VOLVO
Volvo Trucks North America
Greensboro, NC USA

Service Bulletin Trucks

This service bulletin replaces bulletin number 237–47 dated 06.2007.

Date	Group	No.	Page
12.2008	**237**	**47**	1(23)

Unit Injectors, Replacement

W2004685

This information covers replacement operations for the engine unit injectors on Volvo D16 engines.

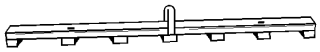
Contents

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

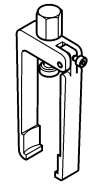
Tools

Special Tools

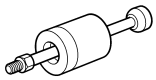
For information on ordering special tools, please refer to the special tools information, group 08.



85109035
Rocker Shaft Lift Tool



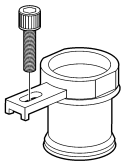
9990006
Injector Puller



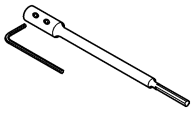
9990013
Slide Hammer

9998249
Protection Sleeve

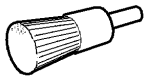
9998251
Protecting Plug



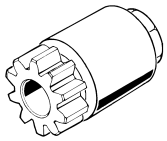
J42885-25
Fuel Bore Protector



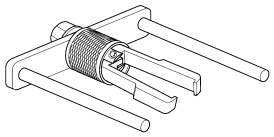
J42885-1
Holder



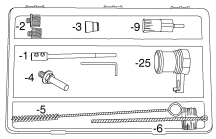
J42885-9
Injector Tube Cleaning Brush



88800014
Flywheel Turning Tool

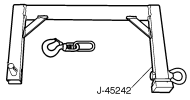


W2006395
J48922
Heavy-Duty Unit Injector Puller

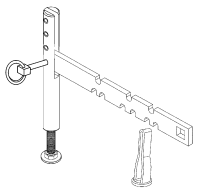


W0002416
J42885
Injector Bore Cleaning Kit

W0001802
9998511
Lever



W0002006
J45242
Lifting Bracket



W0001935
J41989
Valve Spring Compressor

Service Procedures

2374-03-02-01
Unit Injector, Replacement (One)

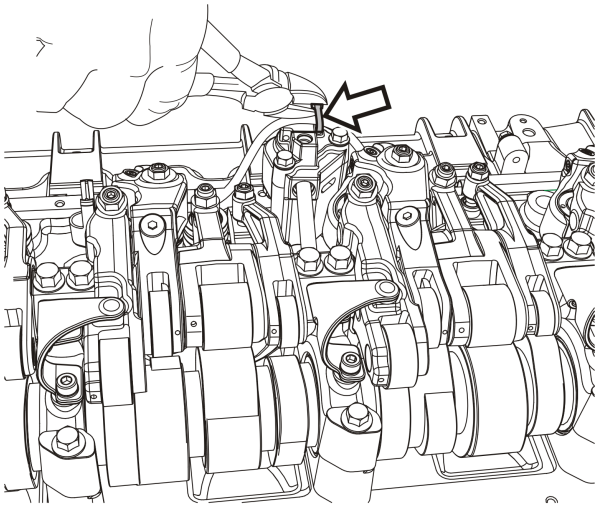
You must read and understand the precautions and guidelines in Service Information, group 20, “General Safety Practices, Engine” before performing this procedure. If you are not properly trained and certified in this procedure, ask your supervisor for training before you perform it.

Special tools: 85109035, 9990006, 9990013, 9998249, 9998251, J41989, J42885-25, J42885-1, J42885-9, J42885–25, J45242, J48922, 88800014, 9998511

Removal

1
Remove the valve cover from the engine. Refer to Group 21 for service procedures.

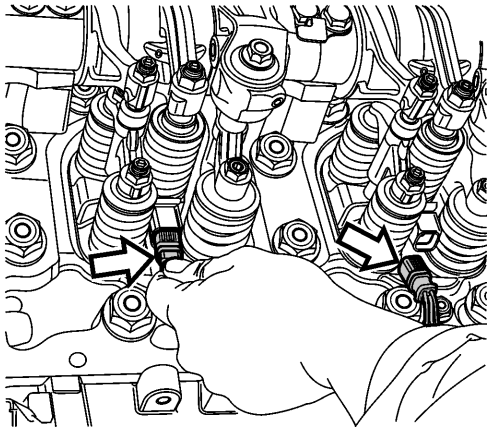
2
Cut the nylon tie straps securing the injector’s electrical wiring harness to the Volvo Engine Brake (VEB) valve.



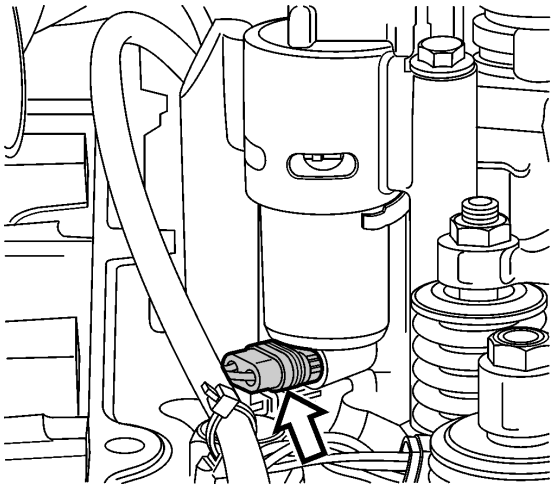
W2005846

Note: On engines not equipped with an engine brake, an oil flow adapter is used in place of the VEB control valve. It is mounted in the same location on the cylinder head and provides oil to the rocker shaft.

