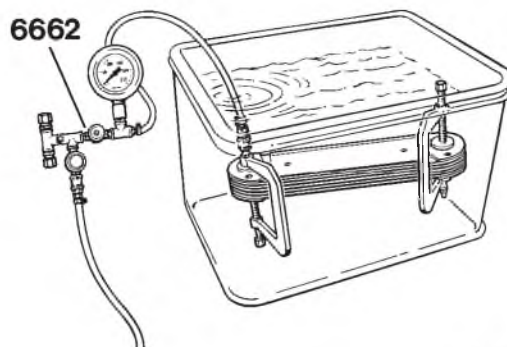
Tools 9996845

T2006695

Install tools 9996845, making sure they are properly seated.

9996845

3



T2006696

Pressure gauge and bath

Make sure the reduction valve knob of pressure gauge 9996662 is fully open and that the pressure gauge is in the "0" position.

9996662  
9996845

Connect the pressure gauge needle to 9996845. Lower the oil cooler element into a bath which contains water at 70° C (160° F).

Increase pressure to **250 kPa (35 psi)** using the reduction valve knob. The test period should last for **at least one minute**.

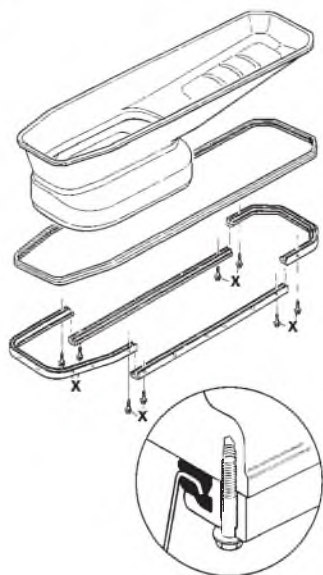
Air bubbles emerging from the oil cooler element indicate a leak and the element should be replaced.



# Service Procedures

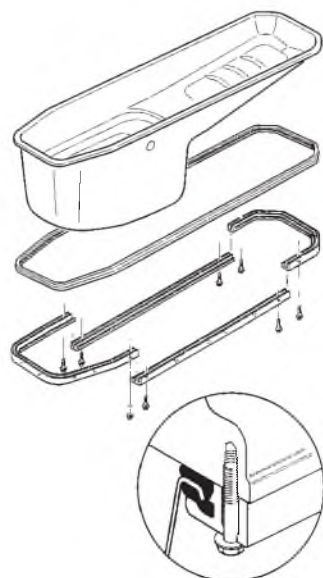
## 2171-02-02-01 Oil Pan, Installation

1



T2006802

Fig. 1: Oil pan, gasket and rail-D12, D12A, D12B, D12C



W2003249

Fig. 2: Oil pan, gasket and rail-D12C

Make sure the gasket is correctly positioned. Then position the oil pan and tighten the bolts to  $24 \pm 4$  Nm ( $18 \pm 3$  ft-lb).

$24 \pm 4$  Nm  
( $18 \pm 3$  ft-lb)

**Note:** Tighten the bolts in the metal rail joints first.

2

Fill the engine with the correct amount of oil.

3

Crank the engine with the starter until oil pressure is recorded on the pressure gauge.

4

Apply parking brake. Place the shift lever in neutral.

5

Start the engine, check operation and perform a leak test.

## 2211-03-02-01 Lube Oil Pump, Replacement

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### WARNING

HOT ENGINE! Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

### WARNING

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

#### (Oil Pan Removed)

Not Included:

- "Oil Filter, Replacement" page 23

## Removal

**1**  
 Drain engine oil into suitable container and remove the oil pan.

**Note:** Dispose of oil according to local and state regulations.

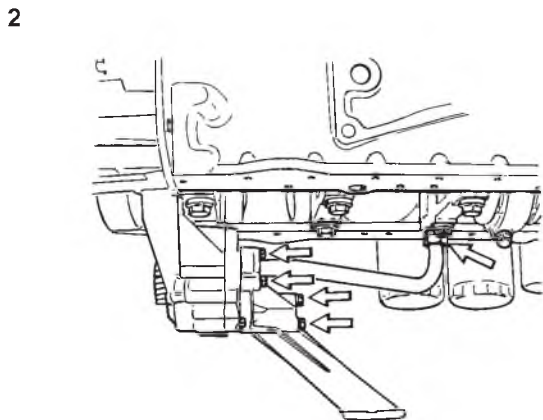


Fig. 3: Oil delivery pipe nuts

Remove the oil delivery pipe nut in the cylinder block, and bolts for the oil strainer.

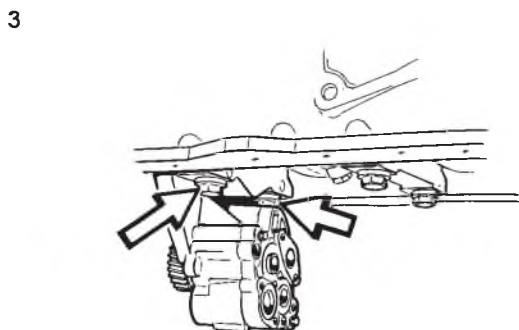


Fig. 4: Oil pump bolts

Remove the bolts for the first main bearing cap. Lift out the oil pump together with the main bearing cap.

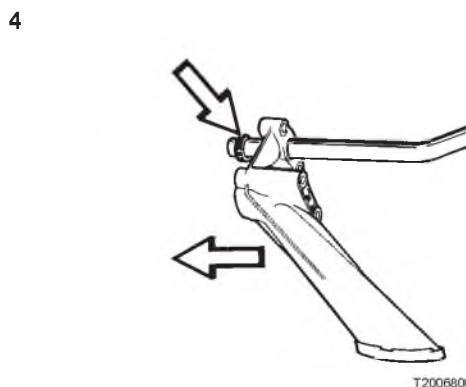


Fig. 5: O-ring and oil strainer

Remove the O-ring and oil strainer from the oil delivery pipe.

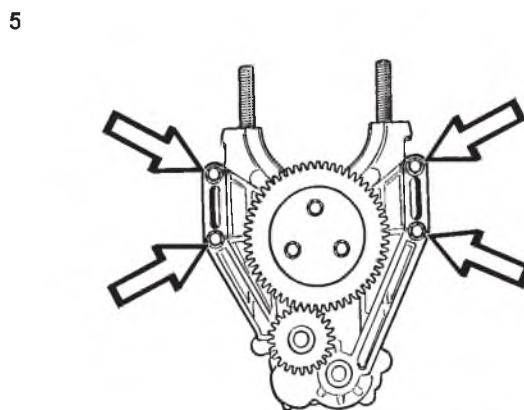


Fig. 6: Remove oil pump

Remove the oil pump from the main bearing cap.

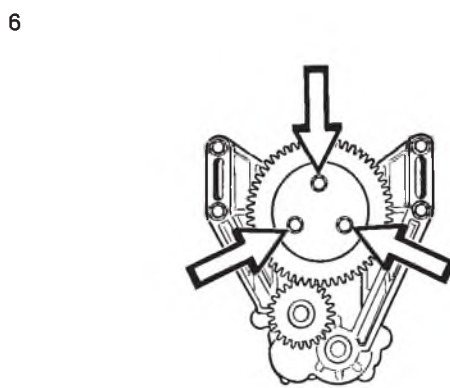


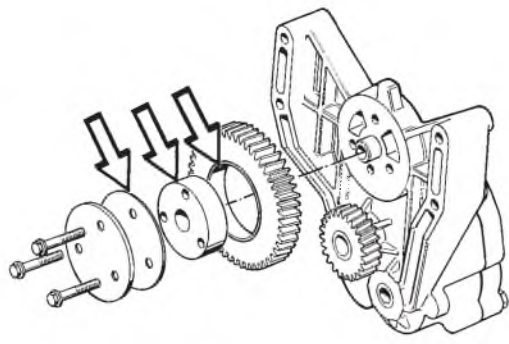
Fig. 7: Intermediate gear

Remove the intermediate gear from the oil pump housing.

**7**  
 Clean the oil strainer. Make sure the oil strainer mesh is not damaged.

**8**  
Clean and check the bushings and teeth on the intermediate gear.

**9**



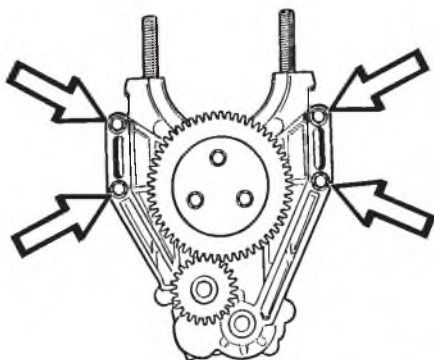
T2006699

Fig. 8: Intermediate bushing locations

Intermediate bushings with engine oil. Tighten the bolts to  $24 \pm 4$  Nm ( $18 \pm 3$  ft-lb).

**Installation**

**1**



T2006697

Fig. 9: Mounting oil pump to main bearing cap

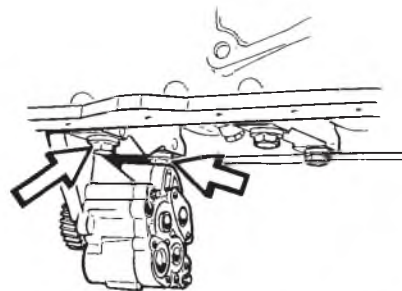
Install the new oil pump on the main bearing cap. Tighten the bolts to  $24 \pm 4$  Nm ( $18 \pm 3$  ft-lb).

**Note:** Remember to install the main bearing cap bolts before fastening the pump to the bearing cap.

**2**

Clean the main bearing shell and lubricate it with engine oil.

**3**



T2006799

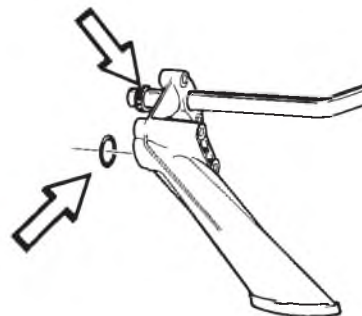
Fig. 10: Installing lube oil pump

Install the lube oil pump, making sure that the teeth in the intermediate gear make contact with the crankshaft drive gear. Tighten the main bearing bolts to  $150 \pm 20$  Nm ( $111 \pm 14$  ft-lb). Then turn a further  $120^\circ \pm 5^\circ$ .

**4**

Check the oil delivery pipe for cracks in the flange where it contacts the union.

**5**



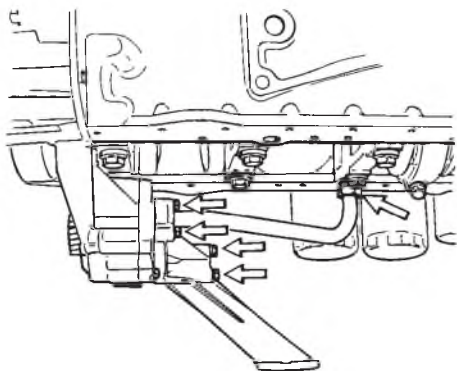
T2006801

Fig. 11: Oil strainer installation

Place the oil strainer on the oil delivery pipe and install new O-rings.



6

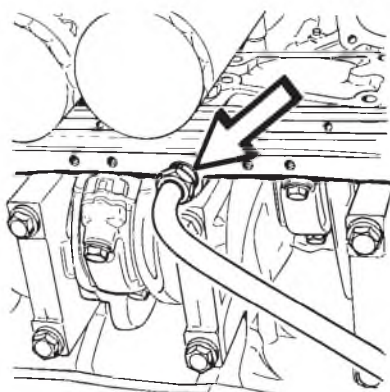


T2006798

Fig. 12: Installing oil strainer and delivery pipe

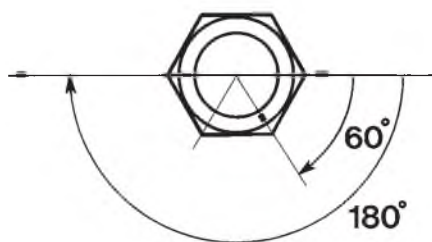
Install the oil strainer and the oil delivery pipe. Tighten the oil strainer to the oil pump to  $27 \pm 4$  Nm ( $20 \pm 3$  ft-lb).

7



T2006701

Fig. 13: Oil pipe union installation



T2006825

Fig. 14: Union tightening torque

Tighten the union in the cylinder block until it bottoms at about 10 Nm (7.4 ft-lb).

For a previously installed pipe, tighten the union a further  $60^\circ$ . For a new pipe, tighten the union a further  $180^\circ$ . Make sure the pipe is installed properly.

## 2211-06-02-01 Lube System Pressure, Checking



Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.



**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

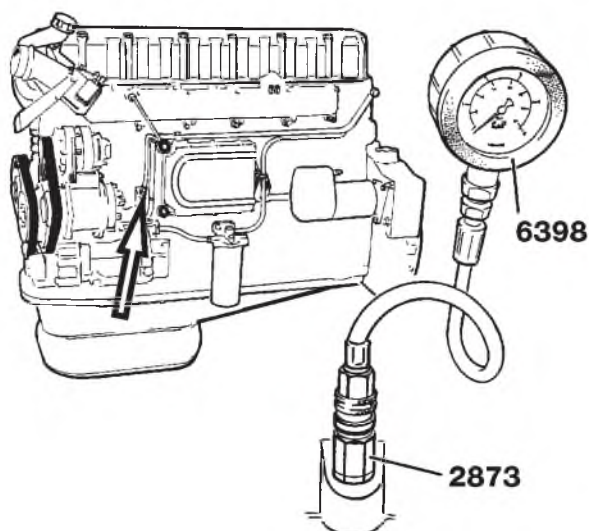
*Special tools: 9992873, 9996398*

**1**  
Place shift lever in neutral and apply parking brake.

**2**  
Lubricating oil pressure is checked by connecting a pressure gauge and hose to the oil pressure sender outlet on the left-hand side of the engine.

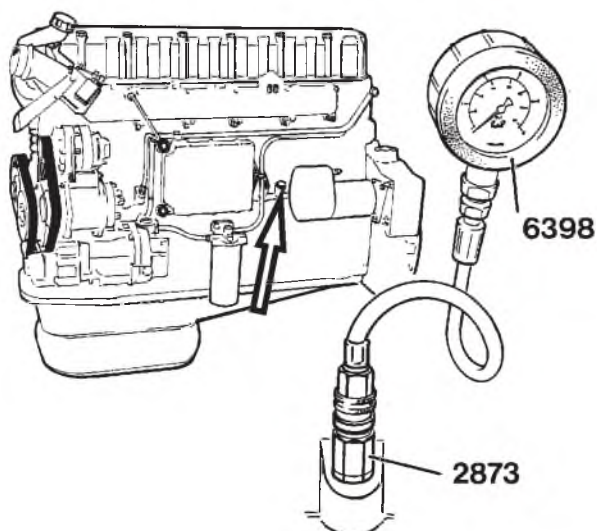
**Note:** The oil pressure sender is mounted in the cylinder block front outlet. The rear outlet can be plugged or an oil temperature sender may be installed. On some trucks, a hose is connected to the front outlet, and the oil pressure sender is positioned in an attachment on the frame side.

3



W2003484

Fig. 15: Pressure gauge and hose installation-D12C



W2003499

Fig. 16: Pressure gauge and hose installation-D12B

Carefully clean and disconnect the oil pressure sender wiring and remove the sender. Install connect union 9992873 into the engine block and then attach the hose and pressure gauge 9996398. Start the engine; engine oil should be at operating temperature. Take the oil pressure reading at low idle speed and at high idle. At low idle speed, the oil pressure should be 150 kPa (22 psi) minimum. At high idle, it should be 300–550 kPa (45–80 psi).

4

Remove the gauge, hose and union. Reinstall the oil sender and reconnect the sender wiring.

## 2223-03-02-01 Oil Filter, Replacement

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### WARNING

HOT ENGINE! Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

### WARNING

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

*Special tools: 9996672*

1

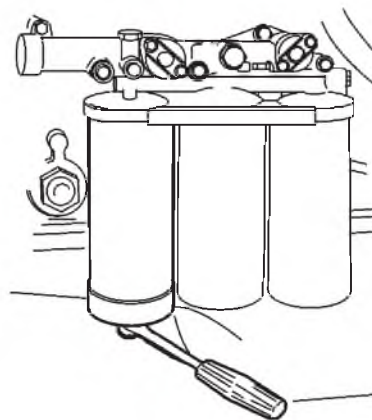


Fig. 17: Replacing oil filters

- 1 Bypass filter
- 2 Full-flow filter
- 3 Full-flow filter

Drain the engine oil into suitable container and clean around the oil filter housing. Remove the filters, using filter tool 9996672.

**Note:** Dispose of oil in accordance to local and state regulations.

**2**  
Moisten the seals of the new filters with clean engine oil and screw on the filters by hand until the seals come in contact with the filter housing. Then tighten the full-flow filters a further 1/2–3/4 turn. Tighten the bypass filter 3/4–1 turn after making contact with the filter housing.

**3**  
Fill the engine with oil.

**4**  
Crank the engine with the starter until oil pressure is recorded on the pressure gauge.

**5**  
Place shift lever in neutral and apply parking brake.

**6**  
Start the engine and check for leaks around the oil filters.

## 2229-03-02-02 Piston Cooling Valve, Replacement

**! DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**! WARNING**

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

**1**  
Clean the filter housing and remove the cover of the piston cooling valve. Remove the O-ring.

**2**  
Remove the piston cooling valve and clean the valve seat in the filter housing. Make sure to remove the old O-ring from the filter housing.

**3**



Fig. 18: Piston cooling valve

Make sure the color marking on the new piston cooling valve is **orange**.

4

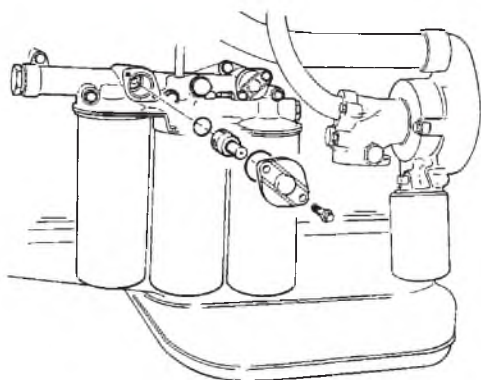


Fig. 19: Inserting valve

T2006684

Insert the new valve in the cover. Place new O-rings on the valve and the filter housing.

5

Install the valve in the filter housing and tighten the cover bolts.

6

Apply parking brake. Place shift lever in neutral.

7

Start the engine and perform a leak test.

## 2229-03-02-03 Piston Cooling Nozzle, Replacement



Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.



Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

(Oil Pan Removed)

**Note:** To prevent the piston cooling nozzles from being damaged, always remove them before removing pistons and cylinder liners.

Special tools: 9996956

1

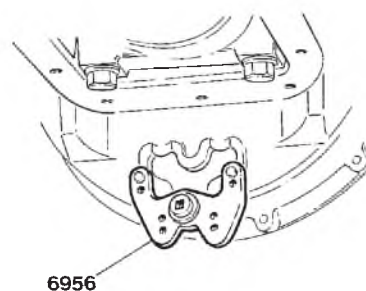


Fig. 20: Cranking tool

T2006702

Remove the inspection cover from the bottom of the flywheel housing and install cranking tool 9996956.

2

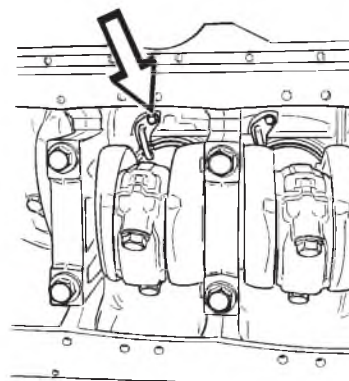


Fig. 21: Piston cooling nozzle

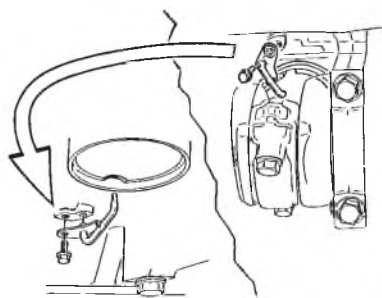
T2006685

Turn the crankshaft until the piston cooling nozzle to be replaced is easily accessible.

3

Remove the piston cooling nozzle.

4



T2006686

Fig. 22: Installing new piston cooling nozzle

Install new piston cooling nozzle, using a new bolt. Tighten to  $24 \pm 4$  Nm ( $18 \pm 3$  ft-lb)

**Note:** The piston cooling nozzle attachment bolt is coated with a friction-inducing compound. Do not reuse.

**Note:** Any piston cooling nozzle suspected to be damaged or deformed must be replaced (this even applies to a new nozzle). Always make sure the piston cooling nozzle fits correctly in its hole in the cylinder block and that the attachment plate is flush with the cylinder block.

5  
Remove the cranking tool and reinstall the inspection cover on the flywheel casing.

## 2229-03-02-04 Oil Pressure Reduction Valve, Replacement



**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

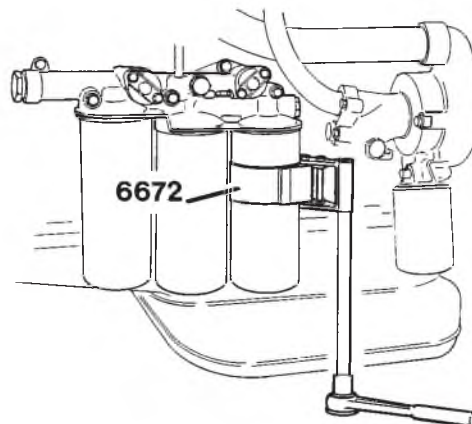


**WARNING**

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

*Special tools:* 9996672

1



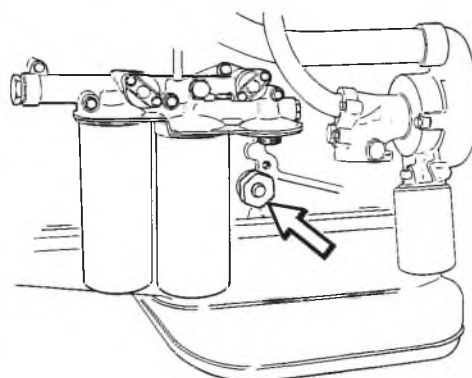
T2006797

Fig. 23: Removing oil filter

Drain the engine oil into a suitable container and clean around the oil filter housing. Remove the front oil filter, using filter removal tool 9996672 or equivalent.

**Note:** Dispose of oil in accordance to local and state regulations.

2



T2006675

Fig. 24: Plug location on engine

Clean around the plug on the cylinder block. Unfasten the plug and remove the regulator valve.

3

Clean the regulator valve seat and make sure to remove the old O-ring.



4

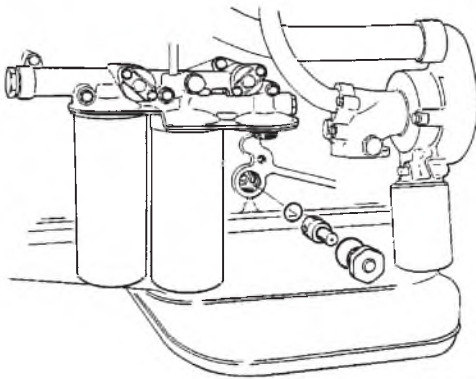


T2006676

Fig. 25: Regulator valve

Check that the color marking on the new regulator valve is **brown**.

5



T2006677

Fig. 26: Inserting regulator valve in plug

Insert the regulator valve in the plug. Place new O-rings on the valve and plug. Install the plug into the cylinder block.

6

Install a new oil filter. Moisten the seal of the new filter with engine oil and screw on the filter by hand until the seal is in contact with the filter housing. Then tighten the filter a further  $\frac{1}{2} - \frac{3}{4}$  turn.

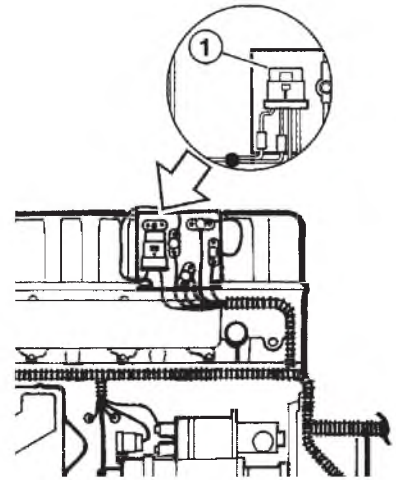
7

Fill the engine with oil.

8

Place the shift lever in neutral and apply parking brake.

9

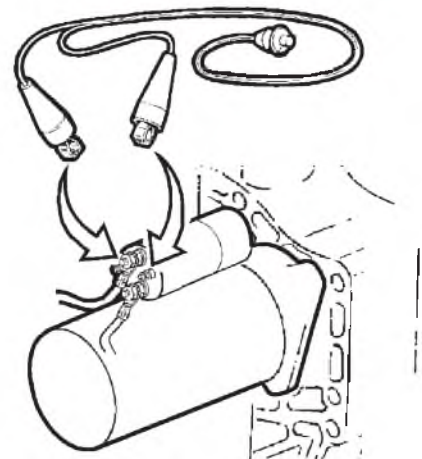


W3000459

Fig. 27: ECM relay location

Remove the ECM relay from engine valve cover.

10



W3000458

Fig. 28: Connections for remote starter cable

Connect a remote starter switch cable (Snap-On® MT302A or equivalent) between the battery (+) and the positive connection (+) on the starter motor solenoid. Crank the engine with the starter until oil pressure is recorded by the pressure gauge.

**Note:** Do not run the starter any longer than 15 seconds at one time. Allow the starter to cool before re-running the starter motor.

11

Remove remote starter cable and replace the ECM relay after completion.

12  
Start the engine and perform an operation and leak check.

## 2232-03-02-01 Oil Cooler Core, Replacement

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### WARNING

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

**(Coolant Drained, Air Compressor Removed.)**

Not Included:

- “Oil Cooler Leak Test, Checking” page 17

**Note:** Radiator and cooling system must be properly cleaned and flushed in the event of a suspected oil cooler failure. Refer to:

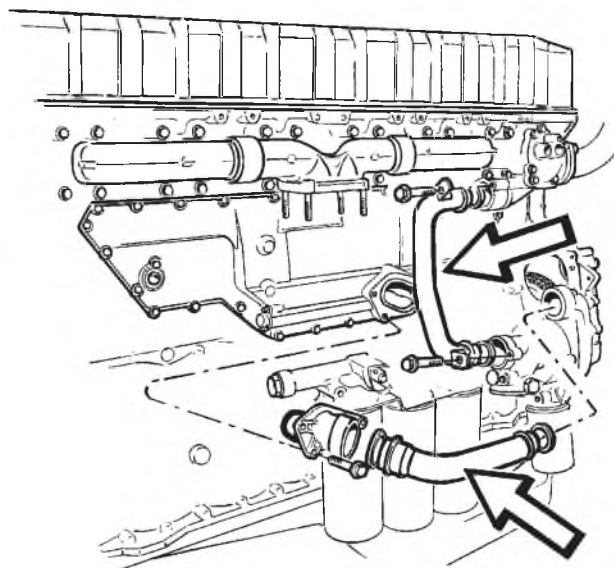
**Service Manual** 260-600  
*Cooling System, VE D12-D12C*

**IMPACT** Function Group 2619  
Information Type: Repair  
“Cooling System”

## Removal

1  
Remove the turbocharger. Plug turbo oil lines and outlet openings to prevent contamination. Install cover on turbo intake and exhaust openings to prevent foreign material from possibly becoming lodged in turbine wheels.

2



T2006687

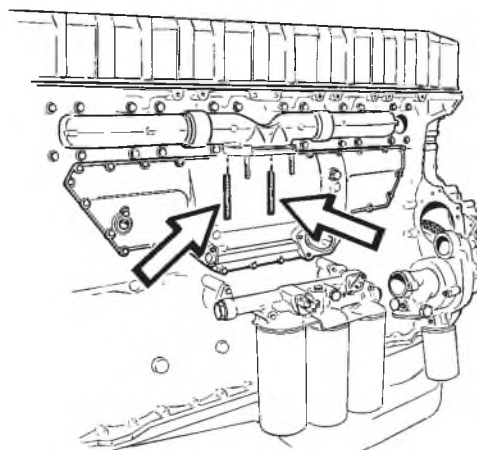
Fig. 29: Removing pipes

Remove the pipes between the thermostat housing and the coolant pump, and between the coolant pump and the oil cooler cover.

3

Remove the thermostat housing.

4



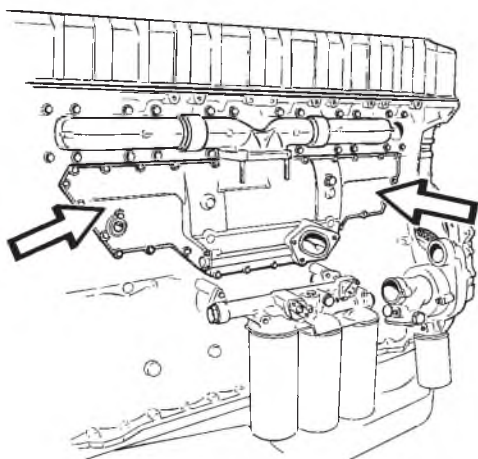
T2006688

Fig. 30: Inner stud bolts

Remove the turbocharger inner mounting stud from the exhaust manifold.



5

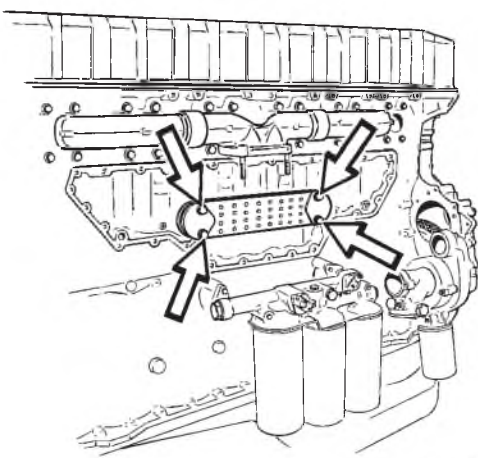


T2006688

Fig. 31: Oil cooler element cover

Remove the oil cooler element cover.

6



T2006690

Fig. 32: Removing oil cooler element

Remove the oil cooler element.

7

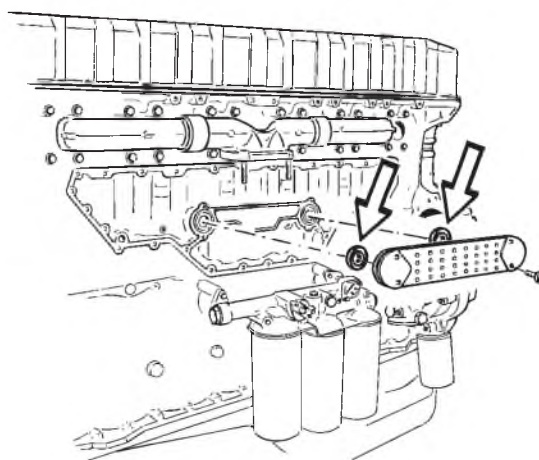
Remove the oil cooler element O-rings and the gasket in the cover. Clean the contact surfaces of the cylinder block and cover.

8

If a leak test on the oil cooler element is desired, see "Oil Cooler Leak Test, Checking" page 17.

## Installation

1

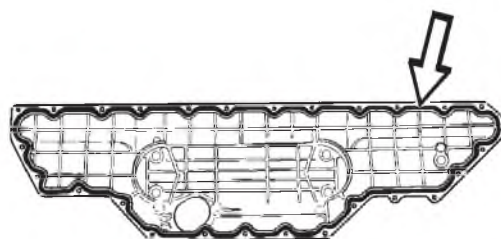


T2006691

Fig. 33: Oil cooler O-rings

Clean and place new O-rings in the cylinder block. Install the oil cooler element and tighten the bolts to  $27 \pm 4$  Nm ( $20 \pm 3$  ft-lb).

2



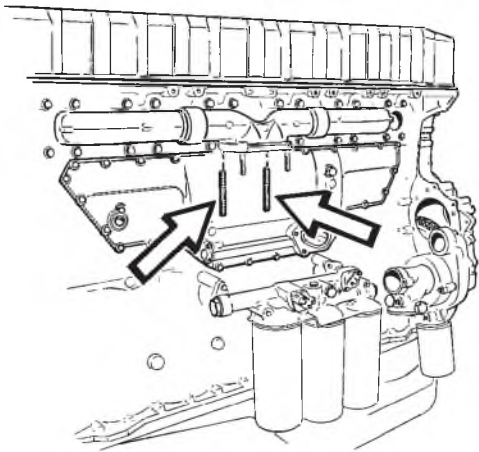
T2006692

Fig. 34: Gasket inserted

Insert a new gasket in the cover. Replace and tighten the cover. Tighten the bolts to  $24 \pm 4$  Nm ( $18 \pm 3$  ft-lb).

**Note:** Tighten the oil cooler cover bolts evenly and in several steps to avoid damaging the oil cooler cover.

3

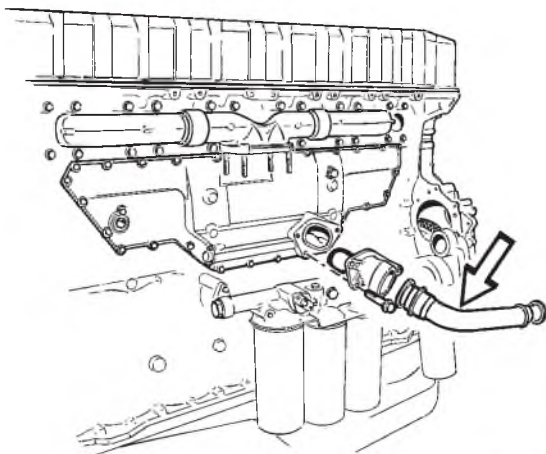


T2006688

Fig. 35: Inner turbo mounting stud

Install the two inner stud bolts for the turbocharger.

4



T2006693

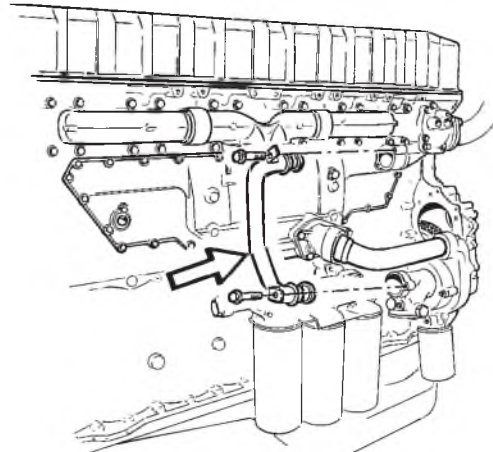
Fig. 36: Installing pipe

Install the pipe between the coolant pump and the oil cooler cover. Replace the gasket between the cover and pipe connection. Use new O-rings.

5

Replace the thermostat housing, using a new gasket.

6



T2006694

Fig. 37: Installing pipe

Install the pipe between the thermostat housing and the coolant pump. Use new O-rings.

7

Replace the turbocharger. Use a new mounting gasket.

8

Replace the air compressor. Use a new mounting gasket.

9

Fill with coolant. Use only a concentrated coolant that meets or exceeds ASTM D4985 specifications. The recommended coolant is monoethylene glycol (MEG) based or monopropylene glycol (MPG) based anti-freeze.

10

Fill the engine with oil.

11

Pre-lube the turbo unit with engine oil. Add two ounces of engine oil through turbo lube line opening before connecting the lube line. This will ensure turbo has sufficient lubricant at start up.

**Note:** It is very important to make sure there is an adequate oil supply to the turbo before starting the engine.

12

Apply parking brake and place shift lever in neutral.

13  
Start the engine and perform operation and leak tests.

## 2239-03-02-02 Oil Cooler Bypass Valve, Replacement

**⚠ DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**⚠ WARNING**

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

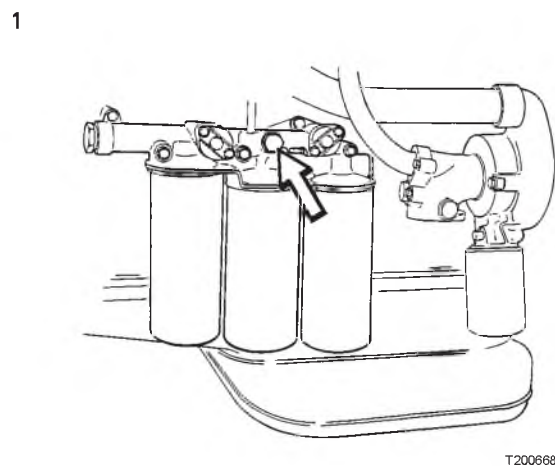


Fig. 38: Installed Plug

Clean around the oil filter housing and remove the plug. Remove the cone and spring.

2  
Clean and check the valve seat. If the valve seat shows signs of corrosion, replace the oil filter housing.

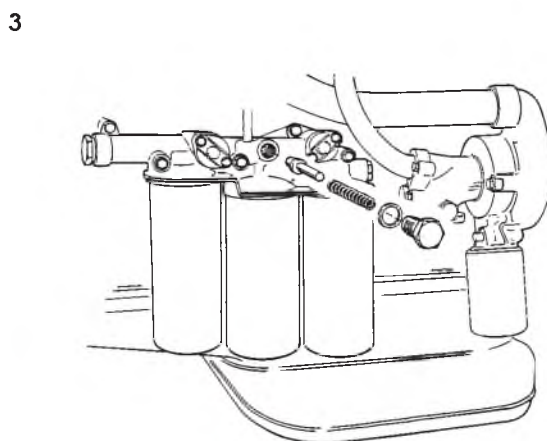


Fig. 39: Inserting cone and spring

Insert the new cone and spring along with a new O-ring. Install and tighten the plug.

4  
Apply parking brake and place shift lever in neutral.

5  
Start the engine and perform a leak test.

## 2209-11-02-01 Oil System Passages, Cleaning

**⚠ DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**⚠ WARNING**

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

**⚠ WARNING**

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

**1**  
Drain coolant into suitable container.

**Note:** Dispose of coolant in accordance to local and state regulations.

**2**  
**Note:** Before flushing the passage you must remove the turbocharger. Refer to:

**Service Manual** 250–600  
*Intake and Exhaust-Systems, D12, D12A, D12B, D12C*

**IPMPACT** Function Group  
Information Type: Repair  
"Turbocharger"

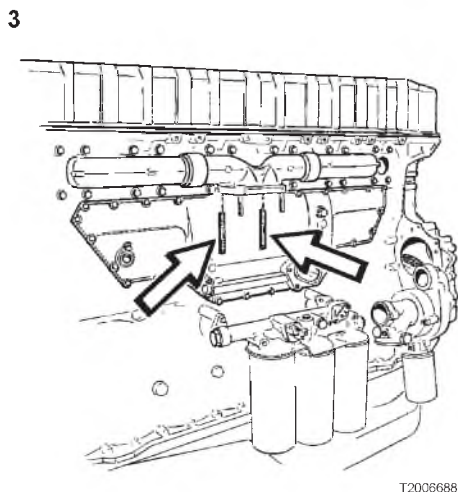


Fig. 40: Turbo mounting studs

Remove the inner 2 turbo mounting studs.

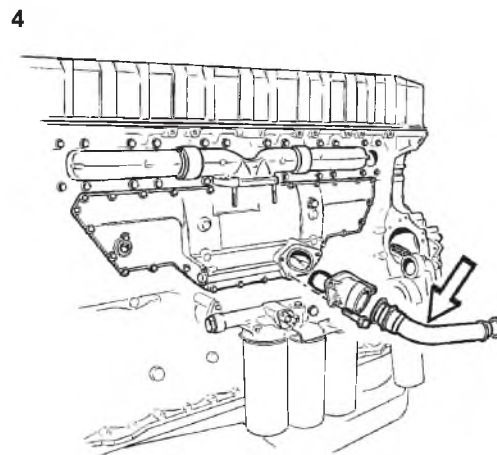


Fig. 41: Water pump discharge pipe

Remove the 3 bolts fastening the water pump discharge pipe to the oil cooler cover. Unplug the Volvo Engine Brake (VEB) temperature sensor (if equipped) and remove the pipe.

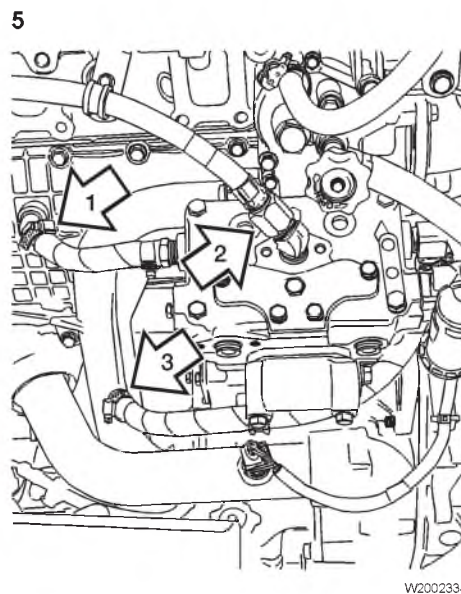


Fig. 42: Air compressor disconnect

- 1) coolant supply hose
- 2) air compressor discharge line
- 3) coolant return hose

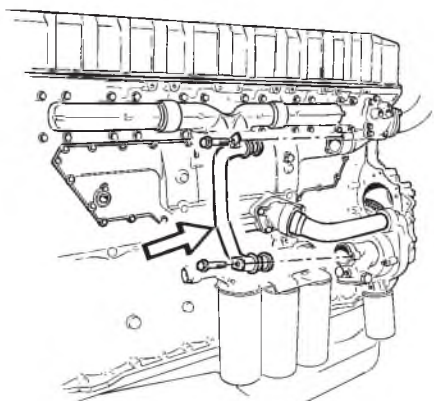
Disconnect the air compressor coolant supply hose (1) from the oil cooler cover.

**6**  
Disconnect the air compressor discharge line (2) from the air compressor.



- 7  
Disconnect the air compressor coolant return hose (3) from the bypass pipe.

8

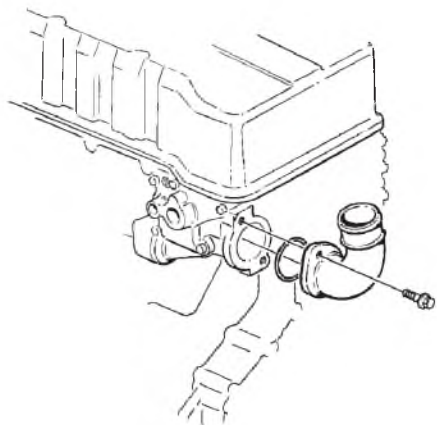


T2006694

Fig. 43: Remove bypass pipe

Remove the bolts fastening the bypass pipe and remove pipe.

9

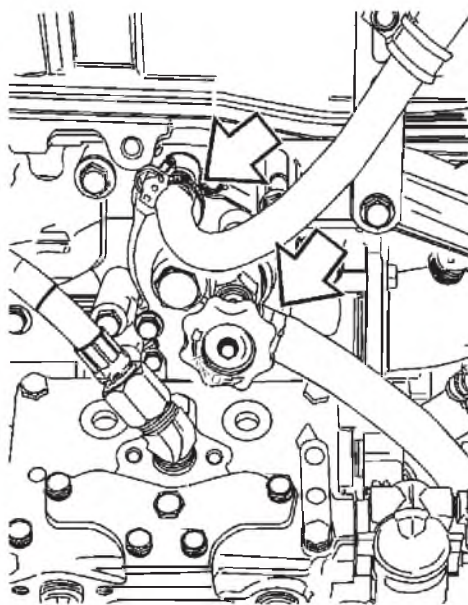


T2007234

Fig. 44: Remove radiator hose neck

Disconnect the wiring harness from the cam sensor and remove the 2 bolts fastening the upper radiator hose neck to the thermostat housing. Move the neck and the upper radiator hose to the side.

10



W2002339

Fig. 45: Thermostat housing hoses

Remove the 2 hoses from the thermostat housing (the heater hose and the bleed hose).

11

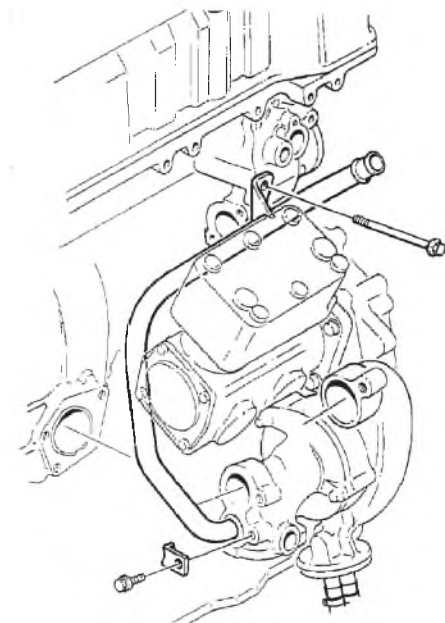
Remove the lower right front exhaust manifold bolt.

12

**For Bendix Air Compressors:** Remove the 4 bolts fastening the outer cover of the thermostat housing. Remove the 3 bolts mounting the thermostat housing to the head. Separate the outer cover from the thermostat housing and remove both separately.

**Note: For Volvo (Knorr) Air Compressors:** Remove the compressor mounting bolts and rotate the compressor for clearance.

13



W2002343

Fig. 46: Expansion tank pipe

Remove the 2 bolts fastening the water pump to the expansion tank pipe. Move the pipe to the side.

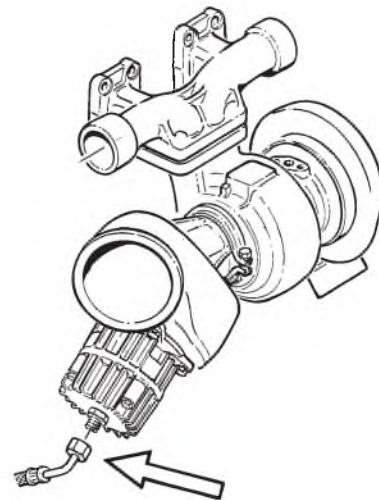
14

Disconnect the wire to the block heater (if equipped with block heater).

15

Remove the bolt fastening the transmission cooler water pipe to the oil cooler cover and move the pipe to the side (if equipped with transmission oil cooler).

16



T2006942

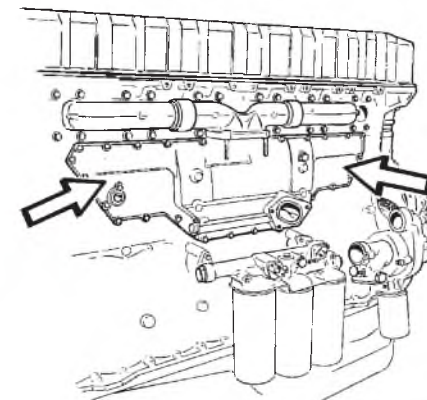
Fig. 47: Remove air supply line

Disconnect the Exhaust Pressure Governor (EPG) air supply line.

17

Remove the clamp fastening the exhaust pipe to the EPG and remove the EPG and centering ring.

18

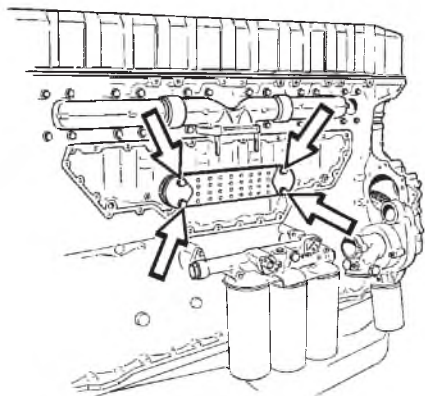


T2006689

Fig. 48: Remove oil cooler cover

Remove all of the 27 bolts fastening the oil cooler cover and remove the cover.

19



T2006690

Fig. 49: Oil cooler element

Remove the 4 bolts fastening the oil cooler element to the engine block and remove the element.

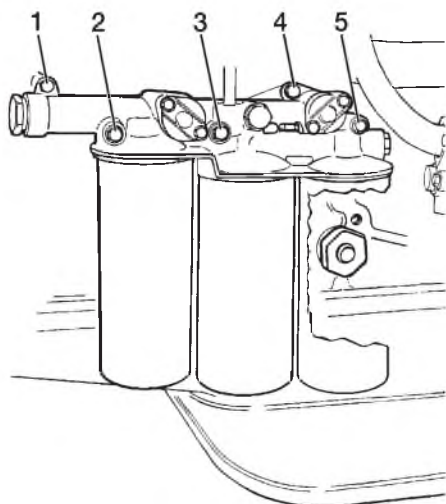
20

Remove the turbo oil return line from the block.

21

Disconnect the lower charge air cooler pipe and remove.

22

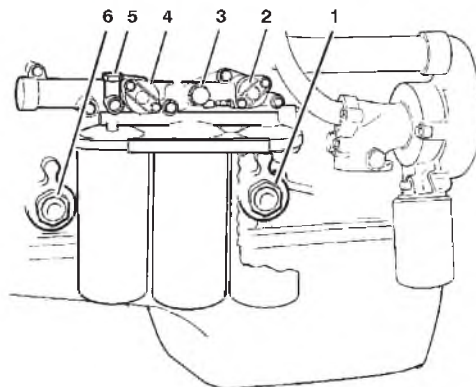


W2002340

Fig. 50: Oil filter base removal

Remove the 5 bolts fastening the oil filter base to the block, and remove the base.

23



T2012843

Fig. 51: Reduction valves

Remove the oil reduction valves (1) and (6).

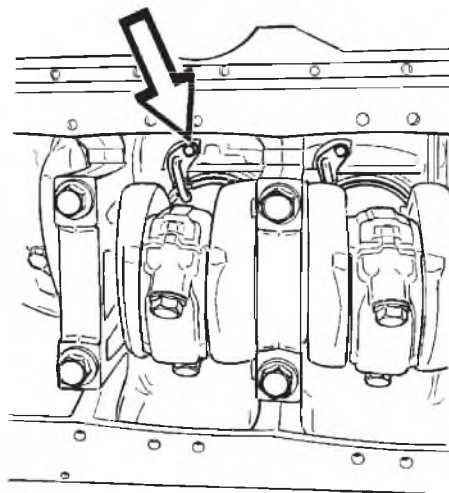
24

Remove the oil pan.

25

Remove the oil pump pick-up and delivery pipe assembly.

26



T2006685

Fig. 52: Remove piston cooling jets

Remove all 6 piston cooling jets.

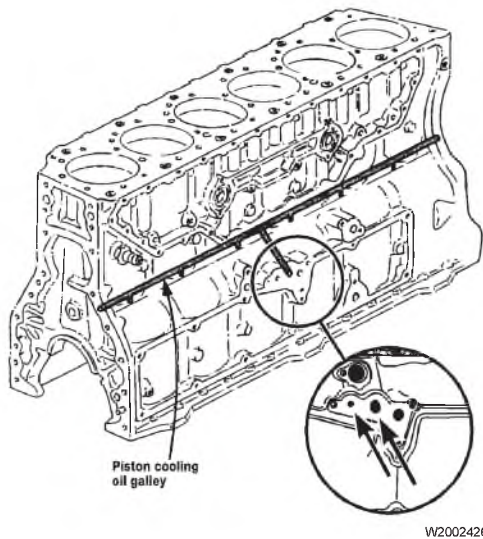
27

Inspect the pistons and liners from the bottom side for damage due to metal contamination.



**28**  
Position the catch pan under the engine.

**29**



W2002426

Fig. 53: Piston cooling oil galley

**! WARNING**

Most solvents are flammable, stay away from open flame and observe extreme caution when using these so as to prevent fire.

**! WARNING**

Always wear eye protection and protective gloves when working with solvent. Exposure to eyes and/or bare skin will cause burns.

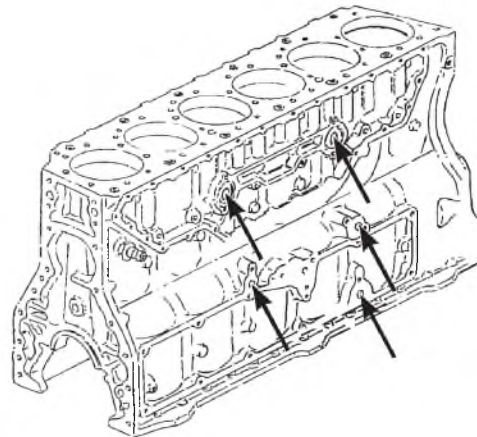
Flush out the piston cooling oil galley using **clean** solvent and a siphon type spray gun. Flush from the top side and also up from the bottom.

**Note:** Do not attempt to remove metal contaminants using shop air only.

**Note:** **Clean** solvent must also be used whenever flushing is required.

**30**  
Flush out the oil reduction valve galley from the side and underside of the block.

**31**



W2002427

Fig. 54: Oil cooler element oil galleys

Flush out both oil cooler element oil galleys.

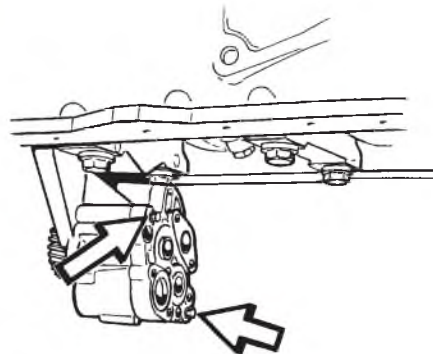
**32**

**! WARNING**

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

Blow dry all flushed oil galleys with compressed air.

**33**



W2002341

Fig. 55: Oil pump cover removal

Remove the rear cover of the oil pump.

**34**  
Flush out the oil pump and inspect the pump housing and gears for damage. Replace if needed.

**35**  
Pre-lube and install the rear cover on the oil pump. Torque bolts  $27 \pm 4$  Nm ( $20 \pm 3$  ft-lb).

**36**  
Flush out all piston cooling jets and install with new bolts. Torque to  $24 \pm 4$  Nm ( $18 \pm 3$  ft-lb).

**Note:** The piston cooling jet attachment bolt is coated with a friction inducing compound. Do not reuse bolts.

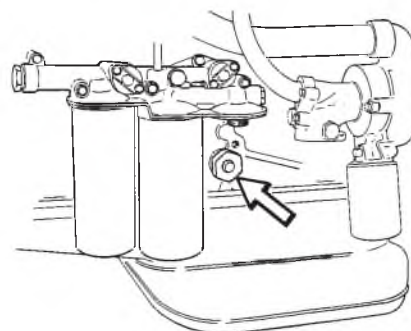
**37**

 <b>WARNING</b>
Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

Flush out and blow dry the oil pipe pick-up and delivery pipe assembly. Inspect the screen for trapped metal chips.

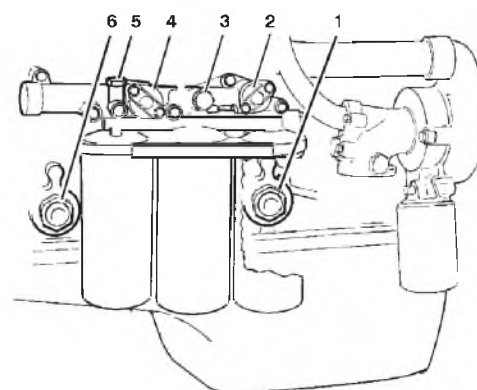
**38**  
Install the oil pump pick-up and delivery pipe assembly with new O-rings. Torque for delivery pipe to block union  $10$  Nm ( $7.4$  ft-lb) plus an additional  $60^\circ$  for a used pipe,  $180^\circ$  for a new pipe. Torque for strainer to oil pump bolts  $27 \pm 4$  Nm ( $20 \pm 3$  ft-lb).

**39**



T2006675

Fig. 56: D12, D12A, D12B Engines



T2012843

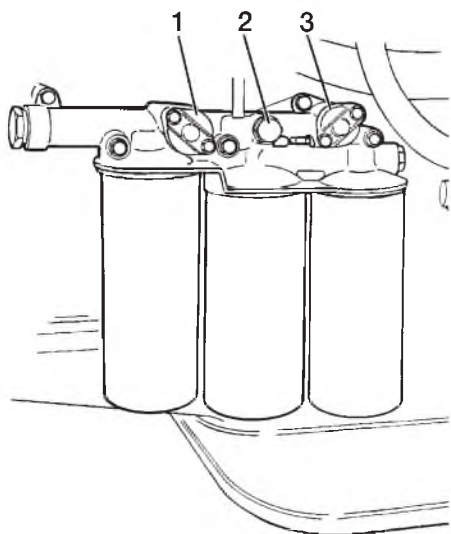
Fig. 57: D12C Engine

Flush and blow dry the reduction valve and inspect for damage or trapped debris.

**40**  
Install the oil reduction valve with a new O-ring on the valve as well as the cover. Torque the cover to  $50$  Nm ( $37$  ft-lb).

**41**  
Remove oil filters and clean the exterior of the filter base.

42



W2002342

Fig. 58: Remove the piston cooling valves

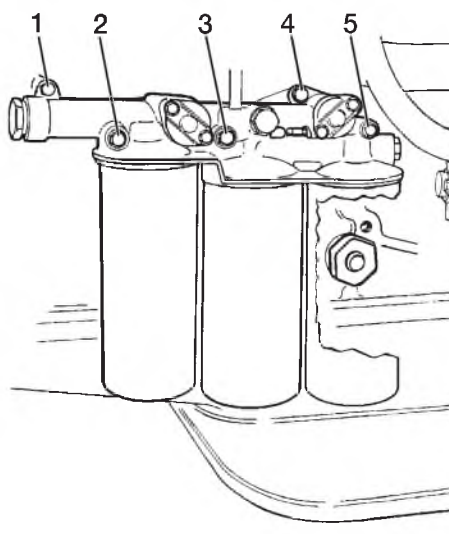
- 1) piston cooling valve
- 2) overflow valve, oil filter
- 3) overflow valve, oil cooler

Remove the piston cooling valve (1) and the 2 overflow valves (2)(3). Flush out and blow dry the filter housing valve ports and valves.

43

Install the 2 overflow valves (2)(3) and the piston cooling valve (1). Torque the bolts to  $10 \pm 2$  Nm ( $7 \pm 1$  ft-lb). Torque plug to  $55 \pm 5$  Nm ( $41 \pm 4$  ft-lb).

44



W2002340

Fig. 59: Torquing the mounting bolts

Attach the oil filter base to the block with a new gasket. Torque the mounting bolts to  $24 \pm 4$  Nm ( $18 \pm 3$  ft-lb).

45

Install new oil filters.

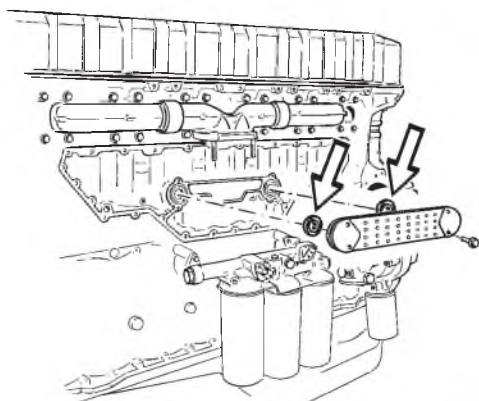
46

Install the oil pan.

47

Install new engine oil.

48



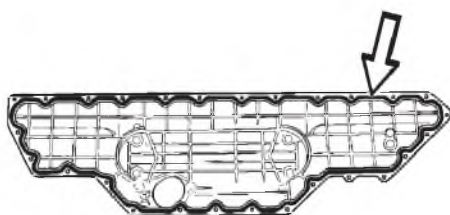
T2006691

Fig. 60: Oil cooler element

Install a new oil cooler element with new seals. Torque bolts to  $27 \pm 4$  Nm ( $20 \pm 3$  ft-lb).

**Note:** Once inside the oil cooler element, metal contamination cannot be flushed out. If this happens, replace the element.

49

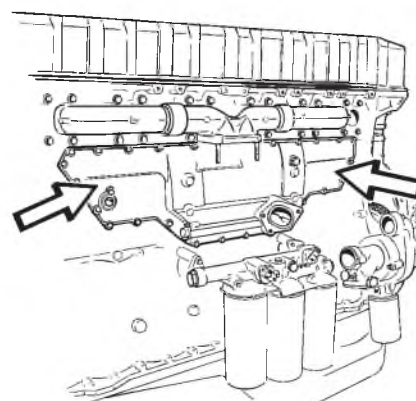


T2006692

Fig. 61: Oil cooler element

Clean the oil cooler element cover and mounting gasket surface of the block.

50



T2006689

Fig. 62: Element cover gaskets

Install the cover with a new gasket. Torque bolts to  $24 \pm 4$  Nm ( $18 \pm 3$  ft-lb).

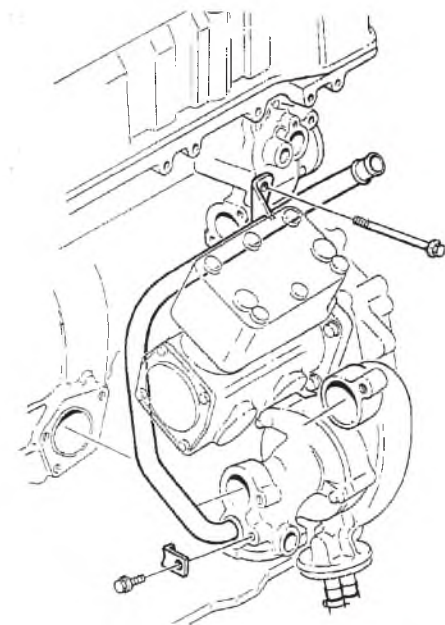
51

Connect the block heater (if equipped).

52

Install the transmission water cooler pipe to the cover with a new seal (if equipped).

53



W2002343

Fig. 63: Water pump installation

Install the water pump to the expansion tank water pipe with a new seal. Install retaining clamp and bolt assembly.

54

Clean all gasket surfaces on the thermostat housing.

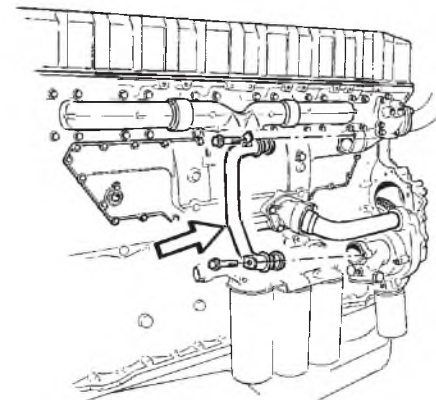
55

Install the thermostat housing with a new seal. Torque the 4 M6 bolts to  $10 \pm 1.5$  Nm ( $7.4 \pm 1$  ft-lb), and the 3 M8 bolts to  $24 \pm 4$  Nm ( $18 \pm 3$  ft-lb).

**For Volvo (Knorr) Air Compressor:** re-align the compressor with mounting bolts and tighten to  $85 \pm 15$  Nm ( $63 \pm 11$  ft-lb).

$10 \pm 1.5$  Nm  
( $7.4 \pm 1$  ft-lb)  
 $24 \pm 4$  Nm  
( $17.7 \pm 3$  ft-lb)  
Knorr:  
 $85 \pm 15$  Nm  
( $63 \pm 11$  ft-lb)

56

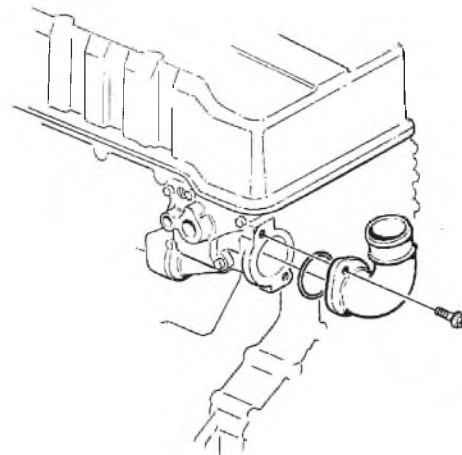


T2006694

Fig. 64: Installing the bypass pipe

Install the bypass pipe using a new seal and gasket.

57



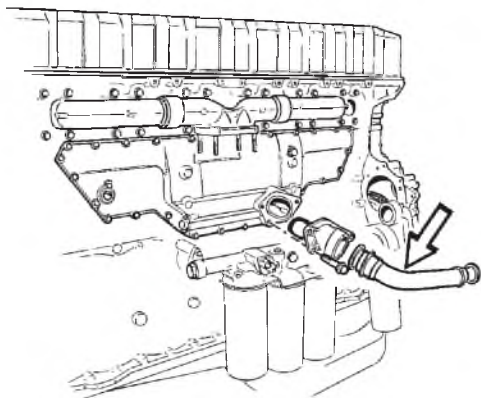
T2007234

Fig. 65: Radiator hose for thermostat housing

Install the top radiator hose neck to the thermostat housing using a new O-ring. Connect the cam sensor wiring harness.



58



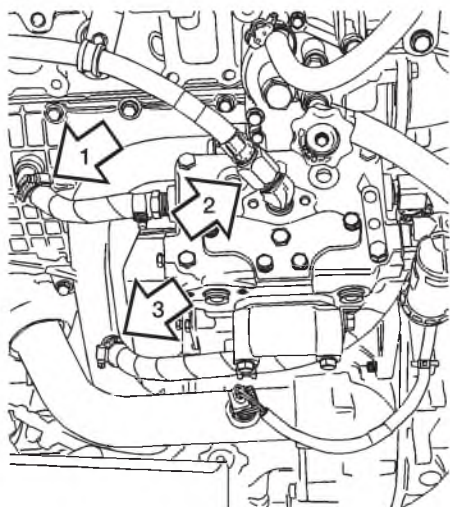
T2006693

Fig. 66: Installing the water pump

Clean and install the water pump to the oil cooler cover pipe using a new gasket and seal. Connect the VEB temperature sensor wiring harness. Torque the 3 mounting bolts to  $24 \pm 4$  Nm ( $18 \pm 3$  ft-lb).

$24 \pm 4$  Nm  
( $18 \pm 3$  ft-lb)

59



W2002338

Fig. 67: Hoses for the air compressor

Connect the air compressor coolant supply hose (1) to the oil cooler cover. Hand-tighten the hose clamp.

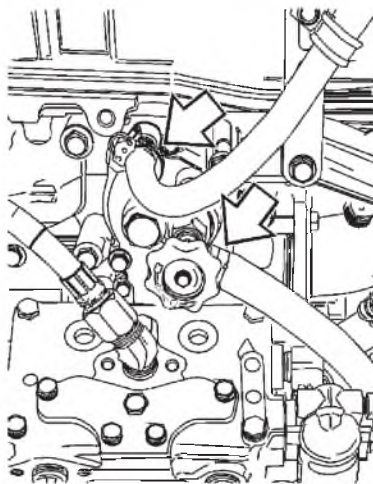
60

Connect the air compressor discharge line (2) to the air compressor.

61

Connect the air compressor coolant return hose (3) to the bypass pipe. Hand-tighten clamp.

62



W2002339

Fig. 68: Hoses to the thermostat housing

Connect the 2 hoses (heater and bleed hoses) to the thermostat housing. Hand-tighten the hose clamps.

63

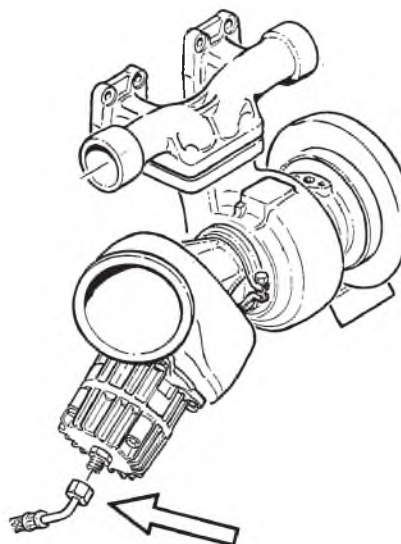
Install the lower right exhaust manifold bolt and torque to  $47 \pm 8$  Nm ( $35 \pm 6$  ft-lb).

$47 \pm 8$  Nm  
( $35 \pm 6$  ft-lb)

64

Add coolant and inspect for leaks.

65



T2006942

Fig. 69: Connecting the EPG air line

Position the centering ring and EPG against the exhaust pipe. Hand-tighten the clamp bolt only. Connect the EPG air line.

66

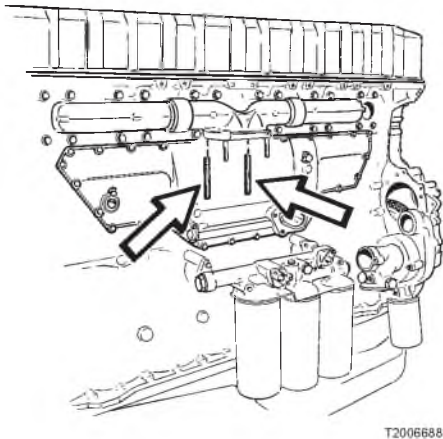


Fig. 70: Turbocharger mounting studs

Install the turbocharger mounting studs.

67

Install the turbocharger, see;

**Service Manual** 250–600  
*Intake and Exhaust-Systems, D12, D12A, D12B, D12C*

**IPMPACT** Function Group  
Information Type: Repair  
"Turbocharger"

68

Tighten the EPG to exhaust pipe clamp. Torque the clamp bolt to  $60 \pm 10$  Nm ( $44 \pm 7$  ft-lb).

69

Start the engine, check for proper operation, and inspect for leaks.

## 2229-03-02-06 Oil Filter Nipple, Replacement

1

Remove oil filters.

2

If the oil filter nipples are loose remove them.

3

Clean the filter base with appropriate cleaning solution.

4

Use an air gun to blow the dirt out of the oil filter base threads.

5

Install thread lock 577 on the nipple threads.

6

Thread the nipple back into the oil filter base by hand until it stops.

7

Thread the nipple installer into the nipple.

8

Use the nipple installer wrench, 9998691, to hold the outer nut.

9998691

9

Using a torque wrench on the jam nut, torque the nut to  $40 \text{ nm} \pm 5$  ( $30 \pm 4$  ft-lb). Remove the torque wrench.

10

Use a pull bar to loosen the jam nut with the wrench holding the outer nut.

11

Remove the nipple installer from the filter base.

12

Let the locktite set up for about 5 minutes before putting the filter back on.

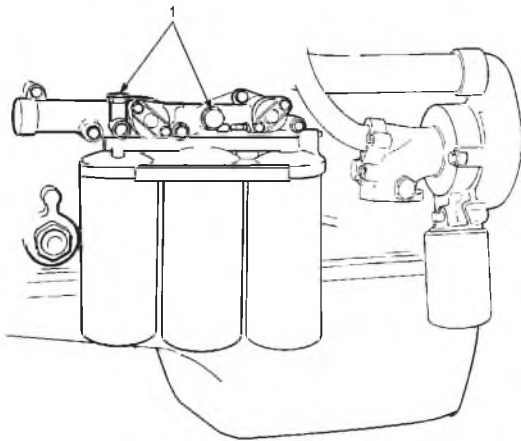
13

Moisten the o-ring on the oil filter with clean engine oil. Put the filter in place and torque to  $15 \text{ nm} \pm 5$  ( $10 \pm 3$  ft-lb).



## 2229-03-02-01 Oil Filter Overflow Valve, Re- placement

1



C2000653

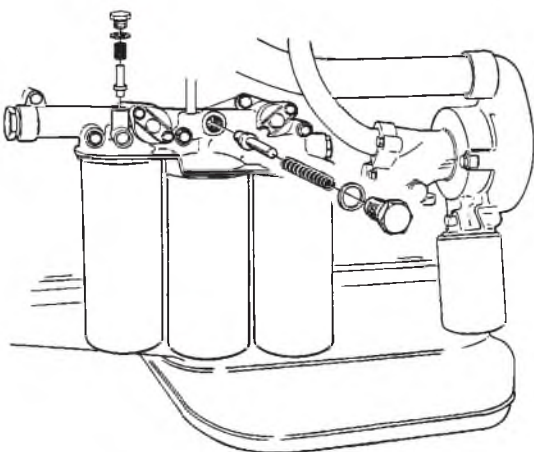
Overflow valve (bypass)

Clean oil filters bracket and remove valves caps (1).  
Remove valves needles and springs.

2

Clean and check valve seats. If valve seat is corroded, oil filters bracket must be changed.

3



C2000646

Fig. 71: Valve needles and springs

Assemble new valve needles and springs.  
Assemble and tighten cap. Use a new seal ring.

4

Start engine and check for leaks.



# Feedback

One of our objectives is that workshop personnel should have access to correct and appropriate service manuals where it concerns fault tracing, repairs and maintenance of Volvo trucks.

In order to maintain the high standards of our literature, your opinions and experience when using this manual would be greatly appreciated.

If you have any comments or suggestions, make a copy of this page, write down your comments and send them to us, either via telefax or mailing directly to the address listed below.

To

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7825 National Service Road

P.O. Box 26115

Greensboro, NC 27402-6115

USA

Fax (336) 393-3170

From

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Comments/proposals

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Concerns Service Manual: .....



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**VOLVO**

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6490 Vipond Drive, Mississauga, Ontario L5T 1W8

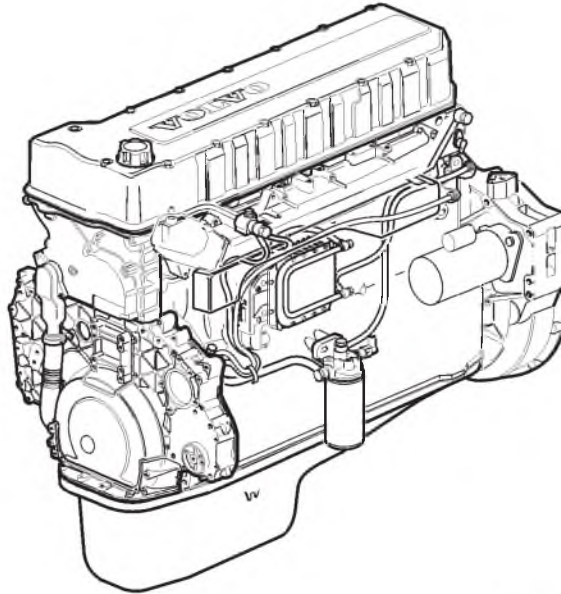
<http://www.volvotrucks.volvo.com>

This TSI Service Bulletin and others in Groups 21 and 33 replace TSI Service Manual 210–600, “Basic Engine, D12, D12A, D12B, D12C” (08.2000), publication no. PV776–TSP142853.

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## Piston to Connecting Rod D12, D12A, D12B, D12C

### Piston to Connecting Rod



W2003244

Fig. 1: VOLVO D12C Engine

This information covers procedures for replacing the piston connecting rod of VOLVO D12 engines.

### Contents

- [“Special Tools” page 2](#)
- [“Piston to Connecting Rod, Replacement” page 3](#)



## Tools

### Special Tools

The following special tools are used to replace or repair components. The tools can be ordered from Volvo; please use the specified part number when ordering.



**9991801**



**9992013**



**9996956**  
Flywheel turning tool



**9996966**  
Clamping tool

## Service Procedures

### 2132-03-05-01 Piston to Connecting Rod, Re- placement

 **CAUTION**

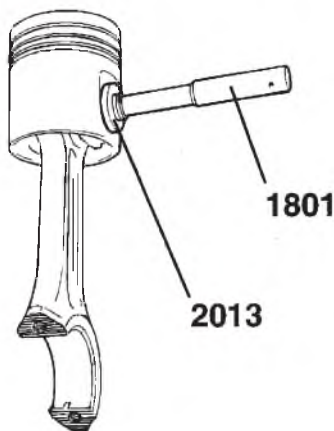
Observe the greatest possible cleanliness when working on the cylinder head. Dirt particles in the fuel and oil channels can cause the unit injectors to malfunction, and can cause the VEB (if equipped) to fail.

*Special tools: 9991801, 9992013*

#### Removal

**1**  
Remove the snap rings from the old piston.

**2**



T2007070

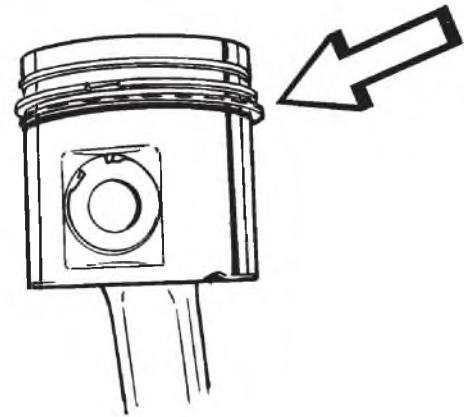
Fig. 2: Removing piston from connecting rod

Remove the piston pin using drift 9991801  
9992013 and handle 9991801. 9992013

**3**

Remove the connecting rod.

**4**



T2007066

Fig. 3: Piston rings

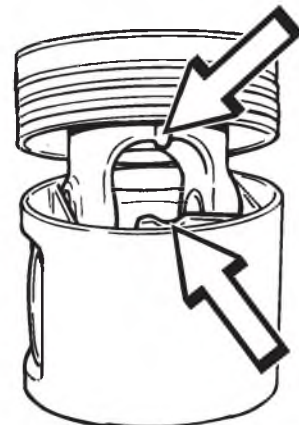
If the piston rings are to be removed and reinstalled, use piston ring pliers.

#### Installation

**1**

Install one snap ring into the piston sleeve.

**2**



T2007069

Fig. 4: Assembling the piston and the piston skirt

Assemble the upper and lower sections of the piston so that the stud in the upper section of the piston mates with the recess in the bottom section.

**Note:** Heat the piston skirt to 100 °C (212 °F) if necessary for easier assembly.

3

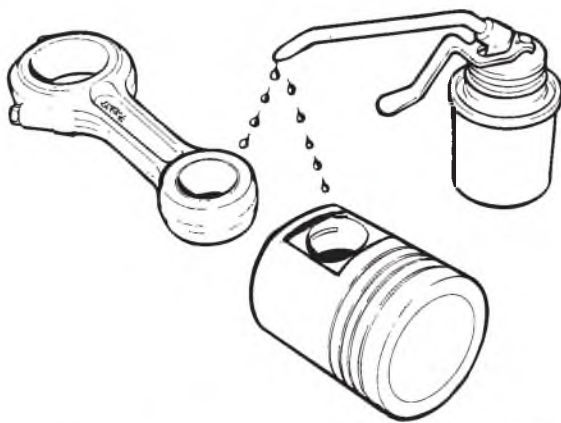


T2007068

Fig. 5: Installing the piston pin

Install the piston pin to hold the piston halves together.

4

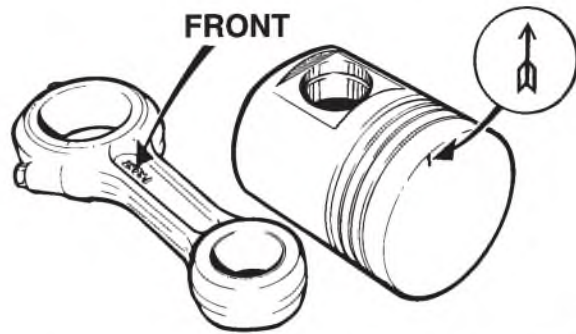


T2007092

Fig. 6: Piston and piston pin lubrication

Lubricate the piston pin, piston pin bushings, and connecting-rod bushing with engine oil.

5

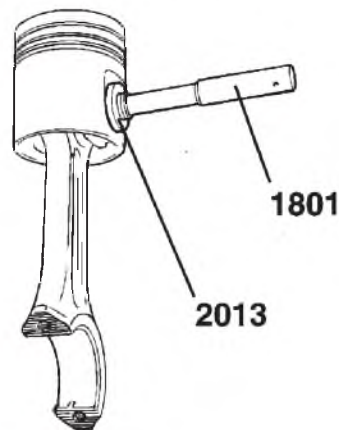


T2007067

Fig. 7: Piston and connecting rod

Align the connecting rod with piston so that the "Front" marking on the connecting rod and arrow on the piston are facing in the same direction.

6



T200707C

Fig. 8: Installing piston pin

Press in the piston pin using drift 9992013 and handle 9991801.

**Note:** It should be possible to lightly press in the piston pin. Do not tap it in.

7

Install the other snap ring to hold the piston pin.

8

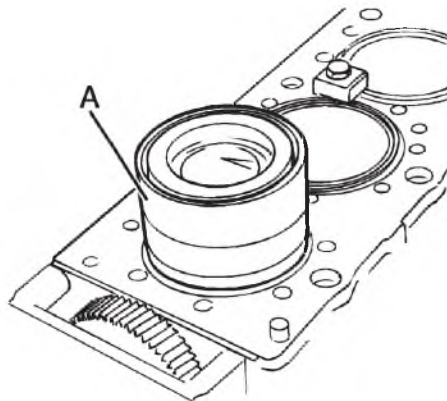
Make sure that the upper and lower sections of the piston can move easily relative to each other and that the piston pin moves freely in the connecting rod bushing.

9

Lubricate the piston and piston rings with engine oil.

**10**  
Make sure that the piston ring gaps are evenly staggered around the piston.

**11**



W2003725

Fig. 9: Installing piston and connecting rod

Install the piston and connecting rod with the arrow and front markings facing forward. Use tool (A) to guide the piston rings into the cylinder liner. **9996966**

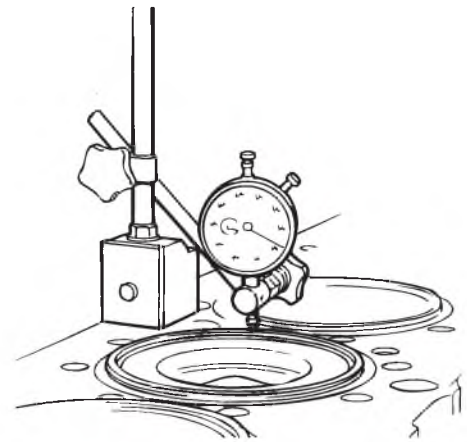
**Note:** Temporarily remove cylinder liner clamping tools 9996966 when using tool piston installation tool. When the piston is in position, reinstall clamping tools 9996966 onto the liner.

**12**  
Lubricate the crankshaft bearing shells and crankshaft pin with engine oil. Install the bearing shells and make sure that they are mounted correctly in the connecting rod and bearing cap.

**13**  
Install the bearing cap according to the marking and tighten the bolts by hand.

**14**  
Make sure clamping tools 9996966 are in position and carefully rotate the flywheel with flywheel turning tool 9996956 until the piston reaches bottom dead center. Torque tighten the rod bearing cap bolts to  $275 \pm_{0}^{25}$  Nm ( $205 \pm_{0}^{11}$  ft-lb). **9996956**  
**9996966**

**15**



T2007059



T2007058

Fig. 10: Measuring the height of the piston

With piston at TDC, measure the height of the piston above the cylinder block face. The height should be 0.15 – 0.65 mm (0.006 – 0.026 in.).

**Note:** It is not necessary to measure the piston height if the cylinder block has **not** been machined.

**16**  
Remove flywheel turning tool 9996956. **9996956**

**17**  
Install and torque-tighten the piston cooling jet to  $24 \pm 4$  Nm ( $18 \pm 3$  ft-lb). **24 ± 4 Nm**  
(**18 ± 3 ft-lb**)

**Note:** Check that the piston cooling jet is not damaged. A damaged jet must be replaced. Also make sure that the jet is directed toward the recess on the piston.

## Timing Gear Cover

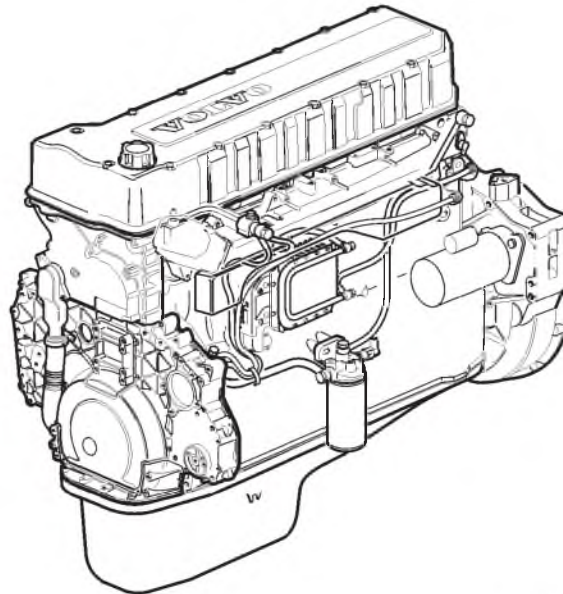


Fig. 1: VOLVO D12C Engine

W2003244

This information covers procedures for replacing the timing gear cover on VOLVO D12C engines.

### Contents

- [“Special Tools” page 2](#)
- [“Timing Gear Cover, Replacement” page 3](#)

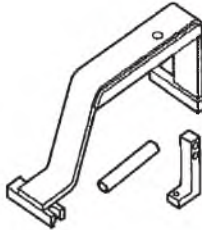
## Tools

### Special Tools

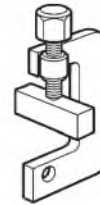
The following special tools are used to replace or repair components. The tools can be ordered from Volvo; please use the specified part number when ordering.



**9996049**  
Drain hose



**9998602-2**  
**9998602-6**  
Upper Front Cover Alignment Tools



**9998628**  
Press tool

## Service Procedures

### 2151-03-02-02 Timing Gear Cover, Replacement



Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

*Special tools: 9996049, 9998602, 9998628*

#### Removal

**1**  
Remove the radiator assembly; see Service Information, Group 26.

**2**  
Remove the fan ring.

**3**  
Remove the fan stud nuts and the fan.

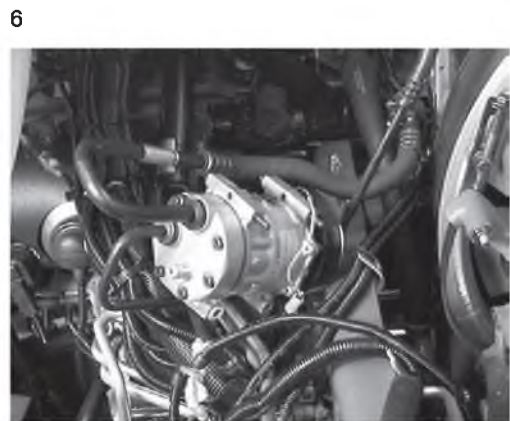
**Note:** When removed from the vehicle, the thermostat-controlled fan can be stored vertically **or** horizontally with the front (bimetal strip) downwards, **without** causing oil to leak internally.



