

V O L V O P E N T A

Repair & Specifications

TWD1744GE



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00-0 General

General information

The product designation and the serial number and specification are shown on the engine decal or type plate. This information must be included in all correspondence concerning the product.

Volvo Penta is constantly developing its products. All information in this Manual is based on product data that was available at the time the Manual was published.

The working methods described in this manual are based on a workshop scenario where the product is mounted in a work fixture. Maintenance work is often carried out in situ, in which case - if nothing else is indicated - using the same working methods as the workshop.

The service manual describes work operations carried out with the aid of Volvo Penta Special Tools, where such have been developed. Volvo Penta Special Tools are designed to ensure the safest and most rational working methods possible.

In some cases local safety regulations and user instructions may be applicable regarding the use of tools and chemicals mentioned in the service manual. These rules must always be observed, so there are no special instructions about this in the workshop information.

Above all, when working on fuel systems, hydraulic systems, lubrication systems, turbochargers, inlet systems, bearings and seals, it is of the utmost importance that dirt and foreign objects are kept away, as malfunctions or shortened service intervals may otherwise result.

Replacement parts

Volvo Penta Original Replacement Parts meet national safety requirements. No damage of any kind caused by the use of replacement parts not approved by Volvo Penta will be compensated by any warranty undertaking.

About this Workshop manual

Certified engines

When performing service and repairs on emission certified engines, it is important to be aware of the following:

Certification means that an engine type has been checked and approved by the relevant authority. The engine manufacturer guarantees that all engines of the same type are manufactured to correspond to the certified engine.

This places special demands on service and repair work, namely:

- Maintenance and service intervals recommended by Volvo Penta must be complied with.
- Only replacement parts approved by Volvo Penta may be used.
- All servicing concerning fuel injection must always be carried out by an authorized Volvo Penta workshop.
- The engine may not be converted or modified, except with accessories and service kits which Volvo Penta has approved for the engine.
- No changes to the exhaust pipe and engine air inlet duct installations may be made.
- No warranty seals (where present on the product) may be broken by unauthorized persons.

IMPORTANT!

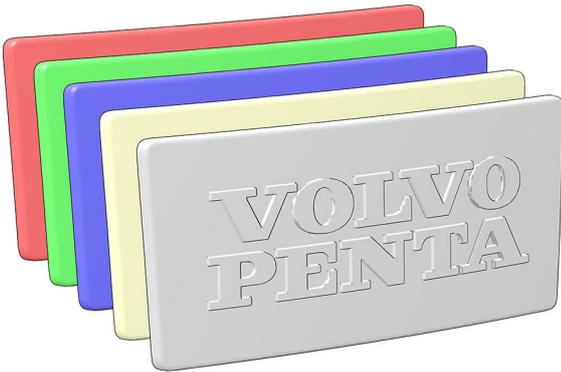
Neglected or poorly-performed maintenance or service and the use of replacement parts not approved by Volvo Penta, will mean that AB Volvo Penta no longer guarantees that the engine conforms to the certified model.

Volvo Penta accepts no responsibility for damage or costs arising as a result of failure to follow the above mentioned standards.

Colors used in images

Most images include a highlighted component which is secured by a screw or similar as part of a (light gray) engine transmission.

NOTICE! Because the images in the maintenance literature are used for different engine variants, certain details may vary compared to the actual model concerned. The essential information is always correct, however.



P0038817

Light gray: Chassis

Yellow: Special tool, tools

Blue: Detail in focus

Green: Seals

Red: Mounts e.g. nuts, stripes, clips

Other types of symbols used in the images are divided into the following categories:

- Safety
- Important
- Cleanliness
- Position
- Movement
- Measured value
- Tools
- Chemicals
- Sealant
- Units

Safety information

Read the safety information below carefully before you start repair or service work.



This symbol is used on the product to let you know that this concerns safety information. Always read such information very carefully.

Warnings take the following priority:



Indicates a dangerous situation which, if not avoided, will lead to death or serious injury.



Indicates a dangerous situation which, if not avoided, could lead to death or serious personal injury.



Indicates a dangerous situation which, if not avoided, can lead to minor or significant injury.



Is used to make you aware of something that may cause minor injury or a minor malfunction to the product or property.

NOTICE! Is used to make you aware of important information that will facilitate the work or operation in progress.



This symbol is used on certain functions to indicate the following:

Before performing this task, theoretical and/or instructor-led training is required. Contact your local training organization for further information.



This symbol informs you that supplemental information needs to be read. And where necessary information can be found.



This symbol means **Dangerous electrical voltage / General electrical danger.**



This symbol is used when a VODIA computer is needed, either for fault tracing, testing or programming.



This symbol is used for facilitation tips when repairing.

A compilation of safety precautions that must be taken and risks which you must be aware of is presented in the following pages.

	Immobilize the engine by turning off the power supply with the main switch(es) and lock it (them) in the off position before work is begun. Place a warning notice at the main switch.		Avoid opening the coolant filler cap when the engine is hot. Steam or hot coolant may spray out and with a resultant system pressure loss.
	All maintenance and service must be carried out on when the engine is stopped. Approaching a running engine is a safety risk.		Never start the engine without the air filter in place. The rotating compressor turbine in the turbocharger can cause severe injury. Install all protective covers before starting the engine.
	Beware of hot surfaces and hot liquids in pipes and hoses on an engine that is running or has just been switched off.		When operating in a confined space, exhaust pipe fumes and crankcase gases must be led away from the engine compartment or workshop area. Ensure good ventilation.
	Make sure that all warning and information decals on the product are always visible. Replace decals that have been damaged or painted over.		Only make connection adjustments with the engine switched off.
	Avoid getting oil on the skin! Use protective gloves and avoid oil-soaked clothes and rags.		Never start the engine with the valve cover removed. There is a risk of personal injury.
	Switch off the engine and disconnect the power at the main switches before starting work on the electrical system.		Stop the engine before working on the cooling system. Marine engines: Close the sea cock/cooling water inlet valve before starting work on the cooling system.
	Always wear protective goggles if there is a risk of splinters, sparks and splashes from acid or other chemicals.		Check that rags soaked in oil or fuel and used fuel and oil filters are stored safely. Oil-soaked rags may ignite spontaneously in certain conditions.
	Never use start gas or similar products as a starting aid.		Never work alone when dismantling heavy components, even if you use lifting equipment.
	Never allow open flames or electrical sparks in the vicinity of fuel. Always ensure that there are fire extinguishers close at hand in the operating area.		Take extreme care when searching for fuel system leaks and testing fuel injector nozzles. Wear safety goggles.
	Batteries must never be exposed to open flames or electrical sparks.		Never use a high-pressure washer to clean the engine. Pay attention to the following when using a high-pressure washer on components other than the actual engine: Never aim the water jet at seals, rubber hoses or electrical components.



Always wear protective goggles when charging or handling the batteries. Rinse immediately with plenty of water and soap if battery electrolyte comes into contact with unprotected skin.

If you get battery acid in your eyes, flush at once with a generous amount of water, and get medical assistance at once.



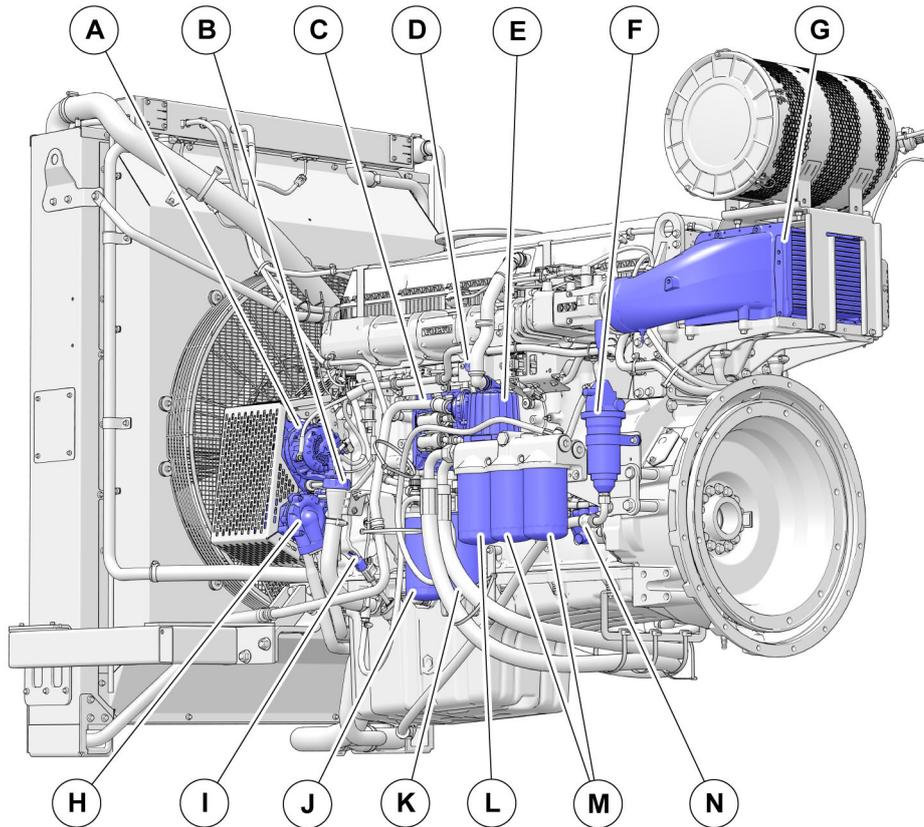
The engine must not be operated in areas where there are explosive materials or gases.



Only use fuels and lubricating oils as recommended by Volvo Penta.

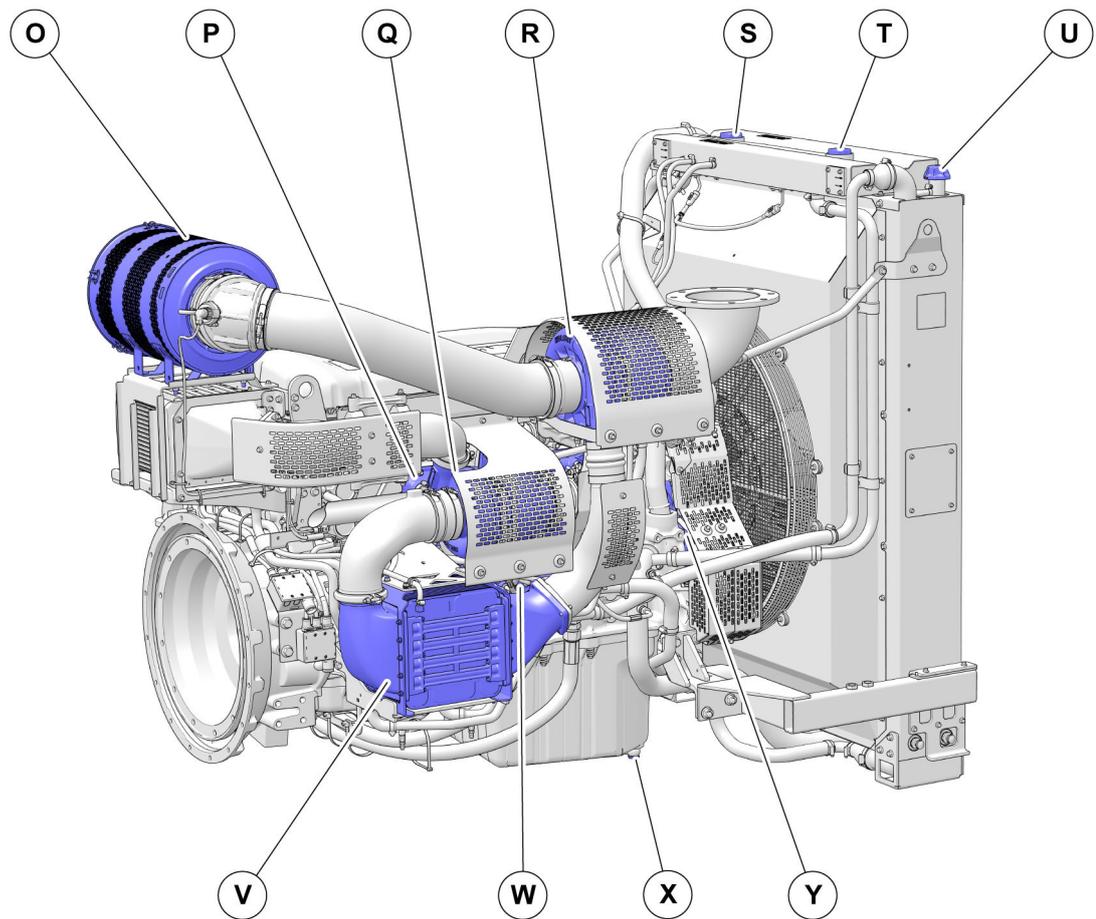
03-0 General Specifications

Component Placement



P0039743

- A. Generator
- B. Filler cap, lubricating oil
- C. Control unit
- D. Stop button
- E. CCV Unit
- F. Hand pump, lubricating oil drain
- G. Intercooler, high-pressure turbocharger
- H. Coolant Pump, Intercooler Circuit
- I. Oil dipstick
- J. Fuel filter
- K. Water separating fuel filter
- L. By-pass filter
- M. Full flow filter
- N. Fuel feed pump



P0039745

- O. Air cleaner
- P. Cover, lubrication oil cooler
- Q. High pressure turbocharger
- R. Low pressure turbocharger
- S. Pressure cap, charge air cooler circuit
- T. Pressure cap, motor circuit
- U. Filler cap, engine circuit
- V. Intercooler, low-pressure turbocharger
- X. Drain plug, lubrication oil
- Y. Coolant pump, engine circuit

General Tightening Torques

General Tightening Torques

M6	10 Nm
M8	24 Nm
M10	48 Nm
M12	85 Nm
M14	140 Nm
M16	220 Nm

IMPORTANT!

Check screws which are to be re-installed. Damaged bolts with e.g. shear marks under the heads, must be scrapped.