3
Remove the unit injector’s electrical connection.

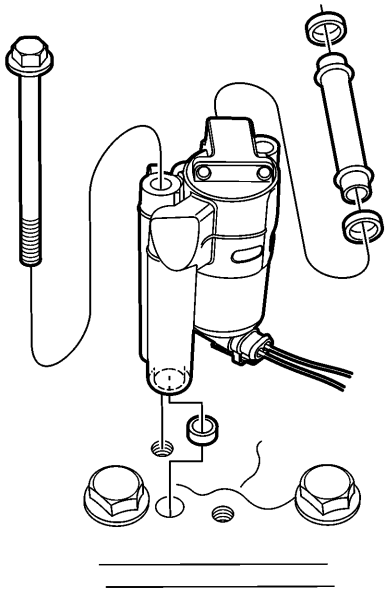


W2005106



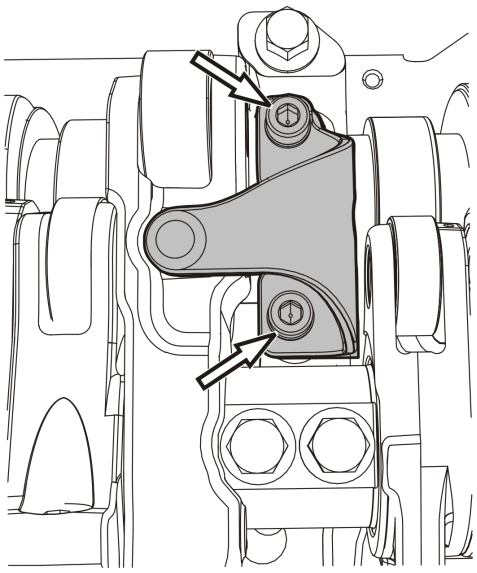
W2004837

4
Clean around the VEB control valve and remove the control valve electrical connector.



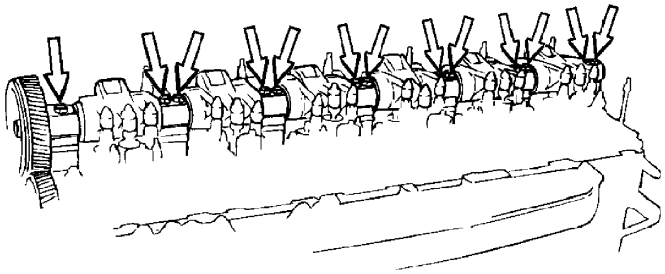
W2004869

5
Remove the VEB control valve bolts. Remove the control valve and the oil pipe between the valve and the rocker arm shaft.



W2005845

6
Using an Allen wrench, remove all mounting fasteners for the leaf spring on the brake rockers, then remove the leaf springs.

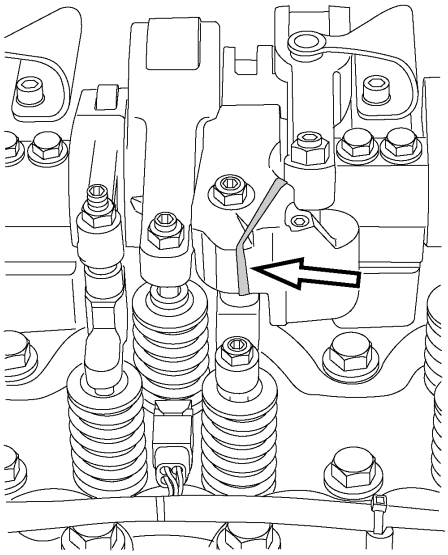


W2006220

7
Beginning at the center camshaft bearing cap and working in sequence alternately forward and back from the center, evenly loosen the rocker arm shaft bolts along the entire length of the shaft until there is no valve or injector spring pressure exerted on the assembly.

CAUTION

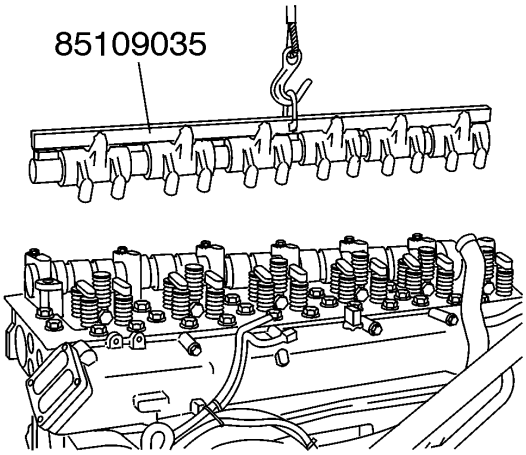
The bolts must be loosened evenly, in stages and in sequence, to prevent bending or damaging the shaft.



W2006218

8
On VEB-equipped engines, secure the pistons in the exhaust rocker arms with elastic bands or similar, to prevent the pistons from falling out when the rocker arm assembly is removed.

Note: Pistons and rocker arms are matched together and should not be mixed.



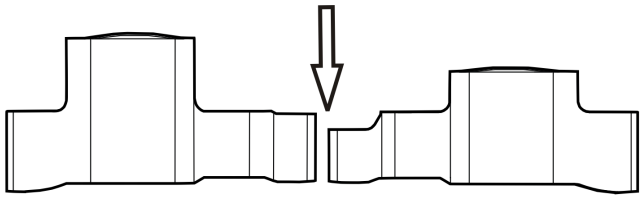
W2005077

9
Remove the bolts on the rocker arm shaft and install the rocker arm lifting tool. Using a suitable lifting device, and offset lifting bracket tool if required, remove the rocker arm assembly.

85109035, J45242

10
Mark the valve bridges so they can be installed in the same location during reassembly. Remove the valve bridges.

Note: Also, mark the location of the injectors for reinstallation. Injectors must be installed in the same order as removed.

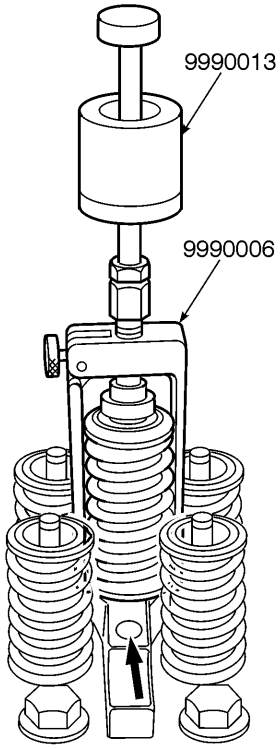


W2006625

Injector Hold Downs

11

Thoroughly clean around the unit injectors that are to be removed. Remove the unit injector's hold down bolt. If the hold down has a recess in the yoke, proceed to Removal Step 12. If the hold down does NOT have a recess in the yoke, proceed to Removal Step 13.