C2002628

Remove the belts.

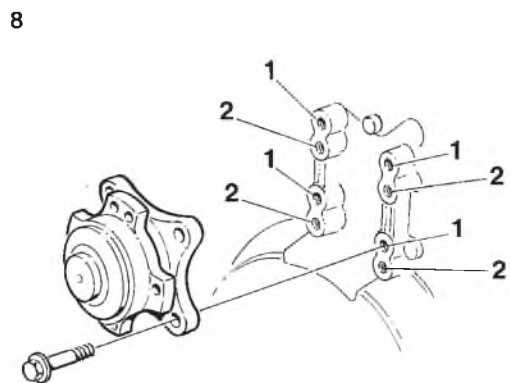
**5**  
Remove the fuel pump drive pulley and the fan pulley.



T2012862

Remove the alternator and air conditioning compressor.

**7**  
Remove the support for the alternator and air conditioning, which is fastened to the timing gear cover.



T2007260

Remove the fan hub.

**9**  
Remove the fuel pump driveshaft.

**10**  
Remove the fan belt tensioner.

**11**  
Remove the plate on the timing gear cover.



**12**  
Remove the air pipe connecting the coil to the air drier.

**13**  
Remove the vent pipe for the timing gear top cover.

**Note:** Loosen the compressor air pipe to remove the vent pipe.

**14**  
Remove the water pipe for the thermostatic valve box, which is fastened to the timing gear cover.

**15**  
Remove the sump front bolts in the timing gear cover.

**16**  
Remove the valve cover.

**CAUTION**

Do not use an impact wrench to remove the bolts. Doing so may loosen the bolts from the cylinder head and can damage the electrical wiring and the valve cover.

**17**  
Remove the camshaft sensor. Save the shims to reuse them when installing the sensor.

**18**  
Remove the timing gear top cover.

**19**  
Remove the timing gear bottom cover.

**Note:** Do not use spatulas on the cover sealing area while removing the cover. Doing so may damage the cover and cause leakage.

## Installation

1

**WARNING**

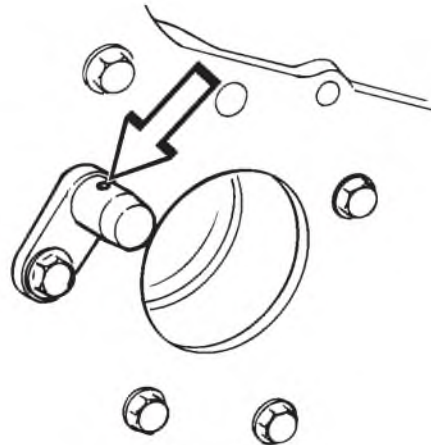
Always wear appropriate eye protection to prevent the risk of eye injury due to contact with debris or fluids.

Clean the engine surface by carefully removing all sealant residue.

**Note:** Protect all gears; do not let tools, objects, or dirt fall inside the oil pan.

2  
Thoroughly clean the timing gear cover.

3

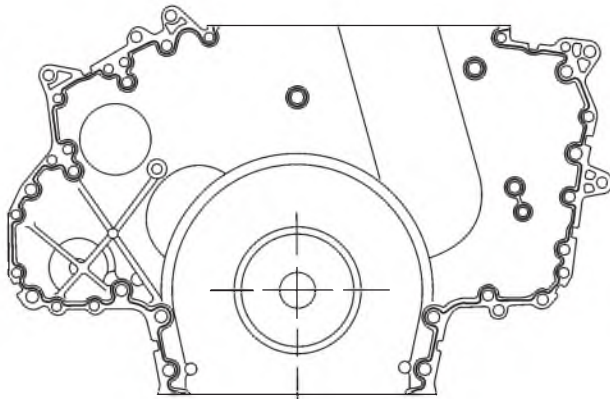


T2009026

Remove the oil injector nozzle from the timing gear plate and check to make sure that the oil channel is not clogged.

4  
Install the oil injector nozzle and torque-tighten the bolt to  $33 \pm 4$  Nm ( $24 \pm 3$  ft-lb).

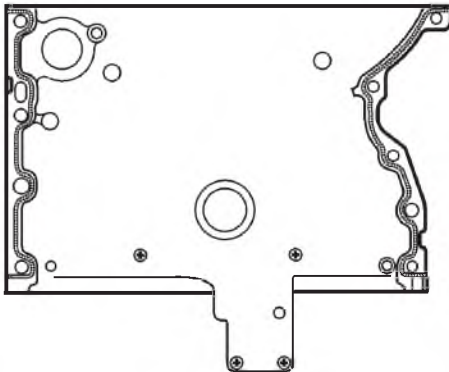
5



C2002668

Apply an even 2 mm bead of Volvo silicone (part no. 1161247) to the inside of the timing gear lower cover and install it in place. Torque-tighten the lower cover bolts to  $34 \pm 4$  Nm ( $25 \pm 3$  ft-lb).

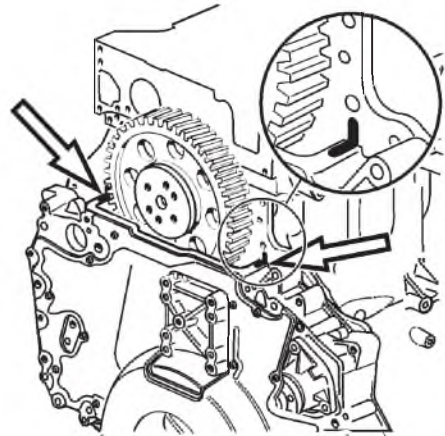
6



T2015004

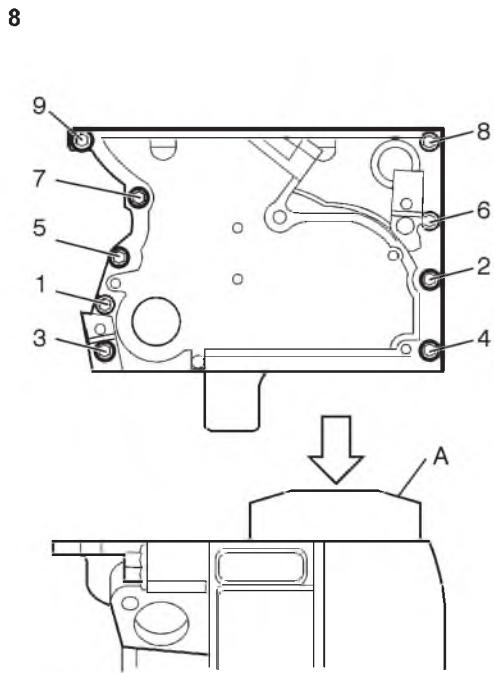
Apply an even 2 mm bead of Volvo silicone on the inside of the timing gear top cover.

7



T2015008

Apply an even 2 mm bead of Volvo silicone on the edge between the timing gear bottom cover and the cylinder head.



T2014150

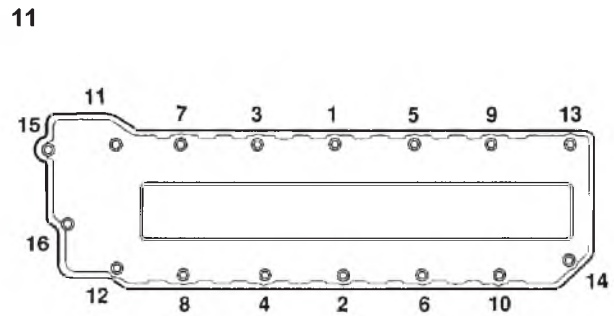
Fig. 2: Upper timing gear cover, tightening sequence

Install the timing gear top cover. Install the alignment tools 9998602-2 and 9998602-6 and tighten them by pressing the timing gear cover down so that the sealing surfaces between the valve cover, the cylinder head and the timing gear cover are lined up. Torque-tighten the upper cover bolts to  $34 \pm 4$  Nm ( $25 \pm 3$  ft-lb) following the proper tightening sequence shown.

**Note:** Install and tighten down the timing gear cover within 20 minutes after having applied the sealant.

**9**  
After torque-tightening the bolts, wait a few minutes for the silicone to harden, then remove the alignment tools.

**10**  
Install the camshaft sensor. Adjust the sensor clearance.



T2012845

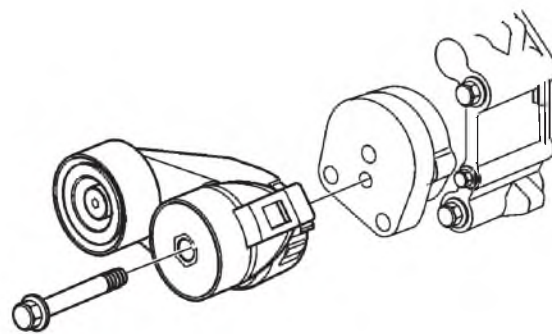
Fig. 3: Valve cover tightening sequence

Install the valve cover and torque-tighten the bolts to  $20 \pm 2$  Nm ( $15 \pm 1.5$  ft-lb) and according to the sequence shown (see Fig. 4: Valve cover tightening sequence, page 6).

**Note:** Check that the nut flanges and rubber seals fit the valve cover holes properly to prevent damage to the valve cover.

**12**  
Install the oil pan bolts in the timing gear cover.

**13**

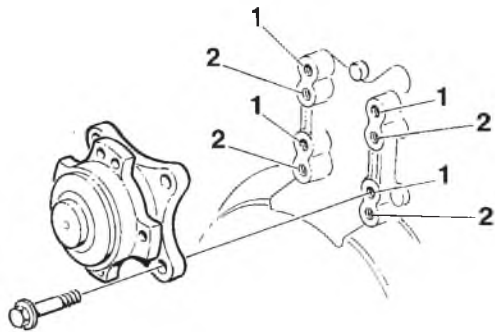


C2002643

Install the plate for the fan belt tensioner in the timing gear cover and install the fan belt tensioner.

**14**  
Install the hub for the fuel pump drive-shaft.

15



T2007260

Install the fan hub.

16

Install the venting pipe in the timing gear top cover.

17

Install the support for the alternator and for the air conditioning compressor in the timing gear cover. Install the alternator in the support.

18

Install the air conditioning compressor. Connect the electrical wiring for the air conditioning compressor.

19

Install the pulleys.

20

Install the belts and adjust the alternator belt.

21

Install the air compressor coil.

22

Install the water pipe for the thermostatic valve box.

23

Install the fan and fan ring.

24

Install the radiator assembly; refer to Service Information, Group 26.

25

Fill up the reservoir with coolant.

26

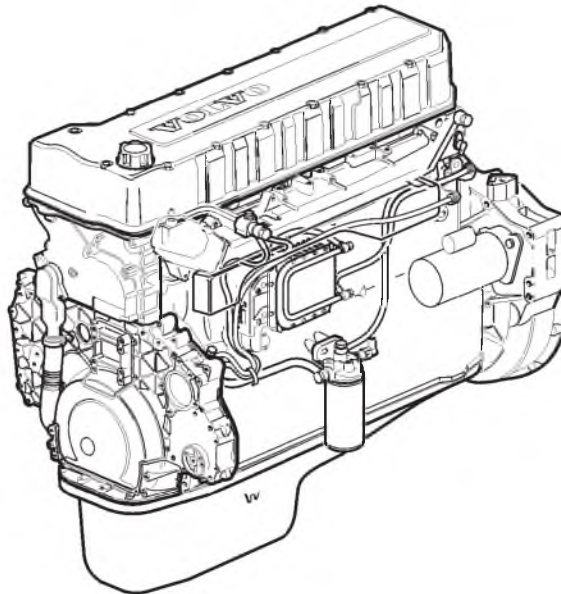
Start the engine and check for leaks.

This TSI Service Bulletin and others in Groups 21 and 33 replace TSI Service Manual 210–600, “Basic Engine, D12, D12A, D12B, D12C” (8.2000), publication no. PV776–TSP142853.

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## Timing Gear Plate D12, D12A, D12B, D12C

### Timing Gear Plate



W2003244

Fig. 1: VOLVO D12C Engine

This information covers procedures for servicing the timing gear plate on VOLVO D12, D12A, D12B, and D12C engines.

### Contents

- [“Special Tools” page 2](#)
- [“Timing Gear Plate Sealant, Replacement” page 3](#)

## Tools

### Special Tools

The following special tools are used to replace or repair components. The tools can be ordered from Volvo; please use the specified part number when ordering.



**9998267**  
Guide Sleeves

## Service Procedures

### 2153-03-05-01 Timing Gear Plate Sealant, Re- placement

(Timing gears, coolant pump, power steering pump,  
and air compressor removed)



Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

Special tools: 9998267

1

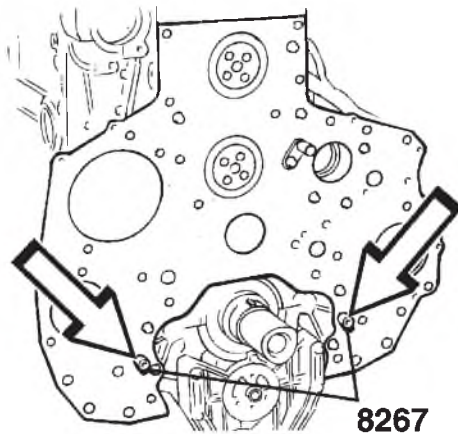


Fig. 2: Guide sleeves for timing gear plate (D12B shown)

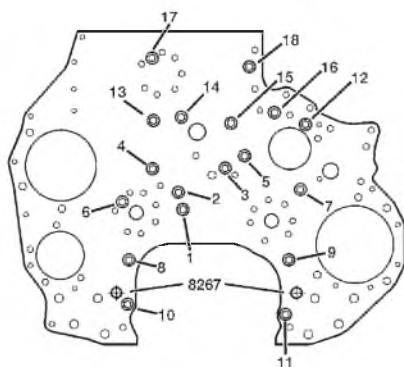
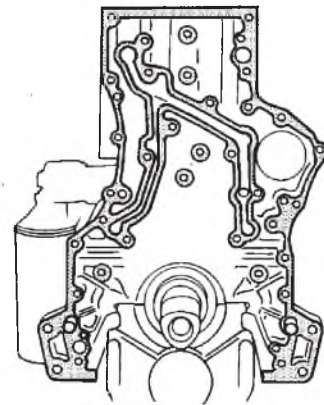


Fig. 3: Guide sleeves for timing gear plate (D12C shown)

Install two guide sleeves 9998267 in the guide holes for the timing gear plate. Remove the bolts (1-18) that hold the plate to the cylinder block. Carefully tap the plate free.

2



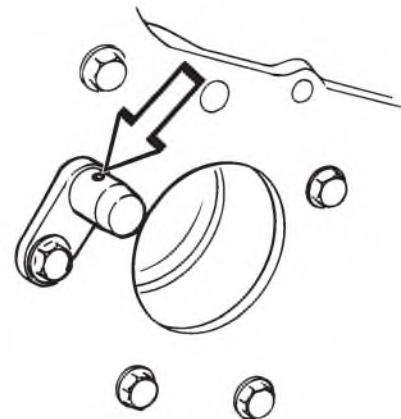
T2007131

Fig. 4: Contact surfaces (D12C shown)

Carefully clean the contact surfaces of the plate and cylinder block, making sure they are free of oil and/or oil residue.

**Note:** Do not remove the guide sleeves.

3



T2006740

Fig. 5: Lube oil nozzle

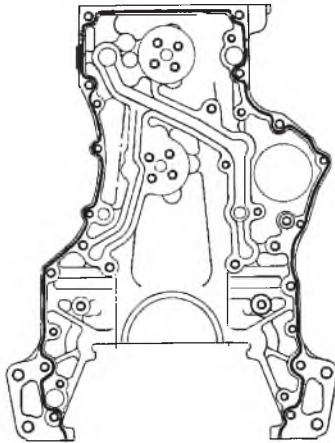


**! WARNING**

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with debris or fluids.

Remove the lube oil nozzle from the timing gear plate and use compressed air to clean the lube holes.

4

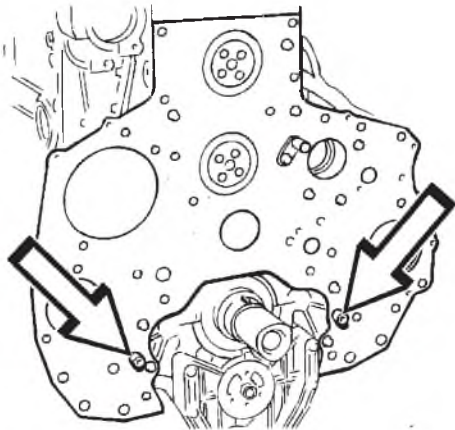


T2007132

Fig. 6: Sealant application (D12B shown)

Apply a 2 mm (0.08 in.) bead of Volvo silicone on the cylinder block as shown in accompanying figure.

5



T2006741

Fig. 7: Guide sleeves (D12B shown)

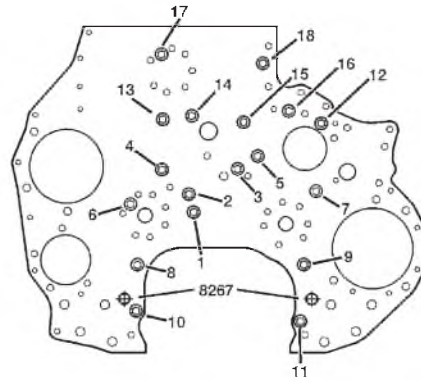
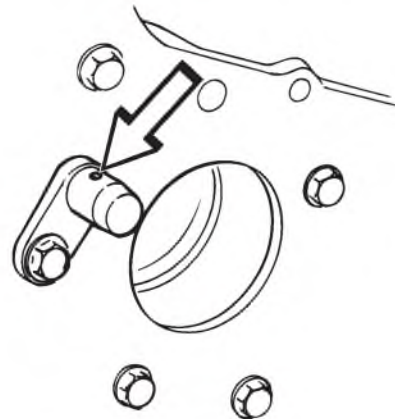


Fig. 8: Guide sleeves (D12C shown)

W2003462

Install the timing gear plate on the cylinder block **within 20 minutes** of sealant application. Torque-tighten bolts to  $33 \pm 4$  Nm ( $24 \pm 3$  ft-lb) following the tightening sequence shown (1±18).

6



T2006740

Fig. 9: Lube oil nozzle

Install the lube oil nozzle.

7

Remove the guide sleeves (9998267). 9998267

This TSI Service Bulletin and others in Groups 21 and 33 replace TSI Service Manual 210–600, “Basic Engine, D12, D12A, D12B, D12C” (8.2000), publication no. PV776–TSP142853.

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## Timing Gears Replacement D12, D12A, D12B

### Timing Gears Replacement

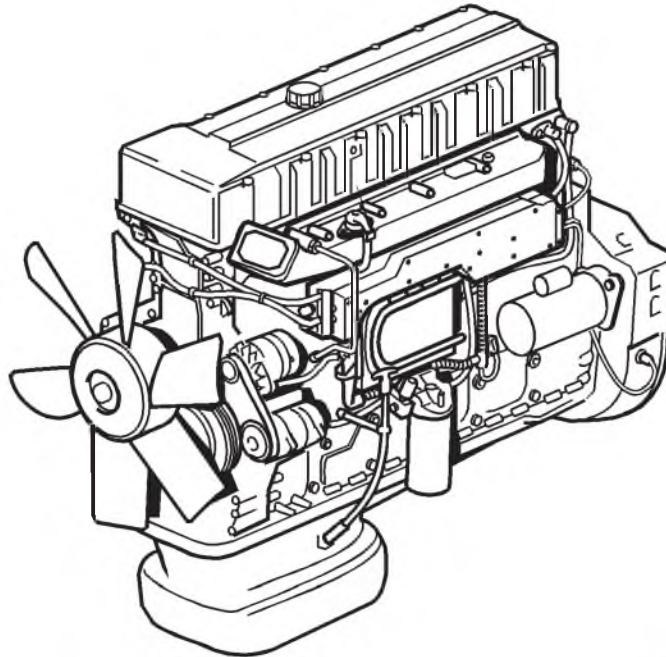


Fig. 1: VOLVO D12B Engine

W2002853

This information covers procedures for replacement of the timing gears on VOLVO D12, D12A, and D12B engines.

### Contents

- [“Special Tools” page 2](#)
- [“Timing Gears, Replacement \(All\)” page 4](#)

## Tools

### Special Tools

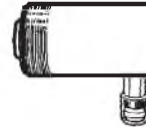
The following special tools are used to replace or repair components. The tools can be ordered from Volvo; please use the specified part number when ordering.



**9992584**  
Hollow Drift



**9992658**  
Crankshaft Drive Gear Puller



**9992671**  
Hydraulic Cylinder, 18-ton capacity



**9996160**  
Pins, used with Yoke 9996358



**9996222**  
Foot Pump



**9996315**  
Spindle



**9996358**  
Timing Gear Yoke



**9996401**  
Puller Arms



**9996413**  
Adapter



**9996600**  
Hydraulic Cylinder, 10-ton capacity



**9996603**  
Adapter



**9996626**  
Hollow Drift



**9996950**  
Flywheel Blocking Tool



**9996956**  
Flywheel Turning Tool



**9996958**  
Polygon Hub Puller



**9996972**  
Puller



**9996973**  
Drift



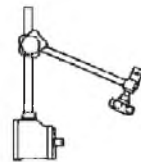
**9998269**  
Gear Wheel Puller



**9998270**  
Counterhold



**999683**  
Rocker Dial Indicator



**999696**  
Magnetic Stand

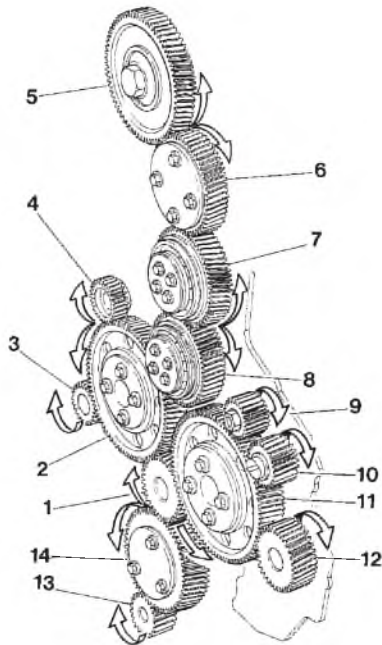
# Service Procedures

## 2153-03-03-01 Timing Gears, Replacement (All)

(Oil pan and timing gear cover removed)

### WARNING

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.



T2006852

Fig. 2: Timing gear arrangement

**Description (no. of teeth):**

- 1 Crankshaft Drive Gear (36)
- 2 Idler Gear, 36 mm (87)
- 3 Coolant Pump Drive Gear (24)
- 4 Air Compressor Drive Gear (27)
- 5 Camshaft (72)
- 6 Adjustable Idler Gear (58)
- 7 Upper Idler Gear (60)
- 8 Lower Idler Gear (58)
- 9 Power Steering Pump Drive Gear (22)
- 10 Drive Gear Arrangement (Accessory Drive Pulley and Fuel Feed Pump) (26)
- 11 Power Take Off (PTO) Idler Gear, 28 mm (87)
- 12 Power Take Off (PTO) Drive Gear for Hydraulic Pump (37)
- 13 Oil Pump Drive Gear (24)
- 14 Oil Pump Idler Gear (57)

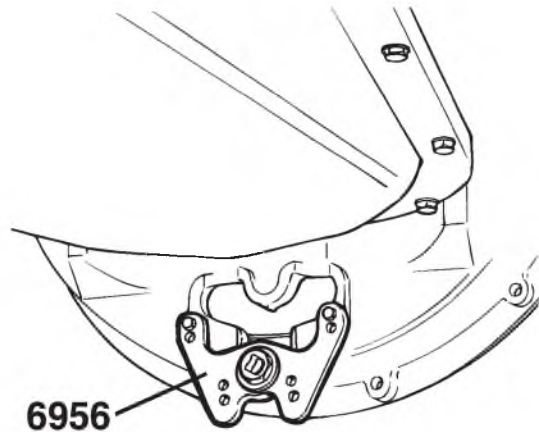
### CAUTION

Never turn the crankshaft or camshaft when the timing gears have been removed. Otherwise, the pistons can come into contact with the valves resulting in damage to engine components.

*Special tools: 9992584, 9992658, 9992671, 9996160, 9996222, 9996315, 9996358, 9996401, 9996413, 9996600, 9996603, 9996626, 9996900, 9996950, 9996956, 9996958, 9996965, 9996972, 9996973, 9998270, 9999683, 9999696*

### Removal of Drive and Idler Gears

1

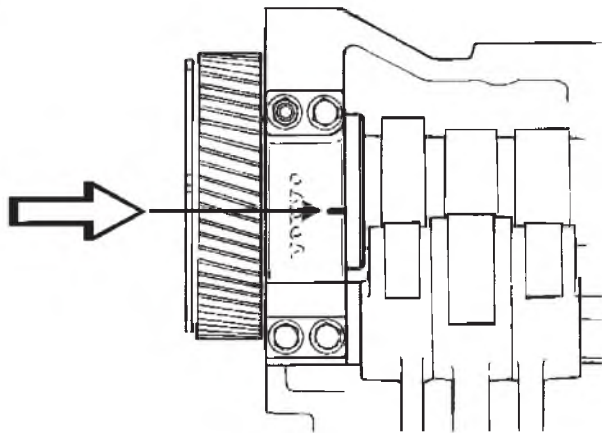


T2006672

Fig. 3: Cranking tool installed

Remove the inspection cover from beneath the flywheel housing and install cranking tool 9996956.

2

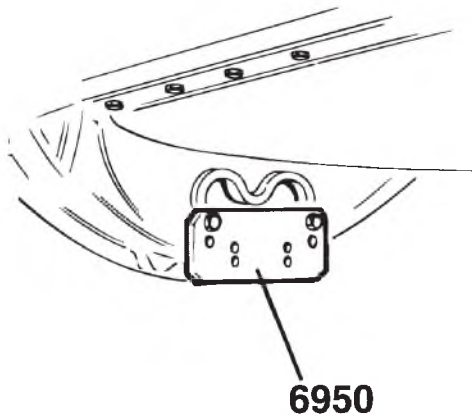


W2000936

Fig. 4: Aligning camshaft

Rotate the Øwheel until number 1 piston is at TDC and the camshaft marking is opposite the marking on the cap.

3

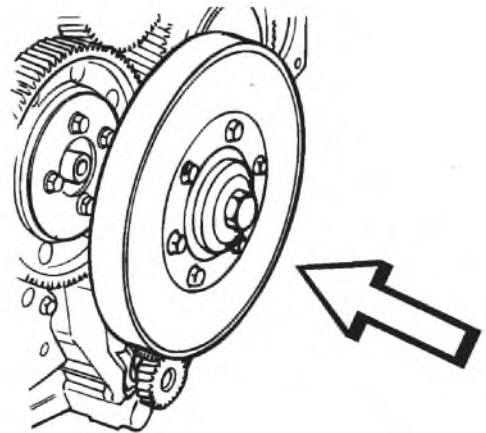


T2006666

Fig. 5: Blocking tool installed

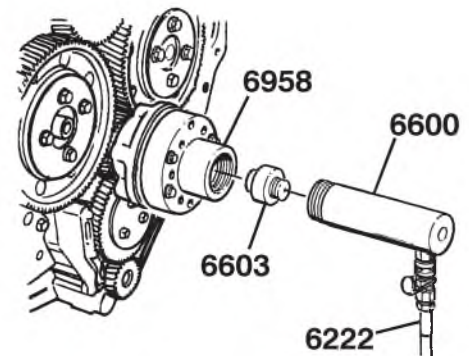
Remove cranking tool 9996956 and install blocking tool 9996950. 9996950 9996956

4



T2007076

Fig. 6: Vibration dampener



T2008984

Fig. 7: Removing polygon hub

Remove the vibration dampener. 9996958  
Remove the crankshaft bolt together with 9996413  
the washer. Secure the puller 9996600  
on the polygon hub. Fit adapter 9996603  
9996603 on hydraulic cylinder 9996600.  
Screw the hydraulic cylinder to the puller and pull off the polygon hub using foot pump 9996222.

5

Remove idler gears (see 2, 6 and 11, Fig. 2: Timing gear arrangement, page 4) from the timing gear plate.

6

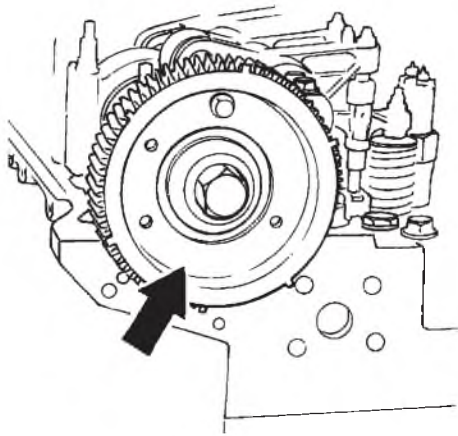
Remove the washers from the upper and lower idler gear (see 7 and 8, Fig. 2: Timing gear arrangement, page 4).

7

Remove the socket head bolts and remove upper and lower idler gears (see 7 and 8, Fig. 2: Timing gear arrangement, page 4). Use two screwdrivers to assist in removal.



8

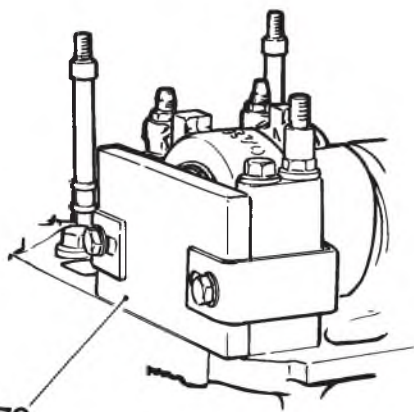


T2007096

Fig. 8: Cam sensor wheel

Remove the cam sensor wheel from the camshaft drive gear.

9

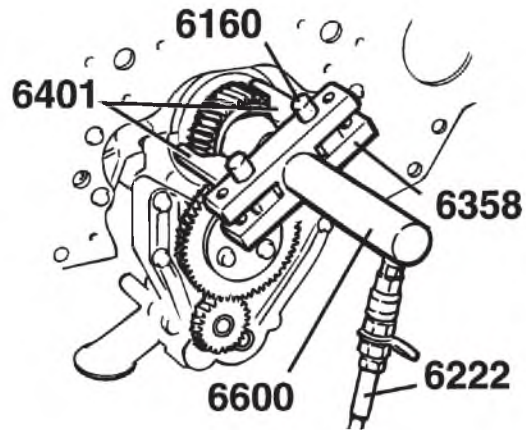


T2007148

Fig. 9: Installing counterhold tool

Attach the camshaft holding tool 9998270 to the rear camshaft support. Remove the camshaft gear retaining bolt and remove the camshaft drive gear (see 5, Fig. 2: Timing gear arrangement, page 4).

10



T2007072

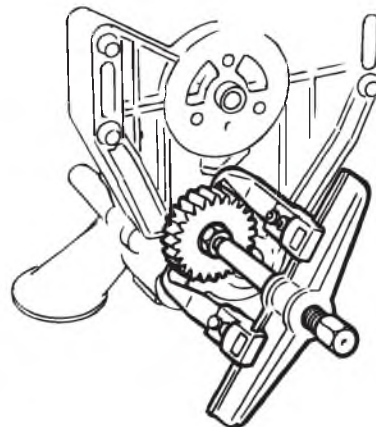
Fig. 10: Removing the crankshaft drive gear

Using cylinder 9996600, pins 9996160, puller arms 9996401, and yoke 9996358 connected to pump 9996222, remove the crankshaft drive gear (see 1, Fig. 2: Timing gear arrangement, page 4).

11

Remove the retaining bolts in the oil pump idler gear and remove the idler gear from the oil pump (see 14, Fig. 2: Timing gear arrangement, page 4).

12



T2007074

Fig. 11: Removing the oil pump drive gear

Install an M12x20 bolt in the shaft for the oil pump drive gear (see 13, Fig. 2: Timing gear arrangement, page 4). Remove the gear, using tool 9996972 and drift 9996973.



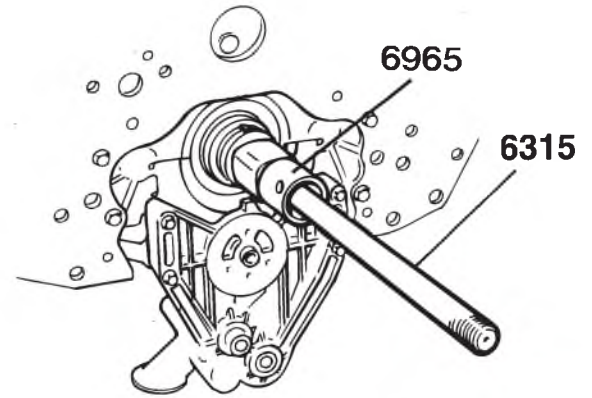
**13**  
Remove the air compressor drive gear (see 4, Fig. 2: Timing gear arrangement, page 4).

**14**  
Remove the power steering pump drive gear (see 9, Fig. 2: Timing gear arrangement, page 4).

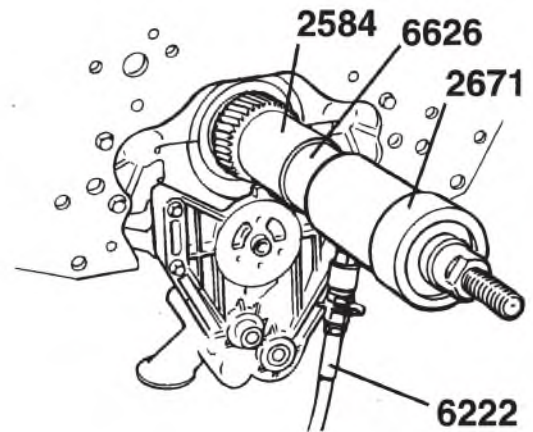
**15**  
Install puller 9998269 onto the coolant pump drive gear (see 3, Fig. 2: Timing gear arrangement, page 4). Place a plug on the shaft as a support and pull off the gear.

**Installation of Drive and Idler Gears**

**16**



T2007151



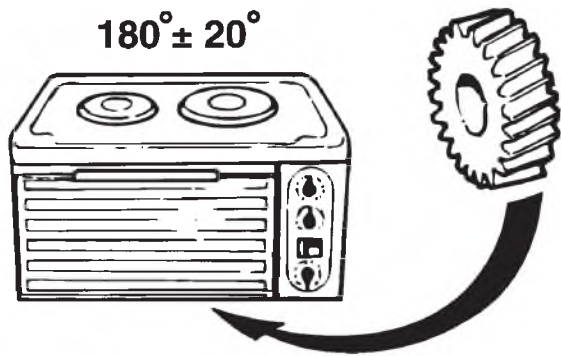
T2007080

Fig. 12: Installation of crankshaft drive gear

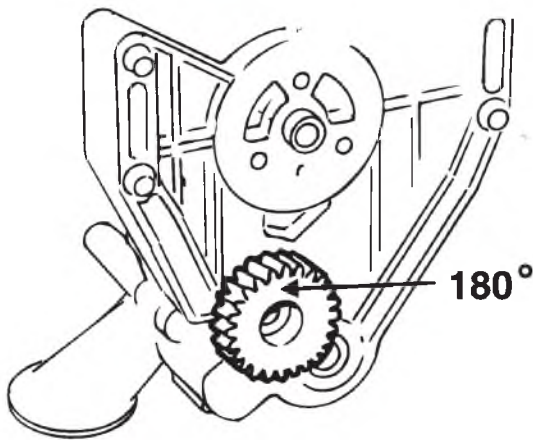
Install adapter and spindle on the crankshaft. Install the new crankshaft drive gear (see 1, Fig. 2: Timing gear arrangement, page 4) on the spindle. Install drifts 9992584 and 9996626 and hydraulic cylinder 9992671. Install the nut and carefully press on the drive gear, using pump 9996222.

**Note:** Make sure that the key remains in position in the keyway. Remove the tools.

17



T2007078



T2007079

Fig. 13: Installation of the oil pump drive gear

Heat the oil pump drive gear (see 13, Fig. 2: Timing gear arrangement, page 4) to approximately 180°C (360°F) and tap it onto the lube oil pump.

18

Install the air compressor drive gear (see 4, Fig. 2: Timing gear arrangement, page 4).

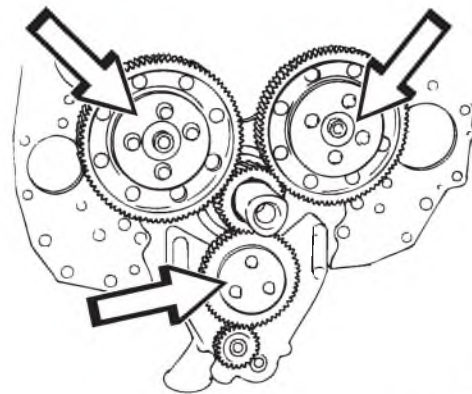
19

Install the power steering pump drive gear (see 9, Fig. 2: Timing gear arrangement, page 4).

20

Apply assembly paste to the coolant pump shaft. Install the spindle into the shaft. Place the coolant pump drive gear (see 3, Fig. 2: Timing gear arrangement, page 4) onto the spindle and press the gear on with the help of the hydraulic cylinder.

21



T2007082

Idler gears

Lubricate the oil pump idler gear (see 14, Fig. 2: Timing gear arrangement, page 4) bearing and install. Torque-tighten bolts to 24 ± 4 Nm (18 ± 3 ft-lb).

24 ± 4 Nm  
(18 ± 3 ft-lb)

22

Lubricate the bearings for idler gears (see 2 and 11, Fig. 2: Timing gear arrangement, page 4). Place them into position and torque-tighten bolts to 15 ± 3 Nm (11 ± 2 ft-lb). Turn an additional 120 ± 5°.

15 ± 3 Nm  
(11 ± 2 ft-lb)  
120 ± 5°

**Note:** New bolts must be used each time the idler gear is loosened or removed; these bolts are designed for single use only and cannot be torqued a second time.

23

Install upper and lower idler gears (see 7 and 8, Fig. 2: Timing gear arrangement, page 4). Torque-tighten the socket head bolts to 15 ± 3 Nm (11 ± 2 ft-lb). Turn an additional 120 ± 5°.

15 ± 3 Nm  
(11 ± 2 ft-lb)  
120° ± 5°

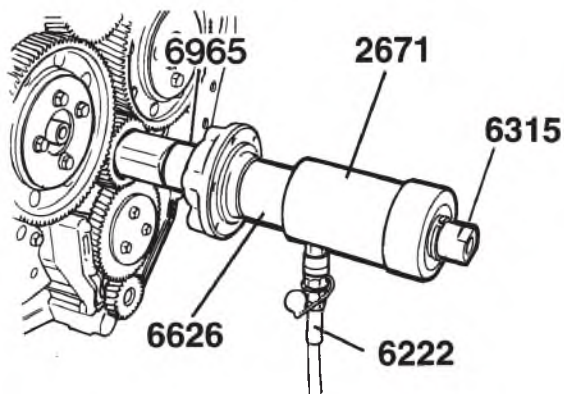
24

Install the washers for the idler gears and torque-tighten to 10 ± 2 Nm (7 ± 1 ft-lb). Turn an additional 60 ± 3°.

10 ± 2 Nm  
(7 ± 1 ft-lb)  
60 ± 3°

**Note:** New bolts must be used each time the idler gear is loosened or removed; these bolts are designed for single use only and cannot be torqued a second time.

25

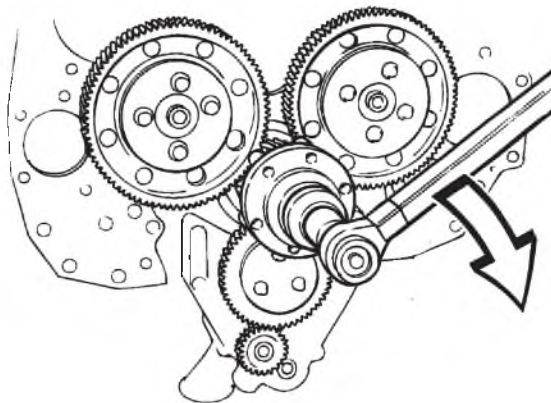


T2007155

Fig. 14: Installing polygon hub

Apply assembly paste to the crankshaft. Place the polygon hub, tool 9996626 and hydraulic cylinder 9992671 on 9996315. Install the nut 9996222 onto the spindle and use tool 9996222 to press on the polygon hub.

26



T2007125

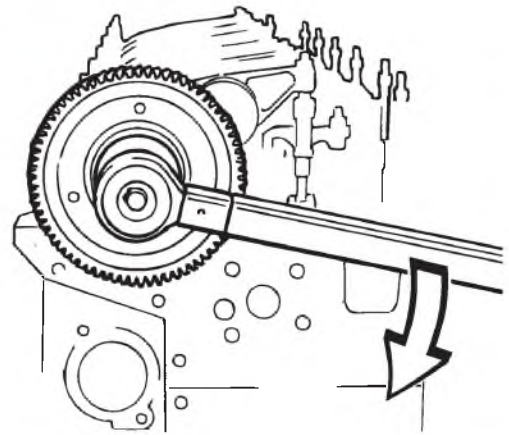
Fig. 15: Torque-tightening the crankshaft drive gear bolt

Remove the tools. Install the bolt and washer and torque-tighten to 645 ± 25 Nm (475 ± 18 ft-lb).

27

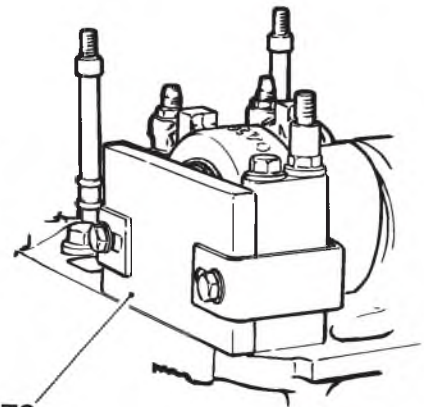
Remove blocking tool 9996950 from the flywheel housing and install flywheel turning tool 9996956.

28



T2007083

Fig. 16: Torque-tightening the camshaft drive gear bolt



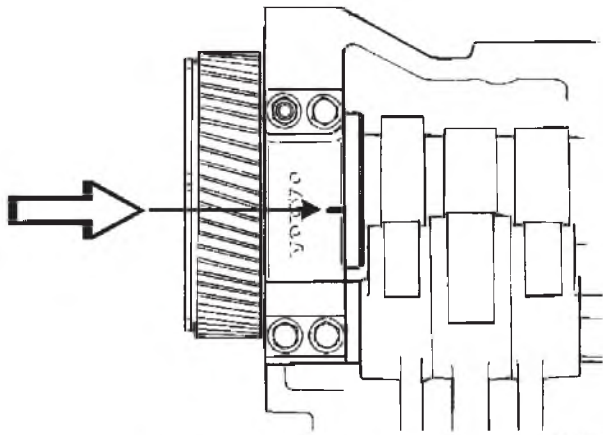
8270

T2007148

Fig. 17: Installing the camshaft drive gear

Install the camshaft drive gear. Use tool 9998270 as a support. Torque-tighten to 645 ± 25 Nm (475 ± 18 ft-lb).

29



W2000936

Fig. 18: Aligning the camshaft

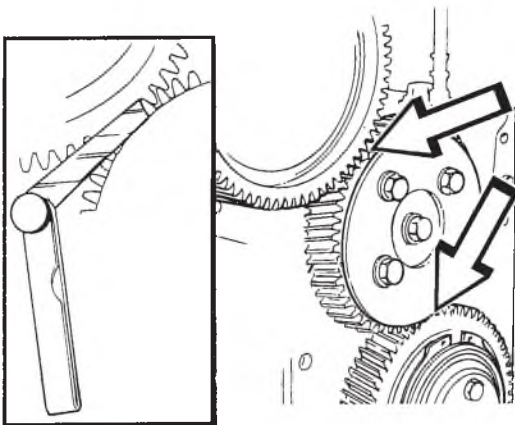
Make sure the  $\phi$ wheel is at  $0^\circ$  and that the camshaft is at TDC (see marking).

30

Install the adjustable idler gear (see 6, Fig. 2: Timing gear arrangement, page 4).

**Note:** Hand-tighten the bolts until they bottom against the bearing shield (these bolts will be individually replaced in a later step).

31

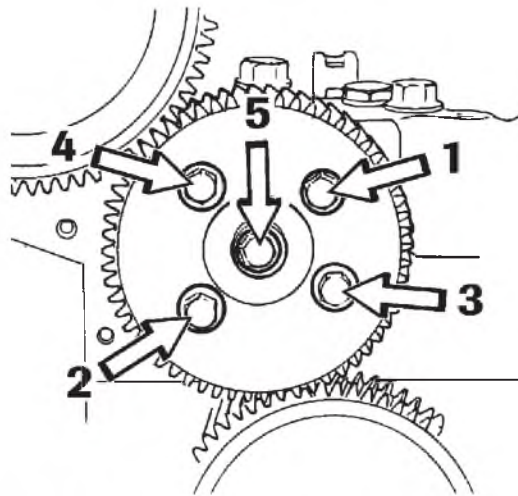


T2C07158

Fig. 19: Idler gear adjustment

Adjust the idler gear using two feeler gauges. The correct backlash is 0.05 – 0.17 mm (0.002 – 0.007 in.). By using feeler gauges, an equal amount of backlash between cam gear and the nonadjustable upper idler gear can be obtained.

32



W2000723

Fig. 20: Torque-tightening sequence for adjustable idler gear

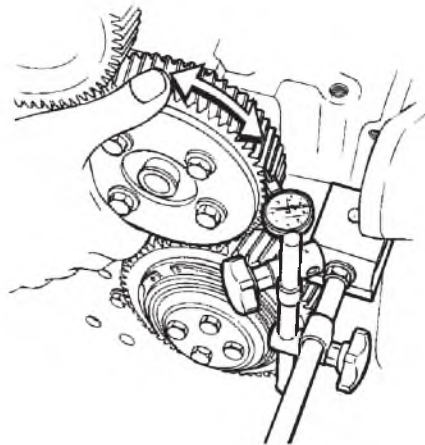
Use a two-step process to torque-tighten the idler gear bolts:

$15 \pm 3$  Nm  
( $11 \pm 2$  ft-lb)  
 $120 \pm 5^\circ$

- Tighten to  $15 \pm 3$  Nm ( $11 \pm 2$  ft-lb).
- Turn bolts an additional  $120 \pm 5^\circ$ .

**Note:** The bolts for the adjustable idler gear are **NOT** reusable. If they are loosened or removed, they **MUST** be replaced with new bolts.

33



T2007084

Fig. 21: Checking the backlash

After adjustment, check the backlash with rocker dial indicator 9999683 mounted on magnetic base 9999696.

9999683  
9999696

**Note:** It is important that backlash is the same for both gear wheels which mesh with the adjustable idler gear.

**34**

Install the cam sensor wheel on the camshaft drive gear. Install and torque-tighten the three bolts to 25 Nm (19 ft-lb).

25 Nm  
(19 ft-lb)

**35**

Install the vibration damper and torque-tighten bolts to 50 ± 5 Nm (37 ± 4 ft-lb).

50 ± 5 Nm  
(37 ± 4 ft-lb)

**Note:** New bolts should be used.

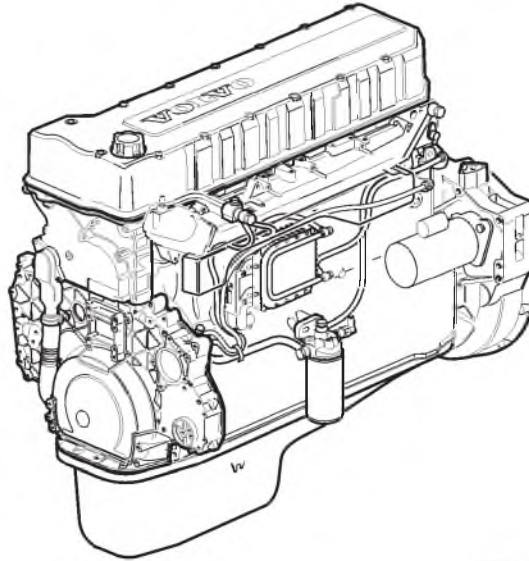


This TSI Service Bulletin replaces TSI Service Bulletin 214-011, "Valve Stem Seals, D12, D12A, D12B, D12C" (11.2002), publication no. PV776-TSP161564.

Date	Group	No.	Supp.	Page
8.2003	<b>214</b>	<b>011</b>		1(5)

## Valve Stem Seals D12, D12A, D12B, D12C

### Valve Stem Seals



W2003244

This information covers the proper procedure for servicing valve stem seals on the VOLVO D12, D12A, D12B, D12C engines.

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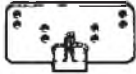
- ["Special Tools" page 2](#)
- ["Valve Stem Seals, Replacement" page 3](#)

**Note:** Information is subject to change without notice. Illustrations are used for reference only and may differ slightly from the actual vehicle being serviced. However, key components addressed in this information are represented as accurately as possible.

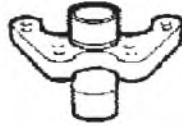
## Tools

### Special Tools

For special tools ordering information, refer to Tool Information, Group 08.



**9996950**  
Flywheel blocking tool



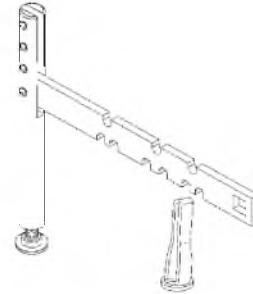
**9996956**  
Flywheel turning tool



**9998335**  
Valve stem seal guide sleeve



**9998255**  
Rocker arm shaft lifting tool



**J-41989**  
Valve spring compressor tool



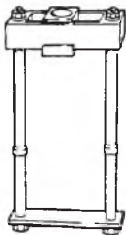
**9996159**  
Tap for Hydraulic Cylinder 9996161



**9996161**  
Hydraulic Cylinder



**9996222**  
Foot Pump for Hydraulic Cylinder



**9998260**  
Press Tool



**9998261**  
Valve Guide Drift



**9998263**  
Valve Guide Removal Drift



# Service Procedures

## 2149-03-02-01

### Valve Stem Seals, Replacement

(Cylinder head installed.)

You must read and understand the precautions and guidelines in Service Information, Group 20, "General Safety Practices, Engine" before performing this procedure. If you are not properly trained and certified in this procedure, ask your supervisor for training before you perform it.

**Note:** Make sure that piston is at TDC for the cylinder where the valve stem seals are being replaced. If valve stem seal replacement is attempted with the piston NOT at TDC, the valve may fall into the cylinder, and the cylinder head may have to be removed.

**Special tools:** 9996950, 9996956, 9998255, 9998335, J-41989

**1**

Remove the valve cover; refer to Service Information, Group 21.

**2**

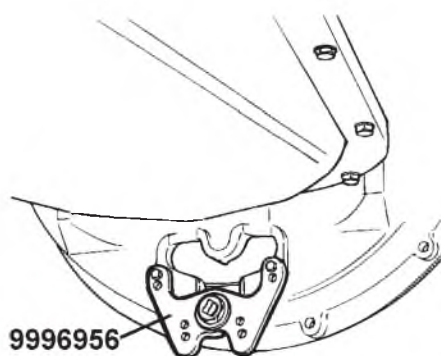
Remove the flywheel housing inspection cover.

**3**

Install tool 9996956 and turn the engine to **TDC**, 0 degrees on the flywheel.

**Note:** When the flywheel is at **TDC**, the piston in No. 1 cylinder will be at the top of the cylinder stroke.

9996956



c2000183.tif

**4**

Remove flywheel turning tool. Install blocking tool 9996950.

9996950

**5**

Loosen the rocker arm shaft bolts gradually to avoid bending the arm shaft assembly. Remove the bolts, install tool 9998255 and lift off the rocker arm shaft assembly.

---

9998255

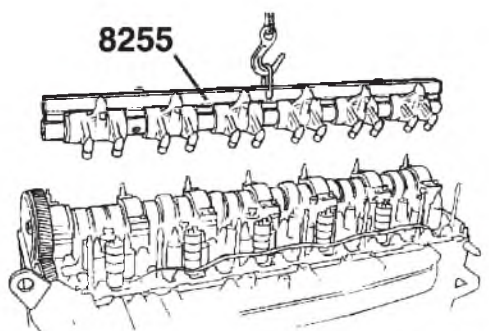
**6**

Using tool 9998255, remove the rocker arm shaft from the cylinder head. Remove all valve bridges.

**Note:** Valve bridges need to be installed in the same location from which they were removed.

---

9998255



w2002159.tif

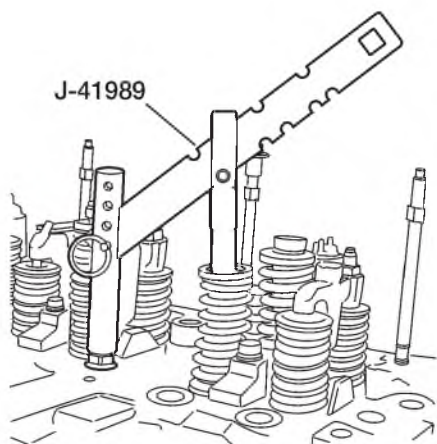
**7**

Install tool J-41989 to remove the valve springs on cylinder No. 1.

With the flywheel locking tool still in place, do the valve seal on No. 6 cylinder, also. Rotate the engine, then move to cylinders 2 and 5. Then, rotate to cylinders 3 and 4.

---

J-41989



W2003366

**8**

Remove the valve springs and old valve seals.

**Note:** Exhaust valves have inner and outer springs (double springs).

**9**

Place tool 9998335 on the valve guide and slip the valve seal over the tool. Push seal until it bottoms against the valve guide.

**Note:** Use tool 9998335 to avoid damage to the new seals.

---

9998335

**10**

Reinstall the valve springs, making sure that the valve retainers (keepers) lock correctly. Make sure that inner springs are on the exhaust valves.

**11**

Replace the valve stem seals on cylinder No. 6 in the same way.

**12**

Remove blocking tool 9996950. Install flywheel turning tool 9996956 and rotate the engine 120° until the next pair of pistons are located at TDC.

9996950, 9996956

**13**

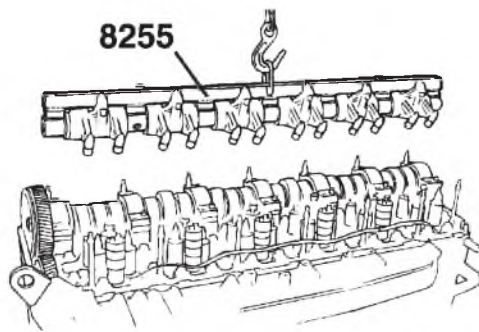
Remove flywheel turning tool 9996956. Reinstall blocking tool 9996950 and replace valve stem seals for these cylinders. Continue until all stem seals have been replaced.

9996950, 9996956

**14**

Remove blocking tool 9996950. Using tool 9998255, install the rocker arm shaft assembly.

9996950, 9998255



w2002159.tif

**15**

Adjust the valve bridges, valves, and injectors on all cylinders; refer to Service Information, Group 21.

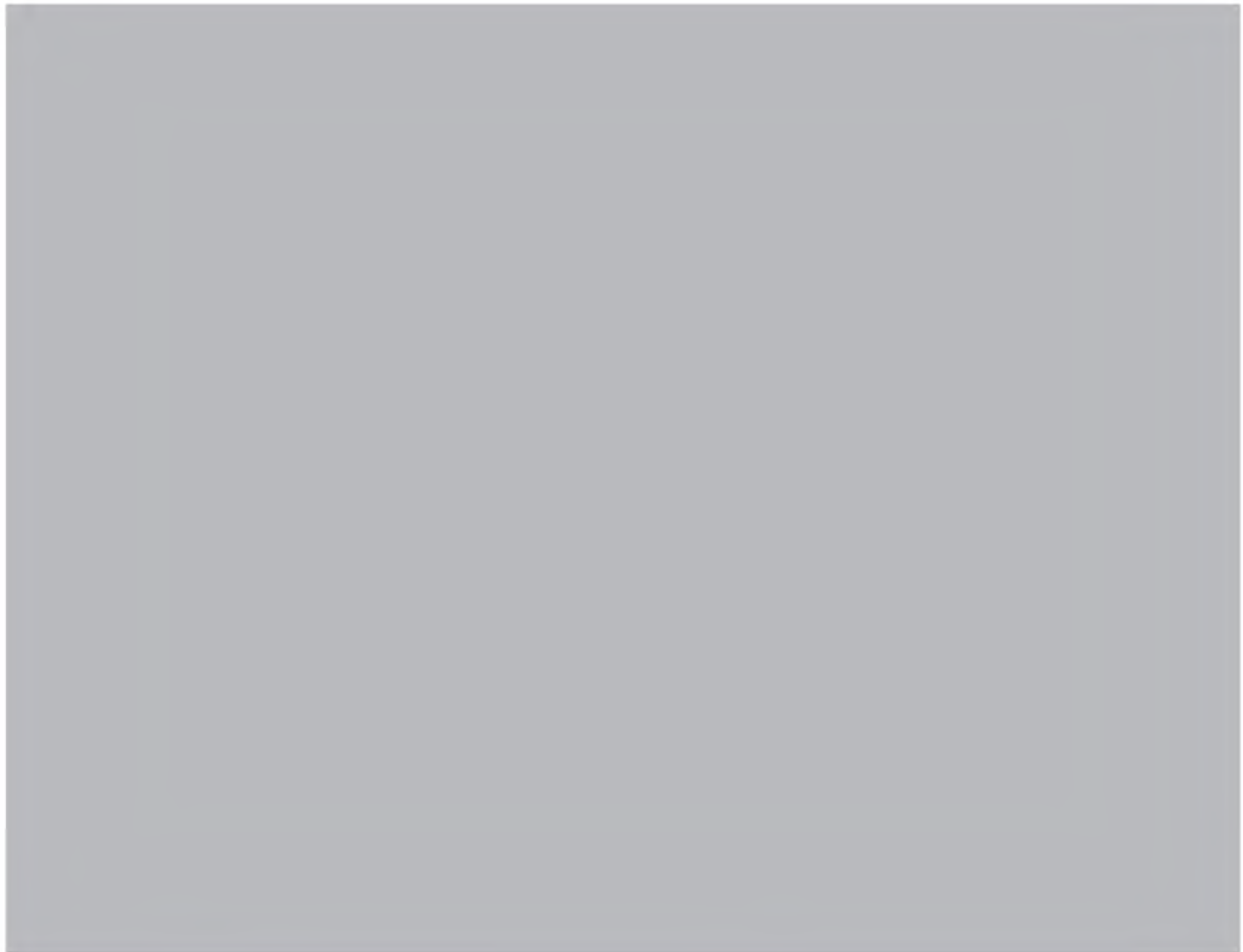
**16**

Install the valve cover.

# TSI

Number  
030-500

## **Vehicle Management System** Vectro II From 1998



PV776-TSP144528

**VOLVO**

# Foreword

The descriptions and service procedures contained in this manual are based on designs and methods studies carried out up to June 2001.

The products are under continuous development. Vehicles and components produced after the above date may therefore have different specifications and repair methods. When this is believed to have a significant bearing on this manual, supplementary service bulletins will be issued to cover the changes.

The new edition of this manual will update the changes.

In service procedures where the title incorporates an operation number, this is a reference to an S.R.T. (Standard Repair Time).

Service procedures which do not include an operation number in the title are for general information and no reference is made to an S.R.T.

The following levels of observations, cautions and warnings are used in this Service Documentation:

**Note:** Indicates a procedure, practice, or condition that must be followed in order to have the vehicle or component function in the manner intended.

**Caution:** Indicates an unsafe practice where damage to the product could occur.

**Warning:** Indicates an unsafe practice where personal injury or severe damage to the product could occur.

**Danger:** Indicates an unsafe practice where serious personal injury or death could occur.

**Volvo Trucks North America, Inc.**

Greensboro, NC USA

**Order number: PV776-144528**

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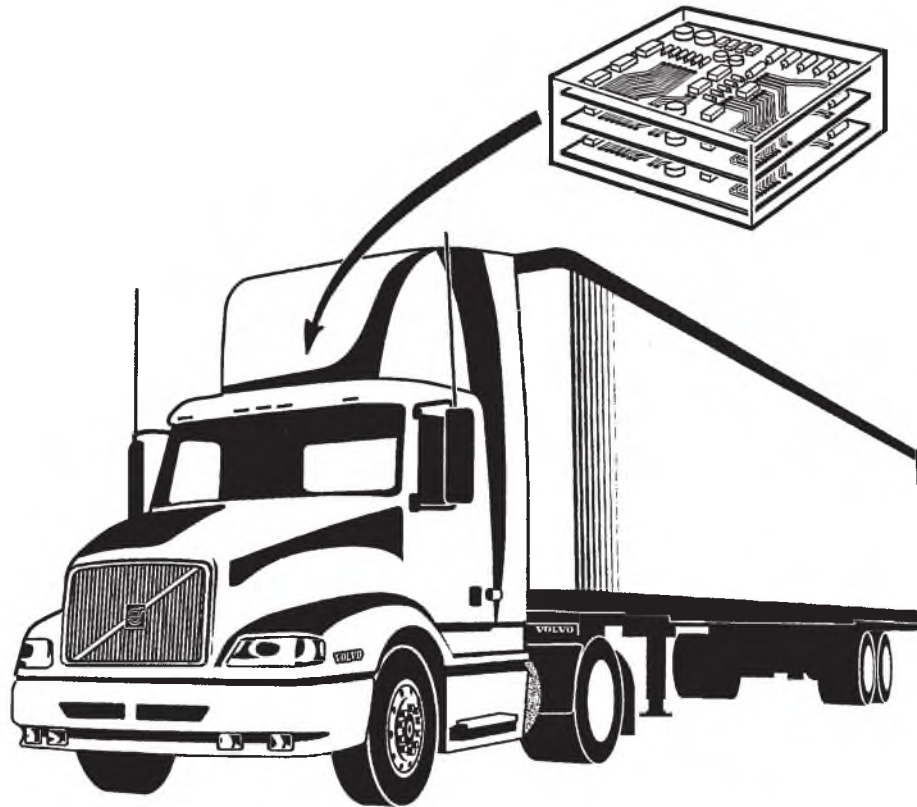
## Feedback

## Operation Numbers



# General

## Vehicle Management System



W2002520

This information covers the Vehicle Management System, which includes VECTRO II electronics, the vehicle ECU, and other control systems used in the vehicle.

## Engine Control System Glossary

### ATA

American Trucking Association

### ATDC (After Top Dead Center)

The 180° of crankshaft rotation after the piston reaches top center (normal direction of rotation).

### AC (Alternating Current)

An electrical current that alternates level and direction.

### BTDC (Before Top Dead Center)

The 180° of crankshaft rotation before the piston reaches top center (normal direction of rotation).

### INFO lamp

Light that warns the operator of an active diagnostic fault code; also referred to as the diagnostic lamp.

### Data link

An electrical connection for communication with other microprocessor-based devices (such as powertrain control, trip recorders and maintenance systems) that are compatible with the ATA and SAE standard.

### Diagnostic fault code

These codes indicate an electronic system malfunction, indicating a problem with the D12 electrical systems.

### Diagnostic flash code

Codes flashed out in a series via the INFO lamp to indicate an active fault code.

### DC (Direct Current)

An electrical current that flows in one direction only.

### EEPROM (Electrical Erasable Programmable Read Only Memory)

The contents of this type of memory may be electronically erased and new information programmed into the device.

### EECU (Engine Electronic Control Unit)

The computer that controls the power supplied to the engine electronics, monitors and governs engine functions.

### EUI (Electronic Unit Injector)

An injector pump which is mechanically activated and electronically controlled. It combines metering and injecting in a single unit.

### Engine brake disable system

During the time ABS (anti-lock braking system) is active, the engine brake is disabled.

### FMI (Failure Mode Identifier)

Numbers and names used to identify how a system or part failed.

FMI	Description
0	Data valid but above normal operating range
1	Data valid but below normal operating range
2	Data erratic, intermittent, or incorrect
3	Voltage above normal
4	Voltage below normal
5	Current below normal or open circuit
6	Current above normal or short circuit
7	Mechanical system not responding properly
8	Abnormal frequency, pulse rate or period
9	Abnormal update
10	Abnormal rate of change
11	Failure mode not identifiable
12	Defective device or component
13	Uncalibrated device or component
14/15	Reserved for future assignment

### Hz (Hertz)

Measure of frequency in cycles per second.

### MID

Message Identification Description

### Open circuit

Condition where an electrical wire or connector is broken, preventing signal or supply voltage from reaching its intended destination.

### Parameter

A programmable value that affects the characteristics or behavior of the engine and/or vehicle.

**PID**

Parameter Identification code.

**PTO (Power Takeoff)**

Operated with the cruise control switches, this mode permits setting a constant engine rpm when the vehicle is not moving.

**PWM (Pulse Width Modulation)**

A signal consisting of variable-width pulses at fixed intervals to vary; "TIME ON" versus "TIME OFF."

**RAM (Random Access Memory)**

A memory that has stored information immediately available when addressed.

**Reference voltage**

A regulated voltage supplied by the EECU to a sensor, which uses it to generate a signal voltage.

**Password**

A group of seven alphanumeric characters designed to restrict access to level-2 parameters. The password is automatically defaulted to seven empty spaces if customer has not specified password.

**SAE**

Society of Automotive Engineers.

**Short circuit**

A connection of comparatively low resistance, accidentally or intentionally made between two points on a circuit.

**SID**

Subsystem Identification code.

**Signal**

A voltage value used to transmit information typically from a sensor to the EECU.

**Supply voltage**

A constant voltage that supplies electrical power to a component. It may be generated by the EECU or supplied by the vehicle battery.

**Throttle Position Sensor (TPS)**

An electronic sensor that is connected to the accelerator pedal and sends a Pulse Width Modulated signal to the EECU.

**Vehicle Specification Programming (VSP)**

VSP consists of two levels of programming: engine configuration (level 1) and customer parameters (level 2).

**Vehicle Speed Sensor (VSS)**

An electromagnetic device that measures vehicle speed from the rotation of gear teeth in the drivetrain of the vehicle.

**VEB (Volvo Engine Brake)**

Consists of a compression brake (VCB) and an exhaust pressure governor (EPG).



# Specifications

## Description of Signals

### EECU (D7C) and Breakout Box Connected in Series Between EECU and Wiring Harness

For the measurements below, the following applies:

- Breakout box J-41132 connected between connector EA or EB and the EECU.
- Jumper harness J-43233 connected between connector EA or EB and the EECU.
- The EECU connected.
- Ignition key in ON position.
- Engine not running.
- Measuring voltage.

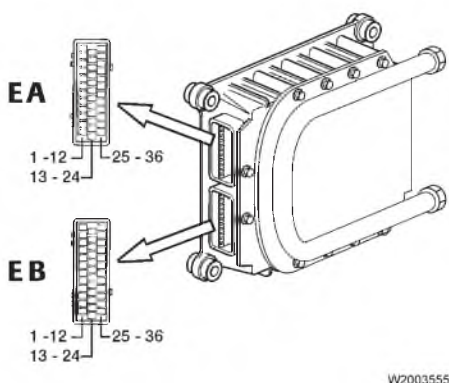


Fig. 1: EECU with pinouts

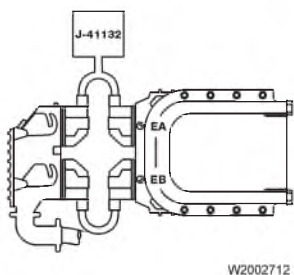


Fig. 2: EECU voltage check, EA

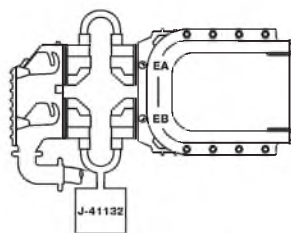


Fig. 3: EECU voltage check, EB

B+ = battery voltage

Conne- ction	Signal type	Measuring points	Ignition key in the ON position	Other
EA1	Oil temperature sensor, signal	EA1 - EA5	3.0 V (+20 °C/68 °F) 0.4 V (+100 °C/212 °F)	
EA2	Intake manifold temperature sensor, signal	EA2 - EA5	2.6 V (+20 °C/68 °F) 1.6 V (+40 °C/104 °F)	
EA3	Intake manifold pressure sensor, signal	EA3 - EA5	1.1 V (sea level)	
EA4	Supply to sensors (5 V), +	EA4 - EA5	4.8 - 5.15 V	
EA5	Signal ground to sensors, -			
EA6	Not currently used			
EA7	Redundant engine speed sensor, +			
EA8	Rack drive PWM, +			
EA9	Timing sleeve PWM, +			

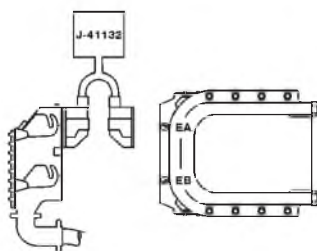
Conne- ction	Signal type	Measuring points	Ignition key in the ON position	Other
EA10	Rack drive PWM, -			
EA11	Not currently used			
EA12	Not currently used			
EA13	Fuel temperature sensor, signal	EA13 - EA5	3.0 V (+20 °C/68 °F) 2.0 V (+40 °C/104 °F)	
EA14	Oil pressure sensor, signal	EA14 - EA5	0.5 V (for cold engines)	
EA15	Needle lift sensor, +			
EA16	Rack position sensor, search coil			
EA17	Rack position sensor, common			
EA18	Redundant engine speed sensor, -			
EA19	Not currently used			
EA20	Not currently used			
EA21	Timing sleeve PWM, -			
EA22	Not currently used			
EA23	Not currently used			
EA24	Not currently used			
EA25	Coolant temperature sensor, signal	EA25 - EA5	3.0 V (+20 °C/68 °F) 0.6 V (+85 °C/185 °F)	
EA26	Not currently used			
EA27	Fuel pressure sensor, signal	EA27-EA5	≈ 0.5V (for cold engines)	D12 C
EA28	Needle lift sensor, -			
EA29	Rack position sensor, reference coil			
EA30	Engine speed sensor (crank), +			
EA31	Engine speed sensor (crank), -			
EA32	Not currently used			
EA33	Not currently used			
EA34	Not currently used			
EA35	Not currently used			
EA36	Not currently used			
EB1	SAE J1939 A Communications link	EB1/EB9	≈2-5V	
EB2	SAE J1939 B Communications link	EB2/EB9	≈0-3V	
EB3	Ambient air temperature sensor, sig- nal	EB3 - EB13	2.6 V (+20 °C/68 °F) 1.2 V (+50 °C/122 °F)	
EB4	Buffered idle validation switch	EB4 - EB9	< 4 V (idle) > 8 V (off idle)	
EB5	Pre-heat sense 1	EB5 - EB9	55 % of B+ (open) 0 V (closed)	Normally closed with the ignition key in the ON position.
EB6	Not currently used			

Conne- ction	Signal type	Measuring points	Ignition key in the ON position	Other
EB7	Coolant level sensor, signal	EB7 - EB8	80% B+ (open) 0 V (closed)	Applies to WX and VN. Normally open with the ignition key in the ON position.
EB8	Signal ground to sensors, -			
EB9	EECU ground, -			
EB10	EECU ground, -			
EB11	EECU B+	EB11 - EB9	B+	
EB12	EECU B+	EB12 - EB10	B+	
EB13	Ambient air temperature sensor			
EB14	Not currently used			
EB15	Not currently used			
EB16	Not currently used			
EB17	Air filter indicator sensor signal			
EB18	Not currently used			
EB19	Not currently used			
EB20	Not currently used			
EB21	Fan control (if equipped with on/off fan)	EB21 - EB9	B+ (fan on) 0 V (fan off)	Normally ON with the ignition key in the ON position.
EB22	Not currently used			
EB23	Not currently used			
EB24	EOL Enable	EB24 - EB9	< 6 V or O/C (EOL Disable) > 9.6 V (EOL Enable)	
EB25	SAE J1587A/J1708A Information link	EB25-EB9	≈ 0-5V	
EB26	SAE J1587B/J1708B Information link	EB26-EB9	≈ 0-5V	
EB27	Not currently used			
EB28	Not currently used			
EB29	Not currently used			
EB30	Not currently used			
EB31	Pre-heating relay, Coil ground	EB31 - EB9	B+ (pre-heat off) 0 V (pre-heat on)	Normally ON with the ignition key in the ON position.
EB32	Not currently used			
EB33	Not currently used			
EB34	Fuel shut-off valve	EB34 - EB9	0 V (valve on) > 1.0V (valve off)	Normally ON with the ignition key in the ON position.
EB35	EPG 1	EB35 - EB9	B+ (EPG off) 0 V (EPG on)	Normally OFF with the ignition key in the ON position.
EB36	Not currently used			

## EECU, D7C, with Breakout Box Connected to Wiring Harness Only

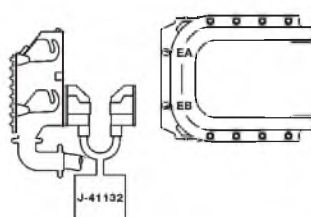
For the measurements below, the following applies:

- Breakout box J-41132 connected to connector EA or EB.
- The EECU is **not** connected.
- Ignition key must be in the OFF position.
- Measuring resistance.



W2002711

Fig. 4: EECU harness checks, EA



W2002713

Fig. 5: EECU harness checks, EB

Conne- ction	Signal type	Measuring points	Ignition key in the OFF position	Other
EA1	Oil temperature sensor, signal	EA1 / EA5	1.9 k $\Omega$ (+20 °C/68 °F) 100 $\Omega$ (+100 °C/212 °F)	
EA2	Intake manifold temperature sensor, signal	EA2 / EA5	6.2 k $\Omega$ (+20 °C/68 °F) 2.5 k $\Omega$ (+40 °C/104 °F)	
EA3	Intake manifold pressure sensor, signal			
EA4	Sensor supply to (5 V), +			
EA5	Sensors ground , -			
EA6	Not currently used			
EA7	Redundant engine speed sensor, +	EA7 / EA18	775 - 945 $\Omega$	
EA8	Rack drive PWM, +	EA8 / EA10 EA8 / alternate ground	1.5 $\Omega$ open circuit	
EA9	Timing sleeve PWM, +	EA9 / EA21 EA9 / alternate ground	1.5 $\Omega$ open circuit	
EA10	Rack drive PWM, -	EA10 / alternate ground	open circuit (see also EA8)	
EA11	Not currently used			
EA12	Not currently used			
EA13	Fuel temperature sensor, signal	EA13 / EA5	1.9 k $\Omega$ (+20 °C/68 °F) 800 $\Omega$ (+40 °C/104 °F)	
EA14	Oil pressure sensor, signal			
EA15	Needle lift sensor, +	EA15 / EA28	65 - 165 $\Omega$	
EA16	Rack position sensor, search coil	EA16 / EA17	20.0 $\Omega$	
EA17	Rack position sensor, common			
EA18	Redundant engine speed sensor, -	EA18 / EA7	775 - 945 $\Omega$	
EA19	Not currently used			

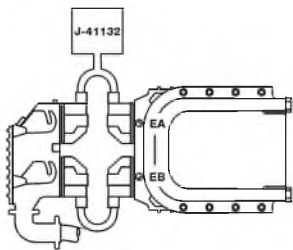
Conne- ction	Signal type	Measuring points	Ignition key in the OFF position	Other
EA20	Not currently used			
EA21	Timing sleeve PWM, -	EA21 / alternate ground	open circuit (see also EA9)	
EA22	Not currently used			
EA23	Not currently used			
EA24	Not currently used			
EA25	Coolant temperature sensor, signal	EA25 / EA5	1.9 k $\Omega$ (+20 °C/68 °F) 160 $\Omega$ (+85 °C/185 °F)	
EA26	Not currently used			
EA27	Fuel pressure sensor			D12 C
EA28	Needle lift sensor, -			
EA29	Rack position sensor, reference coil	EA29 / EA17	20.0 $\Omega$	
EA30	Engine speed sensor (crank), +	EA30 / EA31	775 - 945 $\Omega$	
EA31	Engine speed sensor (crank), -	EA31 / EA30	775 - 945 $\Omega$	
EA32	Not currently used			
EA33	Not currently used			
EA34	Not currently used			
EA35	Not currently used			
EA36	Not currently used			
EB1	SAE J1939A Communications link			
EB2	SAE J1939B Communications link			
EB3	Ambient air temperature sensor, signal	EB3 / EB13	6.2 k $\Omega$ (+20 °C/68 °F) 1.7 k $\Omega$ (+50 °C/122 °F)	
EB4	Buffered idle validation switch			
EB5	Pre-heat sense 1	EB5 / EB9	open circuit (open) < 5 $\Omega$ (closed)	
EB6	Not currently used			
EB7	Coolant level sensor, signal	EB7 / EB8	open circuit (coolant level normal) <1 $\Omega$ (coolant level low)	Applies to WX and VN
EB8	Sensor ground			
EB9	EECU ground, -			
EB10	EECU ground, -			
EB11	EECU, B+			
EB12	EECU, B+			
EB13	Ambient air temperature ground			
EB14	Not currently used			
EB15	Not currently used			
EB16	Not currently used			
EB17	Air filter indicator sensor signal			
EB18	Not currently used			
EB19	Not currently used			
EB20	Not currently used			
EB21	Not currently used			
EB22	Not currently used			
EB23	Not currently used			
EB24	EOL Enable	EB24/EB9	open circuit (open)	

Conne- ction	Signal type	Measuring points	Ignition key in the OFF position	Other
EB25	SAE J1587/J1708 A Information link	EB25 / (connection A in 6 pin diagnostics connector)	<1 $\Omega$	
		EB25 / (connection F in 9 pin diagnostics connector)	<1 $\Omega$	
EB26	SAE J1587/J1708 B Information link	EB26 / (connection B in the 6 pin diagnostics connector)	<1 $\Omega$	
		EB26 / (connection G in the 9 pin diagnostics connector)	<1 $\Omega$	
EB27	Not currently used			
EB28	Not currently used			
EB29	Not currently used			
EB30	Not currently used			
EB31	Pre-heating relay, coil ground			
EB32	Not currently used			
EB33	Not currently used			
EB34	Fuel shut-off valve, include			
EB35	EPG 1, -			
EB36	Not currently used			

## EECU (D12B and D12C), Breakout Box Connected in Series Between EECU and Wiring Harness

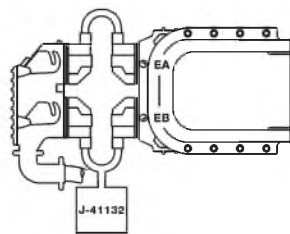
For the measurements below, the following applies:

- Breakout box J-41132 connected between connector EA or EB and the EECU.
- Jumper harness J43233 connected between connector EA or EB and the EECU.
- The EECU connected.
- Ignition key in ON position.
- Engine not running.
- Measuring voltage.



W2002712

Fig. 6: EECU voltage check, EA



W2002710

Fig. 7: EECU voltage check, EB

**B+** = battery voltage

Conne- ction	Signal type	Measuring points	Ignition key in the ON position	Other
EA1	Oil temperature sensor, signal	EA1 / EA5	3.0 V (+20 °C/68 °F) 0.4 V (+100 °C/212 °F)	
EA2	Intake manifold temperature sensor, signal	EA2 / EA5	2.6 V (+20 °C/68 °F) 1.6 V (+40 °C/104 °F)	
EA3	Intake manifold pressure sensor, signal	EA3 / EA5	1.1 V (sea level)	
EA4	Sensor supply (5 V), +	EA4 / EA5	4.8 - 5.15 V	
EA5	Sensor ground			
EA6	Not currently used			
EA7	Engine position sensor (cam), +			
EA8	Not currently used			
EA9	Not currently used			
EA10	Not currently used			
EA11	Unit injector cylinder 1, -			
EA12	Unit injector cylinder 1, 2, 3 (90 Volt), +			
EA13	Fuel temperature sensor, signal			D12 C
EA14	Oil pressure sensor, signal	EA14 / EA5	0.5 V (for cold engines)	
EA15	Not currently used			



Con- nection	Signal type	Measuring points	Ignition key in the ON position	Other
EA16	Not currently used			
EA17	Not currently used			
EA18	Engine position sensor (cam), -			
EA19	Not currently used			
EA20	Not currently used			
EA21	Not currently used			
EA22	Unit injector cylinder 2, -			
EA23	Unit injector cylinder 3, -			
EA24	Unit injector cylinder 4, 5, 6 (90 Volt), +			
EA25	Coolant temperature sensor, signal	EA25 / EA5	3.0 V (+20 °C/68 °F) 0.6 V (+85 °C/185 °F)	
EA26	Not currently used			
EA27	Fuel pressure sensor			D12 C
EA28	Not currently used			
EA29	Not currently used			
EA30	Engine speed sensor (crank), +			
EA31	Engine speed sensor (crank), -			
EA32	Not currently used			
EA33	VCB, -	EA33 / alternate ground	B+ (VCB off) 0 V (VCB on)	Normally OFF with the ignition key in the ON position.
EA34	Unit injector cylinder 4, -			
EA35	Unit injector cylinder 5, -			
EA36	Unit injector cylinder 6, -			
EB1	SAE J1939 Communications link, can HI	EB1/EB9	≈ 2-5V	
EB2	SAE J1939 Communications link, can LOW	EB2/EB9	≈ 0-3V	
EB3	Ambient air temperature sensor, signal	EB3 / EB13	2.6 V (+20 °C/68 °F) 1.2 V (+50 °C/122 °F)	
EB4	Buffered idle validation switch	EB4 / EB9	< 4 V (inactive) > 8 V (active)	
EB5	Pre-heat sense 1 (if equipped)	EB5 / EB9	55% of B+ (open) 0 V (closed)	Normally closed with the ignition key in the ON position.
EB6	Not currently used			
EB7	Coolant level sensor, signal	EB7 / EB8	80% B+ (open) 0 V (closed)	VN and VHD. Normally open with the ignition key in the ON position.
EB8	Sensor ground			
EB9	EECU ground, -			
EB10	EECU ground, -			

Conne- ction	Signal type	Measuring points	Ignition key in the ON position	Other
EB11	EECU B+	EB11 / EB9	B+	
EB12	EECU B+	EB12 / EB10	B+	
EB13	Ambient air temperature sensor			
EB14	Not currently used			
EB15	Not currently used			
EB16	Pre-heat sensor 2 (if equipped)	EB16 / EB9	55 % of B+ (open) 0 V (closed)	Normally closed with the ignition key in the ON position.
EB17	Air filter indicator sensor signal			
EB18	Not currently used			
EB19	Not currently used			
EB20	Not currently used			
EB21	Engine fan control (if equipped with on/off fan), -	EB21 / EB9	B+ (fan on/solenoid inactive) 0 V (fan off/solenoid active)	Normally ON with the ignition key in the ON position.
EB22	Not currently used			
EB23	Not currently used			
EB24	EOL Enable	EB24 / EB9	< 6 V or O/C (EOL disable) > 9.6 V (EOL Enable)	
EB25	SAE J1587/J1708 + Information link			
EB26	SAE J1587/J1708 - Information link	EB25/EB9	≈ 0-5V	
EB27	Not currently used	EB26/EB9	≈ 0-5V	
EB28	Not currently used			
EB29	Not currently used			
EB30	Not currently used			
EB31	Pre-heating relay coil ground (if equipped)	EB31 / EB9	B+ (pre-heat off) 0 V (pre-heat on)	Normally OFF with the ignition key in the ON position.
EB32	Not currently used			
EB33	Not currently used			
EB34	Not currently used			
EB35	EPG 1	EB35 / EB9	B+ (EPG off) 0 V (EPG on)	Normally OFF with the ignition key in the ON position.
EB36	EPG 2	EB36 / EB9	B+ (EPG off) 0 V (EPG on)	Normally OFF with the ignition key in the ON position.

## EECU (D12B and D12C), Breakout Box Connected to Wiring Harness Only

For the measurements below, the following applies:

- Breakout box J-41132 connected to connector EA or EB.
- The EECU **not** connected.
- Ignition key must be in the OFF position.
- Measuring resistance.