03-2 Specifications, Engine

Type Designation	TWD1744GE
Firing order	1-5-3-6-2-4
Number of cylinders	6
Cylinder no X closest to the flywheel	6
Cylinder bore, mm	149
Stroke, mm	165
Cylinder volume, liters ³	17.26
Engine, without fluids, weight, kg	2100
Idle rpm	900
Speed range, loaded, full throttle, RPM	1500/1800

Special Tightening Torques

Group 21 - Engine

Main bearing cap

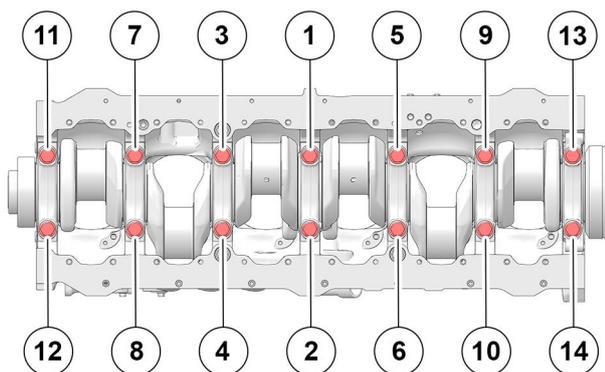
Tighten the screws in sequence.

NOTICE! The screws may be reused twice.

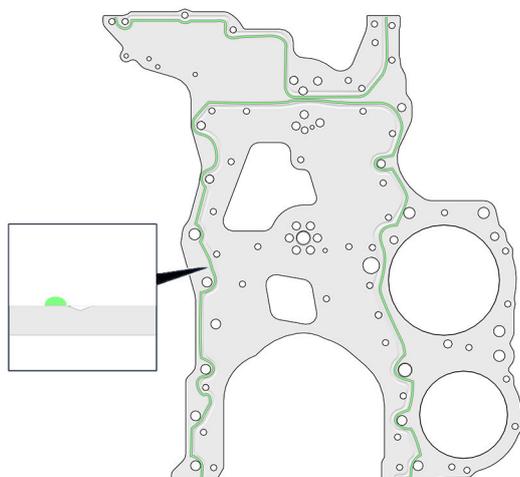
Step 1: **150 Nm**

Step 2: **300 Nm**

Step 3: **120°**



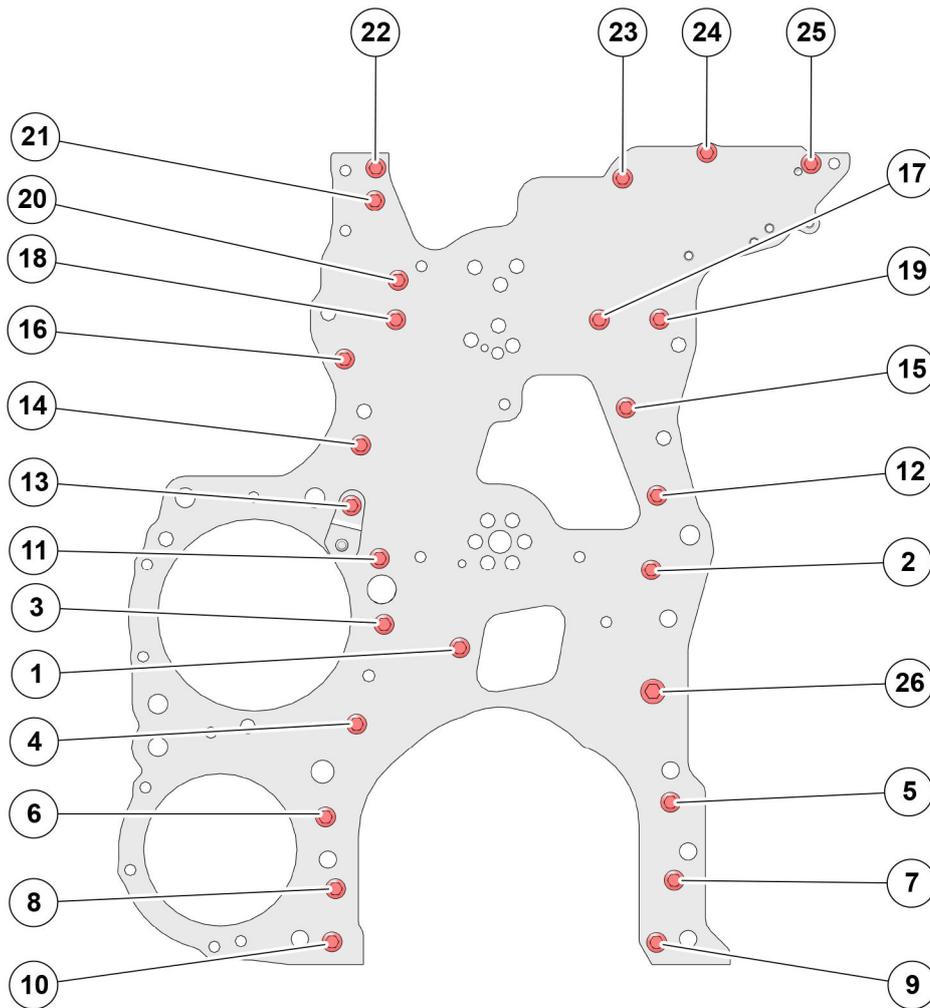
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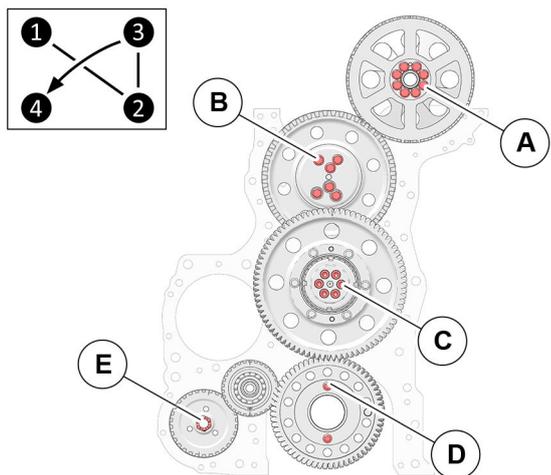
Timing gear plate

NOTICE! Apply a strand of sealant P/N 1161231 with a diameter of approx. 2 mm, refer to illustration.



P0037615

Tighten the screws in sequence.
Screws 1–25: **28 Nm**
Screw 26: **60 Nm**



P0040057

Timing gear wheel

A Oscillation damper, camshaft

Step 1: **45 Nm**

Step 2: **90°**

B Idler gear, adjustable

Step 1: **35 Nm**

Step 2: **120°**

C Idler gear, double

Step 1: **25 Nm**

Step 2: **110°**

D Driving wheel, crankshaft

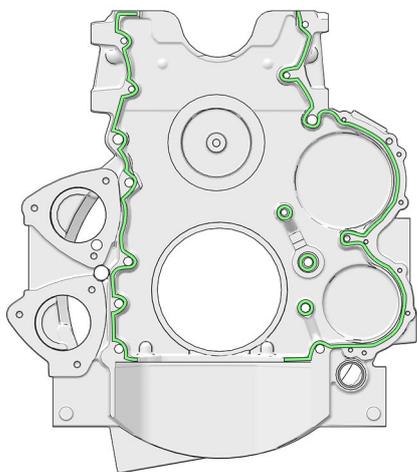
24 Nm

E Drive gear, fuel feed pump

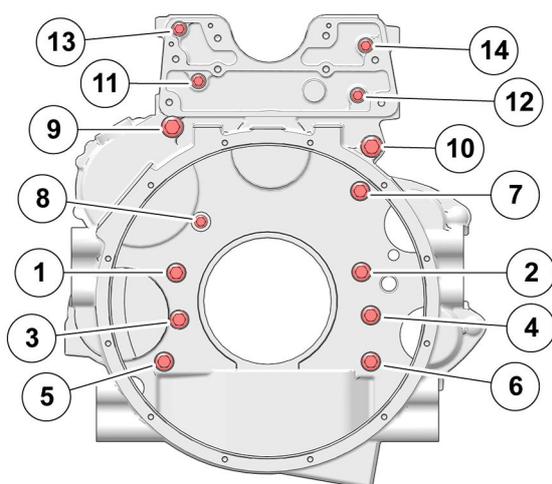
250 Nm

Timing gear casing

NOTICE! Apply a strand of sealant P/N 1161231 with a diameter of approx. 2 mm, refer to illustration.



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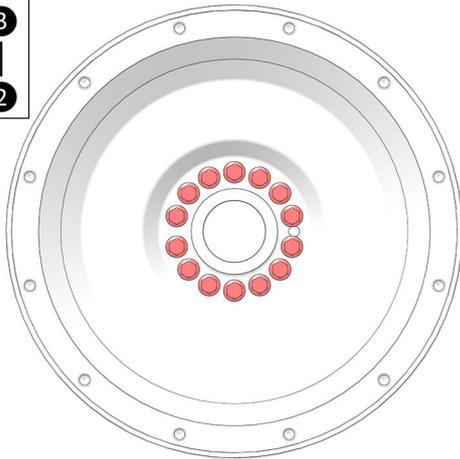
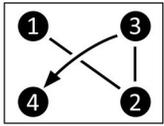
P0039261

Tighten the screws in sequence.

M14: **160 Nm**

M10: **48 Nm**

M8: **24 Nm**

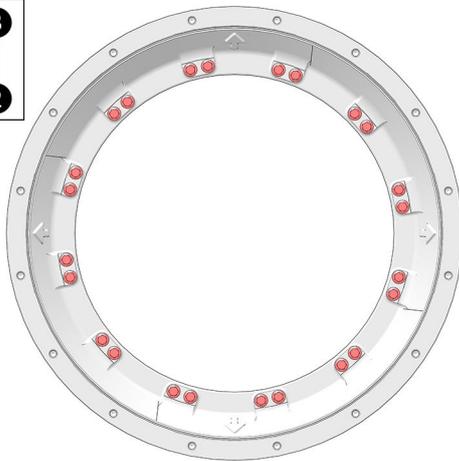
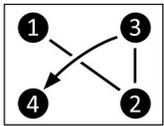


Flywheel

Step 1: **60 Nm**

Step 2: **120°**

P0040058

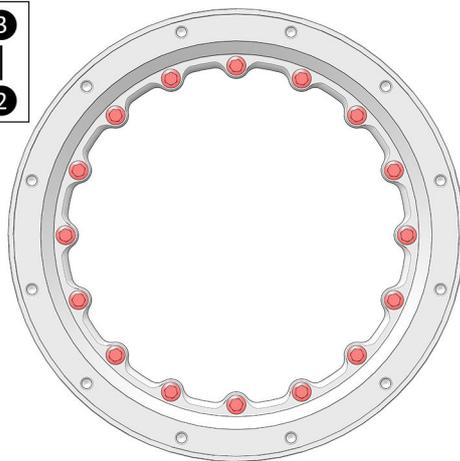
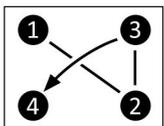


Adapter cover

Step 1: **24 Nm**

Step 2: **48 Nm**

P0040060



Flywheel adapter

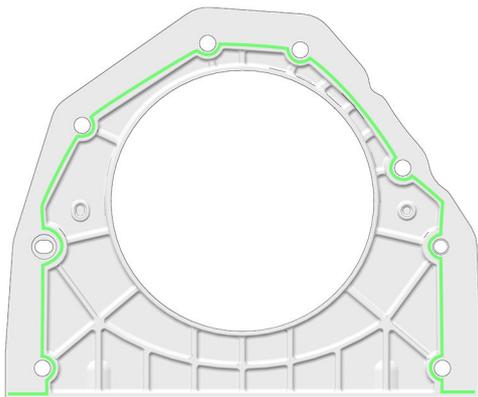
Step 1: **24 Nm**

Step 2: **125 Nm**

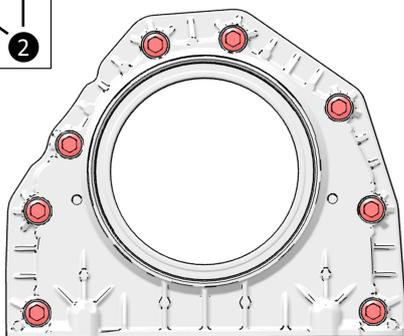
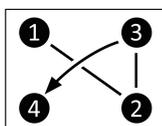
P0040059

Casing, crankshaft seal

NOTICE! Apply a strand of sealant P/N 1161231 with a diameter of approx. 2 mm, refer to illustration.



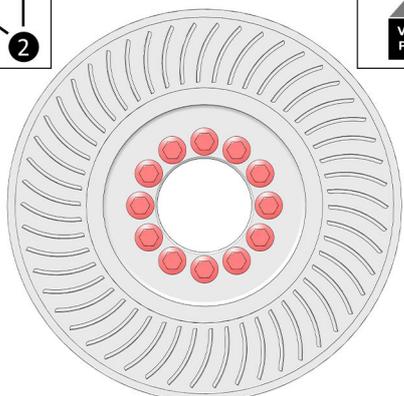
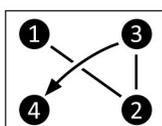
P0036756



Step 1: Tighten until contact

Step 2: **24 Nm**

P0034657

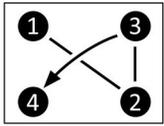
**Vibration damper, crankshaft**

Double vibration dampers

Step 1: **35 Nm**

Step 2: **125 Nm**

P0040056



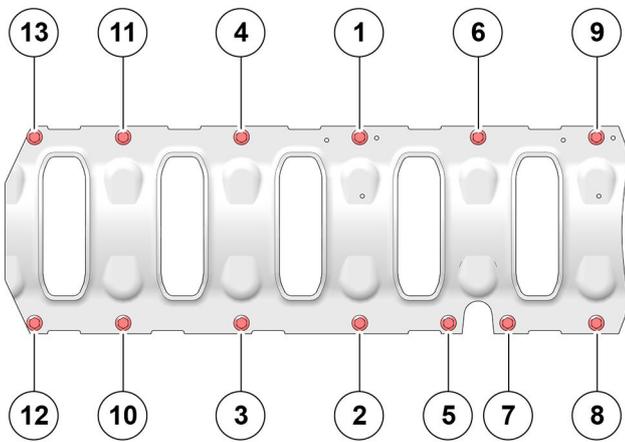
Big end bearing cap

Step 1: **20 Nm**

Step 2: **60 Nm**

Step 3: **90°**

P0037209



Reinforcing plate

Tighten the screws in sequence.