W2005170

12

CAUTION

Do not use excessive force on the injector with the slide hammer. If the injector is stuck in the sleeve, the puller can be damaged by the slide hammer.

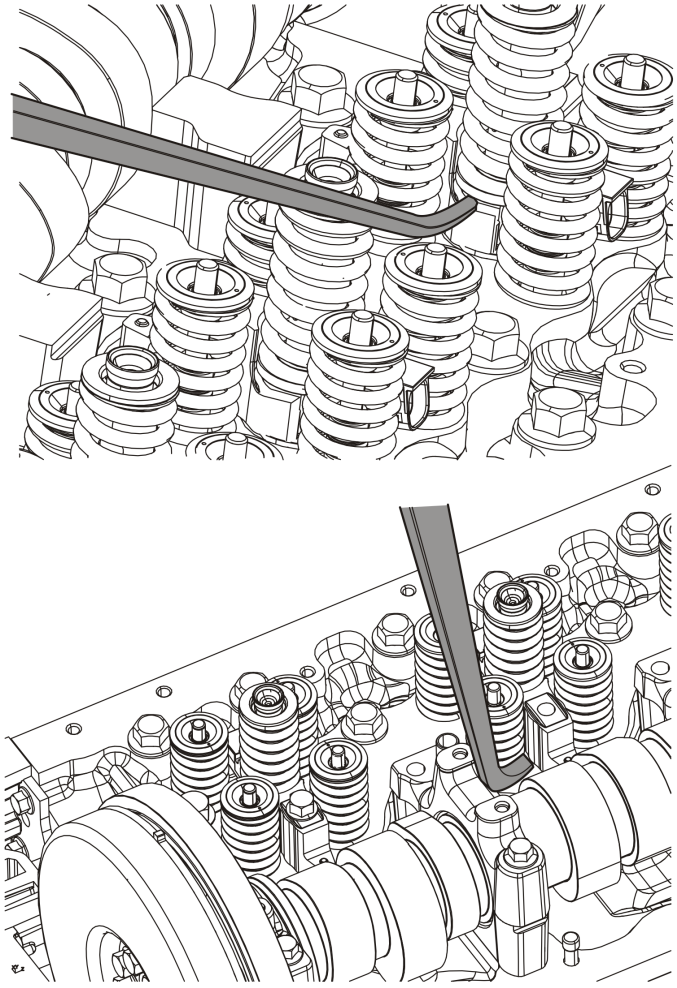
Install the puller onto the unit injector. Position the puller fork in the groove on the unit injector and lock the arm using the thumb screw on the side. Secure the puller by screwing down the screw toward the inner cup of the unit injector. Install the slide hammer. Use reasonable force with the slide hammer to pull the injector free from the cylinder head. If the injector can not be removed with the slide hammer and puller, proceed to Removal Step 18. If the injector can be removed with the slide hammer and puller, proceed to Removal Step 19.

Note: Use care when removing the unit injector because the injector hold down is not secure and could fall off if not held in place.

9990006, 9990013

13

> **CAUTION**
>
> Do not use excessive force on the injector with the pry bar. If the injector is stuck in the sleeve, the pry bar can cause damage to engine components.

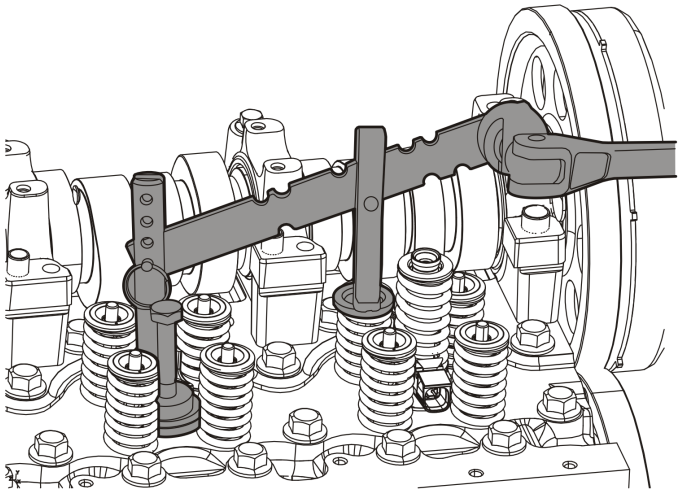


W2006623

Use reasonable force with a pry bar under the hold down or injector lip to remove the injector. If the injector can not be removed with the pry bar, proceed to Removal Step 14. If the injector can be removed with the pry bar, proceed to Removal Step 19.

Note: Use care when removing the unit injector because the injector hold down is not secure and could fall off if not held in place.

9998511



W2006622

14
Install valve spring compressor in adjacent cylinder injector hold down bolt hole.

Note: Cover all oil passage holes in the cylinder head and gear train opening with shop towels.

J41989

15
Remove the shop towel from the gear train opening. Use special tool 88800014 to turn the engine until the camshaft is at TDC. Depending on which injector is being removed, turn the engine from TDC to the appropriate camshaft mark, see table below. Confirm the piston is at the top of the cylinder by using a 40 cm (16 inch) piece of straight stiff wire in the injector hole of the companion cylinder.

Companion Cylinders	Camshaft Mark
1 and 6	TDC V3
2 and 5	V6
3 and 4	V2

88800014

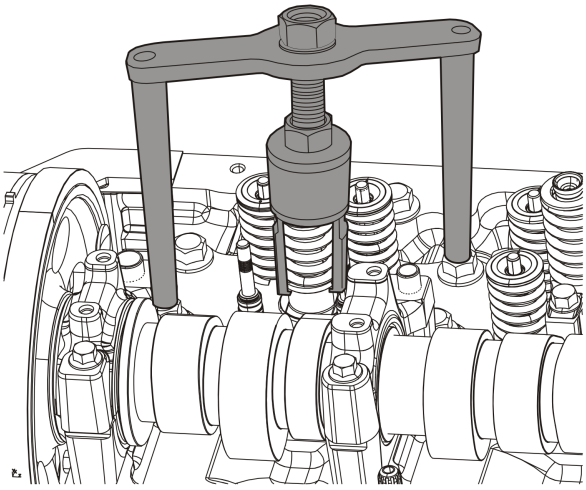
16

WARNING

Use protective goggles or injury to the eyes can occur.