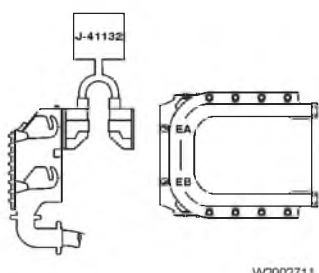


Fig. 8: EECU harness checks, EA

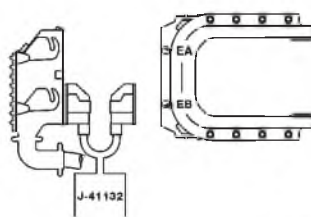


Fig. 9: EECU harness checks, EB

Conne- ction	Signal type	Measuring points	Ignition key in the OFF position	Other
EA1	Oil temperature sensor, signal	EA1 / EA5	1.9 k $\Omega$ (+20 °C/68 °F) 100 $\Omega$ (+100 °C/212 °F)	
EA2	Intake manifold temperature sensor, signal	EA2 / EA5	6.2 k $\Omega$ (+20 °C/68 °F) 2.5 k $\Omega$ (+40 °C/104 °F)	
EA3	Intake manifold pressure sensor, signal			
EA4	Sensor supply (5 V), +			
EA5	Sensor ground			
EA6	Not currently used			
EA7	Engine position sensor (cam), +	EA7 / EA18	775 - 945 $\Omega$	
EA8	Not currently used			
EA9	Not currently used			
EA10	Not currently used			
EA11	Unit injector cylinder 1, -	EA11 / EA12	1.5 - 2.0 $\Omega$	
EA12	Unit injector cylinder 1, 2, 3 (90 Volt), +		see EA11, EA22 and EA23	
EA13	Fuel temperature sensor, signal			D12 C
EA14	Oil pressure sensor, signal			
EA15	Not currently used			
EA16	Not currently used			
EA17	Not currently used			
EA18	Engine position sensor (cam), -		see EA7	
EA19	Not currently used			
EA20	Not currently used			

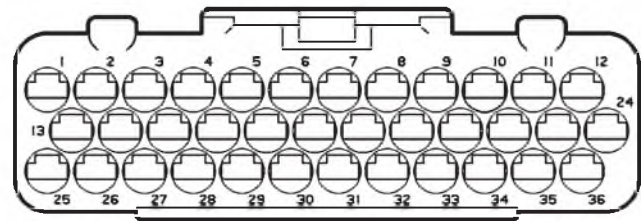
Conne- ction	Signal type	Measuring points	Ignition key in the OFF position	Other
EA21	Not currently used			
EA22	Unit injector cylinder 2, -	EA22 / EA12	1.5 - 2.0 $\Omega$	
EA23	Unit injector cylinder 3, -	EA23 / EA12	1.5 - 2.0 $\Omega$	
EA24	Unit injector cylinder 4, 5, 6 (90 Volt), +		see EA34, EA35, and EA36	
EA25	Coolant temperature sensor, signal	EA25 / EA5	1.9 k $\Omega$ (+20 °C/68 °F) 160 $\Omega$ (+85 °C/185 °F)	
EA26	Fuel pressure sensor, signal			D12 C
EA27	Not currently used			
EA28	Not currently used			
EA29	Not currently used			
EA30	Engine speed sensor (crank), +	EA30 / EA31	775 - 945 $\Omega$	
EA31	Engine speed sensor (crank), -	EA31 / EA30	775 - 945 $\Omega$	
EA32	Not currently used			
EA33	VCB, -			
EA34	Unit injector cylinder 4, -	EA34 / EA24	1.5 - 2.0 $\Omega$	
EA35	Unit injector cylinder 5, -	EA35 / EA24	1.5 - 2.0 $\Omega$	
EA36	Unit injector cylinder 6, -	EA36 / EA24	1.5 - 2.0 $\Omega$	
EB1	SAE J1939 + Communications link			
EB2	SAE J1939 - Communications link			
EB3	Ambient air temperature sensor, signal	EB3 / EB13	6.2 k $\Omega$ (+20 °C/68 °F) 1.7 k $\Omega$ (+50 °C/122 °F)	
EB4	Buffered idle validation switch			
EB5	Pre-heat sense 1 (if equipped)	EB5 / EB9	open circuit (open) < 5.0 $\Omega$ (closed)	
EB6	Not currently used			
EB7	Coolant level sensor, signal	EB7 / EB8	open circuit (coolant level normal) <1 $\Omega$ ; closed (coolant level low)	Applies to WX , VN and VHD
EB8	Sensors ground			
EB9	EECU ground, -			
EB10	EECU ground, -			
EB11	EECU B+			
EB12	EECU B+			
EB13	Ambient air temperature sensor			
EB14	Not currently used			
EB15	Not currently used			
EB16	Pre-heat sensor 2 (if equipped)	EB16 / EB9	open circuit (open) < 5.0 $\Omega$ (closed)	
EB17	Air filter indicator sensor signal			
EB18	Not currently used			
EB19	Not currently used			

Con- nection	Signal type	Measuring points	Ignition key in the OFF position	Other
EB20	Not currently used			
EB21	Engine fan control (if equipped with on/off fan)			
EB22	Not currently used			
EB23	Not currently used			
EB24	EOL Enable	EB24/EB9	Open circuit(open)	
EB25	SAE J1587/J1708 A Information link	EB25 / (connection A in the 6 pin diagnostics connector)	<1 $\Omega$	
		EB25 / DCA (connection F in the 9 pin diagnostics connector)	<1 $\Omega$	
EB26	SAE J1587/J1708 B Information link	EB26 / (connection B in the 6 pin diagnostics connector)	<1 $\Omega$	
		EB26 / (connection G in the 9 pin diagnostics connector)	<1 $\Omega$	
EB27	Not currently used			
EB28	Not currently used			
EB29	Not currently used			
EB30	Not currently used			
EB31	Preheating relay coil ground (if equipped)			
EB32	Not currently used			
EB33	Not currently used			
EB34	Not currently used			
EB35	EPG 1, -			
EB36	EPG 2, -			

## Pinouts

### Engine Electronic Control Unit (EECU)

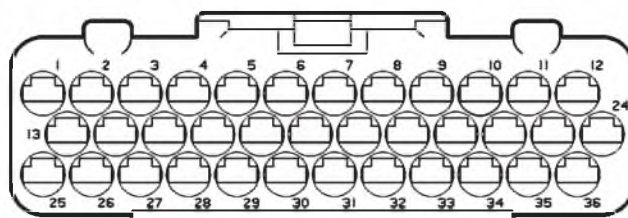
VOLVO D12B/D12C EECU/EA Connector		
Cavity	Color	Description
1	GN	OIL TEMPERATURE
2	BL/W	BOOST TEMPERATURE
3	GR	BOOST PRESSURE
4	GN/W	BOOST & OIL PRESSURE COMMON (+)
5	BN/W	PRESSURE & TEMP. SENSOR COMMON (-)
6		NOT USED
7	Y	ENGINE POSITION SENSOR, CAM (+)
8-10		NOT USED
11	W	INJECTOR, CYL 1 (-)
12	W	CYL 1, CYL 2, CYL 3 INJECTOR COMMON, 90 Volt (+)
13	GN	FUEL TEMPERATURE (D12C)
14	BN	OIL PRESSURE
15-17		NOT USED
18	BN/W	ENGINE POSITION SENSOR, CAM (-)
19-21		NOT USED
22	W	INJECTOR, CYL 2 (-)
23	W	INJECTOR, CYL 3 (-)
24	W	CYL 4, CYL 5, CYL 6 INJECTOR COMMON, 90 Volt (+)
25	Y/W	COOLANT TEMPERATURE
26		NOT USED
27	BN	FUEL PRESSURE (D12C)
28-29		NOT USED
30	BL/SB	ENGINE SPEED SENSOR, CRANK (+)
31	BL/R	ENGINE SPEED SENSOR, CRANK (-)
32		NOT USED
33	GN/W	VCB SOLENOID VALVE RETURN
34	W	INJECTOR, CYL 4 (-)
35	W	INJECTOR, CYL 5 (-)
36	W	INJECTOR, CYL 6 (-)



W3000945

<b>Wire Colors:</b>	BL BLUE	R RED
	BN BROWN	SB SOLID BLACK
	GN GREEN	VO VIOLET
	GR GRAY	W WHITE
	OR ORANGE	Y YELLOW
	P PINK	

VOLVO D12B/D12C EECU/EB Connector		
Cavity	Color	Description
1	Y	DATA LINK J1939 CAN HI
2	GN	DATA LINK J1939 CAN LO
3	BL/Y	AMBIENT AIR TEMPERATURE
4	P	BUFFERED IDLE VALIDATION SWITCH
5	R	PREHEAT SENSE 1
6		NOT USED
7	BL/SB	COOLANT LEVEL WARNING
8	GR/W	AIR FILTER, COOL LVL COMMON
9	W	GROUND (-)
10	W	GROUND (-)
11	R/SB	POWER SUPPLY (+)
12	R/SB	POWER SUPPLY (+)
13	VO/W	AMBIENT AIR TEMP COMMON (-)
14-15		NOT USED
16	R/W	PREHEAT SENSE 2
17	BL/R	AIR FILTER INDICATOR
18-20		NOT USED
21	GR/R	COOLING FAN CONTROL (-)
22-23		NOT USED
24	Y/SB	FACTORY PROGRAMMING (NOT USED)
25	GR	DATA LINK J1708/1587 (+)
26	OR	DATA LINK J1708/1587 (-)
27-30		NOT USED
31	BL/R	PREHEAT RELAY(Coil Ground)
32-34		NOT USED
35	GR/SB	EPG1 CONTROL
36	GR/W	EPG2 CONTROL



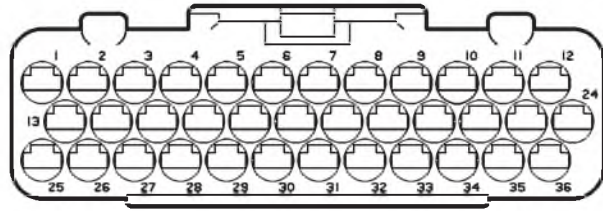
W3000945

**Wire Colors:**

BL	BLUE	R	RED
BN	BROWN	SB	SOLID BLACK
GN	GREEN	VO	VIOLET
GR	GRAY	W	WHITE
OR	ORANGE	Y	YELLOW
P	PINK		



VOLVO D7C EECU/EA Connector		
Cavity	Color	Description
1	GN	OIL TEMPERATURE
2	BL/W	BOOST TEMPERATURE
3	GR	BOOST PRESSURE
4	GN/W	BOOST, OIL & FUEL PRESSURE COMMON (+)
5	BN/W	PRESSURE & TEMP. SENSOR COMMON
6		NOT USED
7	Y	REDUNDANT ENGINE SPEED SENSOR (+)
8	Y/R	RACK DRIVE, PWM (+)
9	Y/SB	TIMING SLEEVE, PWM
10	GN/BN	RACK DRIVE, PWM (-)
11-12		NOT USED
13	GN/BN	FUEL TEMPERATURE
14	BN	OIL PRESSURE
15	GR/SB	NEEDLE LIFT SENSOR(+)
16	BL/R	RACK POSITION SENSOR, SEARCH COIL
17	Y/GR	RACK POSITION SENSOR, COMMON
18	BN/W	REDUNDANT ENGINE SPEED SENSOR (-)
19-20		NOT USED
21	OR	TIMING SLEEVE, PWM (-)
22-24		NOT USED
25	Y/W	COOLANT TEMPERATURE
26		NOT USED
27	BN	FUEL PRESSURE
28	GR/R	NEEDLE LIFT SENSOR (-)
29	Y/W	RACK POSITION SENSOR, REFERENCE COIL
30	BL/SB	ENGINE SPEED SENSOR, CRANK(+)
31	BL/R	ENGINE SPEED SENSOR, CRANK(-)
32-36		NOT USED

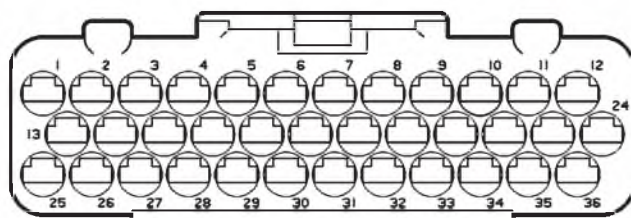


W3000945

**Wire Colors:**

BL	BLUE	R	RED
BN	BROWN	SB	SOLID BLACK
GN	GREEN	VO	VIOLET
GR	GRAY	W	WHITE
OR	ORANGE	Y	YELLOW
P	PINK		

VOLVO D7C EECU/EB Connector		
Cavity	Color	Description
1	Y	DATA LINK J1939 CAN HI
2	GN	DATA LINK J1939 CAN LO
3	BL/Y	AMBIENT AIR TEMPERATURE
4	P	BUFFERED IDLE VALIDATION SWITCH
5	R	PREHEAT SENSE 1
6		NOT USED
7	BL/SB	COOLANT LEVEL WARNING
8	GR/W	AIR FILTER, COOL LEVEL COMMON (-)
9	W	GROUND (-)
10	W	GROUND (-)
11	R/SB	POWER SUPPLY (+)
12	R/SB	POWER SUPPLY (+)
13	VO/W	AMBIENT AIR TEMP COMMON (-)
14-16		NOT USED
17	BL/R	AIR FILTER INDICATOR
18-23		NOT USED
24	Y/SB	FACTORY PROGRAMMING (NOT USED)
25	GR	DATA LINK J1708/1587 (+)
26	OR	DATA LINK J1708/1587 (-)
27-30		NOT USED
31	BL/R	PREHEAT RELAY, CONTROL
32-33		NOT USED
34	Y/BN	FUEL SHUTOFF VALVE CONTROL
35	GR	EPG1
36		NOT USED



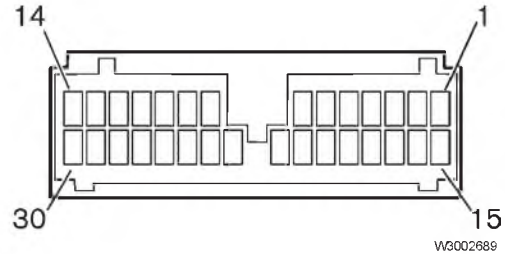
W3000945

<b>Wire Colors:</b>	BL BLUE	R RED
	BN BROWN	SB SOLID BLACK
	GN GREEN	VO VIOLET
	GR GRAY	W WHITE
	OR ORANGE	Y YELLOW
	P PINK	

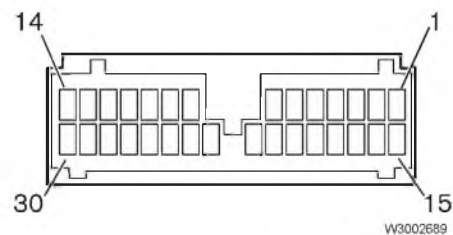
## Pinouts

### Vehicle Electronic Control Unit(VECU)

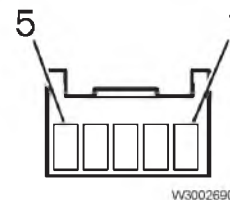
Vehicle ECU Connector A-(GREEN)		
Cavity	Circuit	Description
1	564A	CC/PTO SWITCH SET(-) INPUT
2	563A	CC/PTO SWITCH SET(+) INPUT
3	562A	CC/PTO SWITCH ON INPUT
4		NOT USED
5	567B	SERVICE BRAKE SWITCH INPUT
6	284-A	12V STARTER CONTROL SOLE-NOID FEED
7	245	ENGINE PREHEAT CIRCUIT PROTECTION FEED
8	571	CLUTCH SWITCH INPUT
9	385-A	PARK CONTROL WIPER MOTOR
10	388	INTERMITTENT WIPER INPUT
11	387-C	SWITCH TO WASHER MOTOR
12	0XE	ELECTRONIC GROUND
13	18V	ELECTRONIC ENGINE SWITCHED BATTERY FEED
14	196V	IGNITION SWITCH DR FEED
15-18		NOT USED
19	300D	MANUAL FAN SWITCH INPUT
20	629	ENGINE BRAKE MEDIUM FEED
21	628	ENGINE BRAKE LOW FEED
22		NOT USED
23	555	IDLE VALIDATION INPUT
24	682	HIGH REFRIGERANT PRESSURE SWITCH FEED
25-28		NOT USED
29	573	PTO SWITCH ON INPUT
30	565A	CC/PTO SWITCH RESUME INPUT



Vehicle ECU Connector B-(BLUE)		
Cavity	Circuit	Description
1		NOT USED
2	312A	TRANSMISSION AREA INHIBITOR VALVE RETURN
3-4		NOT USED
5	597	ECU COMMON 12V OUTPUT
6	550	VEHICLE SPEED INPUT
7		NOT USED
8	553	THROTTLE POSITION SENSOR INPUT
9		NOT USED
10	552	THROTTLE POSITION SENSOR SUPPLY
11	581	PARKING BRAKE SWITCH INPUT
12-14		NOT USED
15	583	POWER CONTROL FROM ENGINE ECU
16	389B	INTERMITTENT WIPER RELAY COIL RETURN
17	555A	IDLE VALIDATION FROM ENGINE ECU
18	312C	RANGE INHIBITOR VALVE RETURN
19	558	ECU COMMON +12V OUTPUT
20	551	VEHICLE SPEED RETURN FROM ECU
21	317B	TRANSMISSION LOW RANGE INDICATOR SIGNAL
22	554	THROTTLE POSITION SENSOR RETURN
23-26		NOT USED
27	567A	SERVICE BRAKE SWITCH INPUT
28-30		NOT USED

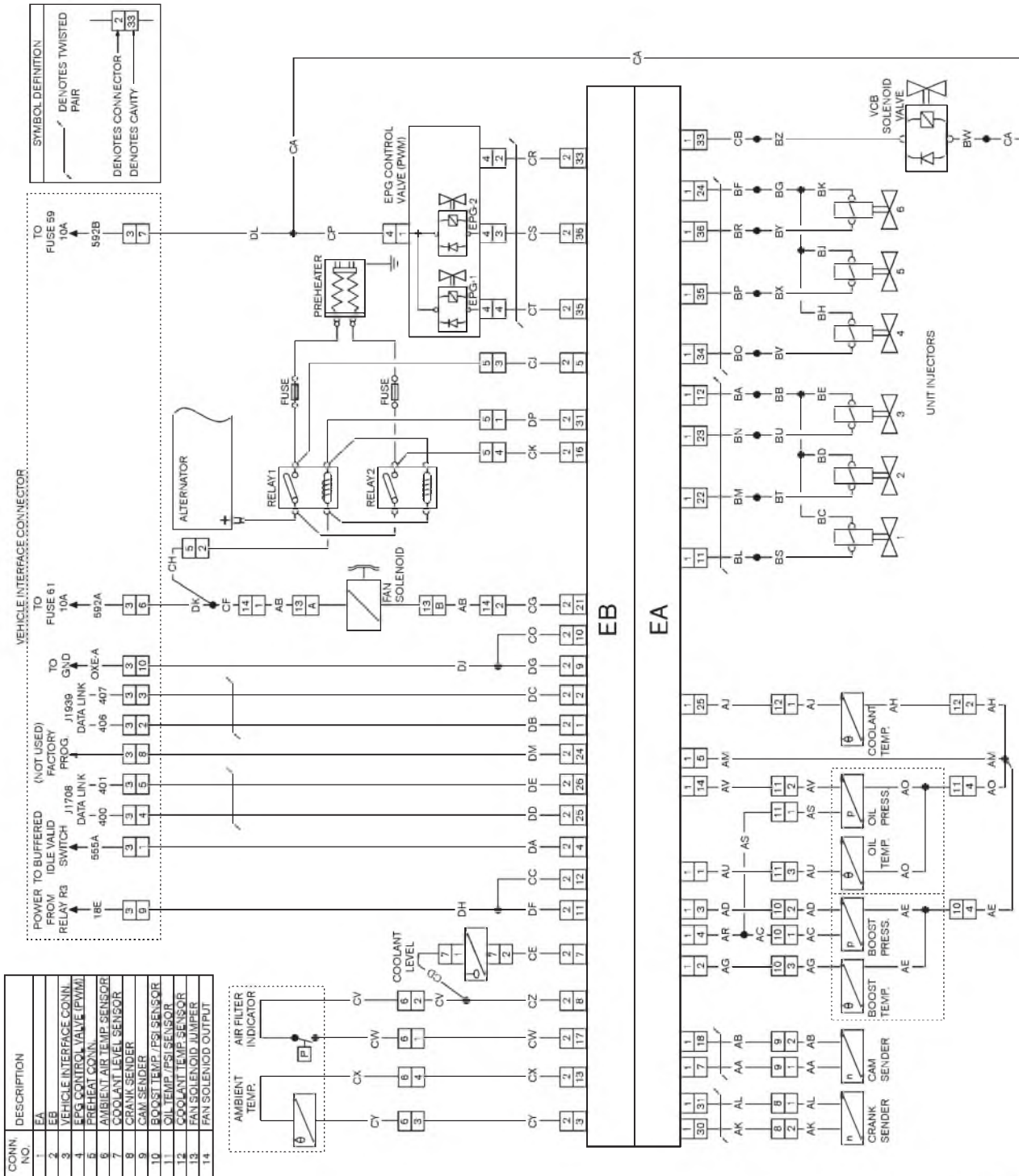


Vehicle ECU Connector C-(GREEN)		
Cavity	Circuit	Description
1	401-D	DATA LINK J1708 (-)
2	400-D	DATA LINK J1708 (+)
3	408-B	DATA LINK J1939 SHIELD
4	406-B	DATA LINK J1939 CAN HI
5	407-B	DATA LINK J1939 CAN LOW



# Schematic

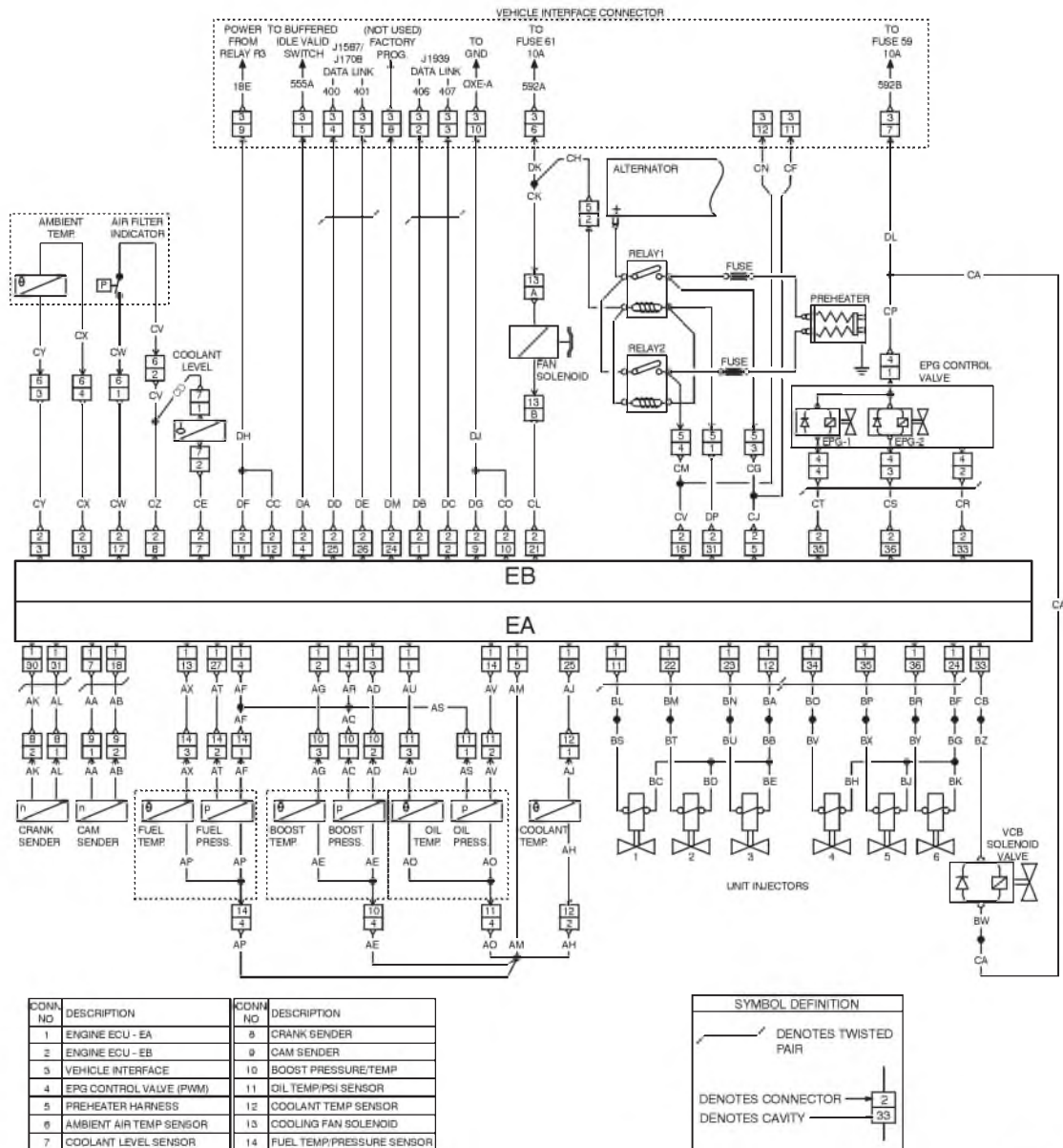
## D12B



W2002827

# Schematic

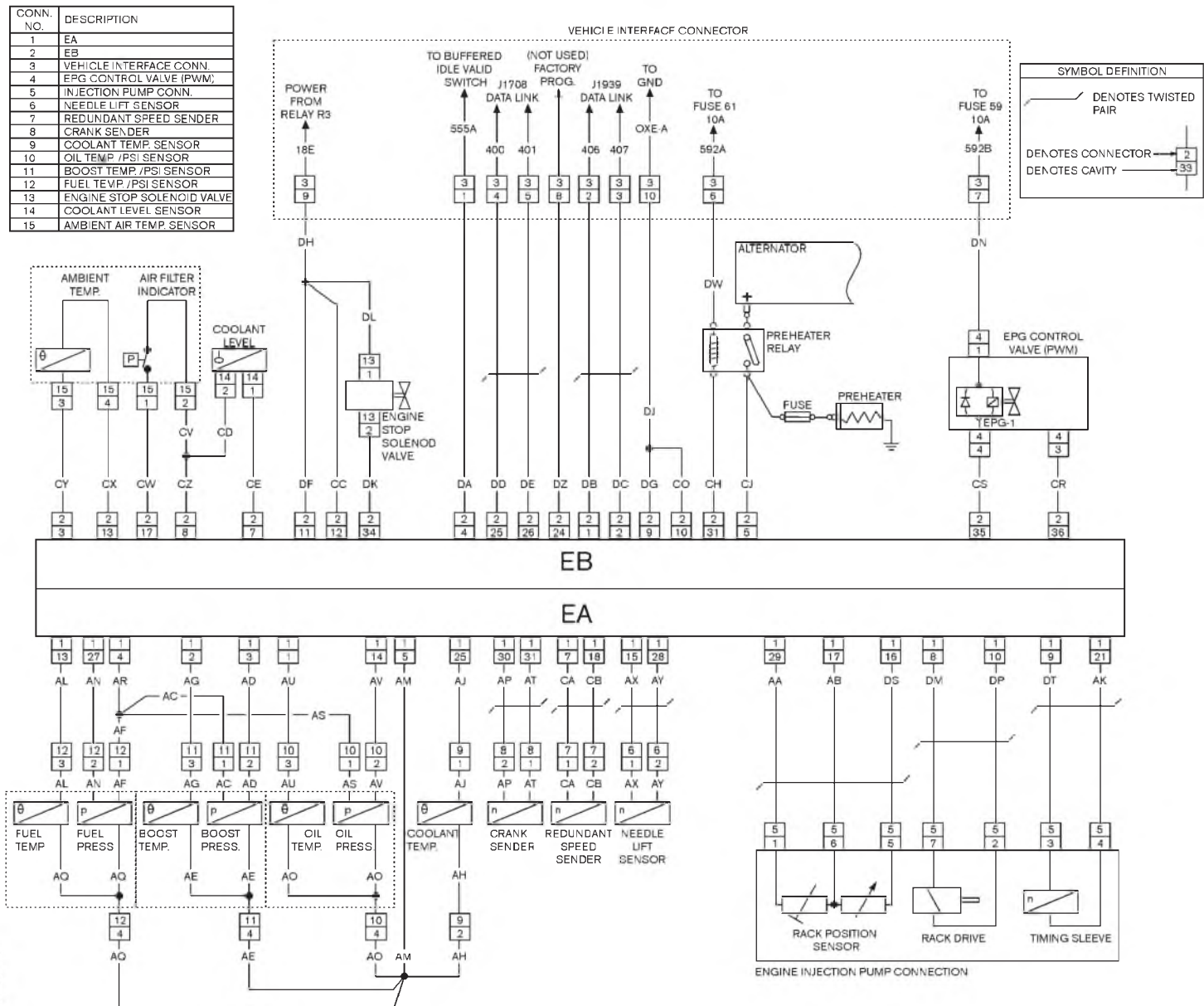
## D12C



W2003348

# Schematic D7C

CONN. NO.	DESCRIPTION
1	EA
2	EB
3	VEHICLE INTERFACE CONN.
4	EPG CONTROL VALVE (PWM)
5	INJECTION PUMP CONN.
6	NEEDLE LIFT SENSOR
7	REDUNDANT SPEED SENDER
8	CRANK SENDER
9	COOLANT TEMP. SENSOR
10	OIL TEMP./PSI SENSOR
11	BOOST TEMP./PSI SENSOR
12	FUEL TEMP./PSI SENSOR
13	ENGINE STOP SOLENOID VALVE
14	COOLANT LEVEL SENSOR
15	AMBIENT AIR TEMP. SENSOR



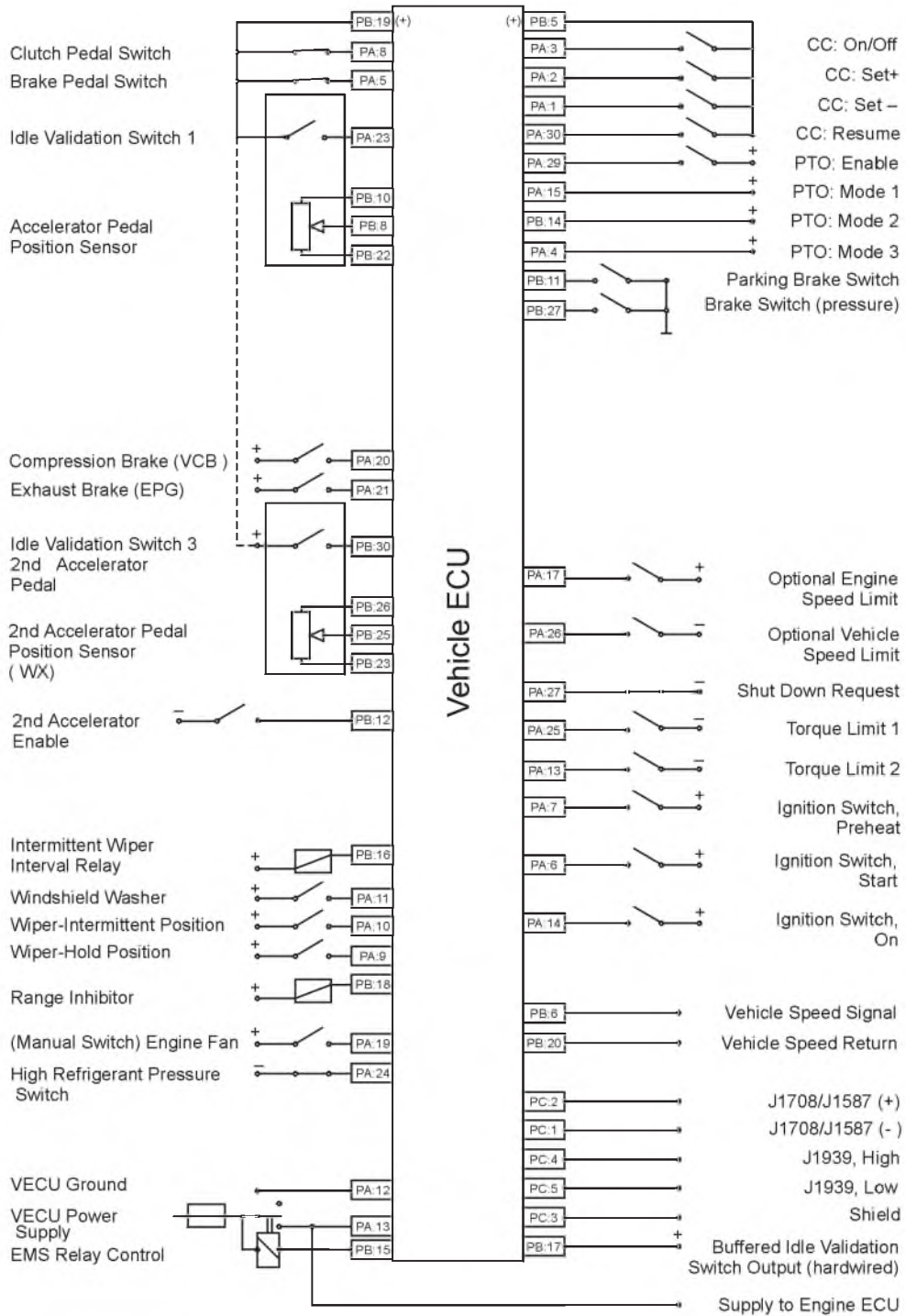
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# Schematic

## VECU

### Vehicle Electronic Control Unit Wiring Schematic



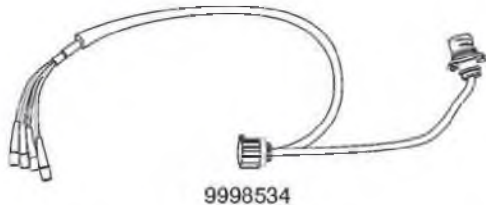
W3003497



# Tools

## Special Tools

The following special tools are required for work with the D12 electronic control system. The 3917916 VOLVO breakout kit, along with its components, is available from Volvo Truck. When requesting tools, provide the appropriate part number. Part numbers beginning with "J" are available from Kent-Moore.



9998534



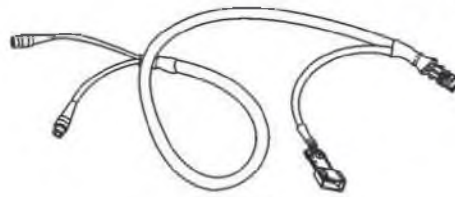
J-39200



J-41132



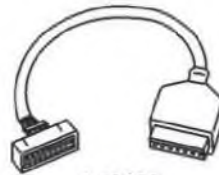
9998482



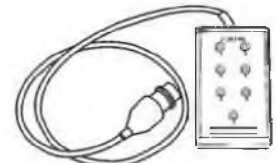
J-43147



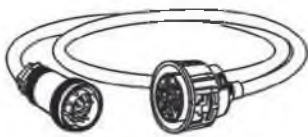
J-42472



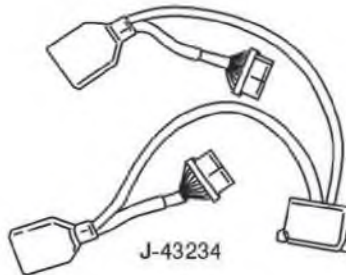
J-43233



J-38748



9809687



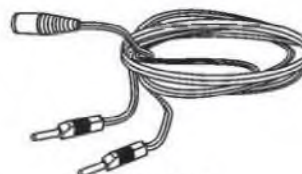
J-43234



9998551/J-43340



9809678



9809685

W2003598

See list on next page for information about the tools in the picture.

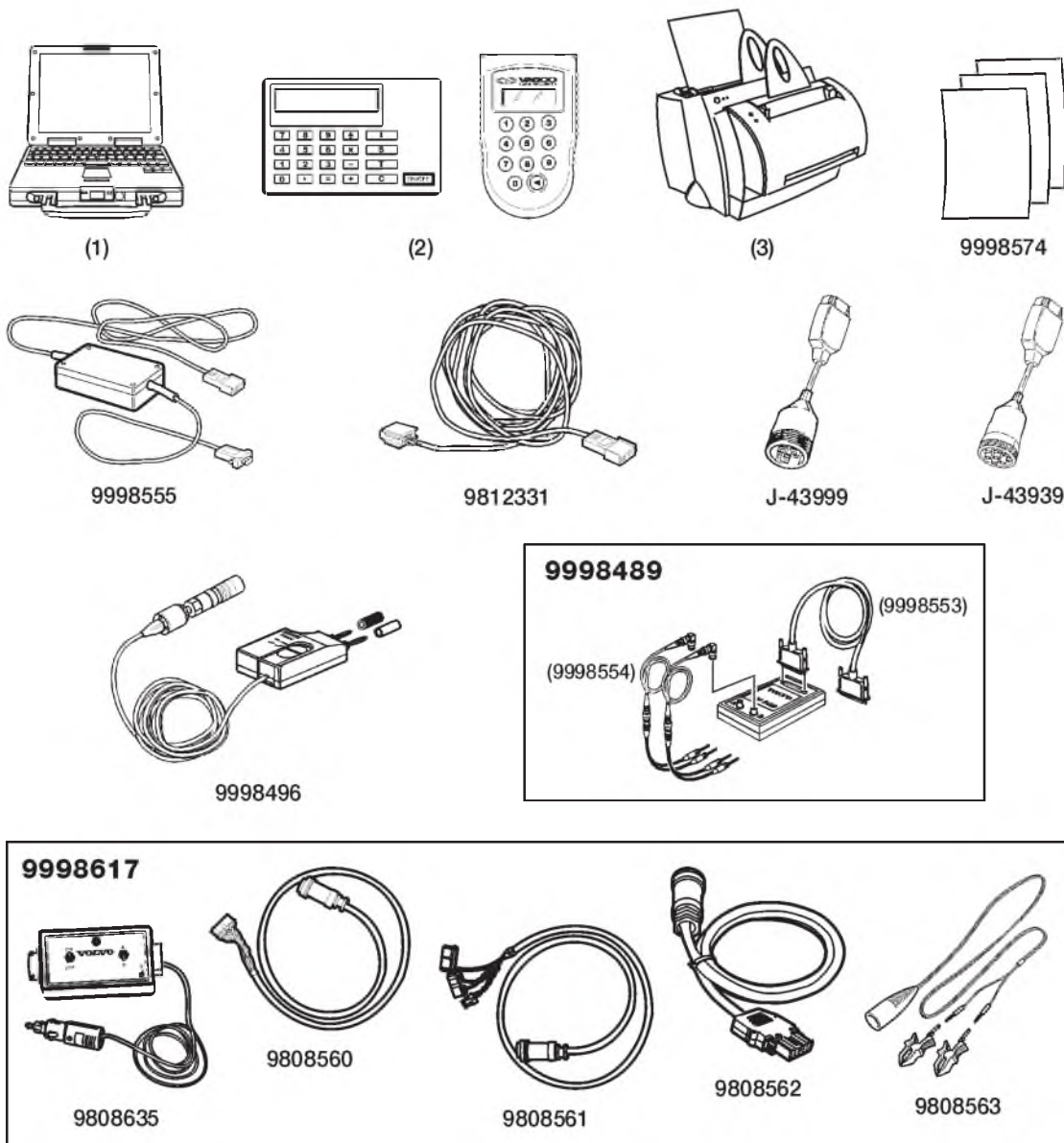
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<b>9998534</b>	4-pin breakout harness	<b>9809687</b>	AC/DC power supply for PC toll.(optional)
<b>J-39200</b>	digital multimeter		
<b>J-43147</b>	2-pin breakout harness	<b>9809678</b>	12 Pin DIN Connector cable-alternative programming cable for EECU
<b>9998482</b>	Guage for inspection of control unit connector	<b>9809685</b>	Power extension cable —used together w/9808635.
<b>J-41132</b>	36-pin breakout box	<b>J-43234</b>	Adapter(Kent Moore).
<b>J-42472</b>	2-pin breakout harness	<b>9998551/J-43340</b>	60 Pin Breakout Box/Overlay.
<b>J-43233</b>	36-pin jumper		
<b>J-38748</b>	7-pin fuel injection pump breakout box		

## Other Special Equipment

The following hardware is used to operate VCADS Pro. The tools can be ordered from Volvo quoting the specified part number.

VCADS Pro tools for diagnostics is for vehicles built from 1998 and later. For diagnostics on vehicles built prior to 1998, use Pro-Link 9000 (J-38500) with Volvo Application Cartridge J-38500-2000.



W2003597

See list on next page for information about the tools in the picture.

1	PC tool -package.
2	Didgipass password generator, model 300 or 500.
3	Laser printer; HP 1100A (To be purchased from a local supplier. Not supplied by Volvo.)
9998574	Laser printer labels. Used when printing labels for the engine electronic control unit (EECU).
9998555	Communication interface unit; for connection between the PC tool and the vehicle's diagnostic connector.
9812331	Extension Cable; for communication, 22 yards (optional)
J-43999	6 Pin Diagnostic adapter; for vehicles prior to 1999
J-43939	9 Pin Diagnostic adapter; for vehicles built from January 1999.
9998496	Pressure Guage
9998489	Oscilloscope interface
9998554	Oscilloscope Cable-BNC connector cable to banana jack (optional)
9998553	Oscilloscope Cable-25 pin parallel cable (optional)
9998617	Programming Kit (see below)
<b>9808635</b>	<b>Programming Unit</b>
9808560	Cable for direct connection to the Engine ECU
9808561	Cable for direct connection to the Vehicle ECU
9808562	Cable for direct connection to the Instrument Cluster
9808563	Cable for power supply

**Note:** There are three ways of connecting the power cable; 1) To radio power supply, 2) Directly to battery with battery. 3) To cigar lighter.

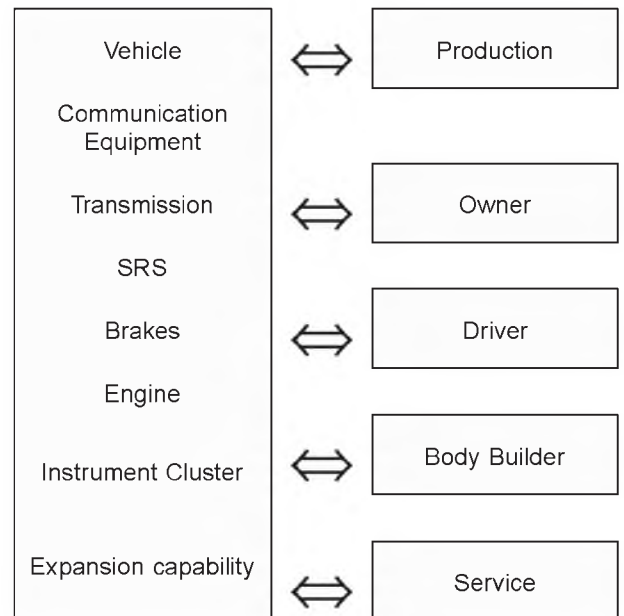
# Design and Function

## Vehicle Management System

### Strategy

The vehicle management system is designed to incorporate the entire vehicle system and instantly receive real-time data from key vehicle components.

- Uniform interfaces between the control systems.
- Standard adaptations to the vehicle's functions.
- Stand-alone diagnostics for the vehicle's main electronic components.



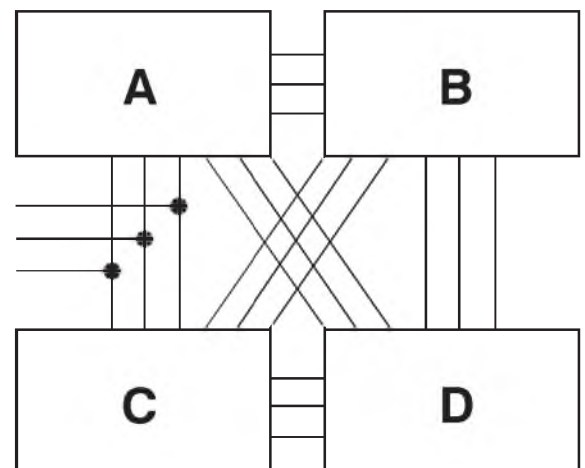
### Conventional Control Systems

In principle, a conventional control system is constructed so that one or several of the vehicle's components have their own control units that receive signals from different sensors. Each control unit serves its own component and sends signals to other control units via electrical wires.

An example of this is the engine control unit that receives signals from different sensors on the engine, as well as from other control units on the vehicle. The accelerator pedal position, the clutch pedal position, the speed signal, engaged power take-off etc., are sent to the engine electronic control unit (EECU) via wires from different sensors and contacts.

The system must have one or more communication ports, to which tools can be connected for programming as well as for reading information and any fault codes.

In the future, the vehicle's sub-components will require several specific control units and the vehicle electronics will therefore become even more complex. In the long run this will limit the ability of conventional control systems to fulfill their tasks.



T3008752



## Data Link System

Volvo's vehicle electronics are constructed on the principle that all communications between the control units in the system are accomplished via two data links:

- the J1939 Control Data Link
- and the J1587/1708 Information Data Link

The vehicle's main components have their own control units that are connected to one or both links in order to be able to communicate with each other.

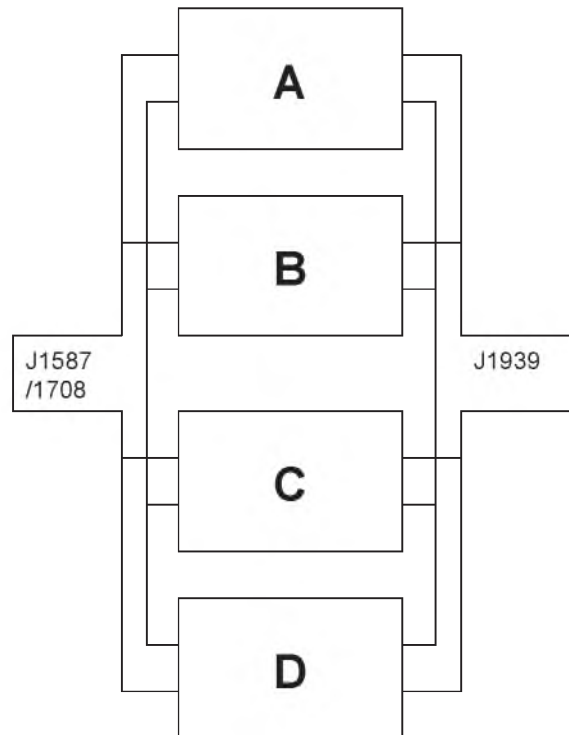
Here is how the system works on a vehicle equipped with a Volvo engine: when the driver wants to increase the vehicle's speed, a signal is sent from the accelerator position sensor to the vehicle electronic control unit (VECU). The signal is then transferred via the data link to the engine electronic control unit (EECU).

The EECU communicates with its own sensors to verify that the conditions exist to permit increased acceleration. If the conditions are met, it carries out the VECU's request.

The EECU communicates with the other control units via the data links, either by requesting or by receiving direct information that all prerequisites are met in order to be able to carry out the request.

If an error should occur in any of the systems, a signal is sent out on the J1587/1708 information data link, which makes it possible to read the information, either on the driver's instrument cluster, or via a PC or diagnostic tool (i.e. Pro-Link, VCADS or VCADS Pro) connected to the diagnostic connector.

The data link system provides an extremely flexible solution with great potential for expansion.



### CAUTION

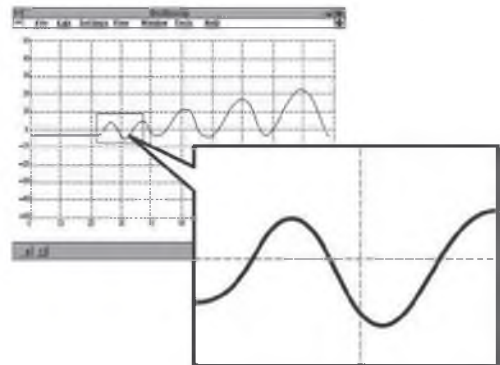
No modifications or connections should be made to wires 406 (yellow), 407 (green) or 408 (shielded). These wires carry the high-speed communications between the electronic systems in the vehicle. **Any modification, connection to, or damage to these wires can result in the failure of the vehicle's electronic systems.**

## Data Links, Design and Function

Data links are one way of transferring information between various components. In conventional systems, analog signals have mostly been used.

Analog signals mean that different voltage levels represent different values. A simplified example of analog signals could be:

- 1 volt = 10° C
- 2 volts = 20° C
- 3 volts = 30° C



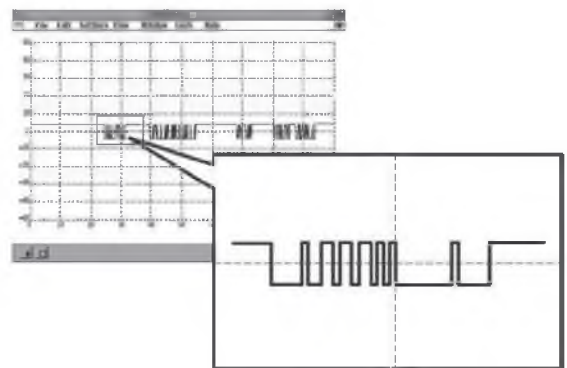
W3003960

Data links use digital communication. This means that the voltage only varies between two different values, either "high" or "low". By combining these high and low signals various values can be described.

The diagram shows an oscilloscope image where the voltage of the data link is measured. As can be seen from the diagram, a large part of the time the link is "silent" but at times a number of fast pulses are sent. A group of pulses is called a message.

The enlarged portion of the diagram shows that each message consists of a combination of high and low voltage levels.

The following sections describe what type of information this message contains.



W3003957

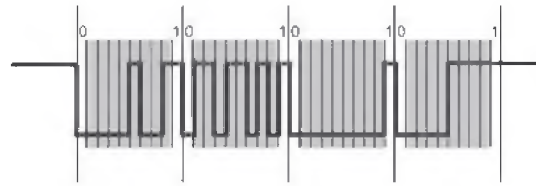
### Messages and Information Content

Different voltage levels are represented by the different numbers in the binary number system. The binary number system has only two numbers, one and zero.

The ones are normally represented by a high voltage and the zeros by a low voltage.

Each binary number is called a "bit". This message consists of four groups of binary numbers. Each group of eight bits makes up a "byte", a decimal number from 0–255 with information, as well as a start bit and a stop bit.

The purpose of the start and stop bits is to function as markers for where that group of data begins and ends. In the diagram above only the start and stop bits are labeled. The other information is shaded.



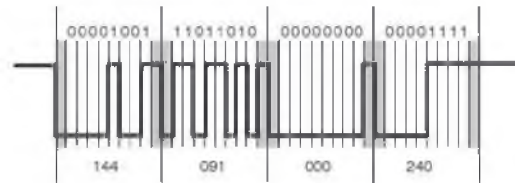
W3003956

### Example

The diagram shows the information content in the four different parts of the message. The start and stop bits are shaded since they do not contain any information.

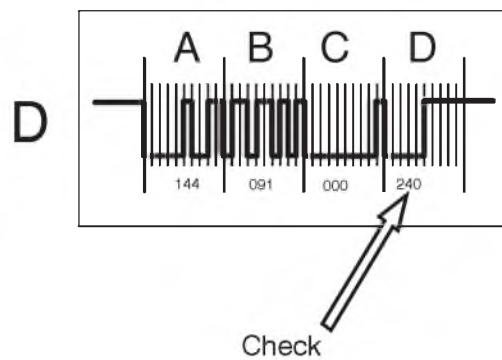
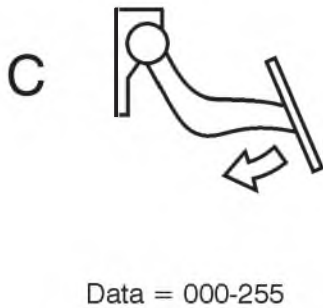
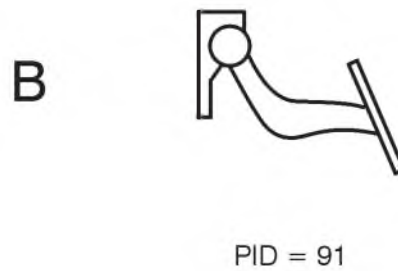
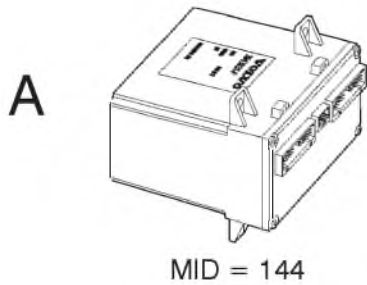
The box in the diagram shows the different binary and decimal values which comprise the message.

**Note:** The information is sent over the data link with the "least" bit first in the binary numbers. The normal way to notate binary numbers is shown in the box in the diagram.



	128	+ 64	+ 32	+ 16	+ 8	+ 4	+ 2	+ 1
144 =	1	0	0	1	0	0	0	0
091 =	0	1	0	1	1	0	1	1
000 =	0	0	0	0	0	0	0	0
240 =	1	1	1	1	0	0	0	0

W3003956



W2003293

Message 144–091–000–240 in this example, has the following meaning:

- A** MID 144 — The message comes from the Vehicle ECU.
- B** PID 091 — The message states the accelerator pedal position percentage.
- C** Data 000 — The accelerator pedal is in the completely released position.

000 is a data component, which in this case states how much the accelerator pedal has been pressed down. The value can vary between 000 for a completely released pedal and 255 for a completely pressed down accelerator pedal.

- D** Check 240 — The checksum is used as a check that the message is reasonable.

## Diagnostic Message Description

The Society of Automotive Engineers (SAE) and the American Trucking Association (ATA) have developed a standardized list of diagnostic messages, or fault codes. These diagnostic messages are used to communicate information about problems detected by an electronic control unit's (ECU's) self-diagnostic program. In addition to the industry-standard SAE codes, Volvo has developed a list of diagnostic messages that are unique to Volvo applications. Generally, diagnostic messages and their descriptions are listed in the service manual for each respective ECU and in the user manual for diagnostic tools.

- MID** MID is an acronym for Message Identification Description. MIDs are SAE standardized codes used to identify individual electronic control units.
- PID** PID is an acronym for Parameter Identification Description. PIDs are SAE standardized codes used to identify parameters or values.
- PPID** PPID is an acronym for Proprietary Parameter Identification Description. PPIDs are Volvo's unique codes used to identify parameters or values.
- SID** SID is an acronym for Subsystem Identification Description. SIDs are SAE standardized codes used to identify components.
- PSID** PSID is an acronym for Proprietary Subsystem Identification Description. PSIDs are Volvo's unique codes used to identify components.
- FMI** FMI is an acronym for Failure Mode Identifier. FMIs are SAE standardized codes used to identify a type of failure.

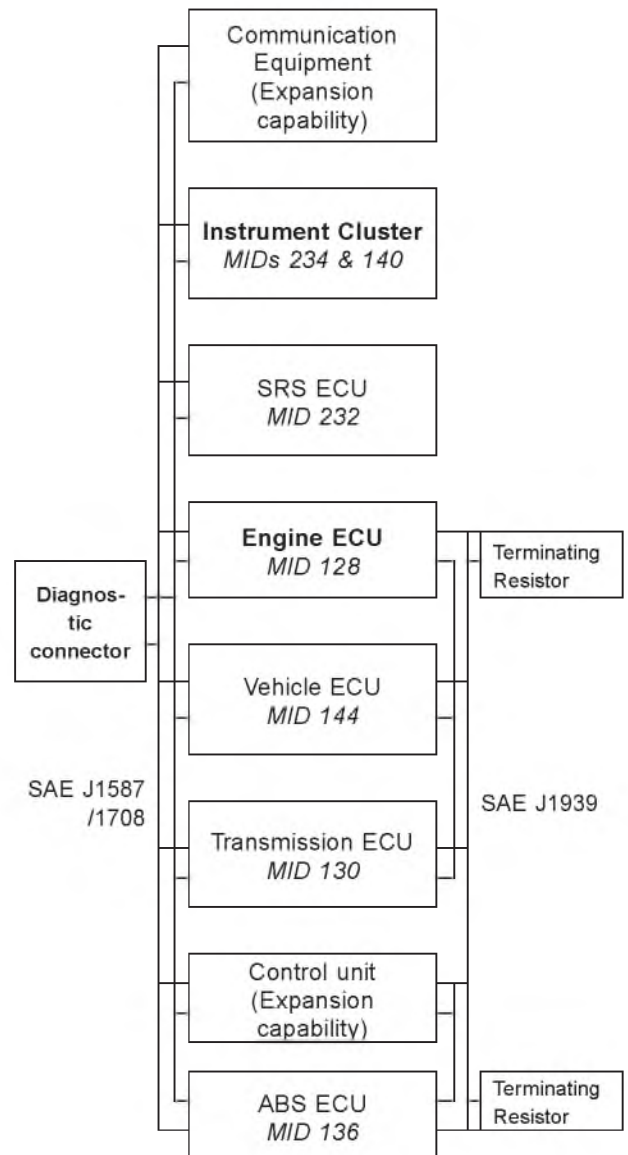
## Data Link Communication

### General

Communication between the different ECUs takes place via the two data links: the J1939 control data link and the J1587/1708 information data link.

The diagram shows how the control units, the diagnostic connector, and the instrument cluster are connected in principle.

**The instrument cluster, the engine ECU and the diagnostic connector** are always included in the system. The system may include other control units, depending on the vehicle type, engine type and optional equipment.



### *SAE J1939 Control Data Link*

The system's **control signals** are sent via this link.

The J1939 link is very fast, operating at 250,000 bits per second. This operating speed allows the system to function more effectively and adapt quickly to changing conditions and vehicle requirements.

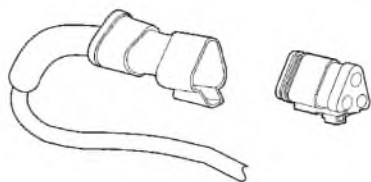
The link complies with SAE standards, and consists of three twisted wires: a green wire (407), a yellow wire (406) and in early designs a shield wire (408—optional). The twisted wire set (40 turns per meter) is used to protect the link from electrical interference.

 **CAUTION**

No modifications or connections should be made to wires 406 (yellow), 407 (green) or 408 (shielded). These wires carry the high-speed communications between the electronic systems in the vehicle. **Any modification, connection to, or damage to these wires can result in the failure of the vehicle's electronic systems.**



### Terminating Resistor



W3002905

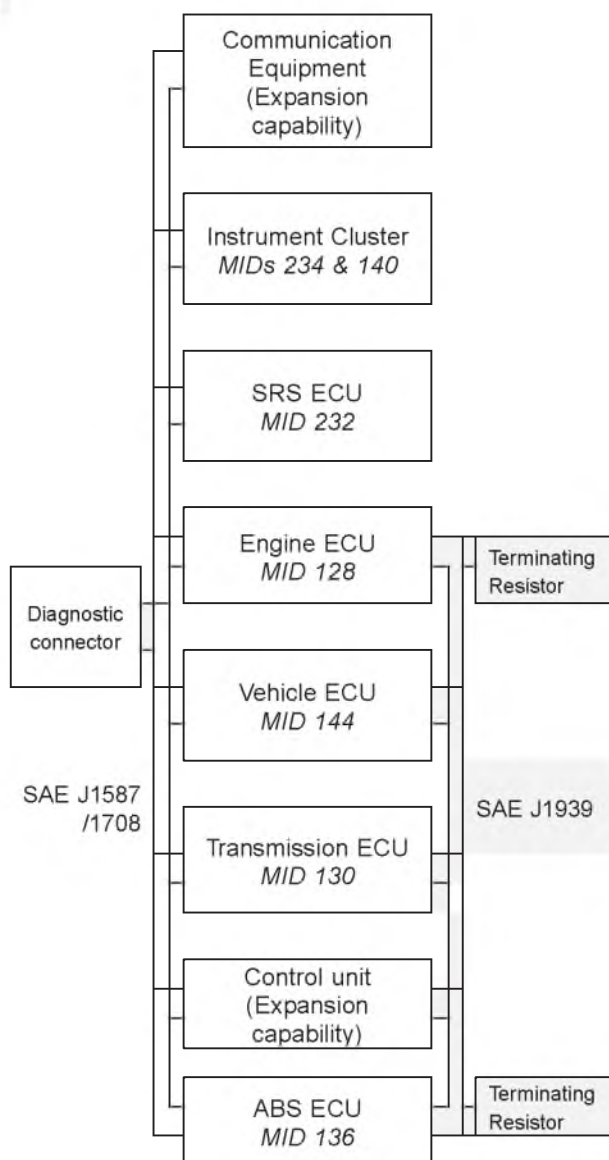
Terminating resistors are wired into each end of the J1939 data link. One is located near the ABS ECU and the other near the engine ECU. On Volvo engines, the terminating resistor at the engine ECU end is located inside the EECU.

If you measure 120 ohm (+/- 10 ohm) between circuits 406 and 407, then there is only one terminating resistor. Check to determine which is missing and reconnect it.

**Note:** With Volvo engines, one terminating resistor is within the engine ECU. The other is positioned at the end of the J1939 network, typically at the ABS ECU. The one within the ECU is not accessible and should not be at fault.

If you measure less than 60 ohm, only two terminating resistors are used in a vehicle. Never install three in one truck. If more than two terminating resistors exist in the J1939 circuit, damage to the ECU electronics can occur over time. You can easily check to see if you have two resistors by measuring the resistance between circuits 406 and 407 with the ignition OFF. The correct resistance is 60Ω.

The purpose of these resistors is to prevent data link signal reflections. They must remain connected for the system to function properly.





### SAE J1587/1708 Information Data Link

Information and diagnostic signals are sent via this link. The link also functions as a "backup" should the J1939 control data link fail to function for any reason.

SAE J1708 is a standard that specifies hardware and a databus speed of 9600 bits per second. SAE J1587 is a protocol that provides a standard method for exchanging information between microprocessors.

The J1587 link consists of two wires (400 and 401) that are twisted around each other approx. 30 turns per meter. The twisted-pair wires are to protect the link against electrical interference.

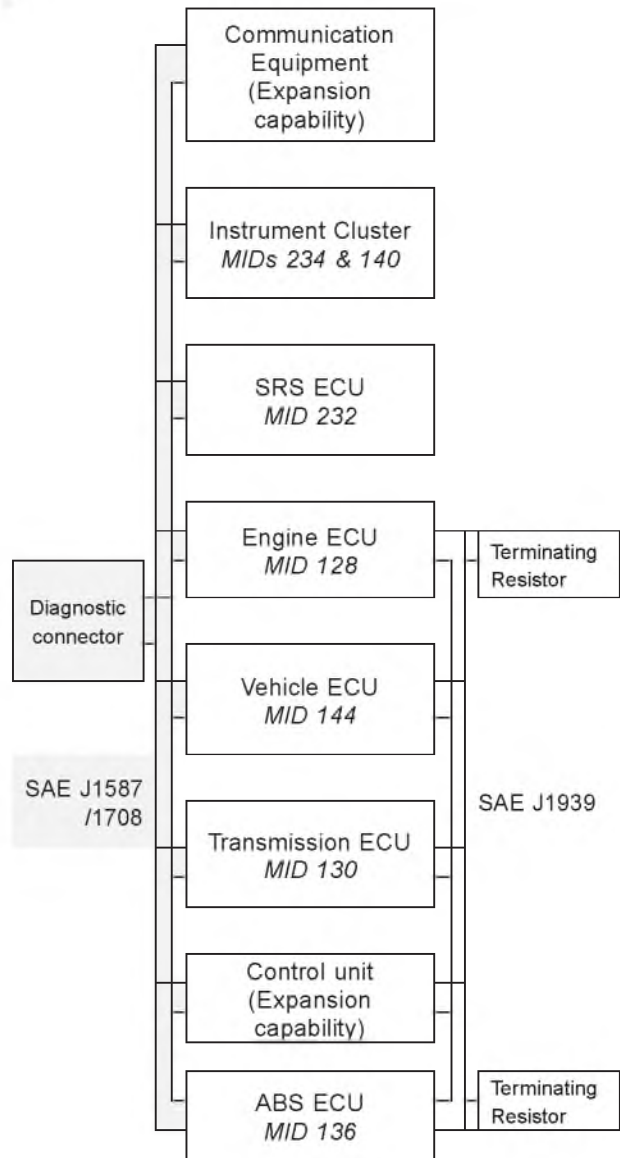
 <b>CAUTION</b>
If a circuit must be added to the electrical system, and will carry high currents or frequencies, route it in a location AWAY from wires 400 and 401 to prevent mutual inductance from interfering with data link functions.

 <b>CAUTION</b>
Wires 400 and 401 MUST NOT be cut or spliced for any connections. These wires are used for the transmission of data for diagnostic messages and gauges. Modifying this circuit can cause these functions to fail.

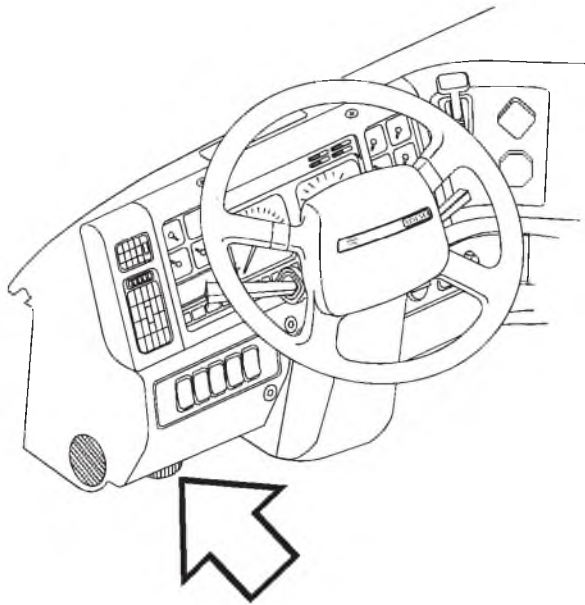
### SAE J1922 Data Link

For a short period of time some vehicles were produced which used the J1922 data link. The J1922 data link was developed as an interim standard until the J1939 control data link was established. The J1922 link operates on J1708 defined hardware and is used like a control link for communication between engine, transmission and ABS ECUs.

The J1922 link consists of two wires (404 and 405) that are twisted around each other approx. 30 turns per meter. The twisted-pair wires are to protect the link against electrical interference.



# Diagnostic Connector



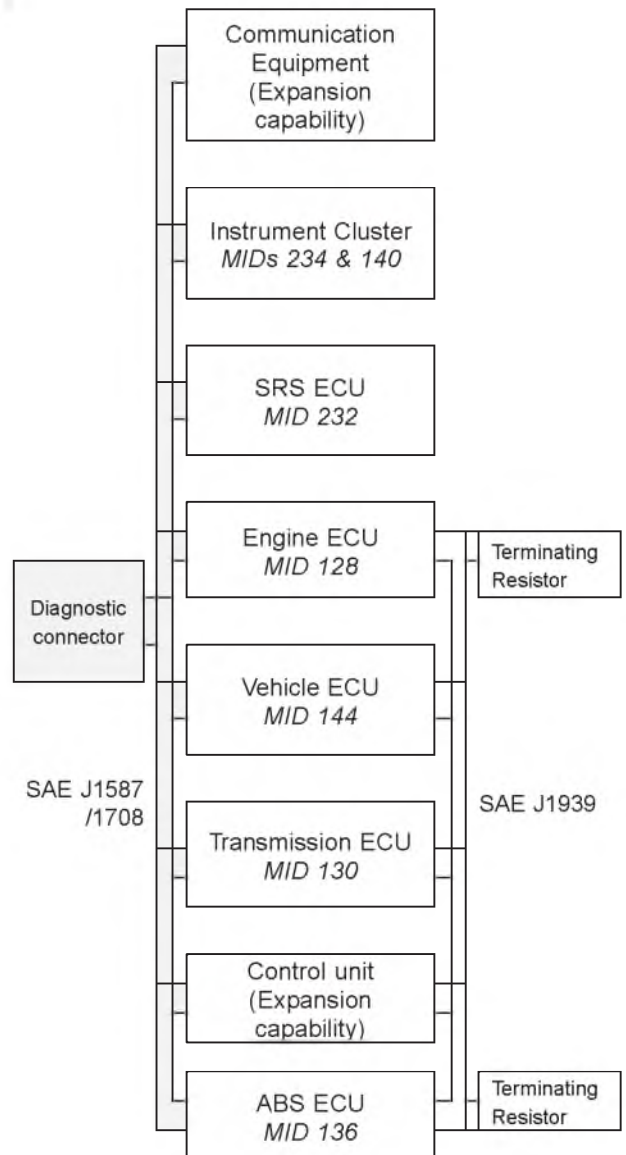
W8001310

The diagnostic connector is a round Deutsch connector located in the driver's side kick panel. The diagnostic connector is connected to the J1587/1708 information link and gives the system a way to communicate with an external PC or diagnostic tool.

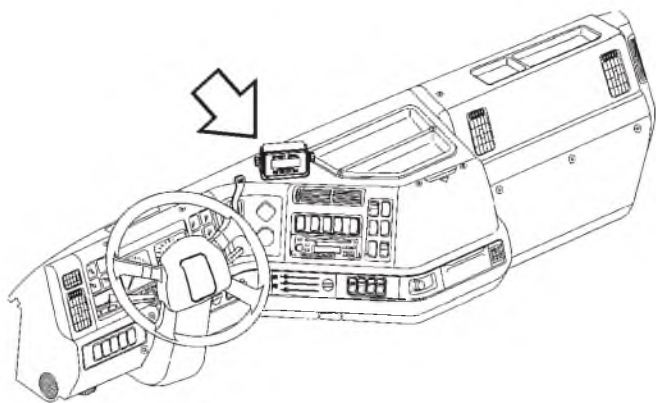
With a PC or diagnostic tool connected, fault codes can be read from all the control units. This is important in fault tracing to carry out basic checks of all the vital parts of the vehicle's electronics.

Some programming can also be done via the diagnostic connector.

The standard diagnostic connector is a 6-pin Deutsch. A newer 9-pin Deutsch version has been introduced on certain vehicle/engine variants. The new 9-pin connector connects to both the J1939 and J1587/1708 data links.



# Communication Equipment



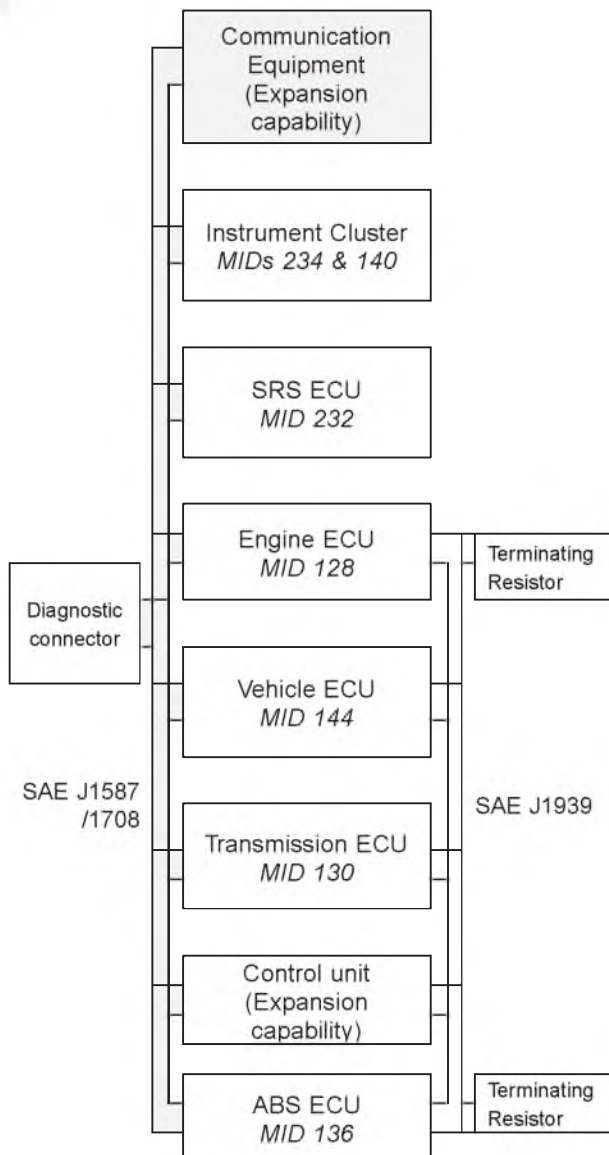
Pro-Driver Display

W2003295

Various manufacturers offer communication equipment designed to allow drivers to keep log book records electronically, maintain communication with the home office, monitor and record vehicle operations, and many other functions. Currently these communication devices are connected to the J1587/1708 Information Data Link. Newer and more sophisticated versions of these devices may also connect to the J1939 Control Data Link. Note: No provisions have currently been made to add communication equipment to the J1939 link in aftermarket adaptations.

CAUTION

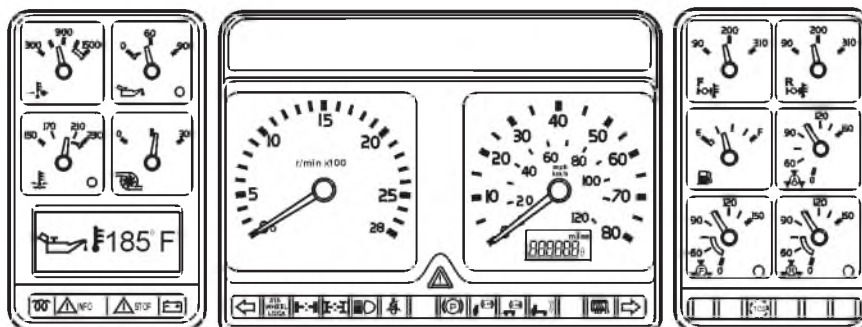
No modifications or connections should be made to wires 406 (yellow), 407 (green) or 408 (shielded). These wires carry the high-speed communications between the electronic systems in the vehicle. **Any modification, connection to, or damage to these wires can result in the failure of the vehicle's electronic systems.**



Provisions are made for adding aftermarket communication devices to the J1587/1708 link via connectors in the wiring harness.

Some of the communication devices currently used in Volvo trucks include Road Relay, Pro-Driver, Qualcomm and Highway Master.

# Instrument Cluster

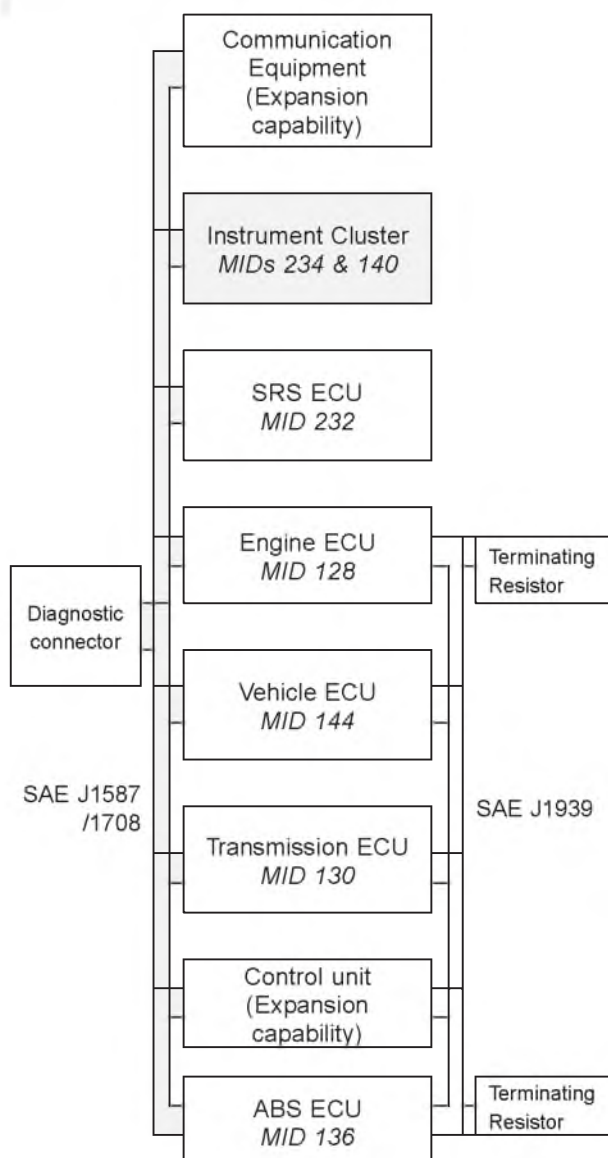


W3003621

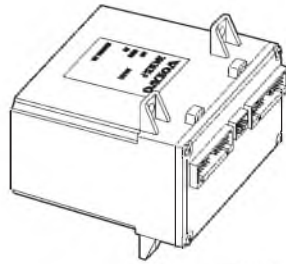
The instrument cluster used on Volvo vehicles uses both data link signals and hardwired sensors depending on the vehicle/engine variant and instrument configuration. A graphic display screen is integrated into the instrument cluster to provide additional features and vehicle system information not available from other gauges. Diagnostic codes can also be retrieved and displayed. The instrument cluster is connected to the J1587/1708 information data link.

For information about the instrumentation that communicates via the data link, refer to service manuals in group 38:

Model:	See Publication:
WG/AC/WC/WI from 1994; WX with electronic engines from 5.96	Data Link Instrumentation, PV776-381-620SM
WX	Kysor Mini-Cluster, PV776-TSP108262
VN from 1.98-2.99	Instrumentation, PV776-TSP106805/1
VN from 3.99 ADN VHD	Instrumentation, PV776-TSP139790



## Vehicle Electronic Control Unit (VECU)



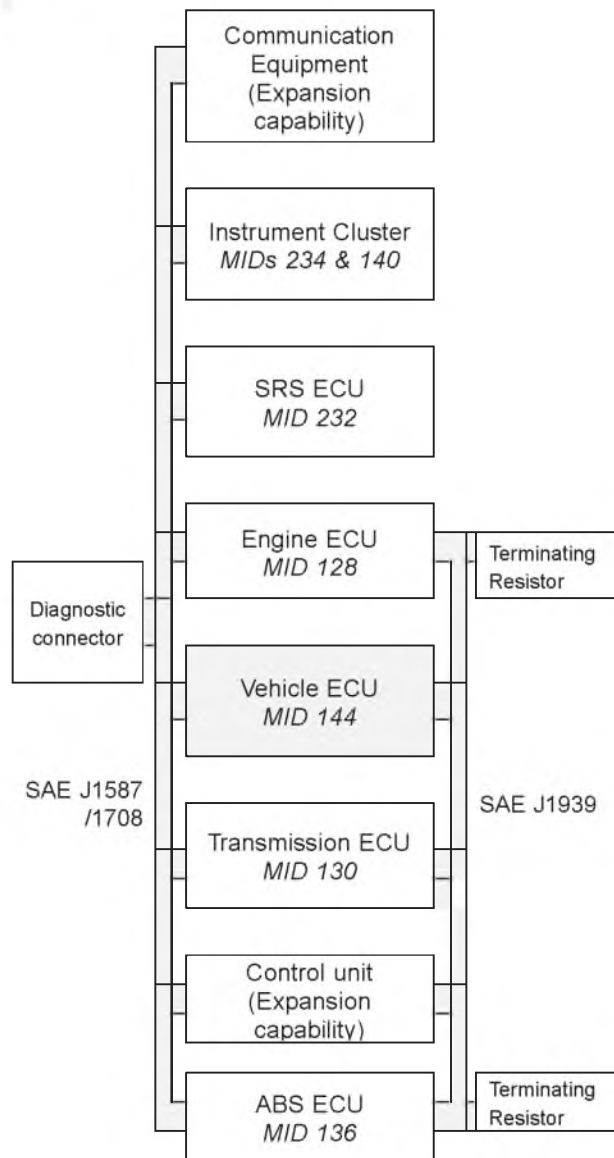
W2002673

The vehicle electronic control unit (VECU) is part of the integrated vehicle electronics. The VECU is located in the cab, but its specific mounting location varies by model.

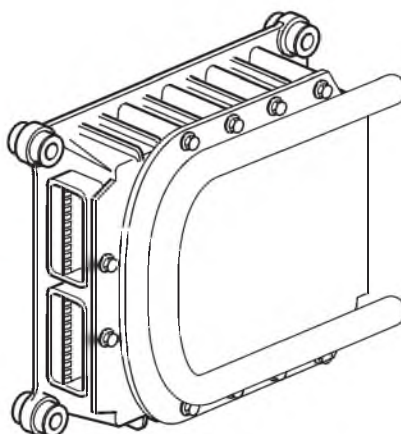
The main function of the VECU is to collect data from different cab control units and then to pass this data to other ECUs in the system (primarily to the engine ECU).

For detailed information about the VECU see *Vehicle Electronic Control Unit, MID 144*, Volvo service publication number PV776-300-610.

**The VECU is only used in vehicles equipped with Volvo engines.**



# Engine Electronic Control Unit

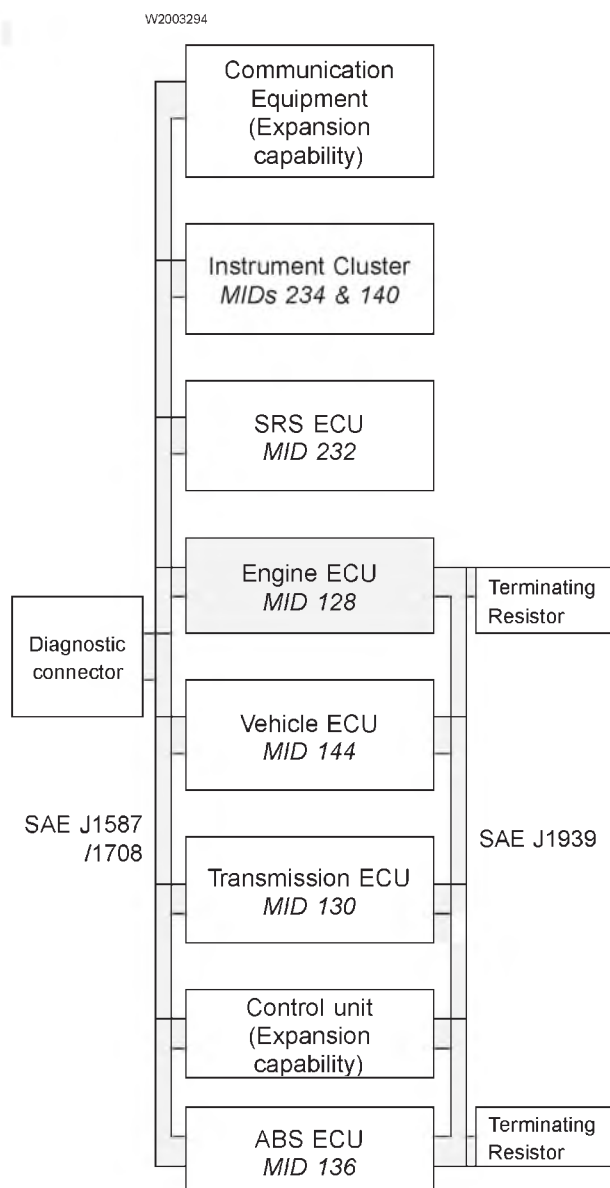


Irrespective of engine variant, the engine electronic control unit (EECU) performs the same basic functions in the system: control of engine operation. The EECU receives signals from various sensors and the data links. Based on these signals and the parameters programmed into the EECU, the EECU calculates the proper injection angle and fuel quantity to satisfy the requested operating requirements.

The EECU is connected to both the J1939 control data link and the J1587/1708 information data link.

**Note:** Early production model EECUs may use only the J1587/1708 data link, or the J1587/1708 and the J1922 data links.

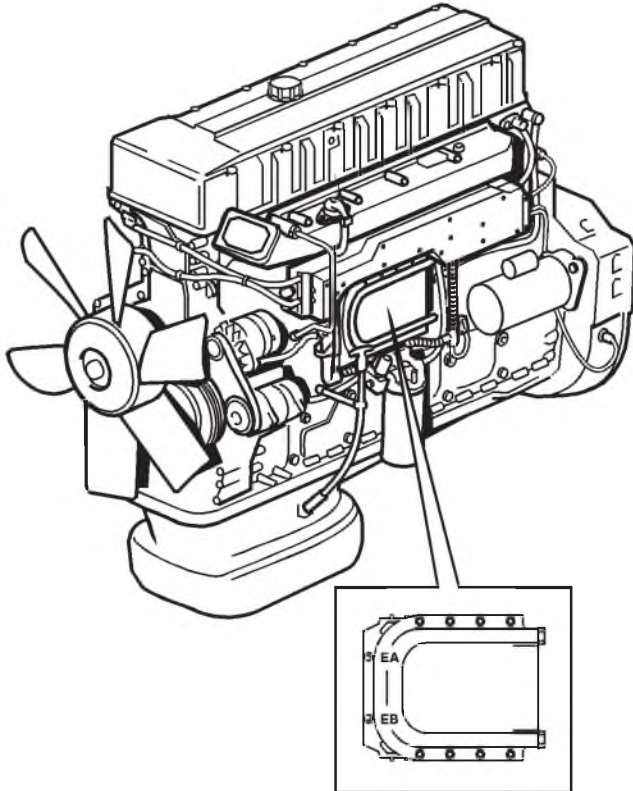
For detailed information about EECUs see the service literature for that particular engine.





## EECU

The EECU is an electronic control unit that monitors certain operational parameters of the Volvo engine from the SAE J1587 Data Link and appropriate sensors.



W2003076

### *ON/OFF Engine Cooling Fan*

The EECU receives the input from the engine coolant temperature sensor to turn on the cooling fan at 115 °C (202 °F). The fan will remain engaged until the engine coolant drops to 90 °C (195 °F).

The ON/OFF cooling fan can also be engaged by the EECU if it receives a signal from the air conditioning systems APADS module. When the A/C system pressure reaches 20.5 bar (300 psi) the APADS module will send a signal to the EECU to engage the cooling fan. The on time of the cooling fan is controlled by the APADS module.

If the EECU does not receive any coolant temperature data, the fan is engaged for a minimum of 30 seconds. The fan will stay engaged until valid coolant temperature data is received and the coolant temperature drops below 90 °C (195 °F).

### *Converting Engine Oil Pressure Signal*

The EECU takes an analog signal from a pressure transducer and broadcasts the signal on the SAE J1587 data link.

### *Engine Information and Warning Lamp-On Dash*

- **Engine Oil Pressure**  
The EECU will make the  $\Delta$  STOP lamp light and the icon in the display light up if the oil pressure is  $< 41 \pm 3$  kPa ( $6 \pm 1.2$  psi). Also a warning signal sounds if the engine is running.
- **Engine Coolant Level**  
The EECU will make the  $\Delta$  STOP lamp light stay on (solid) if the low coolant level sensor detects a low coolant level condition. The low coolant level condition is active only after 5 seconds of a constant signal from the low level sensor.
- **Engine Coolant Temperature**  
The EECU will make the  $\Delta$  STOP lamp light illuminate and gauge LED illuminate, plus the icon in the display if a high coolant temperature from the engine ECU is received.
- **Engine Oil Temperature**  
If the Engine oil temperature becomes too high an information message is shown automatically with the text HIGH. At the same time the yellow  $\Delta$  INFO lamp under the display lights up. The engine may also derate, if it is set up to do so in the engine ECU programming. The temperature which activates this warning varies for different engines. This temperature is set in the engine ECU. For Volvo engines, it is 275 °F (135 °C).

**Note:** If the engine is running and the stop lamp comes on you will get a **buzzer** or warning signal.

### Electronic Unit Injectors

The engine has six unit injectors, one for each cylinder.