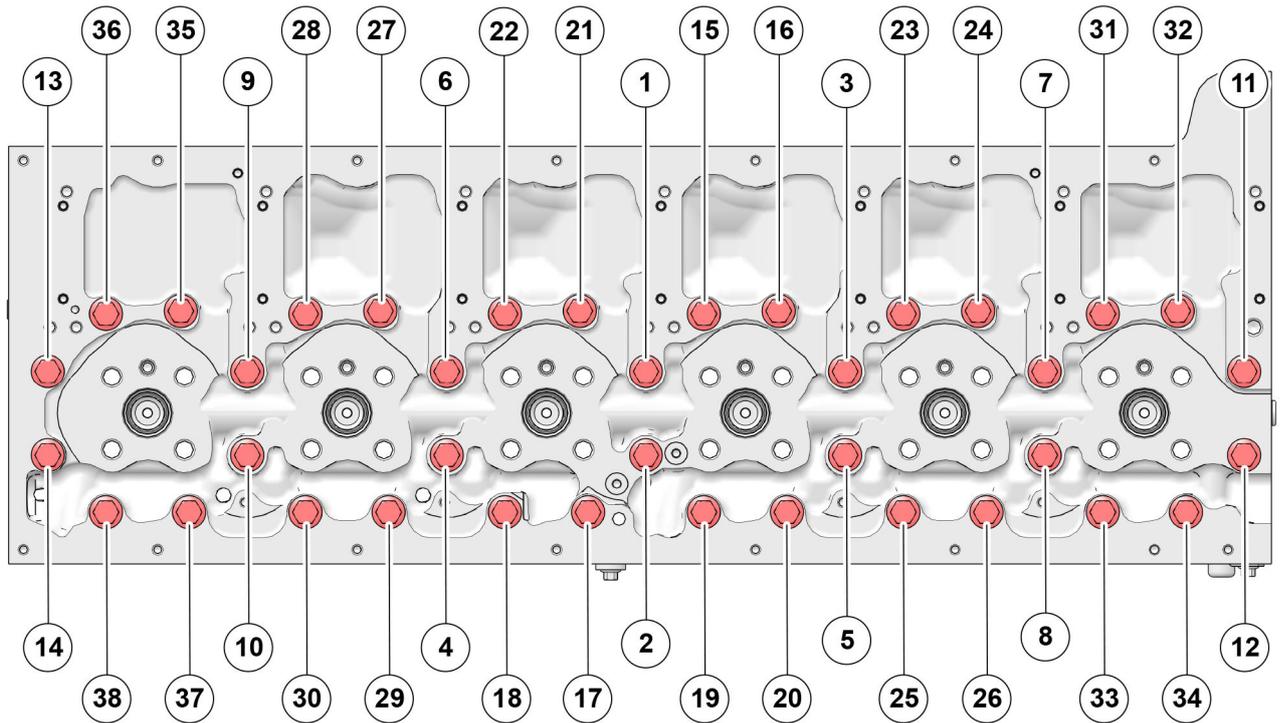
NOTICE! The screws may not be reused.

Step 1: **65 Nm**

Step 2: **90°**

P0039262

Cylinder head

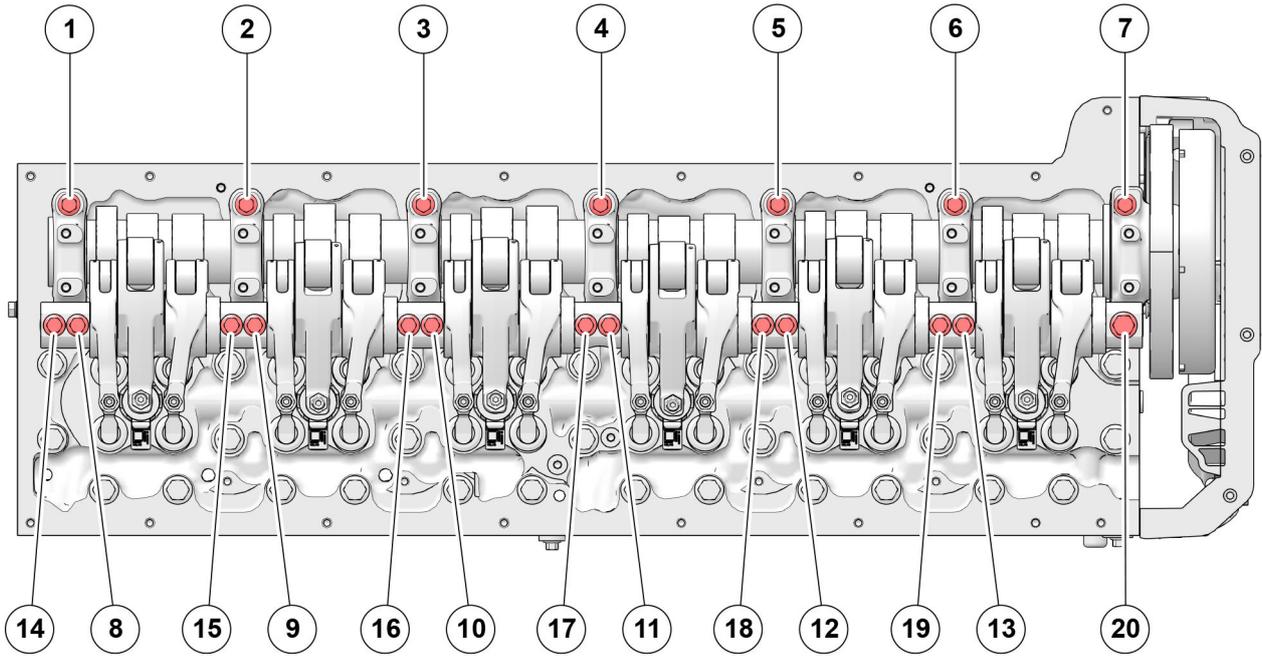


P0037425

Tighten the screws in sequence.

Step 1: **100 Nm**Step 2: **90°**Step 3: **90°**

Camshaft bearing cap



P0037426

Camshaft (Camshaft and bearing caps in place)

Step 1: Tighten the screws 4, 3, 5, 2, 6, 1, 7 **40 Nm**

Step 2: Tighten the screws 8-13 and 20 (with shorter extra screws) **100 Nm**

Step 3: Angle tighten the screws 1-7 **90°**

Step 4: Remove extra screws 8-13 and 20

Rocker arm shaft (Rocker arm shaft in place)

Step 5: Tighten the screws 11, 10, 12, 9, 13, 8, 20 **100 Nm**

Step 6: Tighten the screws 14-19 **50 Nm**

Step 7: Angle tighten the screws 14-19 **120°**

Step 8: Loosen the screws 8-13

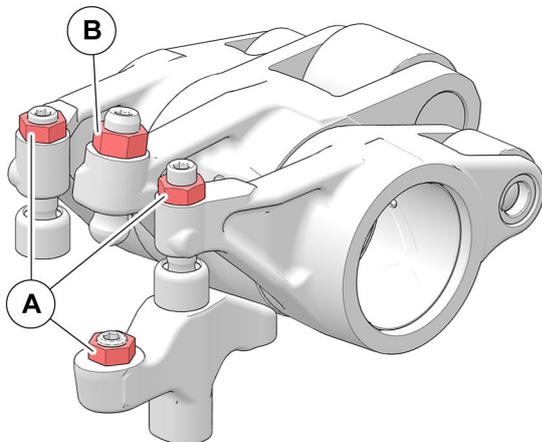
Step 9: Tighten the screws 8-13 **50 Nm**

Step 10: Angle tighten the screws 8-13 & 20 **120°**

Valve mechanism

A: Adjustment Intake, exhaust, exhaust yoke **38 Nm**

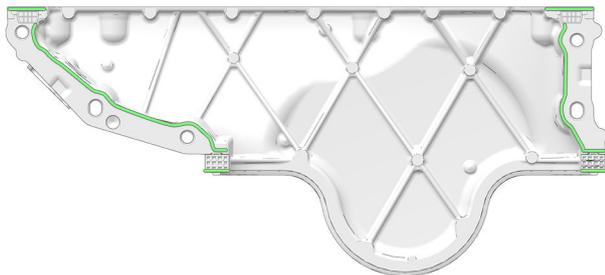
B: Unit injector's adjustment screw **52 Nm**



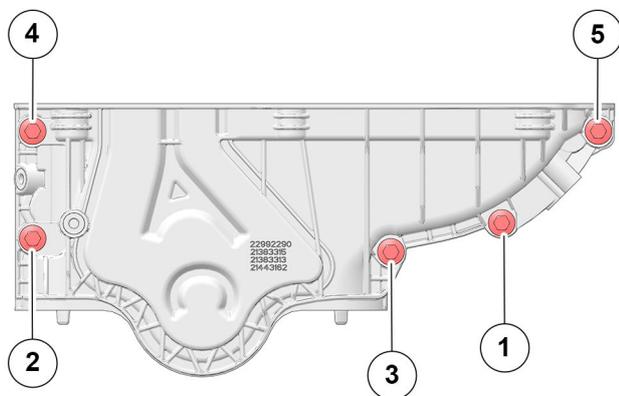
P0039264

Timing gear casing, upper

NOTICE! Apply a strand of sealant P/N 1161231 with a diameter of approx. 2 mm, refer to illustration.



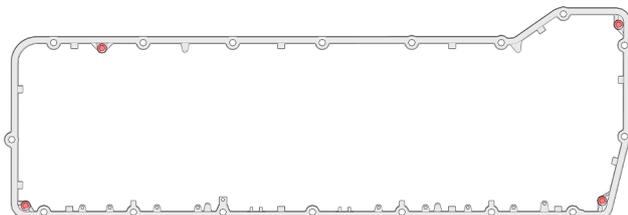
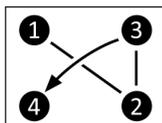
P0040061



Step 1: Fasten the lid with screws 1 and 2. Use special tools P/N 885810 and 9998601 to press the lid into place

Step 2: Tighten the screws in sequence **24 Nm**

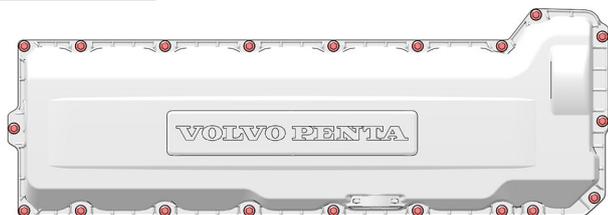
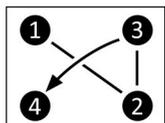
P0037422



Valve cover, lower

Lower:
Tightening torque: **24 Nm**

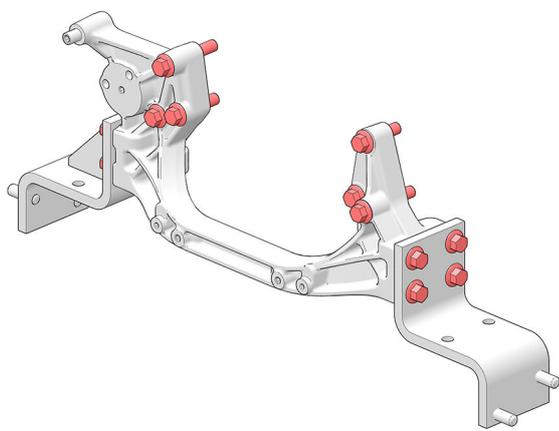
P0039266



P0037424

Valve cover, upper

Upper:
Tightening torque: **24 Nm**



P0039268

Engine mount

Front engine mounting, cylinder block: Tightening torque: **220 Nm**

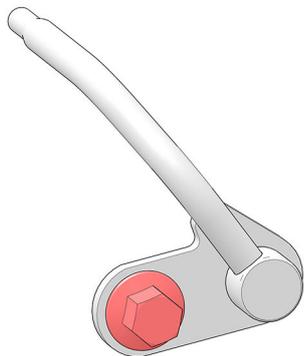
Front engine mount: Tightening torque: **220 Nm**

Rear engine mounting, flywheel housing: Tightening torque: **220 Nm**

Group 22 - Lubrication System

Piston cooling jet

Tightening torque: **24 Nm**



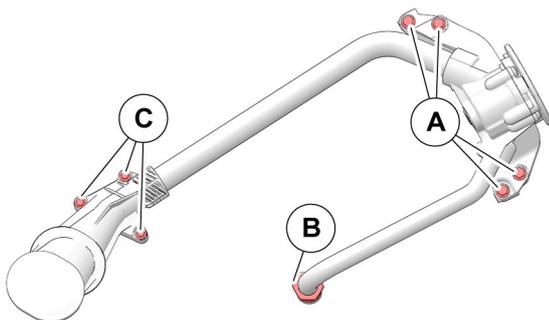
P0040065

Lubricating oil pump

A Step 1: **35 Nm**
Step 2: **90°**

B **200 Nm**

C **24 Nm**



P0040066

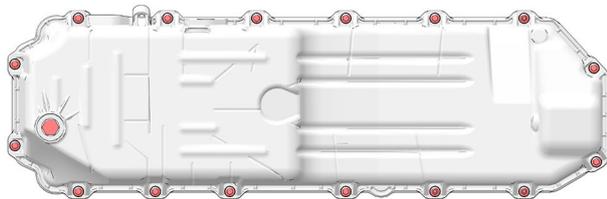
Oil pan

Step 1: Fasten and torque tighten the middle screws

24 Nm

Step 2: Tighten all screws **24 Nm**

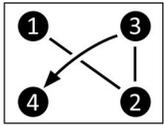
Step 3: Check the tightening torque for the middle screws



P0039301

Oil drain plug

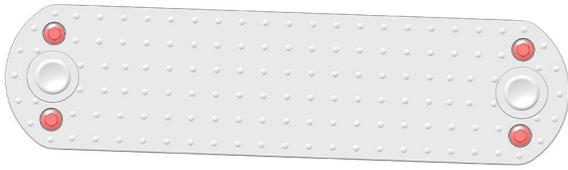
Tightening torque: **60 Nm**



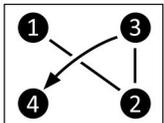
Lubricating oil cooler

Step 1: **10 Nm**

Step 2: **35 Nm**

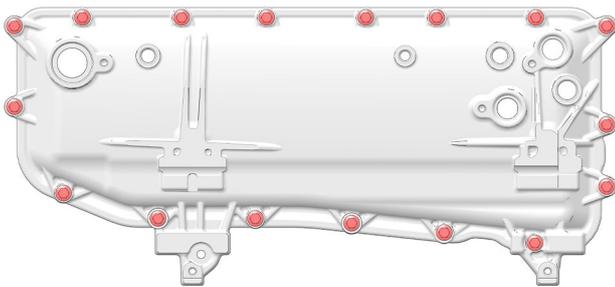


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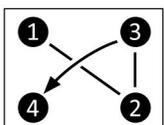