Cover the gear train opening with a shop towel. Compress the intake valve spring and remove keepers and spring. Remove the injector hold down.

17
Position and compress intake valve spring and install keepers. Tap on the valve stem with a soft-faced mallet to make sure keepers are seated properly. Remove the compressor tool from the cylinder head.



W2006624

For clarity, the puller is shown on the cylinder head with the valve springs removed. If the valve springs were removed to remove the hold down, it is not necessary to install the springs before removing the injector. However, installing the springs protects the valve stems from damage during injector removal.

18
Install the puller onto the unit injector. Position the puller forks in the grooves on the unit injector. Secure the puller by sliding the lock collar down over the forks and secure with collar nut to hold the unit injector. Remove the injector, and hold down if not already removed, from the cylinder head using hand tools.

Note: Use care when removing the unit injector because the injector hold down is not secure and could fall off if not held in place.

Note: The upper bearing on the puller pilot shaft is not required for the 16L engine. The bearing prevents the jaws from reaching the injector lip.

CAUTION

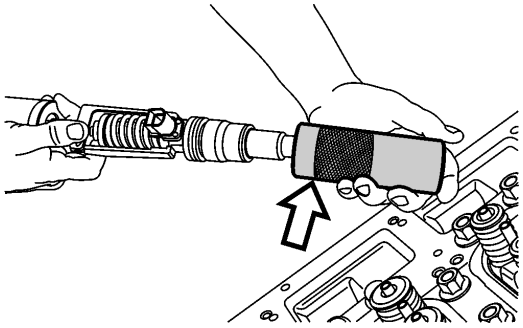
If excessive combustion leakage has resulted in the copper sleeve being stuck-fast to the unit injector by carbon, the unit injector must be replaced. The condition is found when the unit injector is removed and the copper sleeve comes out with the injector.

J48922

19
Remove and discard the injector nozzle gasket (flat washer) from the injector tip or copper sleeve bore.

Note: If an injector nozzle gasket (flat washer) had been used for the seal joint between the injector copper sleeve and the injector, discard the used gasket immediately after the injector is removed. A used gasket must not be reused. When the injector is removed, this gasket may come out attached to the injector or it may remain in the bottom of the injector sleeve.

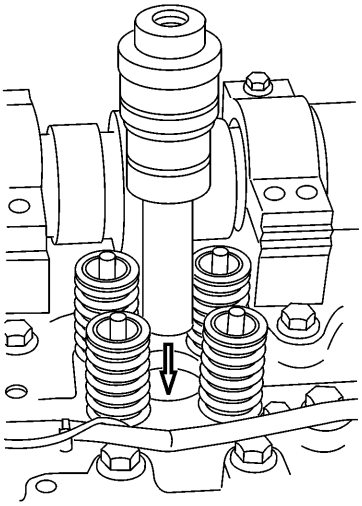
Note: If the nozzle gasket (flat washer) is attached to the injector, loosen it with gentle prying from a thin flat gasket scrapper blade. If the gasket is in the bottom of the injector sleeve, initially attempt to remove it with a magnet. If this is unsuccessful, use a standard flat blade screwdriver with a long thin shank and narrow width blade to loosen the gasket. Locate the blade in the recess between the outside of the gasket and the injector sleeve. Use the blade to apply force on the outside of the gasket at different locations around the gasket. Continue this until the gasket separates from the sleeve.



W2005112

20
Install the protective sleeve over the unit injector to prevent damage.

9998249

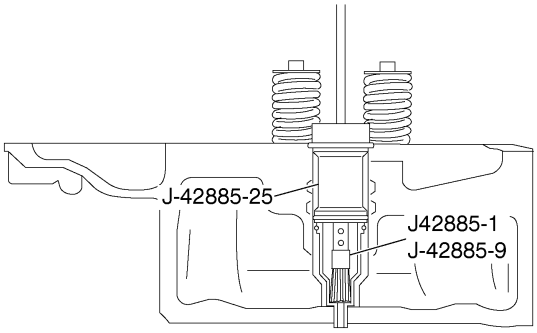


W2005172

21
If the injector is not being installed immediately, install the protective plug into the unit injector bore of the cylinder head to protect it from debris.

9998251

Installation



W2006256

1
Install the protective sleeve and clean the unit injector copper sleeve with the appropriate brush and extension.

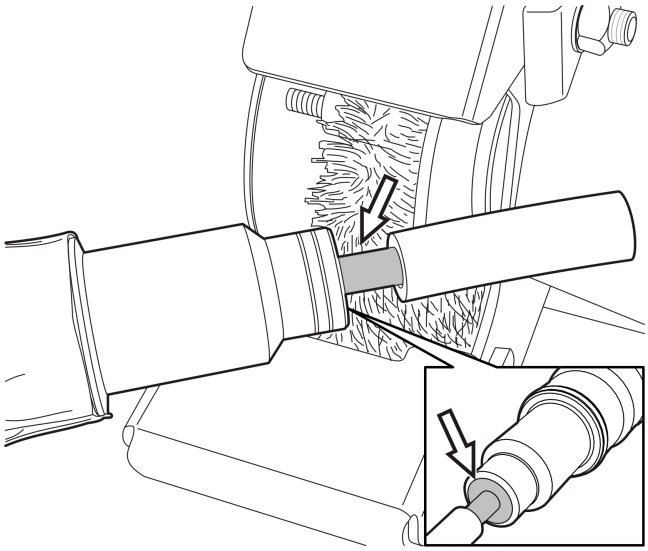
Note: After cleaning the copper sleeve, carefully inspect the inside surface of the sleeve, especially the bottom surface where the injector seal is located. Any remaining contamination is unacceptable and must be removed. Also, if there is any indication of a discrepancy that raises concern about suitability of the sleeve for reuse, replace it with a new sleeve.

J42885-25, J42885-1, J42885-9

2
To determine if the injector is suitable for reuse, the injector must be cleaned. The cap nut seat surface is the only surface which requires a thorough cleaning. Remove the two O-rings from the injector. Cover the two O-ring grooves and the complete area between the grooves with tape or equivalent to prevent contamination from getting into the injector. Also, cover the electrical connection opening. Protect the nozzle spray holes from damage by covering approximately half of the nozzle tip length with a piece of 6 mm (0.25 inch) ID hose.