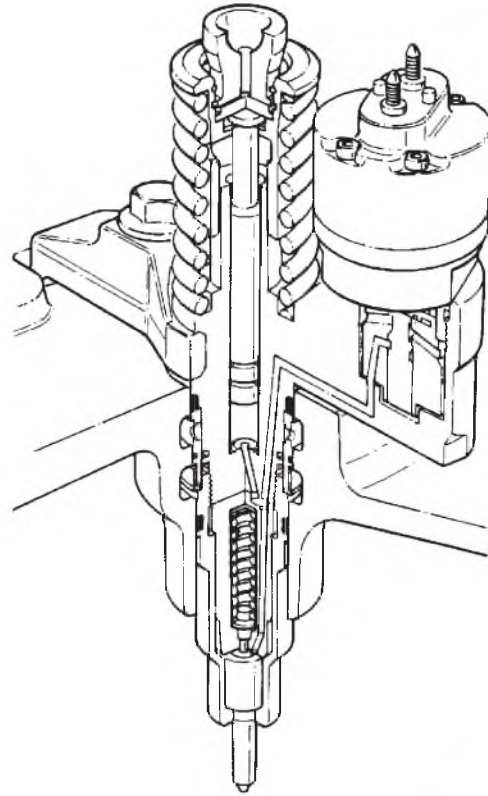
Each **Electronic Unit Injector**, or EUI, is a combination of injection pump and injector, but operates at a considerably higher pressure than a standard injector.

Each unit injector is mounted vertically in the cylinder head at each cylinder, centered between the four valves. The compressive force for the unit injector is developed by a lobe on the overhead camshaft. It is then transferred by a rocker arm to the injector.

The injection angle and the amount of fuel to be injected into the cylinder is determined by the EECU, which transmits signals to the electromagnetically controlled fuel valve in the unit injector valve housing.



Make sure to turn the ignition key off before working on the electronic unit injectors. This eliminates the possibility of electric shock which may result in personal injury or death.



T2006998

Electronic unit injector

### Calculating Fuel Quantities

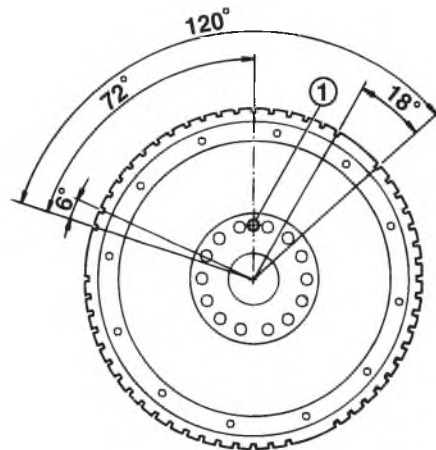
The EECU calculates the quantity of fuel to be injected into a cylinder. This calculation provides the period of time during which the fuel valve is closed (when the fuel valve is closed, fuel is injected into the cylinder). Factors that determine how much fuel to inject into a cylinder are:

- Requested fuel amount
- Limitation of fuel amount

### Flywheel

There are 54 notches cut into the flywheel; these are read by the speed sensor for the flywheel. With the help of these notches, the EECU can set the correct injection angle and calculate the time which gives the correct fuel amount.

The notches are divided into three groups, with 18 notches in each group. There is a flat area between each group of notches equivalent to  $18^\circ$ . A flat area and 18 notches is equivalent to  $120^\circ$  on the flywheel, or a third of a full turn. The area between each notch equals  $6^\circ$  on the flywheel.



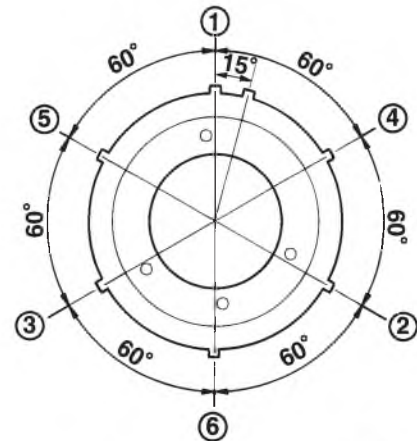
T2007019

Flywheel

### Cam Sensor Wheel

The cam sensor wheel has six teeth (one tooth for each unit injector) evenly spaced at  $60^\circ$  center-to-center, plus an extra tooth, placed  $15^\circ$  before the tooth that indicates cylinder number 1.

The EECU uses these teeth to determine which injector is in line for injection. In other words, each tooth (teeth 1–6) represents the start of a cylinder operating phase (does not apply to the extra tooth).



T2007099

Cam sensor wheel

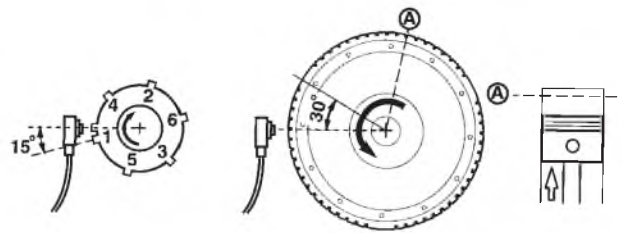
### Flywheel and Cam Sensor Wheel

The ratio between the flywheel and cam sensor is 2:1. This means that when the flywheel has rotated two turns, the cam sensor wheel has rotated one turn or when the flywheel has rotated  $30^\circ$ , the cam sensor wheel has rotated  $15^\circ$  and so on.

### Injector Operational Phases

The operational phase of the number 1 cylinder is given in the following example. Fuel is injected at 7° before top dead center (BTDC) (the injection angle may vary between 18° BTDC and 6° after top dead center).

The cam sensor reacts to the extra tooth on the cam sensor wheel. This informs the control unit that the next tooth in turn (tooth 1) indicates the number 1 cylinder.

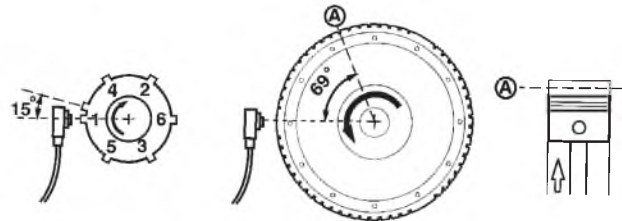


Locating number 1 cylinder

A top dead center (TDC)

The cam sensor wheel detects tooth 1 and the flywheel sensor reaches a flat area on the flywheel at the same time.

At this point, the piston is on its way upward in the cylinder and no fuel is injected into the cylinder.

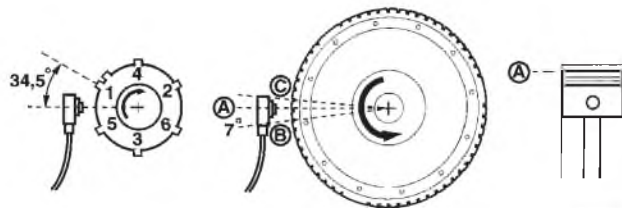


Engine speed calculated

A top dead center (TDC)

The sensor detects the first notch after a flat area on the flywheel. Using the engine speed calculation, the EECU can determine:

- When to begin injecting fuel into the number 1 cylinder. This gives selected injection angle (7° BTDC in the example).
- When to stop injecting fuel into the number 1 cylinder. This gives the selected fuel amount.



Calculating injection angle

A TDC  
 B 7° BTDC (injection begins)  
 C ATDC (injection stops)

From the first notch after a flat area, the EECU advances the angle from which it is to begin injecting fuel into the cylinder and on to the angle where it is to stop injecting fuel into the cylinder. If the calculated angles do not agree with the notches on the flywheel, the EECU measures the time between the last notches to rectify the angles.

Because the EECU must calculate the engine speed during  $120^\circ$ , the engine speed calculation for each cylinder occurs one step ahead at all times. In other words, during the operational phase for one cylinder, the EECU calculates engine speed for the next cylinder and so on.

This procedure is repeated for the next cylinder in the same manner as described for the number 1 cylinder.

**Note:** Note that the calculation of the injection angle and fuel amount takes place continuously, regardless of the operational phase of the cylinders.

### *Cylinder Balancing*

The EECU can provide each cylinder with a different quantity of fuel to make the engine run more smoothly at idling speeds. At higher speeds, there are no problems with smooth running and all cylinders receive the same amount of fuel. If the variation in fuel quantity between different cylinders is too great during cylinder balancing, the EUI, which deviates most, triggers a fault code from 31 to 36. This indicates that there must be a fault in the cylinder in question.

For cylinder balancing to take place, the following conditions must be satisfied:

- Idling speed must be below 650 rpm.
- Fuel requirement must be below a specific rating.
- Idling adjustment function must not be active.
- PTO not active.
- Cruise control mode not active.
- Accelerator pedal in idling position.
- Coolant temperature must be above  $50^\circ\text{C}$  ( $122^\circ\text{F}$ ).
- Vehicle must be at a standstill.
- No fault codes in existence.

### *Other Functions*

The EECU guides the EUIs based on the following "control functions."

**Smoke limitation** — To prevent injecting too much fuel into the cylinder, the EECU checks:

- Boost pressure
- Engine speed
- Boost air temperature

**PTO engine speed** — The engine can be kept at a constant rpm level that is at least 100 rpm greater than low idle and less than high idle.

**Cruise control** — The engine can be set to maintain a constant speed between 48 km/h (30 mph) and 140 km/h (87 mph). For the cruise control mode to function, the following conditions must be satisfied:

- Cruise control in **ON** position.
- Brake pedal must not be depressed.
- Clutch pedal must not be depressed.

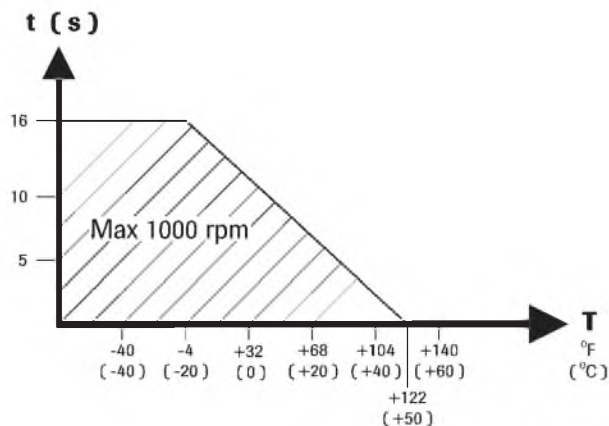
**Speed limitation** — The EECU can be programmed to limit the maximum speed up to 140 km/h (87 mph). A fault on the sensor signal and/or a faulty cable to the EECU generates a fault code.

**Differentiated speed limitation** — This mode is available as an option. It limits the speed to various levels depending on the gear selected. In other words, each gear has a maximum speed.



**Engine protection** — To a certain extent, the EECU can also protect the engine by:

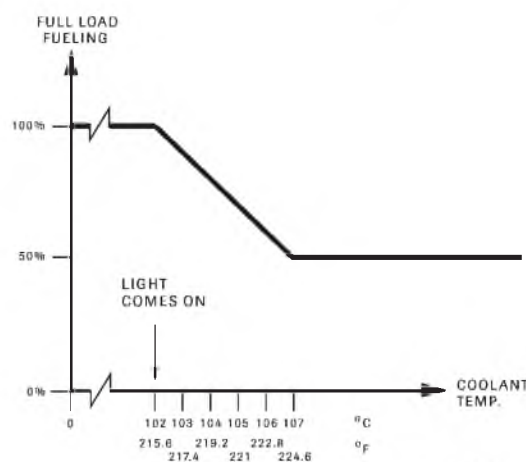
- Reducing engine speed at low coolant temperatures (cold engine cranking): When coolant temperature is lower than 50 °C (122 °F), engine speed is limited during a specific time to 1000 rpm immediately after starting. At -20 °C (-4 °F) and lower, this period is 16 seconds, and above 50 °C (122 °F) the period is 0 second. This function allows oil pressure to build up before engine speeds become too high.



W2000768

Engine speed during cold cranking

- Reducing engine output at high coolant temperatures (during engine operation): Should coolant temperature exceed 102 °C (216 °F), the maximum fuel provision is reduced by a certain percentage of its original rating and the coolant temperature warning lamp lights up. If the coolant temperature becomes **excessively** high, the engine will gradually reduce power to 50%. When coolant temperature has dropped below 100 °C (212 °F), maximum fuel provision is permitted again and the coolant temperature warning lamp goes out.



W2000769

Engine speed during operation

The safety signal is an optional system that enables the EECU to switch off the engine. The EECU can be programmed to provide three levels of engine protection:

- No engine protection (fire engine)
- Engine protection
- Extended engine protection

**Idle shutdown** — This function is available as an option. It switches off the engine after it has run at idling speed for a specific time. This time can be set to between 1 and 40 minutes. The engine will be switched off if the following conditions are met:

- Vehicle speed is 0.
- Parking brake is applied.
- Engine running at idle speed.
- Coolant temperature is above 45 °C (113 °F).

**Cold starts, idling** — Idling speed is automatically boosted to heat the engine more quickly from a cold start when coolant temperature is below a specific level. When this mode is activated, idling speed is boosted to 650 rpm. When coolant temperature has reached 30 °C (86 °F), idling speed drops steadily to its normal level which is reached at a coolant temperature of 45 °C (113 °F).

### Starting the engine

Before any fuel can be injected into the cylinders, the EECU must have had a sufficient amount of time to carry out the first calculations on injection angles and fuel quantities. This time is equivalent to two engine revolutions.

### VEB (VOLVO engine brake)

The VEB consists of an exhaust brake and a compression brake. The EECU activates the VEB when the following conditions are satisfied:

- Accelerator pedal at idling position (fuel injection must not occur).
- Engine speed must exceed 1200 rpm.
- Clutch pedal must not be depressed.
- Boost pressure must be lower than 152 kPa (22 psi) (overpressure).
- PTO not activated.
- Vehicle speed is greater than 3.2 km/h (2 mph).
- ABS not activated.
- Engine coolant temperature is greater than  $40 \pm 2$  °C ( $104 \pm 5$  °F).
- Engine oil temperature is greater than  $55$  °C ( $130$  °F).

The VEB may be activated when the cruise control is in use. For this to take place, the following condition must be satisfied:

- Vehicle road speed must exceed the set speed of the cruise control by between 5 and 30 km/h (4 and 20 mph), depending on what level has been programmed into the EECU.

### Idle Speed Adjustment

**Note:** This service information should be considered supplemental to the Engine Control information for base D12 B and C engine.

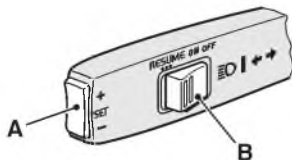
The idle speed is adjusted on the VN vehicles at the turn signal stalk. The idle speed can be adjusted between 500 RPM and 650 RPM.

Prerequisites to adjusting idle speed:

- Accelerator pedal not depressed.
- Engine temperature above 45 °C (113 °F).
- Vehicle is stationary / Parking brake set.

#### Idle speed adjustment

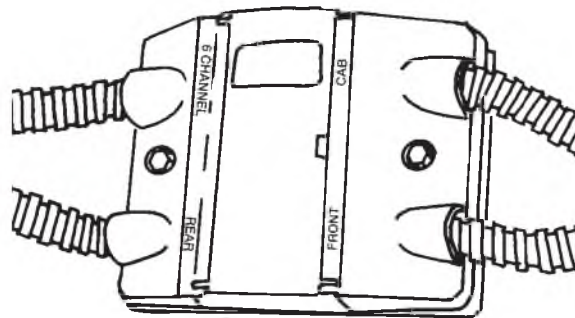
- 1 Cruise control in the ON position.
- 2 Depress the brake pedal and continue to hold it during the entire adjustment procedure.
- 3 Move the ON/OFF switch to the RESUME position and hold for four seconds. Release the switch; the engine speed will drop to approximately 500 RPM.
- 4 The idle speed can be adjusted with the SET switch. Each time the SET switch is pressed, the idle speed will increase approximately 10 RPM.
- 5 Move the ON/OFF switch to the RESUME position and the idle speed will decrease approximately 10 RPM each time.
- 6 Hold in the SET switch and move the ON/OFF switch to the RESUME position and hold them in position for four seconds. Release the switches
- 7 Release the brake pedal and the new idle speed is set. If an error was made during the adjustment procedure, the default idle speed will be maintained.



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- 1 A-Set
- 2 B-Resume, On/Off

## ABS Brake System ECU

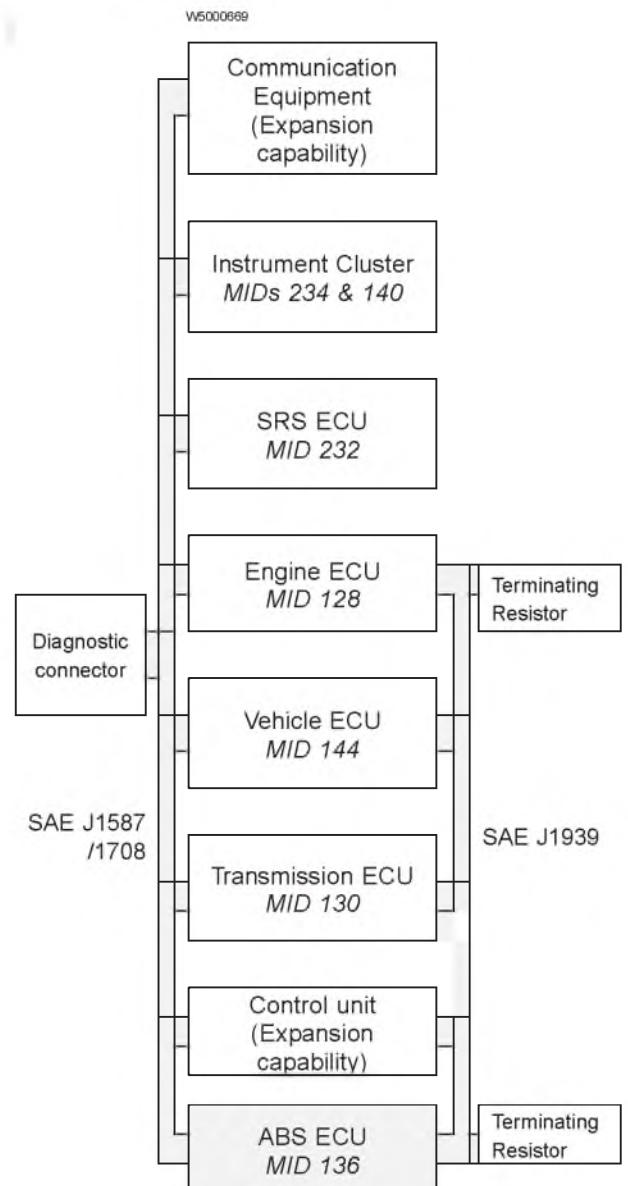


The ABS ECU continuously monitors wheel speed and helps to control braking in extreme situations. It also helps prevent wheel spin in vehicles equipped with traction control systems (ATC or TCS).

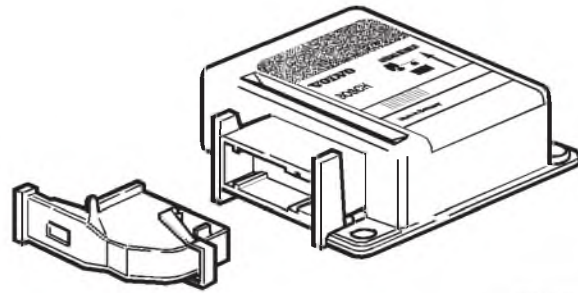
The ABS ECU is connected to the J1939 control data link and the J1587/1708 information data link.

Note: Early production model ABS ECUs may be connected to the J1587/1708 and J1922 data link or have no data link connection at all.

For detailed information about ABS systems see the appropriate service literature for the type of ABS system used on the vehicle.



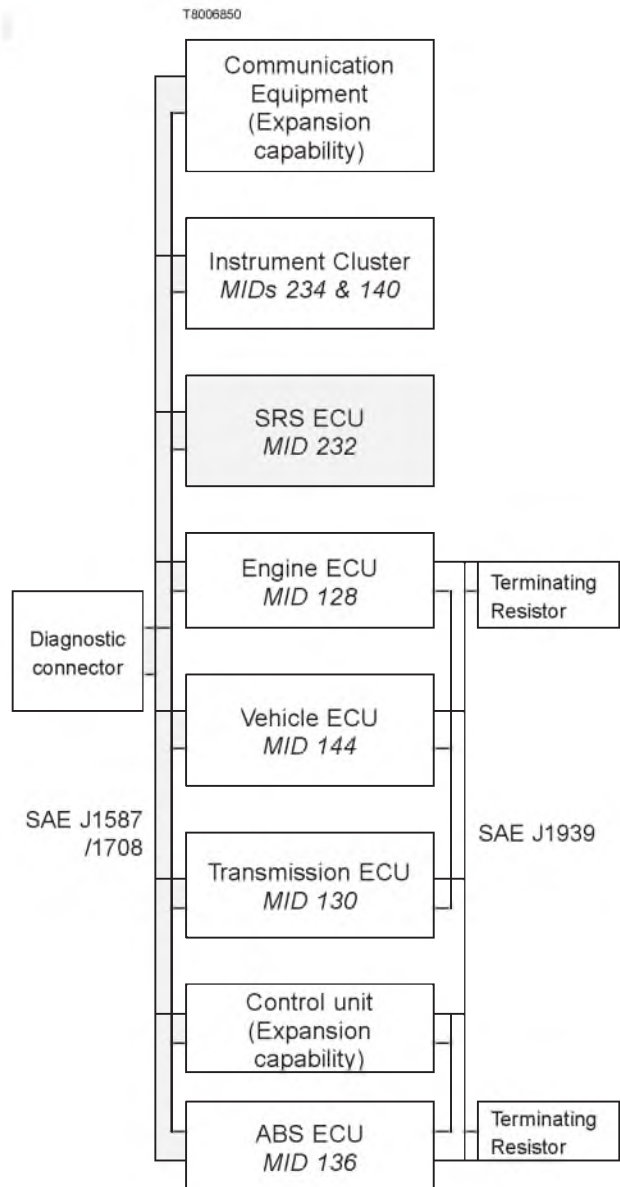
# SRS Airbag ECU



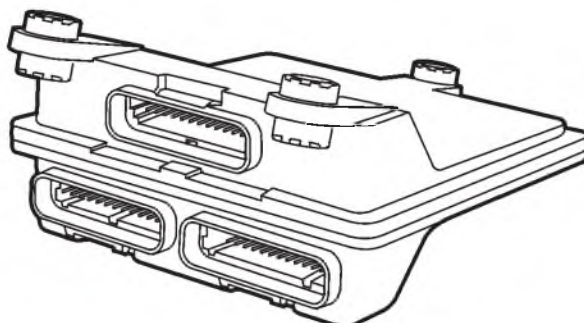
The Supplemental Restraint System (SRS) ECU senses frontal collisions with two rapid deceleration sensors. The SRS ECU will deploy the airbag module in the steering wheel if a collision of sufficient force and duration is detected.

The SRS ECU is connected to the J1587/1708 information data link. For detailed information about the SRS see *Supplemental Restraint System (SRS)*, VNL, VNM, Volvo service publication number PV776-TSP21771/1.

**Note:** The SRS system is not available on all models.



# Transmission ECU

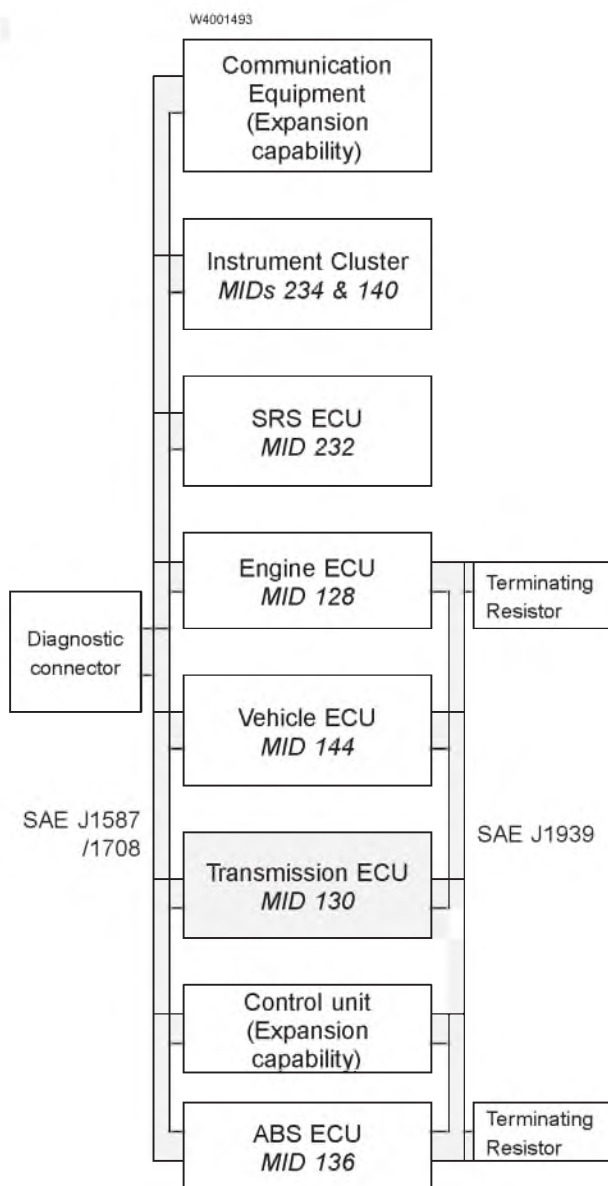


The transmission electronic control unit (ECU) receives signals directly from switches and sensors and via the data links. Based on those inputs, the transmission ECU controls transmission operation via solenoid valves and switches. The transmission ECU also supplies system status and diagnostic information.

The transmission ECU is connected to both the J1939 control data link and the J1587/1708 information data link.

**Note:** Early production model transmission ECUs may be connected to the J1587/1708 and J1922 data links.

For detailed information about transmission ECUs see the service literature for that particular transmission.






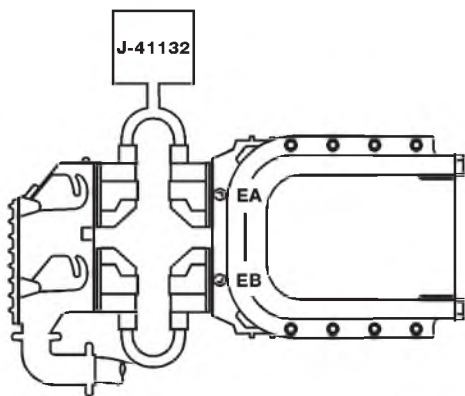
## Breakout Boxes and Harnesses

The harness adapters are used to gain access to the EECU, the VECU, the throttle pedal and certain other sensors on the engine, while the circuit is intact. This allows the technician and vehicle to take measurements on functional circuits.

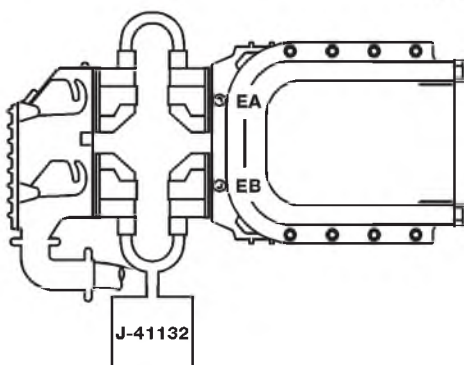
**Example:**

The **36-pin breakout box** allows the technician to measure resistance and voltage on the EECU's EA connector (which covers the engine mounted components) and the EB connector (which covers the remaining components involved).

 <b>CAUTION</b>
<p>Check that the proper cable and connector location is observed and used while connectin to the ECU. Ohterwise, damage to the ECU or tool will occur.</p>



W2002712



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## VECU Overview

The Vehicle Electronic Control Unit (VECU) receives inputs and generates output signals for functions associated with cab devices. It also converts information into digital data to be broadcast over the J1587/1708 Information Link and the J1939 Control Link.

**Note:** The VECU may also be referred to as the “Cab Controller” on the graphics display of the VN series dash and in some Volvo publications.

### *VECU Programming*

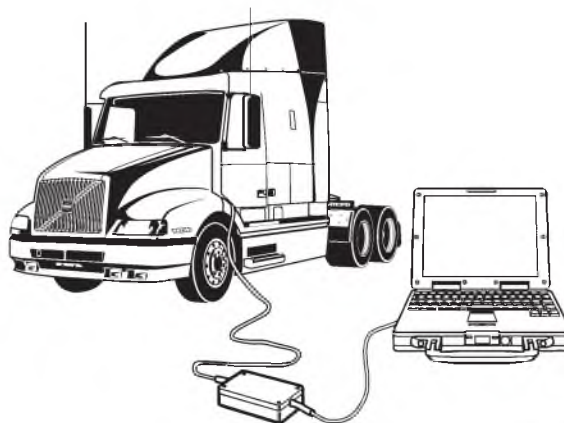
Each VECU is programmed with specific vehicle performance characteristics corresponding to customer-ordered options for that particular vehicle. This dataset is stored in the VECU memory, making the VECU unique to each vehicle.

For this reason, it is not possible to “swap” a suspected faulty VECU with one from another vehicle without reprogramming the replacement VECU.

Replacement VECUs are programmed using the VCADS Pro tool. Programming is based on the particular dataset that matches the vehicle; datasets are stored in the Volvo Data Administration (VDA) database. Authorized technicians can update and/or alter software datasets, change customer parameters, and perform campaigns.

For more information about the proper operation of the VCADS Pro tool and VECU programming, please refer to Information on VCADS Pro in Group O. This manual is also available as a pdf file within VCADS Pro tool located under Help.

**Note:** Customer parameter changes are not stored in the VDA database. Therefore, after a replacement VECU is programmed for the vehicle, it will have to be customized to include those customer alterations.



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## VECU Functions

The following functions are monitored or controlled by the VECU. Only the functions needed for each specific vehicle/engine application are wired and programmed into the VECU.

### *Accelerator Pedal*

The accelerator pedal signals travel first to the VECU and are transferred to the Engine Electronic Control Unit (EECU) via the J1939 Control Link.

If there is a fault in the J1939 Control Link, the accelerator pedal signal travels to the EECU via the J587/1708 Information Link. The vehicle can also be driven in the "limp home" mode if there is a fault in both links. In this situation, the idle validation switch is used to determine when the accelerator pedal is pressed; then, the VECU sends a buffered idle validation switch signal (via hard wire) to the EECU.

### *Second Accelerator Pedal*

If the vehicle is equipped with a second accelerator pedal, the second accelerator pedal signals travel first to the VECU and are transferred to the Engine Electronic Control Unit (EECU) via the J1939 Control Link.

A road speed limit may be programmed into the VECU to limit vehicle speed when the second accelerator pedal is being used. Second accelerator pedal road speed limit can be programmed using the VCADS Pro tool.

### *Speedometer*

The speed signal comes from a sensor on the transmission or as a digital signal, if an electronically-controlled transmission (Allison) is used. The VECU then sends the vehicle speed signal on both the J1939 Control Link and J1587/1708 Information Link. The signal on the J1939 Control Link is used to control vehicle operation. The signal on the J1587/1708 Information Link is collected by the instrument cluster and is displayed on the speedometer.

### *Cruise Control*

The VECU receives signals from the cruise control switch and sends signals to the EECU via the J1939 Control Link. Cruise control parameters can be programmed with the VCADS Pro tool.

### *Power Take-Off (PTO)*

PTO functions are controlled by the VECU through the cruise control switch. Basic or optional PTO parameters can be programmed with the VCADS Pro tool.

### *Ignition Switch*

Ignition switch positions are recognized by the VECU, which transfers the ignition switch position information to the EECU.

### *Idle Shut-Down*

Timed engine shut-off can be controlled by the VECU as a customer option. Idle shut-down time can be programmed with the VCADS Pro tool.

### *Engine Brake*

The control for the engine brake (including the exhaust pressure governor [EPG] and compression brake [VCB], if installed) are monitored by the VECU. At the request of the ABS ECU, the VECU can de-activate the engine brake.

### *Windshield Wipers*

Windshield wiper function on the VN and VHD (with Volvo engine) is controlled by the VECU using signals received from the wiper switch.

### *Calibration Number*

The calibration number (K factor) is a measurement of "Drivetrain Constant Pulses per Mile" and is used by the VECU to determine vehicle speed and distance traveled. The calibration number is calculated by multiplying "tire revolutions per mile" x "rear axle ratio" x "number of teeth on the transmission output shaft chopper wheel."

The calibration number is programmed into the VECU using the VCADS Pro tool.

### *Optional Engine Speed Limit*

Optional engine speed limit is the maximum speed at which the engine can be operated with the vehicle at zero road speed and the PTO mode engaged. Optional engine speed limit parameters can be programmed with the VCADS Pro tool.

### *Optional Vehicle Speed Limit*

Optional vehicle speed limit allows for an optional switch to limit vehicle speed. Typically, this switch is operated on the vehicle by someone other than the driver, such as a garbage collector who rides on the back of the vehicle. Optional vehicle speed limit parameters can be programmed with the VCADS Pro tool.

**Note:** Basic vehicle speed limit is set by the EECU.

### *Shut-Down Request*

Optional engine shut-down request is made via a remote mounted switch (the ignition switch is the basic engine shut-down request). After the VECU receives the shut-down request, the request is sent to the EECU via the J1939 Control Link. Shut-down request is enabled using the VCADS Pro tool.

**Note:** The engine shut-down request function should not be considered or used as an emergency shut-down.

### *Torque Limit*

Torque limit 1 and 2 are used to limit drive line torque. Torque limit parameters can be programmed with the VCADS Pro tool.

### *Engine Fan Request*

The VECU receives the request for engine fan operation from either a manual switch or a high pressure A/C refrigerant switch. The VECU then transfers the request to the EECU via the J1939 Control Link.

### *Brake/Clutch Status Switches*

The VECU recognizes the position of the brake, clutch, and parking brake. Various VECU functions (i.e. cruise control or PTO) operate only when these switches are in the proper position.

## Safety Warnings/Cautions

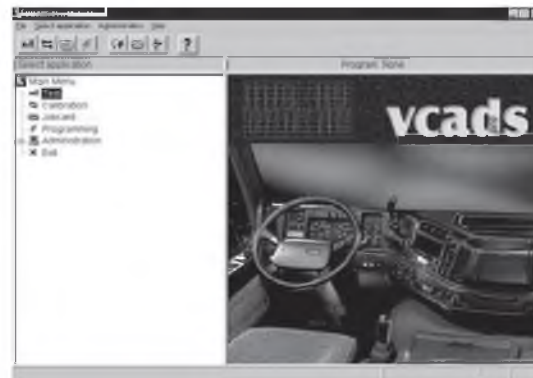
- Always wear approved eye protection.
- To avoid personal injury and damage to the vehicle, always refer to and follow the vehicle manufacturer's WARNINGS, CAUTIONS, and service procedures.
- Unless otherwise directed, turn the ignition switch **OFF** before disconnecting or connecting any electrical components.
- Read and understand the manual provided with the tool before operating your Pro-Link® 9000.
- VGHT recommends an assistant drive the vehicle while you use the Pro-Link® 9000.
- Never leave the vehicle unattended while testing.

## VCADS Pro

From the VCADS Pro Main Menu, VCADS Pro Test, Calibration, Programming and Job Cards are started. In addition, a number of settings can be done, i.e. the selection of language. Ensure your "language" is selected to get the right tests for your country's vehicle variant.

Do one of the following to start an application:

- Select the application in the menu Select application. When highlighted press "Enter".
- Click the program's function button in the toolbar; test (1), calibration (2), programming (3) and job card (4).
- Double click the desired program in the function tree.



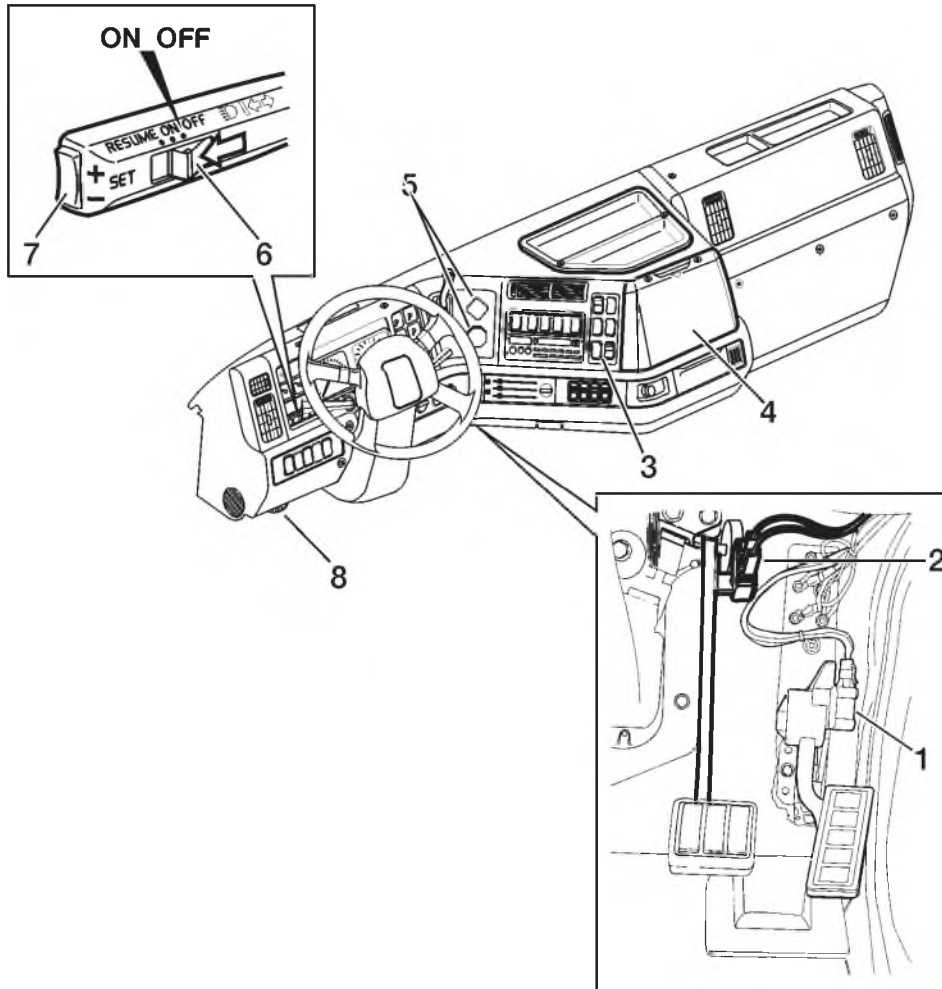
The following can be performed in the Administrative functions

- Language selection
- Selection of screen saver and screen saver delay.
- Selection of background image.
- Selection of default application.
- Update the system. Get a new program version of VCADS Pro from Volvo via connection to the central systems.
- User administration. Select the user to change the password for. This function requires authorization and is not available to all users.
- General administration. Selection of communication method, vehicle/machine type and activation/deactivation of the simulator is possible.



## Sensor Locations

### VN/VHD Sensors and Switches



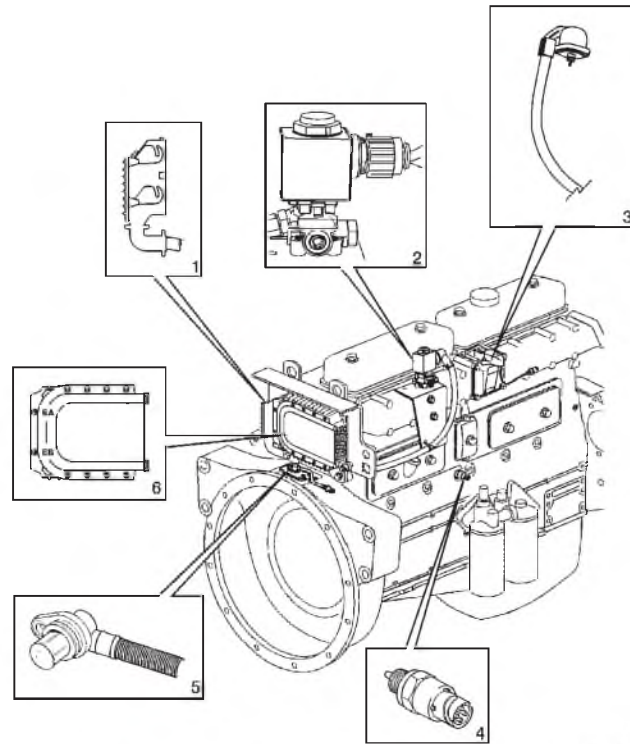
Inside cab

- 1 Throttle position sensor
- 2 Microswitch(service brake)
- 3 Engine/Exhaust Brake
- 4 VECU
- 5 Pressure Switch-Parking and Service Brake
- 6 ON/OFF—Resume Switch
- 7 Resume Switch
- 8 Diagnostic connector

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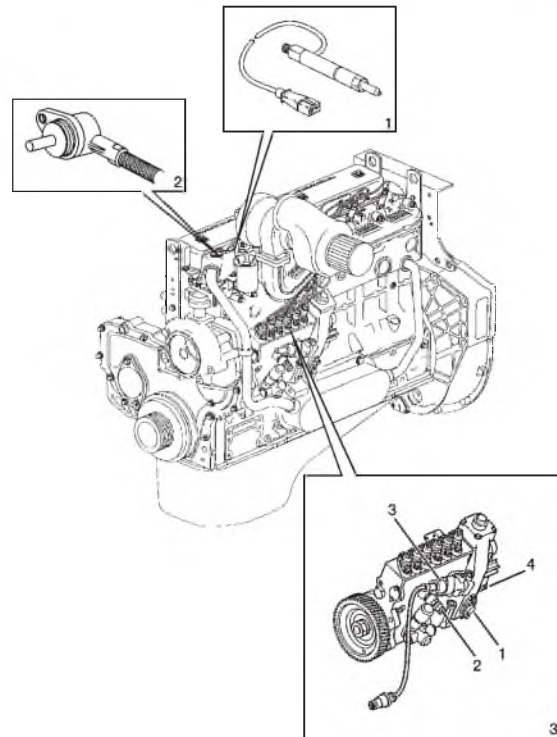
**D7C**

- 1 EECU connector EA/EB
- 2 EPG solenoid
- 3 Boost pressure/temperature sensor
- 4 Oil pressure/temperature sensor
- 5 Engine timing (crank) sensor
- 6 Engine electronic control unit (EECU)



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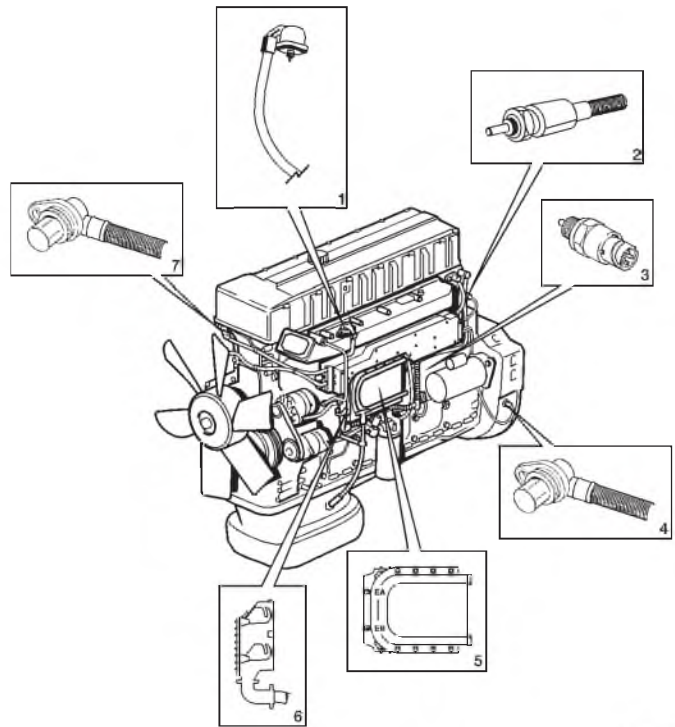
- 1 Needle lift sensor (at injector #1)
- 2 Coolant temperature sensor
- 3 Redundant engine speed sensor (1); Fuel pressure/temperature sensor (2); Fuel shut-off valve (3); 7-pin connector (4), includes rack drive, rack position sensor, and timing sleeve



W2002749

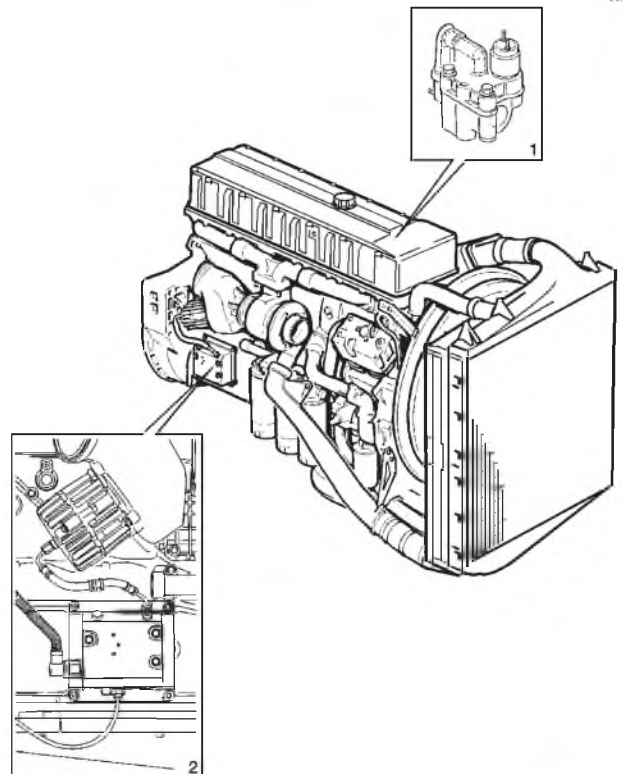
### D12B

- 1 Boost pressure/temperature sensor
- 2 Coolant temperature sensor
- 3 Oil pressure/temperature sensor
- 4 Engine timing (crank) sensor
- 5 Engine electronic control unit (EECU)
- 6 EECU connector EA/EB
- 7 Engine position (cam) sensor



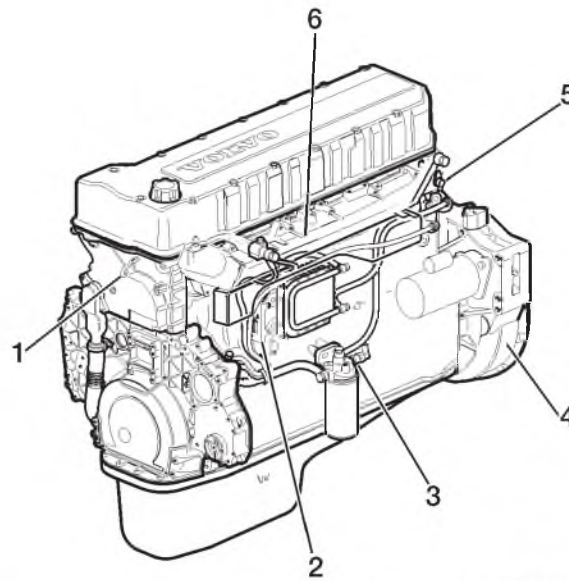
W2002745

- 1 Compression brake, VCB (under valve cover)
- 2 EPG control (PWM box)



W2002746

## D12C



W2003560

Fig. 10: Engine electronic control unit (EECU) sensor locations D12C

Several engine sensors send signals to the EECU. They are:

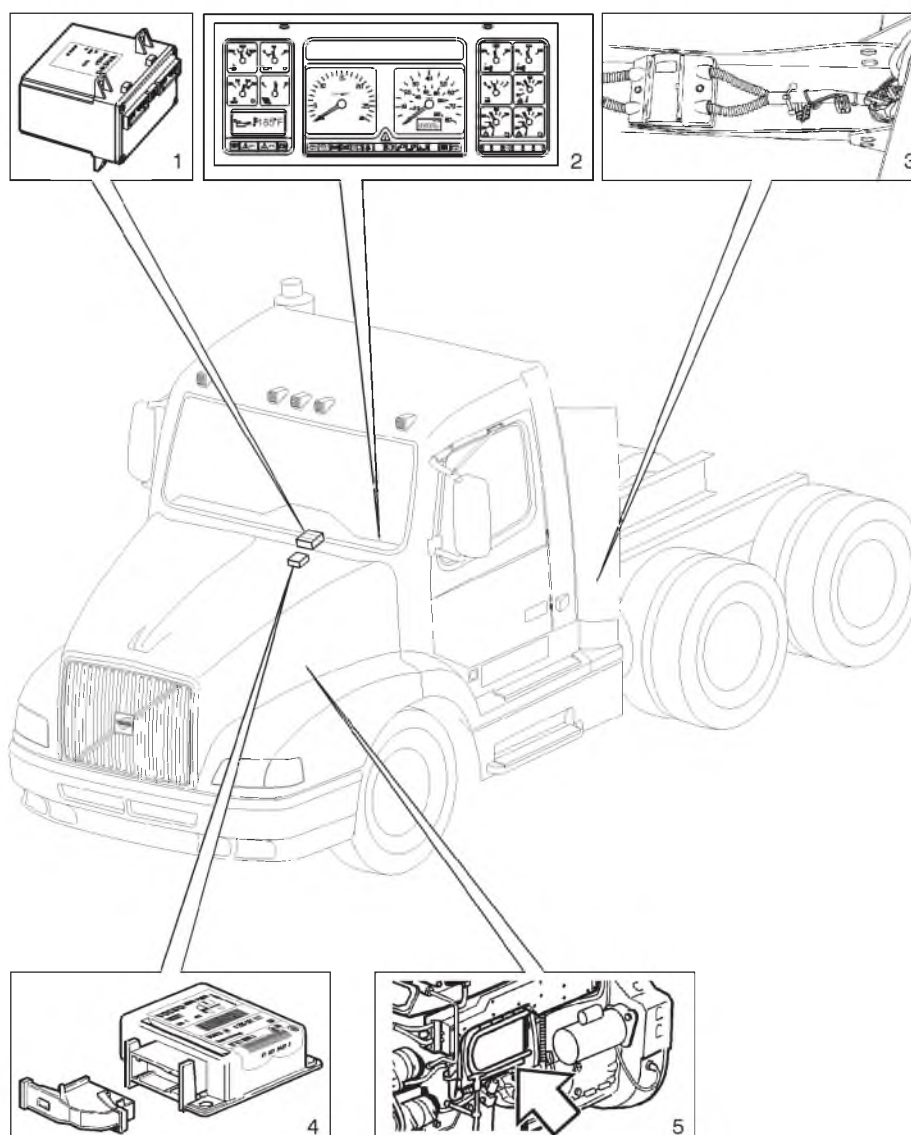
- 1 **Cam Sensor (timing gears)**—This sensor determines which cylinder is in line for injection. It detects the camshaft's position via a pole wheel bolted to the camshaft drive gear.
- 2 **Oil Pressure/temperature sensor (cylinder block)**—This combined sensor monitors oil pressure and oil temperature.
- 3 **Fuel Pressure/Temperature Sensor** — Monitors the fuel pressure and fuel temperature
- 4 **Crank Sensor (flywheel housing)** — This sensor detects the crank-shaft's position and speed, via teeth in the flywheel. Detects Engine RPM's.
- 5 **Coolant Temperature Sensor (cylinder head)**— This sensor monitors coolant temperature.
- 6 **Intake Manifold Pressure (intake manifold)**—This is a combined sensor that monitors both the intake manifold air pressure and temperature.

## Control Unit Locations

### VN/VHD: Cab and Engine Compartment

The diagram shows the normal location of the different control units on a VN vehicle equipped with a Volvo engine.

Control units may vary slightly in location, depending on vehicle and component type (variant). The locations are virtually the same on a VHD vehicle.



W3003955

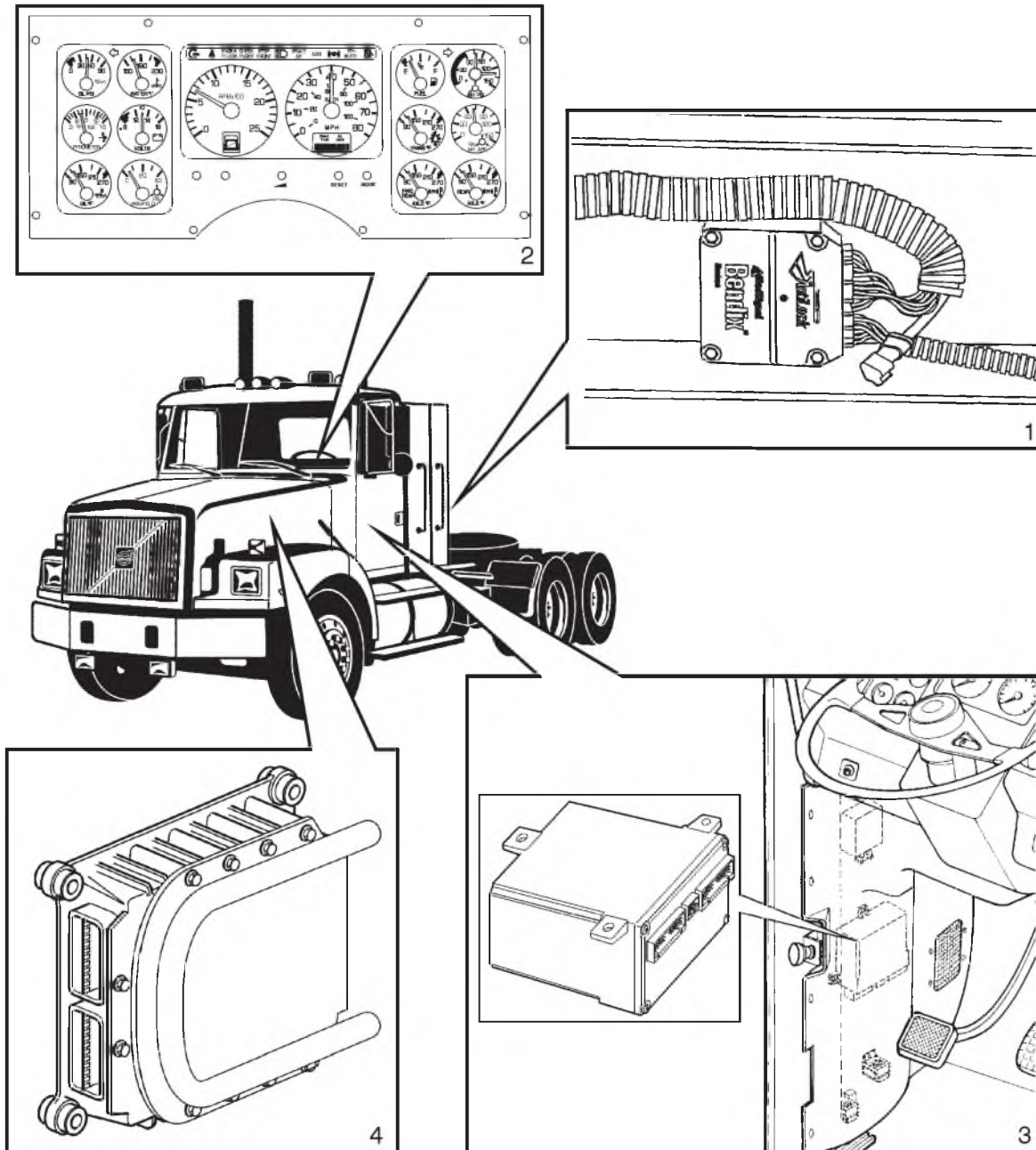
- |   |  |   |                                       |
|---|--|---|---------------------------------------|
| 1 | Vehicle electronic control unit (VECU)                   | 4 | SRS control unit                      |
| 2 | Instrument cluster                                       | 5 | Engine electronic control unit (EECU) |
| 3 | ABS control unit; crossmember located toward rear of cab |   |                                       |



## WG/AC: Cab and Engine Compartment

The diagram shows the normal location of the different control units on WG and AC vehicles.

Control units may vary slightly in location, depending on vehicle type (variant).



- 1 ABS control unit, on right side frame rail
- 2 Instrument cluster

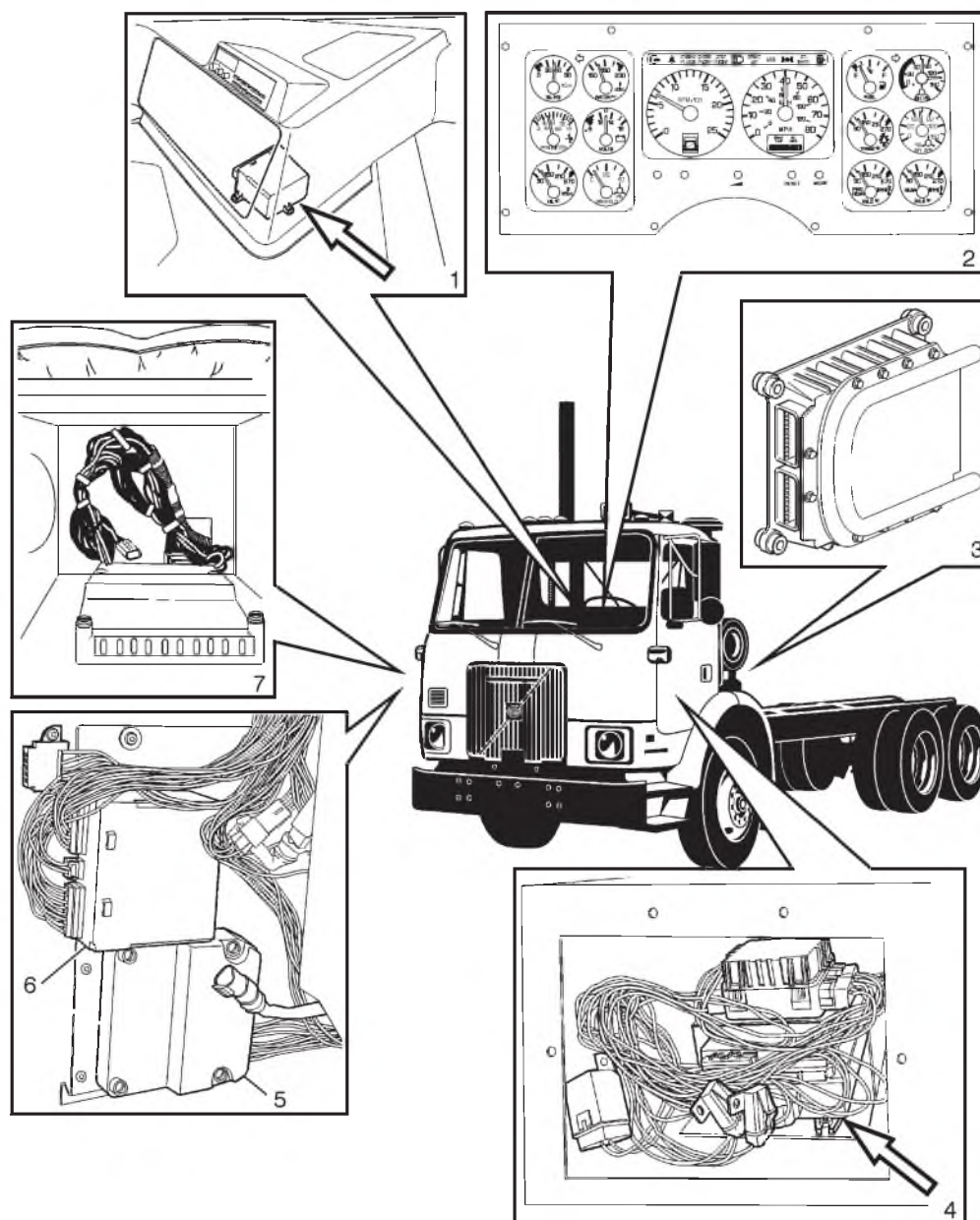
- 3 Vehicle electronic control unit (VECU)
- 4 Engine electronic control unit (EECU)

WG003963

## WX/WXLL: Cab and Engine Compartment

The diagram shows the normal location of the different control units on a WX or WXLL vehicle.

Control units may vary slightly in location, depending on vehicle type (variant).



- 1 Vehicle electronic control unit (VECU), location in WX narrow cab only
- 2 Instrument cluster
- 3 Engine electronic control unit (EECU)
- 4 Transmission ECU, under driver's seat
- 5 ABS control unit, right side engine tunnel
- 6 VECU, WX and WXLL, right side engine tunnel
- 7 ABS control unit, location in WX narrow cab only

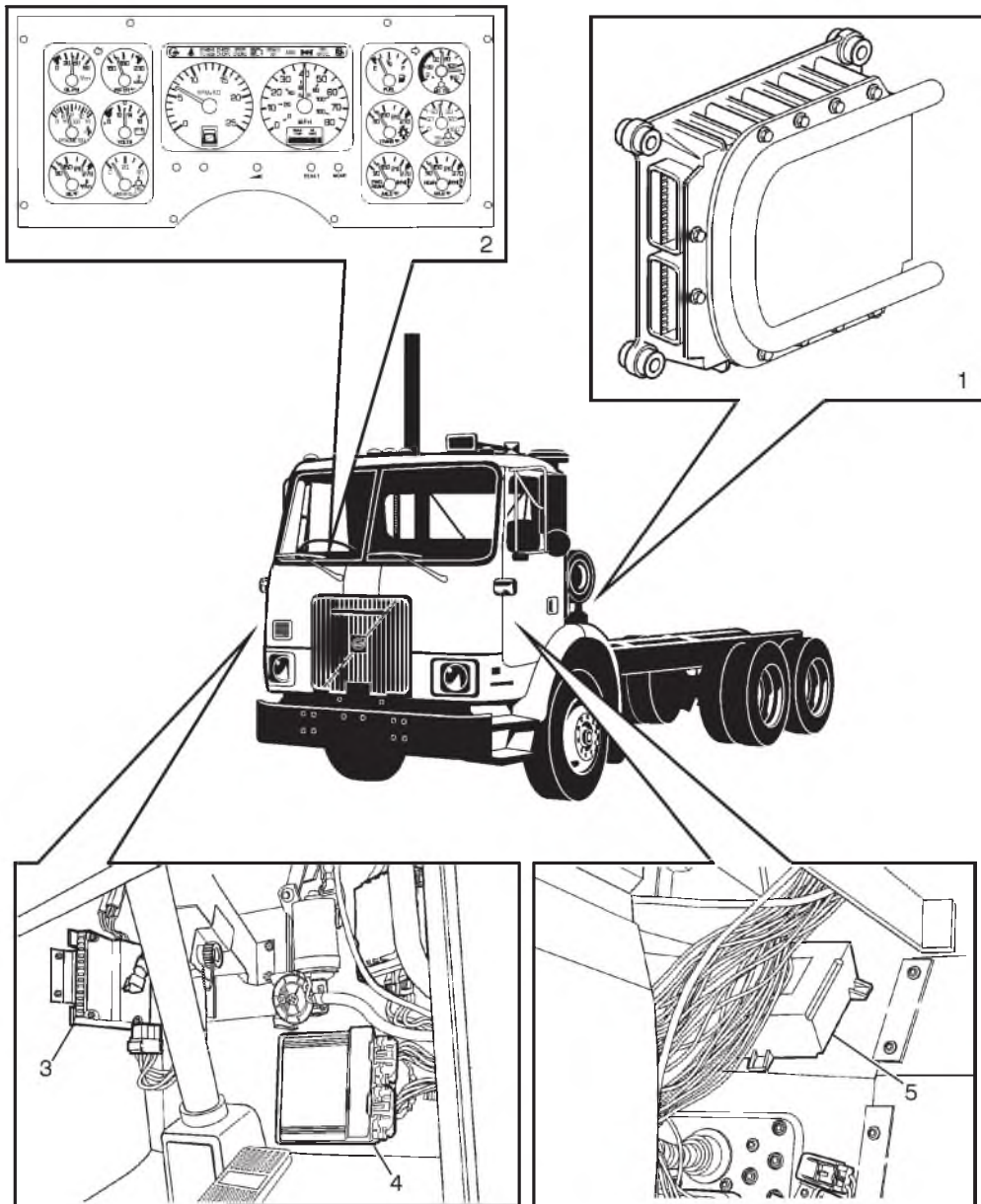
W3003961



## WXR: Cab and Engine Compartment

The diagram shows the normal location of the different control units on a WXR vehicle.

Control units may vary slightly in location, depending on vehicle type (variant).

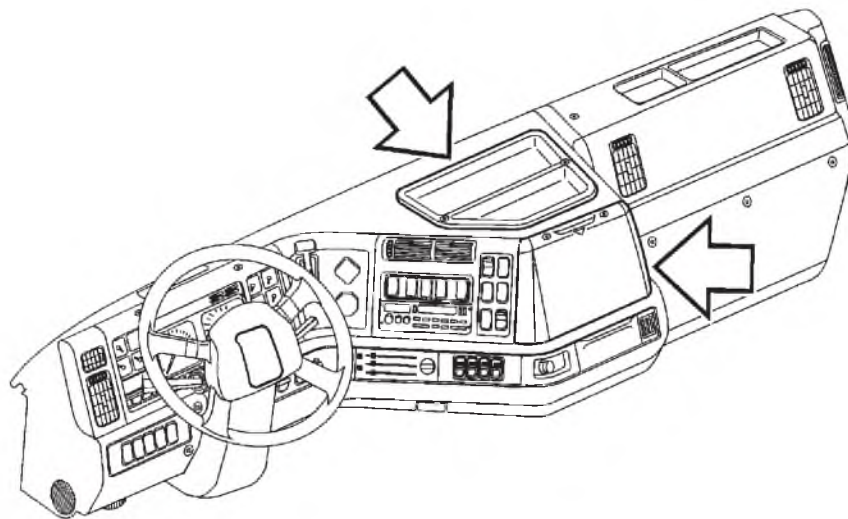


- 1 Engine electronic control unit (EECU)
- 2 Instrument cluster
- 3 ABS control unit

- 4 Transmission ECU
- 5 Vehicle electronic control unit (VECU) — on left side of cab, below center dash panel

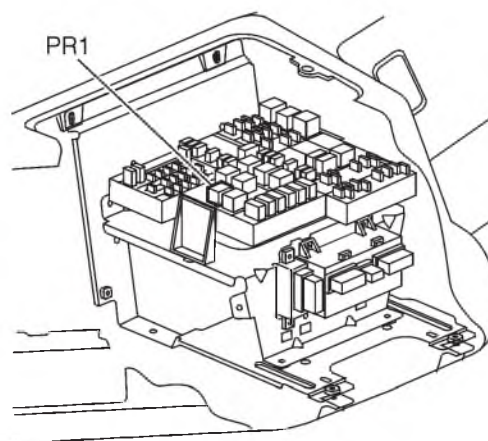
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## Fuses and Relays



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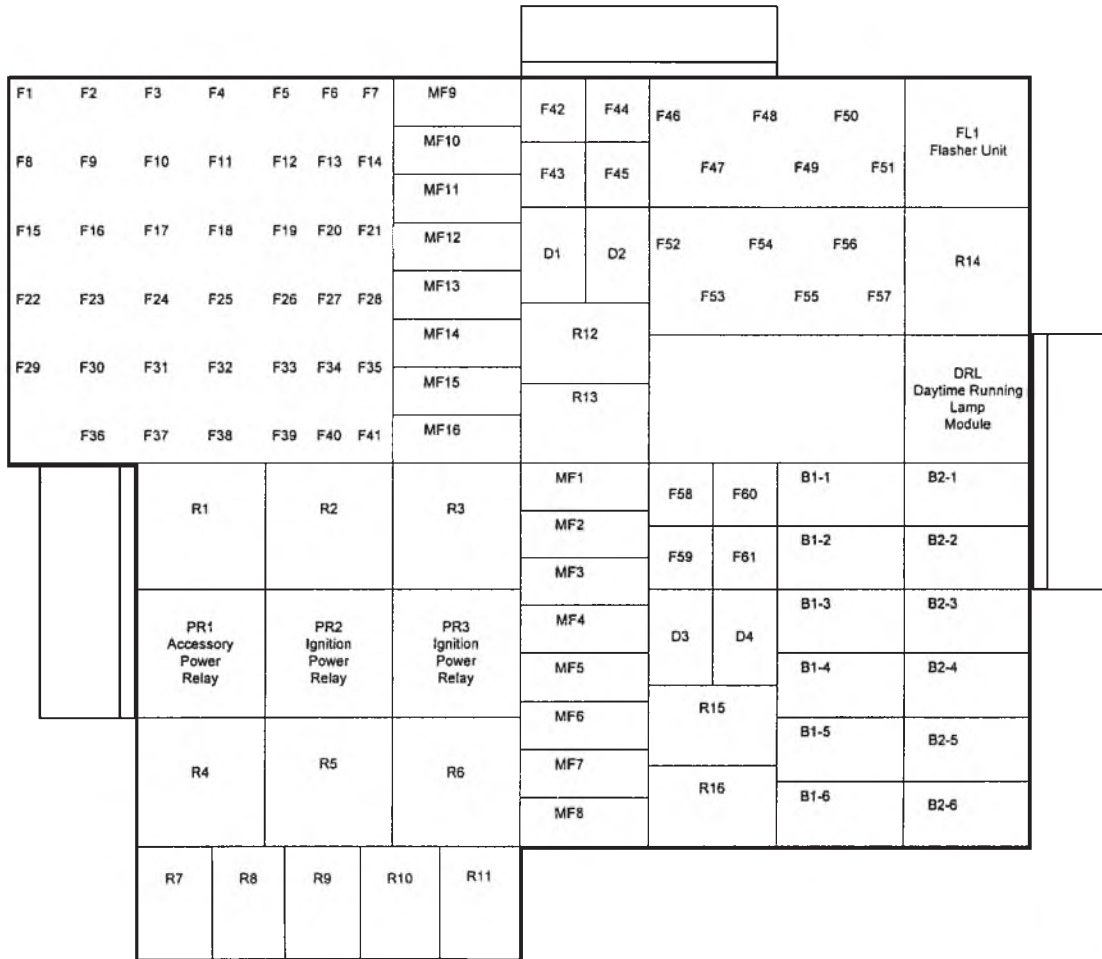
The VN/VHD vehicles have easy access to the TEC panel. Fuses and relays are easily identified by referring to the decals inside the TEC covers.



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**VN**

**Note:** Refer to the decal inside the TEC cover for vehicle's exact fuse descriptions and ratings.



W0002729

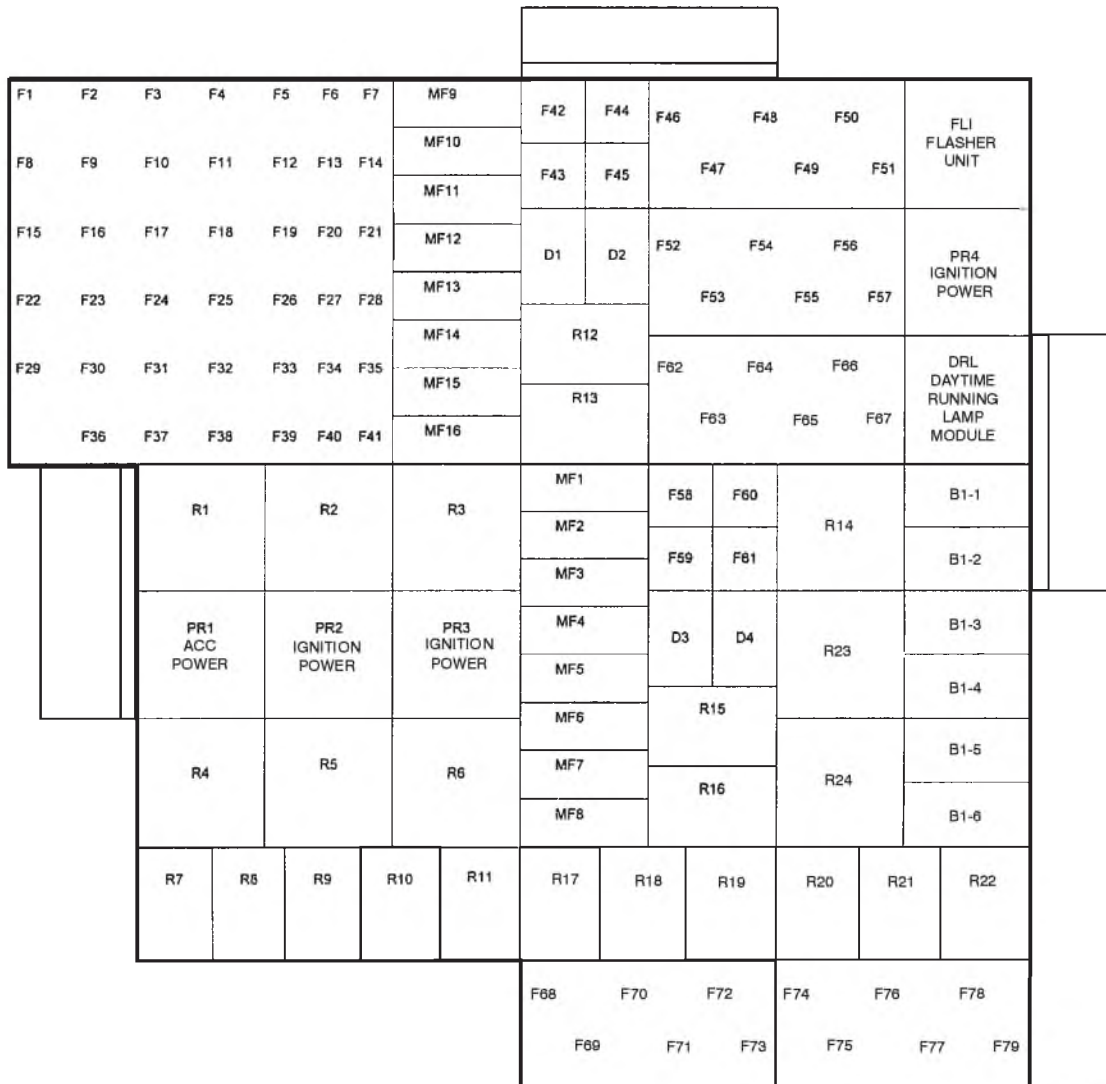
Fig. 11: Fuse and Relay Positions (in the top TEC panel, VN)

- B1-1 through B1-6** Ignition Expansion Blocks
- B2-2 through B2-4** Battery Expansion Blocks
- PR1** Accessory Power Relay
- PR2, PR3** Ignition Power Relays

One Accessory and two Ignition Power relays are used to transfer the heavy current load coming from the battery to the Ignition/Accessory circuits. These relays are located on the TEC tray for easy access and replacement.

### VHD

Note: Refer to the decal inside the TEC cover for vehicle's exact fuse descriptions and ratings.



W3004362

Fig. 12: Fuse and Relay Positions (in the top TEC panel, VHD)

- B1-1 through B1-6** Battery and Ignition Expansion Block
- PR1** Accessory Power Relay
- PR2, PR3, PR4, R24** Ignition Power Relays

One Accessory and four ignition Power relays are used to transfer the heavy current load coming from the battery to the Ignition/Accessory circuits. These relays are located on the TEC tray for easy access and replacement. PR4 is used in the VHD bodybuilder applications



# Troubleshooting

## Fault Code Troubleshooting

### Message and Parameter Descriptions

MID's (message ID's)	Description
128	EECU (Engine Electronic Control Unit)
232	SRS (Supplemental Restraint System)
136	ABS (Antilock Braking System)
140	Instrument Cluster Center Module
234	Instrument Cluster Left Module
144	VECU (Vehicle Electronic Control Unit)
130	TECU (Transmission Electronic Control Unit)

PID's (Parameter ID's)	Description
84	Road Speed
91	% Accelerator Pedal
100	Engine Oil Pressure
102	Boost Pressure
105	Air Inlet Temperature
110	Engine Coolant Temperature
111	Coolant Level
173	Pyrometer
175	Engine Oil Temperature
190	Engine Speed

PPID's (Proprietary Parameter ID's)	Description
69	Buffered idle switch
70	Pedal switches, supply
71	Cruise control and retarder, supply switch
72	Accelerator pedal and retarder, supply sensors
73	Accelerator control 2 and primary tank, supply sensors
75	Range inhibitor, status solenoid valve
77	Compressor, status solenoid valve
78	Interval wiper, status relay
79	Area inhibitor, status solenoid valve
86	Engine brake torque percent
109	EOG3 drive stage failure
121	MTE (Engine compssor control output) failure
122	VCB Engine compression brake
123	EPG2 Start and Warmhold
124	EPG1 Engine brake
125	EOL Enable failure
195	Proprietary Diagnostic Data Request Clear Count
196	Proprietary Diagnostic Data/Count Clear Response



## FMI Table

### SAE Standard

FMI value	SAE Text
0	Data Valid, but above normal operating range.
1	Data Valid, but under normal operating range.
2	Intermittent or incorrect data.
3	Abnormally high voltage.
4	Abnormally low voltage.
5	Abnormally low current or open circuit.
6	Abnormally high current or chort circuit.
7	Mechanical system no repsonse
8	Abnormal frequency or Pulse Width
9	Abnormal update rate
10	Abnormal change rate
11	Failure unkown
12	Bad device
13	Out of calibration
14	Special instruction (see Note)
Note: The special instruction FMI 14 is broadcast when the airbag has stored crash data.	

### Engine-specific for Injectors

FMI value	Explanation
2	Short circuit to battery voltage, unit injector high side.
3	Short circuit to battery voltage, unit injector low side.
4	Short circuit to ground, unit injector high or low side.
5	Open circuit in the unit injector circuit.

### Engine-specific for Injection Pump

FMI value	Explanation
2	Short circuit to battery voltage, injection pump high side.
3	Short circuit to battery voltage, injection pump low side.
4	Short circuit to ground, injection pump high or low side.
5	Open circuit in the unit injection pump circuit.
6	Short circuit to ground, injection pump high side.
8	Injection pump current too high for long period of time.

## Reading/Clearing Fault Codes

Fault codes can be read and cleared using the VCADS Pro tool or the Pro-Link tool with Volvo application cartridge. See the appropriate service information for details on reading and clearing fault codes using VCADS Pro or Pro-Link tools.

On VN-series vehicles, fault codes also can be accessed, read, and cleared via the instrument cluster graphic display. Clearing fault codes is password protected. For information, see "Instrumentation VN, from 3/99 and VHD," Volvo Service Publication PV776-TSP139790."

The Data Link Instrument cluster used WX-series vehicles can access and read a limited number of fault codes. However, it does not have the ability to clear fault codes. For more information, see "Data Link Instrumentation," Volvo Service Publication PV776-381-620SM.

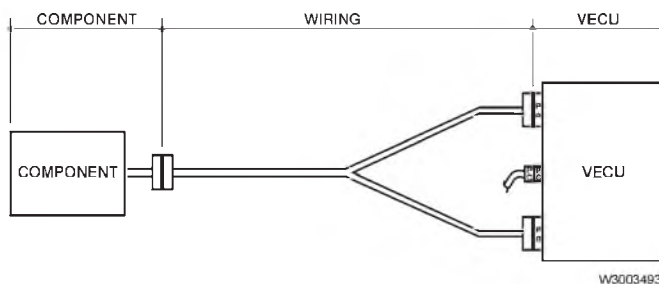
## Fault Tracing Strategy



**CAUTION**

Check that the proper cable and connector location is observed and used while connecting to the ECU. Failure to do so may result in permanent damage to the ECU or the tool.

Generally, the fault tracing strategy employed in this section follows a set sequence in which measurements are taken at specific points in the vehicle wiring. The three basic elements in this strategy are:



- 1 Vehicle Electronic Control Unit (VECU)
- 2 The actual component being tested (varies with each fault code)
- 3 Wiring between VECU and the component being tested

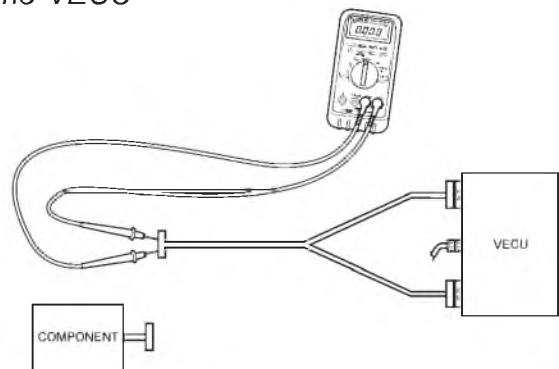
The following information describes the three test strategies:

- "Measurement at the Component's Connector, to the VECU" page 90
- "Check of Component" page 90
- "Check of the Subsystem" page 91

### *Measurement at the Component's Connector, to the VECU*

In this procedure, the component is disconnected and measurements are made at specific pin locations on the wiring harness end of the connector. Measurements usually involve supply, ground, and signal wire connections through the wiring harness and VECU.

Breakout boxes or harnesses may be used to assist in taking measurements. Measurements outside "expected values" may indicate faults in the wiring or in the VECU itself

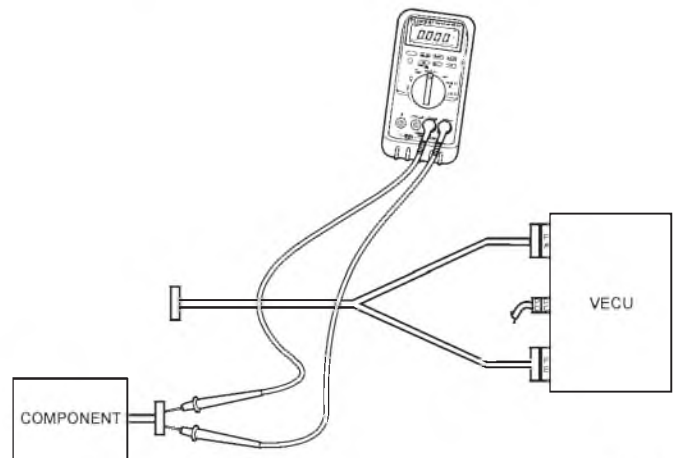


W3003494

### *Check of Component*

In this procedure, the component is disconnected and measurements are made at specific pin locations on the component wiring harness or directly to the component. The component is usually a sensor or switch; it is identified at the beginning of each check.

Breakout boxes or harnesses may be used to assist in taking measurements. Measurements outside "expected values" may indicate faults in the component or in the wiring to the component.



W3003495

### *Check of the Subsystem*

In this procedure, the VECU is disconnected, a breakout box is connected between the VECU and wiring harness, and measurements are made at specific pin locations on the breakout box. This check is made to measure the voltage that is present at the VECU with the circuit intact.

Measurements outside "expected values" may indicate faults in the component, wiring, or VECU.

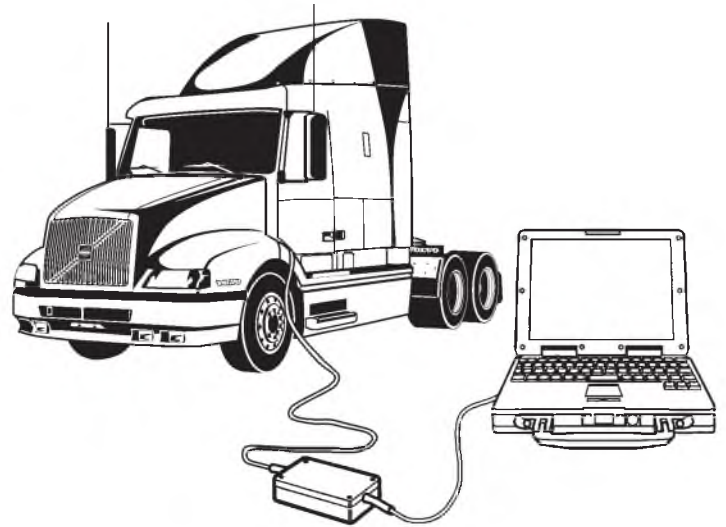
### *Tests Using the VCADS Pro Tool*

The VCADS Pro tool is a Windows95<sup>®</sup>-based PC tool that is used to program, test, and read information from the VECU and EECU.

A number of "real time" tests can be performed by connecting the VCADS Pro tool to the vehicle's diagnostic connector. If a test in the VCADS Pro tool may be of benefit when troubleshooting a specific fault code, that test will be referenced in the section titled, "Appropriate tests in the VCADS Pro tool."

**Note:** Not all tests will apply to all vehicle variants. When starting VCADS Pro, menu selections for various vehicles and engines are entered. Only those tests that apply will be available for selection.

For information about the proper operation of the VCADS Pro tool, please refer to VCADS Pro Service Information in group 0.