Lubricating oil cooler, cover

Tightening torque: **24 Nm**

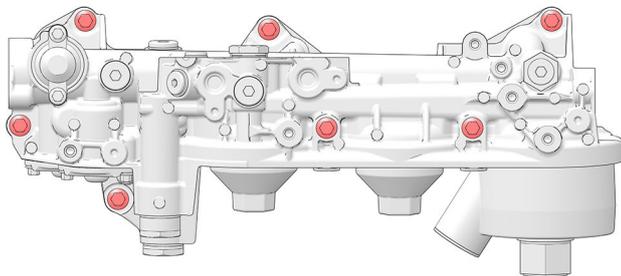


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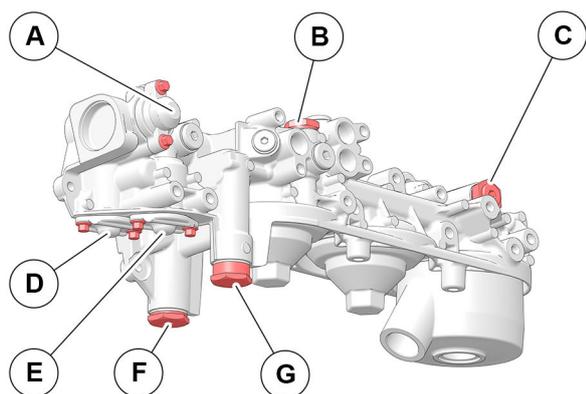


Oil valve housing

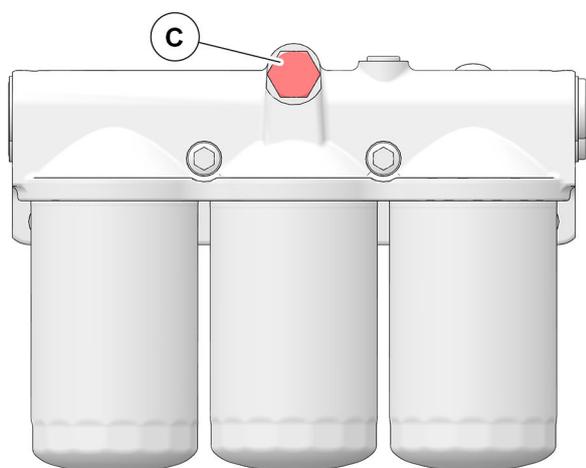
Tightening torque: **24 Nm**



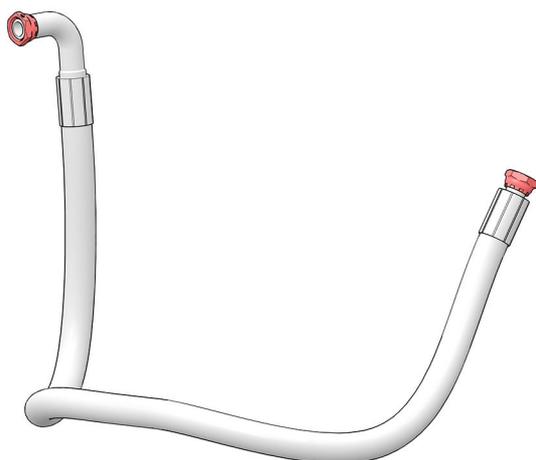
P0039304



P0040068



P0040069



P0039307

Oil valves

- A Thermostat, oil cooler: **10 Nm**
- B Overflow valve, bypass filter: **55 Nm**
- C Overflow valve, full flow filter/plug: **55 Nm**
- D Safety valve, lubricating oil pump: **10 Nm**
- E Relief valve: **10 Nm**
- F Control valve, piston cooling: **55 Nm**
- G Opening valve, piston cooling: **55 Nm**

IMPORTANT:

The opening pressure and design of the valves differ between standard / remote mounted oil filters. On remote systems, the overflow valve (H) is located in the filter holder. For the correct part number and thus the correct opening pressure on the valves, see Spare parts information (EPC).

Oil pressure pipe

- Pipe diameter 12 mm: **80 Nm**
- Pipe diameter 18 mm: **110 Nm**
- Pipe diameter 20 mm: **130 Nm**
- Pipe diameter 22 mm: **170 Nm**
- Pipe diameter 28 mm: **200 Nm**

Group 23 - Fuel System

Yoke bracket, injectors

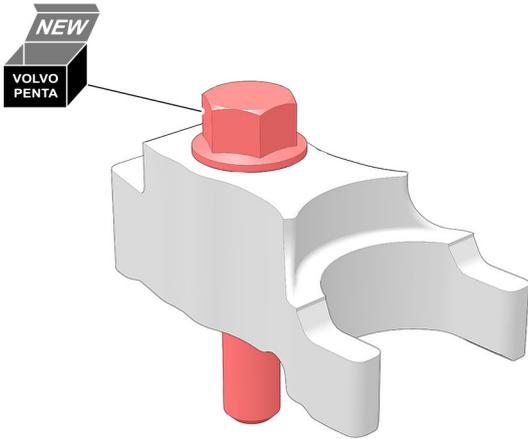
In case of a new sleeve:

- Step 1: **20 Nm**
- Step 2: **180°**
- Step 3: Loosen the screw
- Step 4: **25 Nm**
- Step 5: **90°**

If re-using a socket:

- Step 1: **25 Nm**
- Step 2: **90°**

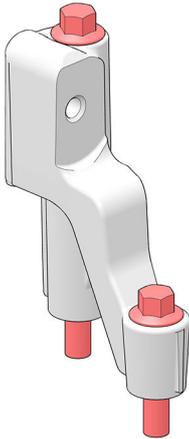
NOTICE! Once an injector has been loosened, a new washer must always be used using the same mounting method as when replacing a complete socket.



P0034662

Common rail unit, bracket

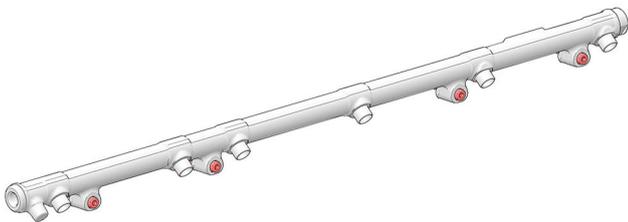
Tightening torque: **24 Nm**



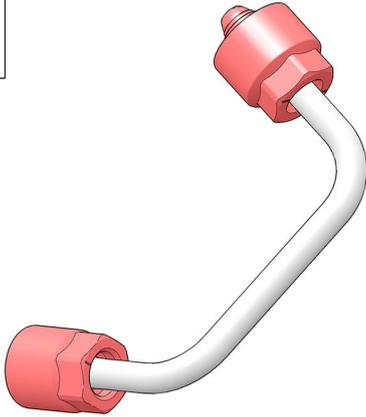
P0039313

Common rail unit

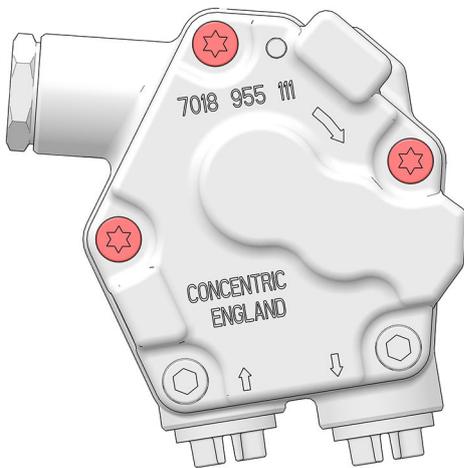
Tightening torque: **24 Nm**



P0039314



P0039315

Pressure pipeStep 1: **11 Nm**Step 2: **20 Nm**Step 3: **30°**

P0039316

Fuel pumpTightening torque: **10 Nm**

P0040071

Intermediate housing, fuel pumpTightening torque: **24 Nm**

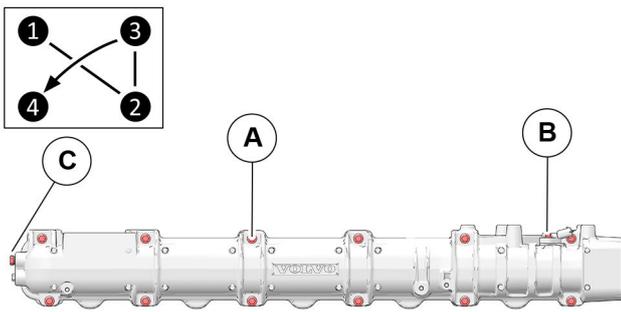
Group 25 - Inlet and Exhaust System

Inlet pipe

A Inlet pipe: **37 Nm**

B Sensor, charge air pressure / temperature: **10 Nm**

C Plug: **12 Nm**



P0039318

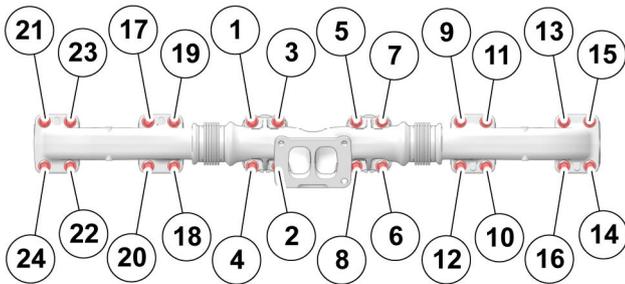
Exhaust manifold

Tighten the screws in sequence

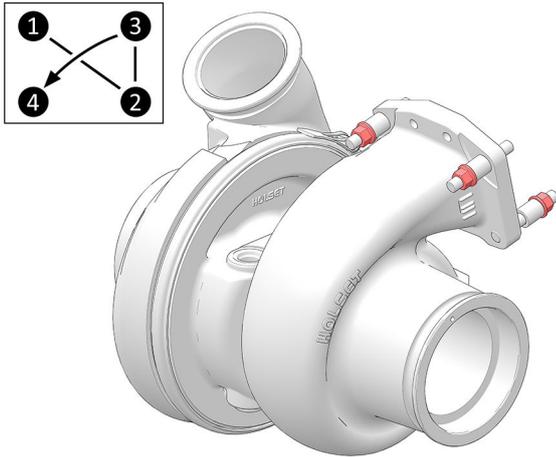
Step 1: **10 Nm**

Step 2: **40 Nm**

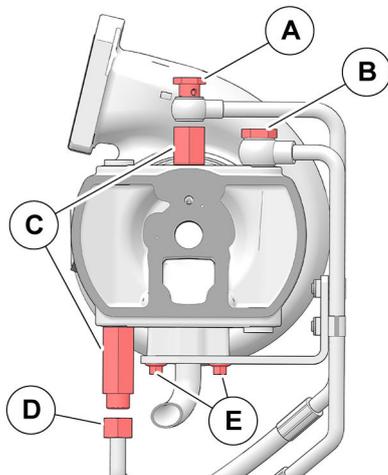
Step 3: **54 Nm**



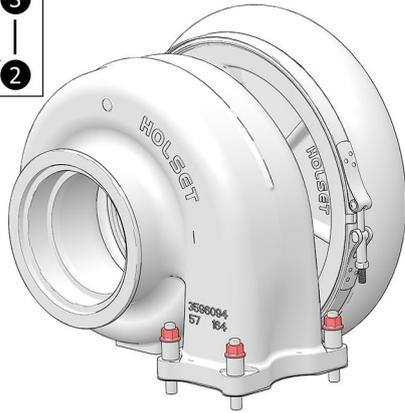
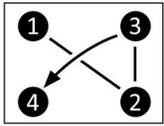
P0040081

**Turbocharger HP**Step 1: **10 Nm**Step 2: **25 Nm**Step 3: **60 Nm**

P0040075

**Connections**A **40 Nm**B **48 Nm**C **60 Nm**D **40 Nm**E **24 Nm**

P0040079



Turbocharger LP

Step 1: **10 Nm**

Step 2: **25 Nm**

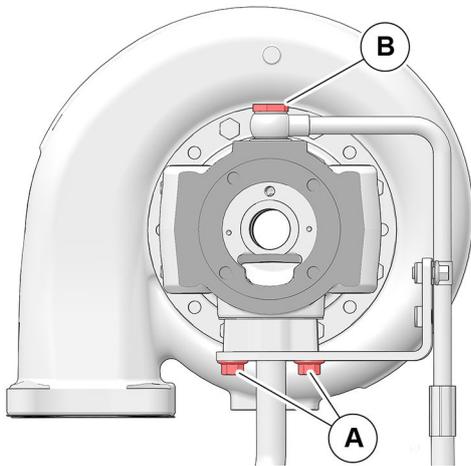
Step 3: **60 Nm**

P0040076

Connections

A **48 Nm**

B **60 Nm**



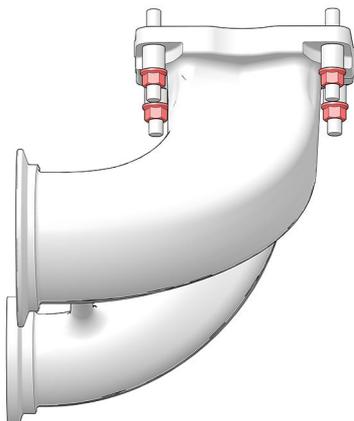
P0040078

Lower Y-pipe

Step 1: **10 Nm**

Step 2: **25 Nm**

Step 3: **60 Nm**

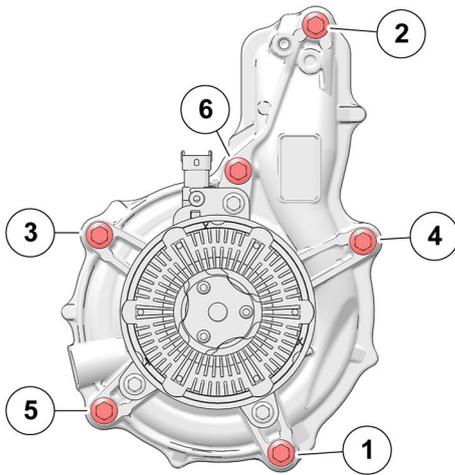


P0040077

Group 26 - Cooling System

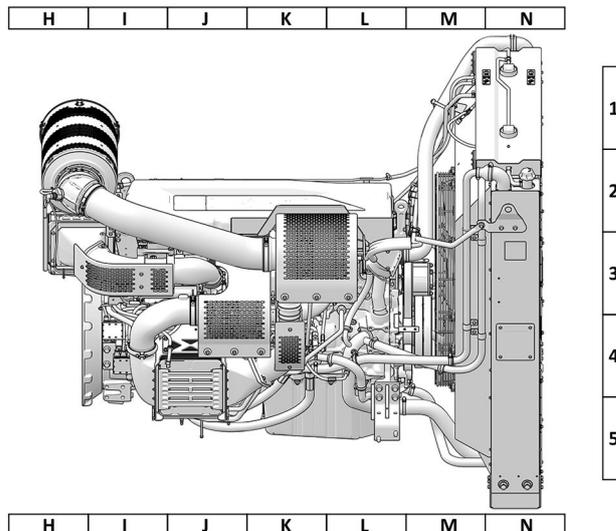
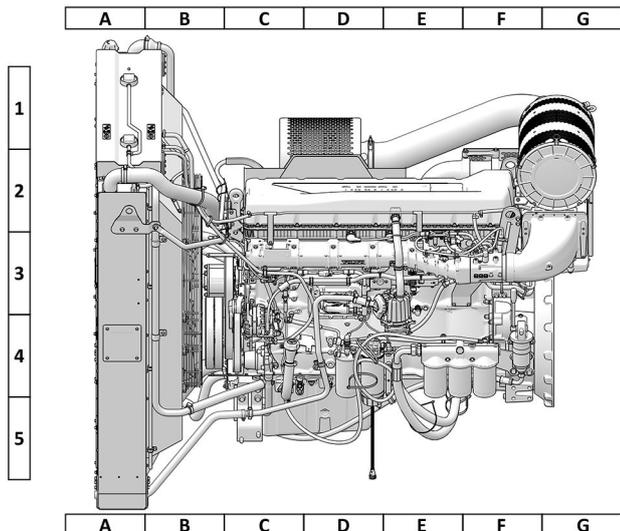
Coolant pump