CAUTION

Unit injectors operate at very high fuel injection pressures, which keep the nozzle tip spray holes clean and free of carbon. The outer surface of the tip spray holes does not need to be cleaned and to prevent spray hole damage MUST NOT be cleaned with a wire wheel.



W2006513

3
With the unit injector surfaces protected as described above, clean the cap nut seat surface of hard carbon deposits by careful use of a wire wheel, confining the wire wheel contact to the cap nut seat surface only and completing the cleaning with hand tools. Carefully remove the carbon by applying slight nominal pressure with the wire wheel against the cap nut and nozzle for short periods of time. Clean any remaining carbon using hand tools such as a hand scraper or medium grit emery cloth.

CAUTION

The carbon will be very hard and difficult to remove. Variables such as size and condition of the wire wheel may result in a tendency to force the wheel harder against the cap nut. However, it is very important to not use excessive pressure against the wire wheel to clean the cap nut seat surface. The use of excessive force must be avoided and can damage the seat surface resulting in an injector that cannot be reused.

Note: Using the precautions described in this procedure, a steel wire wheel is allowed to be used to clean the nozzle cap nut seat surface as described, but must not touch the nozzle tip spray holes under any circumstances or hole damage will result.

Note: The spray hole damage described here cannot be seen with a magnifying glass or an eye loop. A microscope with a minimum 10x magnification is needed to see this damage.

4
After cleaning, inspect the injector nozzle cap nut seat surface for pitting or related damage. If there is pitting or other damage, the injector can not be reused. If there is no pitting on the seat surface, the unit injector can be reused.

Note: Pitting on surfaces other than the cap nut seat surface does not effect the function of the unit injector and is acceptable.

5
Install new O-rings on the unit injector as follows:

- Upper ring — large diameter, violet
- Lower ring — small diameter, violet

6
Lubricate both sealing O-rings with clean engine oil.

7

Preassemble the new injection nozzle NBR washer to the injector. Three small projections (grippers) on the inside diameter of this NBR washer provide the means to retain the gasket to the injector on assembly. Using hand force, push the NBR washer over the injector tip until it becomes fully seated against the bottom of the injector.

Note: Before installing the gasket, inspect it to ensure that it is the correct part. The correct gasket is identified by three small projections on the inside diameter and a gray coating over the entire gasket to enhance the ability to seal.

Note: This gasket must be installed dry. Do not use grease or any other materials to secure this gasket to the injector for installation.

8

CAUTION

Any oil which may have pooled in the bottom of the injector yoke screw hole must be cleaned from the hole to avoid hydraulic lock when the screw is installed and tightened. Hydraulic lock would result in a lack of clamp load and/or a cylinder head cracked at the screw hole.

CAUTION

The new long screw must be used with the 38 mm high yoke. If the shorter screw for the 28 mm high yoke is used with the 38 mm yoke, insufficient thread engagement in the cylinder head will result and the cylinder head threads will fail during screw tightening.

When reusing a hold down screw, clean the screw before installation. Apply a light coat of oil to the threads on the screw and to the underside of the screw head. Slip the injector hold down and screw onto the unit injector.

9

Center the unit injector between the valve springs and then push down on the unit injector using hand pressure to seat the O-rings. Clamp the injector in position with the injector hold down by tightening the injector hold down bolt. Tighten the injector hold down bolt using the following procedure:

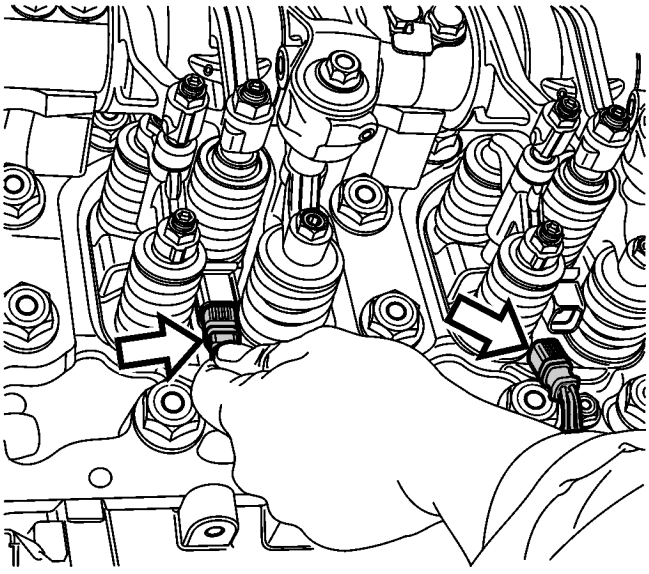
1 Tighten 20 + 5-0 Nm (15 + 4-0 lb-ft).
2 Tighten 180 ± 5 degrees angle of tightening.
3 Loosen the hold down bolt until torque is 10 to 15 Nm (7.0 to 11.0 lb-ft), then:

Note: This should be achieved by loosening with an angle of 100-110 degrees. Do not completely loosen the bolt to prevent components from moving after the previous seating process.

4 Tighten 20 + 5-0 Nm (15 + 4-0 lb-ft).
5 Tighten 90 ± 5 degrees angle of tightening.

Note:

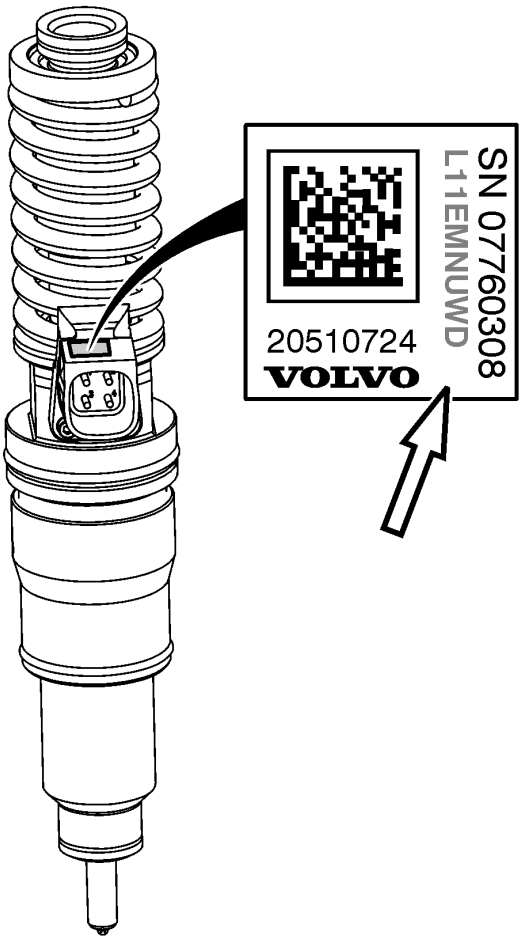
- Assembly with a new injection nozzle gasket always requires that the five (5) step injector hold down bolt tightening process be used.
- The injector hold down bolt can be reused only four (4) times. After the initial installation, every additional application of the 5 step injector hold down bolt tightening process requires that a punch mark be applied to the head of the bolt. After four (4) punch marks have been accumulated, the bolt cannot be reused again and must be replaced.



W2005106

10

Plug in the unit injector electrical connector until fully engaged. Push in the connector until you hear a distinct “click.”



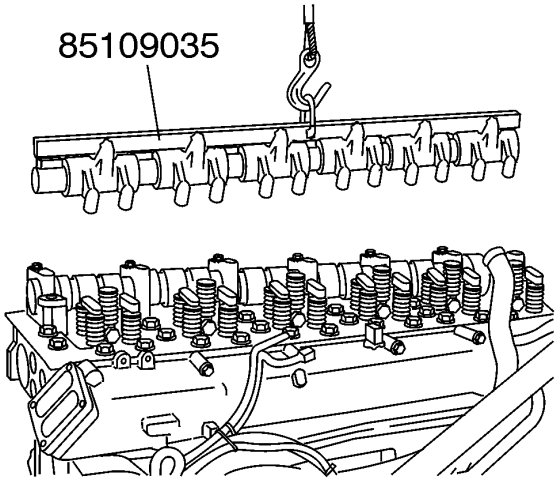
W2004684

11
When replacing unit injectors, the control unit must be programmed with the new injector's trim codes. The code is printed on top of the unit injector electrical connector. The programming is performed using VCADS and is necessary to ensure that engine timing and emission levels are correct.

Note: Due to the Engine Electronic Control Unit (EECU) self learning capability, it is necessary to reset learned EECU parameters after servicing some engine related components. This allows the EECU to learn the new components behavior. After servicing is complete, perform the "Learned Data Reset" using the PC tool. This is located in the Function Group 1 menu.

Note: If reinstalling an injector into the same location, reprogramming is not required.

12
Install the valve bridges over their respective exhaust and intake valves as marked at disassembly. Oil the valve bridges and the camshaft lobes with engine oil.

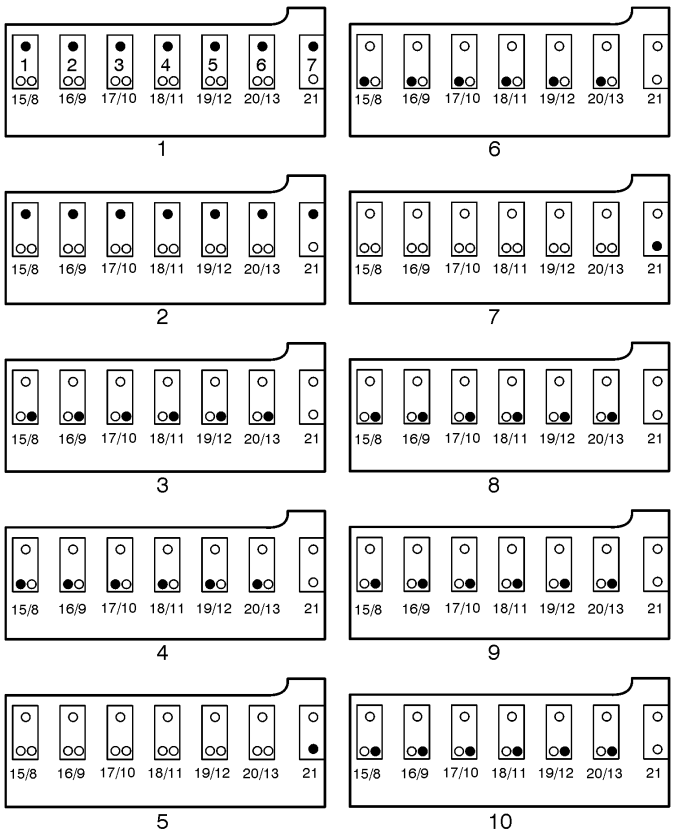


W2005077

13
Using the lifting tool and an assistant, place the shaft with rocker arms and springs in position on the inboard side of the camshaft bearing caps. Install and tighten the rocker arm shaft bolts a little at a time, evenly across the entire shaft so that the shaft does not become distorted, bent or fractured.

Note: Make sure that the rocker arm shaft is seated properly in the guide dowels of the camshaft bearing caps. On engines equipped with the VEB, remove the restraints (rubber bands or tie straps) securing the exhaust rocker arm pistons.

85109035



W2005266

14
Tighten the rocker arm shaft in stages, so that the rocker arm shaft does not bend. Check that the guide pins come into the correct bearing brackets. Torque the rocker arm shaft according to the specification table below.

Note: Tighten bolts in the following steps to ensure that the rocker arm shaft is fully seated without bending.

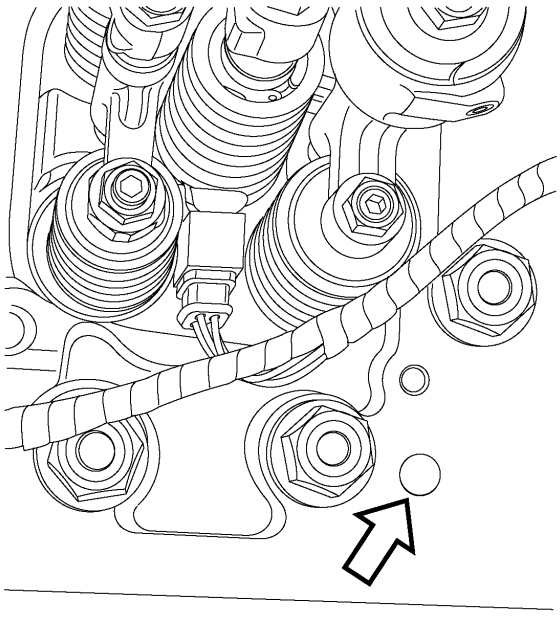
Discard removed bolts with four marks and substitute new bolts.