W0001632

# MID 128 EECU

## MID 128 Fault Code Table

**MID:**Message Identification Description.

**SID:**Subsystem Identification Description.

**PID:**Parameter Identification Description.

**FMI:**Failure Mode Identifier.

Error code	Component/Function	FMI	Section
MID 128-PID 45	Preheater Status	3, 4, 5	"MID 128 PID 45 Preheater Status" page 96
MID 128-PID 49	ABS Control Status	9	"MID 128 PID 49 ABS Control Status" page 98
MID 128-PID 84	Road speed	9, 11	"MID 128 PID 84 Road Speed" page 100
MID 128-PID 85	Cruise Control Status	9	"MID 128 PID 85 Cruise Control Status" page 102
MID 128-PID 91	Accelerator Pedal Position	9, 11	"MID 128 PID 91 Accelerator Pedal Position" page 104
MID 128-PID 94	Fuel Delivery Pressure (D7C and D12C only)	1, 3, 4	"MID 128 PID 94 Fuel Delivery Pressure" page 106
MID 128-PID 100	Engine Oil Pressure	1, 3, 4	"MID 128 PID 100 Engine Oil Pressure" page 110
MID 128-PID 102	Boost Pressure	3, 4	"MID 128 PID 102 Boost Pressure" page 114
MID 128-PID 105	Boost Air Temperature	3, 4	"MID 128 PID 105 Boost Air Temperature" page 118
MID 128-PID 107	Air Filter Differential Pressure	0, 3, 4, 5	"MID 128 PID 107 Air Filter Differential Pressure" page 122
MID 128-PID 108	Atmospheric Pressure	3, 4	"MID 128 PID 108 Atmospheric Pressure" page 125
MID 128-PID 110	Engine Coolant Temperature	0, 3, 4	"MID 128 PID 110 Engine Coolant Temperature" page 126
MID 128-PID 111	Coolant level	1	"MID 128 PID 111 Coolant Level" page 129
MID 128-PID 158	Battery Voltage	3	"MID 128 PID 158 Battery Voltage" page 131
MID 128-PID 172	Air Inlet Temperature	3, 4	"MID 128 PID 172 Air Inlet Temperature" page 133
MID 128-PID 174	Fuel Temperature (D7C and D12C only)	3, 4	"MID 128 PID 174 Fuel Temperature" page 136

Error code	Component/Function	FMI	Section
MID 128–PID 175	Engine Oil Temperature	0, 3, 4	“MID 128 PID 175 Engine Oil Temperature” page 140
MID 128–PID 228	Road Speed Sensor Calibration	11	“MID 128 PID 228 Road Speed Sensor Calibration” page 144
MID 128–PPID 86	Engine Brake Torque Percent	9	“MID 128 PPID 86 Engine Brake Torque Percent” page 146
MID 128–PPID 119	High Coolant Temperature	0	“MID 128 PPID 119 High Coolant Temperature” page 148
MID 128–PPID 122	VCB Engine Compression Brake (D12B and D12C only)	3, 4, 5	“MID 128 PPID 122 VCB Engine Compression Brake” page 151
MID 128–PPID 123	EPG 2 (D12B and D12C only)	3, 4, 5	“MID 128 PPID 123 EPG 2” page 153
MID 128–PPID 124	EPG 1	3, 4, 5	“MID 128 PPID 124 EPG 1” page 155
MID 128–SID 1-6	Injector (D12B and D12C only)	2, 3, 4, 5, 7, 11	“MID 128 SID 1/2/3/4/5/6 Injector ” page 157
MID 128–SID 17	Fuel Shutoff Valve (D7C only)	3, 4, 5	“MID 128 SID 17 Fuel Shutoff Valve” page 161
MID 128–SID 20	Timing Sleeve (D7C only)	2, 3, 4, 5, 6, 7, 8, 11	“MID 128 SID 20 Timing Sleeve” page 163
MID 128–SID 21	Engine Position Timing Sensor (D12B and D12C)	3, 8	“MID 128 SID 21 Engine Position Timing Sensor” page 166
MID 128–SID 21	Needle Lift Sensor (D7C only)	2	“MID 128 SID 21 Needle Lift Sensor” page 168
MID 128–SID 22	Engine Speed Sensor	2, 3, 8	“MID 128 SID 22 Engine Speed Sensor” page 170
MID 128–SID 23	Rack Actuator (D7C only)	2, 3, 4, 5, 6, 7, 8, 11	“MID 128 SID 23 Rack Actuator” page 172
MID 128–SID 24	Rack Position Sensor (D7C only)	2, 13	“MID 128 SID 24 Rack Position Sensor” page 175
MID 128–SID 33	Fan Control	3, 4, 5	“MID 128 SID 33 Fan Control” page 177
MID 128–SID 64	Redundant Engine Speed Sensor (D7C only)	3, 8	“MID 128 SID 64 Redundant Engine Speed Sensor” page 179
MID 128–SID 70	Preheater Element 1	3, 4, 5	“MID 128 SID 70 Preheater Element 1” page 181

<b>Error code</b>	<b>Component/Function</b>	<b>FMI</b>	<b>Section</b>
MID 128–SID 71	Preheater Element 2 (D12B only)	3, 4, 5	“MID 128 SID 71 Preheater Element 2” page 183
MID 128–SID 230	Idle Validation Switch 1	3, 4	“MID 128 SID 230 Idle Validation Switch 1” page 185
MID 128–SID 231	SAE J1939 Control Link	2, 9, 11, 12	“MID 128 SID 231 SAE J1939 Control Link” page 187
MID 128–SID 232	5 Volt DC Supply	3, 4	“MID 128 SID 232 5 Volt DC Supply” page 189
MID 128–SID 240	Program Memory	2, 12	“MID 128 SID 240 Program Memory” page 191
MID 128–SID 250	SAE J1587/1708 Information Link	12	“MID 128 SID 250 SAE J1587/1708 Information Link” page 192
MID 128–SID 253	Data Set Memory EEPROM	2, 12	“MID 128 SID 253 Data Set Memory EEPROM” page 193
MID 128–SID 254	Engine Electronic Control Unit (EECU)	2, 8, 9, 11, 12, 13	“MID 128 SID 254 Engine Electronic Control Unit (EECU)” page 194





## MID 128 PID 45 Preheater Status

The preheat relay is provided battery voltage at all times through the supply wire. If the EECU requests preheat operation (based on engine temperature), the control wire will be grounded through the EECU. Preheating is standard on the D7C engine with one preheat relay/element. Preheating is optional on the D12B engine with two preheat relays/elements.

### Fault Codes

#### FMI 3

Short circuit to battery voltage.

*Conditions for fault code:*

- Output activated.
- Short circuit to battery voltage on EB31.

*Possible cause:*

- Short circuit to battery voltage on wire between preheating relay and EECU.
- Short circuit in the preheating relay.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- The EECU switches off the output.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The preheating relay is not activated.
- White smoke for cold start.
- Difficult to start in extreme cold.

#### FMI 4

Short circuit to ground.

*Conditions for fault code:*

- Output switched off.
- Short circuit to ground on EB31.

*Possible cause:*

- Short circuit to ground on wire between preheating relay and EECU.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The intake air is warm since the preheating relay is on all the time.
- High current consumption.

#### FMI 5:

Break

*Conditions for fault code:*

- Output switched off.
- Open circuit.

*Possible cause:*

- Blown fuse to the supply for preheating relay.
- Open circuit in wire between EECU and preheating relay.
- Open circuit in the preheating relay.
- Open circuit in supply wire to preheating relay.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- The EECU switches off the output.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The preheating relay is not activated.
- White smoke for cold start.
- Difficult to start in extreme cold.

## MID 128 PID 45 Preheater Status, Check

Special tools: J-43233, J-39200, J-41132

### NOTE!

Check all the particular connectors for loose connections, switch resistance, and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Measurement at the component's connector, to the EECU

1

**Note:** Check the component to verify that each of the following values is correct. Incorrect values can cause this component to fail.

2

Disconnect the control wire (D7C: small blue/red wire; D12B: small solid black wire) at the preheat relay.

#### Control wire:

3

Ignition key must be in the OFF position. J-39200

Measuring points	Optimal value
Control wire / alternate ground	180 k $\Omega$

#### Supply wire:

4

Measure the voltage at the supply wire (D7C: small solid black wire; D12B: small blue/red wire) using voltmeter J-39200. J-39200

Ignition key must be in the ON position.

Measuring points	Optimal value
Supply wire / alternate ground	B+

## Check of component

### Preheating relay

1

Disconnect the control and supply wires to the preheat relay. J-39200

Ignition key must be in the OFF position.

**Note:** Each relay must be checked independently.

Measuring points	Optimal value
Control and supply terminals on the preheat relay	8.5 $\Omega$

## Check of Subsystem

### Control of the preheating relay

1

Ignition key must be in the ON position. J-41132  
J-43233  
J-39200

Connect breakout box J-41132 in series between connector EB and the EECU. Connect jumper harness J-43233 in series between connector EA and the EECU.

**Note:** Test with "Preheat ON" can only be performed if the EECU requested preheat.

Measuring points	Optimal value
EB31 / EB9	B+ (preheat off)
EB31 / EB9	0 V (preheat on)
Ground term EB31 with a jumper wire	preheat relay clicks on

## MID 128 PID 49 ABS Control Status

Applies only to vehicles with ABS.

### Fault Codes

#### **FMI 9**

Status message from the ABS control unit is not available (SAE J1587 message).

*Conditions for fault code:*

- PID 49 — the message is unavailable or is not being updated regularly.

*Possible cause:*

- Error in the information link (SAE J1587).
- Error from the ABS control unit.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.

## MID 128 PID 49 ABS Control Status, Check

*Special tools: J-43233, J-39200, J-41132*

### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

Also check if the ABS system has any active fault codes. This fault code could be due to the fact that there is a fault in the ABS system.

### Check of Subsystem

*Check of the SAE J1587 Information link*

**1**

Ignition key must be in the OFF position.

Connect breakout box J-41132 in series between connector EB and the EECU.

**2**

Connect jumper harness J-43233 in series between connector EA and the EECU.

J-41132  
J-43233  
J-39200

Measuring points	Optimal value
EB25 / DCA (connection A in diagnostics connector)	<1 $\Omega$
EB26 / DCB (connection B in diagnostics connector)	<1 $\Omega$

## MID 128 PID 84 Road Speed Fault Codes

### FMI 9

Vehicle road speed signal not available (SAE J1587 message).

*Conditions for fault code:*

- PID 84 — the message is unavailable or is not being updated regularly.

*Possible cause:*

- Fault in speed sensor.
- Fault in the information link (SAE J1587).
- Error from the vehicle ECU (VECU).

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- If FMI 11 has also been set, the EECU limits the engine speed to approx. 1700 rpm.

*Noticeable external symptom:*

- Yellow lamp lights up.
- If FMI 11 has also been set, the maximum engine speed is approx. 1700 rpm.

### FMI 11

Vehicle road speed signal not available. (SAE J1939 message).

*Conditions for fault code:*

- The vehicle speed signal is not available on the communications link (SAE J1939).

*Possible cause:*

- Fault in speed sensor.
- Fault in the communications link (SAE J1939).
- Fault in VECU.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- The message is read from the information link (SAE J1587) instead.
- If FMI 9 has also been set, the EECU limits the engine speed to approx. 1700 rpm.

*Noticeable external symptom:*

- Yellow lamp lights up.
- If FMI 9 has also been set, the maximum engine speed is approx. 1700 rpm.

## MID 128 PID 84 Road Speed, Check

*Special tools: J-43233, J-39200, J-41132*

### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

Also check the speed sensor and the VECU. This fault code could be due to the fact that there is a fault in any of these components.

### Check of Subsystem

*Check of the SAE J1587 Information link*

#### 1

Ignition key must be in the OFF position.

Connect breakout box J-41132 in series between connector EB and the EECU.

#### 2

Connect jumper harness J-43233 in series between connector EA and the EECU.

J-41132  
J-43233  
J-39200

Measuring points	Optimal value
EB25 / DCA (connection A in diagnostics connector)	<1 $\Omega$
EB26 / DCB (connection B in diagnostics connector)	<1 $\Omega$



## MID 128 PID 85 Cruise Control Status

### Fault Codes

#### **FMI 9**

Status message from Cruise Control is not available (SAE J1587 message).

*Conditions for fault code:*

- PID 85 — the message is unavailable or not being updated regularly.

*Possible cause:*

- Fault in the information link (SAE J1587).
- Fault in the VECU.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.

## MID 128 PID 85 Cruise Control Status, Check

*Special tools: J-43233, J-39200, J-41132*

### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

Also check the cruise control switch and VECU. This fault code could be due to the fact that there is a fault in any of these components.

### Check of Subsystem

*Check of the SAE J1587 Information link*

**1**

Ignition key must be in the OFF position.

Connect breakout box J-41132 in series between connector EB and the EECU.

**2**

Connect jumper harness J-43233 in series between connector EA and the EECU.

J-41132  
J-43233  
J-39200

Measuring points	Optimal value
EB25 / DCA (connection A in diagnostics connector)	<1 $\Omega$
EB26 / DCB (connection B in diagnostics connector)	<1 $\Omega$

## MID 128 PID 91 Accelerator Pedal Position

### Fault Codes

#### FMI 9

Accelerator pedal message not available. (SAE J1587 message)

*Conditions for fault code:*

- PID 91 message is unavailable or not being updated regularly.

*Possible cause:*

- Fault in the accelerator pedal.
- Fault in the information link (SAE J1587).
- Error from the VECU.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- If FMI 11 has also been set, the EECU will switch to the "Limp home mode".

*Noticeable external symptom:*

- Yellow lamp lights up.
- If FMI 11 has also been set, the engine will be put in the "Limp home mode" and the buffered idle validation switch is used instead of the accelerator pedal position sensor.

#### FMI 11

Accelerator pedal faulty. (SAE J1939 message)

*Conditions for fault code:*

- Faults in the accelerator pedal sensor are sent on the communications link (SAE J1939).
- The accelerator pedal signal is not available on the communications link (SAE J1939).

*Possible cause:*

- Fault in the accelerator pedal.
- Fault in the communications link (SAE J1939).
- Error from the VECU.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- Accelerator pedal signal is retrieved instead from the information link (SAE J1587).
- If FMI 9 has also been set, the EECU will switch to

the "Limp home mode."

*Noticeable external symptom:*

- Yellow lamp lights up.
- If FMI 9 has also been set, the engine will be put in the "Limp home mode" and the buffered idle validation switch is used instead of the accelerator pedal position sensor.

## MID 128 PID 91 Accelerator Pedal Position, Check

*Special tools: J-43233, J-39200, J-41132*

### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

Also check the accelerator pedal and the VECU. This fault code could be due to the fact that there is a fault in any of these components.

### Check of Subsystem

*Check of the SAE J1587 Information link*

#### 1

Ignition key must be in the OFF position.

Connect breakout box J-41132 in series between connector EB and the EECU.

#### 2

Connect jumper harness J-43233 in series between connector EA and the EECU.

J-41132  
J-43233  
J-39200

Measuring points	Optimal value
EB25 / DCA (connection A in diagnostics connector)	<1 $\Omega$
EB26 / DCB (connection B in diagnostics connector)	<1 $\Omega$

## MID 128 PID 94 Fuel Delivery Pressure

### D7C and D12C

In addition to the fuel pressure, the sensor also measures the fuel temperature.

### Fault Codes

#### FMI 1

Pressure too low.

*Conditions for fault code:*

- The voltage on EA27 is below the alarm limit.

*Possible cause:*

- Clogged fuel filter.
- Air in fuel system.
- Opening pressure too low on overflow valve.
- Worn out fuel pump.
- Mechanical fault in sensor.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Low power output.
- Difficult to start.
- Blue smoke.

#### FMI 3

Short circuit to voltage or permanent loss of signal.

*Conditions for fault code:*

- The voltage on EA27 is below the alarm limit.

*Possible cause:*

- Short circuit to voltage, 5 V supply wire

- Short circuit to voltage, signal wire.
- Fault in sensor.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.

#### FMI 4

Short circuit to ground.

*Conditions for fault code:*

- The voltage on EA27 is under 0.08 V.

*Possible cause:*

- Break, 5 V supply wire.
- Break, signal wire.
- Break, ground wire.
- Short circuit to ground, 5 V supply wire.
- Short circuit to ground, signal wire.
- Fault in sensor

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.

## MID 128 PID 94 Fuel Delivery Pressure, Check

### D7C and D12C

*Special tools: J-43233, J-39200, J-41132, 9998534*

#### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Measurement at the component's connector, to the EECU

1

**Note:** An incorrect value (below) can also cause the component to fail; therefore, it is important to check the component if any of the values are incorrect.

2

Disconnect the connector for the fuel pressure sensor. Install breakout harness 9998534 to the wiring harness end only.

#### Ground wire:

3

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
4 / alternate ground	<1 $\Omega$

#### Supply wire:

4

Measure the voltage with voltmeter J-39200.

Ignition key must be in the ON position.

Measuring points	Optimal value
1 / alternate ground	5 V

#### Signal wire:

5

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
2 / alternate ground	100 k $\Omega$

### Check of component

#### Fuel pressure sensor

1

Disconnect the connector for the fuel pressure sensor. Install breakout harness 9998534 to the sensor connector only.

2

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
1 / 4	11 k $\Omega$
1 / 2	40 k $\Omega$
2 / 4	40 k $\Omega$
1 / alternate ground	open circuit
2 / alternate ground	open circuit
4 / alternate ground	open circuit

## Check of Subsystem

### *Fuel Pressure*

#### 1

Ignition key must be in the ON position.

J-41132

J-43233

Connect breakout box J-41132 in series between connector EA and the EECU. Connect jumper harness J-43233 in series between connector EB and the EECU.

J-39200

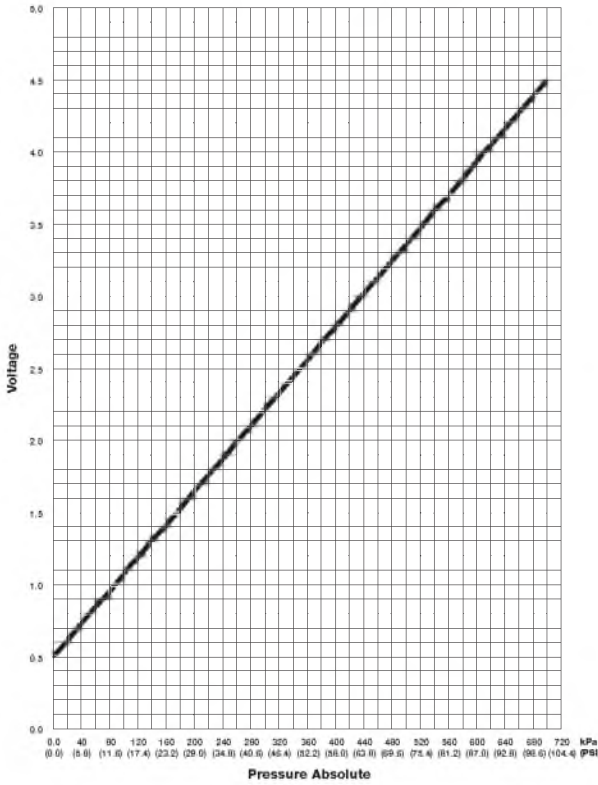
Measuring points	Optimal value
EA27 / EA5	0.5 V (engine not running)

**Note:** For fuel pressure/voltage chart, see page 109.



# Fuel Pressure Sensor, Pressure/Voltage Chart

Fuel Pressure Sensor



Bars	kPa	PSI	Volts	Volts (High)	Volts (Low)
0	0	0	0.50	0.52	0.49
0.2	20	2.9	0.61	0.63	0.60
0.4	40	5.8	0.73	0.75	0.71
0.6	60	8.7	0.84	0.87	0.82
0.8	80	11.6	0.96	0.99	0.93
1	100	14.5	1.07	1.10	1.04
1.2	120	17.4	1.19	1.22	1.15
1.4	140	20.3	1.30	1.34	1.26
1.6	160	23.2	1.41	1.46	1.37
1.8	180	26.1	1.53	1.57	1.48
2	200	29.0	1.64	1.69	1.59
2.2	220	31.9	1.76	1.81	1.70
2.4	240	34.8	1.87	1.93	1.82
2.6	260	37.7	1.99	2.05	1.93
2.8	280	40.6	2.10	2.16	2.04
3	300	43.5	2.21	2.28	2.15
3.2	320	46.4	2.33	2.40	2.26
3.4	340	49.3	2.44	2.52	2.37
3.6	360	52.2	2.56	2.63	2.48
3.8	380	55.1	2.67	2.75	2.59
4	400	58.0	2.79	2.87	2.70
4.2	420	60.9	2.90	2.99	2.81
4.4	440	63.8	3.01	3.10	2.92
4.6	460	66.7	3.13	3.22	3.03
4.8	480	69.6	3.24	3.34	3.15
5	500	72.5	3.36	3.46	3.26
5.2	520	75.4	3.47	3.58	3.37
5.4	540	78.3	3.59	3.69	3.48
5.6	560	81.2	3.70	3.81	3.59
5.8	580	84.1	3.81	3.93	3.70
6	600	87.0	3.93	4.05	3.81
6.2	620	89.9	4.04	4.16	3.92
6.4	640	92.8	4.16	4.28	4.03
6.6	660	95.7	4.27	4.40	4.14
6.8	680	98.6	4.39	4.52	4.25
7	700	101.5	4.50	4.63	4.36

W2002799

## MID 128 PID 100 Engine Oil Pressure

In addition to the oil pressure, the sensor also measures the oil temperature.

### Fault Codes

#### FMI 1

Pressure too low.

*Conditions for fault code:*

- The voltage on EA14 is below the alarm limit.

*Possible cause:*

- Fault in overflow valve.
- Oil level too low.
- Contaminated oil, slow-flowing or too thin.
- Worn oil pump.
- Fault in sensor.

*Reaction from the EECU:*

- Fault code is set.
- Power reduction in the first stage and shutdown in 2nd stage (if engine protection is chosen in the data set).

*Noticeable external symptom:*

- LED lights up at the oil pressure gauge.
- Power reduction (if engine protection is chosen in the data set).
- Engine shut-down if the vehicle speed falls below 5 mph (3 km/h), if engine protection is chosen in the data set.

#### FMI 3

Short circuit to voltage.

*Conditions for fault code:*

- The voltage on EA14 exceeds 4.95 V.

*Possible cause:*

- Short circuit to battery voltage, 5 V supply wire.
- Short circuit to battery voltage or 5 V, signal wire.

- Fault in sensor.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- The EECU stops sending PID 100.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The oil pressure gauge shows 0.

#### FMI 4

Short circuit to ground or open circuit.

*Conditions for fault code:*

- The voltage on EA14 is under 0.08 V.

*Possible cause:*

- Break, 5 V supply wire.
- Break, signal wire.
- Short circuit to ground, 5 V supply wire.
- Short circuit to ground, signal wire.
- Fault in sensor.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- The EECU stops sending PID 100.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The oil pressure gauge shows 0.

## MID 128 PID 100 Engine Oil Pressure, Check

*Special tools: J-43233, J-39200, J-41132, 9998534*

### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Measurement at the component's connector, to the EECU

**1**  
**Note:** An incorrect value (below) can also cause the component to fail; therefore, it is important to check the component if any of the values are incorrect.

**2**  
Disconnect the connector to the oil pressure sensor. Install breakout harness 9998534 to the wiring harness end only.

#### Ground wire:

**3**  
Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
4 / alternate ground	<1 $\Omega$

#### Supply wire:

**4**  
Measure the voltage with voltmeter J-39200.

Ignition key must be in the ON position.

Measuring points	Optimal value
1 / alternate ground	5 V

#### Signal wire:

**5**  
Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
2 / alternate ground	100 k $\Omega$

### Check of component

#### Oil pressure sensor

**1**  
Disconnect the connector to the oil pressure sensor. Install breakout harness 9998534 to the sensor harness end only.

**2**  
Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
1 / 4	11 k $\Omega$
1 / 2	40 k $\Omega$
2 / 4	40 k $\Omega$
1 / alternate ground	open circuit
2 / alternate ground	open circuit
4 / alternate ground	open circuit

## Check of Subsystem

### *Oil pressure*

#### 1

Ignition key must be in the ON position.

J-41132

J-43233

Connect breakout box J-41132 in series between connector EA and the EECU. Connect jumper harness J-43233 in series between connector EB and the EECU.

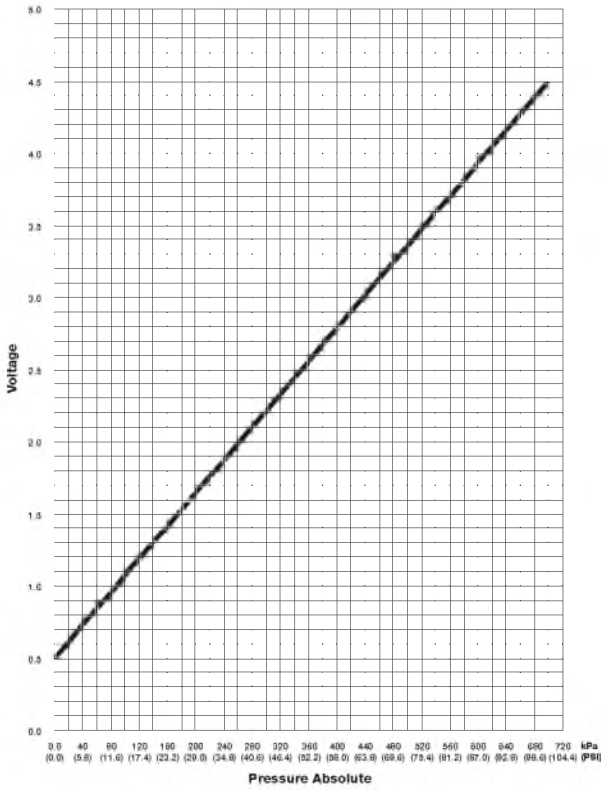
J-39200

Measuring points	Optimal value
EA14 / EA5	0.5 V (engine not running)

**Note:** For oil pressure/voltage chart, see "Oil Pressure Sensor, Pressure/Voltage Chart" page 113.

# Oil Pressure Sensor, Pressure/Voltage Chart

Oil Pressure Sensor



Bars	kPa	PSI	Volts	Volts (High)	Volts (Low)
0	0	0	0.50	0.52	0.49
0.2	20	2.9	0.61	0.63	0.60
0.4	40	5.8	0.73	0.75	0.71
0.6	60	8.7	0.84	0.87	0.82
0.8	80	11.6	0.96	0.99	0.93
1	100	14.5	1.07	1.10	1.04
1.2	120	17.4	1.19	1.22	1.15
1.4	140	20.3	1.30	1.34	1.26
1.6	160	23.2	1.41	1.46	1.37
1.8	180	26.1	1.53	1.57	1.48
2	200	29.0	1.64	1.69	1.59
2.2	220	31.9	1.76	1.81	1.70
2.4	240	34.8	1.87	1.93	1.82
2.6	260	37.7	1.99	2.05	1.93
2.8	280	40.6	2.10	2.16	2.04
3	300	43.5	2.21	2.28	2.15
3.2	320	46.4	2.33	2.40	2.26
3.4	340	49.3	2.44	2.52	2.37
3.6	360	52.2	2.56	2.63	2.48
3.8	380	55.1	2.67	2.75	2.59
4	400	58.0	2.79	2.87	2.70
4.2	420	60.9	2.90	2.99	2.81
4.4	440	63.8	3.01	3.10	2.92
4.6	460	66.7	3.13	3.22	3.03
4.8	480	69.6	3.24	3.34	3.15
5	500	72.5	3.36	3.46	3.26
5.2	520	75.4	3.47	3.58	3.37
5.4	540	78.3	3.59	3.69	3.48
5.6	560	81.2	3.70	3.81	3.59
5.8	580	84.1	3.81	3.93	3.70
6	600	87.0	3.93	4.05	3.81
6.2	620	89.9	4.04	4.16	3.92
6.4	640	92.8	4.16	4.28	4.03
6.6	660	95.7	4.27	4.40	4.14
6.8	680	98.6	4.39	4.52	4.25
7	700	101.5	4.50	4.63	4.36

W2002732

## MID 128 PID 102 Boost Pressure

In addition to the boost pressure, the sensor also measures the boost air temperature.

### Fault Codes

#### FMI 3

Short circuit to voltage.

*Conditions for fault code:*

- The voltage on EA3 exceeds 4.95 V.

*Possible cause:*

- Short circuit to battery voltage, 5 V supply wire.
- Short circuit to battery voltage or 5 V, signal wire.
- Fault in sensor.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- The EECU stops sending PID 102.
- Power reduction.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The boost pressure gauge shows 0.
- Low power output.

#### FMI 4

Short circuit to ground or open circuit.

*Conditions for fault code:*

- The voltage on EA3 is under 0.08 V.

*Possible cause:*

- Break, 5 V supply wire.
- Break, signal wire.
- Short circuit to ground, 5 V supply wire.
- Short circuit to ground, signal wire.
- Fault in sensor.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- The EECU stops sending PID 102.
- Power reduction.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The boost pressure gauge shows 0.
- Low power output.

## MID 128 PID 102 Boost Pressure, Check

*Special tools: J-43233, J-39200, J-41132, 9998534*

### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VN/VHD, Electrical Schematics," Group 37.

### Measurement at the component's connector, to the EECU

**1**  
**Note:** An incorrect value (below) can also cause the component to fail; therefore, it is important to check the component if any of the values are incorrect.

**2**  
Disconnect the connector to the boost pressure sensor. Install breakout harness 9998534 to the wiring harness end only.

#### Ground wire:

**3**  
Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
4 / alternate ground	<1 $\Omega$

#### Supply wire:

**4**  
Measure the voltage with voltmeter J-39200.

Ignition key must be in the ON position.

Measuring points	Optimal value
1 / alternate ground	5 V

#### Signal wire:

**5**  
Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
2 / alternate ground	100 k $\Omega$

### Check of component

#### Boost pressure sensor

**1**  
Disconnect the connector to the boost pressure sensor. Install breakout harness 9998534 to the sensor harness end only.

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
1 / 4	11.5 k $\Omega$
1 / 2	44 k $\Omega$
2 / 4	44 k $\Omega$
1 / alternate ground	open circuit
2 / alternate ground	open circuit
4 / alternate ground	open circuit



## Check of Subsystem

### *Boost pressure*

#### 1

Ignition key must be in the ON position.

J-41132

J-43233

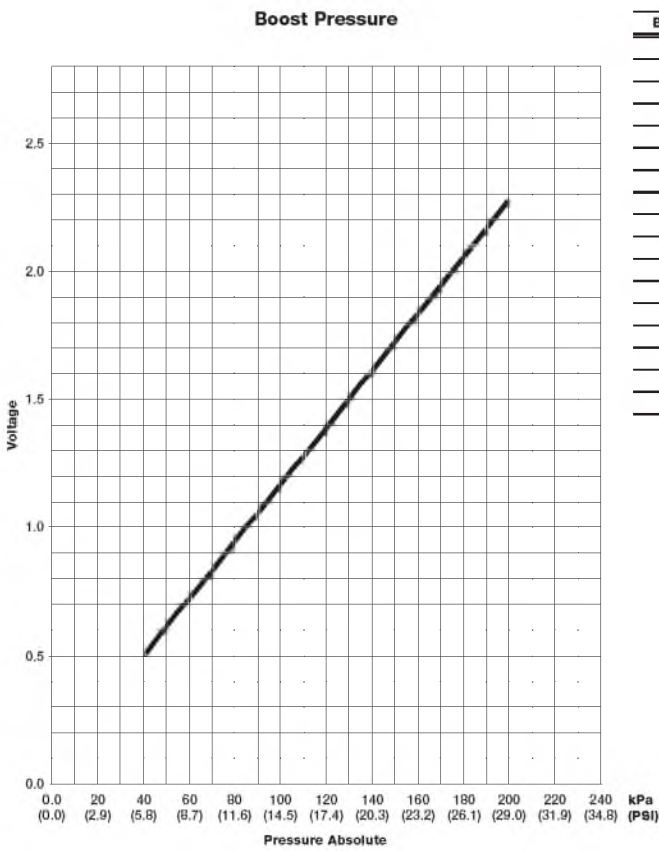
Connect breakout box J-41132 in series between connector EA and the EECU. Connect jumper harness J-43233 in series between connector EB and the EECU.

J-39200

Measuring points	Optimal value
EA3 / EA5	1.2 V (sea level, engine not running)

**Note:** For boost pressure/voltage chart, see "Boost Pressure Sensor, Pressure/Voltage Chart" page 117.

# Boost Pressure Sensor, Pressure/Voltage Chart



Bars	kPa	PSI	Volts	Volts (High)	Volts (Low)
0.4	40	5.8	0.50	0.53	0.47
0.5	50	7.3	0.61	0.64	0.58
0.6	60	8.7	0.72	0.76	0.69
0.7	70	10.2	0.83	0.87	0.80
0.8	80	11.6	0.94	0.98	0.91
0.9	90	13.1	1.06	1.09	1.02
1.0	100	14.5	1.17	1.20	1.13
1.1	110	16.0	1.28	1.31	1.24
1.2	120	17.4	1.39	1.42	1.36
1.3	130	18.9	1.50	1.53	1.47
1.4	140	20.3	1.61	1.64	1.58
1.5	150	21.8	1.72	1.76	1.69
1.6	160	23.2	1.83	1.87	1.80
1.7	170	24.7	1.94	1.98	1.91
1.8	180	26.1	2.06	2.09	2.02
1.9	190	27.6	2.17	2.20	2.13
2.0	200	29.0	2.28	2.31	2.24

W2002730

## MID 128 PID 105 Boost Air Temperature

In addition to the boost air temperature, the sensor also measures the boost pressure.  
The boost air temperature signal can be used to switch on the radiator fan.

### Fault Codes

#### FMI 3

Short circuit to voltage or open circuit.

*Conditions for fault code:*

- The voltage on EA2 exceeds 4.95 V.

*Possible cause:*

- Short circuit to voltage, signal wire.
- Short circuit to voltage, ground wire.
- Break, signal wire.
- Break, ground wire.
- Fault in sensor.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.

#### FMI 4

Short circuit to ground.

*Conditions for fault code:*

- The voltage on EA2 is under 0.08 V.

*Possible cause:*

- Short circuit to ground, signal wire.
- Fault in sensor.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.

## MID 128 PID 105 Boost Air Temperature, Check

*Special tools: J-43233, J-39200, J-41132, 9998534*

### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Measurement at the component's connector, to the EECU

**1**  
**Note:** An incorrect value (below) can also cause the component to fail; therefore, it is important to check the component if any of the values are incorrect.

**2**  
Disconnect the connector to the boost air temperature sensor. Install break-out harness 9998534 to the wiring harness end only.

#### Ground wire:

**3**  
Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
4 / alternate ground	<1 $\Omega$

#### Supply wire:

**4**  
Measure the voltage with voltmeter J-39200.

Ignition key must be in the ON position.

Measuring points	Optimal value
1 / alternate ground	5 V

#### Signal wire:

**5**  
Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
3 / alternate ground	5.7 k $\Omega$

### Check of component

#### Boost air temperature sensor

**1**  
Disconnect the connector to the boost air temperature sensor. Install break-out harness 9998534 to the sensor harness only.

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
3 / 4	6.2 k $\Omega$ (20 °C/68 °F)
3 / 4	2.5 k $\Omega$ (40 °C/104 °F)
1 / alternate ground	open circuit
2 / alternate ground	open circuit
4 / alternate ground	open circuit

**Note:** For boost air temperature/resistance chart, see "Boost Air Temperature Sensor, Temperature/Resistance Chart" page 121.

## Check of Subsystem

### *Boost air temperature*

#### 1

Ignition key must be in the ON position.

Connect breakout box J-41132 in series between connector EA and the EECU. Connect jumper harness J-43233 in series between connector EB and the EECU.

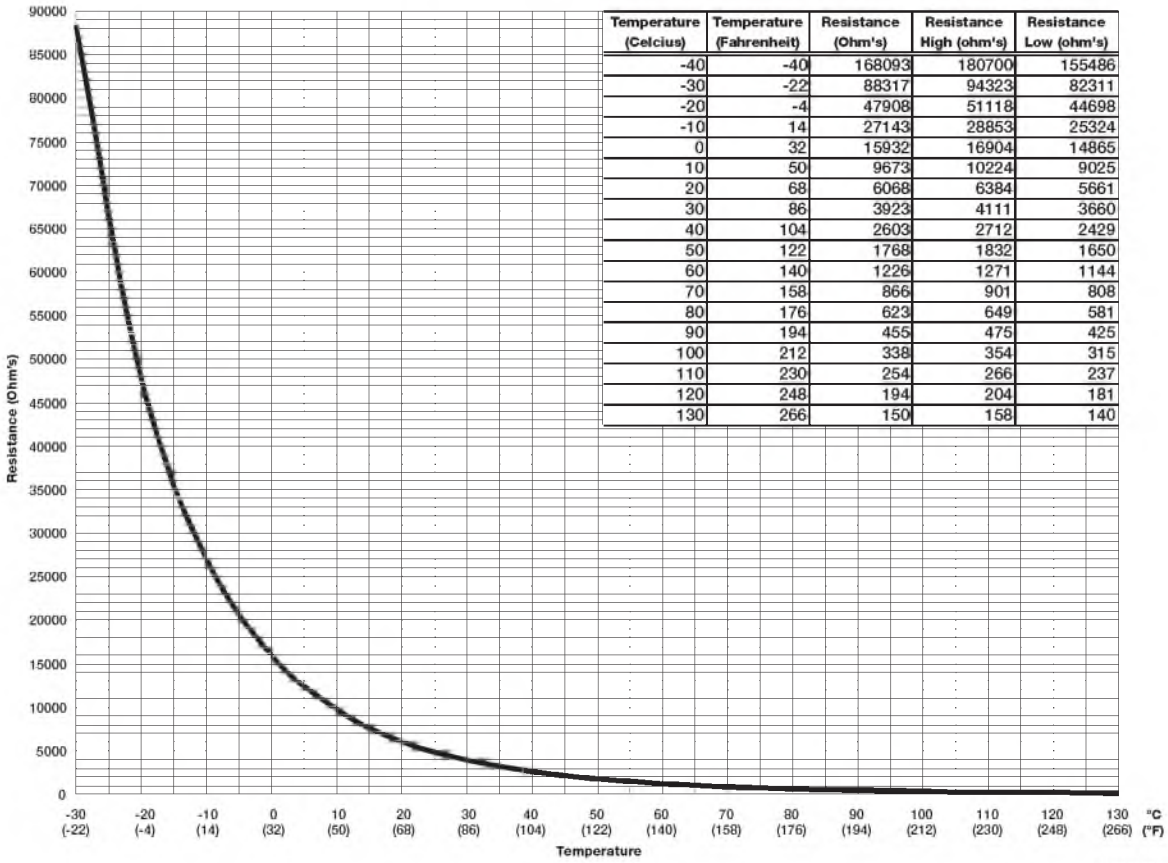
J-41132  
J-43233 J-  
39200

Measuring points	Optimal value
EA2 / EA5	2.6 V (20 °C/68 °F)
EA2 / EA5	1.6 V (40 °C/104 °F)

**Note:** For boost air temperature/resistance chart, see "Boost Air Temperature Sensor, Temperature/Resistance Chart" page 121.

# Boost Air Temperature Sensor, Temperature/Resistance Chart

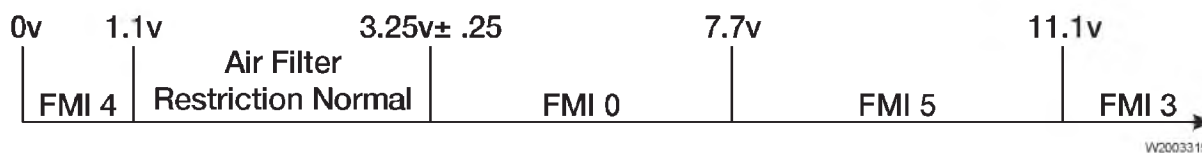
Intake Manifold Air Temperature Sensor



W2002728

## MID 128 PID 107 Air Filter Differential Pressure

(D12B, D12C, D7C Engines)



### Fault Codes

#### FMI 0

Filter restriction is too great.

The pressure drop (filter restriction) is greatest at high engine speed/load. With current engine software, once PID 107 is triggered, it remains active until the ignition is turned to the OFF position. At that time, the fault code is reset (neither active nor inactive) until the fault condition recurs.

*Conditions for fault code:*

- Filter restriction too great.
- Voltage between EB17–EB8 exceeds  $3.25 \pm 0.25$  V.

*Possible cause:*

- Clogged air filter.
- Fault in sensor.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp is illuminated.
- Loss of tractive power.

*Possible action:*

- Check/replace the air filter.
- See Service Bulletin, “Checklist A: Turbo Boost Pressure,” publication number PV776–200–040SB.

#### FMI 3

Short circuit to battery voltage.

*Conditions for fault code:*

- Voltage between EB17–EB8 exceeds 11.1 V.

*Possible cause:*

- Short circuit to battery voltage, signal wire.
- Short circuit to battery voltage, ground wire.
- Fault in sensor.

*Reaction from the EECU:*

- Fault code is set.

- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.

*Possible checks:*

- “MID 128 PID 107 Air Filter Differential Pressure, Check” page 124.

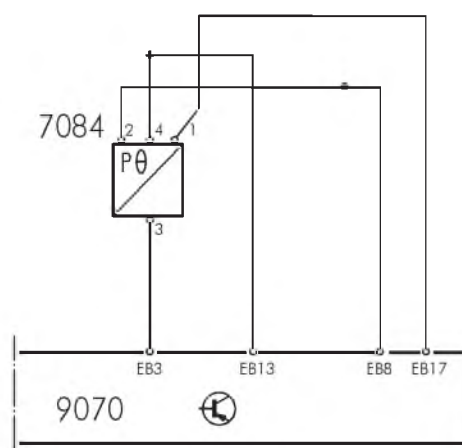


Fig. 13: 7084 - air filter restriction/temperature sensor; 9070 - EECU.

T2012730



## FMI 4

Short circuit to ground.

*Conditions for fault code:*

- Voltage between EB17–EB8 is under 1.1 V.

*Possible cause:*

- Short circuit to ground, signal wire.
- Fault in sensor.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.

*Possible checks:*

- "MID 128 PID 107 Air Filter Differential Pressure, Check" page 124.

## FMI 5:

Break

*Conditions for fault code:*

- Voltage between EB17–EB8 exceeds 7.7 V.

*Possible cause:*

- Break in signal wire.
- Fault in sensor.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.

*Possible checks:*

- "MID 128 PID 107 Air Filter Differential Pressure, Check" page 124.

## MID 128 PID 107 Air Filter Differential Pressure, Check

(D12B, D12C, D7C Engines)

Special tools: 9998534, J-39200, J-43233, J-41132

### NOTE!

Check all the particular connectors for loose connections, switch resistance, and oxidation.

For detailed circuit information, refer to "VN/VHD, Electrical Schematics," Group 37.

### Measurement at the Component's Connector, to the EECU

1

**Note:** Check to verify that each of the following values is correct. Incorrect values can also cause this component to fail. It is important to check the component if any of the values are incorrect.

2

Disconnect the connector to the air filter restriction/temperature sensor. Install breakout harness 9998534 to the wiring harness only.

#### Ground wire:

3

Measure the resistance using DMM J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
2 / alternate ground	<1 Ω

#### Signal wire/supply wire:

4

Measure the voltage at the supply wire using DMM J-39200.

Ignition key must be in the ON position.

Measuring points	Optimal value
1 / alternate ground	80% B+

## Check of Component

**Note:** Faults in the component can be caused by faults in the wiring harness of the EECU. Thus, a check of the wiring harness should also be made before connecting a new component.

### Air Filter Restriction/Temperature Sensor

1

Disconnect the connector to the air filter restriction/temperature sensor. Install breakout harness 9998534 to the sensor harness end only.

2

Measure the resistance with DMM J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
1 / 2	330 Ω (inactive; normal position)
1 / 2	2.2 kΩ (active)

## Check of Subsystem

### Air Filter Indicator

1

Connect breakout box J-41132 in series between connector EB and the EECU. Connect jumper harness J-43233 in series between connector EA and the EECU.

2

Measure the voltage with DMM J-39200.

Ignition key must be in the ON position.

Measuring points	Optimal value
EB8 / EB17	1.35 V (inactive; normal position) 5.1 V (active)

## MID 128 PID 108 Atmospheric Pressure

The sensor is located inside the EECU and therefore cannot be checked. The signal is used to calculate the turbo pressure and to compensate the fuel when driving at high altitudes.

### Fault Codes

#### FMI 3

Short circuit to voltage.

*Conditions for fault code:*

- The signal from the internal sensor exceeds 4.95 V.

*Possible cause:*

- Internal fault in the EECU.
- The EECU has been exposed to extremely high pressure.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Poor response at high altitudes.

#### FMI 4

Short circuit to ground or open circuit.

*Conditions for fault code:*

- The signal from the internal sensor is under 0.08 V.

*Possible cause:*

- Internal fault in the EECU.
- The EECU has been exposed to extremely low pressure.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Poor response at high altitudes.

## MID 128 PID 110 Engine Coolant Temperature

### Fault Codes

#### FMI 0

Temperature too high.

*Conditions for fault code:*

- The coolant temperature exceeds 102 °C/216 °F.

*Possible cause:*

- Low coolant level.
- Fault in thermostat.
- Clogged radiator (internally/externally).
- Clogged intercooler (on the outside).
- Poor through-flow in the cooling system.
- Worn coolant pump.
- Fault in pressure cap, expansion tank.
- Fault in sensor.

*Reaction from the EECU:*

- Fault code is set.
- Power reduction in the first stage.
- The engine is shut down in the second stage (if engine protection is chosen in the data set).

*Noticeable external symptom:*

- LED lights up at the coolant temperature gauge.
- Low power output.
- The engine is shut down (if engine protection is chosen in the data set).

#### FMI 3

Short circuit to voltage or open circuit.

*Conditions for fault code:*

- The voltage on EA25 exceeds 4.95 V.

*Possible cause:*

- Short circuit to battery or 5 V voltage, signal wire.
- Short circuit to voltage, ground wire.
- Break, signal wire.
- Break, ground wire.
- Fault in sensor.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- The EECU stops sending PID 110.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The coolant temperature gauge shows 0.

#### FMI 4

Short circuit to ground.

*Conditions for fault code:*

- The voltage on EA25 is under 0.08 V.

*Possible cause:*

- Short circuit to ground, signal wire.
- Fault in sensor.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- The EECU stops sending PID 110.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The coolant temperature gauge shows 0.

## MID 128 PID 110 Engine Coolant Temperature, Check

*Special tools:* J-43233, J-39200, J-41132, 9998534

### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Measurement at the component's connector, to the EECU

1

**Note:** An incorrect value (below) can also cause the component to fail; therefore, it is important to check the component if any of the values are incorrect.

2

Disconnect the connector to the coolant temperature sensor. Install breakout harness 9998534 to the wiring harness end only.

*Ground wire:*

3

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
2 / alternate ground	<1 $\Omega$

*Signal wire:*

4

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
1 / alternate ground	1.4 k $\Omega$

### Check of component

*Coolant temperature sensor*

1

Disconnect the connector to the coolant temperature sensor. Install breakout harness 9998534 to the sensor harness only.

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

**Note:** For coolant temperature/resistance chart, see "Coolant Temperature Sensor, Temperature/Resistance Chart" page 128.

Measuring points	Optimal value
1 / 2	1.9 k $\Omega$ (20 °C/68 °F)
1 / 2	160 $\Omega$ (85 °C/185 °F)
1 / alternate ground	open circuit
2 / alternate ground	open circuit

### Check of Subsystem

*Coolant temperature*

1

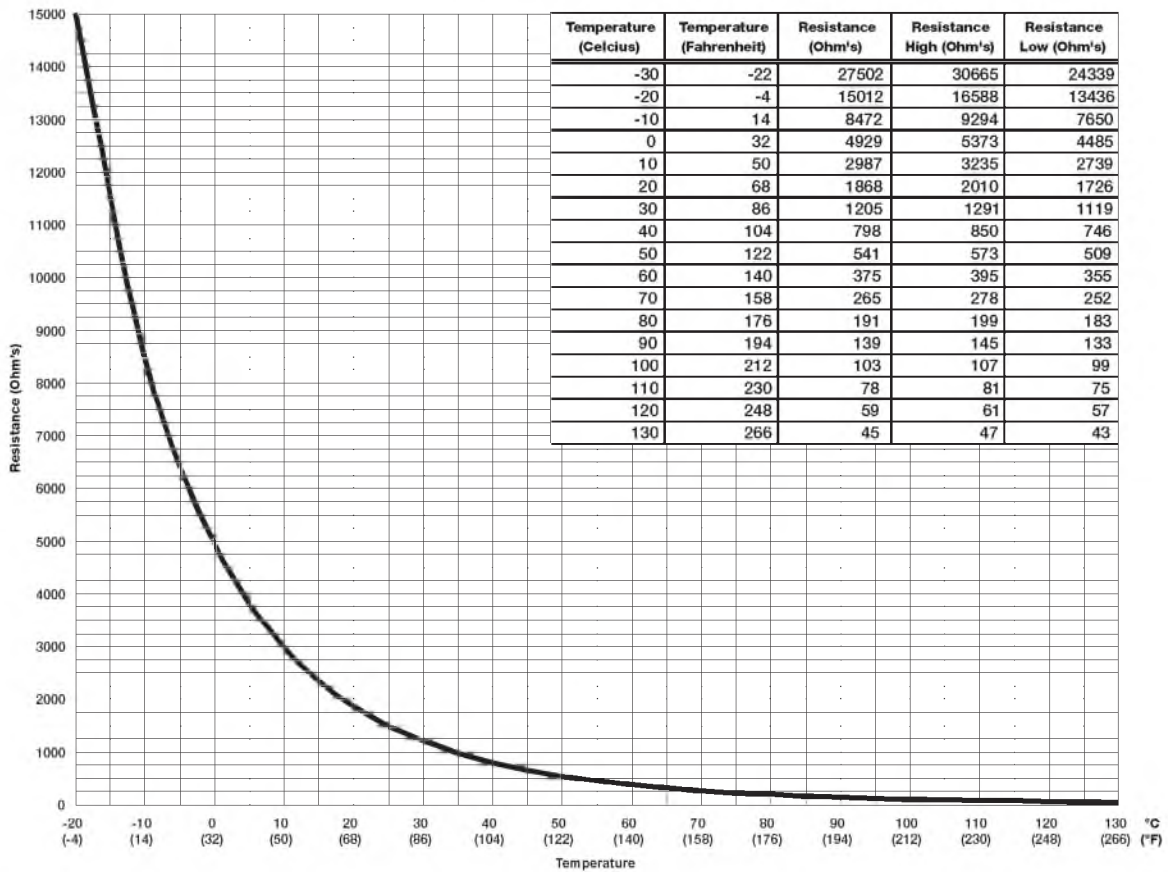
Ignition key must be in the ON position. Connect breakout box J-41132 in series between connector EA and the EECU. Connect jumper harness J-43233 in series between connector EB and the EECU.

Measuring points	Optimal value
EA25 / EA5	3.0 V (20 °C/68 °F)
EA25 / EA5	0.6 V (85 °C/185 °F)

**Note:** For coolant temperature/resistance chart, see "Coolant Temperature Sensor, Temperature/Resistance Chart" page 128.

# Coolant Temperature Sensor, Temperature/Resistance Chart

Coolant Temperature Sensor



W2002729

## MID 128 PID 111 Coolant Level

The information applies only to the magnetic coolant level sensor that is mounted in the bottom of the radiator expansion tank. Some models (WG, AC) are equipped with a capacitive probe and an electronic coolant level module that converts the capacitive signal to an output signal that the EECU can understand.

### Fault Codes

#### FMI 1

Level too low.

*Conditions for fault code:*

- Coolant level switch closed.
- The voltage on EB7 is under 45% of the battery voltage.

*Possible cause:*

- Low coolant level.
- Short circuit to ground, signal wire.
- Fault in sensor.

*Reaction from the EECU:*

- Fault code is set.
- Red lamp is requested.
- The EECU reduces the output after 30 seconds and shuts down the engine if the vehicle speed goes under 5 mph or 3 km/h (if engine protection is chosen in the data set).

*Noticeable external symptom:*

- Red lamp lights up.
- The EECU reduces the output after 30 seconds and shuts down the engine if the vehicle speed goes under 5 mph or 3 km/h (if engine protection is chosen in the data set).



## MID 128 PID 111 Coolant Level, Check

Special tools: J-43233, J-39200, J-41132, J-42472

### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Measurement at the component's connector, to the EECU

1

**Note:** An incorrect value (below) can also cause the component to fail; therefore, it is important to check the component if any of the values are incorrect.

2

Disconnect the connector to the coolant level sensor. Install breakout harness J-42472 to the wiring harness end only.

#### Ground wire:

3

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
1 / alternate ground	<1 Ω

#### Signal wire:

4

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
2 / alternate ground	2.1 kΩ

## Check of component

### The coolant level sensor

1

Disconnect the connector to the coolant level sensor. Install breakout harness J-42472 to the sensor harness end only.

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
1 / 2	open circuit (coolant level normal)
1 / 2	<1 Ω (coolant level low)
1 / alternate ground	open circuit
2 / alternate ground	open circuit

## Check of Subsystem

### Coolant level

1

Ignition key must be in the ON position.

Connect breakout box J-41132 in series between connector EB and the EECU. Connect jumper harness J-43233 in series between connector EA and the EECU.

Measuring points	Optimal value
EB7 / EB8	80% B+ (open, coolant level normal)
EB7 / EB8	0 V (closed, coolant level low)

## MID 128 PID 158 Battery Voltage

### Fault Codes

#### **FMI 3**

Battery voltage too high.

*Conditions for fault code:*

- The battery voltage exceeds 36 V.

*Possible cause:*

- Fault in alternator.
- Fast charger connected.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.

## MID 128 PID 158 Battery Voltage, Check

*Special tools: J-43233, J-39200, J-41132*

### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Check of Subsystem

#### *EECU supply relay*

**1**

Ignition key must be in the ON position. J-41132  
J-43233

Connect breakout box J-41132 in series between connector EB and the EECU. Connect jumper harness J-43233 in series between connector EA and the EECU. J-39200

Measuring points	Optimal value
EB9 / EB11	B+
EB10 / EB12	B+
EB9 / EB10	<1 $\Omega$
EB11 / EB12	<1 $\Omega$

## MID 128 PID 172 Air Inlet Temperature

An ambient air temperature sensor is mounted in the piping between the air filter and the turbo inlet. In addition to ambient air temperature, the sensor also measures air filter restriction. The air filter restriction function is currently not used.

### Fault Codes

#### FMI 3

Short circuit to voltage or open circuit.

*Conditions for fault code:*

- The voltage on EB3 exceeds 4.95 V.

*Possible cause:*

- Short circuit to voltage, signal wire.
- Short circuit to voltage, ground wire.
- Break, signal wire.
- Break, ground wire.
- Fault in sensor.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Blue smoke in cold weather conditions.

#### FMI 4

Short circuit to ground.

*Conditions for fault code:*

- The voltage on EB3 is under 0.08 V.

*Possible cause:*

- Short circuit to ground, signal wire.
- Fault in sensor.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Blue smoke in cold weather conditions.

## MID 128 PID 172 Air Inlet Temperature, Check

*Special tools: J-43233, J-39200, J-41132, 9998534*

### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Measurement at the component's connector, to the EECU

1

**Note:** An incorrect value (below) can also cause the component to fail; therefore, it is important to check the component if any of the values are incorrect.

2

Disconnect the connector to the ambient air temperature sensor. Install breakout harness 9998534 to the wiring harness only.

#### Ground wire:

3

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
4 / alternate ground	<1 $\Omega$

#### Signal wire:

4

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
3 / alternate ground	6 k $\Omega$

## Check of component

### Air temperature sensor

1

Disconnect the connector to the ambient air temperature sensor. Install breakout harness 9998534 to the sensor harness end only.

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

**Note:** For ambient air temperature/resistance chart, see "Ambient Air Temperature Sensor, Temperature/Resistance Chart" page 135.

Measuring points	Optimal value
3 / 4	5.7 k $\Omega$ (20 °C/68 °F)

## Check of Subsystem

### Ambient air temperature inlet

1

Ignition key must be in the ON position.

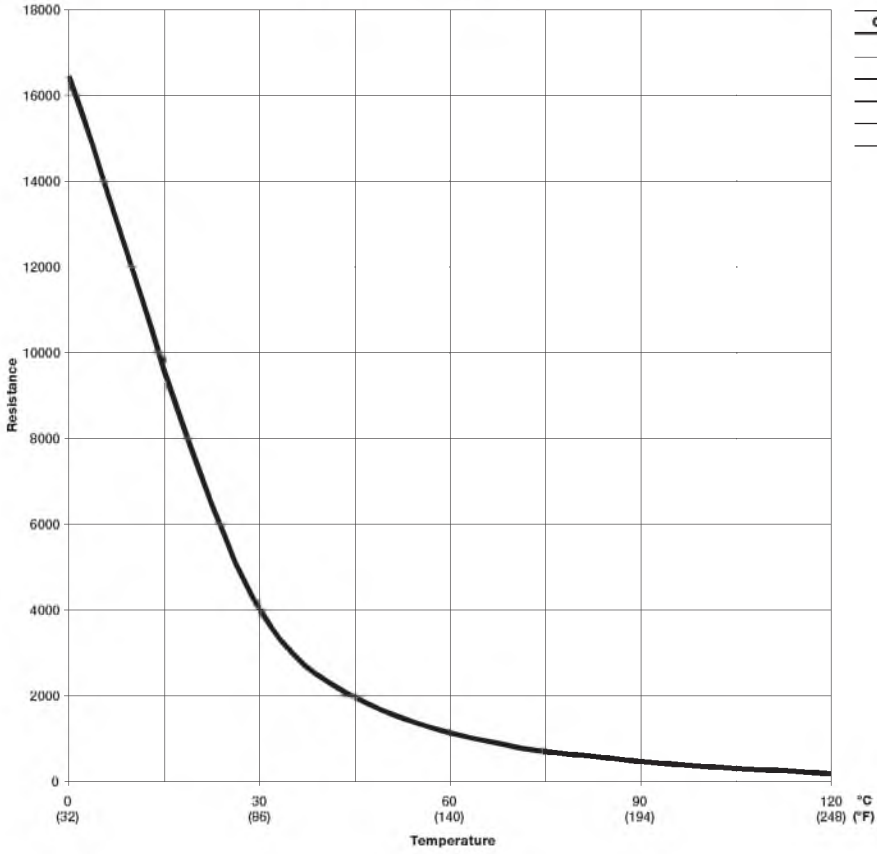
Connect breakout box J-41132 in series between connector EB and the EECU. Connect jumper harness J-43233 in series between connector EA and the EECU.

Measuring points	Optimal value
EB3 / EB13	2.6 V (20 °C/68 °F)
EB3 / EB13	1.2 V (50 °C/122 °F)

**Note:** For ambient air temperature/resistance chart, see "Ambient Air Temperature Sensor, Temperature/Resistance Chart" page 135.

# Ambient Air Temperature Sensor, Temperature/Resistance Chart

Air Inlet Temperature Sensor



Celsius	Fahrenheit	Resistance
0	32	16445
30	86	4026
60	140	1246
90	194	463
120	248	198

W2002733

## MID 128 PID 174 Fuel Temperature

### D7C and D12C

In addition to the fuel temperature, the sensor also measures the fuel pressure. The signal is used for fuel density compensation.

### Fault Codes

#### FMI 3

Short circuit to voltage or open circuit.

*Conditions for fault code:*

- The voltage on EA13 exceeds 4.95 V.

*Possible cause:*

- Short circuit to voltage, signal wire.
- Short circuit to voltage, ground wire.
- Break, signal wire.
- Break, ground wire.
- Fault in sensor.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Incorrect fuel quantity.

#### FMI 4

Short circuit to ground.

*Conditions for fault code:*

- The voltage on EA13 is under 0.08 V.

*Possible cause:*

- Short circuit to ground, signal wire.
- Fault in sensor.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Incorrect fuel quantity.



## MID 128 PID 174 Fuel Temperature, Check

*Special tools: J-43233, J-39200, J-41132, 9998534*

### D7C and D12C

**Note:** Check all the particular connectors for loose connections as well as for switch resistance and oxidation. For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Measurement at the component's connector, to the EECU

1

**Note:** An incorrect value (below) can also cause the component to fail; therefore, it is important to check the component if any of the values are incorrect.

2

Disconnect the connector to the fuel temperature sensor. Install breakout harness 9998534 to the wiring harness end only.

#### Ground wire:

3

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
4 / alternate ground	<1 $\Omega$

#### Supply wire:

4

Measure the voltage with voltmeter J-39200.

Ignition key must be in the ON position.

Measuring points	Optimal value
1 / alternate ground	5 V

#### Signal wire:

5

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
3 / alternate ground	1.4 k $\Omega$

### Check of component

#### Fuel temperature sensor

1

Disconnect the connector to the fuel temperature sensor. Install breakout harness 9998534 to the sensor connector only.

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

**Note:** For fuel temperature/resistance chart, see "Fuel Temperature Sensor, Temperature/Resistance Chart" page 139.

Measuring points	Optimal value
3 / 4	1.9 k $\Omega$ (20 $^{\circ}$ C/68 $^{\circ}$ F)
3 / 4	800 $\Omega$ (40 $^{\circ}$ C/104 $^{\circ}$ F)
1 / alternate ground	open circuit
3 / alternate ground	open circuit
4 / alternate ground	open circuit

## Check of Subsystem

### *Fuel temperature*

#### 1

Ignition key must be in the ON position.

J-41132

J-43233

Connect breakout box J-41132 in series between connector EA and the EECU. Connect jumper harness J-43233 in series between connector EB and the EECU.

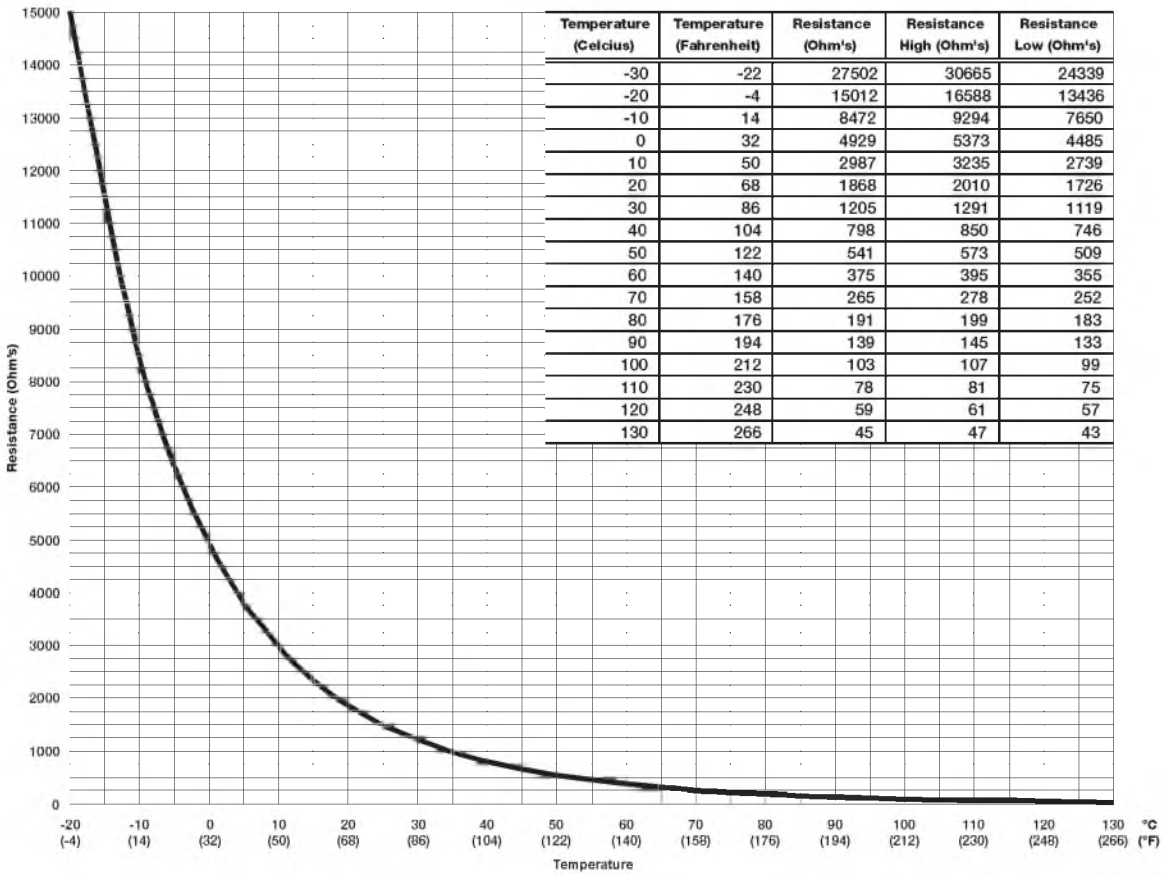
J-39200

Measuring points	Optimal value
EA13 / EA5	3.0 V (20 °C/68 °F)
EA13 / EA5	2.0 V (40 °C/104 °F)

**Note:** For fuel temperature/resistance chart, see "Fuel Temperature Sensor, Temperature/Resistance Chart" page 139.

# Fuel Temperature Sensor, Temperature/Resistance Chart

Fuel Temperature Sensor



W2002742

## MID 128 PID 175 Engine Oil Temperature

In addition to the oil temperature, the sensor also measures the oil pressure.

### Fault Codes

#### FMI 0

Temperature too high.

*Conditions for fault code:*

- The oil temperature exceeds 130 °C (266 °F).

*Possible cause:*

- Poor cooling capacity.
- Fault in sensor.

*Reaction from the EECU:*

- Fault code is set.
- Red lamp is requested.

*Noticeable external symptom:*

- Red lamp lights up.
- Power reduction in the first stage (at 130 °C (266 °F) and shutdown in 2nd stage (if engine protection is chosen in the data set).

#### FMI 3

Short circuit to voltage or open circuit.

*Conditions for fault code:*

- The voltage on EA1 exceeds 4.95 V.

*Possible cause:*

- Short circuit to voltage, signal wire.
- Short circuit to voltage, ground wire.
- Break, signal wire.
- Break, ground wire.
- Fault in sensor.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- The EECU stops sending PID 175.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The oil temperature gauge shows 0.

#### FMI 4

Short circuit to ground.

*Conditions for fault code:*

- The voltage on EA1 is under 0.08 V.

*Possible cause:*

- Short circuit to ground, signal wire.
- Fault in sensor.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- The EECU stops sending PID 175.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The oil temperature gauge shows 0.

## MID 128 PID 175 Engine Oil Temperature, Check

*Special tools: J-43233, J-39200, J-41132, 9998534*

### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VN/VHD, Electrical Schematics," Group 37.

### Measurement at the component's connector, to the EECU

1

**Note:** An incorrect value (below) can also cause the component to fail; therefore, it is important to check the component if any of the values are incorrect.

2

Disconnect the connector to the oil temperature sensor. Install breakout harness 9998534 to the wiring harness end only.

#### Ground wire:

3

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
4 / alternate ground	<1 $\Omega$

#### Supply wire:

4

Measure the voltage with voltmeter J-39200.

Ignition key must be in the ON position.

Measuring points	Optimal value
1 / alternate ground	5 V

#### Signal wire:

5

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
3 / alternate ground	1.44 k $\Omega$

### Check of component

#### Oil temperature sensor

1

Disconnect the connector to the oil temperature sensor. Install breakout harness 9998534 to the sensor harness end only.

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

**Note:** For oil temperature/resistance chart, see "Oil Temperature Sensor, Temperature/Resistance Chart" page 143.

Measuring points	Optimal value
3 / 4	1.9 k $\Omega$ (20 °C/68 °F)
3 / 4	100 $\Omega$ (100 °C/212 °F)

## Check of Subsystem

### *Oil temperature*

#### 1

Ignition key must be in the ON position.

J-41132

J-43233

Connect breakout box J-41132 in series between connector EA and the EECU. Connect jumper harness J-43233 in series between connector EB and the EECU.

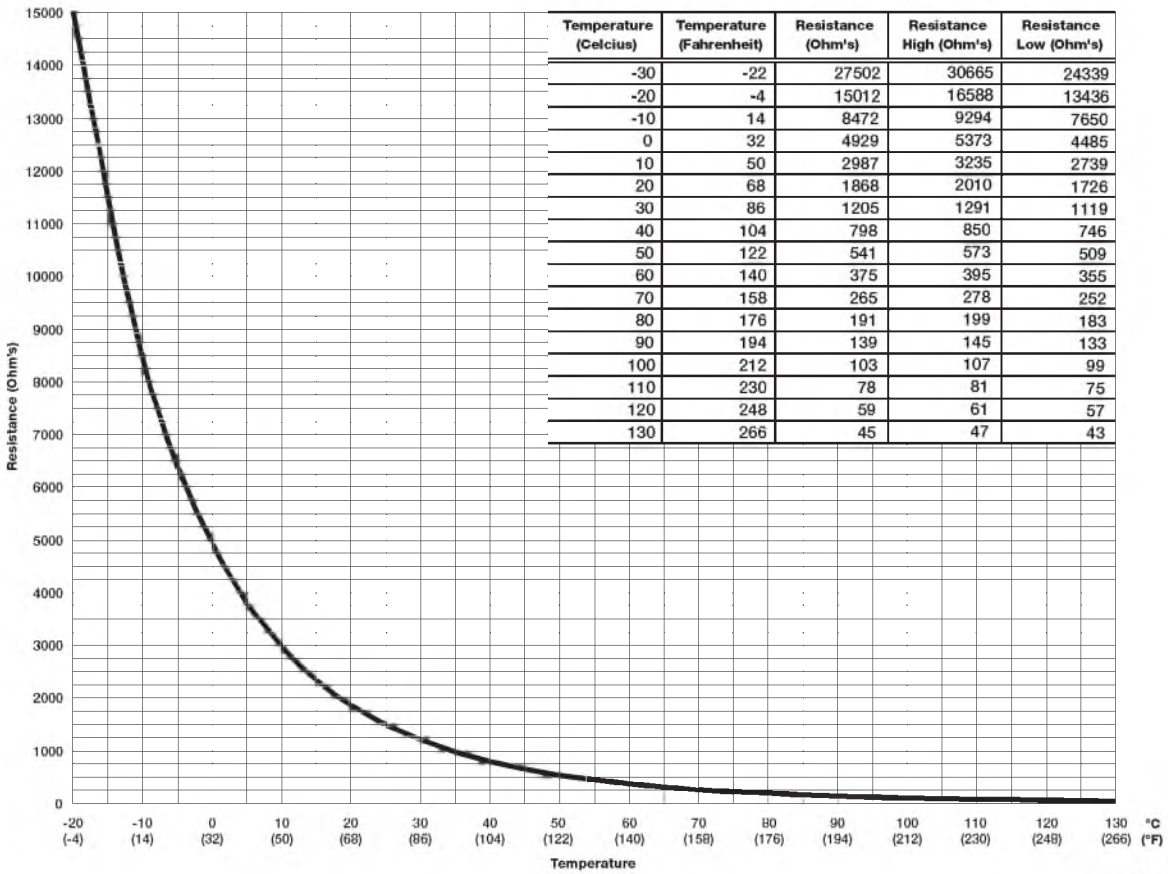
J-39200

Measuring points	Optimal value
EA1 / EA5	3.0 V (20 °C/68 °F)
EA1 / EA5	0.4 V (100 °C/212 °F)

**Note:** For oil temperature/resistance chart, see "Oil Temperature Sensor, Temperature/Resistance Chart" page 143.

# Oil Temperature Sensor, Temperature/Resistance Chart

Oil Temperature Sensor



W2002727



## MID 128 PID 228 Road Speed Sensor Calibration

### Fault Codes

#### **FMI 11**

K factor message not available on the information link (SAE J1587).

*Conditions for fault code:*

- PID 228 the message is not available on the information link (SAE J1587).

*Possible cause:*

- Fault in the information link (SAE J1587).
- Error from the VECU.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.

## MID 128 PID 228 Road Speed Sensor Calibration, Check

*Special tools: J-43233, J-39200, J-41132*

### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

Also check the VECU. This fault code could be due to the fact that there is a fault in the VECU.

### Check of Subsystem

*Check of the SAE J1587 Information link*

#### 1

Ignition key must be in the ON position. J-41132  
J-43233

Connect breakout box J-41132 in series between connector EB and the EECU. Connect jumper harness J-43233 in series between connector EA and the EECU. J-39200

Measuring points	Optimal value
EB25 / DCA (connection A in diagnostics connector)	<1 Ω
EB26 / DCB (connection B in diagnostics connector)	<1 Ω

## MID 128 PPID 86 Engine Brake Torque Percent

### Fault Codes

#### **FMI 9**

Engine brake torque information is not available (SAE J1587 message).

*Conditions for fault code:*

- PPID 86 the message is not available on the information link (SAE J1587).

*Possible cause:*

- Fault in the information link (SAE J1587).
- Error from the VECU.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.

## MID 128 PPID 86 Engine Brake Torque Percent, Check

*Special tools: J-43233, J-39200, J-41132*

### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

Also check the VECU. This fault code could be due to the fact that there is a fault in the VECU.

### Check of Subsystem

*Check of the SAE J1587 Information link*

#### 1

Ignition key must be in the ON position. J-41132  
J-43233

Connect breakout box J-41132 in series between connector EB and the EECU. Connect jumper harness J-43233 in series between connector EA and the EECU. J-39200

Measuring points	Optimal value
EB25 / DCA (connection A in diagnostics socket)	<1 $\Omega$
EB26 / DCB (connection B in diagnostics socket)	<1 $\Omega$

## MID 128 PPID 119 High Coolant Temperature

D12B, D12C, D7C Engines

### Fault Codes

#### FMI 0

Temperature too high.

*Conditions for fault code:*

- The coolant temperature exceeds 102 °C (216 °F).

*Possible cause:*

- Low coolant level.
- Fault in thermostat.
- Clogged radiator (internally/externally).
- Clogged intercooler (on the outside).
- Poor through-flow in the cooling system.
- Worn coolant pump.
- Fault in pressure cap, expansion tank.
- Fault in sensor.

*Reaction from the EECU:*

- Fault code is set.
- Power reduction in the first stage.
- The engine is shut down in the second stage (if engine protection is chosen in the data set).

*Noticeable external symptom:*

- LED lights up at the coolant temperature gauge.
- Low power output.
- The engine is shut down (if engine protection is chosen in the data set).

*Possible checks:*

- "MID 128 PPID 119 High Coolant Temperature, Check" page 149.

## MID 128 PPID 119 High Coolant Temperature, Check

(D12B, D12C, D7C Engines)

*Special tools: 9998534, J-43233, J-39200, J-41132*

### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Measurement at the Component's Connector, to the EECU

**Note:** An incorrect value (below) can also cause the component to fail; therefore, it is important to check the component if any of the values are incorrect.

- 1**  
Disconnect the connector to the coolant temperature sensor. Install breakout harness 9998534 to the wiring harness end only.

#### Ground wire:

- 2**  
Measure the resistance using DMM J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
2 / alternate ground	<1 $\Omega$

#### Signal wire:

- 3**  
Measure the resistance using DMM J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
1 / alternate ground	1.4 k $\Omega$

## Check of Component

**Note:** Faults in the component can be caused by faults in the wiring harness of the EECU. Thus, a check of the wiring harness should also be made before connecting a new component.

### Coolant Temperature Sensor

- 1**  
Disconnect the connector to the coolant temperature sensor. Install breakout harness 9998534 to the sensor harness end only.

- 2**  
Measure the resistance with DMM J-39200.

Ignition key must be in the OFF position.

**Note:** A coolant temperature/resistance chart is available; see "System Check" in Service Publication 200-870, "Fault Codes, Engine Electronic Control Unit," order number PV776-TSP105620/1.

Measuring points	Optimal value
1 / 2	1.9 k $\Omega$ / 20 °C (68 °F)
1 / 2	160 $\Omega$ / 85 °C (185 °F)
1 / alternate ground	open circuit
2 / alternate ground	open circuit

## Check of Subsystem

### *Coolant Temperature*

#### 1

Connect breakout box J-41132 in series between connector EA and the EECU. Connect jumper harness J-43233 in series between connector EB and the EECU.

#### 2

Measure the voltage using DMM J-39200.

J-41132  
J-43233  
J-39200

Ignition key must be in the ON position.

Measuring points	Optimal value
EA25 / EA5	3.0 V / 20 °C (68 °F)
EA25 / EA5	0.6 V / 85 °C (185 °F)



## MID 128 PPID 122 VCB Engine Compression Brake

### D12B and D12C Fault Codes

#### FMI 3

Short circuit to voltage.

*Conditions for fault code:*

- Output activated.
- Short circuit to battery voltage on EA33.

*Possible cause:*

- Short circuit to battery voltage between the VCB solenoid valve and EECU.
- Short circuit in VCB solenoid valve.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- The output is switched off.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Reduced engine brake power because the VCB cannot be activated.

#### FMI 4

Short circuit to ground.

*Conditions for fault code:*

- Output switched off.
- Short circuit to ground on EA33.

*Possible cause:*

- Short circuit to ground between the VCB solenoid valve and EECU.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

- The output is switched off.

*Noticeable external symptom:*

- Yellow lamp lights up.
- VCB is on all the time.
- Low power output.
- Black smoke.
- Extreme uneven operation.

#### FMI 5

Break.

*Conditions for fault code:*

- Output switched off.
- Open circuit in the VCB circuit.

*Possible cause:*

- Open circuit between the VCB solenoid valve and EECU.
- Open circuit in the supply wire to VCB solenoid valve.
- Blown fuse for supply to VCB solenoid valve.
- Open circuit in VCB solenoid valve.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- Output is switched off.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Reduced engine brake power because the VCB cannot be activated.

## MID 128 PPID 122 VCB Engine Compression Brake, Check

Special tools: J-43233, J-39200, J-41132

### D12B and D12C

#### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

#### Measurement at the component's connector, to the EECU

1

**Note:** An incorrect value (below) can also cause the component to fail; therefore, it is important to check the component if any of the values are incorrect.

2

Disconnect the two wires at the compression brake solenoid. The compression brake solenoid is located under the valve cover.

*"Ground wire"/Control wire:*

3

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
Ground control wire / alternate ground	215 kΩ

*Supply wire:*

4

Measure the voltage with voltmeter J-39200.

Ignition key must be in the ON position.

Measuring points	Optimal value
Supply wire / alternate ground	B+

#### Check of component

*Compression brake solenoid, VCB*

1

Disconnect the two wires at the compression brake solenoid. The compression brake solenoid is located under the valve cover.

J-39200

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
Solenoid terminal A / B	21 Ω
A / alternate ground	open circuit
B / alternate ground	open circuit

#### Check of Subsystem

*Compression brake, VCB*

1

Ignition key must be in the ON position.

J-41132  
J-43233  
J-39200

Connect breakout box J-41132 in series between connector EA and the EECU. Connect jumper harness J-43233 in series between connector EB and the EECU.

**Note:** Test with "VCB On" can be performed only if the EECU has requested VCB operation.

Measuring points	Optimal value
EA33 / alternate ground	B+ (VCB off)
EA33 / alternate ground	0 V (VCB on)
ground terminal EA33 with a jumper wire	VCB solenoid clicks on

## MID 128 PPID 123 EPG 2

### D12B and D12C Fault Codes

#### FMI 3

Short circuit to voltage.

*Conditions for fault code:*

- Output activated.
- Short circuit to battery voltage on EB36.

*Possible cause:*

- Short circuit to battery voltage between solenoid valve and EECU.
- Short circuit in solenoid valve.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- EPG1, EPG2 and VCB outputs are switched off.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The heat retention does not function.
- Blue smoke under cold conditions.
- The engine may be difficult to start.
- Engine brake does not function.

#### FMI 4

Short circuit to ground.

*Conditions for fault code:*

- Output switched off.
- Short circuit to ground on EB36.

*Possible cause:*

- Short circuit to ground between solenoid valve and EECU.

*Reaction from the EECU:*

- Fault code is set.

- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- EPG 2 constantly activated.
- Low power output.
- Black smoke.

#### FMI 5

Break.

*Conditions for fault code:*

- Output switched off.
- Open circuit in the EPG2 circuit.

*Possible cause:*

- Open circuit between solenoid valve and EECU.
- Open circuit in supply wire to solenoid valve.
- Blown fuse for supply to EPG2.
- Open circuit in the solenoid valve.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- EPG1, EPG2 and VCB outputs are switched off.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The heat retention does not function.
- Blue smoke under cold conditions.
- The engine may be difficult to start.
- Engine brake does not function.

## MID 128 PPID 123 EPG 2, Check

### D12B and D12C

*Special tools: J-43233, J-39200, J-41132, 9998534*

#### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Measurement at the component's connector, to the EECU

1

**Note:** An incorrect value (below) can also cause the component to fail; therefore, it is important to check the component if any of the values are incorrect.

2

Disconnect the connector to the EPG control box. Install breakout harness 9998534 to the wiring harness end only.

*"Ground wire"/Control wire:*

3

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
3 / alternate ground	180 k $\Omega$

*Supply wire:*

4

Measure the voltage with voltmeter J-39200.

Ignition key must be in the ON position.

Measuring points	Optimal value
1 / alternate ground	B+

## Check of component

*EPG control (PWM box)*

1

Disconnect the connector to the EPG control box. Install breakout harness 9998534 to the EPG control connector only.

9998534  
J-39200

Ignition key must be in the OFF position.

Measuring points	Optimal value
1 / 3	23 $\Omega$
1 / alternate ground	open circuit
3 / alternate ground	open circuit

## Check of Subsystem

*Exhaust pressure governor 2, EPG 2*

1

Ignition key must be in the RUN position. Connect breakout box J-41132 in series between connector EB and the EECU. Connect jumper harness J-43233 in series between connector EA and the EECU.

J-41132  
J-43233  
J-39200

**Note:** Test with "EPG On" can be performed only if the EECU has requested EPG 2 operation.

Measuring points	Optimal value
EB36 / EB9	B+, EPG 2 off (Engine running, parking brake released, accelerator pedal above idle)
EB36 / EB9	0 V, EPG 2 on (Engine running, parking brake on, accelerator at idle)

## MID 128 PPID 124 EPG 1

### Fault Codes

#### FMI 3

Short circuit to voltage.

*Conditions for fault code:*

- Output activated.
- Short circuit to battery voltage on EB35.

*Possible cause:*

- Short circuit to battery voltage between solenoid valve and EECU.
- Short circuit in solenoid valve.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- EPG1, EPG2 and VCB outputs are switched off.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Heat retention does not function.
- Blue smoke under cold conditions.
- Engine may be difficult to start.
- Engine brake does not function.

#### FMI 4

Short circuit to ground.

*Conditions for fault code:*

- Output switched off.
- Short circuit to ground on EB35.

*Possible cause:*

- Short circuit to ground between solenoid valve and EECU.

*Reaction from the EECU:*

- Fault code is set.

- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- EPG 1 constantly activated.
- Low power output.
- Black smoke.

#### FMI 5

Break.

*Conditions for fault code:*

- Output switched off.
- Open circuit in the EPG1 circuit.

*Possible cause:*

- Open circuit between solenoid valve and EECU.
- Open circuit in supply wire to solenoid valve.
- Blown fuse for supply to EPG1.
- Open circuit in the solenoid valve.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- EPG1, EPG2 and VCB outputs are switched off.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Engine brake does not function.
- Heat retention does not function.
- Blue smoke under cold conditions.
- Engine may be difficult to start.

## MID 128 PPID 124 EPG 1, Check

*Special tools: J-43233, J-39200, J-41132, 9998534*

### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

## Measurement at the component's connector, to the EECU

### 1

**Note:** An incorrect value (below) can also cause the component to fail; therefore, it is important to check the component if any of the values are incorrect.

### 2

Disconnect the connector to the EPG control box (D12B) or the EPG solenoid (D7C). Install breakout harness 9998534 to the wiring harness end only.

*"Ground wire"/Control wire:*

### 3

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
4 / alternate ground	180 Ω

*Supply wire:*

### 4

Measure the voltage with voltmeter J-39200.

Ignition key must be in the ON position.

Measuring points	Optimal value
1 / alternate ground	B+

## Check of component (D12B only)

*EPG control (PWM box)*

### 1

**Note:** This procedure is for the D12B engine only. The D7C engine uses a single EPG solenoid; to check the solenoid used on the D7C, see publication TSI-270-600-07 (11/96).

### 2

Disconnect the connector to EPG control. Install breakout harness 9998534 to the EPG control connector only.

Ignition key must be in the OFF position.

Measuring points	Optimal value
1 / 4	23 Ω
1 / alternate ground	open circuit
4 / alternate ground	open circuit

## Check of Subsystem

*Exhaust pressure governor 1, EPG 1*

### 1

Ignition key must be in the ON position. Connect breakout box J-41132 in series between connector EB and the EECU. Connect jumper harness J-43233 in series between connector EA and the EECU.

**Note:** Test with "EPG On" can be performed only if the EECU has requested EPG 1 operation.

Measuring points	Optimal value
EB35 / EB9	B+ (EPG off)
EB35 / EB9	0 V (EPG on)

## MID 128 SID 1/2/3/4/5/6 Injector

### D12B and D12C

#### Error Code Information

Error code	Explanation
SID 1	Injector 1
SID 2	Injector 2
SID 3	Injector 3
SID 4	Injector 4
SID 5	Injector 5
SID 6	Injector 6

## Fault Codes

### FMI 2

Short circuit to battery voltage, injectors high side.

#### Conditions for fault code:

- Injector activated.
- Short circuit to battery voltage on pin EA12 or EA24 (each respective injector bank's high side).

#### Possible cause:

- Short circuit to battery voltage in the wiring to the injectors' high side.

#### Reaction from the EECU:

- Fault code is set.
- Yellow lamp is requested.
- The particular injector bank is switched off.

#### Noticeable external symptom:

- Yellow lamp lights up.
- Low power output.
- Uneven operation.
- Abnormal noise.
- 3 cylinder operation.

### FMI 3

Short circuit to battery voltage or short-circuited injector, injector low side.

#### Conditions for fault code:

- Injector activated.
- Short circuit to battery voltage on each respective injector's low side (EA11, EA22, EA23, EA34, EA35, EA36).

#### Possible cause:

- Short circuit between high and low side.
- Short circuit to battery voltage in the wiring to the injectors' low side.

#### Reaction from the EECU:

- Fault code is set.
- Yellow lamp is requested.
- The particular injector or the whole of the affected injector bank is switched off.

#### Noticeable external symptom:

- Yellow lamp lights up.
- Low power output.
- Uneven operation.
- Abnormal noise.
- 3 or 5 cylinder operation.



**FMI 4**

Short circuit to ground, injector low or high side.

*Conditions for fault code:*

- Injector activated.
- Short circuit to ground on each respective injector's low side (EA11, EA22, EA23, EA34, EA35, EA36) or high side (EA12, EA24).

*Possible cause:*

- Short circuit to ground in the wiring for each respective injector's low or high side.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- The particular injector bank is switched off.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Low power output.
- Uneven operation.
- Abnormal noise.
- 3 cylinder operation.

**FMI 5**

Open circuit in the injector circuit.

*Conditions for fault code:*

- Injector activated.
- Open circuit in the injector circuit.

*Possible cause:*

- Open circuit in the wiring on low or high side. If 3 fault codes have been set (a bank) the open circuit is on that bank's high side, if there is only one fault code the open circuit is on the particular injector's low side.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- One or three injectors are switched off.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Low power output.
- Uneven operation.
- Abnormal noise.

- 3 or 5 cylinder operation.

**FMI 7**

The mechanical system does not respond in the correct way

*Conditions for fault code:*

- Injector activated.
- Cylinder balancing data too high.

*Possible cause:*

- Fault in injector.
- Poor compression.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- The particular injector is switched off.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Low power output.
- Uneven operation.
- Abnormal noise.
- 5 cylinder operation.

**FMI 11**

Unidentifiable error.

*Conditions for fault code:*

- Injector activated.

*Possible cause:*

- Intermittent faults.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- The particular injector or the whole injector bank is switched off.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Low power output.
- Uneven operation.
- Abnormal noise.
- 3 or 5 cylinder operation.