Tightening torque: **24 Nm**

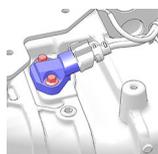


P0039325

Location of Sensors

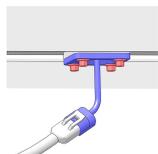


P0039739



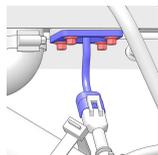
Boost pressure and charge air temperature
Tightening torque **10 Nm**
Pos. E3

P0039092



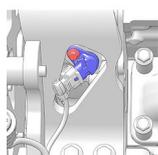
Coolant level
Tightening torque **10 Nm**
Pos. A1

P0039740



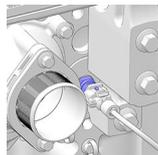
Coolant level
Tightening torque **10 Nm**
Pos. A2

P0039741



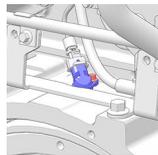
Camshaft position
Tightening torque **10 Nm**
Pos. I3

P0039090



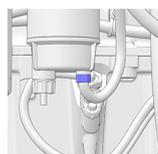
Coolant temperature
Tightening torque **20 Nm**
Pos. L3

P0040331



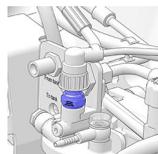
Flywheel speed
Tightening torque **8 Nm**
Pos. I3

P0039099



Monitor, water in fuel
Pos. D5

P0039097



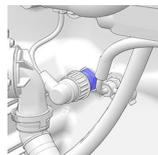
Fuel pressure
Tightening torque **25 Nm**
Pos. D4

P0039106



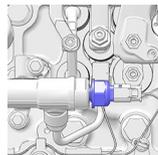
Oil level / oil temperature
Tightening torque **Standard torque**
Pos. C5

P0039742



Oil pressure
Tightening torque **25 Nm**
Pos. E3

P0039095



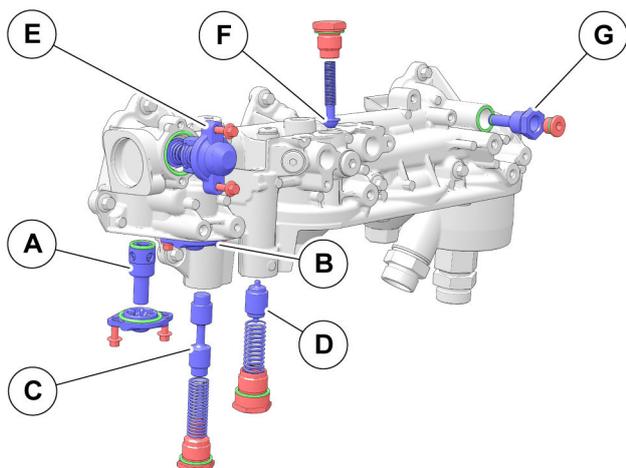
Commonrail pressure
Tightening torque **90 Nm**
Pos. F2 (under the valve cover)

P0039096

Control valve, overview

Oil valves

- A Safety valve, oil pressure
- B Relief valve
- C Control valve, piston cooling
- D Opening valve, piston cooling
- E Thermostat, oil cooler
- F Overflow valve, bypass filter / plug

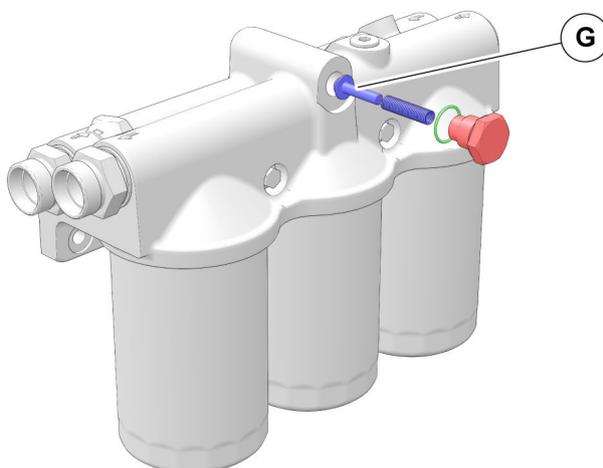


P0039125

- G Overflow valve, full flow filter / plug

IMPORTANT:

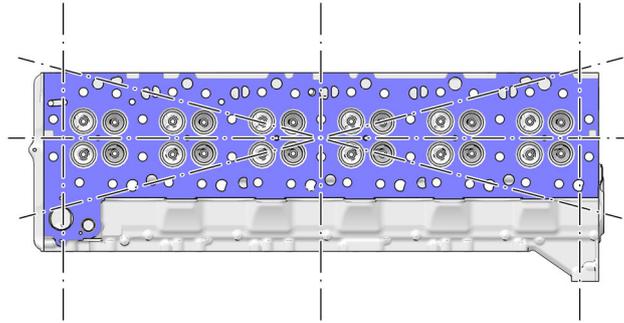
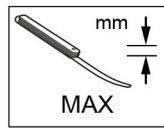
The opening pressure and design of the valves differ between standard / remote mounted oil filters. On remote systems, the overflow valve (G) is located in the filter holder. For the correct part number and thus the correct opening pressure on the valves, see Spare parts information (EPC).



P0039124

Engine

Cylinder head



P0037846

Max flatness error (base plane)	0.2 mm
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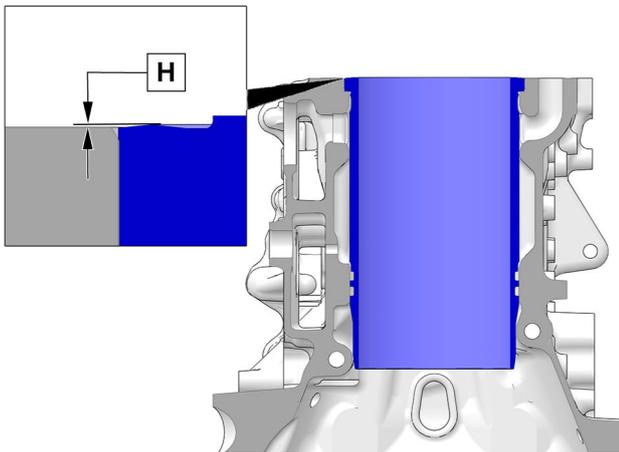
Cylinder Head Bolts

No. per cylinder head

Number	38 (1)
Thread size	M18

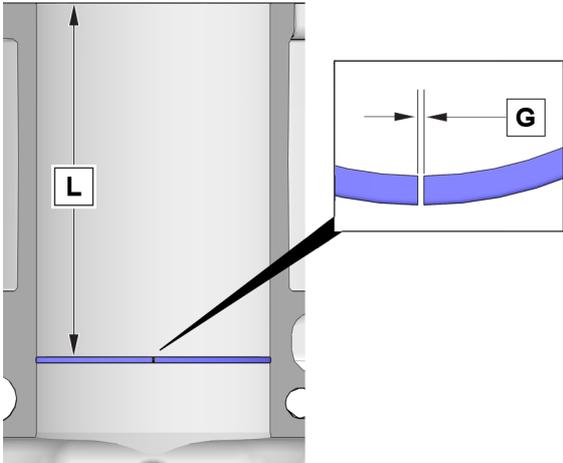
1) The screws may be re-used a maximum of 2 times

Cylinder lining



P0040424

Height above cylinder block plane (H)	0.15- 0.21 mm
Max height difference between cylinder liners	0.06 mm

Pistons	
Dimensions between piston in TDC and block plane Maximum permissible deviation between all cylinders. (mm)	0.15
Piston rings	
	
Upper compression ring, piston ring gap (G) at position (L=200 mm), max	0.45-0.67 mm
Piston pin	
Piston pin, diameter (mm)	63 +0 / -0.006

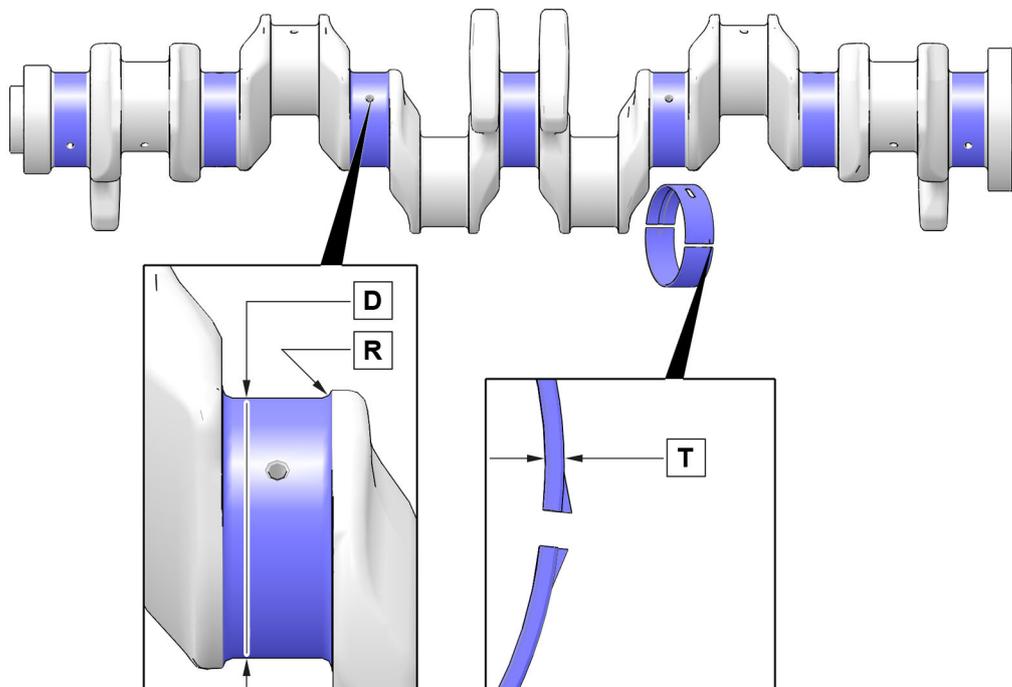
Crank Mechanism

Crankshaft

Axial play	0.10-0.40 mm ¹⁾
------------	----------------------------

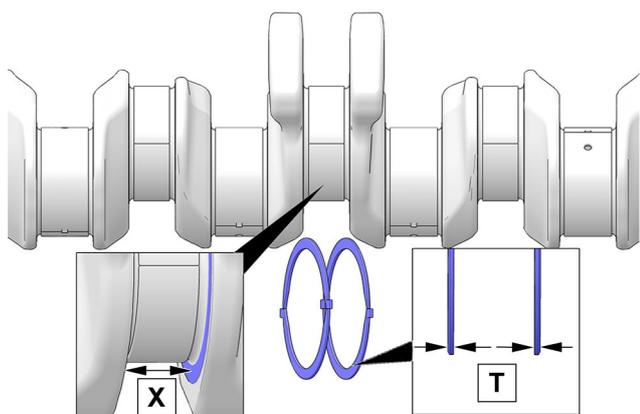
1) Dimensions apply to oiled components.