1 Tighten bolts 1-7 to 15±3 **Nm** (11±2 **ft-lb**).
2 Angle tighten bolts 1-7 to 90±5 degrees **Angle of tightening.**
3 Tighten bolts 8-13, begin with bolt 11 to 100±10 **Nm** (74±7 **ft-lb**).
4 Tighten bolts 15-20 to 50±5 **Nm** (37±4 **ft-lb**).
5 Tighten bolt 21 to 60±5 **Nm** (44±4 **ft-lb**).
6 Angle tighten bolts 15-20 to 120±5 degrees **Angle of tightening.**
7 Angle tighten bolt 21 to 100±5 degrees **Angle of tightening.**
8 Loosen bolts 8-13.
9 Tighten bolts 8-13 to 50±5 **Nm** (37±4 **ft-lb).**
10 Angle tighten bolts 8-13 to 120±5 degrees **Angle of tightening.**

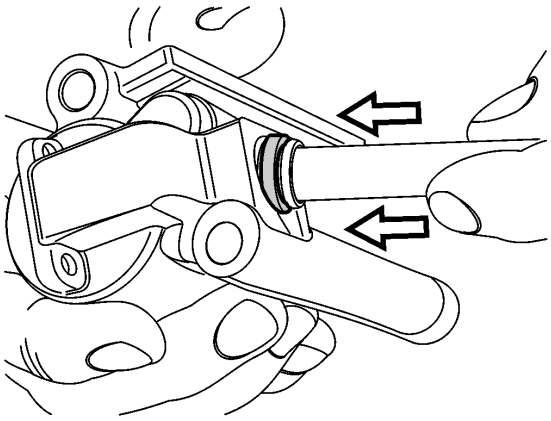
CAUTION

Gradually tighten the bolts in two or three steps to avoid damaging the rocker arm shaft.

15
Clean the cylinder head sealing surface for the VEB control valve. Check that there is no dirt in the cylinder head oil gallery.

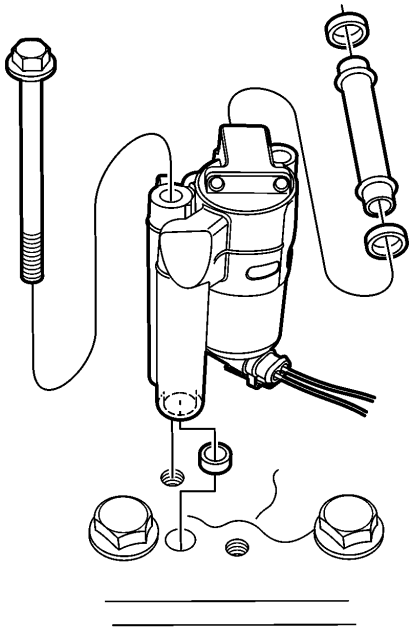


W2006227



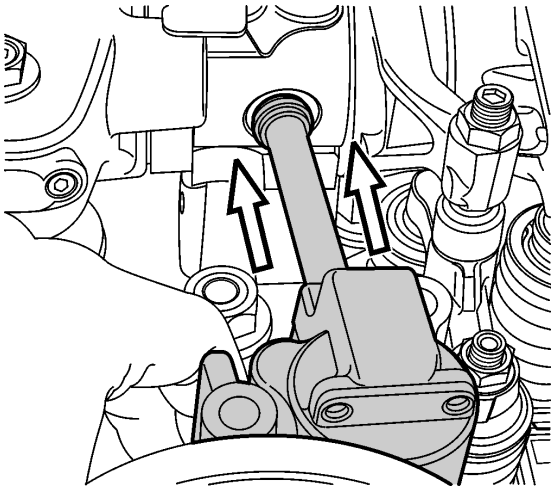
W2004871

16
Install new sealing rings on each end of the oil pipe and lubricate with fresh engine oil. Install the oil pipe into the VEB control valve.



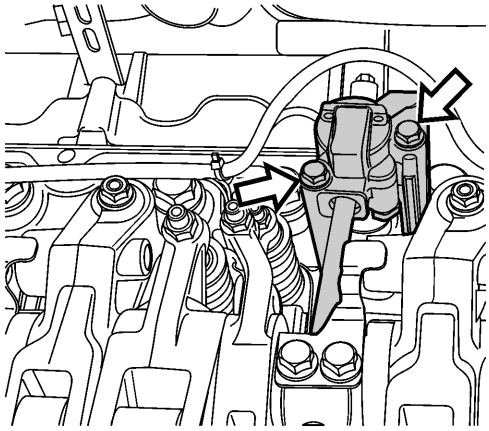
W2004869

17
Position the VEB control valve on the cylinder head.



W2004870

18
Position the VEB valve and at the same time, press the oil pipe into the rocker arm shaft. Make sure the seal remains correctly located during oil pipe installation into the rocker arm.



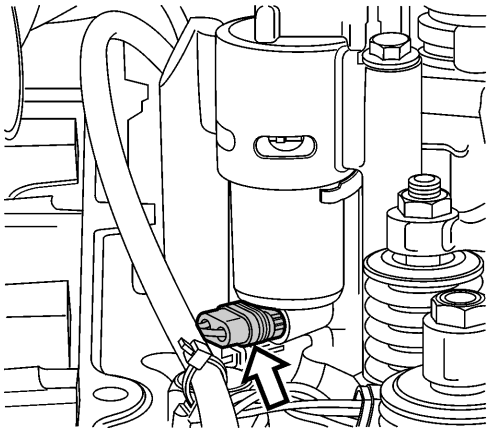
W2004838

19
Install the VEB control valve bolts and torque-tighten to 20 ± 3 Nm (15 ± 2 ft-lb).

Note: Make sure the VEB oil pipe O-ring is fully seated.