## MID 128 SID 1/2/3/4/5/6 Injector, Check

*Special tools: J-43233, J-39200, J-41132*

### D12B and D12C

#### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

Note that small resistances are difficult to measure. Use the value instead as a standard value for the open circuit in the injector circuits.

### Measurement at the component's connector, to the EECU

1

**Note:** An incorrect value (below) can also cause the component to fail; therefore, it is important to check the component if any of the values are incorrect.

#### Wires

2

Connect breakout box J-41132 to the EA connector, wiring harness end only. **DO NOT connect 100pt to the EECU.**

J-39200  
J-41132

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
EA11 / EA12	1.7 $\Omega$
EA22 / EA12	1.7 $\Omega$
EA23 / EA12	1.7 $\Omega$
EA34 / EA24	1.7 $\Omega$
EA35 / EA24	1.7 $\Omega$
EA36 / EA24	1.7 $\Omega$
EA11 / alternate ground	open circuit
EA22 / alternate ground	open circuit
EA23 / alternate ground	open circuit
EA34 / alternate ground	open circuit
EA35 / alternate ground	open circuit
EA36 / alternate ground	open circuit

## Check of component

### *Injectors*

#### 1

Disconnect both the connections for each respective injector. J-39200

Measure the resistance with ohmmeter J-39200 on the injector.

Ignition key must be in the OFF position.

Measuring points	Optimal value
High side / low side	1.5 - 2.0 $\Omega$
High side / alternate ground	open circuit
Low side / alternate ground	open circuit

## MID 128 SID 17 Fuel Shutoff Valve

D7C only

### Fault Codes

#### FMI 3

Short circuit to battery voltage.

*Conditions for fault code:*

- Output activated.
- Short circuit to battery voltage on EB34.

*Possible cause:*

- Short circuit to battery voltage on wire between solenoid valve and EECU.
- Short circuit internally in the solenoid valve.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- Output is switched off.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Engine stops or does not start.
- No fuel reaches the nozzle.

#### FMI 4

Short circuit to ground.

*Conditions for fault code:*

- Output switched off.
- Short circuit to ground on EB34.

*Possible cause:*

- Short circuit to ground on wire between solenoid

valve and EECU.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The solenoid valve permanently activated.

#### FMI 5

Open circuit in the fuel shut-off circuit.

*Conditions for fault code:*

- Output switched off.
- Open circuit in the fuel shut-off circuit.

*Possible cause:*

- Open circuit between solenoid valve and EECU.
- Open circuit in supply wire to fuel shut-off valve.
- Open circuit in solenoid valve.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Engine stops or does not start.
- No fuel reaches the nozzle.

## MID 128 SID 17 Fuel Shutoff Valve, Check

*Special tools: J-43233, J-39200, J-41132, 9998534*

### D7C only

### Measurement at the component's connector, to the EECU

**1**

**Note:** An incorrect value (below) can also cause the component to fail; therefore, it is important to check the component if any of the values are incorrect.

**2**

Disconnect the connector to the fuel shut-off valve solenoid. Install breakout harness 9998534 to the wiring harness end only.

*"Ground wire"/Control wire:*

**3**

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
2 / alternate ground	190 k $\Omega$

*Supply wire:*

**4**

Measure the voltage with voltmeter J-39200.

Ignition key must be in the ON position.

Measuring points	Optimal value
1 / alternate ground	B+

## Check of component

*Fuel shut-off valve solenoid*

**1**

Disconnect the connector to the fuel shut-off valve solenoid. Install breakout harness 9998534 to the solenoid harness end only.

Ignition key must be in the OFF position.

Measuring points	Optimal value
1 / 2	10.7 $\Omega$
1 / alternate ground	open circuit
2 / alternate ground	open circuit

## Check of Subsystem

*Fuel shut-off*

**1**

Ignition key must be in the ON position. Connect breakout box J-41132 in series between connector EB and the EECU. Connect jumper harness J-43233 in series between connector EA and the EECU.

Measuring points	Optimal value
EB34 / EB9	0 V

## MID 128 SID 20 Timing Sleeve

### D7C only Fault Codes

#### FMI 2

Short circuit to battery voltage, timing sleeve, positive side.

*Conditions for fault code:*

- Short circuit to battery voltage on EA9 (EECU checks only when switching on the ignition).

*Possible cause:*

- Short circuit to battery voltage on positive side.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.

#### FMI 3

Short circuit to battery voltage, timing sleeve, ground side.

*Conditions for fault code:*

- Short circuit to battery voltage on EA21 (EECU checks only when switching on the ignition).

*Possible cause:*

- Short circuit between power and ground side.
- Short circuit to battery voltage on ground side.

*Reaction from the EECU:*

- Fault code is set.
- Red lamp is requested.
- The timing sleeve cannot be checked.
- Output for timing sleeve and rack drive are switched off.

*Noticeable external symptom:*

- Red lamp lights up.
- The engine stops or does not start.

#### FMI 4

Short circuit to ground, timing sleeve, ground side.

*Conditions for fault code:*

- Short circuit to ground on EA21.

*Possible cause:*

162

- Short circuit to ground, ground side.

*Reaction from the EECU:*

- Fault code is set.
- Red lamp is requested.
- Injection angle cannot be checked.
- Output for timing sleeve and rack drive are switched off.

*Noticeable external symptom:*

- Red lamp lights up.
- The engine stops or does not start.

#### FMI 5

Open circuit in the circuit to timing sleeve.

*Conditions for fault code:*

- Open circuit between the EECU and the injection pump.

*Possible cause:*

- Open circuit in the wires between the EECU and the injection pump.

*Reaction from the EECU:*

- Fault code is set.
- Red lamp is requested.
- Output for timing sleeve and rack drive are switched off.

*Noticeable external symptom:*

- Red lamp lights up.
- The engine stops or does not start.

**FMI 6**

Short circuit to ground, timing sleeve positive side.

*Conditions for fault code:*

- Short circuit to ground on EA9.

*Possible cause:*

- Short circuit to ground, positive side.

*Reaction from the EECU:*

- Fault code is set.
- Red lamp is requested.
- Output for timing sleeve and rack drive are switched off.

*Noticeable external symptom:*

- Red lamp lights up.
- The engine stops or does not start.

**FMI 7**

The mechanical system does not respond in the correct way

*Conditions for fault code:*

- Needle lift signal available.
- Incorrect timing sleeve.

*Possible cause:*

- Internal fault in the injection pump.
- Interference in needle lift signal.

*Reaction from the EECU:*

- Fault code is set.
- Red lamp is requested.
- Output for timing sleeve and rack drive are switched off.

*Noticeable external symptom:*

- Red lamp lights up.
- The engine stops or does not start.

**FMI 8**

Current too high to timing sleeve under long period of time.

*Conditions for fault code:*

- Current too high to timing sleeve.

*Possible cause:*

- Internal fault in the injection pump.
- Internal fault in the EECU.

*Reaction from the EECU:*

- Fault code is set.
- Red lamp is requested.
- Output for timing sleeve and rack drive are switched off.

*Noticeable external symptom:*

- Red lamp lights up.
- The engine stops or does not start.

**FMI 11**

Unidentifiable error.

*Conditions for fault code:*

- An unidentifiable error has been found.

*Reaction from the EECU:*

- Fault code is set.
- Red lamp is requested.
- Output for timing sleeve and rack drive are switched off.

*Noticeable external symptom:*

- Red lamp lights up.
- The engine stops or does not start.



## MID 128 SID 20 Timing Sleeve, Check

*Special tools: J-43233, J-39200, J-41132, J-38748*

### D7C only

#### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to:

**Service Manuals**      Function Group 37  
Electrical Schematics, VNL, VNM

**IMPACT**              Function Group 2841  
Information Type: Diagnostic "Fault Codes"

Note that small resistances are difficult to measure. Use the value instead as a standard value for an open in the timing sleeve circuit.

### Measurement at the component's connector, to the EECU

1

**Note:** An incorrect value (below) can also cause the component to fail; therefore, it is important to check the component if any of the values are incorrect.

2

Disconnect the connector to the timing sleeve (7-pin connector on the rear of the injection pump). Take measurements on the wiring harness connector only.

#### Ground wire:

3

Measure the resistance with ohmmeter J-39200.      J-39200

Ignition key must be in the OFF position.

Measuring points	Optimal value
4 / alternate ground	60 k $\Omega$

#### Supply wire:

4

Measure the resistance with ohmmeter J-39200.      J-39200

Ignition key must be in the OFF position.

Measuring points	Optimal value
3 / alternate ground	40 $\Omega$

### Check of component

#### Timing sleeve

1

Disconnect the connector to the timing sleeve (7-pin connector on the rear of the injection pump). Install breakout box J-38748 to the pump connector end only.      J-38748  
J-39200

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
3 / 4	1.3 $\Omega$
3 / alternate ground	open circuit
4 / alternate ground	open circuit

## MID 128 SID 21 Engine Position Timing Sensor

### D12B and D12C

The primary function of the engine position sensor (cam sensor) is to provide engine position information to the EECU. As a secondary function, it also provides engine timing (speed) information.

### Fault Codes

#### FMI 3

Short circuit to voltage or permanent loss of signal.

*Conditions for fault code:*

- Engine position signal is not available.

*Possible cause:*

- Short circuit to voltage, positive wire.
- Short circuit to voltage, negative wire.
- Short circuit to ground, positive wire.
- Open circuit in positive wire.
- Open circuit in negative wire.
- An incorrectly installed sensor (incorrect distance to cam sensor wheel).
- Reversed polarity on the sensor.
- Faulty sensor.
- Damaged cam sensor wheel.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- The EECU uses engine timing sensor signal instead; if this is also incorrect, the engine stops.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Difficult to start at the next start (no symptom if the fault code is set when the engine is running).

#### FMI 8

Abnormal frequency.

*Conditions for fault code:*

- The EECU detects extra pulses on the engine position signal.

*Possible cause:*

- Electrical interference in the engine position signal.
- Poor insulation or faulty wires.
- An incorrectly installed sensor (incorrect distance to

cam sensor wheel).

- Faulty sensor.
- Damaged cam sensor wheel.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- The EECU uses the engine timing sensor signal instead; if this is also incorrect, the engine stops.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Difficult to start at the next start (no symptom if the fault code is set when the engine is running).

## MID 128 SID 21 Engine Position Timing Sensor, Check

*Special tools: J-43233, J-39200, J-41132, 998534*

### D12B and D12C

#### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Measurement at the component's connector, to the EECU

1

**Note:** An incorrect value (below) can also cause the component to fail; therefore, it is important to check the component if any of the values are incorrect.

2

Disconnect the connector to the engine position sensor. Install breakout harness 9998534 to the wiring harness end only.

9998534

#### Ground wire:

3

Measure the resistance with ohmmeter J-39200.

J-39200

Ignition key must be in the OFF position.

Measuring points	Optimal value
2 / alternate ground	48 k $\Omega$

#### Supply wire:

4

Measure the voltage with voltmeter J-39200.

J-39200

Ignition key must be in the ON position.

Measuring points	Optimal value
1 / alternate ground	2 V

### Check of component

#### Engine position sensor

1

Disconnect the connector to the engine position sensor. Install breakout harness 9998534 to the sensor harness end only.

9998534  
J-39200

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
1 / 2	775 - 945 $\Omega$
1 / alternate ground	open circuit
2 / alternate ground	open circuit

## MID 128 SID 21 Needle Lift Sensor

D7C only

Needle lift sensor. The needle lift sensor is located on first the cylinder.

### Fault Codes

#### FMI 2

Intermittent loss of signal or incorrect signal.

*Conditions for fault code:*

- Engine speed greater than 450 rpm.
- Fuel injection is carried out.
- Missing signal.

*Possible cause:*

- Loose connection sensor.
- Open circuit in one of the wires.
- Short circuit to ground on any of the wires.
- Short circuit to battery voltage on any of the wires.
- Lack of fuel.
- Faulty sensor.
- No fuel injection in cylinder 1.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- Timing sleeve (injection angle) is controlled without feedback.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Higher fuel consumption than normal.

## MID 128 SID 21 Needle Lift Sensor, Check

*Special tools: J-43233, J-39200, J-41132, 9998534*

### D7C only

#### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Measurement at the component's connector, to the EECU

**1**  
**Note:** An incorrect value (below) can also cause the component to fail; therefore, it is important to check the component if any of the values are incorrect.

**2**  
Disconnect the connector to the needle lift sensor. Install breakout harness 9998534 to the wiring harness end only.

#### Ground wire:

**3**  
Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
2 / alternate ground	0.5 $\Omega$

#### Supply wire:

**4**  
Measure the voltage with voltmeter J-39200.

Ignition key must be in the ON position.

Measuring points	Optimal value
1 / alternate ground	B+

### Check of component

#### Needle lift sensor

**1**  
Disconnect the connector to the needle lift sensor. Install breakout harness 9998534 to the sensor harness end only.

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
1 / 2	65 - 165 $\Omega$
1 / alternate ground	open circuit
2 / alternate ground	open circuit

## MID 128 SID 22 Engine Speed Sensor

The primary function of the engine timing sensor (crank sensor) is to provide engine timing (speed) information to the EECU. As a secondary function, it also provides limited engine position information.

### Fault Codes

#### FMI 2

Intermittent loss of signal or incorrect signal.

*Conditions for fault code:*

- Incorrect engine timing signal.

*Possible cause:*

- Electrical interference in the engine timing signal.
- Loose connection.
- Poor insulation or faulty wire.
- An incorrectly installed sensor (incorrect distance to the flywheel).
- Faulty sensor.
- Damaged teeth on flywheel.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- The EECU uses the engine position signal instead. If this is also incorrect, the engine stops.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The engine stops if the engine position signal also disappears.

#### FMI 3

Short circuit to voltage or permanent loss of signal.

*Conditions for fault code:*

- Signal is not available.

*Possible cause:*

- Short circuit to voltage, positive wire.
- Short circuit to voltage, negative wire.
- Short circuit to ground, positive wire.
- Open circuit in positive wire.
- Open circuit in negative wire.
- An incorrectly installed sensor.
- Faulty sensor.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- The EECU uses the engine position signal instead. If this is also incorrect, the engine stops.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The engine stops if the engine position signal also disappears.

#### FMI 8

Abnormal frequency.

*Conditions for fault code:*

- The EECU detects extra pulses on the engine timing signal.

*Possible cause:*

- Electrical interference.
- An incorrectly installed sensor.
- Faulty sensor.
- Damaged teeth on flywheel.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- The EECU uses the engine position signal instead. If this is also incorrect, the engine stops.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The engine stops if the engine position signal also disappears.

## MID 128 SID 22 Engine Speed Sensor, Check

*Special tools:* J-43233, J-39200, J-41132, 9998534

### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Measurement at the component's connector, to the EECU

1

**Note:** An incorrect value (below) can also cause the component to fail; therefore, it is important to check the component if any of the values are incorrect.

2

Disconnect the connector to the engine timing sensor. Install breakout harness 9998534 to the wiring harness end only.

*Ground wire:*

3

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
2 / alternate ground	48 k $\Omega$

*Supply wire:*

4

Measure the voltage with voltmeter J-39200.

Ignition key must be in the ON position.

Measuring points	Optimal value
1 / alternate ground	2 V

### Check of component

*Engine timing sensor*

1

Disconnect the connector to the engine timing sensor. Install breakout harness 9998534 to the sensor harness end only.

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
1 / 2	775 - 945 $\Omega$
1 / alternate ground	open circuit
2 / alternate ground	open circuit



## MID 128 SID 23 Rack Actuator

### D7C only Fault Codes

#### FMI 2

Short circuit to battery voltage, rack drive positive side.

*Conditions for fault code:*

- Short circuit to battery voltage on EA8 (EECU checks only when switching on the ignition).

*Possible cause:*

- Short circuit to battery voltage, positive side.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.

#### FMI 3

Short circuit to battery voltage, rack drive ground side.

*Conditions for fault code:*

- Fuel injection is requested.
- Short circuit to battery voltage on EA10.

*Possible cause:*

- Short circuit between power and ground side.
- Short circuit to battery voltage, ground side.

*Reaction from the EECU:*

- Fault code is set.
- Red lamp is requested.
- EECU connection for power and ground sides is switched off.

*Noticeable external symptom:*

- Red lamp lights up.
- The engine stops or does not start.

#### FMI 4

Short circuit to ground, rack drive ground side.

*Conditions for fault code:*

- Short circuit to ground on EA10.

*Possible cause:*

- Short circuit to ground, ground side.

*Reaction from the EECU:*

- Fault code is set.
- Red lamp is requested.
- EECU connection for power and ground sides is switched off.

*Noticeable external symptom:*

- Red lamp lights up.
- The engine stops or does not start.

#### FMI 5

Open circuit in the circuit for rack drive.

*Conditions for fault code:*

- Open circuit in the circuit for rack drive.

*Possible cause:*

- Open circuit in wires between EECU and rack drive.
- Open circuit in rack drive.

*Reaction from the EECU:*

- Fault code is set.
- Red lamp is requested.
- EECU connection for power and ground sides is switched off.

*Noticeable external symptom:*

- Red lamp lights up.
- The engine stops or does not start.

**FMI 6**

Short circuit to ground, rack drive positive side.

*Conditions for fault code:*

- Short circuit to ground on EA8.

*Possible cause:*

- Short circuit to ground, positive side.

*Reaction from the EECU:*

- Fault code is set.
- Red lamp is requested.
- EECU connection for power and ground sides is switched off.

*Noticeable external symptom:*

- Red lamp lights up.
- The engine stops or does not start.

**FMI 7**

The mechanical system does not respond in the correct way

*Conditions for fault code:*

- The rack drive does not move as expected.

*Possible cause:*

- Rack drive stuck.
- Mechanical fault in the pump.
- Fault in rack drive position sensor.

*Reaction from the EECU:*

- Fault code is set.
- Red lamp is requested.
- EECU connection for power and ground sides is switched off.

*Noticeable external symptom:*

- Red lamp lights up.

- The engine stops or does not start.

**FMI 8**

Current too high to rack drive under long period of time.

*Conditions for fault code:*

- The current to rack drive is too high for a long period.

*Possible cause:*

- Internal fault in the pump.
- Internal fault in the EECU.

*Reaction from the EECU:*

- Fault code is set.
- Red lamp is requested.
- EECU connection for power and ground sides is switched off.

*Noticeable external symptom:*

- Red lamp lights up.
- The engine stops or does not start.

**FMI 11**

Unidentifiable error.

*Conditions for fault code:*

- An unidentifiable error has been found.

*Reaction from the EECU:*

- Fault code is set.
- Red lamp is requested.
- EECU connection for power and ground sides is switched off.

*Noticeable external symptom:*

- Red lamp lights up.
- The engine stops or does not start.

## MID 128 SID 23 Rack Actuator, Check

*Special tools: J-43233, J-39200, J-41132, J-38748*

### D7C only

#### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

Note that small resistances are difficult to measure. Use the value instead as a standard value for an open in the rack drive.

### Measurement at the component's connector, to the EECU

1

**Note:** An incorrect value (below) can also cause the component to fail; therefore, it is important to check the component if any of the values are incorrect.

2

Disconnect the connector to the rack drive (7-pin connector on the rear of the injection pump). Take measurements on the wiring harness connector only.

#### Ground wire:

3

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
2 / alternate ground	60 kΩ

#### Supply wire:

4

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
7 / alternate ground	40 kΩ

### Check of component

#### Rack drive

1

Disconnect the connector to the rack drive (7-pin connector on the rear of the injection pump). Install breakout box J-38748 to the pump connector end only.

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
2 / 7	0.7 Ω
1 / alternate ground	open circuit
2 / alternate ground	open circuit

## MID 128 SID 24 Rack Position Sensor

D7C only

### Fault Codes

#### FMI 2

Incorrect data.

*Conditions for fault code:*

- Unreasonable measurement value from rack position sensor.

*Possible cause:*

- Sensor value outside measurement range.
- Open circuit or short circuit in wires.
- Internal fault in the pump.
- Faulty sensor.

*Reaction from the EECU:*

- Fault code is set.
- Red lamp is requested.
- Output for rack drive is switched off.

*Noticeable external symptom:*

- Red lamp lights up.
- The engine stops or does not start.

#### FMI 13

Sensor values outside calibration values.

*Conditions for fault code:*

- Unreasonable measurement value at start-up.

*Possible cause:*

- Uncalibrated sensor.
- Faulty sensor.

*Reaction from the EECU:*

- Fault code is set.
- Red lamp is requested.
- Output for rack drive actuator is switched off.

*Noticeable external symptom:*

- Red lamp lights up.
- The engine does not start.

## MID 128 SID 24 Rack Position Sensor, Check

*Special tools: J-43233, J-39200, J-41132, J-38748*

### D7C only

#### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

Note that small resistances are difficult to measure. Use the value instead as a standard value for an open in the rack position sensor.

### Measurement at the component's connector, to the EECU

1

**Note:** An incorrect value (below) can also cause the component to fail; therefore, it is important to check the component if any of the values are incorrect.

2

Disconnect the connector to the rack drive (7-pin connector on the rear of the injection pump). Take measurements on the wiring harness connector only.

#### Reference wire:

3

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
1 / alternate ground	5.5 kΩ

#### Search wire:

4

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
5 / alternate ground	5.5 kΩ

### Check of component

#### Rack position sensor

1

Disconnect the connector to the rack drive (7-pin connector on the rear of the injection pump). Install breakout box J-38748 to the pump connector end only.

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
5 / 6	20 Ω (search coil)
1 / 6	20 Ω (reference coil)
1, 5, 6 / alternate ground	open circuit

## MID 128 SID 33 Fan Control

### Fault Codes

#### FMI 3

Short circuit to voltage.

*Conditions for fault code:*

- Output activated.
- Short circuit to voltage on EB21.

*Possible cause:*

- Short circuit to battery voltage between solenoid valve and EECU.
- Short circuit in solenoid valve for fan control.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- Output is switched off.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The fan is in constant operation.
- Increased fuel consumption.

#### FMI 4

Short circuit to ground.

*Conditions for fault code:*

- Output switched off.
- Short circuit to ground on EB21.

*Possible cause:*

- Short circuit to ground between solenoid valve and EECU.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- Output is switched off.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The fan does not come on.
- Increased coolant temperature.

#### FMI 5

Break.

*Conditions for fault code:*

- Output switched off.
- Open circuit in the circuit for fan control.

*Possible cause:*

- Open circuit in the wiring between solenoid valve and EECU.
- Open circuit in solenoid valve for fan control.
- Open circuit in supply wire to solenoid valve for fan control.
- Blown fuse to supply for the fan control's solenoid valve.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- Output is switched off.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The fan is in constant operation.
- Increased fuel consumption.

## MID 128 SID 33 Fan Control, Check

*Special tools: J-43233, J-39200, J-41132, J-43147*

### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Measurement at the component's connector, to the EECU

1

**Note:** An incorrect value (below) can also cause the component to fail; therefore, it is important to check the component if any of the values are incorrect.

2

Disconnect the connector to the fan control solenoid valve. Install breakout harness J-43147 to the wiring harness end only. J-43147

*"Ground wire"/Control wire:*

3

Measure the resistance with ohmmeter J-39200. J-39200

Ignition key must be in the OFF position.

Measuring points	Optimal value
B / alternate ground	200 kΩ

*Supply wire:*

4

Measure the voltage with voltmeter J-39200. J-39200

Ignition key must be in the ON position.

Measuring points	Optimal value
A / alternate ground	B+

## Check of component

*Fan control solenoid valve*

1

Disconnect the connector to the fan control solenoid valve. Install breakout harness J-43147 to the solenoid valve harness end only. J-43147  
J-39200

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
A / B	20 Ω

## Check of Subsystem

*Fan control*

1

Ignition key must be in the ON position. J-41132  
J-43233  
J-39200  
Connect breakout box J-41132 in series between connector EB and the EECU. Connect jumper harness J-43233 in series between connector EA and the EECU.

Measuring points	Optimal value
EB21 / EB9	B+ (fan on)
EB21 / EB9	0 V (fan off)
ground terminal EB21 with a jumper wire	fan control solenoid valve releases fan



## MID 128 SID 64 Redundant Engine Speed Sensor

### D7C only

The redundant engine speed sensor is used as a secondary engine timing (speed) and secondary engine position sensor. Primary engine timing (speed) information is provided by the engine timing (crank) sensor. Primary engine position information is provided by the needle lift sensor.

### Fault Codes

#### FMI 3

Short circuit to voltage or permanent loss of signal.

*Conditions for fault code:*

- Engine position signal is not available.

*Possible cause:*

- Short circuit to battery voltage, positive wire.
- Short circuit to voltage, negative wire.
- Short circuit to ground, positive wire.
- Open circuit in positive wire.
- Open circuit in negative wire.
- An incorrectly installed sensor (incorrect distance to pump speed sensor wheel).
- Reversed polarity on the sensor.
- Faulty sensor.
- Damaged pump speed sensor wheel.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.

#### FMI 8

Abnormal frequency.

*Conditions for fault code:*

- The EECU detects extra pulses on the engine position signal.

*Possible cause:*

- Electrical interference in the engine position signal.
- Poor insulation or faulty wires.
- An incorrectly installed sensor (incorrect distance to pump speed sensor wheel).
- Faulty sensor.
- Damaged pump speed sensor wheel.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.

## MID 128 SID 64 Redundant Engine Speed Sensor, Check

Special tools: J-43233, J-39200, J-41132

### D7C only

#### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Measurement at the component's connector, to the EECU

1

**Note:** An incorrect value (below) can also cause the component to fail; therefore, it is important to check the component if any of the values are incorrect.

2

Disconnect the connector to the engine position sensor. Install breakout harness 9998534 to the wiring harness end only.

#### Ground wire:

3

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
2 / alternate ground	48 kΩ

#### Supply wire:

4

Measure the voltage with voltmeter J-39200.

Ignition key must be in the ON position.

Measuring points	Optimal value
1 / alternate ground	2 V

### Check of component

#### Redundant engine speed sensor

1

Disconnect the connector to the redundant engine speed sensor. Install breakout harness J-43233 to the sensor harness end only.

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
1 / 2	775 - 945 Ω
1 / alternate ground	open circuit
2 / alternate ground	open circuit

## MID 128 SID 70 Preheater Element 1

Each preheater is equipped with a fuse between the preheating relay and element. The fuse and element are monitored by a sense wire that determines if the circuit is intact.

### Fault Codes

#### FMI 3

Short circuit to battery voltage.

*Conditions for fault code:*

- Preheating relay not activated.
- The voltage on EB5 is greater than 65% B+.

*Possible cause:*

- Short circuit to battery voltage on EB5.
- Preheating relay constantly on.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- Preheating relay is switched off.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Preheating relay may be constantly activated.
- High inlet temperature.
- High current consumption.
- Discharged battery.

#### FMI 4

Short circuit to ground.

*Conditions for fault code:*

- Preheating requested.
- Short circuit to ground on EB5.

*Possible cause:*

- Short circuit to ground on EB5.
- Preheating relay damaged.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- Output to pre-heating relay is switched off.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Preheating does not function.
- White smoke for cold start.
- Difficult to start in extreme cold.

#### FMI 5

Break.

*Conditions for fault code:*

- The voltage on EB5 is greater than 5% B+ and less than 65% B+.

*Possible cause:*

- Open circuit in element or wires.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- Output for the pre-heating relay is switched off.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Preheating does not function.
- Difficult to start in extreme cold.

## MID 128 SID 70 Preheater Element 1, Check

Special tools: J-43233, J-39200, J-41132

### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Measurement at the component's connector, to the EECU

1

**Note:** An incorrect value (below) can also cause the component to fail; therefore, it is important to check the component if any of the values are incorrect.

2

Disconnect sense wire (small solid red wire) at pre-heat relay #1.

#### Signal wire:

3

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
Sense wire / alternate ground	1.4 k $\Omega$

### Check of component

#### Preheating 1, element

1

Remove the fuse and support (red plastic part) between the pre-heat relay and the pre-heat element terminal.

Ignition key must be in the OFF position.

Measure the resistance with ohmmeter J-39200.

Measuring points	Optimal value
Preheat element terminal / alternate ground	<1 $\Omega$

### Check of Subsystem

#### Preheating 1, element diagnostics

1

Ignition key must be in the ON position. J-41132 J-43233

Connect breakout box J-41132 in series between connector EB and the EECU. Connect jumper harness J-43233 in series between connector EA and the EECU. J-39200

**Note:** Test with "Preheat On" can be performed only if the EECU has requested pre-heat.

Measuring points	Optimal value
EB5 / EB9	B+ (Preheating on)
EB5 / EB9	0 V (Preheating off)

## MID 128 SID 71 Preheater Element 2

### D12B only

Each preheater is equipped with a fuse between the preheating relay and element. The fuse and element are monitored by a sense wire that determines if the circuit is intact.

### Fault Codes

#### FMI 3

Short circuit to battery voltage.

*Conditions for fault code:*

- Preheating relay not activated.
- The voltage on EB16 is greater than 65% B+.

*Possible cause:*

- Short circuit to battery voltage on EB16.
- Preheating relay constantly on.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- The preheating relay is switched off.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Preheating relay may be constantly on.
- High inlet temperature.
- High current consumption.
- Discharged battery.

#### FMI 4

Short circuit to ground.

*Conditions for fault code:*

- Preheating requested.
- Short circuit to ground on EB16.

*Possible cause:*

- Short circuit to ground on EB16.
- Preheating relay damaged.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- Output to preheating relay is switched off.

*Noticeable external symptom:*

- Yellow lamp lights up.

- Preheating does not function.
- White smoke for cold start.
- Difficult to start in extreme cold.

#### FMI 5

Break.

*Conditions for fault code:*

- The voltage on EB16 is greater than 5% B+ and less than 65% B+.

*Possible cause:*

- Open circuit in element or wires.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- Output for preheating relay is switched off.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Preheating does not function.
- Difficult to start in extreme cold.

## MID 128 SID 71 Preheater Element 2, Check

*Special tools: J-43233, J-39200, J-41132*

### D12B

#### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Measurement at the component's connector, to the EECU

1

**Note:** An incorrect value (below) can also cause the component to fail; therefore, it is important to check the component if any of the values are incorrect.

2

Disconnect the sense wire (small red/white wire) at pre-heat relay #2.

#### *Signal wire:*

3

Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
Sense wire / alternate ground	1.4 k $\Omega$

### Check of component

#### *Preheating 2, element*

1

Remove the fuse and support (red plastic part) between pre-heat relay #2 and pre-heat element #2 terminal. J-39200

Ignition key must be in the OFF position.

Measure the resistance with ohmmeter J-39200.

Measuring points	Optimal value
Preheat element terminal / alternate ground	<1 $\Omega$

### Check of Subsystem

#### *Preheating 2, element diagnostics*

1

Ignition key must be in the ON position. J-41132 J-43233

Connect breakout box J-41132 in series between connector EB and the EECU. Connect jumper harness J-43233 in series between connector EA and the EECU. J-39200

**Note:** Test with "Preheat On" can be performed only if the EECU has requested pre-heat.

Measuring points	Optimal value
EB16 / EB9	B+ (Preheating on)
EB16 / EB9	0 V (Preheating off)

## MID 128 SID 230 Idle Validation Switch 1

### Fault Codes

#### FMI 3

Short circuit to battery voltage.

*Conditions for fault code:*

- Accelerator pedal released.
- The voltage on EB4 exceeds 75% of B+.

*Possible cause:*

- Short circuit to battery voltage on wire between EECU and VECU.
- Error in accelerator pedal.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The "limp home" function does not function.

#### FMI 4

Short circuit to ground or open circuit.

*Conditions for fault code:*

- Accelerator pedal pressed down > 50 %.
- The voltage on EB4 is below 25% of B+.

*Possible cause:*

- Short circuit to ground on wire between EECU and VECU.
- Open circuit in wire between EECU and VECU.
- Error in accelerator pedal.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The "limp home" function does not function.



## MID 128 SID 230 Idle Validation Switch 1, Check

*Special tools: J-43233, J-39200, J-41132*

### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Check of Subsystem

#### *Buffered idle validation switch*

#### 1

Ignition key must be in the ON position. J-41132  
J-43233

Connect breakout box J-41132 in series between connector EB and the EECU. Connect jumper harness J-43233 in series between connector EA and the EECU. J-39200

Measuring points	Optimal value
EB4 / EB9	< 4 V (accelerator pedal at idle)
EB4 / EB9	> 8 V (accelerator pedal off idle)

## MID 128 SID 231 SAE J1939 Control Link

### Fault Codes

#### FMI 2

Communications link (SAE J1939) does not function.

*Conditions for fault code:*

- No messages are received from the communications link (SAE J1939).

*Possible cause:*

- Open circuit in communications link (SAE J1939).
- Short circuit to voltage on communications link (SAE J1939).
- Short circuit to ground on communications link (SAE J1939).
- wires in communications link (SAE J1939) short-circuited to each other.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- Information is read/sent instead on the information link (SAE J1587).

*Noticeable external symptom:*

- Yellow lamp lights up.
- Cruise Control does not function.
- PTO does not function.
- Preheating relay does not function.
- Engine brake does not function.
- Driver position no. 2 does not function.

#### FMI 9

Communications link (SAE J1939) does not function.

*Conditions for fault code:*

- Communications link (SAE J1939) does not function.

*Possible cause:*

- Wires in communications link (SAE J1939) short-circuited to each other.
- Temporary malfunction in hardware.
- Loose connection.
- Intermittent fault in the wiring.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

- Information is read/sent instead on the information link (SAE J1587).

*Noticeable external symptom:*

- Yellow lamp lights up.
- Temporary loss of function on:- Cruise Control- PTO.- Pre-heating- Engine brake- Driver position no. 2

#### FMI 11

Unidentifiable error.

*Conditions for fault code:*

- Communications link (SAE J1939) does not function internally in EECU at start-up.

*Possible cause:*

- Internal fault in EECU.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- Information is read/sent instead on the information link (SAE J1587).

*Noticeable external symptom:*

- Yellow lamp lights up.
- Cruise Control does not function.
- PTO does not function.
- Preheating does not function.
- Engine brake does not function.
- Driver position no. 2 does not function.

## FMI 12

Loss of message from the VECU.

*Conditions for fault code:*

- The communication between EECU and VECU does not function.

*Possible cause:*

- No contact with VECU.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.
- Information is read/sent instead on the information link (SAE J1587).

*Noticeable external symptom:*

- Yellow lamp lights up.
- Cruise Control does not function.
- PTO does not function.
- Preheating does not function.
- Engine brake does not function.
- Driver position no. 2 does not function.

## MID 128 SID 232 5 Volt DC Supply

### Fault Codes

#### FMI 3

Short circuit to voltage.

*Conditions for fault code:*

- The voltage on EA4 exceeds 5.5 V.

*Possible cause:*

- Short circuit to battery voltage on the output.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Incorrect values on oil pressure sensor and boost pressure sensor.
- fault code on oil pressure sensor and boost pressure sensor.
- Low power output.
- Oil pressure gauge and boost pressure gauge show 0 in the instrument.

#### FMI 4

Short circuit to ground.

*Conditions for fault code:*

- The voltage on EA4 is under 4.5 V.

*Possible cause:*

- Short circuit to ground.
- Short circuit in sensor.
- Faulty sensor.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- fault code on oil pressure sensor and boost pressure sensor.
- Oil pressure gauge and boost pressure gauge show 0 in the instrument.
- Low power output.

## MID 128 SID 232 5 Volt DC Supply, Check

*Special tools: J-43233, J-39200, J-41132, 9998534*

### NOTE!

Check all the particular connectors for loose connections as well as for switch resistance and oxidation.

For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Measurement at the component's connector, to the EECU

**1**  
**Note:** An incorrect value (below) can also cause the component to fail; therefore, it is important to check the component if any of the values are incorrect.

**2**  
Disconnect the individual connectors to the fuel temperature sensor (D7C only), boost air temperature/pressure sensor, coolant temperature sensor, and oil temperature/pressure sensor. Install breakout harness 9998534 to the wiring harness end only.

#### Ground wire:

**3**  
Measure the resistance with ohmmeter J-39200.

Ignition key must be in the OFF position.

Measuring points	Optimal value
2 / alternate ground	<1 Ω (coolant temperature)
4 / alternate ground	<1 Ω (oil pressure/temperature, boost air pressure/temperature, fuel temperature)

#### Supply wire:

**4**  
Measure the voltage with voltmeter J-39200.

Ignition key must be in the ON position.

Measuring points	Optimal value
1 / alternate ground	5 V (oil pressure/temperature, boost air pressure/temperature, fuel temperature)

### Check of sub-system

#### 5 V supply to sensors

**1**  
Ignition key must be in the ON position. Connect breakout box J-41132 in series between connector EA and the EECU. Connect jumper harness J-43233 in series between connector EB and the EECU.

Measuring points	Optimal value
EA4 / EA5	4.8 - 5.15 V

## MID 128 SID 240 Program Memory

### Fault Codes

#### FMI 2

Incorrect checksum in program memory.

*Conditions for fault code:*

- Incorrect checksum (EECU calculates only at start-up).

*Possible cause:*

- Error when programming.
- Internal fault in the EECU.

*Reaction from the EECU:*

- Fault code is set.
- Red lamp is requested.

*Noticeable external symptom:*

- Red lamp lights up.
- The engine does not start.

#### FMI 12

Incorrect checksum in program memory.

*Conditions for fault code:*

- Incorrect checksum.

*Possible cause:*

- Internal fault in the EECU.

*Reaction from the EECU:*

- Fault code is set.

*Noticeable external symptom:*

- None.

## MID 128 SID 250 SAE J1587/1708 Information Link

### Fault Codes

#### **FMI 12**

Internal fault in the EECU.

*Conditions for fault code:*

- The information link (SAE J1587) does not function internally in the EECU.

*Possible cause:*

- Internal fault in the EECU.

*Reaction from the EECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Information from the EECU is not available on the information link (SAE J1587).
- The boost pressure gauge shows 0.
- The oil pressure gauge shows 0.
- The oil temperature gauge shows 0.
- The coolant temperature gauge shows 0.
- The tachometer shows 0.



## MID 128 SID 253 Data Set Memory EEPROM

### Fault Codes

#### **FMI 2**

Incorrect checksum in data set memory.

*Conditions for fault code:*

- Checksum error.

*Possible cause:*

- Internal fault in the EECU.
- Error when programming.

*Reaction from the EECU:*

- Fault code is set.
- Red lamp is requested.

*Noticeable external symptom:*

- Red lamp lights up.
- The engine does not start.

#### **FMI 12**

Incorrect checksum in data set memory.

*Conditions for fault code:*

- Checksum error.

*Possible cause:*

- Internal fault in the EECU.

*Reaction from the EECU:*

- Fault code is set.
- Red lamp is requested.

*Noticeable external symptom:*

- Red lamp lights up.
- The engine does not start.

## MID 128 SID 254 Engine Electronic Control Unit (EECU)

### Fault Codes

#### FMI 2

Internal fault in the EECU.

*Conditions for fault code:*

- Incorrect self test in the EECU.

*Possible cause:*

- Internal fault in the EECU.

*Reaction from the EECU:*

- Fault code is set.
- Red lamp is requested.

*Noticeable external symptom:*

- Red lamp lights up.
- The engine does not start.

#### FMI 8

Internal fault in the EECU.

*Conditions for fault code:*

- Incorrect self test in the EECU.

*Possible cause:*

- Internal fault in the EECU.

*Reaction from the EECU:*

- Fault code is set.
- Red lamp is requested.

*Noticeable external symptom:*

- Red lamp lights up.
- The engine does not start.

#### FMI 9

Internal fault in the EECU.

*Conditions for fault code:*

- Incorrect self test in the EECU.

*Possible cause:*

- Internal fault in the EECU.

*Reaction from the EECU:*

- Fault code is set.
- Red lamp is requested.

*Noticeable external symptom:*

- Red lamp lights up.
- The engine does not start.

#### FMI 11

Internal fault in the EECU.

*Conditions for fault code:*

- Incorrect self test in the EECU.

*Possible cause:*

- Internal fault in the EECU.

*Reaction from the EECU:*

- Fault code is set.
- Red lamp is requested.

*Noticeable external symptom:*

- Red lamp lights up.
- The engine does not start.

## FMI 12

Internal fault in the EECU.

*Conditions for fault code:*

- Incorrect self test in the EECU.

*Possible cause:*

- Internal fault in the EECU.

*Reaction from the EECU:*

- Fault code is set.
- Red lamp is requested.

*Noticeable external symptom:*

- Red lamp lights up.
- The engine does not start.

## FMI 13

Internal fault in the EECU.

*Conditions for fault code:*

- Incorrect self test in the EECU.

*Possible cause:*

- Internal fault in the EECU.

*Reaction from the EECU:*

- The EECU restarts.
- fault code can be requested, will not automatically be shown.

*Noticeable external symptom:*

- The engine falters.

# MID 144 VECU

## MID 144 Fault Code Table

**MID:**Message Identification Description.

**SID:**Subsystem Identification Description.

**PID:**Parameter Identification Description.

**FMI:**Failure Mode Identifier.

Error code	Component/Function	FMI	Section
MID 144-PID 29	SecondAccelerator Pedal Position	3, 4, 5	"MID 144 PID 29 Second Accelerator Pedal Position Sensor" page 198
MID 144-PID 84	Road Speed	9	"MID 144 PID 84 Road Speed" page 201
MID 144-PID 91	Accelerator Pedal Position	9, 11	"MID 144 PID 91 Accelerator Pedal Position" page 204
MID 144-PID 152	VECU, Number of Resets	9	"MID 144 PID 152 VECU, Number of Resets" page 207
MID 144-PPID 69	Idle Validation Switch	9, 11	"MID 144 PPID 69 Idle Validation Switch" page 208
MID 144-PPID 70	Pedal Switches, Supply	1, 3, 4	"MID 144 PPID 70 Pedal Switches, Supply" page 211
MID 144-PPID 71	Cruise Control and Engine Brake, Supply Switch	1, 3, 4	"MID 144 PPID 71 Cruise Control and Engine Brake, Supply Switch" page 215
MID 144-PPID 72	Accelerator Pedal, Supply Sensors	3, 4	"MID 144 PPID 72 Accelerator Pedal, Supply Sensors" page 220
MID 144-PPID 73	Second Accelerator Pedal, Supply Sensors	3, 4	"MID 144 PPID 73 Second Accelerator Pedal, Supply Sensors" page 223
MID 144-PPID 75	Range Inhibitor, Solenoid Valve Status	0, 3, 4, 5	"MID 144 PPID 75 Range Inhibitor, Solenoid Valve Status" page 226
MID 144-SID 230	Idle Validation Switch 1	3, 4	"MID 144 SID 230 Idle Validation Switch 1" page 229
MID 144-SID 231	SAE J1939 Control Link	0, 3, 4	"MID 144 SID 231 SAE J1939 Control Link" page 232
MID 144-SID 240	Program Memory	1	"MID 144 SID 240 Program Memory" page 234
MID 144-SID 243	Crusie Control Set Switch	3	"MID 144 SID 243 Cruise Control Set Switch" page 235

<b>Error code</b>	<b>Component/Function</b>	<b>FMI</b>	<b>Section</b>
MID 144–SID 250	SAE J1587/1708 Information Link	3, 4	“MID 144 SID 250 SAE J1587/1708 Information Link” page 238
MID 144–SID 253	Data Set Memory EEPROM	3, 4	“MID 144 SID 253 Data Set Memory EEPROM” page 240
MID144-PSID 3	Idle Validation Switch 3	7	“MID 144 PSID 3 Idle Validation Switch 3” page 241

## MID 144 PID 29 Second Accelerator Pedal Position Sensor

Applies only to vehicles with a second accelerator pedal assembly (such as the WX).

- **Text Messages**  
In vehicles equipped with diagnostic display, the following message(s) will appear:
- **Instrument Cluster Graphics Display (VN):**  
Second throttle.
- **Data Link Instrument Cluster (WG, AC, WX):**  
The Data Link instrument cluster graphics display used on WG-, AC-, and WX-series vehicles can display a limited number of text messages. For information, see "Data Link Instrumentation," Volvo Service Publication PV776-381-620SM.
- **VCADS Pro Display:**  
Second throttle position, %

## Fault Codes

### FMI 3

Abnormally high voltage.

*Conditions for fault code:*

- If the VECU receives a signal from the sensor that is higher than 4.3 V, the VECU interprets this as a fault and a fault code is set.

*Possible cause:*

- Open circuit in ground wire.
- Signal wire short circuited to higher voltage.
- Faulty second accelerator position sensor.
- Faulty idle validation switch 3.

*Reaction from the VECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The engine does not respond when the second accelerator pedal is depressed.

### FMI 4

Abnormally low voltage.

*Conditions for fault code:*

- If the VECU receives a signal from the sensor that is lower than 0.4 V, the VECU interprets this as a fault and a fault code is set.

*Possible cause:*

- Open circuit in supply wire.
- Open circuit in signal wire.
- Signal wire short-circuited to ground.
- Faulty second accelerator position sensor.
- Switch resistance and oxidation.

*Reaction from the VECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The engine does not respond when the second accelerator pedal is depressed.

## MID 144 PID 29 Second Accelerator Pedal Position Sensor, Check

Other special equipment: J-39200, J-41133, 9998551, J-43340, J-43234

### NOTE!

- Read off the other fault codes for the VECU.
- Check the particular connectors during the fault tracing for oxidation and switch resistance. For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Appropriate Tests in the VCADS Pro Tool

The following test(s) are useful for closely examining the component's function:

**27104-8** Extra accelerator control, switches and sensor, test

### Measurement at the Component's Connector, to the VECU

**Note:** Faults in the wiring harness to the VECU can damage the component. Therefore, a check of the component should also be made if any of the measurement values deviate from the expected value.

**1** Disconnect the connector at the second accelerator pedal. Install 5-pin breakout harness J-41133 to the wiring harness end only.

#### Ground wire:

**2** Turn the ignition key to the OFF position.

**3** Connect an ohmmeter to the breakout harness pins and measure the resistance.

Measuring points	Expected value
Pin E / alternate ground	<1 $\Omega$

#### Supply wire:

**4** Turn the ignition key to the ON position.

**5** Connect a voltmeter to the breakout harness pins and measure the voltage. J-39200

Measuring points	Expected value
Pin A / Pin E	5.4 $\pm$ 20% V

#### Signal wire:

**6** Turn the ignition key to the OFF position.

**7** Connect an ohmmeter to the breakout harness pins and measure the resistance. J-39200

Measuring points	Expected value
Pin B / Pin E	100 $\pm$ 20% k $\Omega$

#### Wiring harness

**8** To check the wiring harness, see "VNL, VNM Electrical Schematics," Group 37.

### Check of component

#### Second accelerator position sensor

**Note:** Faults in the component can be caused by faults in the wiring harness of the VECU. A check of the wiring harness should also therefore be made before connecting a new component.

**1** Disconnect the connector at the second accelerator pedal. Install 5-pin breakout harness J-41133 to the second accelerator pedal harness end only. J-41133

**2** Turn the ignition key to the OFF position.

**3** Connect an ohmmeter to the breakout harness pins and measure the resistance. J-39200

Measuring points	Expected value
Pin A / Pin E	4 $\pm$ 20% k $\Omega$
Pin A / Pin B	4.5 $\pm$ 20% k $\Omega$ (accelerator pedal at idle)



## Check of Subsystem

**1**  
Disconnect the VECU and install adapter J-43234 between the VECU and wiring harness connectors PB/PA.

**2**  
Connect the 60-pin breakout box 9998551 (with overlay J-43340) to the adapter.

### Ground wire:

**3**  
Turn the ignition key to the OFF position.

**4**  
Connect an ohmmeter to the 60-pin breakout box and measure the resistance.

Measuring points	Optimal value
PB23 / Alternate ground	<1 Ω

### Supply wire:

**5**  
Ignition key in ON position.

**6**  
Connect a voltmeter to the 60-pin breakout box and measure the voltage.

Measuring points	Optimal value
PB26 / PB23	5 ± 20% V

### Signal wire:

**7**  
Turn the ignition key to the ON position.

**8**  
Connect a voltmeter to the 60-pin breakout box and measure the voltage.

Measuring points	Expected value
PB25 / PB23	0.5 ± 20% V (accelerator pedal at idle)
	3.2 ± 20% V (full acceleration)

## Verification

To verify that the fault has been corrected, use the test in the VCADS Pro tool (see "Appropriate Tests in the VCADS Pro Tool" page 198).

## MID 144 PID 84 Road Speed

The speed signal comes from a sensor on the transmission or as a digital signal if an electronically-controlled transmission is used (i.e. Allison). Diagnostic settings (level 1.5 parameters) are factory programmed based on the transmission type used.

- **Text Messages**

In vehicles equipped with diagnostic display, the following message(s) will appear:

- **Instrument Cluster Graphics Display (VN):**

Road speed.

- **Data Link Instrument Cluster (WG, AC, WX):**

The Data Link instrument cluster graphics display used on WG-, AC-, and WX-series vehicles can display a limited number of text messages. For information, see "Data Link Instrumentation," Volvo Service Publication PV776-381-620SM.

- **VCADS Pro Display:**

Road speed

## Fault Codes

### FMI 5

Abnormally low current or open circuit.

*Conditions for fault code:*

- If the VECU registers a current lower than 90  $\mu\text{A}$  on any of the signal wires from the speed sensor the VECU interprets this as a fault and a fault code is set.

*Possible cause:*

- Poor contact, sensor connection.
- Switch resistance and oxidation.
- Break, signal wire.
- Fault in sensor.

*Reaction from the VECU:*

- Yellow lamp lights up.

*Noticeable external symptom:*

- No vehicle speed on gauge.
- No PTO.
- No cruise control.

### FMI 6

Abnormally high current or short circuit.

*Conditions for fault code:*

- If the VECU registers a current higher than 140  $\mu\text{A}$  on any of the signal wires from the speed sensor, the VECU interprets this as a fault and a fault code is set.

*Possible cause:*

- Signal wire short-circuited to higher voltage.
- Signal wire short-circuited to ground.
- Fault in sensor.

*Reaction from the VECU:*

- Yellow lamp lights up.

*Noticeable external symptom:*

- No vehicle speed on gauge.
- No PTO.
- No cruise control.

## MID 144 PID 84 Road Speed, Check

Other special equipment: J-39200, 9998551, J-43340, J-43234

### NOTE!

- Read off the other fault codes for the VECU.
- Check the particular connectors during the fault tracing for oxidation and switch resistance. For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Appropriate Tests in the VCADS Pro Tool

The following test(s) are useful for closely examining the component's function:

N/A No test currently available.

### Measurement at the Component's Connector, to the VECU

**Note:** Faults in the wiring harness to the VECU can damage the component. Therefore, a check of the component should also be made if any of the measurement values deviate from the expected value.

**1**  
Disconnect the VECU and install adapter J-43234 to the wiring harness connector PB only.

**2**  
Connect 60-pin breakout box 9998511 (with overlay J-43340) to the adapter.

### Signal wire

**3**  
Turn the ignition key to the OFF position.

**4**  
Connect an ohmmeter to the 60-pin breakout box and measure resistance.

Measuring points	Expected value	Transmission
PB6/PB20	265 ± 20% Ω	Volvo
	3.4k ± 20% Ω	Fuller
	3.17k ± 20% Ω	Allison HT-740
	NO DIAG-NOSTICS	Allison Automatic
* Value may vary depending on transmission manufacturer.		

### Wiring Harness

**5**  
To check the wiring harness, refer to "VNL, VNM Electrical Schematics," Group 37.

### Check of Component — Vehicle Speed Sensor

**Note:** Faults in the component can be caused by faults in the wiring harness of the VECU. A check of the wiring harness should also therefore be made before connecting a new component.

**1**  
Disconnect the 2-pin vehicle speed sensor connector at the transmission.

**2**  
Turn the ignition key to the OFF position.

**3**  
Connect an ohmmeter to the vehicle speed sensor connector and measure the resistance. J-39200

Measuring points	Expected value*	Transmission
Pin A / Pin B	265 ± 20% Ω	Volvo
	3.4k ± 20% Ω	Fuller
	3.17k ± 20% Ω	Allison HT-740
	NO DIAG-NOSTICS	Allison Automatic
* Value may vary depending on transmission manufacturer.		

## Check of Subsystem



Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**1**  
Disconnect the VECU and install adapter J-43234 between the VECU and wiring harness connector PA/PB.

**2**  
Connect 60-pin breakout box 9998551 (with overlay J-43340) to the adapter.

**3**



Personal injury hazard. Never work under or around a raised vehicle unless it is securely supported on jack stands of adequate rating and the front wheels are securely chocked. Failure to use adequate jack stands and chock the wheels can result in the vehicle falling, which can cause serious injury or death to anyone under or near the vehicle.

Chock the front wheels. Release the parking brake and jack up one rear wheel so that it can be turned by hand.

## Signal wire

**4**  
Turn the ignition key to the OFF position.

**5**  
Connect a voltmeter to the 60-pin breakout box and measure the voltage while turning the wheel by hand. The voltage will alternate from positive to negative and will vary with speed. Voltmeter function "MIN/MAX" may be useful to determine value.

J-39200

**Note:** The transmission output shaft must be turning.

Measuring points	Expected minimum value	Transmission
PB6 / PB20	+0.1 V to -0.1 V	Volvo
	+0.1 V to -0.1 V	Fuller
	+0.1 V to -0.1 V	Allison HT-740
	NO DIAG-NOSTICS	Allison Automatic

## Verification

No VCADS Pro tool test is currently available to verify this fault correction.

## MID 144 PID 91 Accelerator Pedal Position

- **Text Messages**  
In vehicles equipped with diagnostic display, the following message(s) will appear:
- **Instrument Cluster Graphics Display (VN):**  
Acc. pedal pos. %
- **Data Link Instrument Cluster (WG, AC, WX):**  
The Data Link instrument cluster graphics display used on WG-, AC-, and WX-series vehicles can display a limited number of text messages. For information, see "Data Link Instrumentation," Volvo Service Publication PV776-381-620SM.
- **VCADS Pro Display:**  
Accelerator pedal position, %

## Fault Codes

### FMI 3

Abnormally high voltage.

*Conditions for fault code:*

- If the VECU receives a signal from the sensor that is higher than 4.3 V, the VECU interprets this as a fault and a fault code is set.

*Possible cause:*

- Open circuit in ground wire.
- Open circuit in supply wire.
- Signal wire short-circuited to higher voltage.
- Faulty accelerator position sensor.
- Faulty idle validation switch 1.
- Switch resistance and oxidation.

*Reaction from the VECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The engine does not respond when the accelerator pedal is depressed.

### FMI 4

Abnormally low voltage.

*Conditions for fault code:*

- If the VECU receives a signal from the sensor that is lower than 0.4 V, the VECU interprets this as a fault and a fault code is set.

*Possible cause:*

- Open circuit in supply wire.
- Open circuit in signal wire.
- Signal wire short-circuited to ground.
- Faulty accelerator position sensor.
- Switch resistance and oxidation.

*Reaction from the VECU:*

- fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The engine does not respond when the accelerator pedal is depressed.

## MID 144 PID 91 Accelerator Pedal Position, Check

Other special equipment: J-39200, J-43234, 9998551, J-41133, J-43340

### NOTE!

- Read off the other fault codes for the VECU.
- Check the particular connectors during the fault tracing for oxidation and switch resistance. For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

## Appropriate Tests in the VCADS Pro Tool

The following test(s) are useful for closely examining the component's function:

**27102-8** Accelerator pedal, switches and sensor, test

## Measurement at the Component's Connector, to the VECU

**Note:** Faults in the wiring harness to the VECU can damage the component. Therefore, a check of the component should also be made if any of the measurement values deviate from the expected value.

**1** Disconnect the connector at the accelerator pedal. Install 5-pin breakout harness J-41133 to the wiring harness end only.

### Ground wire:

**2** Turn the ignition key to the OFF position.

**3** Using ohmmeter J-39200, measure resistance from pin E (5-pin harness) to alternate ground.

Measuring points	Expected value
Pin E / alternate ground	<1 $\Omega$

### Supply Wire:

**4** Turn the ignition key to the ON position.

**5** Connect a voltmeter to the connector and measure the voltage from pin A to pin E (5-pin harness). J-39200

Measuring points	Expected value
Pin A / Pin E	5.4 $\pm$ 20% V

### Signal Wire:

**6** Turn the ignition key to the OFF position.

**7** Using an ohmmeter, measure the resistance from pin B to pin E (5-pin harness). J-39200

Measuring points	Expected value
Pin B / Pin E	100 $\pm$ 20% k $\Omega$

### Wiring harness

**8** To check the wiring harness, refer to "VNL, VNM Electrical Schematics," Group 37.

## Check of component — accelerator pedal position sensor

**Note:** Faults in the component can be caused by faults in the wiring harness of the VECU. A check of the wiring harness should also therefore be made before connecting a new component.

**1** Disconnect the connector at the accelerator pedal. Install 5-pin breakout harness J-41133 to the accelerator pedal harness only.

**2**  
Turn the ignition key to the OFF position.

**3**  
Using an ohmmeter, measure the resistance of pin A to pin E, and pin A to pin B. J-39200

Measuring points	Expected value
Pin A / Pin E	4 ± 20% kΩ
Pin A / Pin B	4.5 ± 20% kΩ

**4**  
Remove the 5-pin breakout harness and reconnect the connector at the accelerator pedal.

### Check of Subsystem

**1**  
Disconnect the VECU and install adapter J-43234 between the VECU and wiring harness connectors PA/PB. J-43234

**2**  
Connect 60-pin breakout box 9998551 (with overlay J-43340) to the adapter. 9998551 J-43340

### Ground Wire

**3**  
Turn the ignition key to the OFF position.

**4**  
Using an ohmmeter at the 60-pin breakout box, measure the resistance between pin PB22 and the alternate ground. J-39200

Measuring points	Expected value
PB22 / alternate ground	<1 Ω

### Supply Wire:

**5**  
Turn the ignition key to the ON position.

**6**  
Using a voltmeter at the 60-pin breakout box, measure the voltage from pin PB10 to PB22. J-39200

Measuring points	Expected value
PB10 / PB22	5 ± 20% V

### Signal Wire:

**7**  
Ignition key in the ON position.

**8**  
Using a voltmeter at the 60-pin breakout box, measure the voltage from pin PB8 to PB22. J-39200

Measuring points	Expected value
PB8 / PB22	0.5 ± 20% V (accelerator at idle)
	3.2 ± 20% V (full acceleration)

### Verification

To verify that the fault has been corrected, use the test in the VCADS Pro tool (see "Appropriate Tests in the VCADS Pro Tool" page 204).

## MID 144 PID 152 VECU, Number of Resets

The software in the VECU contains an internal checking function that restarts the VECU when there is a fault in the execution of the software. PID 152 contains information about how many such restarts that have been made.

- **Text Messages**

In vehicles equipped with diagnostic display, the following message(s) will appear:

- **Instrument Cluster Graphics Display (VN):**

No. of ECU resets

- **Data Link Instrument Cluster (WG, AC, WX):**

The Data Link instrument cluster graphics display used on WG-, AC-, and WX-series vehicles can display a limited number of text messages. For information, see "Data Link Instrumentation," Volvo Service Publication PV776-381-620SM.

- **VCADS Pro Display:**

Number of ECU resets

## Fault Codes

### FMI 12

Faulty unit or component.

*Conditions for fault code:*

- If an internal software fault occurs an fault code is set.

*Possible cause:*

- The system has been switched off by disconnecting the battery or using a battery master switch instead of switching it off with the ignition key.
- The system has been restarted due to an internal software fault.

*Reaction from the VECU:*

- Fault code is set.
- The system is restarted.



## MID 144 PPID 69 Idle Validation Switch

The function is used to be able to drive the vehicle in "limp home mode" if a fault has occurred in the wiring to the engine electronic control unit (EECU).

- **Text Messages**

In vehicles equipped with diagnostic display, the following message(s) will appear:

- **Instrument Cluster Graphics Display (VN):**

Buff. idle val. sw.

- **Data Link Instrument Cluster (WG, AC, WX):**

The Data Link instrument cluster graphics display used on WG-, AC-, and WX-series vehicles can display a limited number of text messages. For information, see "Data Link Instrumentation," Volvo Service Publication PV776-381-620SM.

- **VCADS Pro Display:**

Buffered idle validation switch

## Fault Codes

### FMI 4

Abnormally low voltage.

*Conditions for fault code:*

- If the output signal from the buffered idle validation switch deviates from the input signal from idle validation switch 1, the VECU interprets this as a fault and a fault code is set.

**Note:** The fault code is set first when the accelerator pedal is depressed.

*Possible cause:*

- Short circuit to ground, signal wire

*Reaction from the VECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.

## MID 144 PPID 69 Idle Validation Switch, Check

*Other special equipment: J-39200, J-41132, J-43234, J-43233, 9998551, J-43340*

### NOTE!

- Read off the other fault codes for the VECU.
- Check the particular connectors during the fault tracing for oxidation and switch resistance. For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Appropriate Tests in the VCADS Pro Tool

The following test(s) are useful for closely examining the component's function:

N/A No test currently available.

### Measurement at the Component's Connector, to the VECU

**Note:** Faults in the wiring harness to the VECU can damage the component. Therefore, a check of the component should be made if any of the measurements deviate from the expected values.

**1**

Disconnect connector (EA and EB) at the engine electronic control unit (EECU).

**2**

Connect jumper J-43233 between EECU's EA (upper) connector and the wiring harness. J-43233

**3**

Connect the 36-pin breakout box J-41132 between the EECU's EB (lower) connector and the wiring harness. J-41132

### Signal Wire:

**4**

Turn the ignition key to the ON position.

**5**

Connect voltmeter J-39200 to the 36-pin breakout box at pin 4 (buffered idle validation switch) and pin 9 (ground). J-39200

Measuring points	Expected value
EB4 / EB9	0 V (accelerator pedal at idle)
	B+ (accelerator pedal above idle)

### Wiring harness

**6**

To check the wiring harness, refer to "VNL, VNM Electrical Schematics," Group 37.

### Check of component — buffered idle validation switch

**Note:** Faults in the component can be caused by faults in the wiring harness of the VECU. Therefore, a check of the wiring harness should be made before connecting a new component.

**1**

Disconnect connector (EA and EB) at the EECU.

**2**

Connect jumper J-43233 between EECU's EA (upper) connector and the wiring harness. J-43233

**3**

Connect the 36-pin breakout box J-41132 between the EECU's EB (lower) connector and the wiring harness. J-41132

**4**

Turn the ignition key to the OFF position.

**5**

Using ohmmeter J-39200 at the 36-pin breakout box, measure resistance from pin 4 to pin 9. J-39200

Measuring points	Expected value
EB4 / EB9	2.9 ± 20% kΩ

## Check of subsystem

**1**

Disconnect the VECU and install adapter J-43234 between the VECU and wiring harness connectors PA/PB.

J-43234

**2**

Connect the 60-pin breakout box 9998551 (with overlay J-43340) to the adapter.

9998551  
J-43340

### *Signal Wire:*

**3**

Turn the ignition key to the ON position.

**4**

Connect voltmeter J-39200 to the 60-pin breakout box and measure the voltage.

J-39200

Measuring points	Expected value
PB17 / PB22	0 V (accelerator pedal at idle)
	B+ (accelerator pedal above idle)

## Verification

No VCADS Pro tool test is currently available to verify this fault correction.

## MID 144 PPID 70 Pedal Switches, Supply

Voltage supply to pedal switches.

- **Text Messages**  
In vehicles equipped with diagnostic display, the following message(s) will appear:
- **Instrument Cluster Graphics Display (VN):**  
Output supply #3
- **Data Link Instrument Cluster (WG, AC, WX):**  
The Data Link instrument cluster graphics display used on WG-, AC-, and WX-series vehicles can display a limited number of text messages. For information, see "Data Link Instrumentation," Volvo Service Publication PV776-381-620SM.
- **VCADS Pro Display:**  
Pedal switches supply

## Fault Codes

### FMI 4

Abnormally low voltage.

*Conditions for fault code:*

- If the VECU registers a voltage lower than 2.5 V on the supply wire, the VECU interprets this as a fault and a fault code is set.

*Possible cause:*

- The supply wire short-circuited to ground.
- The signal wire for brakes/clutch short-circuited to ground.
- Signal wire for idle validation switch 1 short-circuited to ground.
- Faulty switch.

*Reaction from the VECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The cruise control function does not work.

## MID 144 PPID 70 Pedal Switches, Supply, Check

*Other special equipment: J-39200, J-43234, 9998551, J-43340, J-41133*

### NOTE!

- Read off the other fault codes for the VECU.
- Check the particular connectors during the fault tracing for oxidation and switch resistance. For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Appropriate Tests in the VCADS Pro Tool

The following test(s) are useful for closely examining the component's function:

**27102-8** Accelerator pedal, switches and sensor, test

**27503-8** Cruise control, switch, test

### Measurement at the Component's Connector, to the VECU

**Note:** Faults in the wiring harness to the VECU can damage the component. Therefore, a check of the component should also be made if any of the measurement values deviate from the expected value.

**1**  
Disconnect the connector at the accelerator pedal. Install 5-pin breakout harness J-41133 to the wiring harness end only. J-41133

**2**  
Disconnect the connector at the brake pedal switch (two pin, Common-558A wire and Normal Open-567B wire).

**3**  
Disconnect the connector at the clutch pedal switch (two pin, Normal Open-571 wire and Common 558B wire).

#### *Supply wire, idle validation switch 1:*

**4**  
Turn the ignition key to the ON position.

**5**  
Connect a voltmeter to the breakout harness connector and measure the voltage. J-39200

Measuring points	Expected value
Pin D / alternate ground	B+

#### *Supply wire, brake pedal switch:*

**6**  
Turn the ignition key to the ON position.

**7**  
Connect a voltmeter to the wiring harness connector and measure the voltage. J-39200

Measuring points	Expected value
"COMMON" / alternate ground	B+

#### *Supply wire, clutch pedal switch:*

**8**  
Turn the ignition key to the ON position.

**9**  
Connect a voltmeter to the wiring harness connector and measure the voltage. J-39200

Measuring points	Expected value
"COMMON" / alternate ground	B+

#### *Signal wire, idle validation switch 1:*

**10**  
Turn the ignition key to the OFF position.

**11**  
Connect an ohmmeter to the breakout harness connector and measure the resistance. J-39200

Measuring points	Expected value
Pin C / alternate ground	1.2 ± 20% kΩ

#### *Signal wire, brake pedal switch:*

**12**  
Turn the ignition key to the OFF position.

- 13**  
Connect an ohmmeter to the wiring harness connector and measure the resistance. J-39200

Measuring points	Expected value
"Normal Open" / alternate ground	1.2 ± 20% kΩ

*Signal wire, clutch pedal switch:*

- 14**  
Turn the ignition key to the OFF position.

- 15**  
Connect an ohmmeter to the wiring harness connector and measure the resistance. J-39200

Measuring points	Expected value
"Normal Open" / alternate ground	1.2 ± 20% kΩ

*Wiring harness*

- 16**  
To check the wiring harness, see "VNL, VNM Electrical Schematics," Group 37.

## Check of component

- Idle validation switch
- Brake pedal switch
- Clutch pedal switch

**Note:** Faults in the component can be caused by faults in the wiring harness of the VECU. A check of the wiring harness should also therefore be made before connecting a new component.

*Check of idle validation switch 1:*

- 1**  
Disconnect the connector at the accelerator pedal. Install 5-pin breakout harness J-41133 to the accelerator pedal harness end only. J-41133

- 2**  
Turn the ignition key to the OFF position.

- 3**  
Connect an ohmmeter to the connector and measure the resistance. J-39200

Measuring points	Expected value
Pin D / Pin C	Open circuit (accelerator pedal at idle)
	20-90 Ω (full acceleration)

*Check of the brake pedal switch:*

- 4**  
Disconnect the connector at the brake pedal switch (two pin).

- 5**  
Turn the ignition key to the OFF position.

- 6**  
Connect an ohmmeter to the switch terminals and measure the resistance. J-39200

Measuring points	Expected value
"COMMON" / "Normal Open"	<1 Ω (brake pedal not depressed)
	open circuit (brake pedal depressed)

*Check of clutch pedal switch:*

- 7**  
Disconnect the connector at the clutch pedal switch (two pin).

- 8**  
Turn the ignition key to the OFF position.

- 9**  
Connect an ohmmeter to the switch terminals and measure the resistance. J-39200

Measuring points	Expected value
"COMMON" / "Normal Open"	<1 Ω (clutch pedal not depressed)
	open circuit (clutch pedal depressed)

## Check of Subsystem

**1**  
Disconnect the VECU and install adapter J-43234 between the VECU and wiring harness PA/PB. J-43234

**2**  
Connect 60-pin breakout box 9998551 (with overlay J-43340) to the adapter. 9998551 J-43340

### Supply wire:

**3**  
Turn the ignition key to the ON position.

**4**  
Connect a voltmeter to the 60-pin breakout boxes and measure the voltage. J-39200

Measuring points	Expected value
PB19 / PA12	B+

### Signal wire, idle validation switch 1:

**5**  
Turn the ignition key to the ON position.

**6**  
Connect a voltmeter to the 60-pin breakout box and measure the voltage. J-39200

Measuring points	Expected value
PA23 / PA12	0 V (accelerator pedal at idle)
	B+ (full acceleration)

### Signal wire, brake pedal switch:

**7**  
Turn the ignition key to the ON position.

**8**  
Connect a voltmeter to the 60-pin breakout box and measure the voltage. J-39200

Measuring points	Expected value
PA5 / PA12	B+ (brake pedal not depressed)
	0 V (brake pedal depressed)

### Signal wire, clutch pedal switch:

**9**  
Turn the ignition key to the ON position.

**10**  
Connect a voltmeter to the 60-pin breakout box and measure the voltage. J-39200

Measuring points	Expected value
PA8 / PA12	B+ (clutch pedal not depressed)
	0 V (clutch pedal depressed)

## Verification

To check that the fault has been corrected, use the test in the VCADS Pro tool (see "Appropriate Tests in the VCADS Pro Tool" page 211).

## MID 144 PPID 71 Cruise Control and Engine Brake, Supply Switch

Voltage supply to the cruise control and exhaust brake control switches. Also voltage supply to the idle validation switch 3 (on second accelerator pedal), if so equipped

- **Text Messages**

In vehicles equipped with diagnostic display, the following message(s) will appear:

- **Instrument Cluster Graphics Display (VN):**

Output supply #4

- **Data Link Instrument Cluster (WG, AC, WX):**

The Data Link instrument cluster graphics display used on WG-, AC-, and WX-series vehicles can display a limited number of text messages. For information, see "Data Link Instrumentation," Volvo Service Publication PV776-381-620SM.

- **VCADS Pro Display:**

Cruise control and retarder switch supply

## Fault Codes

### FMI 4

Abnormally low voltage.

*Conditions for fault code:*

- If the VECU registers a voltage lower than 2.5 V on the supply wire, the VECU interprets this as a fault and a fault code is set.

*Possible cause:*

- The supply wire short-circuited to ground.
- The signal wire for the cruise control (SET+/SET-/RESUME/ON) short-circuited to ground.
- The signal wire for the exhaust brake switch (EPG/VEB) short-circuited to ground.
- The signal wire for the idle validation switch 3 short-circuited to ground.

*Reaction from the VECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The cruise control does not function.
- Exhaust brake does not function.
- Idle validation switch 3 does not function.



## MID 144 PPID 71 Cruise Control and Engine Brake, Supply Switch, Check

*Other special equipment: J-39200, 9998551, J-41133, J-43340, J-43234*

### NOTE!

- Read off the other fault codes for the VECU.
- Check the particular connectors during the fault tracing for oxidation and switch resistance. For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.
- Note: checks concerning VCB only apply to vehicles equipped with Volvo Compression Brake.

### Appropriate Tests in the VCADS Pro Tool

The following test(s) are useful for closely examining the component's function:

- 27503-8** Cruise control, switch, test
- 25336-8** Exhaust brake, switch, test
- 27104-8** Extra accelerator control, switches and sensor, test

### Measurement at the Component's Connector, to the VECU

**Note:** Faults in the wiring harness to the VECU can damage the component. Therefore, a check of the component should also be made if any of the measurement values deviate from the expected value.

**1**  
Disconnect the connector at the switch for the cruise control. Measurements should be taken only on the wiring harness connector end.

**2**  
Disconnect the connector at the switch for the exhaust brake, if the vehicle is equipped with one. Measurements should be taken only on the wiring harness connector end.

**3**  
Disconnect the connector at the second accelerator pedal, if the vehicle is equipped with one. Install the 5-pin breakout harness J-41133 to the wiring harness end only.

### Supply wire, cruise control switch:

**4**  
Turn the ignition key to the ON position.

**5**  
Connect a voltmeter to the connector and measure the voltage. J-39200

Measuring points	Expected value
Pin A (wire #597A) / alternate ground	B+

### Supply wire, exhaust brake switch:

**6**  
Turn the ignition key to the ON position.

**7**  
Connect a voltmeter to the connector and measure the voltage. J-39200

Measuring points	Expected value
Pin 1 (wire #597B) / alternate ground	B+

### Supply wire, idle validation switch 3

**8**  
Turn the ignition key to the ON position.

**9**  
Connect a voltmeter to the connector and measure the voltage. J-39200

Measuring points	Expected value
Pin D / alternate ground	B+

### Signal wire, cruise control switch:

**10**  
Turn the ignition key to the OFF position.

**11**

Connect an ohmmeter to the connector and measure the resistance. J-39200

Measuring points	Expected value
Pin E (wire #563A) / alternate ground	SET+ 1.2 ± 20% kΩ
Pin G (wire #564A) / alternate ground	SET- 1.2 ± 20% kΩ
Pin C (wire #562A) / alternate ground	ON 1.2 ± 20% kΩ
Pin H (wire #565A) / alternate ground	RESUME 1.2 ± 20% kΩ

**Signal wire, exhaust brake switch:****12**

Turn the ignition key to the OFF position.

**13**

Connect an ohmmeter to the connector and measure the resistance. J-39200

Measuring points	Expected value
Pin 6 (wire #628) / alternate ground	EPG 1.2 ± 20% kΩ
Pin 5 (wire #629) / alternate ground	VCB 1.2 ± 20% kΩ

**Signal wire, idle validation switch 3:****14**

Turn the ignition key to the OFF position.

**15**

Connect an ohmmeter to the connector and measure the resistance. J-39200

Measuring points	Expected value
Pin C / alternate ground	1.2 ± 20% kΩ

**Wiring harness:****16**

To check the wiring harness, see "VNL, VNM Electrical Schematics," Group 37.

**Check of component**

- Cruise control switch
- Exhaust brake switch
- Idle validation switch 3

**Note:** Faults in the component can be caused by faults in the wiring harness of the VECU. A check of the wiring

harness should also therefore be made before connecting a new component.

**Check of the switch for the cruise control:****1**

Disconnect the connector at the switch for cruise control. Measurements should be taken only on the cruise control switch connector.

**2**

Turn the ignition key to the OFF position.

**3**

Connect an ohmmeter to the connector pins and measure the resistance. J-39200

Measuring points	Expected value
Pin E / Pin A	open circuit (SET+ inactive)
	<1 Ω (SET+ active)
Pin H / Pin A	open circuit (RESUME inactive)
	<1 Ω (RESUME active)
Pin C / Pin A	open circuit (OFF)
	<1 Ω (ON)
	<1 Ω (RESUME active)
Pin G / Pin A	<1 Ω (SET- active)
	open circuit (SET- inactive)

**Check of the switch for the exhaust brake:****4**

Disconnect the connector at the switch for exhaust brake. Measurements should be taken only on the exhaust brake switch pins.

**5**

Turn the ignition key to the OFF position.

**6**  
Connect an ohmmeter to the switch pins and measure the resistance. J-39200

Measuring points	Expected value
Pin 1 / Pin 6	open circuit (switch OFF) <1 Ω (switch position 1 - EPG) <1 Ω (switch position 2 - VCB)
Pin 1 / Pin 5	open circuit (switch OFF) open circuit (switch position 1 - EPG) <1 Ω (switch position 2 - VCB)

*Check of the idle validation switch 3:*

**7**  
Disconnect the connector at the second accelerator pedal. Install the 5-pin breakout harness J-41133 to the accelerator pedal harness end only. J-41133

**8**  
Turn the ignition key to the OFF position.

**9**  
Connect an ohmmeter to the switch pins and measure the resistance. J-39200

Measuring points	Expected value
Pin C / Pin D	open circuit (accelerator at idle)
	20-90 Ω (full acceleration)

**Check of Subsystem**

**1**  
Disconnect the VECU and install adapter J-43234 between the VECU and wiring harness connectors PA/PB. J-43234

**2**  
Connect 60-pin breakout box 9998551 (with overlay J-43234) to the adapter. 9998551 J-43234

*Supply wire:*

**3**  
Turn the ignition key to the ON position.

**4**  
Connect a voltmeter to the connector and measure the voltage. J-39200

Measuring points	Expected value
PB5 / PA12	B+

**Signal wire, cruise control switch:****5**

Turn the ignition key to the ON position.

**6**

Connect a voltmeter to the 60-pin breakout box and measure the voltage.

J-39200

Measuring points	Expected value
PA2 / PA12	0 V (SET+ inactive)
	B+ (SET+ active)
PA30 / PA12	0 V (RESUME inactive)
	B+ (RESUME active)
PA3 / PA12	0 V (cruise switch OFF)
	B+ (cruise switch ON)
PA1 / PA12	0 V (SET- inactive)
	B+ (SET- active)
PA30 / PA12	B+ (RESUME active)
	0 V (RESUME inactive)

**Signal wire, exhaust brake switch:****7**

Turn the ignition key to the ON position.

**8**

Connect a voltmeter to the 60-pin breakout box and measure the voltage.

J-39200

Measuring points	Expected value
PA21 / PA12	0 V (exhaust brake switch OFF)
	B+ (exhaust brake switch position 1 - EPG)
	B+ (exhaust brake switch position 2 - VCB)
PA20 / PA12	0 V (exhaust brake switch OFF )
	0 V (exhaust brake switch position 1 - EPG)
	B+ (exhaust brake switch position 2 - VCB)

**Signal wire, idle validation switch 3:****9**

Turn the ignition key to the ON position.

**10**

Connect a voltmeter to the 60-pin breakout box and measure the voltage.

J-39200

Measuring points	Expected value
PB30 / PA12	0 V (accelerator at idle)
	B+ (full acceleration)

**Verification**

To check that the fault has been corrected, use the test in the VCADS Pro tool (see "Appropriate Tests in the VCADS Pro Tool" page 215).

## MID 144 PPID 72 Accelerator Pedal, Supply Sensors

The accelerator pedal position sensor is supplied with a reference voltage of 5.0 V. Each change of the accelerator pedal angle controls the input signal to the VECU.

- **Text Messages**  
In vehicles equipped with diagnostic display, the following message(s) will appear:
- **Instrument Cluster Graphics Display (VN):**  
Output supply #1
- **Data Link Instrument Cluster (WG, AC, WX):**  
The Data Link instrument cluster graphics display used on WG-, AC-, and WX-series vehicles can display a limited number of text messages. For information, see "Data Link Instrumentation," Volvo Service Publication PV776-381-620SM.
- **VCADS Pro Display:**  
Accelerator pedal and retarder sensor supply

## Fault Codess

### FMI 3

Abnormally high voltage.

*Conditions for fault code:*

- If the VECU registers a voltage higher than 5.5 V on the supply wire, the VECU interprets this as a fault and an fault code is set.

*Possible cause:*

- Open circuit in ground wire.
- Supply wire short-circuited to higher voltage.
- Open circuit in supply wire.
- Faulty accelerator position sensor.
- Switch resistance and oxidation.

*Reaction from the VECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The engine does not respond when the accelerator pedal is depressed.

### FMI 4

Abnormally low voltage.

*Conditions for fault code:*

- If the VECU registers a voltage lower than 4.5 V on the supply wire, the VECU interprets this as a fault and an fault code is set.

*Possible cause:*

- Supply wire short-circuited to ground or lower voltage.
- Faulty accelerator position sensor.

*Reaction from the VECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Engine does not respond when the accelerator pedal is depressed.

## MID 144 PPID 72 Accelerator Pedal, Supply Sensors, Check

Other special equipment: J-39200, J-41133, 9998551, J-43340, J-43234

### NOTE!

- Read off the other fault codes for the VECU.
- Check the particular connectors during the fault tracing for oxidation and switch resistance. For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

## Appropriate Tests in the VCADS Pro Tool

The following test(s) are useful for closely examining the component's function:

**27102-8** Accelerator pedal, switches and sensor, test

## Measurement at the Component's Connector, to the VECU

**Note:** Faults in the wiring harness to the VECU can damage the component. Therefore, a check of the component should also be made if any of the measurement values deviate from the expected value.

- 1** Disconnect the connector at the accelerator pedal. Install 5-pin breakout harness J-41133 to the wiring harness end only. J-41133

### Ground wire:

- 2** Turn the ignition key to the OFF position.

- 3** Using ohmmeter J-39200, measure the resistance from pin E (5-pin harness) to the alternate ground. J-39200

Measuring points	Expected value
Pin E / alternate ground	<1 $\Omega$

### Supply wire:

- 4** Turn the ignition key to the ON position.

- 5** Connect a voltmeter to the connector and measure the voltage from pin A to pin E (5-pin harness). J-39200

Measuring points	Expected value
Pin A / Pin E	5.4 $\pm$ 20% V

### Signal wire:

- 6** Turn the ignition key to the OFF position.

- 7** Connect an ohmmeter to the 5-pin breakout harness and measure the resistance. J-39200

Measuring points	Expected value
Pin B / Pin E	100 $\pm$ 20% k $\Omega$

### Wiring harness

- 8** To check the wiring harness, see "VNL, VNM Electrical Schematics," Group 37.

## Check of component

### Accelerator position sensor

**Note:** Faults in the component can be caused by faults in the wiring harness of the VECU. A check of the wiring harness should also therefore be made before connecting a new component.

- 1** Disconnect the connector at the accelerator pedal. Install 5-pin breakout harness J-41133 to the accelerator pedal harness end only. J-41133

- 2** Turn the ignition key to the OFF position.

- 3** Connect an ohmmeter to the breakout harness pins and measure the resistance. J-39200

Measuring points	Expected value
Pin A / Pin E	4 $\pm$ 20% k $\Omega$
Pin A / Pin B	4.5 $\pm$ 20% k $\Omega$ (accelerator pedal at idle)

## Check of Subsystem

**1**  
Disconnect the VECU and install adapter J-43234 between the VECU and wiring harness connectors PB/PA.

**2**  
Connect the 60-pin breakout box 9998551 (with overlay J-43340) to the adapter.

### Ground wire:

**3**  
Turn the ignition key to the OFF position.

**4**  
Connect an ohmmeter to the 60-pin breakout box and measure the resistance between pin PB22 and the alternate ground.

Measuring points	Optimal value
PB22/ Alternate ground	<1 $\Omega$

### Supply wire:

**5**  
Ignition key in ON position.

**6**  
Connect a voltmeter to the 60-pin breakout box and measure the voltage from pin PB10 to PB22.

Measuring points	Optimal value
PB10 / PB22	5 $\pm$ 20% V

### Signal wire:

**7**  
Turn the ignition key to the ON position.

**8**  
Connect a voltmeter to the 60-pin breakout box and measure the voltage from pin PB8 to PB22.

Measuring points	Expected value
PB8 / PB22	0.5 $\pm$ 20% V (accelerator pedal at idle)
	3.2 $\pm$ 20% V (full acceleration)

## Verification

To verify that the fault has been corrected, use the test in the VCADS Pro tool (see "Appropriate Tests in the VCADS Pro Tool" page 220).

## MID 144 PPID 73 Second Accelerator Pedal, Supply Sensors

The second accelerator pedal position sensor is supplied with a reference voltage of 5.0 V. Each change of the second accelerator pedal angle controls the input signal to the VECU.

**Note:** Applies only to vehicles with a second accelerator pedal assembly (such as the WX).

- **Text Messages**

In vehicles equipped with diagnostic display, the following message(s) will appear:

- **Instrument Cluster Graphics Display (VN):**

Output supply #2

- **Data Link Instrument Cluster (WG, AC, WX):**

The Data Link instrument cluster graphics display used on WG-, AC-, and WX-series vehicles can display a limited number of text messages. For information, see "Data Link Instrumentation," Volvo Service Publication PV776-381-620SM.

- **VCADS Pro Display:**

Second throttle and wet tank sensor supply

## Fault Codes

### FMI 3

Abnormally high voltage.

*Conditions for fault code:*

- If the VECU registers a voltage higher than 5.5 V on the supply wire, the VECU interprets this as a fault and a fault code is set.

*Possible cause:*

- Open circuit in ground wire.
- Supply wire short-circuited to higher voltage.
- Open circuit in supply wire.
- Faulty second accelerator pedal position sensor.
- Switch resistance and oxidation.

*Reaction from the VECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The engine does not respond when the second accelerator pedal is depressed.

*Conditions for fault code:*

- If the VECU registers a voltage lower than 4.5 V on the supply wire, the VECU interprets this as a fault and a fault code is set.

*Possible cause:*

- Supply wire short-circuited to ground or lower voltage.
- Faulty second accelerator pedal position sensor.

*Reaction from the VECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- Engine does not respond when the second accelerator pedal is depressed.

### FMI 4

Abnormally low voltage.



## MID 144 PPID 73 Second Accelerator Pedal, Supply Sensors, Check

Other special equipment: J-39200, J-41133, 9998551, J-43340, J-43234

### NOTE!

- Read off the other fault codes for the VECU.
- Check the particular connectors during the fault tracing for oxidation and switch resistance. For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Appropriate Tests in the VCADS Pro Tool

The following test(s) are useful for closely examining the component's function:

**27104-8** Extra accelerator pedal, switches and sensor, test

### Measurement at the Component's Connector, to the VECU

**Note:** Faults in the wiring harness to the VECU can damage the component. Therefore, a check of the component should also be made if any of the measurement values deviate from the expected value.