Main bearing journals



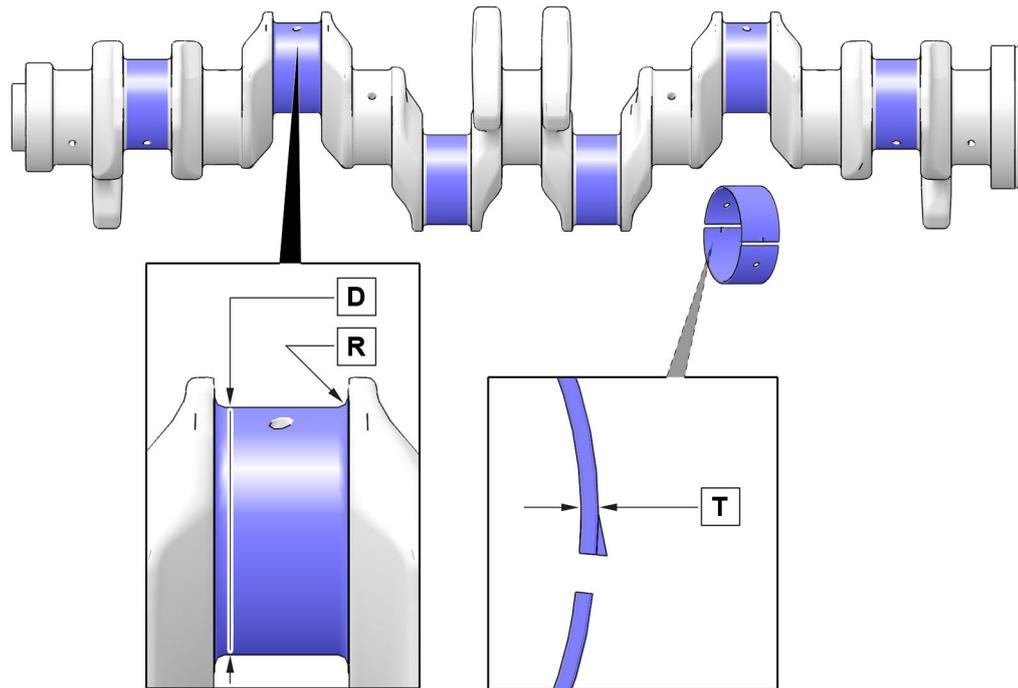
P0034818

Standard diameter (D)	118 mm
Main bearing pin, ovality, max [mm]	0.006
Main bearing pin, conicity, max [mm]	0.006
Fillet radius (R)	4.5 mm
Main bearing shell, standard bearing, dimension (T)	2.51 mm



P0040425

Thrust bearing pin, standard bearing, width dimension (X)	49 mm
Thrust bearing, standard bearing, dimension (T)	3.14-3.21 mm

Big-end bearing journals

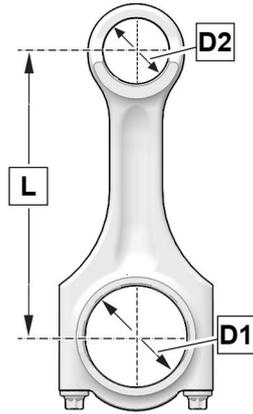
P0029860

Standard diameter (D)	112 mm
Big end bearing journal, ovality, max [mm]	0.006
Big end bearing pin, conicity, max [mm]	0.006
Fillet radius (R)	4.5 mm

Big end bearing cup

Big end bearing cup, standard bearing, dimension (T) [mm]	2.346
---	-------

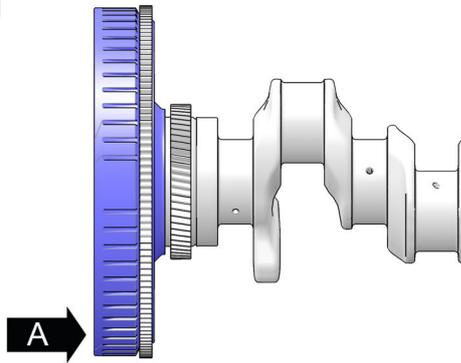
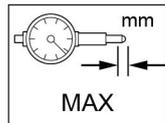
Con rods



P0029858

Diameter (D1)	116.8 mm
Diameter (D2)	63 mm
Length, connecting rod (L) center measurement between (D1) and (D2)	280 mm

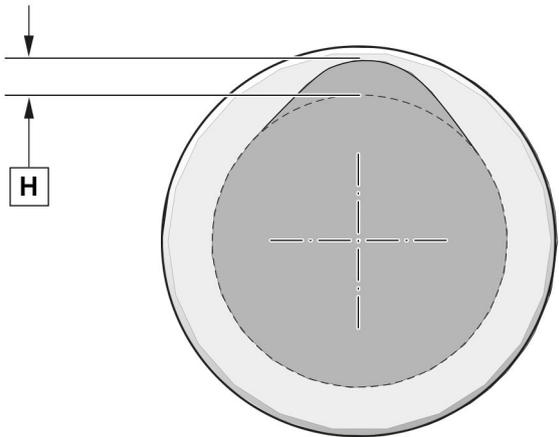
Flywheel

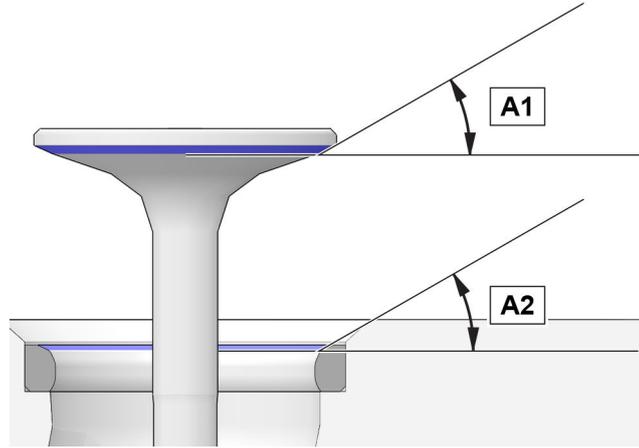


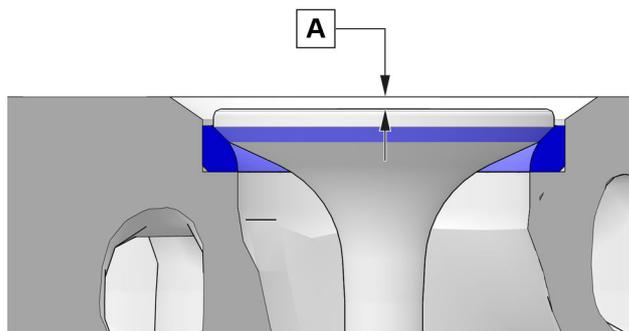
P0034830

Axial eccentricity (A), max	0.25 mm
-----------------------------	---------

Valve mechanism

Camshaft			
 <p style="text-align: center;">P0034822</p>			
Bearing stubs, diameter	69.97-70.00 mm		
Bearing pins, ovality, max	0.008 mm		
Axial play camshaft - bearing position, max	0.35 mm		
	Inlet	Exhaust	Injector
Camshaft, lift height (H)	9.43 mm	8.92 mm	13.99 mm
Permissible wear between the base circle and max lift:	0.1 mm		

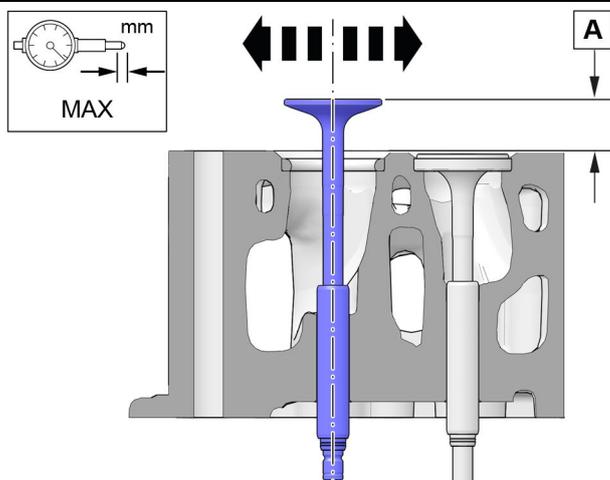
Valves	
 <p style="text-align: center;">P0034833</p>	
Inlet	
Valve, seat angle (A1)	24.5°
Valve seat, seat angle (A2)	25°
Outlet	
Valve, seat angle (A1)	34.5°
Valve seat, seat angle (A2)	35°
Valve stem, inlet, diameter	9.96 mm
Valve stem, outlet, diameter	9.94 mm



P0034832

Valve dimensions below cylinder casing plane (A), inlet, max 1.15 mm

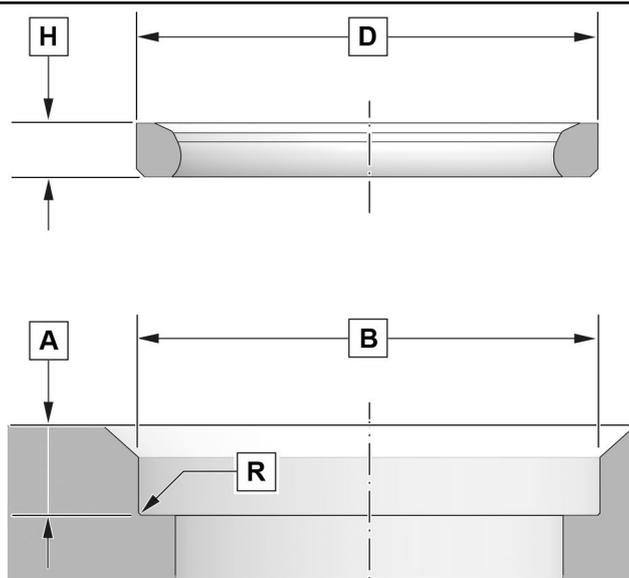
Valve dimensions below cylinder casing plane (A), outlet, max 1.65 mm



P0034829

Radial play, inlet, valve / valve guide, max max 0.4 mm
Measurement at height "A"= 20

Radial play, outlet, valve / valve guide, max max 0.4 mm
Measurement at height "A"= 20

Valve seats

P0034834

Valve seat, height (H)

Inlet	6.1 mm
Outlet	5.75 mm

Valve seat diameter (D)

Inlet	52.08 mm
Outlet	49.08 mm

Valve seat position in cylinder head, inlet, depth (A)	10.2 mm
--	---------

Position of the valve seat in the cylinder head, inlet, diameter (B)	52.0 +0.03 mm
--	---------------

Valve seat position in cylinder head, inlet, radius (R)	max 0.8 mm
---	------------

Valve seat position in the cylinder head, outlet, depth (A)	10.2 mm
---	---------

Valve seat position in the cylinder head, outlet, diameter (B)	49.0 +0.03 mm
--	---------------

Valve seat position in the cylinder head, outlet, radius (A)	max 0.8 mm
--	------------

Valve springs

Valve spring, length, inlet, unloaded	68.7 mm
---------------------------------------	---------

Valve spring, length, inlet loaded with 552 ±41 N	57 mm
---	-------

Valve spring, outer, length, outlet, unloaded	68.4 mm
---	---------

Valve spring, outer, length, outlet, loaded with 460 ±34 N	54 mm
--	-------

Valve spring, inner, length, outlet, unloaded	66.8 mm
---	---------

Valve spring, inner, length, outlet, loaded with 396 ±26 N	51 mm
--	-------

Lubrication System

Lubricating oil, engine	
Oil volume, (including oil filter): (1)	
Oil volume incl. filter, standard sump	52 L
Oil volume between min and max markings:	15 L

1) The volume of oil may vary depending on the design of the oil pan. Always use the oil dipstick to ensure the correct oil level.

Engine Oil Pressure	
Lubrication oil pressure, idle, warm engine, min	160 kPa
Lubrication oil pressure, operating speed, warm engine, min	270 kPa
Oil temperature, loaded, max	125°C

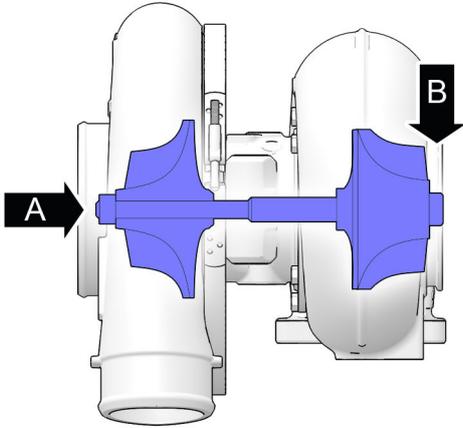
Thermostat	
Thermostat, oil cooler, opening temperature	103-107°C
Thermostat, oil cooler, fully open	116°C

Fuel System

Fuel system	
Injection pressure, max	1600 bar
Pressure from feed pump, at idle, min	100 kPa
Pressure from feed pump, operating RPM, min	300 kPa
Max permissible negative pressure to feed pump	-20 kPa

Inlet and Exhaust System

Turbo



P0034831

Axial play (A)	Visual inspection with the wheels not contacting the housing
Radial play (B), turbine wheel	Visual inspection with the wheels not contacting the housing
Boost pressure, max RPM/load, air temp 20-25°C	469 ±10 kPa at 1500 RPM 449 ±10 kPa at 1800 RPM

Cooling System

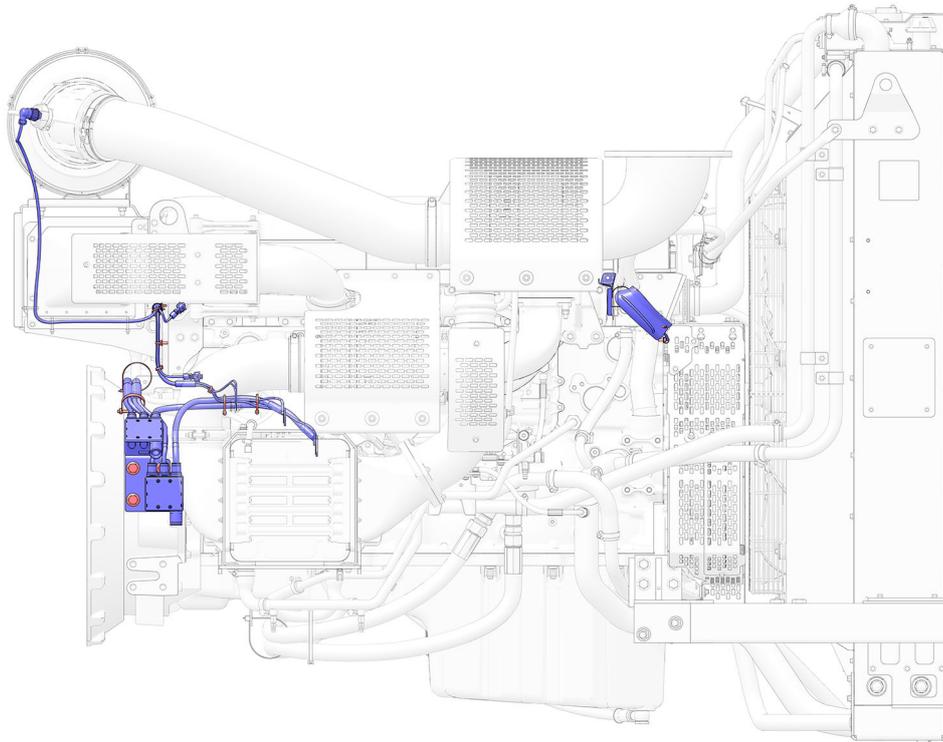
Cooling system	
Coolant, type	VCS 2
Coolant, engine + coolant volume	60 L
Coolant, charge cooler + coolant volume	30 L
Opening pressure of the filling cap	100 kPa