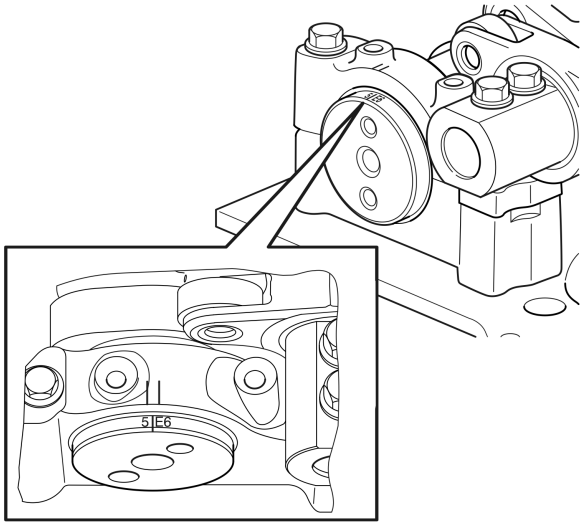
20 ± 3 Nm
(15 ± 2 ft-lb)

20
Reposition the fuel injector harness over the VEB control valve and secure with tie straps.



W2004837

21
Plug in the VEB connector. Push in the connector until you hear a distinct “click.”



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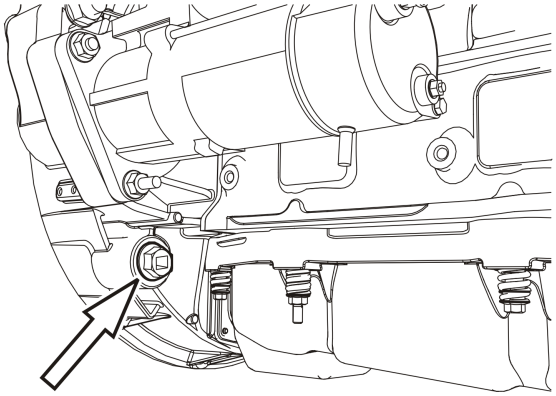
22
When adjusting the valves, make sure to start with the camshaft cylinder alignment marks between the two lines on the front camshaft.



W0002368

23
Remove the plug from the lower right side of the flywheel housing and install the flywheel turning tool 88800014.

88800014

24
Adjust the inlet and exhaust valves and unit injectors using the pattern outlined in the chart below. Use flywheel turning tool to advance the engine to the next setting.

Note: Ensure the flywheel turning tool is well greased before attempting to rotate the flywheel.
Camshaft markings for setting of valves and unit injectors:

- **Without VEB:** Markings 1–6 apply to adjustment of inlet valves, exhaust valves and unit injectors.
- **With VEB:** Markings 1–6 apply to adjustment of inlet valves and unit injector.
  Markings E1–E6 apply to adjustment of exhaust valves.

Valve and Injector Settings

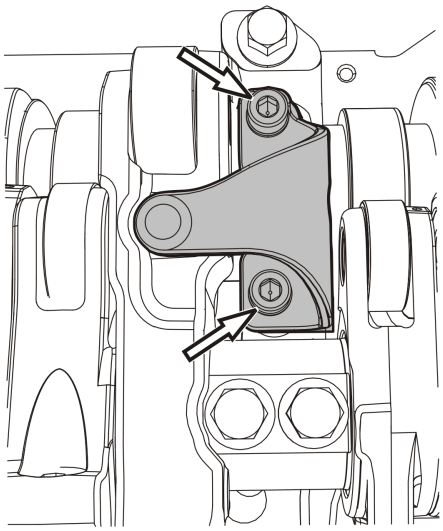
Cam Position	Injector	Intake Exhaust	Exhaust (VEB)	VEB
5	X	X		
E6			X	X
3	X	X		
E2			X	X
6	X	X		
E4			X	X
2	X	X		
E1			X	X
4	X	X		
E5			X	X
1	X	X		
V3			X	X

25
Adjust the valves and unit injectors to the lash settings below:

- Inlet Valve Clearance: 0.30 ± 0.05 mm (0.012 ± 0.002 inch)
- Exhaust Valve Clearance, VEB: 0.60 ± 0.05 mm (0.024 ± 0.002 inch)
- Exhaust Brake Rocker Clearance, VEB: 4.2 ± 0.10 mm (0.165 ± 0.004 inch)
- Adjust the unit injector to zero lash and then turn 4 flats (240° CW).

Note: Torque-tighten valve adjustment locknuts to specification following each valve adjustment.

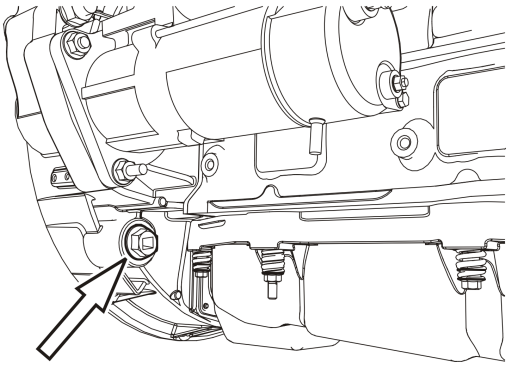
If further instructions on adjusting valves and unit injectors is required, refer to group 21.



W2005845

26
After all unit injectors and valves have been checked and adjusted, install and secure the VEB rocker leaf springs. Tighten the screws to specification, 25 ± 3 Nm (18 ± 2 ft-lb), using an Allen wrench and suitable torque wrench.

25 ± 3 Nm
(18 ± 2 ft-lb)



W0002368

27
Remove the flywheel turning tool, 88800014, and reinstall the dust plug.

88800014

28
Install the valve cover on the cylinder head. Refer to Group 21 for service procedures.

29
Start the engine and run until the engine clears and runs without stumbling. This procedure may need to be repeated once or twice to get the fuel system completely free of air.

Note: If the engine does not start on the first attempt, prime the fuel system again, and refer to the previous step. Engine priming may need to occur several times in order to get the engine to start.

30
Allow the engine to run at low idle for about 5 minutes. Check for any fuel leaks and correct if necessary.

Note: The engine speed should **not** be increased as any air pockets can be forced into the cylinder head which can result in the engine stopping.