**1** Disconnect the connector at the second accelerator pedal. Install 5-pin breakout harness J-41133 to the wiring harness end only. J-41133

#### Ground wire:

**2** Turn the ignition key to the OFF position.

**3** Using ohmmeter J-39200, measure the resistance from pin E (5-pin harness) to the alternate ground. J-39200

Measuring points	Expected value
Pin E / alternate ground	<1 Ω

#### Supply wire:

**4** Turn the ignition key to the ON position.

**5** Connect a voltmeter to the connector and measure the voltage from pin A to pin E (5-pin harness). J-39200

Measuring points	Expected value
Pin A / Pin E	5.4 ± 20% V

#### Signal wire:

**6** Turn the ignition key to the OFF position.

**7** Connect an ohmmeter to the 5-pin breakout harness and measure the resistance. J-39200

Measuring points	Expected value
Pin B / Pin E	100 ± 20% kΩ

#### Wiring harness

**8** To check the wiring harness, see "VNL, VNM Electrical Schematics," Group 37.

### Check of component Second accelerator position sensor

**Note:** Faults in the component can be caused by faults in the wiring harness of the VECU. A check of the wiring harness should also therefore be made before connecting a new component.

**1** Disconnect the connector at the second accelerator pedal. Install 5-pin breakout harness J-41133 to the second accelerator pedal harness end only. J-41133

**2** Turn the ignition key to the OFF position.

**3** Connect an ohmmeter to the breakout harness pins and measure the resistance. J-39200

Measuring points	Expected value
Pin A / Pin E	4 ± 20% kΩ
Pin A / Pin B	4.5 ± 20% kΩ (accelerator pedal at idle)

## Check of Subsystem

**1**  
Disconnect the VECU and install adapter J-43234 between the VECU and wiring harness connectors PB/PA.

**2**  
Connect the 60-pin breakout box 9998551 (with overlay J-43340) to the adapter.

### Ground wire:

**3**  
Turn the ignition key to the OFF position.

**4**  
Connect an ohmmeter to the 60-pin breakout box and measure the resistance between pin PB23 and the alternate ground.

Measuring points	Optimal value
PB23/ Alternate ground	<1 $\Omega$

### Supply wire:

**5**  
Ignition key in ON position.

**6**  
Connect a voltmeter to the 60-pin breakout box and measure the voltage from pin PB26 to PB23.

Measuring points	Optimal value
PB26 / PB23	5 $\pm$ 20% V

### Signal wire:

**7**  
Turn the ignition key to the ON position.

**8**  
Connect a voltmeter to the 60-pin breakout box and measure the voltage from pin PB25 to PB23.

Measuring points	Expected value
PB25 / PB23	0.5 $\pm$ 20% V (accelerator pedal at idle)
	3.2 $\pm$ 20% V (full acceleration)

## Verification

To verify that the fault has been corrected, use the test in the VCADS Pro tool (see "Appropriate Tests in the VCADS Pro Tool" page 223).

## MID 144 PPID 75 Range Inhibitor, Solenoid Valve Status

This applies only to vehicles with Volvo transmissions.

- **Text Messages**  
In vehicles equipped with diagnostic display, the following message(s) will appear:
- **Instrument Cluster Graphics Display (VN):**  
Range inhibitor
- **Data Link Instrument Cluster (WG, AC, WX):**  
The Data Link instrument cluster graphics display used on WG-, AC-, and WX-series vehicles can display a limited number of text messages. For information, see "Data Link Instrumentation," Volvo Service Publication PV776–381–620SM.
- **VCADS Pro Display:**  
Range inhibitor solenoid valve

## Fault Codes

### FMI 3

Abnormally high voltage.

*Conditions for fault code:*

- If the VECU registers a voltage higher than 6.5 V when the function is active, the VECU interprets this as a fault and a fault code is set.

**Note:** The fault code is set first at the speed when the inhibitor is to engage — at approx 40 km/h (25 mph).

*Possible cause:*

- The wire between the solenoid valve and the VECU short-circuited to battery voltage (B+).
- Faulty solenoid valve.

*Reaction from the VECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The range inhibitor is not activated.

### FMI 4

Abnormally low voltage.

*Conditions for fault code:*

- If the VECU registers a voltage lower than 2.3 V when the function is inactive, the VECU interprets this as a fault and a fault code is set.

**Note:** The fault code is set first at the speed when

the inhibitor is to be released — approximately 36 km/h (23 mph).

*Possible cause:*

- The wire between the solenoid valve and the VECU short-circuited to ground.
- Open circuit, wire between solenoid valve and VECU.
- Open circuit, supply wire to solenoid valve.
- Faulty solenoid valve.
- Switch resistance and oxidation.

*Reaction from the VECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The range inhibitor is not activated or is constantly active.

## MID 144 PPID 75 Range Inhibitor, Solenoid Valve Status, Check

*Other special equipment: J-39200, 9998551, J-43340, J-43234, J-42472*

### NOTE!

- Read off the other fault codes for the VECU.
- Check the particular connectors during the fault tracing for oxidation and switch resistance. For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Appropriate Tests in the VCADS Pro Tool

The following test(s) are useful for closely examining the component's function:

N/A No test currently available.

### Measurement at the Component's Connector, to the VECU

**Note:** Faults in the wiring harness to the VECU can damage the component. Therefore, a check of the component should also be made if any of the measurement values deviate from the expected value.

- 1** Disconnect the connector at the range inhibitor solenoid valve. Install 2-pin breakout harness J-42472 to the wiring harness end only.

#### Ground wire:

- 2** Turn the ignition key to the OFF position.

- 3** Connect an ohmmeter and measure the resistance.

Measuring points	Expected value
Terminal 2 (breakout harness) / alternate ground	1.5 ± 20% MΩ

#### Supply wire:

- 4** Turn the ignition key to the ON position.

- 5** Connect a voltmeter from the breakout harness terminals to the alternate ground and measure the voltage. J-39200

Measuring points	Expected value
Terminal 1 (breakout harness) / alternate ground	B+

#### Wiring harness:

- 6** To check the wiring harness, refer to "VNL, VNM Electrical Schematics," Group 37.

### Check of Component

Range Inhibitor Solenoid


**Note:** Faults in the component can be caused by faults in the wiring harness of the VECU. A check of the wiring harness should also therefore be made before connecting a new component.

- 1** Disconnect the connector at the range inhibitor solenoid valve.

- 2** Install 2-pin breakout harness J-42472 between the solenoid valve and the wiring harness. J-42472

- 3** Turn the ignition key to the ON position.

**4**  
Ground the #2 breakout pin to an alternate ground. Listen for the range inhibitor valve to click.

 <b>CAUTION</b>
Accidental grounding of pin #1 may blow a fuse or cause wiring damage.

### Check of Subsystem

**1**  
Disconnect the VECU and install adapter J-43234 between the VECU and wiring harness connectors PA/PB. J-43234

**2**  
Connect 60-pin breakout box 9998551 (with overlay J-43340) to the adapter. 9998551 J-43340

**3**  
Turn the ignition key to the ON position.

**4**  
Connect a voltmeter to the 60-pin breakout box and measure the voltage. J-39200

Measuring points	Expected value
PB18 / PA12	B+
Connect a jumper wire from PB18 to an alternate ground	Click at range inhibitor solenoid

### Verification

No VCADS Pro tool test is currently available to verify this fault correction.

## MID 144 SID 230 Idle Validation Switch 1

Idle validation switch 1 is located at the driver's accelerator pedal assembly.

- **Text Messages**

In vehicles equipped with diagnostic display, the following message(s) will appear:

- **Instrument Cluster Graphics Display (VN):**

Idle valid switch

- **Data Link Instrument Cluster (WG, AC, WX):**

The Data Link instrument cluster graphics display used on WG-, AC-, and WX-series vehicles can display a limited number of text messages. For information, see "Data Link Instrumentation," Volvo Service Publication PV776-381-620SM.

- **VCADS Pro Display:**

Idle validation switch

## Fault Codes

### FMI 7

Incorrect response from mechanical system.

*Conditions for fault code:*

- If the signal from the idle validation switch is not available, with the accelerator position sensor below 13% travel, the VECU interprets this as a fault and a fault code is set.

*Possible cause:*

- Incorrect or faulty idle validation switch.
- Open circuit in the supply wire.
- Open circuit in the signal wire.
- The signal wire short-circuited to ground.
- The signal wire short-circuited to voltage.
- Switch resistance or oxidation.

*Reaction from the VECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The engine does not respond correctly to acceleration.

## MID 144 SID 230 Idle Validation Switch 1, Check

Other special equipment: J-39200, 9998551, J-43340, J-41133, J-43234

### NOTE!

- Read off the other fault codes for the VECU.
- Check the particular connectors during the fault tracing for oxidation and switch resistance. For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Appropriate Tests in the VCADS Pro Tool

The following test(s) are useful for closely examining the component's function:

**27102-8** Accelerator pedal, switches and sensor, test

### Measurement at the Component's Connector, to the VECU

**Note:** Faults in the wiring harness to the VECU can damage the component. Therefore, a check of the component should also be made if any of the measurement values deviate from the expected value.

**1** Disconnect the connector at the accelerator pedal. Install 5-pin breakout harness J-41133 to the wiring harness end only.

#### Supply wire:

**2** Turn the ignition key to the ON position.

**3** Connect a voltmeter to the breakout harness pins and measure the voltage. J-39200

Measuring points	Expected value
Pin D / alternate ground	B+

#### Signal wire:

**4** Turn the ignition key to the OFF position.

**5** Connect an ohmmeter to the breakout harness pins and measure the resistance. J-39200

Measuring points	Expected value
Pin C / alternate ground	1.2 ± 20% kΩ

#### Wiring harness

**6** To check the wiring harness, refer to "VNL, VNM Electrical Schematics," Group 37.

### Check of Component

Idle validation switch 1

**Note:** Faults in the component can be caused by faults in the wiring harness of the VECU. A check of the wiring harness should also therefore be made before connecting a new component.

**1** Disconnect the connector at the accelerator pedal. Install 5-pin breakout harness J-41133 to the accelerator pedal harness only. J-41133

**2** Turn the ignition key to the OFF position.

**3** Connect an ohmmeter to the breakout harness pins and measure the resistance.

Measuring points	Expected value
Pin C / Pin D	open circuit (accelerator at idle)
	20-90 Ω (full acceleration)

## Check of Subsystem

**1**  
Disconnect the VECU and install adapter J-43234 between the VECU and wiring harness connectors PA/PB.

**2**  
Connect 60-pin breakout box 9998551 (with overlay J-43340) to the adapter.

### *Signal wire:*

**3**  
Turn the ignition key to the ON position.

**4**  
Connect a voltmeter to the 60-pin breakout box and measure the voltage.

Measuring points	Expected value
PA23 / PA12	0 V (accelerator at idle)
	B+ (full acceleration)

## Verification

To check that the fault has been corrected, use the test in the VCADS Pro tool (see "Appropriate Tests in the VCADS Pro Tool" page 229).



## MID 144 SID 231 SAE J1939 Control Link

High-speed digital communication between different electronic control units takes place over the J1939 Control Link; this is used to control vehicle operation. If the J1939 Control Link fails, the J1587/1708 Information Link serves as a "back-up" control link.

- **Text Messages**  
In vehicles equipped with diagnostic display, the following message(s) will appear:
- **Instrument Cluster Graphics Display (VN):**  
SAE J1939 data link
- **Data Link Instrument Cluster (WG, AC, WX):**  
The Data Link instrument cluster graphics display used on WG-, AC-, and WX-series vehicles can display a limited number of text messages. For information, see "Data Link Instrumentation," Volvo Service Publication PV776-381-620SM.
- **VCADS Pro Display:**  
SAE J1939 data link

## Fault Codes

### FMI 2

Intermittent or incorrect data.

*Conditions for fault code:*

- If the VECU does not receive confirmation for the messages on the J1939 Control Link, the VECU interprets this as a fault and a fault code is set.

*Possible cause:*

- Loose connection.
- Open circuit in J1939 Control Link wire.
- Switch resistance and oxidation.

*Reaction from the VECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.

### FMI 12

Faulty unit or component.

*Conditions for fault code:*

- If the expected messages are not available from a control unit on the J1939 Control Link, the VECU interprets this as a fault and a fault code is set.

*Possible cause:*

- Open circuit in J1939 Control Link wire.

- Switch resistance and oxidation.

*Reaction from the VECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.

## MID 144 SID 231 SAE J1939 Control Link, Check

*Other special equipment: J-39200*

### NOTE!

- Read off the other fault codes for the VECU.
- Check the particular connectors during the fault tracing for oxidation and switch resistance. For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Appropriate Tests in the VCADS Pro Tool

The following test(s) are useful for closely examining the component's function:

**N/A** No test currently available.

### Check of Subsystem

**1**

Turn the ignition key to the OFF position.

**2**

Using an ohmmeter, back probe connector PC (Green 5-pin) at connectors PC4 and PC5 with the connector installed in the VECU. J-39200

Measuring points	Expected value
PC4 / PC5	60 ± 10 Ω

**3**

Turn the ignition key to the ON position.

**4**

Using a voltmeter, back probe connector PC (Green 5-pin) at connectors PC4 and PC5 with the connector installed in the VECU.

**Note:** This may require the use of voltmeter function MIN/MAX.

Measuring points	Expected value
PC4 / Alternate ground	2-5 V DC
PC5 / Alternate ground	0-3 V DC
PC4 / PC5	0-5 V DC

**Note:** The voltage of the control link varies and is dependent on the number of electronic control units and traffic on the control link.

### Verification

No VCADS Pro tool test is currently available to verify this fault correction.

## MID 144 SID 240 Program Memory

At startup, a checksum is calculated for the software in the VECU's flash memory. This is compared with the previously stored checksum to verify that the checksum is correct.

- **Text Messages**  
In vehicles equipped with diagnostic display, the following message(s) will appear:
- **Instrument Cluster Graphics Display (VN):**  
Program memory
- **Data Link Instrument Cluster (WG, AC, WX):**  
The Data Link instrument cluster graphics display used on WG-, AC-, and WX-series vehicles can display a limited number of text messages. For information, see "Data Link Instrumentation," Volvo Service Publication PV776-381-620SM.
- **VCADS Pro Display:**  
Programm memory

## Fault Codes

### FMI 2

Intermittent or incorrect data.

*Conditions for fault code:*

- If the checksum stored at start up does not agree with the previously stored checksum, the VECU interprets this as a fault and a fault code is set.

*Possible cause:*

- Internal software fault.
- Faulty memory circuit.

*Reaction from the VECU:*

- The VECU continuously restarts.

*Noticeable external symptom:*

- Yellow lamp is lit by the instrument control unit since the VECU does not respond to the call.
- The vehicle can only be run in "limp home mode."

## MID 144 SID 243 Cruise Control Set Switch

- **Text Messages**

In vehicles equipped with diagnostic display, the following message(s) will appear:

- **Instrument Cluster Graphics Display (VN):**

CC Set switch

- **Data Link Instrument Cluster (WG, AC, WX):**

The Data Link instrument cluster graphics display used on WG-, AC-, and WX-series vehicles can display a limited number of text messages. For information, see "Data Link Instrumentation," Volvo Service Publication PV776-381-620SM.

- **VCADS Pro Display:**

CC set switch

## Fault Codes

### FMI 7

Incorrect response from mechanical system.

*Conditions for fault code:*

- If the VECU receives the signals for SET+ and SET- at the same time, the VECU interprets this as a fault and a fault code is set.

*Possible cause:*

- Faulty switch.
- Signal wire short-circuited to voltage.

*Reaction from the VECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The cruise control function does not work. The speed cannot be set.

**Note:** If the speed has been previously set, it can be "resumed."

## MID 144 SID 243 Cruise Control Set Switch, Check

Other special equipment: J-39200, 9998551, J-43340, J-43234

### NOTE!

- Read off the other fault codes for the VECU.
- Check the particular connectors during the fault tracing for oxidation and switch resistance. For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Appropriate Tests in the VCADS Pro Tool

The following test(s) are useful for closely examining the component's function:

27503-8 Cruise control, switch, test

### Measurement at the Component's Connector, to the VECU

**Note:** Faults in the wiring harness to the VECU can damage the component. Therefore, a check of the component should also be made if any of the measurement values deviate from the expected value.

**1**  
Disconnect the connector at the switch for the cruise control. Measurements should be taken only on the wiring harness connector.

#### Supply wire:

**2**  
Turn the ignition key to the ON position.

**3**  
Connect a voltmeter to the connector and measure the voltage. J-39200

Measuring points	Expected value
Wiring harness connector A / alternate ground	B+

#### Signal wire:

#### SET+

**4**  
Turn the ignition key to the OFF position.

**5**  
Connect an ohmmeter to the connector and measure the resistance. J-39200

Measuring points	Expected value
Wiring harness connector E / alternate ground	1.2 ± 20% kΩ

### RESUME

**6**  
Turn the ignition key to the OFF position.

**7**  
Connect an ohmmeter to the connector and measure the resistance. J-39200

Measuring points	Expected value
Wiring harness connector H / alternate ground	1.2 ± 20% kΩ

### ON

**8**  
Turn the ignition key to the OFF position.

**9**  
Connect an ohmmeter to the connector and measure the resistance. J-39200

Measuring points	Expected value
Wiring harness connector C / alternate ground	1.2 ± 20% kΩ

### SET-

**10**  
Turn the ignition key to the OFF position.

**11**  
Connect an ohmmeter to the connector and measure the resistance. J-39200

Measuring points	Expected value
Wiring harness connector G / alternate ground	1.2 ± 20% kΩ

### Wiring harness

**12**  
To check the wiring harness, see "VNL, VNM Electrical Schematics," Group 37.

## Check of Component

Cruise control set switch

**Note:** Faults in the component can be caused by faults in the wiring harness of the VECU. A check of the wiring harness should also therefore be made before connecting a new component.

**1**

Disconnect the connector at the switch for the cruise control. Measurements should be taken only on the cruise control switch connector.

**2**

Turn the ignition key to the OFF position.

**3**

Connect an ohmmeter to the connector and measure the resistance.

J-39200

Measuring points	Expected value
Cruise control switch connectors E / G	open circuit (SET+ and SET- inactive)
	open circuit (ON and SET+ active)
	open circuit (RESUME active and SET+ active)
	open circuit (ON and SET- active)
	open circuit (RESUME active and SET- active)

## Check of Subsystem

**1**

Disconnect the VECU and install adapter J-43234 between the VECU and wiring harness connectors PA/PB.

J-43234

**2**

Connect 60-pin breakout box 9998551 (with overlay J-43340) to the adapter. 9998551  
J-43340

*Signal wire:*

**3**

Turn the ignition key to the ON position.

**4**

Connect a voltmeter to the 60-pin breakout box and measure the voltage. J-39200

Measuring points	Expected value
PA1 / PA12	B+ (OFF and SET- active)
	0 V (OFF and SET+ active)
	0 V (ON and SET+ active)
	0 V (RESUME active and SET+ active)
PA2 / PA12	B+ (OFF and SET+ active)
	0 V (OFF and SET- active)
	0 V (ON and SET- active)
	0 V (RESUME active and SET- active)

## Verification

To check that the fault has been corrected, use the test in the VCADS Pro tool (see "Appropriate Tests in the VCADS Pro Tool" page 235).

## MID 144 SID 250 SAE J1587/1708 Information Link

The J1587/1708 Information Link is used to communicate gauge information and diagnostic messages.

High-speed digital communication between different electronic control units takes place over the J1939 Control Link; this is used to control vehicle operation. If the J1939 Control Link fails, the J1587/1708 Information Link serves as a "back-up" control link.

- **Text Messages**  
In vehicles equipped with diagnostic display, the following message(s) will appear:
- **Instrument Cluster Graphics Display (VN):**  
SAE J1708 data link
- **Data Link Instrument Cluster (WG, AC, WX):**  
The Data Link instrument cluster graphics display used on WG-, AC-, and WX-series vehicles can display a limited number of text messages. For information, see "Data Link Instrumentation," Volvo Service Publication PV776-381-620SM.
- **VCADS Pro Display:**  
SAE J1587/1708 data link

## Fault Codes

### FMI 2

Intermittent or incorrect data.

*Conditions for fault code:*

- If the VECU registers incorrect messages on the J1587/1708 Information Link, the VECU interprets this as a fault and a fault code is set.

*Possible cause:*

- Several units are sending at the same time on the J1587/1708 Information Link.

*Reaction from the VECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.

## MID 144 SID 250 SAE J1587/1708 Information Link, Check

*Special tools: J-39200*

### NOTE!

- Read off the other fault codes for the VECU.
- Check the particular connectors during the fault tracing for oxidation and switch resistance. For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Appropriate Tests in the VCADS Pro Tool

The following test(s) are useful for closely examining the component's function:

N/A No test currently available.

### Check of Subsystem

1

Turn the ignition key to the ON position.

2

Using a voltmeter, back the probe connector PC (Green, 5-pin) at connectors PC1 and PC2 with the connector installed in the VECU.

J-39200

**Note:** This may require the use of voltmeter function MIN/MAX.

Measuring points	Expected value
PC1 / Alternate ground	0-5 V DC
PC2 / Alternate ground	0-5 V DC
PC1 / PC2	2-5 V DC

**Note:** The voltage of the information link varies and is dependent on the number of electronic control units and traffic on the information link.

### Verification

No VCADS Pro tool test is currently available to verify this fault correction.



## MID 144 SID 253 Data Set Memory EEPROM

At start-up, a checksum is calculated for the data set in the VECU's EEPROM memory. This is compared with the previously stored checksum to verify that the data set is correct.

- **Text Messages**  
In vehicles equipped with diagnostic display, the following message(s) will appear:
- **Instrument Cluster Graphics Display (VN):**  
Calibration memory
- **Data Link Instrument Cluster (WG, AC, WX):**  
The Data Link instrument cluster graphics display used on WG-, AC-, and WX-series vehicles can display a limited number of text messages. For information, see "Data Link Instrumentation," Volvo Service Publication PV776-381-620SM.
- **VCADS Pro Display:**  
Calibration memory EEPROM

## Fault Codes

### FMI 2

Intermittent or incorrect data.

*Conditions for fault code:*

- If the VECU receives an error in calculating the checksum in the calibration memory, the VECU interprets this as a fault and a fault code is set.

*Possible cause:*

- The memory circuit is faulty.
- Error when programming.

*Reaction from the VECU:*

- Fault code is set.
- Red lamp is requested.

*Noticeable external symptom:*

- Red lamp lights up.
- The vehicle can only be driven in the "limp home mode."

### FMI 13

Values outside calibration values.

*Conditions for fault code:*

- If the VECU receives an error when calculating the checksums for the data sets, the VECU interprets this as a fault and a fault code is set.

*Possible cause:*

- The memory circuit is faulty.

- Error when programming of the data sets.

*Reaction from the VECU:*

- Fault code is set.
- Red lamp is requested.

*Noticeable external symptom:*

- Red lamp lights up.
- The vehicle can only be driven in the "limp home mode."

## MID 144 PSID 3 Idle Validation Switch 3

This applies only to vehicles with a second accelerator pedal assembly (WX).

**Note:** Idle validation switch 2 is not used in North American applications.

- **Text Messages**

In vehicles equipped with diagnostic display, the following message(s) will appear:

- **Instrument Cluster Graphics Display (VN):**

Idle validation switch 3

- **Data Link Instrument Cluster (WG, AC, WX):**

The Data Link instrument cluster graphics display used on WG-, AC-, and WX-series vehicles can display a limited number of text messages. For information, see "Data Link Instrumentation," Volvo Service Publication PV776-381-620SM.

- **VCADS Pro Display:**

Idle validation switch 3

## Fault Codes

### FMI 7

Incorrect response from mechanical system.

*Conditions for fault code:*

- If the signal from the idle validation switch is not available with the accelerator position sensor below 13% travel, the VECU interprets this as a fault and a fault code is set.

*Possible cause:*

- Faulty idle validation switch.
- Open circuit in the supply wire.
- Open circuit in the signal wire.
- The signal wire short-circuited to ground.
- The signal wire short-circuited to voltage.
- Switch resistance and oxidation.

*Reaction from the VECU:*

- Fault code is set.
- Yellow lamp is requested.

*Noticeable external symptom:*

- Yellow lamp lights up.
- The engine does not respond correctly when the second accelerator pedal is depressed.

## MID 144 PSID 3 Idle Validation Switch 3, Check

Other special equipment: J-39200, 9998551, J-43340, J-43234, J-41133

### NOTE!

- Read off the other fault codes for the VECU.
- Check the particular connectors during the fault tracing for oxidation and switch resistance. For detailed circuit information, refer to "VNL, VNM Electrical Schematics," Group 37.

### Appropriate Tests in the VCADS Pro Tool

The following test(s) are useful for closely examining the component's function:

**27104-8** Extra accelerator control, switches and sensor, test

### Measurement at the Component's Connector, to the VECU

**Note:** Faults in the component can be caused by faults in the wiring harness of the VECU. A check of the wiring harness should also therefore be made before connecting a new component.

**1** Disconnect the connector at the second accelerator pedal. Install 5-pin breakout harness J-41133 to the wiring harness end only. J-41133

#### Supply wire:

**2** Turn the ignition key to the ON position.

**3** Connect a voltmeter to the connector and measure the voltage. J-39200

Measuring points	Expected value
Pin D / alternate ground	B+

#### Signal wire:

**4** Turn the ignition key to the OFF position.

**5** Connect an ohmmeter to the connector and measure the resistance. J-39200

Measuring points	Expected value
Pin C / alternate ground	1.2 ± 20% kΩ

#### Wiring harness

**6** To check the wiring harness, see "VNL, VNM Electrical Schematics," Group 37.

### Check of Component

Idle validation switch 3

**Note:** Faults in the component can be caused by faults in the wiring harness of the VECU. A check of the wiring harness should also therefore be made before connecting a new component.

**1** Disconnect the connector at the second accelerator pedal. Install 5-pin breakout harness J-41133 to the accelerator pedal harness end only. J-41133

**2** Turn the ignition key to the OFF position.

**3** Connect an ohmmeter to the connector and measure the resistance. J-39200

Measuring points	Expected value
Pin C / Pin D	open circuit (accelerator at idle)
	20-90 Ω (full acceleration)

## Check of Subsystem

**1**

Disconnect the VECU and install adapter J-43234 between the VECU and wiring harness connectors PA/PB.

J-43234

**2**

Connect a 60-pin breakout box 9998551 (with overlay J-43340) to the adapter.

9998551

J-43340

### *Signal wire:*

**3**

Turn the ignition key to the ON position.

**4**

Connect a voltmeter to the 60-pin breakout box and measure the voltage.

J-39200

Measuring points	Expected value
PB30 / PA12	0 V (accelerator at idle)
	B+ (full acceleration)

## Verification

To check that the fault has been corrected, use the test in the VCADS Pro tool (see "Appropriate Tests in the VCADS Pro Tool" page 241).

## Service Procedures

### 2841-03-02-01

### Engine ECU, Replacement

Special tools: 9998482

1

**Note:** Make sure that the parking brake is applied.

2

Disconnect the power with main switch

#### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

#### WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. Clean up fuel spills immediately.

3



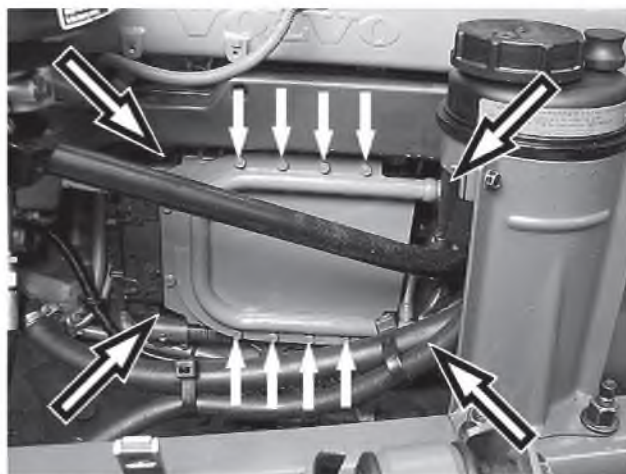
T2014053

Remove the connector from the control unit by pressing the catch and pushing the handle up.

4

Cut the clamps round the cable harness under the control unit and fold away the connector for the control unit.

5



T2014052

Remove the bolts for the cooling coil on the control unit.

**Note:** Do not release the fuel lines on the cooling coil.

6

Remove the control unit's hold-down bolts (4, see previous illustration) and lift off the control unit.

7

Install the new control unit.

**Note:** Make sure that the framework line is positioned correctly and that the mating surface on the engine block is free from rust.

If the control unit is painted where the cooling coil is to be installed: Remove the paint where the cooling coil is in contact with the control unit to ensure maximum cooling.

8

Install the cooling coil on the control unit.

9

Check the clamping force of the terminal in the connector for the control unit by means of gauge 9998482.

9998482

10

Install the connector on the control unit. Make sure that the catch locks on the connector.

**11**

Clamp the cables under the control unit.

**12**

Switch on the power.

**Note:** When starting the engine with cab up, make sure that a gear is not engaged. The parking brake should be applied.

**13**

Conduct a function check. Check that there are no fault codes in the control unit.

# Feedback

One of our objectives is that workshop personnel should have access to correct and appropriate service manuals where it concerns fault tracing, repairs and maintenance of Volvo trucks.

In order to maintain the high standards of our literature, your opinions and experience when using this manual would be greatly appreciated.

If you have any comments or suggestions, make a copy of this page, write down your comments and send them to us, either via telefax or mailing directly to the address listed below.

To

From

Volvo Trucks North America, Inc.

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Comments/proposals

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Concerns Service Manual: .....





# Operation Numbers

2841-03-02-01 Engine ECU, Replacement . . . . . 243

**VOLVO**

**Volvo Trucks North America, Inc.**

P.O. Box 26115, Greensboro, NC 27402-6115

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# Service Manual Trucks

Group **250-610**

VOLVO Engine Brake  
VE D12, D12A, D12B



# Foreword

The descriptions and service procedures contained in this manual are based on designs and methods studies carried out up to February 2000.

The products are under continuous development. Vehicles and components produced after the above date may therefore have different specifications and repair methods. When this is believed to have a significant bearing on this manual, supplementary service bulletins will be issued to cover the changes.

The new edition of this manual will update the changes.

In service procedures where the title incorporates an operation number, this is a reference to an V.S.T. (Volvo Standard Times).

Service procedures which do not include an operation number in the title are for general information and no reference is made to an V.S.T.

The following levels of observations, cautions and warnings are used in this Service Documentation:

**Note:** Indicates a procedure, practice, or condition that must be followed in order to have the vehicle or component function in the manner intended.

**Caution:** Indicates an unsafe practice where damage to the product could occur.

**Warning:** Indicates an unsafe practice where personal injury or severe damage to the product could occur.

**Danger:** Indicates an unsafe practice where serious personal injury or death could occur.

**Volvo Trucks North America, Inc.**  
Greensboro, NC USA

**Order number: PV776-TSP0250610/2**

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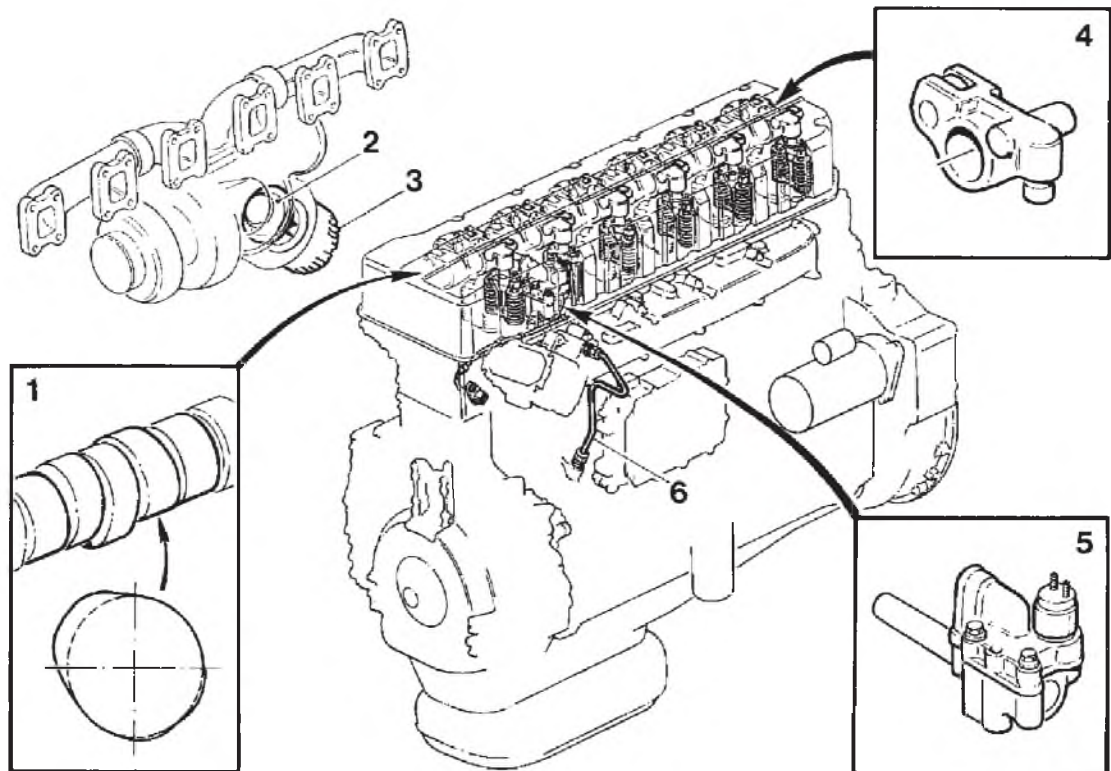
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## General

### VOLVO Engine Brake (VEB)

Successful troubleshooting of the VOLVO engine brake system requires information regarding system design and knowledge of how the different components function in relation to each other.



W2002155

- 1 Camshaft
- 2 Shutter
- 3 Exhaust pressure governor

- 4 Rocker arm
- 5 Control valve
- 6 Oil pipe

The description, operation and service of the Volvo Engine Brake is detailed as follows:

The Troubleshooting section is subdivided into **Electrical Troubleshooting** and **Mechanical Troubleshooting**.

Refer to this information along with the description and operation information when performing troubleshooting.

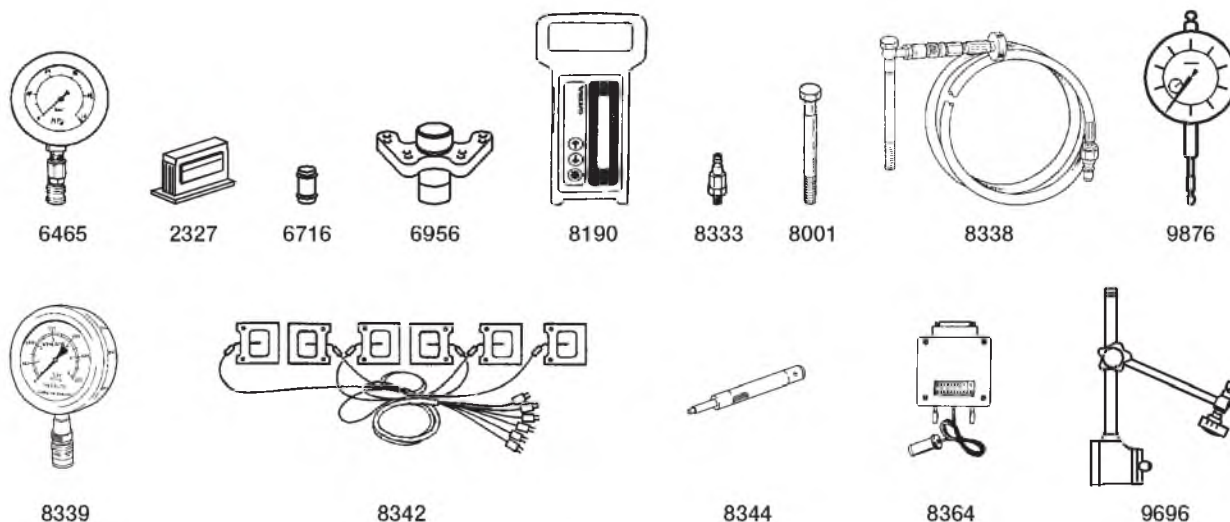




# Tools

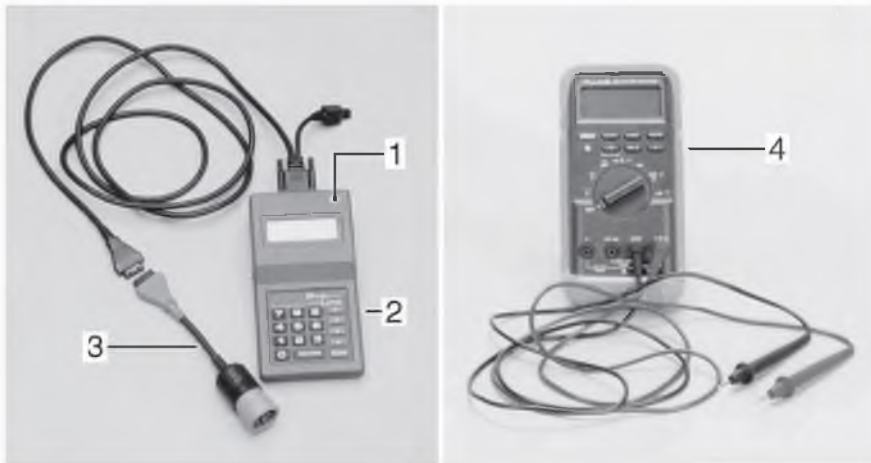
## VOLVO Engine Brake, Special Tools

Servicing the Volvo Engine Brake (VEB) requires the following special tools. The tools are available from the Parts Department of Volvo Truck North America, Inc. Unless otherwise noted, all tool numbers are preceded by "999." Please specify the complete part number when ordering. Tools with part numbers beginning with "J" are available only from Kent-Moore.



W2002194

<b>9996465</b>	Pressure gauge, 0 –10 bar (0 – 145 psi)	<b>9998338</b>	Connector for checking oil pressure in the rocker arm shaft
<b>9812327</b>	Memory cassette	<b>9989876</b>	Dial indicator
<b>9996716</b>	Drift	<b>9998339</b>	Pressure gauge, 0 – 6 bar (0 – 90 psi)
<b>9996956</b>	Cranking tool for flywheel	<b>9998342</b>	Temperature sensors for measuring exhaust gas temperature
<b>9998190</b>	Measuring instrument	<b>9998344</b>	Drift, used when changing ball seating in the rocker arm
<b>9998333</b>	Union, used together with pressure gauge 9996465	<b>9998364</b>	Collation unit for temperature measuring
<b>9808001</b>	Bolt	<b>9999696</b>	Magnetic base

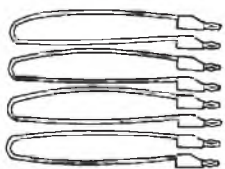


W2003381

- 1 J-38500-1 Pro-Link® 9000
- 2 J-38500-1000 Cartridge
- 3 J-38500-60A Adapter
- 4 9510060 Multimeter

### Other special equipment

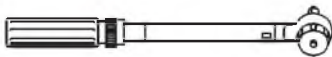
Tools with part numbers beginning with the letter “J” are available from your local Kent Moore dealer.



J 35616-20



J 42472



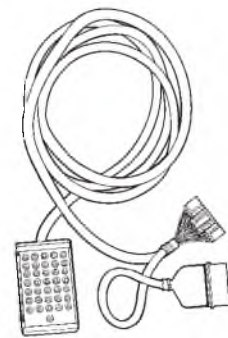
115 9794



999 9708



J 39200



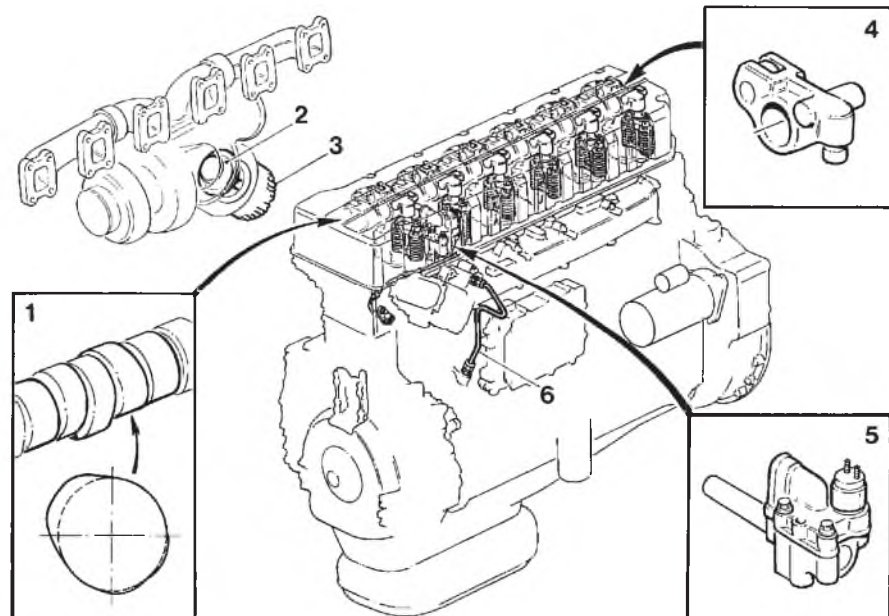
J 41132

W2002195

<b>J-35616-20</b>	Jumper wires	<b>9999708</b>	Torque wrench 0 – 17.5 Nm (0 – 15 ft-lb)
<b>J-42472</b>	2-pin breakout harness	<b>J- 39200</b>	Fluke 87 digital multimeter
<b>1159794</b>	Torque wrench 10 – 100 Nm (7.5 – 75 ft-lb)	<b>J- 41132</b>	36-pin breakout box

# Design and Function

## Engine Brake



W2000702

- |   |          |   |                           |   |               |
|---|----------|---|---------------------------|---|---------------|
| 1 | Camshaft | 3 | Exhaust Pressure Governor | 5 | Control valve |
| 2 | Shutter  | 4 | Rocker arm                | 6 | Oil pipe      |

The Volvo Engine Brake consists of **two** different systems, the **exhaust brake** and the **compression brake**. In the VEB, both systems operate at the same time.

## Exhaust Brake

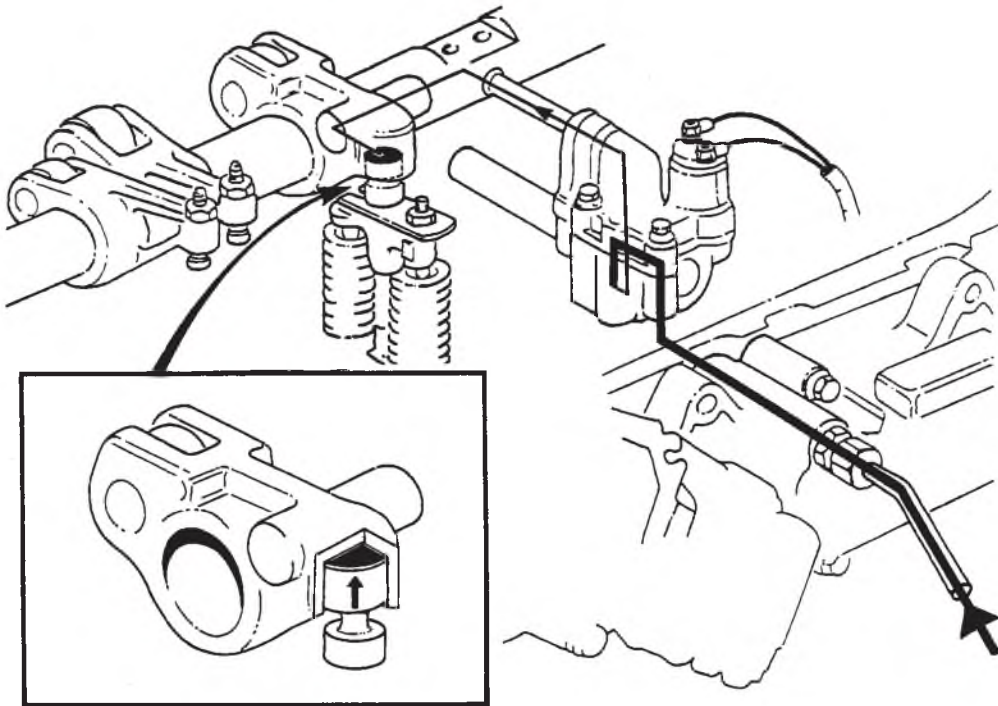
The exhaust pressure governor includes a shutter, mounted in the exhaust side of the turbocharger. This shutter, which is connected to the exhaust pressure governor plunger, restricts the exhaust gas flow when activated. Braking is achieved during the exhaust stroke by the backpressure created when the exhaust gas flow is blocked.

## Compression Brake

The compression brake controls the opening of exhaust valves during the engine compression and combustion (operating) stroke. This creates backpressure in the combustion chamber which, in turn, has a braking effect.

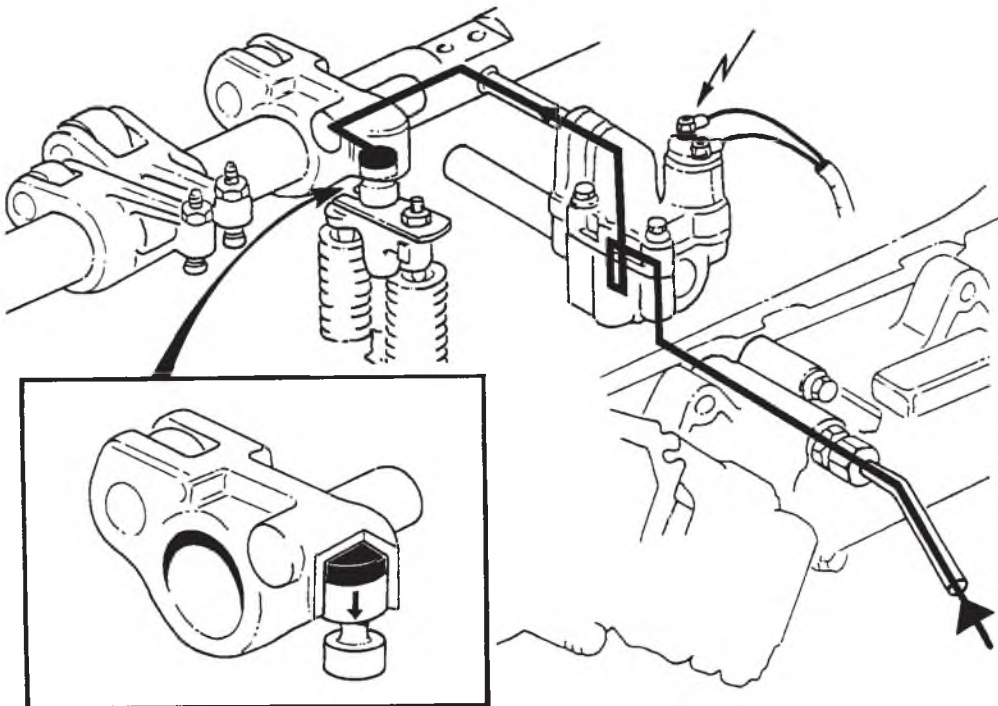
On engines with compression brakes, the camshaft has two extra lobes on each exhaust cam profile. The lift height of the extra lobes is very low compared to that of normal exhaust lobes. To enable the extra lobes to open the exhaust valves, the exhaust rocker arms are arranged in a manner which reduces valve clearance during the braking sequence.

# Control Valve (VEB)



T2007789

Fig. 1: Engine in operation, the control valve solenoid valve not activated



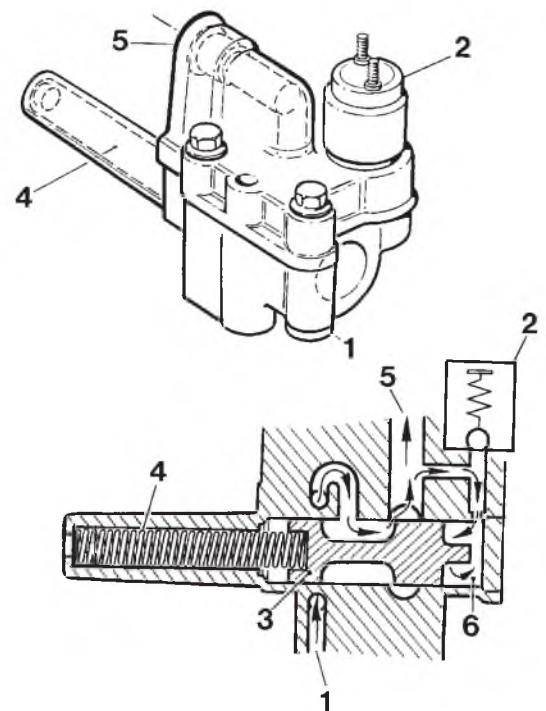
T2007788

Fig. 2: VEB engine braking, the control valve solenoid valve activated

The control valve is mounted on the cylinder head under the valve cover and is connected to the oil system ahead of the rocker arm shaft. Its purpose is to reduce oil pressure to the rocker arms while the engine is operating. There is always full system oil pressure to the control valve inlet (1). A pipe connects the inlet to the lube oil gallery in the cylinder block. Oil pressure to the rocker arm shaft can be increased by a solenoid valve (2) mounted on the control valve, from about 100 kPa (14.5 psi) while the engine is operating to over 200 kPa (29 psi) during compression braking.

During engine operation, the springs' force and oil pressure in the oil chamber hold the control valve plunger in balance. This action reduces oil pressure.

When the solenoid valve is activated, the oil chamber (6) is drained and the spring (4) presses the plunger (3) to its end position. The plunger completely opens the oil outlet (5) and the oil pressure to the rocker arm shaft is increased.



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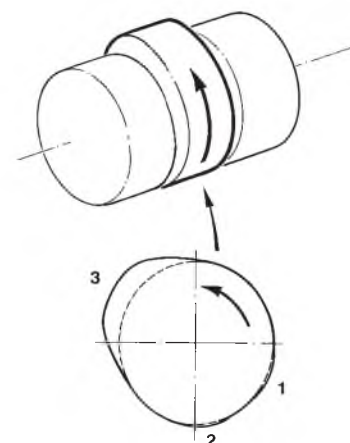
Fig. 3: Control valve

- 1 Oil inlet
- 2 Solenoid valve
- 3 Plunger
- 4 Spring
- 5 Oil outlet
- 6 Oil chamber

## Camshaft (VEB)

On engines with a compression brake, the camshaft has an induction lobe (1) and decompression lobe (2) in addition to the normal exhaust lobe (3) on each cam profile for the exhaust valves. The induction and decompression lobe lift height is 0.8 mm (0.032 in.) above the basic circle, which is equivalent to about 1.1 mm (0.043 in.) at the valve bridge. The induction lobe is positioned to open the exhaust valves at the end of the intake stroke and hold them open at the beginning of the compression stroke. The decompression lobe is positioned to open the exhaust valves at the end of the compression stroke.

The valve clearance must be zero for the induction and decompression lobes to open the exhaust valves.



T2006826

Fig. 4: Camshaft section

- 1 Induction lobe
- 2 Decompression lobe
- 3 Exhaust lobe



## Exhaust Rocker Arms (VEB)

The exhaust rocker arms on an engine with a compression brake are larger than those of a conventional engine.

The rocker arm is equipped with a non-return valve and a plunger with a pressure-limiting valve. Its purpose is to regulate oil flow during compression braking.

Spring-tab pressure holds the rocker arm at the rest position against the valve bridge.

Valve clearance is greater on an engine without a compression brake, as the induction and decompression lobes must not open the exhaust valves while the engine is operating.

Shims are placed on the valve bridge to adjust valves.

**Note:** Do not use more than two shims to obtain proper valve clearance.

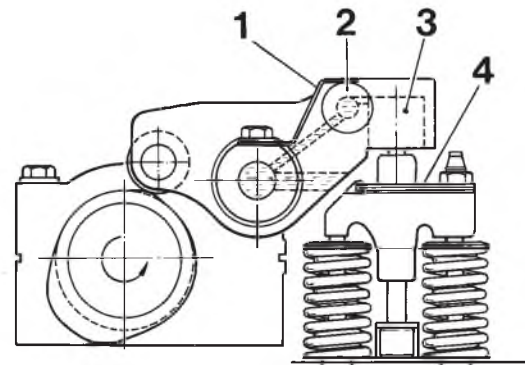


Fig. 5: Exhaust rocker arm

- 1 Spring tab
- 2 Non-return valve
- 3 Rocker arm plunger
- 4 Shims

## Non-Return Valve (VEB)

There is a non-return valve, consisting of a plunger (1), spring (2) and ball (3) in the rocker arm. When oil from the rocker arm shaft is forced into the valve, the spring force and the oil pressure determine movement of the plunger.

When the oil pressure is low, about 100 kPa (14.5 psi), the control valve is in its engine operating position. During this time, the plunger (1) will not move out of its rest position because the oil pressure cannot overcome the spring force. The plunger pin prevents the ball (3) from seating and the oil can flow freely through the valve in both directions.

When the control valve takes up the position for compression braking, oil pressure to the non-return valve increases. The spring force in the non-return valve is such that when the oil pressure exceeds about 200 kPa (29 psi), it overcomes the spring force and moves the plunger (1) to where it no longer controls the ball (3). The spring (5) forces the ball against its seat and the oil contained above the plunger (4) cannot flow past the ball (3). As a result, high oil pressure is formed above the plunger (4).

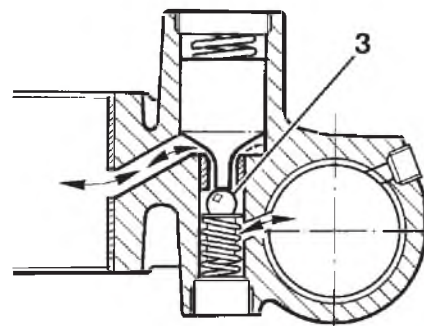


Fig. 6: Non-return valve during engine operation

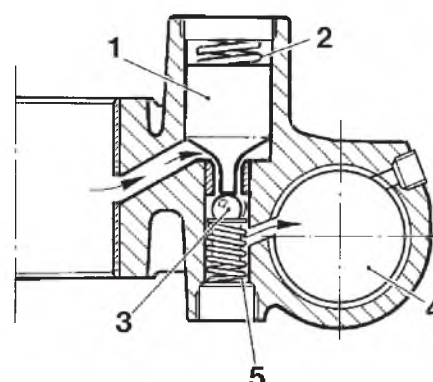


Fig. 7: Non-return valve during VEB operation

- 1 Plunger
- 2 Spring
- 3 Ball
- 4 Rocker arm plunger
- 5 Spring

## Rocker Arm Plunger

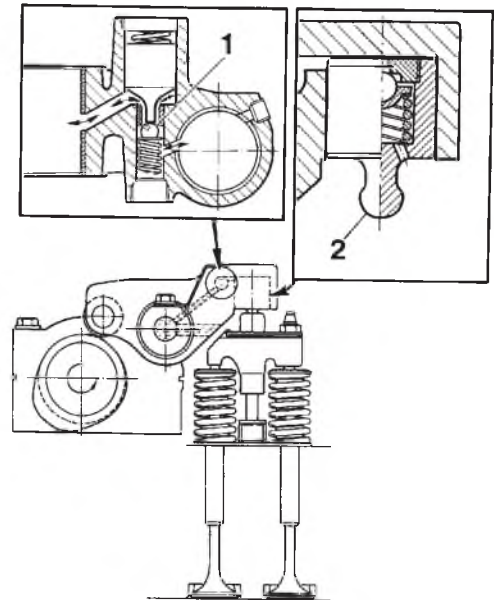
The purpose of the plunger is to zero-set the valve clearance during compression braking.

### Engine Operation

When the engine is operating, there is reduced oil pressure through the control valve to the rocker arm shaft, and the rocker arm non-return valve (1) is open. Oil can flow freely through the non-return valve in both directions. Therefore, no oil pressure is built up between the rocker arm plunger (2) and the rocker arm.

The set valve clearances are great enough to prevent the cam shaft induction and decompression lobes from opening the exhaust valves.

The valve mechanism operates as it would on an engine without a compression brake. That is, only the exhaust lobe opens the exhaust valves.



T2006828

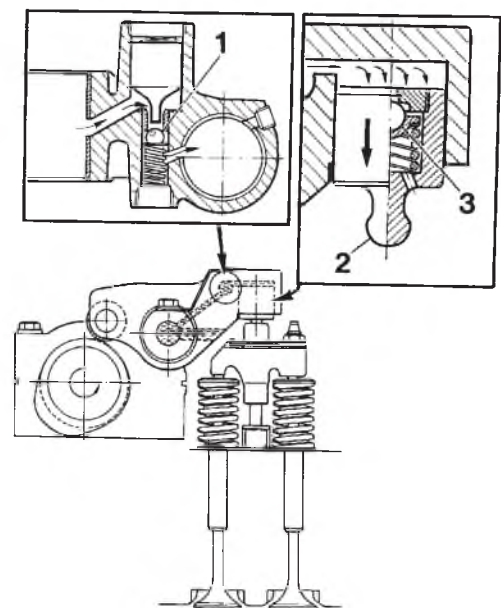
Fig. 8: Rocker arm plunger during engine operation

- 1 Non-return valve
- 2 Rocker arm plunger

## Compression Braking

During compression braking, an oil pressure of at least 200 kPa (29 psi) is delivered to the rocker arm shaft as the control valve does not reduce the oil pressure.

The pressure in the rocker arm non-return valve (1) increases enough to move the plunger in the non-return valve from its rest position, and the ball now functions as a non-return valve. Pressure builds up between the rocker arm plunger (2) and the rocker arm. The plunger moves out and forces the rocker arm roller against the lobes on the camshaft. The valve clearance is eliminated and the lift height on the induction and decompression lobes is sufficient to open the exhaust valves. The rocker arm plunger is equipped with a pressure-limiting valve (3). When oil pressure between the rocker arm plunger and the rocker arm becomes too high, the pressure-limiting valve opens and oil can exit through the hole in the bottom of the plunger. The opening pressure of the pressure-limiting valve is governed by the force of the valve spring.



T2006836

Fig. 9: Rocker arm plunger during compression braking

- 1 Non-return valve
- 2 Rocker arm plunger
- 3 Pressure-limiting valve

# Engine Braking

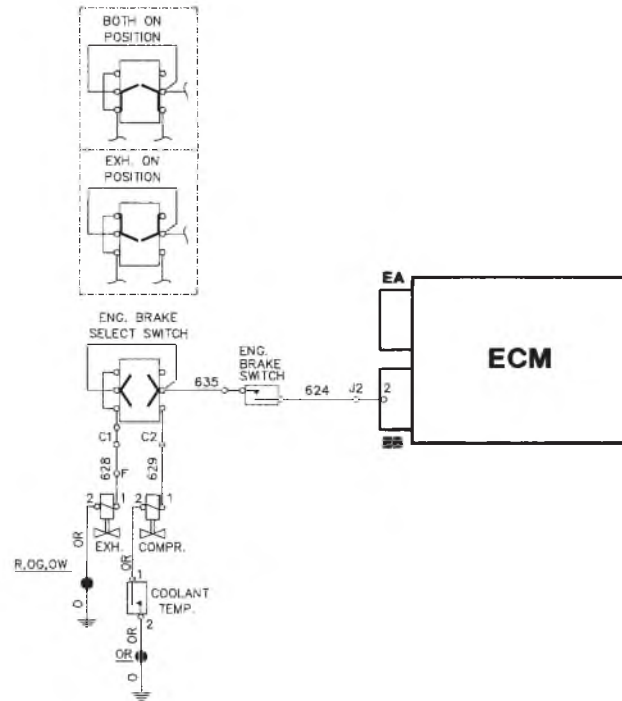
## Control System, D12 and D12 A

With the complete release of the accelerator pedal, the engine brake is activated according to the selection made on the dash board, but only if certain conditions are met:

- Accelerator pedal must be fully released (fuel injection must not occur).
- Engine speed must be greater than 1100 rpm.
- Clutch pedal must not be depressed.
- Boost pressure must be lower than 150 kPa (22 psi).
- Constant engine speed mode (PTO) must not be activated.
- Engine brake disabled, input must not be activated (ABS).
- Vehicle speed must be greater than 3.2 km/h (2 mph).
- Engine temperature must be higher than the following:

Part number of Temperature Switch	Temperature measured at outlet of cooling pump
p/n 8155799	43°C (110°F)
p/n 3985349	67°C (158°F)

As an additional option, the engine brake may be enabled automatically if the vehicle exceeds a specified cruise control limit. If this option is selected, the engine brake may be applied at a selectable speed from 6.4 to 32 km/h (4 to 20 mph) above the cruise control set speed.



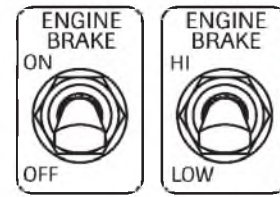
W2000877

Fig. 10: Engine brake logic schematic, D12 and D12 A.



## Switches

On the dash the switches for the engine brake have different configurations. With the two dual-position switches, the brake system is activated by placing one of the switches in **ON** position. The HI/LO switch, in the HI position, selects both the exhaust brake and the compression brake (Volvo engine brake or VEB). In the LO position, only the exhaust brake is selected.



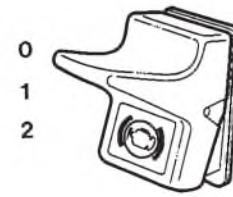
W3002627

Fig. 11: Dual-position switches for Engine brake

The engine brake switches are on some truck models replaced by a single three-position switch. As with the switches above it also regulates the engine brake for the cruise control.

The three position switch has the following selection:

- 1 No engine brake engaged
- 2 Exhaust brake, EPG
- 3 Exhaust brake and compression brake



T2006953

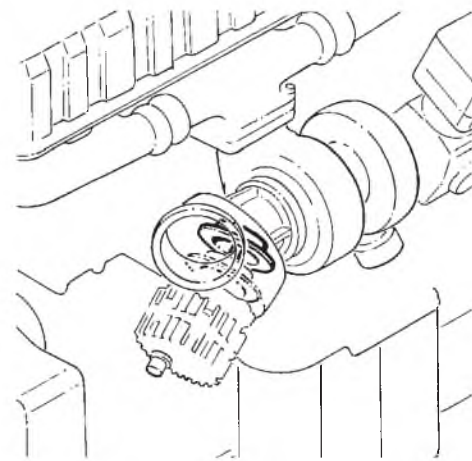
Fig. 12: Three-position switch for engine brake

## Exhaust Brake

During exhaust braking, control pressure of about 752 kPa (109 psi) activates the exhaust pressure governor. The exhaust pressure governor plunger is activated and the shutter connected to the plunger restricts the flow of exhaust gases out of the cylinders.

Restricting the flow of exhaust gases creates a back pressure between the shutter and the piston crowns. This provides a braking effect on the pistons as the exhaust valves open.

The higher the engine speed during exhaust braking, the greater the braking effect.



T2006832

Fig. 13: Exhaust pressure governor

## Compression Brake

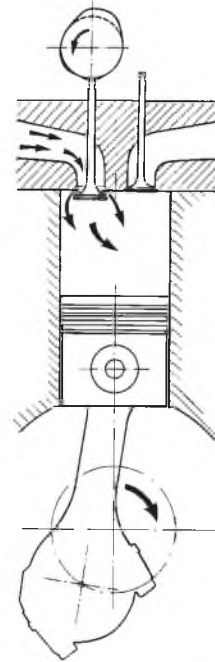
The exhaust brake is always engaged with the compression brake. This is because the compression brake induction phase fully utilizes the backpressure created by the exhaust brake in the exhaust manifold.

## Induction Phase

The induction phase begins at the end of the intake stroke and continues slightly into the compression stroke.

The piston travels downward toward bottom dead center and the camshaft induction lobe opens the exhaust valves long enough to fill the cylinder with the backpressure created by the exhaust brake in the exhaust manifold.

When the induction lobe closes the exhaust valves, the cylinder has a backpressure at the start of the compression stroke. This backpressure increases compression considerably during the compression stroke which, in turn, creates a powerful braking effect when the piston moves upward.

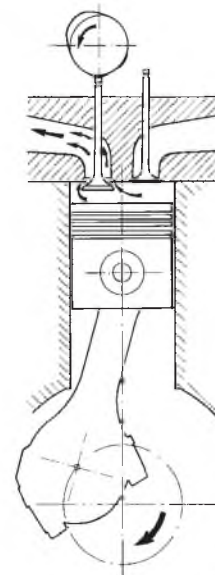


T2006830

Fig. 14: Induction phase

## Decompression pPhase

At the end of the compression stroke, as the piston approaches top dead center, the camshaft decompression lobe opens the exhaust valves and releases the pressure from the cylinder. Shortly before bottom dead center, the ordinary exhaust lobe opens the exhaust valves. During the exhaust stroke, a backpressure is created in the exhaust manifold. This has a braking effect because the exhaust pressure governor shutter is closed.



T2006831

Fig. 15: Decompression phase

## Troubleshooting

### Engine Brake, Fault Tracing



#### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.



#### DANGER

When operating a vehicle on streets and highways, during data collection procedure, it is mandatory to have a second person drive while a technician collects the data.



#### DANGER

Never disconnect an air system component unless all system pressure has been depleted. Failure to deplete system pressure before disconnecting hoses or components may result in their violent separation and can cause serious bodily injury.



#### WARNING

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving or hot engine parts. A hot engine can cause serious burns or can permanently damage test equipment.



#### WARNING

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.



#### CAUTION

Always clean the engine before servicing and keep the compression brake components clean during all service and repair procedures. Lack of cleanliness during service and repair work could result in a fault or malfunction of the compression brake system.

Basic knowledge of the system description and operation is necessary to perform the troubleshooting procedures in this manual. For basic system knowledge, refer to:

**Service Manuals** V776–200–820SM  
*Specifications, VE D12*  
 284–610, PV776–TSP128229  
*Engine Control System, VE D12*

### VEB Diagnosis and Troubleshooting

The D12 engine is equipped with a diagnostic system to simplify troubleshooting.

The first step to take with all troubleshooting should be to check whether the diagnostic system indicates any fault codes.

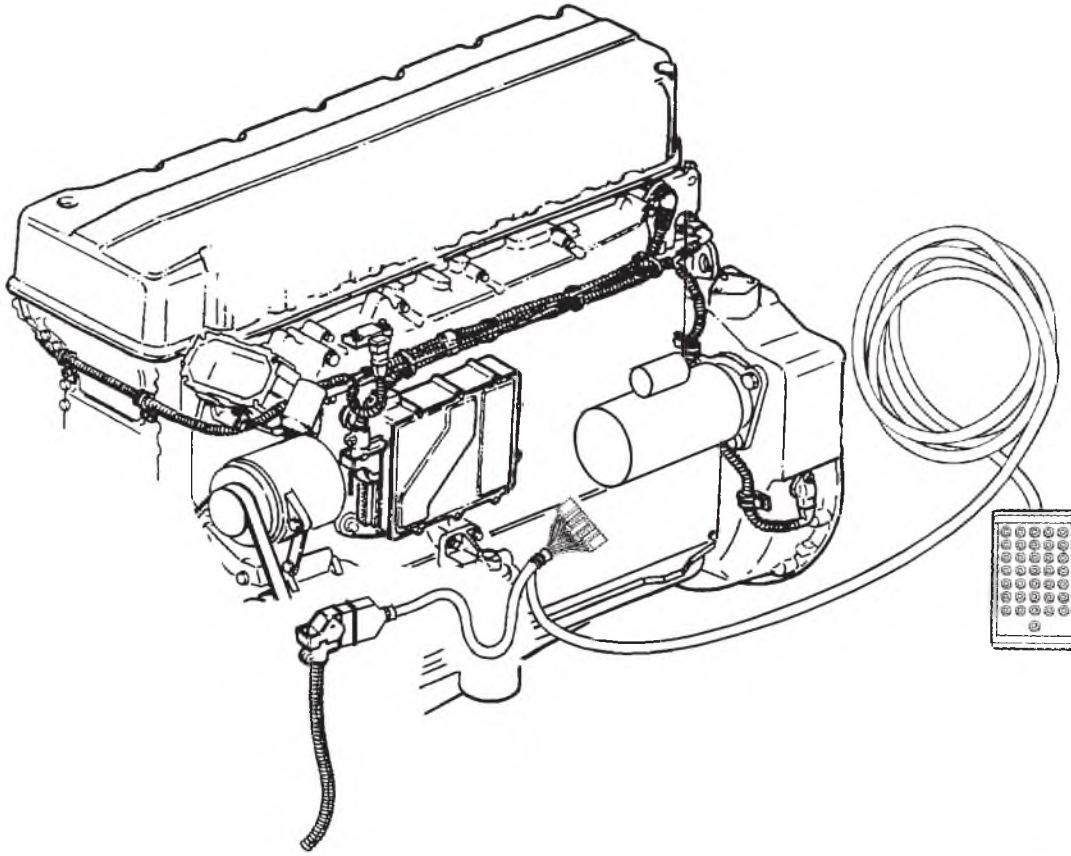
If fault codes are present, these should be corrected before proceeding further with the troubleshooting, even if the fault codes do not indicate a fault that would affect the engine brake system.

If the truck is equipped with ABS, verify that information code 61 is not displayed during the check.

For details about how the fault codes and information codes are interpreted, refer to:

**Service Manual** 280–600, PV776–TSP105620/1  
*Fault Codes, Engine Electronic Control Unit*

## Electrical Troubleshooting



V2002196

### Special tools: J-41132

#### Connecting test equipment

- 1 Make sure that the ignition key is in the "OFF" position.
- 2 Clean the area around the EECU and harness connectors.
- 3 Disconnect the **EB** harness (lower harness). Inspect the harness for corrosion and damage to the connector housing, terminals, and seal. Repair as required.
- 4 Connect the 36-pin breakout box to the **EB** harness only.  
Make sure the harness connectors are properly pressed together. Do not force connectors together.

**Note:** Do **not** connect the breakout box to the EECU.

## Voltage measurement

### Conditions:

- Engine running
- Engine brake switch in the **ON** position
- Selector switch in the HI position
- Throttle pedal in idle position
- Clutch pedal released
- ABS not activated
- PTO not activated
- Vehicle speed greater than 3.2 km/h (2 mph)
- Sufficient coolant temperature, see table page 12.

Voltage Measurement	36-Pin Box Selection	Intended Value	Probable Cause
Engine brake supply (if all conditions are met)	2:9	B+	Faulty connection Faulty engine brake switches Faulty harness

## Resistance measurement

### Conditions for Resistance Measurements:

- Ignition off
- Engine not running
- Engine brake switch in the **ON** position

**Note:** Values in table apply to solenoid valve with part no 1610563 and 1610567.

For solenoid valves with part numbers 8143014 and 8143018, please refer to:

**Service Manual** PV776–280–600SM  
*Electronic Controls, VE D12, D12 A, D12 B*

Resistance Measurement	36-Pin Box Selection	Intended Value	Probable Cause
Solenoid valve, exhaust brake (engine brake selector switch in <b>LOW</b> position)	2:9	13 – 16 $\Omega$	Faulty connection Faulty harness Solenoid valve (exhaust brake) Faulty exhaust brake Faulty engine brake switches
Solenoid valve exhaust brake and compression brake (engine brake selector in HI position)	2:9	7.5 – 9.5 $\Omega$	Faulty connection Faulty harness Solenoid valve (compression brake) Faulty engine brake switches Faulty VEB coolant temperature switch

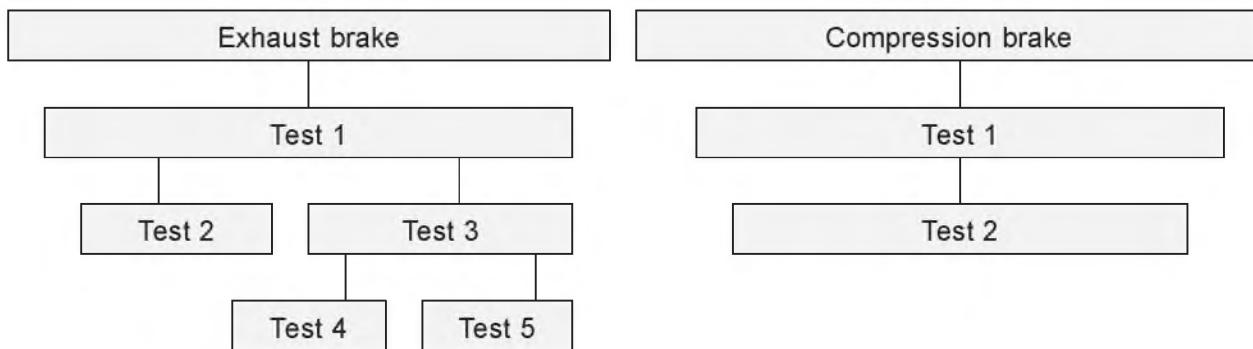
**Note:** If the multimeter shows 20–22  $\Omega$  when the engine brake select switch is in the HI position, the exhaust brake solenoid valve is damaged.

## Mechanical Troubleshooting

### Conditions

- The electrical troubleshooting has been carried out, or any possible faults in the electrical system can be completely eliminated.
- The truck has full pressure [827 kPa (120 psi)] in the air system.
- The engine has normal oil pressure.
- The engine coolant temperature is at operating temperature.

Service procedures not contained in this information are to be found in the service information for the VOLVO D12 engine under the respective group.



Carry out the tests on the exhaust brake and compression brake in numerical order according to the above diagram, when either one of the brake systems does not work.

If both brake systems work, but give poor braking effect, see "Low Engine Braking Effect (VEB)" page 21.

## VEB Troubleshooting, Order to Follow

If the fault remains after correcting any indicated fault codes, and the engine and electrical system function normally, troubleshooting should be performed in the following order:

### 1

Begin troubleshooting by attempting to establish which of the brake systems is faulty (exhaust brake, compression brake, or both systems).

### 2

Verify that the following preconditions for **exhaust braking** are satisfied, with the switch(es) on the instrument panel in the ON/LOW (exhaust brake only) positions.

- Accelerator pedal position at 0% (idle position)
- Clutch pedal not depressed
- Engine speed should be greater than 1100 RPM
- PTO not activated
- Vehicle speed should be greater than 3 km/h (2 mph).
- Anti-lock Braking System (ABS) not activated.
- Boost pressure less than 150 kPa (22 psi).

**Note:** The exhaust brake will engage only when all of these preconditions are satisfied.

**Note:** When the exhaust pressure governor (EPG) is activated in conjunction with starting, running the engine warm, and keeping the engine warm, other preconditions apply.

### 3

Verify that the following preconditions for **VEB (exhaust braking and compression braking)** are satisfied, with the switches on the instrument panel in the ON/HI (exhaust brake and compression brake, VEB) positions.

- Accelerator pedal position at 0% (idle position)
- Clutch pedal not depressed
- Engine speed should be over 1100 RPM
- PTO not activated
- Vehicle speed should be greater than 3 km/h (2 mph).
- Anti-lock Braking System (ABS) not activated.
- The coolant temperature should be over 43 °C (110°F), otherwise only the exhaust brake will be engaged.
- Boost pressure less than 150 kPa (22 psi).

**Note:** An additional option is to have the VEB enable automatically if the vehicle exceeds a specified cruise control limit. If this option is selected, the VEB will automatically engage at a selectable speed approximately 6.4 to 32 km/h (4 to 20 mph) above the set cruise control speed.

### 4

**Always begin with electrical troubleshooting, unless a fault in the electrical system can be completely ruled out.**



## VEB Fault Symptoms

### Fault symptom 1

#### The engine will not start

Probable fault:

- The control valve plunger may be stuck in its rest position. If this is the case, oil is fed to the rocker arm shaft with full pressure and the plungers in the rocker arm shafts will be pressed out. This will eliminate the valve clearance and the decompression lobes will open the exhaust valves. This impairs the compression build-up and the engine cannot start.

Carry out mechanical troubleshooting.

### Fault symptom 2

#### Neither the exhaust brake nor the compression brake functions

This indicates a fault in the electrical system. The control signal is not reaching the exhaust pressure governor and the control valve solenoid valves.

Carry out electrical troubleshooting.

### Fault symptom 3

#### The exhaust brake functions, but not the compression brake

Probable fault:

- No control signal to the compression brake control valve
- Defective temperature sensor or diode
- Defective control valve or control valve plunger stuck
- No ground at coolant temperature switch
- Drain channel is clogged

Carry out electrical troubleshooting.

If the fault remains:

Carry out mechanical troubleshooting.

### Fault symptom 4

#### The compression brake functions, but not the exhaust brake

Probable fault:

- No or low air pressure supplied to the EPG
- No control signal to the exhaust pressure governor solenoid valve
- Defective solenoid valve
- Defective exhaust pressure governor
- Defective quick-release valve
- Air leakage

Carry out electrical troubleshooting.

If the fault remains:

Carry out mechanical troubleshooting.

### Fault symptom 5

#### Poor braking effect from the exhaust brake

Probable fault:

- Low control pressure supplied to the EPG
- Leaks in the exhaust manifold gaskets
- Exhaust pressure governor seizing
- Defective or leaking exhaust pressure governor

Carry out mechanical troubleshooting.

### Fault symptom 6

#### Poor braking effect from the engine brake (exhaust brake and compression brake)

Probable fault:

- Low control pressure supplied to the EPG
- The control valve gives too low oil pressure
- Defective non-return valve in one or more of the rocker arms
- Defective pressure limiting valve in one or more of the rocker arm plungers
- The exhaust brake functions poorly or not at all
- Exhaust valve clearance is too large

See the procedures in "Low Engine Braking Effect (VEB)" page 21.

### Fault symptom 7

#### The compression brake engages but will not disengage

If the compression brake remains engaged with full effect even though the accelerator pedal is depressed, this is due to the control valve plunger remaining in the "VEB position" and directing full system oil pressure out to the rocker arms.

#### DANGER

Do not depress the clutch pedal unless necessary. Engine may stop if compression brake stays engaged. This will result in loss of power steering assistance.

If the compression brake only partly disengages, it is most probable that one of the rocker arm plungers has locked in its outer position. With this fault, the engine runs unevenly due to low compression pressure in the cylinder where the rocker arm plunger has stuck.

The fault generates one of the fault codes 31–36, as the control unit compensates for the loss of power in the cylinder by increasing the amount of fuel delivered to the cylinder through the unit injector. When the maximum amount of fuel delivered by the unit injector can not compensate for the loss of power in the cylinder, the fault code is generated.

Carry out mechanical troubleshooting.

**Note:** Fault codes 31–36 can also be generated by an electrical fault in the fuel system.



## Low Engine Braking Effect (VEB)

**Note:** Before carrying out the following procedure, read the troubleshooting general information in "Engine Brake, Fault Tracing" page 15.

### Check Before the Test:

- That the conditions for exhaust braking and compression braking are satisfied.
- That the general condition of the engine is good.
- That the engine has normal oil pressure.
- That both the engine brake systems are functioning.

Check that both the exhaust brake and engine brake are functioning by test-driving the truck.

- Set the engine brake switch to **OFF**.
- Drive the truck downhill, fully release the accelerator pedal and set the switches to ON/LOW positions. If the engine sound does not alter and/or there is no braking effect, the exhaust brake does not function. If the engine sound changes and there is a noticeable braking effect, the exhaust brake does function. Set the switches to ON/HI positions.
- If no difference can be noted in the sound or in the braking effect, the compression brake does not function.
- If the engine sound changes and there is a noticeable braking effect, the compression brake does function.

Check that the valve clearances are within the tolerance range.

## Test Equipment, Installation

1

Install the equipment for measuring the oil pressure in the rocker arm shaft according to the instructions in "Oil Pressure, Compression Brake, Checking" page 36.

2

Set the control switches to the **OFF** position (VEB disabled). Start the engine and measure the rocker arm shaft oil pressure. The pressure should be approximately 1 bar (14.5 psi).

If the pressure fluctuates or is under 0.5 bar (7.25 psi) or over 1.5 bar (21.75 psi), the control valve is faulty.

**Note:** Low oil pressure in the rocker arm shaft may also be due to excessive wear in the rocker arm bushings and/or the rocker arms which result in excessive oil pressure loss. See "Rocker Arm Roller, Checking" page 46.

3

Install the equipment for measuring the exhaust gas temperature, including the 36-pin breakout box. See "Exhaust Temperature, Checking" page 40.

## Test-driving and Measuring

To obtain good test results, the exhaust pressure governor should be disabled when checking the function of the compression brake.

- Route the 36-pin breakout box into the cab and secure.
- Make sure the engine brake switch is **OFF**.
- Bridge terminals 2 and 11 of the 36-pin breakout box.

### DANGER

When terminals 2 and 11 of the 36-pin breakout box are bridged, the compression brake will activate anytime the VEB control switch is in the **ON** position, regardless of status. The compression brake will remain **ON** until the control switch is moved to the **OFF** position. While the engine brake is activated, do not depress the accelerator or clutch. If the accelerator is depressed, engine damage may result. If the clutch is depressed a loss of power steering assist may occur. Be prepared to switch off the engine brake at any time. Failure to do so may result in personal injury or death.

### DANGER

When operating a vehicle on streets and highways, during data collection procedure, it is mandatory to have a second person drive while a technician collects the data.

When engine braking, the exhaust gas temperature increases on those cylinders where the compression brake functions.

On the cylinder(s) where there is little or no braking effect there is very little exhaust gas temperature increase, thus, the cylinder which gives a very low or no braking effect can be identified.

**Note:** The temperature difference between cylinders is not important when performing this test. Only note the difference in temperature at the beginning and end of the engine braking function **on each individual cylinder**.

For the measurement to be valid, select gears, speed and section of road where the braking procedures can be carried out continuously and without interruption.

Select a long, at least 1.2 mile (2 km), downhill section of road, where the engine braking procedures can be carried out without reducing the speed of the truck.

The truck should be loaded and the road conditions clear.

Make sure that the engine brake switch(es) on the instrument panel are in the **OFF** position, until ready to perform the test at the test location.

Voltage supply to the measuring instrument is provided by the cigarette lighter socket and the purpose of the instrument back-up mode is to prevent **stored** information being lost if the external voltage supply is temporarily broken.

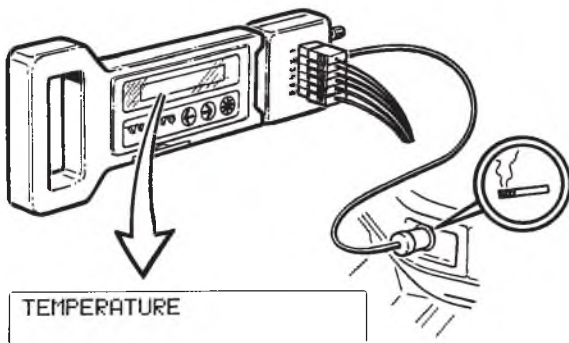
When the external voltage supply is broken, the display lighting goes out and the text begins to flash. If this occurs during measuring, the stored values are retained and the measurement procedure can continue when the instrument voltage supply is restored.

The instrument can store 10 measurement values. The first measurement value is stored as value A, the second measurement value is stored as value B, the third as value C etc. The instrument can also calculate the difference between two measurement values, for example B – A, D – C, etc.

**Note:** It is not possible to carry out measurements or store measurement values when the instrument is in the back-up mode.

### Brake Test

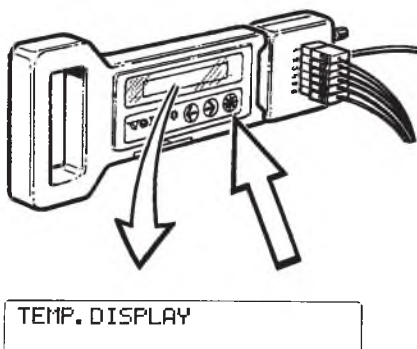
1



T2008010

Check that the measurement instrument display shows the text **Temperature**.

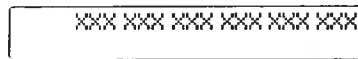
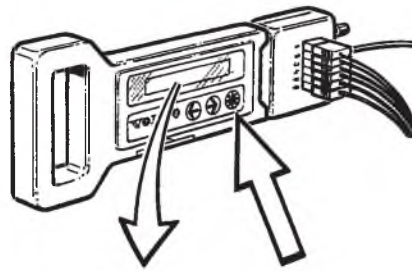
2



T2008011

Press \* once. The display should now show the text **Temp. Display**.

3



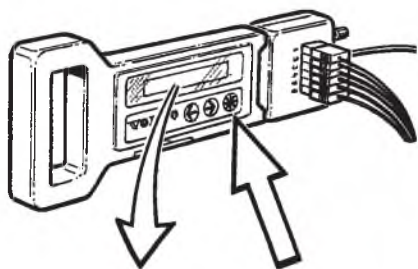
T2008019

Press \* one more time. The display should now show six temperature values, one for each cylinder, with no. 1 cylinder shown on the extreme left of the display. The instrument will now measure temperature continuously.

4

Accelerate the truck and select a gear that enables you to hold a stable engine speed of approximately 1400 RPM when the accelerator pedal is completely released (idle position). (Use the service brakes as an aid in holding a stable engine speed, as this procedure is to be performed with the engine brake OFF.)

5



A

T2008012

- Completely release the accelerator pedal (idle position).
- While viewing the measurement instrument, wait for the exhaust gas temperature to drop and begin to stabilize.
- Press \* once.

The measurement value designation A is shown for approximately 1 second on the display and is a confirmation that the value is registered and stored.

The measurement instrument then returns automatically to continuous measurement and shows six measurement values, one for each cylinder.

6

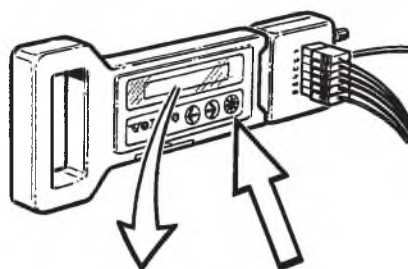
### DANGER

When terminals 2 and 11 of the 36-pin breakout box are bridged, the compression brake will activate anytime the VEB control switch is in the **ON** position, regardless of status. The compression brake will remain **ON** until the control switch is moved to the **OFF** position. While the engine brake is activated, do not depress the accelerator or clutch. If the accelerator is depressed, engine damage may result. If the clutch is depressed a loss of power steering assist may occur. Be prepared to switch off the engine brake at any time. Failure to do so may result in personal injury or death.

Set the engine brake switches to ON/HI. Read the rocker arm shaft oil pressure on the pressure gauge when the pressure has stabilized.

Note the value.