Thermostat	
Starts to open at:	82°C
Thermostat, fully open at temp:	92°C

03-3 Specifications, Electrical

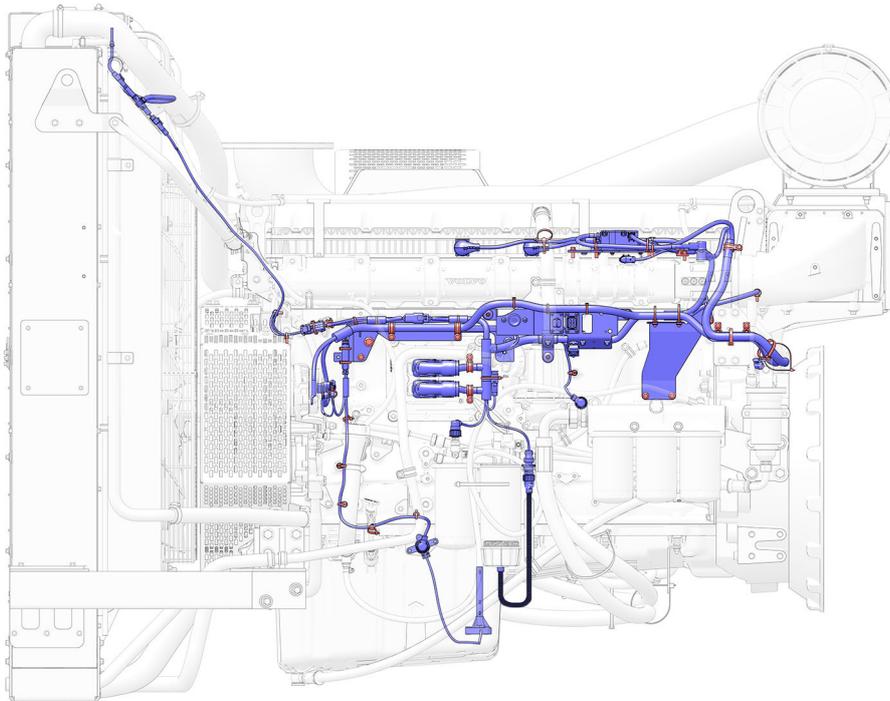
Cable description

Hot side



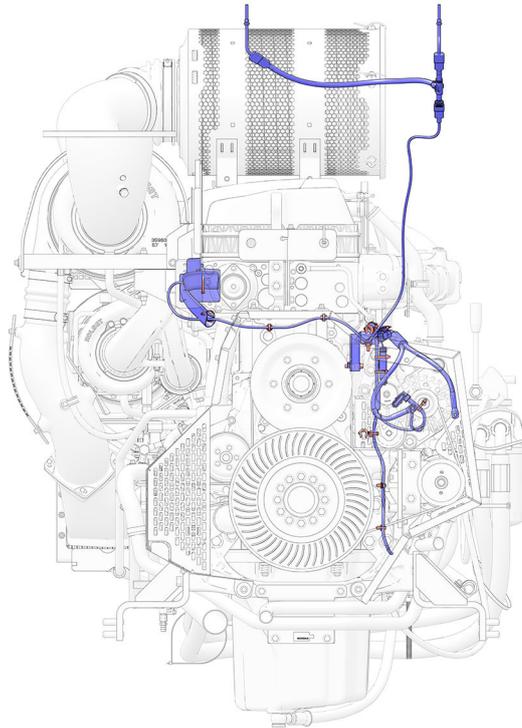
P0039775

Cold side



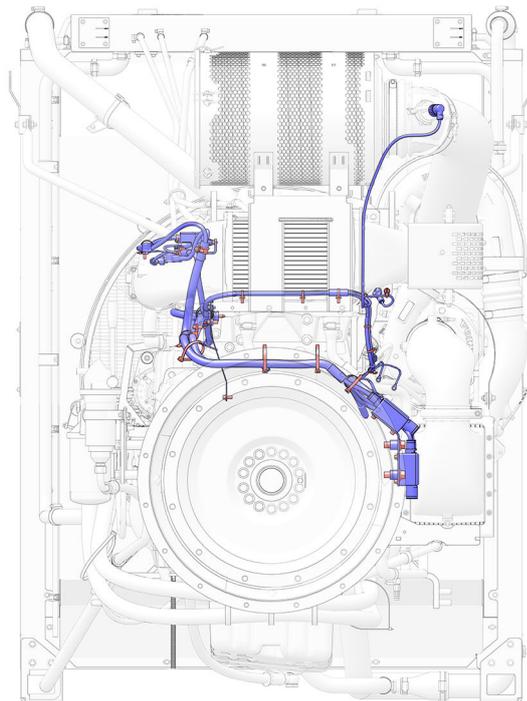
P0039773

Front side



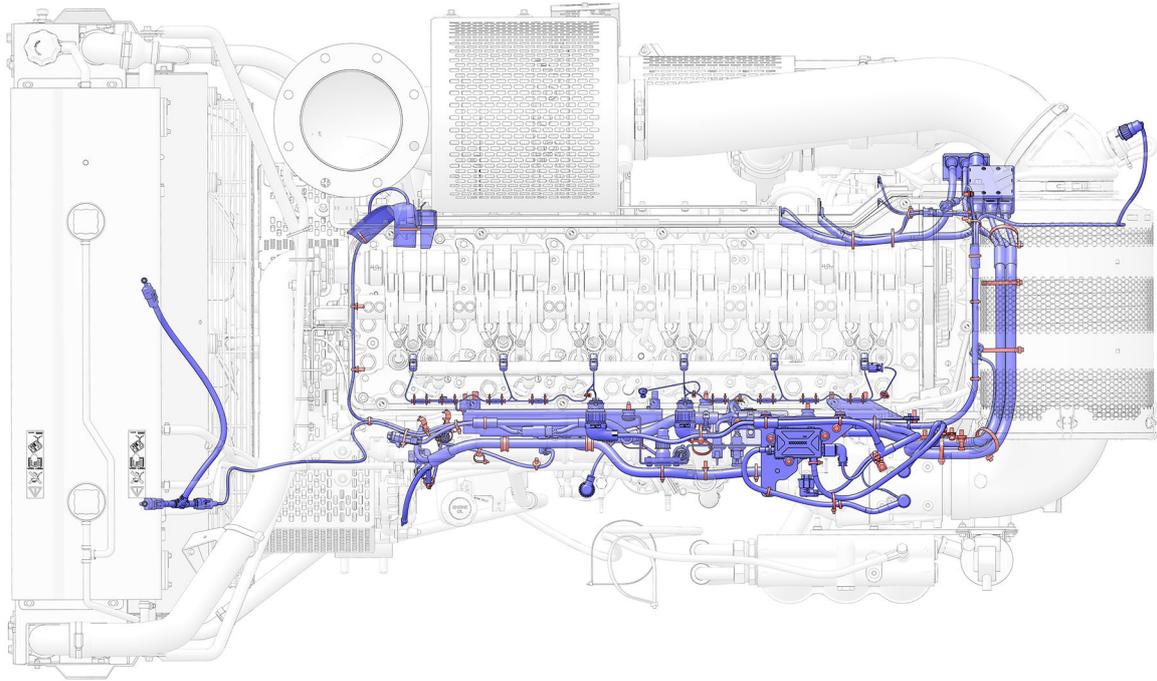
P0039772

Rear side



P0039771

Top side



P0039774

Electrical System

Electrical System

System voltage	24 V
Generator, max charging current	80 A

05-1 Safety Instructions



Cleanliness requirements

Absolute cleanliness must be observed during all work on lead-free bearings.

Even very small particles have a markedly negative effect, especially on lead-free bearings.

Particles on bearing races during assembly can lead to relatively quickly occurring bearing failures.

The product's service life is directly dependent on the level of cleanliness maintained during service and repair work.

Lead-free bearings that had been used in operation should not be reused.

Remember to:

- Thoroughly clean the outside of the engine before starting work.
- Keep the immediate surroundings clean while work is in progress (in the vehicle or workshop).
- If possible, make sure no dirt is brought in from outside. For example, close engine compartment ventilation. Close the doors and such to the workshop workspace.
- Make sure no 'dirty' work takes place in the vicinity, i.e. no forklift driving, spray painting, grinding or welding etc. nearby.
- Certain spare parts may need to be cleaned before installation.

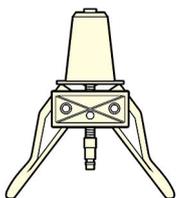
NOTICE! Bearings may never be washed but must be stored in their packaging until installation.

- Make sure all tools are clean when working.
- Use lint-free gloves and absorbent paper.
- Canned spray-on cleaning agent may be used as necessary, but not on rubber parts.

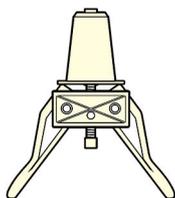
08-2 Special Service Tools



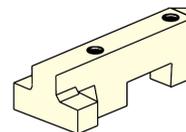
Use the following special tools when working on the engine. The special tools can be ordered from AB Volvo Penta by specifying the tool number concerned.



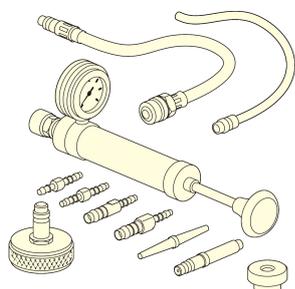
885536 Plug



885539 Plug

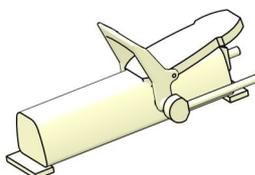


885810 Fixture



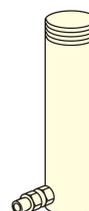
3849613 Pressure testing kit

For upper transmission cover



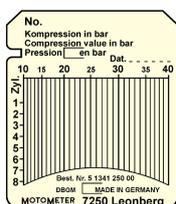
9809726 Pneumatic hydraulic pump

Used with 9809729



9809729 Hydraulic cylinder

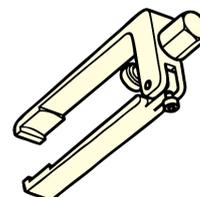
Used with press tool 9990176



998539 Compression meter

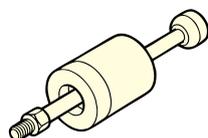


9989876 Dial indicator

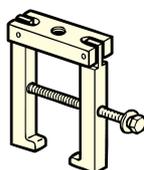


9990006 Puller

For unit injectors

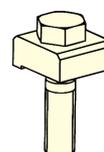


9990013 Slide hammer

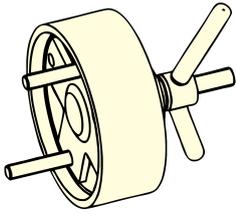


9990114 Puller

Used for crankshaft bearing caps



9990157 Press tool



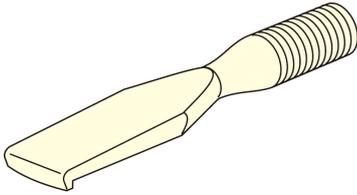
9990166 Mounting tool
For rear crankshaft seal



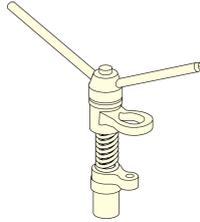
9990176 Press tool
For removal/installation of valve springs and valve guides



9990185 Lifting tool
For rocker arm bridge



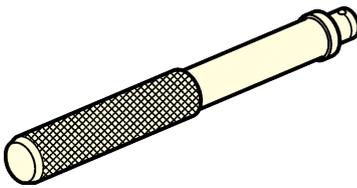
9990192 Puller
For rear crankshaft seal, for use with 9996400



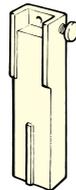
9990210 Valve spring compressor



9990263 Nipple



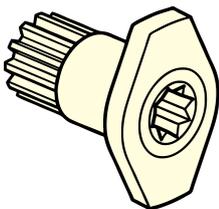
9992000 Handle



9992479 Holder for dial indicator



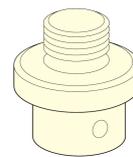
9992671 Hydraulic cylinder



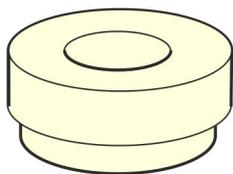
9993590 Rotation tool



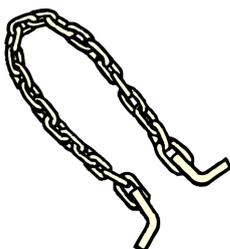
9996049 Draining hose



9996159 Adapter
For hydraulic cylinder 9809729

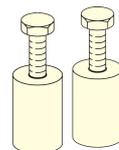


9996180 Drift

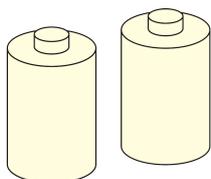


9996239 Lifting tool

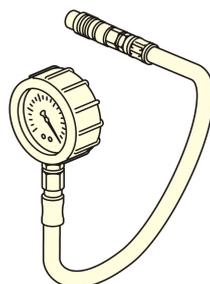
For removal/installation of cylinder head and flywheel housing, (2 pcs. required)



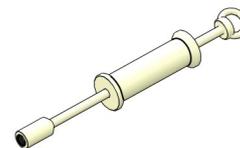
9996394 Support



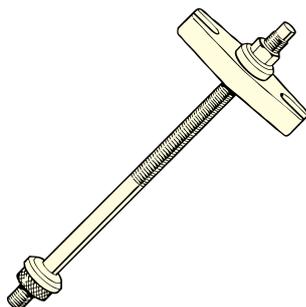
9996395 Support



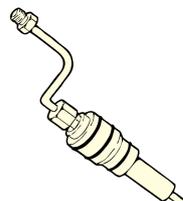
9996398 Manometer



9996400 Slide hammer

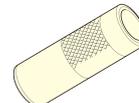


9996645 Puller



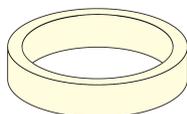
9998248 Adapter

To measure cylinder compression (6 pcs required)



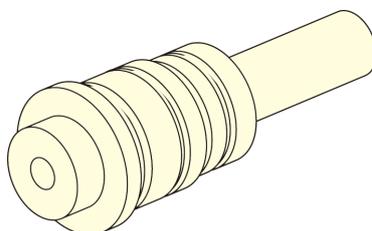
9998249 Protective sleeve

For unit injectors (6 pcs. required)



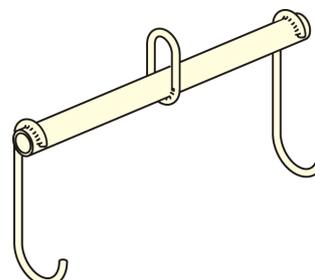
9998250 Sealing ring

For fuel duct in cylinder head (2 pcs. needed)