7



B

T2008013

- View the measurement instrument, wait for the temperature to rise and begin to stabilize.
- Press \* once.

The measurement value designation B is shown for approximately 1 second on the display and is a confirmation that the value is registered and stored.

The measurement instrument then returns automatically to continuous measurement.

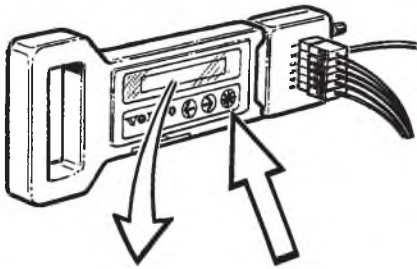
Carry out the brake test and measurements at least three times to obtain a valid result.

**Note:** Remember the engine brake will remain active until switched **OFF**.

Store the measurement values by pressing \*.

The instrument can store 10 measurement values (the results from 5 measurements of Low / High temperatures per cylinder).

8



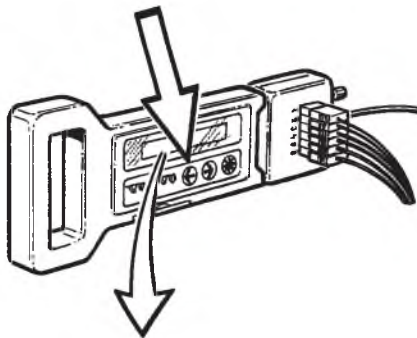
TEMP. DISPLAY

T2008011

When a sufficient number of measurements have been carried out, set the engine brake switch(es) to the OFF position and remove the bridge between terminals 2 and 11 at the 36-pin connector.

Hold \* pressed in (approximately 2 seconds) until the text **Temp. Display** is shown on the display.

9

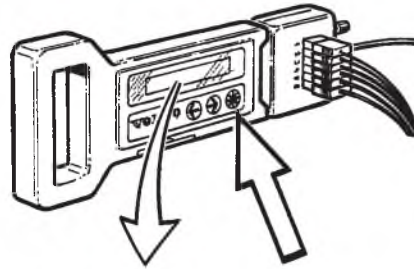


TEMP. EVALUATION

T2008014

Press ← until the text **Temp. Evaluation** is shown on the display.

10



A XXX XXX XXX XXX XXX XXX

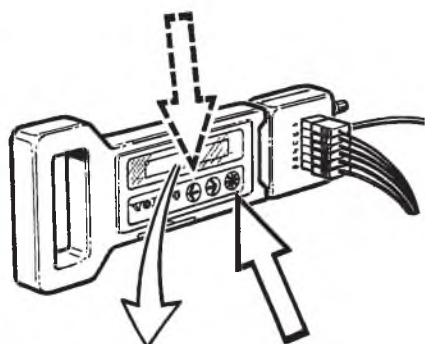
T2008021

Press \* and the first stored measurement value is displayed. The identification letter A appears before the measurement value.

By pressing ← or → it is possible to view all the values on the display.

By pressing \* again, the measurement value stored after the letter B is displayed.

11



B-A XXXX XXXX XXXX XXXX . . . . .

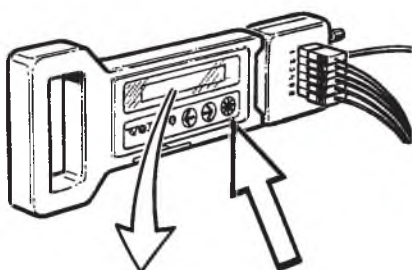
T2008022

By pressing \* again, the difference between measurement values B and A is shown.

By pressing ← or → it is possible to view all the values on the display.

**Note:** If the first measurement value is greater than the second, the difference between the values will be shown as a minus value on the display.

12



C XXXX XXXX XXXX XXXX XXXX XXXX

T2008020

Press \* once.

The first stored value from the second measurement (value C) is shown on the display.

By pressing \* one more time, the measurement value stored after the letter D is displayed.

By pressing \* again, the difference between measurement values D and C is shown.

13

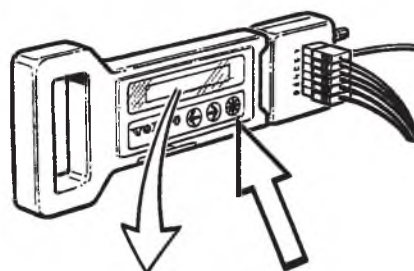
The results from the third, and if necessary, the fourth and fifth measurements are produced in the same way as with measurements one and two.

By pressing \*, it is possible to move between 10 measurement values and 5 differences.

14

Note the measurement results and remember that a fully charged back-up battery retains the stored measurement values in the instrument for **max. 20 minutes** after the external voltage supply has been broken. If possible, do not break the voltage supply to the instrument before all the measurement results have been noted.

15

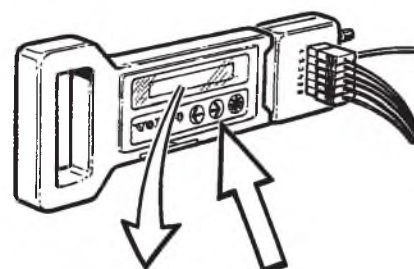


TEMP. EVALUATION

T2008015

Hold \* pressed in (approx. 2 seconds), when all measurement results have been noted, until the text **Temp. Evaluation** is shown on the display.

16



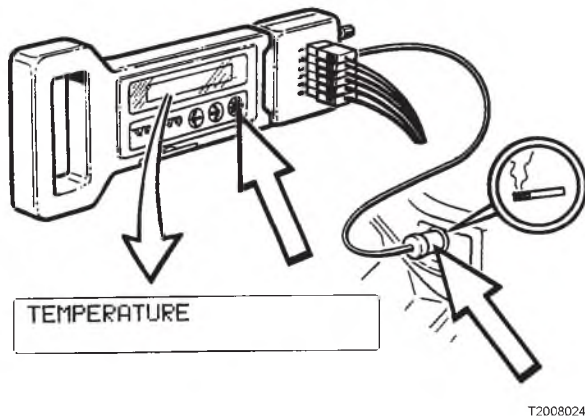
TEMP. DISPLAY

T2008023

Press → until the display shows the text **Temp. Display**.



17



By holding **\*** pressed in for approximately 2 seconds until the display shows the text **Temperature**, the instrument leaves the back-up mode and **all the stored measurement values are cleared**.

**Note:** Make sure that the values are noted before the instrument is set in position **Temperature**.

18

Disconnect the electrical plug for the external voltage supply.

**Note:** Switch the instrument off by holding **\*** pressed in for approx. 2 seconds when the display shows the text **Temp. Evaluation** or **Temp. Display**, after the external supply contact has been broken.

Do not leave the instrument in battery back-up mode. The battery will discharge very quickly if the external voltage supply is broken and the instrument has to rely on battery back-up.

19

Evaluate the test.

## Evaluation of the Brake Test

When the switch(es) are moved from position **OFF** to positions **ON/HL**, the oil pressure in the rocker arm shaft should rise to min. 2 bar (29 psi).

If the oil pressure does not exceed 2 bar (29 psi), the control valve is faulty.

**Note:** Low oil pressure in the rocker arm shaft may also be due to excessive wear in the rocker arm bushing and/or rocker arms which result in excessive oil pressure loss. See "Rocker Arm Roller, Checking" page 46.

The temperature increase for each individual cylinder should be between 90°C and 130°C (194°F and 266°F) in order to be certain that the compression brake on each cylinder is functioning properly.

If there is no temperature increase, or if the temperature increase is less than 80°C (176°F) on any individual cylinder, the compression brake on that cylinder is not functioning properly.

If the result of a test is not clear, the test must be repeated. At least three tests should be carried out in order to obtain valid results.

The measured exhaust gas temperature varies between the cylinders, depending on the position of the cylinders.

The cylinders that are positioned nearest the turbocharger will have a higher measured value than those at either end of the cylinder block. This is due to the temperature sensors also being influenced by the passing air flow from the cylinders furthest away from the exhaust manifold outlet.

When evaluating the test, this point should also be taken into consideration.

For example, when comparing cylinders 1 and 6, the temperature increase should more or less be the same, providing that the compression brake is functioning properly on both cylinders.

The same comparison can be made between cylinders 2 and 5 and cylinders 3 and 4.

It should be pointed out that it requires repeated brake testing to be able to obtain an indication that the braking effect on a cylinder is reduced.

In instances where there is no braking effect on a cylinder, there is also no reference to compare an equivalent cylinder with.

The less the braking effect is reduced on a cylinder, the greater the difficulty in identifying the cylinder.

## 2531-06-02-01 Engine Brake, Checking

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### WARNING

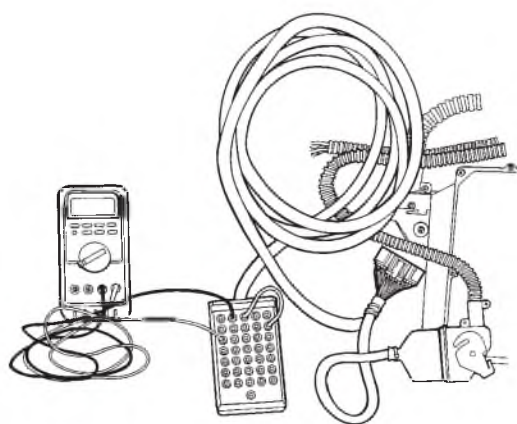
**HOT ENGINE!** Keep yourself and your test equipment clear of all moving or hot engine parts. A hot engine can cause serious burns or can permanently damage test equipment.

**Note:** Before carrying out the following procedure, read the troubleshooting general information in "Engine Brake, Fault Tracing" page 15.

*Special tools: J-39200 Fluke 87 Multimeter*

### Measurement 1

1



W2002218

Move the switch(es) on the instrument panel to ON/HI (exhaust brake and compression brake, VEB) positions.

2

Bridge terminals 3 and 10 on the breakout box. Doing so energizes the EECU power supply relay by providing a ground to the coil side of the relay.

3

Set Multimeter to measure **Amps** and connect it to terminals 2 and 11 on the 36-pin breakout box. This supplies battery voltage and measures current draw to the brake circuit (exhaust brake only).

4

An audible "click" should be heard from the exhaust brake solenoid valve when the multimeter is connected.

5

If no "click" is heard from the exhaust brake solenoid valve, and the exhaust brake measurement 1 results were OK, replace the HI/LO switch. Otherwise, proceed to step 6.

6

Disconnect the connector on the exhaust brake solenoid valve.

7

Bridge terminals 3 and 10 on the breakout box.

8

Set Multimeter to measure **Amps** and connect it to terminals 2 and 11 on the 36-pin breakout box.

9

A faint "click" should be heard from the compression brake solenoid valve when the multimeter is connected.

**Note:** Coolant temperature should be above 43°C (110°F), otherwise VEB coolant switch must have a jumper wire installed.

10

The multimeter should show **0.525 Amp**.

11

If no "click" is heard from the compression brake solenoid valve, or if the multimeter does not show the value 0.525 Amp, carry out **Measurement 2**.

## Measurement 2

- 1**  
Bridge terminals 2 and 11 on the 36-pin breakout box.
- 2**  
Disconnect the 2-pin connector at the exhaust brake solenoid valve and connect the J-42472 breakout harness between the solenoid valve and the wiring harness.
- 3**  
Set multimeter to measure **Voltage** and connect it to pins 1 and 2 on the compression brake connector at the upper timing gear cover.  
**Intended value: B+**
- 4**  
If the intended value is correct, remove the valve cover and carry out **Measurement 3**.
- 5**  
If the intended value is not correct, carry out **Measurement 4**.

## Measurement 3

- 1**  
Set multimeter to measure **Ohm ( $\Omega$ )**.
- 2**  
Measure between 1 and 2 on the compression brake solenoid valve.  
**Intended value:  $20 \pm 2 \Omega$**
- 3**  
If the intended value is correct, check the cables between the compression brake solenoid valve and the connector at the upper timing gear cover.
- 4**  
If the intended value is not correct, replace the compression brake solenoid valve.

## Measurement 4

- 1**  
Set Multimeter to measure **Voltage**.
- 2**  
Measure between alternate ground and pin 1 in the connector for the control valve solenoid valve at the upper timing gear cover.  
**Intended value: B+**
- 3**  
If the value is not correct, check the wire to pin 1 in the connector for the control valve at the upper timing gear cover and to pin 2 at the EB connector including the engine brake switch(es). Make repairs and retest.
- 4**  
If the value is correct, measure between alternate battery supply and pin 2 in the connector for the control valve solenoid at the upper timing gear cover.  
**Intended value: B+**
- 5**  
If the value is correct, clean and inspect both pins and sockets at the connector for the control valve solenoid. Repeat measurement 1.
- 6**  
If the value is not correct, check the wire from pin 2 in the connector for the control valve at the upper timing gear cover to its ground location, including compression brake coolant temperature switch.



## 2533-06-02-01 Solenoid Valve, Compression Brake, Checking

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### DANGER

Never disconnect an air system component unless all system pressure has been depleted. Failure to deplete system pressure before disconnecting hoses or components may result in their violent separation and can cause serious bodily injury.

### WARNING

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving or hot engine parts. A hot engine can cause serious burns or can permanently damage test equipment.

### WARNING

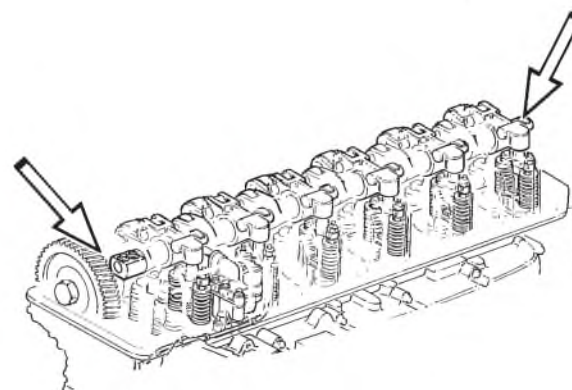
Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

**Note:** Before carrying out the following procedure, read the troubleshooting general information in "Engine Brake, Fault Tracing" page 15.

**Special tools:** 9998338, 9998339

### Test 1

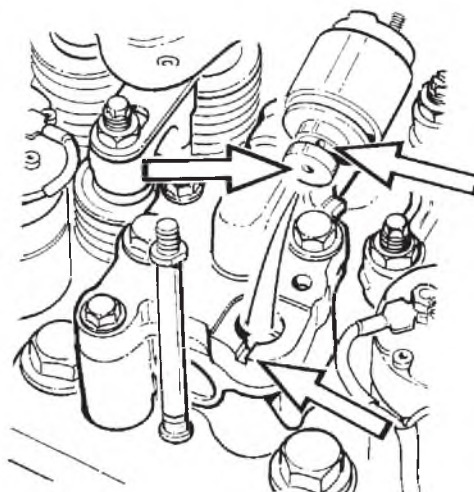
1



T2007704

Remove the valve cover and check that the plugs in the front and rear end of the rocker arm shaft are in position.

2



T2007740

Remove the control solenoid valve and check that the drain holes in the solenoid valve are not clogged.

3

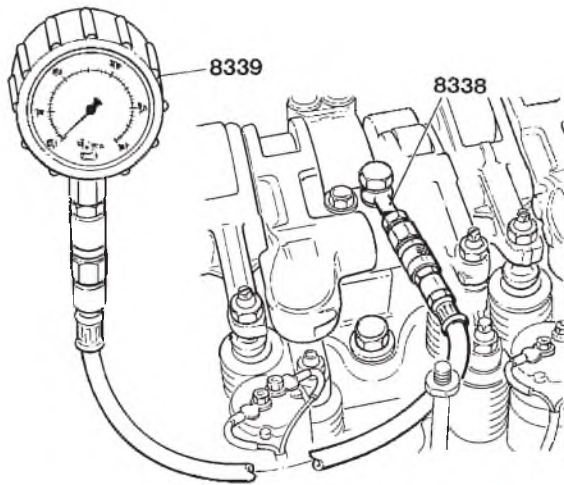
Check that the drain channel in the control valve is not clogged.

4

Check that the valve clearances are within tolerance.

**Test 2**

1



W2002231

Install the equipment for measuring the oil pressure in the rocker arm shaft according to the instructions in "Oil Pressure, Compression Brake, Checking" page 36.

2

Test-drive the vehicle and allow it to reach operating temperature.

3

Activate the engine brake by making sure the switch(es) on the instrument panel are in the ON/HI position and the conditions for engine braking are satisfied.

4

When the oil pressure has stabilized record the gauge reading during engine brake operation. The pressure should be **at least 2 bar (29 psi)**.

5

Repeat the test a number of times to confirm the measurement reading.

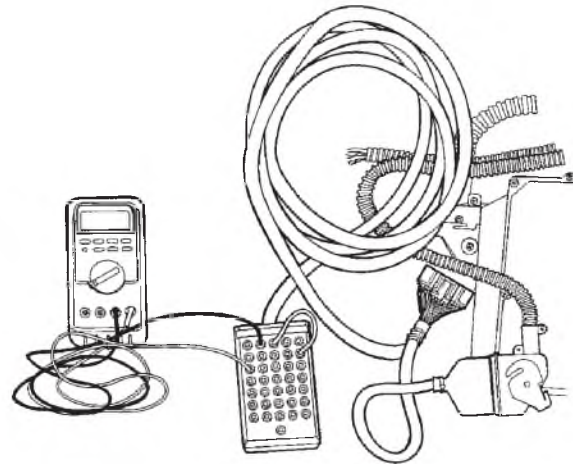
6

Replace the control valve if the measured pressure is below **2 bar (29 psi)** and the rocker arms, nozzles for lubricating the ball sockets, bushings and other components on the rocker arm bridge are not damaged.

## 2531-06-02-02 Exhaust Brake, Electronic Checking

**Note:** Before carrying out the following procedure, read the troubleshooting general information in "Engine Brake, Fault Tracing" page 15.

**Special tools:** J-3920 Fluke 87 Multimeter



W2002218

**Measurement 1**

1

Move the switch(es) on the instrument panel to ON/LOW (exhaust brake only) positions.

2

Bridge terminals 3 and 10 on the breakout box. Doing so energizes the EECU power supply relay by providing a ground to the coil side of the relay.

3

Set Multimeter to measure **Amps** and connect it to terminals 2 and 11 on the 36-pin breakout box. This supplies battery voltage and measures current draw to the brake circuit (exhaust brake only).

4

An audible "click" should be heard from the exhaust brake solenoid valve when the multimeter is connected.

5

The multimeter should show **0.7 ± 0.1 Amp**.

**6**

If no "click" is heard from the exhaust brake solenoid valve, or if the multimeter does not show the value  $0.7 \pm 0.1$  Amp, proceed to the next measurement.

**Measurement 2****1**

Bridge terminals 2 and 11 on the 36-pin breakout box in addition to the connections in measurement 1.

**2**

Disconnect the 2-pin connector at the exhaust brake solenoid valve and connect the J-42472 breakout harness between the solenoid valve and the wiring harness.

**3**

Set multimeter to measure **Voltage**. Measure between pins 1 and 2 on the breakout harness. **Intended value: B+ (battery positive voltage ~12V)**.

**4**

If the intended value is correct, replace the exhaust brake solenoid valve.

**5**

If the intended value is not correct, carry out **Measurement 3**.

**Measurement 3****1**

Set multimeter to measure **Voltage**.

**2**

Measure between alternate ground and pin 1 in the breakout harness.

**Intended value: B+**

**3**

If the intended value is correct, check the cable from pin 2 in the connector for the exhaust brake solenoid valve to ground.

**4**

If the intended value is not correct, check the wire between pin 1 in the connector for the exhaust brake solenoid valve and pin 2 at connector EB, including the engine brake switch(es).

**Measurement 4****1**

**Note:** A functional diode allows current to flow in one direction only. Connect the J-42472 2-pin breakout harness to the exhaust brake solenoid only.

**Note:** Do not connect to the engine harness.

**2**

Select the diode test on the Fluke 87 or equivalent multimeter.

**3**

Touch the red probe to the positive side of the diode (pin 1 of the J-42472 breakout harness) and the black probe to the negative side of the diode (pin 2 of the breakout harness).

**4**

If the diode is good, the voltage drop should typically be 0.5 V to 0.8 V.

**5**

Reverse the probes and measure the voltage across the diode again. If the diode is good, the display will show OL (overload).

**6**

If the display shows 0.00 in both directions, the diode is shorted. If the display shows OL in both directions, the diode is open. Replace the solenoid. See "Solenoid Valve, Compression Brake, Replacement" page 51.

## 2531-06-02-03 Exhaust Brake, Mechanical Checking

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### WARNING

HOT ENGINE! Keep yourself and your test equipment clear of all moving or hot engine parts. A hot engine can cause serious burns or can permanently damage test equipment.

### WARNING

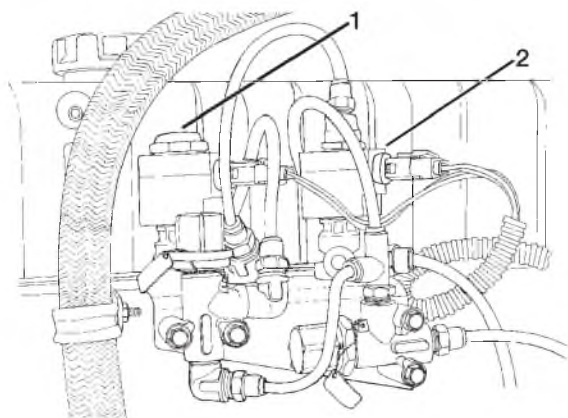
Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

**Note:** Before carrying out the following procedure, read the troubleshooting general information in "Engine Brake, Fault Tracing" page 15.

**Special tools:** 9996465, 9998333

### Test 1

1



W2002234

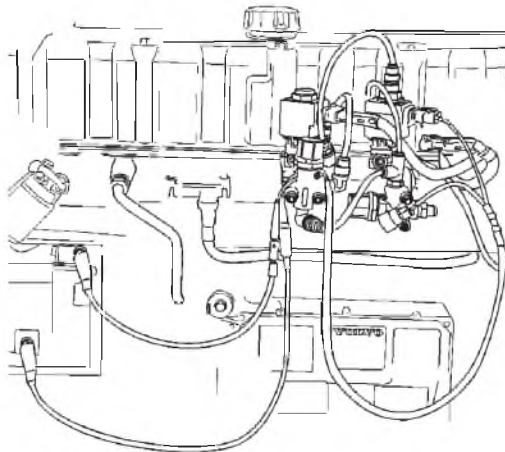
- 1 EPG solenoid (cold mode)
- 2 Exhaust brake solenoid

Verify proper wiring to solenoids. Wire 628 to the exhaust brake solenoid and wire 636k to the exhaust pressure governor (EPG) solenoid.

2

Verify correct air regulator valve is used with the proper system. The exhaust brake requires the 7.5 bar regulator, while the EPG utilizes a 2.3 bar regulator.

3



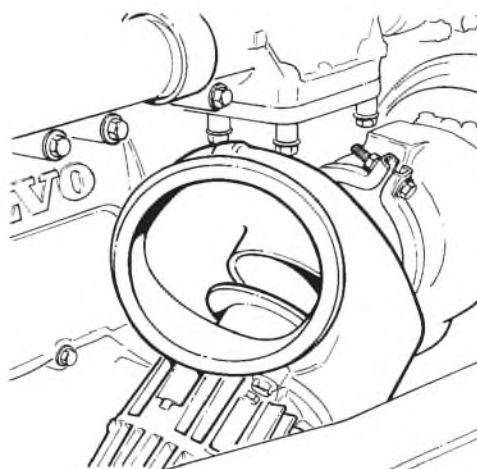
W2002198

VN solenoid location — other vehicles have solenoids located on bulkhead

Connect the J-42472 2-pin breakout harness to the exhaust brake solenoid valve, using 2 jumper wires with "alligator" type ends, supply the solenoid with an alternate ground and B+ and listen to hear if the exhaust pressure governor shutter moves.

**Note:** Make sure that pin 1 of the J-42472 is connected to B+ and pin 2 is connected to B-.

4

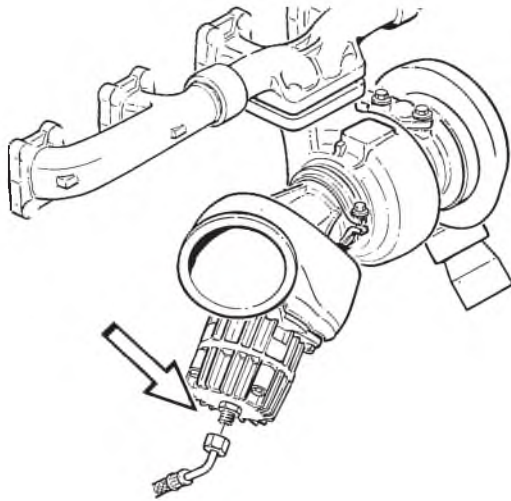


T2007700

If the exhaust pressure governor shutter moves, carry out test 3.



5



T2007701

If the exhaust pressure governor shutter does not move, remove the air hose from the exhaust pressure governor and activate the exhaust brake solenoid valve again.

6

If no air comes out of the hose, carry out **Test 2**.

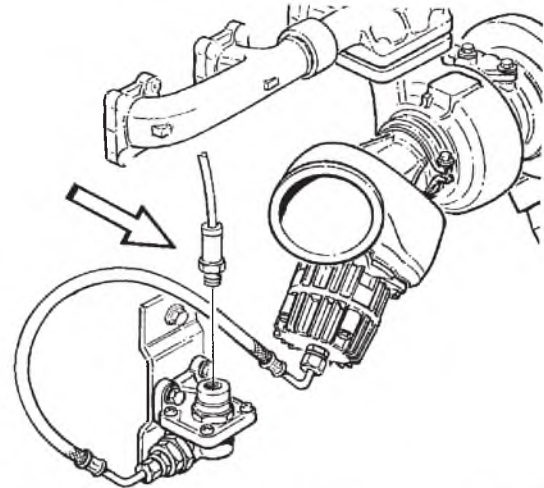
If air comes out of the hose, carry out **Test 3**.

## Test 2

1

Check that the air hoses are not twisted or blocked.  
Replace damaged hoses.

2



T2007953

Remove the air hose from the quick release valve and activate the exhaust brake solenoid valve.

If air comes from the hose, the quick release valve is faulty and should be replaced.

3

If no air comes out of the hose, check that air reaches the exhaust brake solenoid valve.

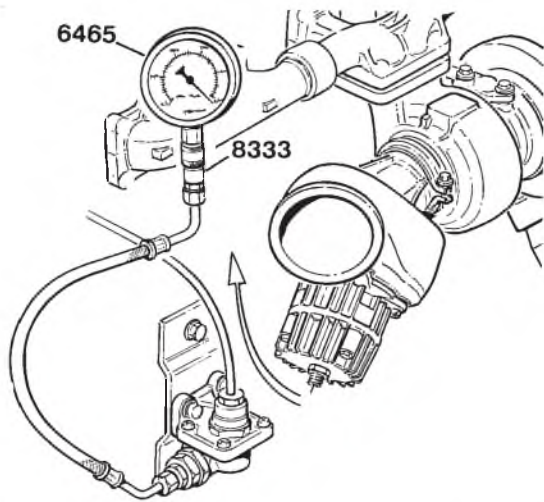
If air reaches the exhaust brake solenoid valve, the valve is faulty and should be replaced.

4

If no air reaches the exhaust brake solenoid valve, check that air reaches the regulator valve for the exhaust brake solenoid. If no air reaches the air regulator valve, check or replace the air supply hose. If air reaches the air regulator valve, then the air regulator valve is faulty and should be replaced.

**Test 3**

1



Connect the pressure gauge to the exhaust pressure governor hose and activate the exhaust brake solenoid valve.

T2007707  
999 6465  
999 8333

**Note:** The pressure in the hose should be  $7.5 \pm 0.3$  bars ( $109 \pm 4.4$  psi).

2

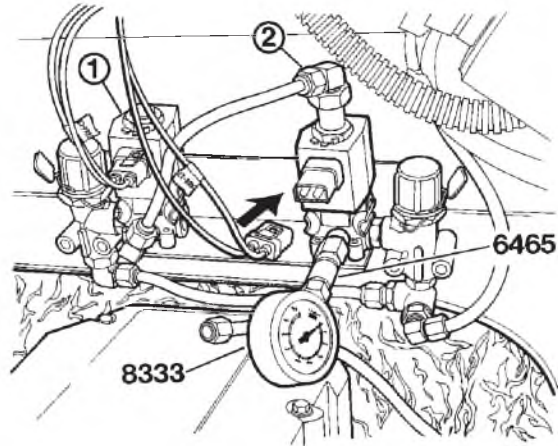
If the pressure is too high or too low, carry out **Test 4**.  
If the pressure is within the tolerances, carry out **Test 5**.

**Test 4**

1

Check that the hoses are not twisted or blocked. 999 6465  
Replace damaged hoses. 999 8333

2



1 EPG solenoid (cold mode)  
2 Exhaust brake solenoid  
Solenoids are located on the bulkhead; VN vehicles have solenoids mounted on the engine

W2002211

Remove the hose from the exhaust brake solenoid valve and measure the output pressure. The pressure should be  $7.5 \pm 0.3$  bars ( $109 \pm 4.4$  psi).

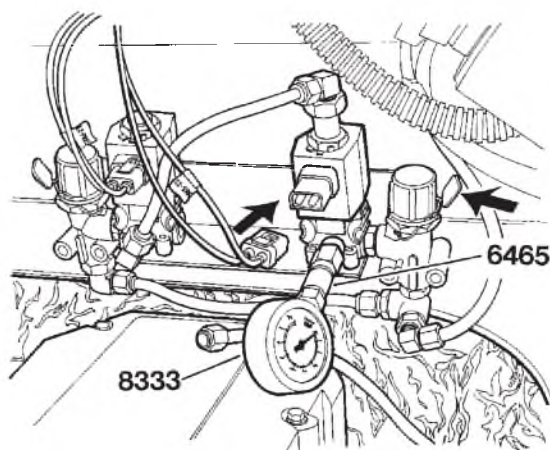
**⚠ DANGER**

Never disconnect an air system component unless all system pressure has been depleted. Failure to deplete system pressure before disconnecting hoses or components may result in their violent separation and can cause serious bodily injury.

3

If the pressure is within the tolerances, the quick release valve is faulty and should be replaced.

4



W2002212

If the pressure is too high, go to step 4.  
If the pressure is too low, go to step 5.

**Note:** Trucks with a higher system pressure than 7.5 bar (109 psi) are equipped with an adjustable reduction valve to reduce the pressure to the exhaust pressure governor.

5

Adjust the valve setting to specified pressure. If pressure will not respond to adjustment, replace regulator. After adjustment, the knob on the valve should be sealed or made tamper proof.

6

Check the outlet pressure of the regulator going to the exhaust brake solenoid.

**Intended value: 752 ± 30 kPa (109 ± 4.4 psi)**

7

Pressure OK:

- Restriction in line from regulator valve to exhaust brake solenoid. (VN series)
- Faulty solenoid.

8

Pressure not OK:

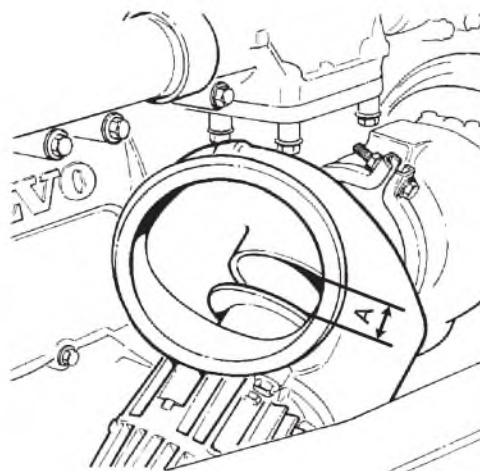
- Regulator valve out of adjustment or faulty.
- Insufficient supply pressure.

## Test 5

1

Remove the exhaust pipe from the shutter housing.

2



W2002189

Measure the opening between the shutter disk and shutter housing (A), to check that the EPG shutter has not jammed in the closed or half-closed position.

**The value (measurement A) should be 30 ± 2 mm (1.18 ± .08 in).**

3

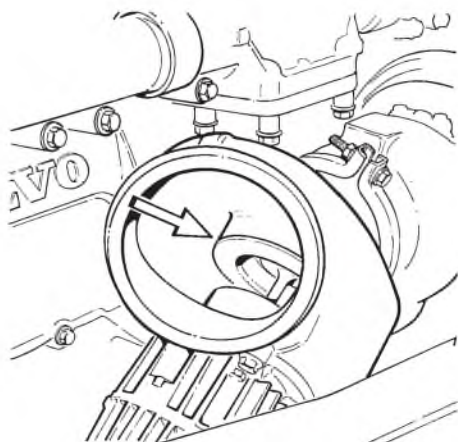
If the value is correct, replace or overhaul the EPG in accordance with the procedures found in:

<b>Service Manual</b>	V776-250-600SM <i>Intake and Exhaust Systems, VE D12</i>
-----------------------	---

4

Activate the exhaust brake solenoid valve.

5



Check if the exhaust pressure governor shutter seals against the shutter housing.

6

If the shutter does not seal against the housing, replace or overhaul the exhaust pressure governor according to the procedures found in:

**Service Manual** V776-250-600SM  
*Intake and Exhaust Systems, VE D12*

7

If the shutter seals against the housing, remove the exhaust pressure governor and check the shutter and shutter housing.

## 2533-06-02-02 Oil Pressure, Compression Brake, Checking

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### DANGER

Never disconnect an air system component unless all system pressure has been depleted. Failure to deplete system pressure before disconnecting hoses or components may result in their violent separation and can cause serious bodily injury.

### WARNING

**HOT ENGINE!** Keep yourself and your test equipment clear of all moving or hot engine parts. A hot engine can cause serious burns or can permanently damage test equipment.

### WARNING

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.



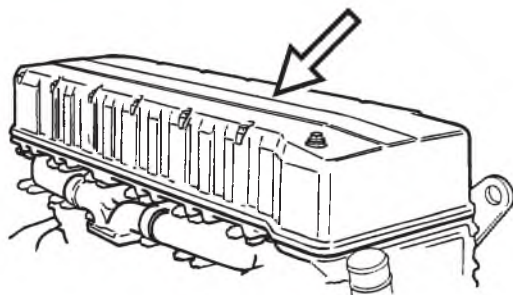
(Measured at rocker shaft.)

**Special tools:** 9998338, 9998339, J-41203  
(Kent Moore)

## Installation

**1**  
Set the parking brake.

**2**

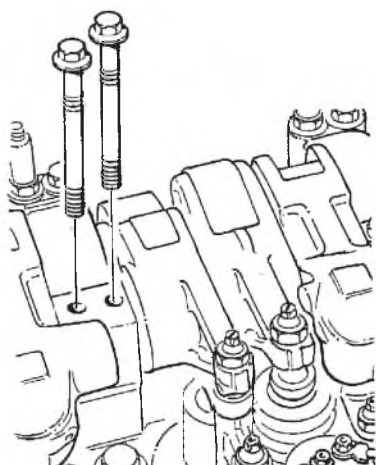


T2006731

Remove the valve cover.

**Note:** With older engines avoid damage to the valve cover and internal injector cable harness by making sure the mounting screws do not unscrew from the cylinder head during removal. **Do not** use impact tools to remove the nuts securing the valve cover.

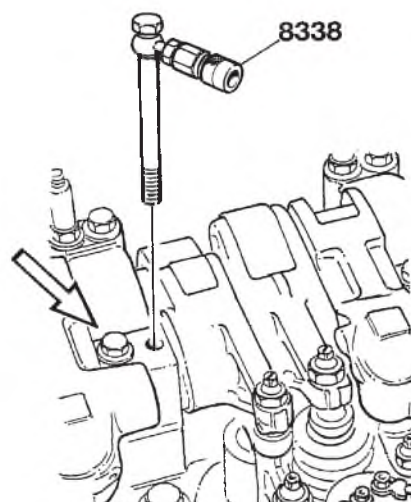
**3**



T2008279

Remove the bolts retaining the rocker arm bridge between cylinders 4 and 5. Remove the spring washer.

**4**



T2008278

Reinstall the front bolt **without** the spring washer. Install bolt 9808001 with connector 9998338 into the rear bolt hole and tighten both bolts.

9998338

**Note:** Bolt 9808001 must be used. It has been modified and is shorter than the previous version and does not use a sleeve.

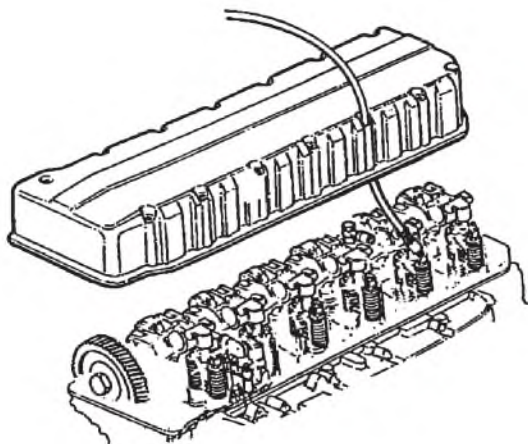
**5**

Remove the valve cover stud located between no. 4 and 5 injector solenoids.

J-41203

**Note:** Use Kent Moore tool J-41203 to remove the stud on earlier D12 engines.

6



W2002199

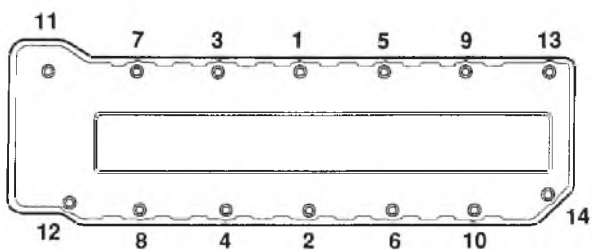
Route the oil pressure hose through the hole in the valve cover where the stud has been removed. Connect the oil pressure hose to connector 9998338.

**Note:** Check that connector 9998338 and the oil pressure hose do not obstruct the rocker arms. If necessary, use cable ties to prevent the oil pressure hose from being damaged by the rocker arms.

7

Install the valve cover and make sure the oil pressure hose does not interfere with any part of the valve mechanism.

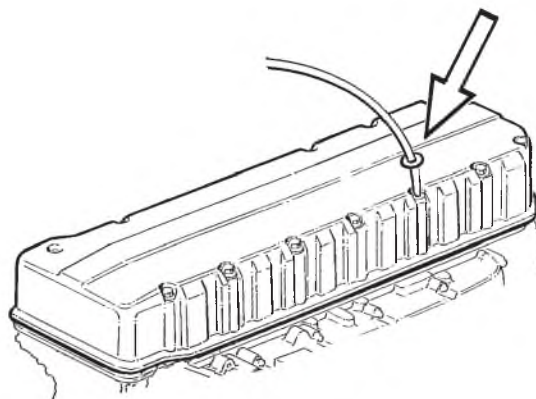
8



T2007003

Tighten the valve cover nuts to  $30 \pm 3$  Nm ( $22 \pm 2$  ft-lb). Follow the tightening sequence shown.

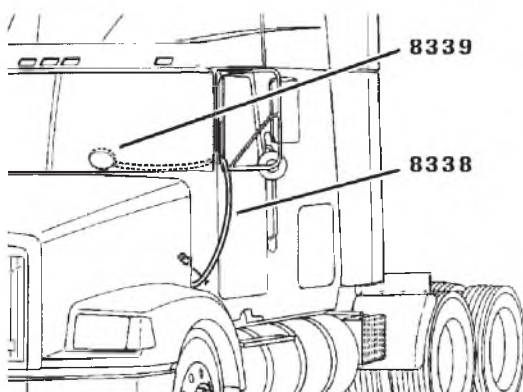
9



W2002200

Install the seal for the oil pressure hose into the hole in the valve cover. Make sure the seal fits into the stud hole in the valve cover.

10



W2002213

9998339

Route the oil pressure hose into the cab as shown. Install pressure gauge 9998339

**Note:** Secure the oil hose with cable ties to prevent kinks that would restrict flow.

## Testing

**1**  
Set the control switches to the **OFF** position (VEB disabled). Start the engine and measure the rocker arm shaft oil pressure. The pressure should be approximately 1 bar (14.5 psi).

**2**  
If the pressure fluctuates or is under 0.5 bar (7.25 psi) or over 1.5 bar (21.75 psi), the control valve is faulty.

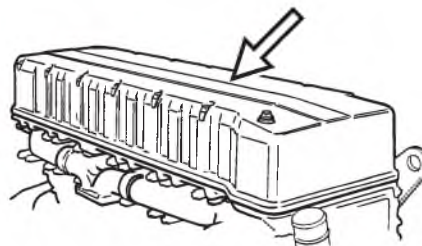
**Note:** Low oil pressure in the rocker arm shaft may also be due to excessive wear in the rocker arm bushings and/or the rocker arms which result in excessive oil pressure loss. See "Rocker Arm Roller, Checking" page 46.

**3**  
Install the equipment for measuring the exhaust gas temperature, including the 36-pin breakout box. See "Exhaust Temperature, Checking" page 40.

## Removal

**1**  
Set the parking brake. Remove the pressure gauge and oil pressure hose from the cab. Cut the oil hose free from the cable ties and disconnect the pressure gauge.

**2**



T2006731

Remove the valve cover.

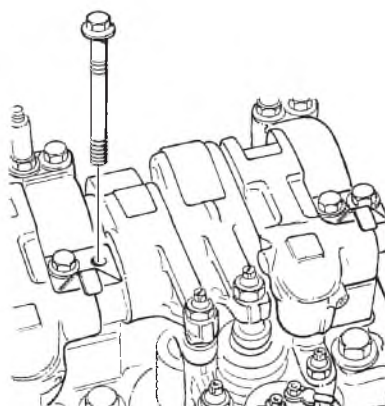


### CAUTION

With older engines avoid damage to the valve cover and internal injector cable harness by making sure the mounting screws do not unscrew from the cylinder head during removal. **Do not** use impact tools to remove the nuts securing the valve cover.

**3**  
Remove the oil pressure hose from connector 9998338. Pull the oil pressure hose through the valve cover and remove the oil seal.

**4**



T2007706

Remove connector 9998338 and bolt 9808001 from the rocker arm shaft. Install the spring washer and the two rocker arm bridge bolts.

- 5**  
Tighten the rocker arm bridge bolts in two steps:
- 1 Torque to 15 Nm (11 ft-lb).
  - 2 Tighten both bolts an additional 90°.

15 Nm  
(11 ft-lb)

- 6**  
Clean the threaded hole in the cylinder head where the valve cover stud was removed. Clean the valve cover stud bolt and apply locking fluid. Torque the stud to 48 ± 8 Nm (35 ± 6 ft-lb).

J-41203  
48 ± 8 Nm  
(35 ± 6 ft-lb)

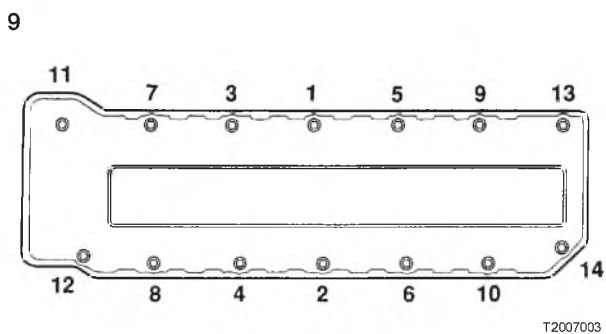
Carefully remove any excess locking fluid after the stud bolt has been tightened.

**Note:** Use Kent Moore tool J-41203 on early D12 engines to torque the stud.

- 7**  
Press the electronic cable clamp onto the stud bolt.

**Note:** The electronic cable must be positioned on the outside of the valve cover studs.

- 8**  
Install the valve cover.



Tighten the valve cover nuts to 30 ± 3 Nm (22 ± 2 ft-lb). Follow the tightening sequence shown.

30 ± 3 Nm  
(22 ± 2 ft-lb)

- 10**  
Test run engine and check for oil leaks.

## 2515-06-02-01 Exhaust Temperature, Checking

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### WARNING

HOT ENGINE! Keep yourself and your test equipment clear of all moving or hot engine parts. A hot engine can cause serious burns or can permanently damage test equipment.

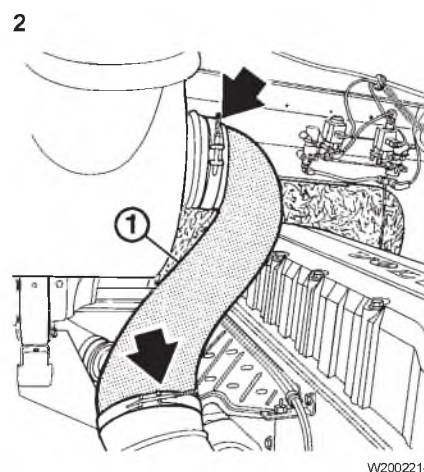
### WARNING

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

*Special tools:* 9998190, 9998342, 9998364, J-41132

### Installation

- 1**  
Set the parking brake.



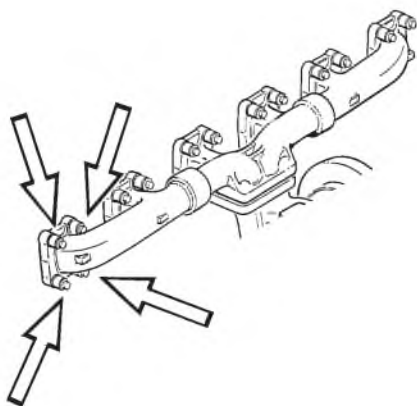
Disconnect the pipe from the air compressor and remove the intake pipe between the air cleaner and turbocharger.

**3**  
Remove bolts and spacers fastening the heat shield to the exhaust manifold.

**4**  
Disconnect the air compressor discharge line and lay aside.

**5**  
Unbolt the oil supply line at the turbo only.

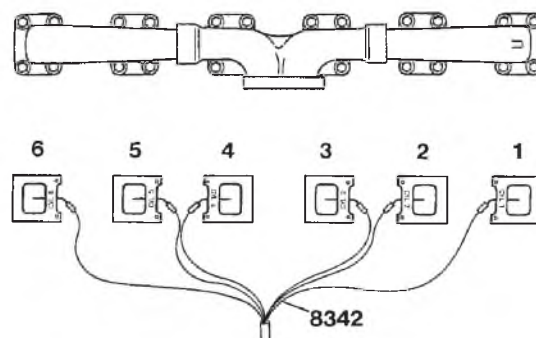
**6**



12007719

Loosen the exhaust manifold bolts just enough so that some threads remain in the cylinder head.

**7**



T2006047

9998342

Insert the temperature sensors between the exhaust manifold and the cylinder head.

Insert the temperature sensors far enough that the guide pins are against the edge of the exhaust manifold.

**Note:** The temperature sensors are numbered from one to six for the respective cylinders.

Make sure that the sensors are installed to the correct cylinders.

The sensors can be installed on either side of the gasket.

(The gaskets are replaced after the test.)

**8**

Tighten the exhaust manifold bolts.

**9**

Tighten the oil supply line at the turbo.

**10**

Connect the air compressor discharge line.

**11**

Secure the temperature sensor cables with cable ties away from the exhaust manifold and to avoid damage during testing.

Route the cables into the cab for connection to the measuring instrument.

**12**

Install the intake pipe between the air cleaner and the turbocharger. Connect the pipe to the air compressor.



**13**  
Make sure that the ignition key is in the **OFF** position.

**14**  
Clean the area around the EECU and harness connectors.

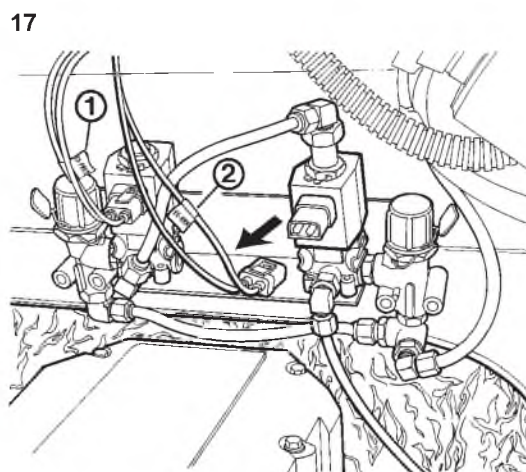
**15**  
Disconnect the **EB** harness (lower harness) from the EECU and connect the 36-pin breakout box between the **EB** harness and the EECU.

Make sure the harness connectors are properly pressed together. Do not force the connectors together.

**16**  
Route the 36-pin breakout box into the cab and secure.

**⚠ DANGER**

When terminals 2 and 11 of the 36-pin breakout box are bridged, the compression brake will activate anytime the VEB control switch is in the **ON** position, regardless of status. The compression brake will remain **ON** until the control switch is moved to the **OFF** position. While the engine brake is activated, do not depress the accelerator or clutch. If the accelerator is depressed, engine damage may result. If the clutch is depressed a loss of power steering assist may occur. Be prepared to switch off the engine brake at any time. Failure to do so may result in personal injury or death.



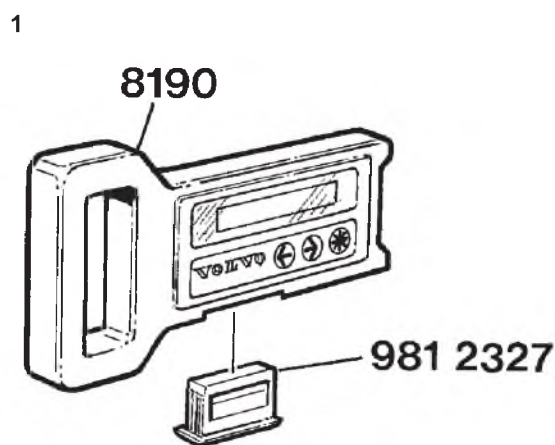
W2002215

- 1 EPG solenoid wiring harness
- 2 Exhaust brake solenoid wiring harness

Remove the connector from the exhaust brake solenoid valve.

**Note:** A more reliable measurement result is obtained when the exhaust brake is disabled.

*Measurement instrument 9998190*

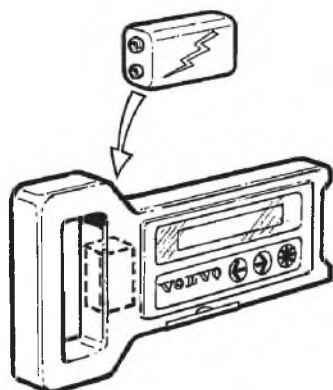


Check that the correct program unit is installed in measurement instrument 9998190.

T2008016  
9998190  
9812327

**Note:** When temperature measuring, program unit **9812327** is required.

2



T2008017

Make sure that a back-up battery is installed in measurement instrument 9998190.

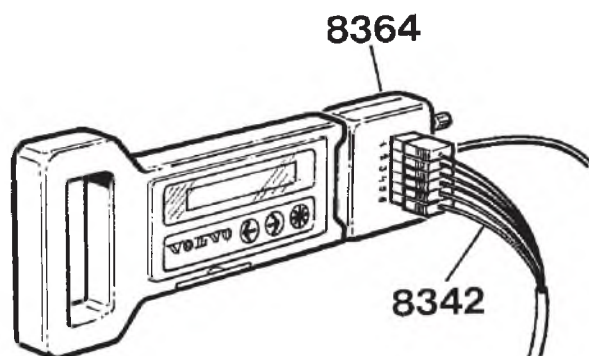
The back-up function is there to make sure that the stored information is not lost in the event of a temporary loss of supply voltage.

With a fully charged battery, the stored values in the instrument are retained for **max. 20 minutes** after the external voltage supply has been broken. Always make sure that the battery is fully charged when temperature measurement is to be carried out.

**Note:** Only use a 9 Volt rechargeable nickel-cadmium battery in the measurement instrument.

*Collation unit 8364*

1

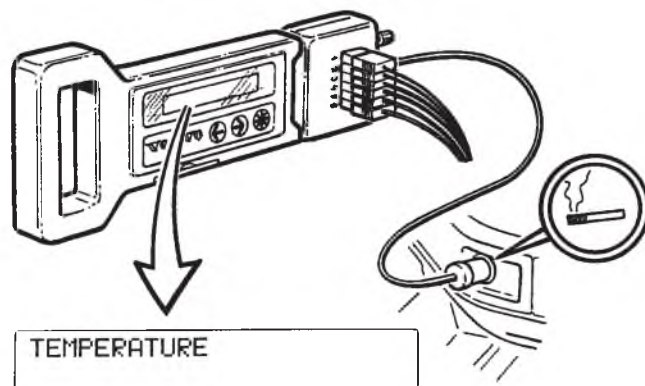


T2008018

Connect the collation unit to the measurement instrument and plug in the numbered electrical connectors from the temperature sensors to the numbered positions in the collation unit connection panel.

9998364

2



T2008010

Connect the collation unit electrical cable to the cigarette lighter socket and turn the ignition key to "ON" position.

**Note:** Check that the text *Temperature* is shown on the measurement instrument display. The measurement instrument automatically selects the temperature measurement function when the collation unit is connected.

## Removal

1

Set the parking brake. Take the measurement instrument and temperature sensor electrical cables out of the cab.

2

Remove the cable ties and the electrical sensor cables.

3

Disconnect the pipe from the air compressor and remove the intake pipe between the air cleaner and turbocharger.

4

Remove the 4 mounting bolts and lift away the air filter housing.

5

Disconnect the oil supply line to the air compressor at the oil filter housing and remove the line clamp.

**Note:** Cover the fitting and the end of the line to keep out any debris.

6

Remove the 2 bolts attaching the lower charge air cooler pipe to the turbo and the bolt supporting the lower end of the pipe.

7

Pry the charge air cooler pipe away from the turbo and remove the end adapter for more clearance.

8

Remove the shutter housing turbo clamp. Move the shutter housing away from the turbo and let it rest on the frame.

9

Blow all debris away from the area where the turbocharger oil supply line enters the oil filter base. Remove the 2 bolts fastening the supply line to the turbocharger and remove the line.

**Note:** Cover the open hole in the oil filter base to prevent debris from entering.

44



### CAUTION

In order to prevent personal injury, always wear safety glasses when working with compressed air.

10

Remove the 2 bolts fastening the oil drain back tube to the turbo.

11

Remove the 4 bolts mounting the turbo to the exhaust manifold and lift off the turbo.

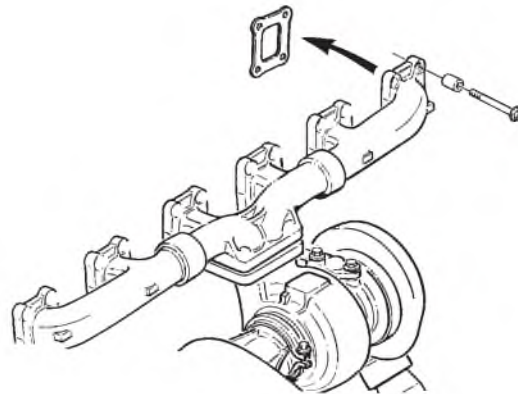
12

Remove the exhaust manifold mounting bolts and lift the manifold away from the engine.

13

Remove all of the temperature sensors.

14

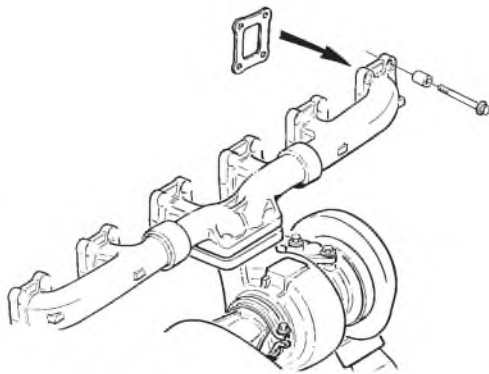


T2007717

Clean the cylinder head and exhaust manifold contact surfaces.  
Blow clean with compressed air.



15

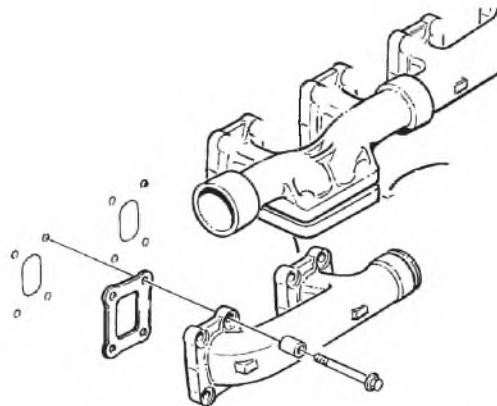


T2007718

Glue the new gaskets onto the exhaust manifold with the correct side facing the manifold.

**Note:** The marking "MANIFOLD SIDE" should be turned toward the exhaust manifold.

16

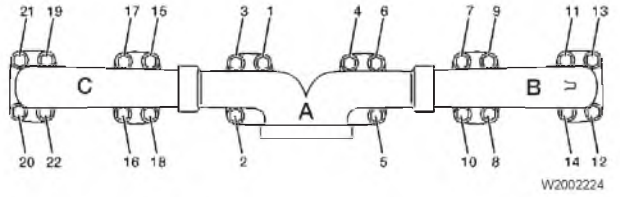


T2007724

Install 2 alignment dowels in the cylinder head to help position the manifold. Install the exhaust manifold and the corresponding bolts.

**Note:** Make sure that the sleeves are properly positioned in the counterbore of the manifold flange.

17



Tighten all the exhaust manifold bolts to a torque of  $48 \pm 8$  Nm ( $35 \pm 6$  ft-lb).

$48 \pm 8$  Nm  
( $35 \pm 6$  ft-lb)

Use the torque tightening sequence shown.

18

**Note:** Make sure that all gasket surfaces on the turbocharger are free of gasket material and clean. Make sure that there is nothing inside the exhaust manifold or air piping e.g. debris from a previous failure.

Install the turbocharger with a new mounting gasket onto the exhaust manifold. Torque mounting nuts to  $48 \pm 8$  Nm ( $35 \pm 6$  ft-lb).

$48 \pm 8$  Nm  
( $35 \pm 6$  ft-lb)

19

Position the shutter housing and exhaust piping onto the rear of the turbocharger. Install clamp and torque to  $24 \pm 2$  Nm ( $18 \pm 2$  ft-lb).

$24 \pm 2$  Nm  
( $18 \pm 2$  ft-lb)

20

Connect the oil return tube (using a new gasket) to the turbocharger. Torque bolts to  $24 \pm 4$  Nm ( $18 \pm 3$  ft-lb).

$24 \pm 4$  Nm  
( $18 \pm 3$  ft-lb)

21

Install the oil supply tube with a new seal and gasket. Torque bolts to  $24 \pm 4$  Nm ( $18 \pm 3$  ft-lb).

$24 \pm 4$  Nm  
( $18 \pm 3$  ft-lb)

**Note:** Make sure the port in the oil filter housing for the oil supply tube and seal assembly is clean and smooth, also before installing the supply tube, pre-lubricate the turbo with clean engine oil.

**22**

Connect the lower charge air cooler pipe and adapter with new O-ring seals to the turbo. Install and torque the 3 charge air cooler pipe support bolts to  $24 \pm 4$  Nm ( $18 \pm 3$  ft-lb).

$24 \pm 4$  Nm  
( $18 \pm 3$  ft-lb)

**Note:** To make installation easier, apply a soapy solution to the O-rings prior to installation.

**23**

Connect the air compressor oil supply line and support clamp. Torque the clamp bolt to  $24 \pm 4$  Nm ( $18 \pm 3$  ft-lb).

$24 \pm 4$  Nm  
( $18 \pm 3$  ft-lb)

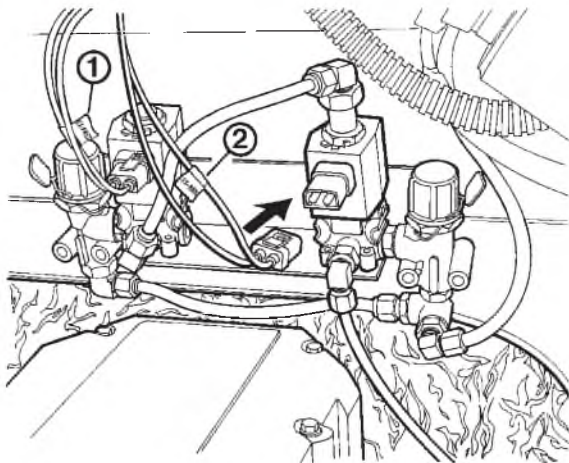
**24**

Install the heat shield and all of the air compressor discharge line support brackets. Connect the discharge line to the air compressor. Torque the heat shield bolts to  $48 \pm 8$  Nm ( $35 \pm 6$  ft-lb).

$48 \pm 8$  Nm  
( $35 \pm 6$  ft-lb)

**25**

Install the air filter housing and all air piping.

**26**

W2002216

Attach the connector to the exhaust pressure governor solenoid valve.

**27**

Remove the 36-pin breakout harness and reconnect the **EB** harness connector to the EECU.

## 2145-06-02-02 Rocker Arm Roller, Checking

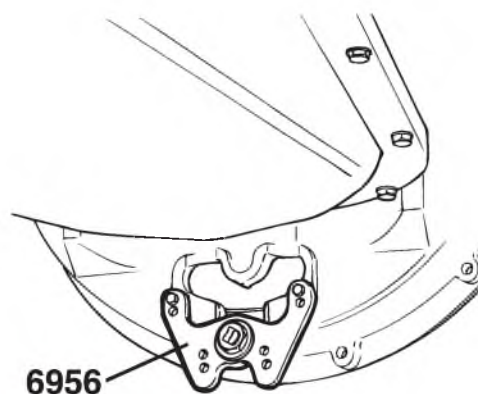
**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

*Special tools:* 9996956

*Other special equipment:* 9989876, 9999696

1



T2006672

Install the cranking tool and rotate the flywheel around until the camshaft is in a position where the rocker arm roller is not resting on any of the camshaft lobes.

9996956

2

Check that there is a gap between the rocker arm roller and the camshaft.

3

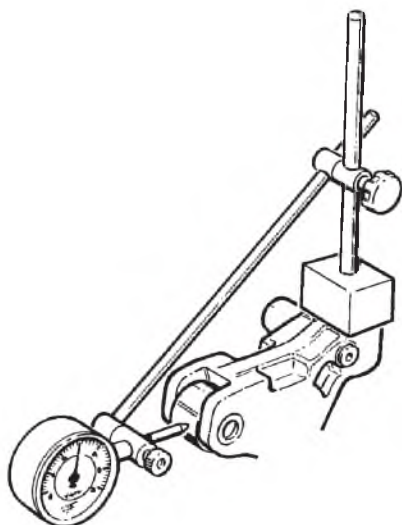


T2007946

Rotate the roller a number of turns to disperse the oil film between the bushing and shaft.

**Note:** If the roller seizes, the rocker arm must be replaced.

4



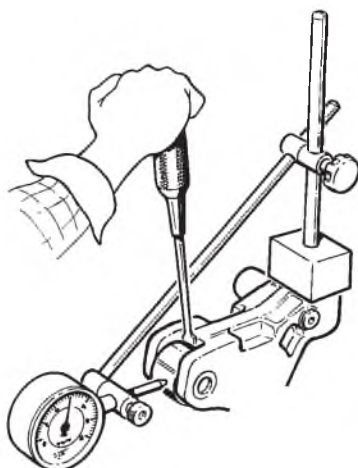
T2007949

Install a dial indicator on a magnetic base and position the magnetic base as level as possible on the rocker arm. Adjust the dial indicator probe horizontally against the center of the roller. Set the dial indicator to zero.

9999876  
9999696

**Note:** Check that the dial indicator measuring probe is pre-loaded and permits movement in both directions.

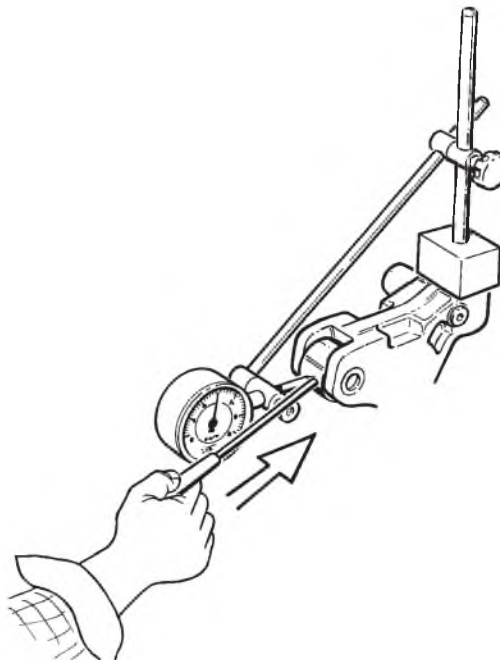
5



T2007960

Place a screwdriver between the rocker arm and roller. Press out the roller as far as possible and read the value on the dial indicator.

6



T2007951

Using a blunt object, press the roller inwards as far as possible and read the measurement value on the dial indicator.

**Max. 0.1 mm  
(0.004 in)**

The max. permitted play between the bushing and the shaft is **0.1 mm (0.004 in)**. If the play is greater, the rocker arm should be replaced.

7



T2007792

If it is necessary to replace a rocker arm, lubricate the new rocker arm bushing with engine oil. Use a manual pump oil can and insert the nozzle in the oil channel hole.

Rotate the roller while pumping oil into the channel hole. Continue until oil runs out both sides of the roller.



## Service Procedures

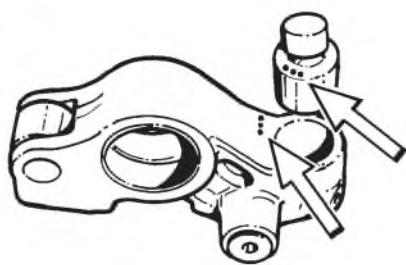
### 2145-04-04-02

#### Rocker Arm, Overhaul

Special tools: 9996716, 9998344

Repair kit: 8148353

1

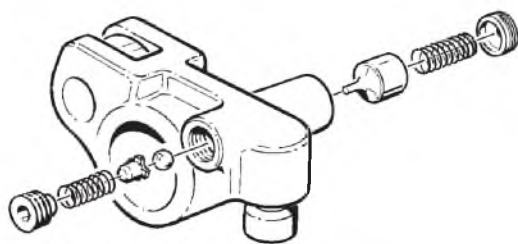


T2007725

Remove the plunger from the rocker arm.

**Note:** The plunger and rocker arm are a matched pair and are punch-marked for identification. They are not to be mixed when reassembled.

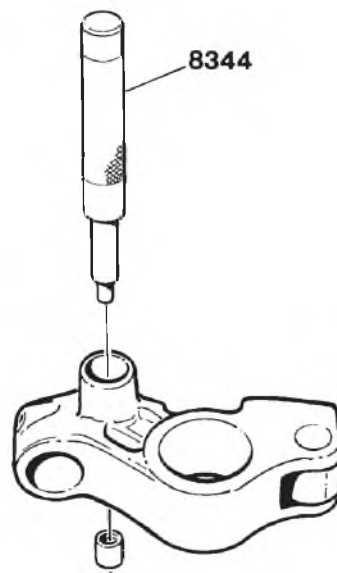
2



T2007726

Carefully heat the rocker arm plugs. Remove the plugs and take the springs, plunger, ball and spring guide out of the rocker arm.

3



T2007727

Press out the ball seat with drift 9998344.

9998344

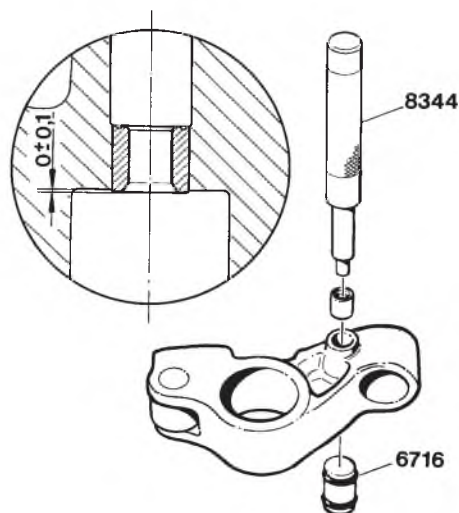
**Note:** Press the ball seating out in the direction as shown.

4

Clean and check the rocker arm. Make sure that all dirt is removed before assembling.

**Note:** If the rocker arm shaft bushing or roller is damaged, the complete rocker arm must be replaced.

5



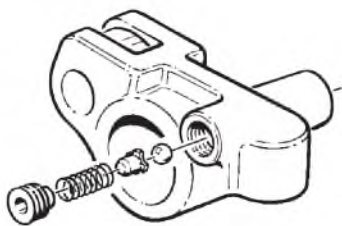
T2007728

Use drift 9996716 as a counter-hold in the hole for the non-return valve plunger. Lubricate the new ball seat with **gear oil** and press in the seat with drift 9998344 until it bottoms against the counter-hold. Check the measurement for the ball seat position in the rocker arm.

9996716,  
9998344  
 $0 \pm 0.1 \text{ mm}$   
( $0 \pm 0.003 \text{ in.}$ )

**Note:** Make sure that the ball seat is positioned with the ring groove towards the ball and that no metal particles remain after pressing in the seat.

6

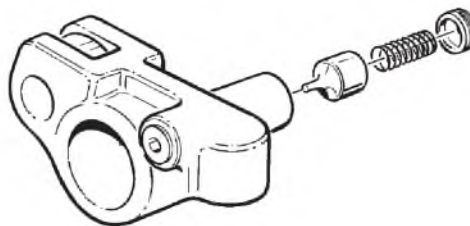


T2007729

Lubricate the components with engine oil and install the ball, spring guide and spring. Apply **one drop** of locking fluid to the threads of the new plug and install the plug.

**Note:** Make sure that the plug and rocker arm threads are clean and dry before the locking fluid is applied. Carefully wipe off any excess locking fluid after the plug is installed.

7

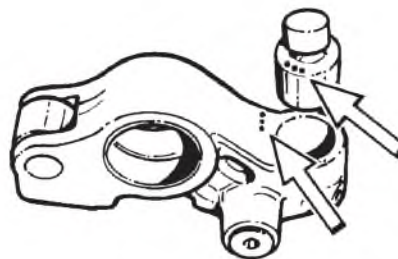


T2007730

Lubricate the non-return valve plunger with engine oil, check that the plunger moves easily in the rocker arm and install the spring. Apply **one drop** of locking fluid to the threads of the new plug and install the plug.

**Note:** Make sure that the plug and rocker arm threads are clean and dry before the locking fluid is applied. Carefully wipe off any excess locking fluid after the plug is installed.

8



T2007725

Make sure the rocker arm and rocker arm plunger punch marks are the same. Lubricate the rocker arm plunger with engine oil and install it in the rocker arm.

**Note:** Place a rubber band around the rocker arm and plunger to prevent the plunger from falling out.



9



T2007792

Lubricate the journaling for the rocker arm roller with engine oil. Use a manual pump oil can and insert the nozzle in the oil channel hole. Rotate the roller while pumping oil into the channel. Continue until oil runs out both sides of the roller.

## 2533-03-02-05 Solenoid Valve, Compression Brake, Replacement

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### WARNING

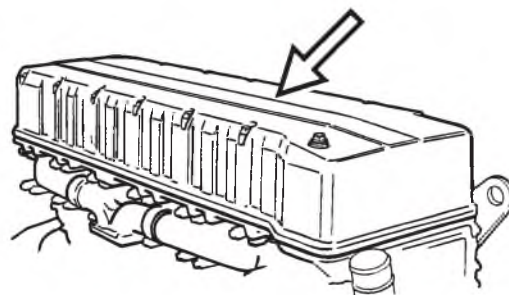
**HOT ENGINE!** Keep yourself and your test equipment clear of all moving or hot engine parts. A hot engine can cause serious burns or can permanently damage test equipment.

### WARNING

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

- 1 Set the parking brake.

2



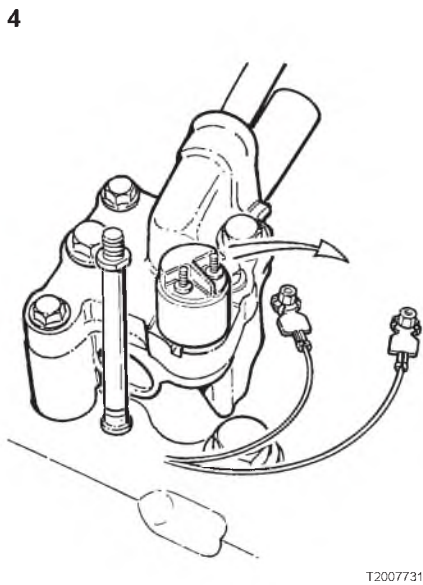
T2006731

Remove the valve cover.

**⚠ CAUTION**

With older engines, avoid damage to the valve cover and injector cable harness by making sure the mounting screws do not unscrew from the cylinder head during removal. **Do not** use impact tools to remove the nuts securing the valve cover.

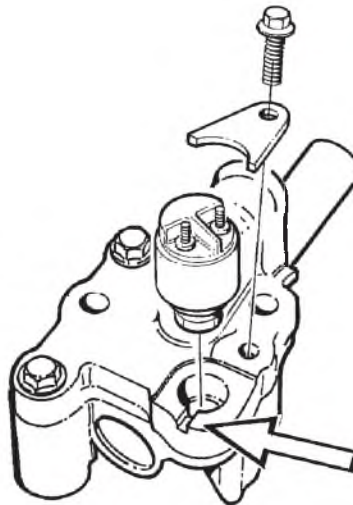
**3**  
Clean the area round the solenoid valve.



T2007731

Remove the electrical connections from the solenoid valve.

**5**

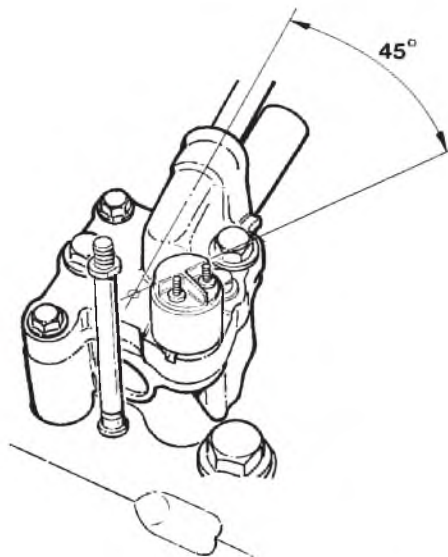


T2007732

Remove the mounting bolt and flange. Lift off the old solenoid valve.

**Note:** Check that the drain channel in the VEB control valve is not clogged.

**6**



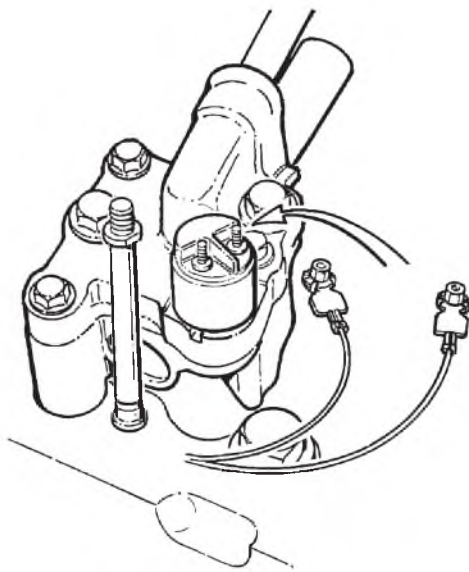
T2007736

Install the new solenoid valve, flange, and mounting bolt. **12.2 Nm (9 ft-lb)**

**Note:** The solenoid mounting angle is important. The terminals of the solenoid should be at a 0 to 45° angle to the VEB control valve oil pipe. Torque the solenoid mounting screw to 12.2 Nm (9 ft-lb).



7

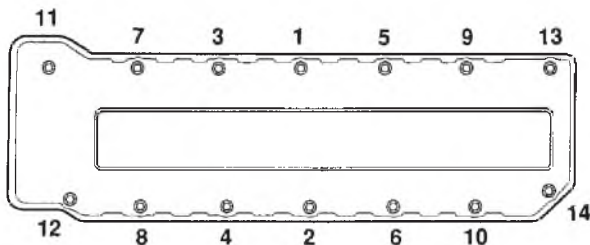


T2007733

Connect the electrical cables to the solenoid valve and tighten the nuts to a torque of 1.4 Nm (1 ft-lb).

8  
Install the valve cover.

9



T2007003

Tighten the valve cover nuts to  $30 \pm 3$  Nm ( $22 \pm 2$  ft-lb). Follow the tightening sequence shown.

10  
Test run engine and check for oil leaks.

## 2531-03-02-02 Control Valve, Engine Brake, Replacement

### DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

### WARNING

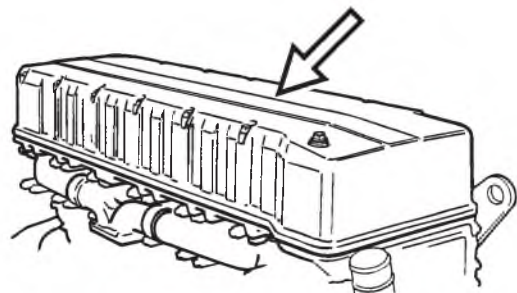
HOT ENGINE! Keep yourself and your test equipment clear of all moving or hot engine parts. A hot engine can cause serious burns or can permanently damage test equipment.

### WARNING

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with engine debris or fluids.

1  
Set the parking brake.

2



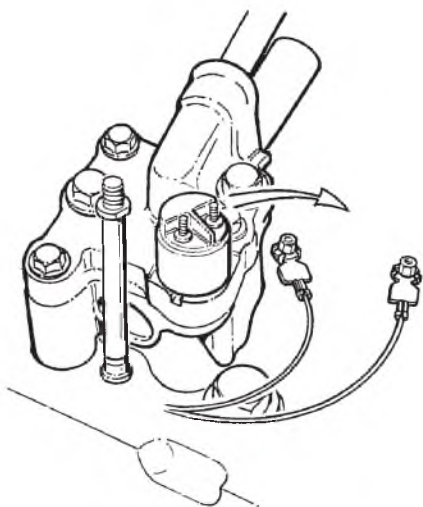
T2006731

Remove the valve cover.

**Note:** With older engines, avoid damage to the valve cover and injector cable harness by making sure the mounting screws do not unscrew from the cylinder head during removal. Do not use impact tools to remove the nuts securing the valve cover.

3  
Clean the area around the solenoid valve.

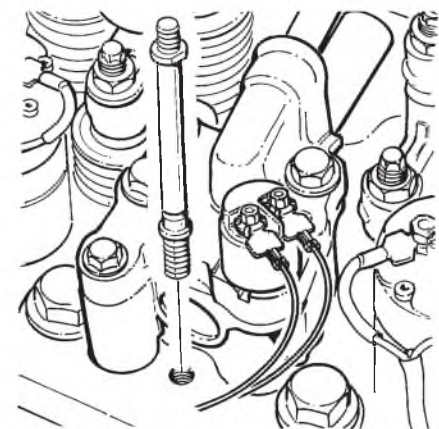
4



T2007731

Remove the electrical connections from the solenoid valve.

5



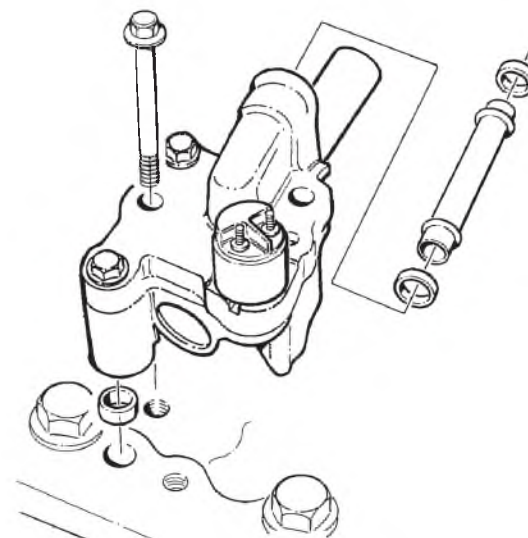
T2007722

Remove the valve cover stud located beside the VEB control valve.

J-41203

**Note:** Use Kent Moore tool J-41203 to torque the studs on early D12 engines.

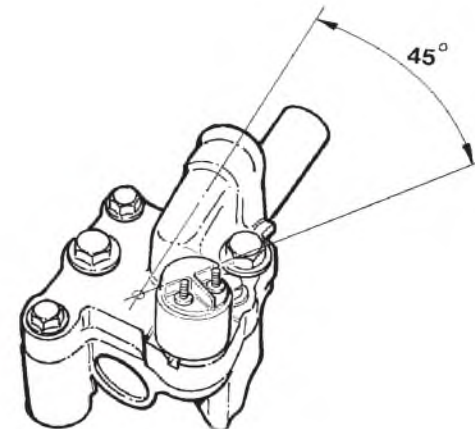
6



T2007734

Loosen the attaching bolts and remove the control valve. Also remove the oil pipe and seals between the control valve and rocker arm shaft.

7



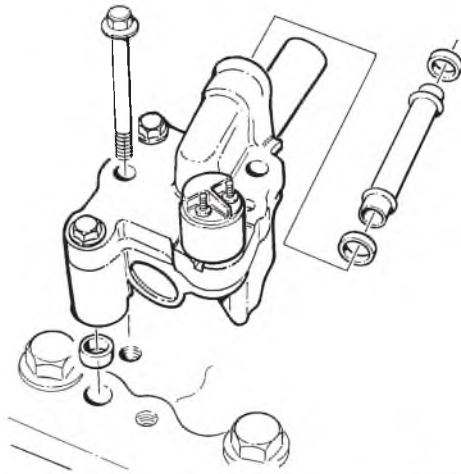
T2007794

Transfer the solenoid valve to the new control valve, if it is to be re-used. Torque the solenoid mounting screw to 12.2 Nm (9 ft-lb).

12.2 Nm  
(9 ft-lb)

**Note:** Check that the drain holes in the VEB solenoid valve are not clogged. The solenoid mounting angle is important. The terminals of the solenoid should be at a 0 to 45° angle to the VEB control valve oil pipe.

8



T2007734

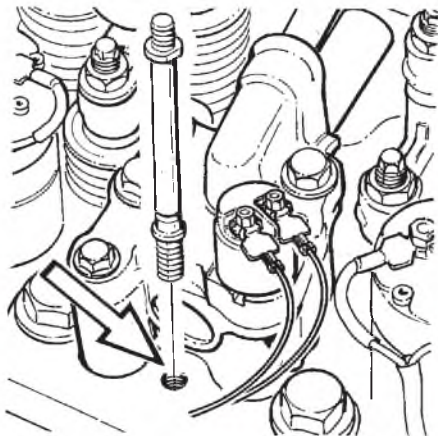
Install new seals on the pipe between the control valve and rocker arm shaft. Press the pipe (together with the seal) into the pipe valve. Install a new seal in the control valve oil inlet hole where it mates with the cylinder head.

20 ± 3 Nm  
(15 ± 2 ft-lb)

Install and bolt down the control valve. Make sure that the seals against the cylinder head and rocker arm shaft are positioned correctly.

Torque the control valve mounting bolts to 20 ± 3 Nm (15 ± 2 ft-lb).

9



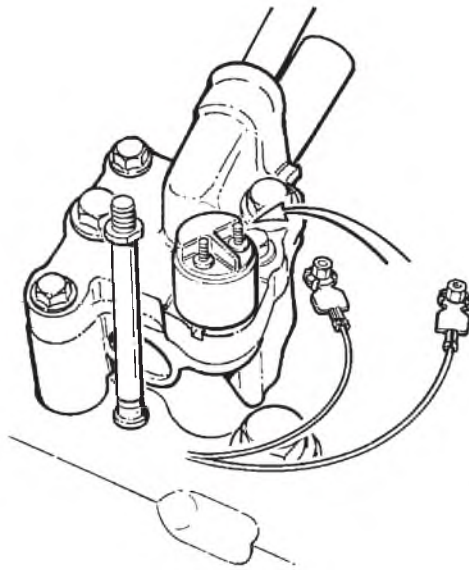
T2007723

Clean the threaded hole in the cylinder head located beside the VEB control valve. Clean the valve cover stud bolt and apply locking fluid. Torque the stud to 48 ± 8 Nm (35 ± 6 ft-lb).

J-41203  
48 ± 8 Nm  
(35 ± 6 ft-lb)

**Note:** Use Kent Moore tool J-41203 to torque the studs on early D12 engines. Carefully remove any excess locking fluid after the stud bolt has been tightened.

10



T2007733

Connect the electrical cables to the solenoid valve and tighten the nuts to a torque of 1.4 Nm (1 ft-lb).

1.4 Nm  
(1 ft-lb)

11

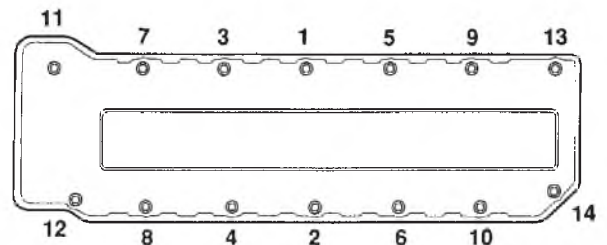
Press the electrical cable clamp onto the stud bolt.

**Note:** The electrical cable must be positioned on the outside of the valve cover stud.

12

Install the valve cover.

13



T2007003

Tighten the valve cover nuts to 30 ± 3 Nm (22 ± 2 ft-lb). Follow the tightening sequence shown.

30 ± 3 Nm  
(22 ± 2 ft-lb)

14

Test run engine and check for oil leaks.



# Operation Numbers

2145-04-04-02	Rocker Arm, Overhaul . . . . .	49
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2515-06-02-01	Exhaust Temperature, Checking . . . . .	40
2531-03-02-02	Control Valve, Engine Brake, Replacement . . . . .	53
2531-06-02-01	Engine Brake, Checking . . . . .	27
2531-06-02-02	Exhaust Brake, Electronic Checking . . . . .	30
2531-06-02-03	Exhaust Brake, Mechanical Checking . . . . .	32
2533-03-02-05	Solenoid Valve, Compression Brake, Replacement . . . . .	51
2533-06-02-01	Solenoid Valve, Compression Brake, Checking . . . . .	29
2533-06-02-02	Oil Pressure, Compression Brake, Checking . . . . .	36

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