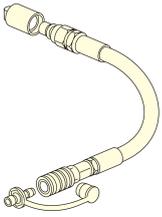
9998251 Protection plug

For cylinder head (6 pcs. required)

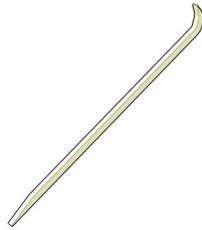


9998264 Lifting tool

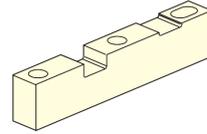
For camshaft



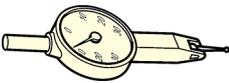
9998494 Hose



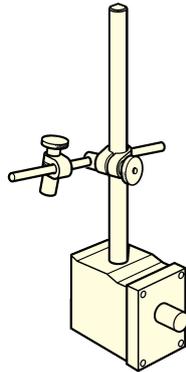
9998511 Lever



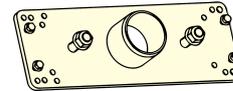
9998601 Fixture
For upper transmission cover



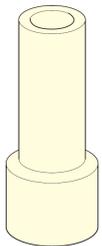
9999683 Dial indicator (short probe)



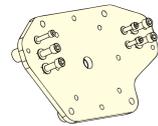
9999696 Magnetic stand



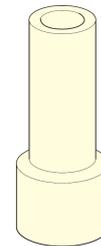
88800058 Stand



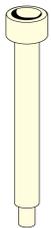
88800064 Drift
For changing valve guides (inlet), mounting



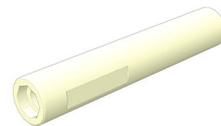
88800123 Plate
Used with 88800345



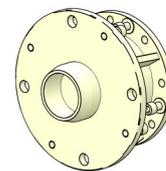
88800127 Drift
For changing valve guides, removal



88800147 Drift
For changing valve guides (outlet), mounting



88800151 Drift
For valve stem seal



88800345 Adapter



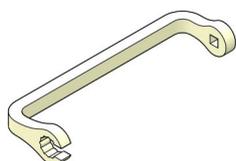
88800352 Lifting tool



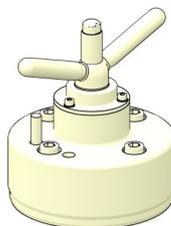
88800387 Puller



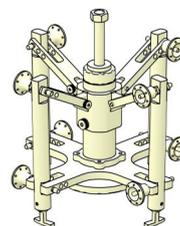
88800460 Sleeve



88800474 Wrench



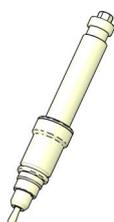
88800501 Mounting tool



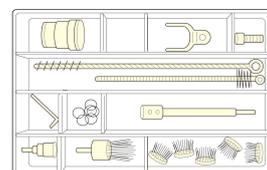
88800502 Puller



88800503 Mounting tool



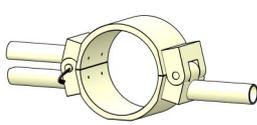
88800513 Drift



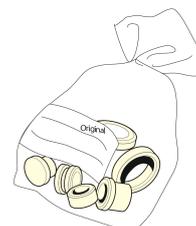
88800550 Cleaning kit



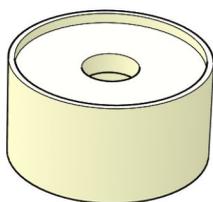
88800829 Extractor plate



88800831 Piston ring compressor



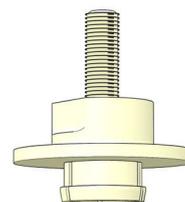
88840290 Plugs



88880175 Counterhold



88880176 Guide pin



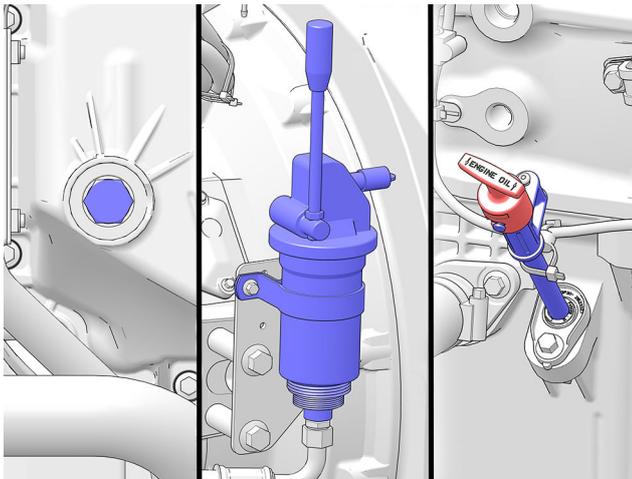
**88880199 Extractor
88880200 Extractor**

17-3 Maintenance Service

Engine oil and oil filter, Replace

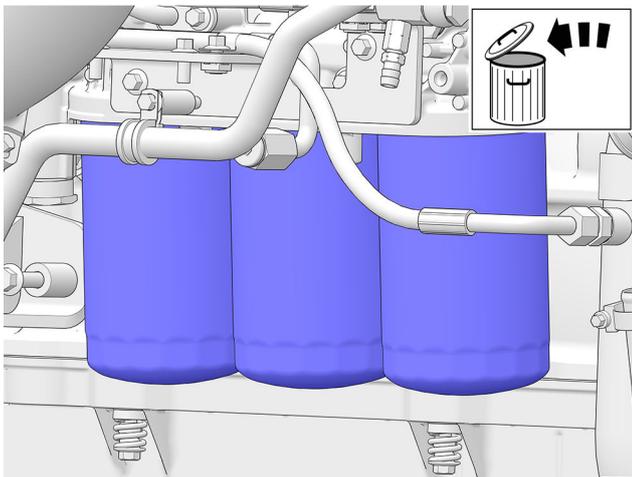
- 1 Drain the engine of oil, 3 options are possible.
 - 1 Plug in oil pan
 - 2 Hand pump (optional extra)
 - 3 Emptying with vacuum suction via dipstick hole

NOTICE! Warm engine oil is drained more easily.



P0039761

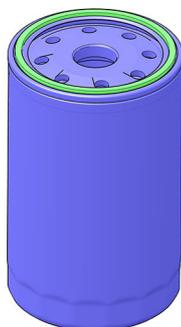
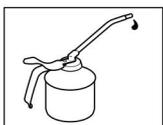
- 2 Remove the oil filter.



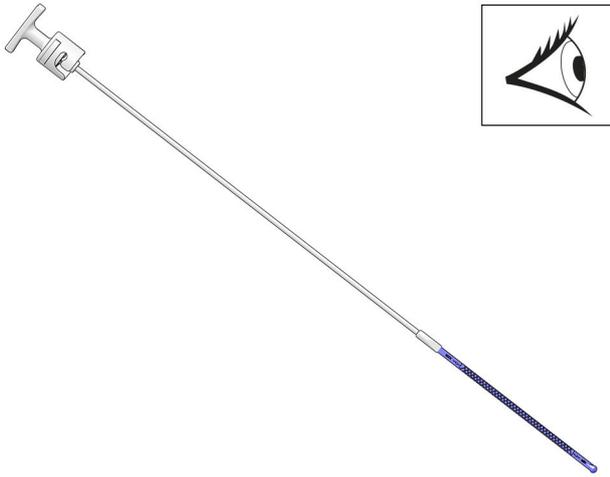
P0039762

- 3 Install new oil filters.
Tighten according to the instructions on the filters.

NOTICE! Lubricate gasket on oil filter before mounting.



P0039763

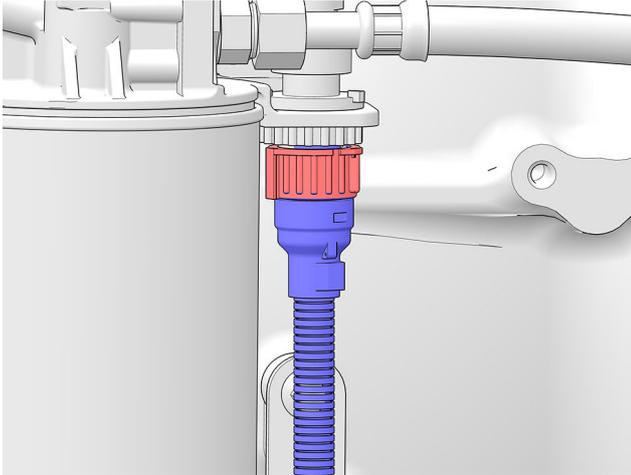


- 4 Fill with oil; refer to *Engine*, page 32.
- 5 Start the engine and let it idle for a few minutes. Turn off the engine, check the oil level on the dipstick.

P0039764

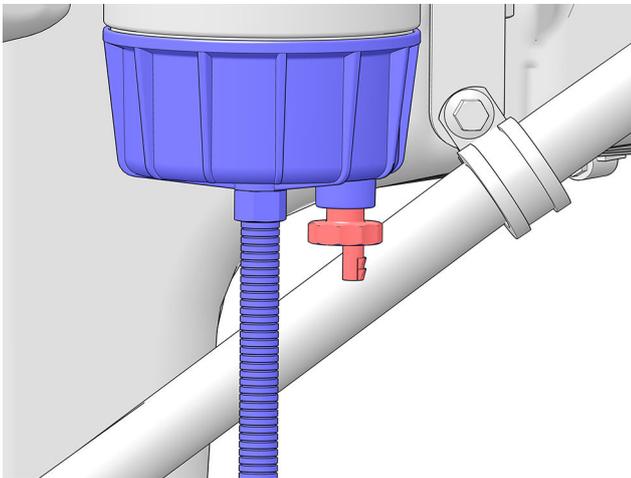
Engine Fuel Filter Replacement

- 1 Remove the water separator sensor connector.



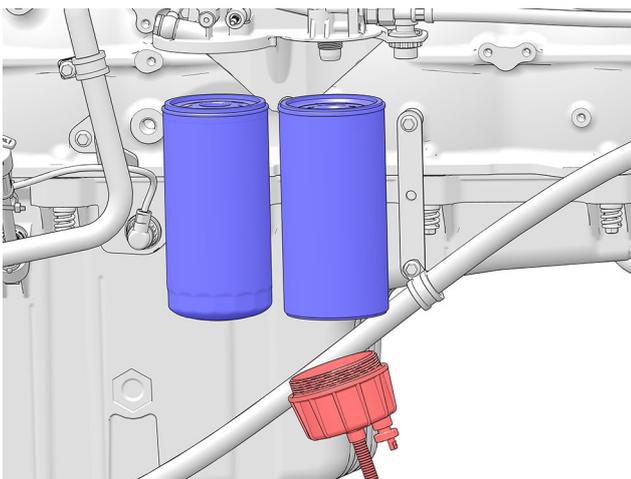
P0039754

- 2 Drain the water separator.

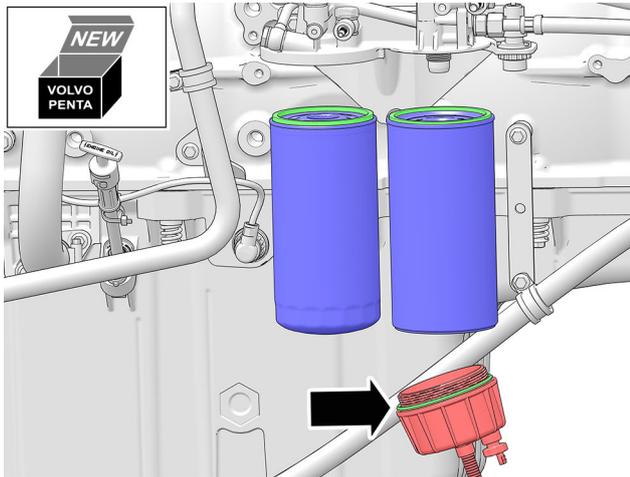


P0039751

- 3 Remove the water separator.
Remove the fuel filter.



P0039753



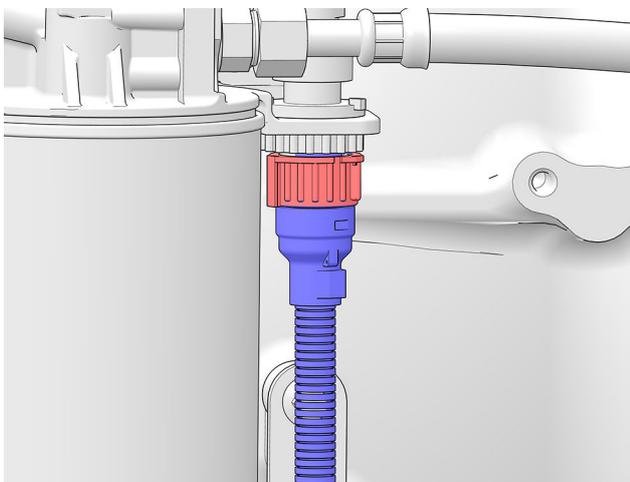
P0039752

4 **NOTICE!** Lubricate gaskets with diesel oil.

Install:

- fuel filter
- water separator

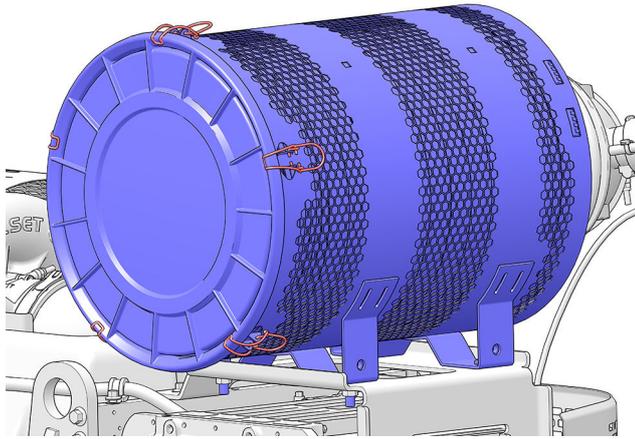
Tighten according to the instructions on the fuel filter.



P0039754

5 Install the plug for the water separator.

6 Vent the fuel system; refer to *Fuel system, bleeding*, page 126.



P0039760

Air Filter, Replace

- 1
 - Open the fasteners and remove the cover
 - Pull out the filter
 - Clean the filter holder
 - Install a new filter
 - Install the lid, lock in place with fasteners

NOTICE! Scrap the old filter. May not be cleaned.

Coolant, Replace

Tools:

9996049 Draining hose

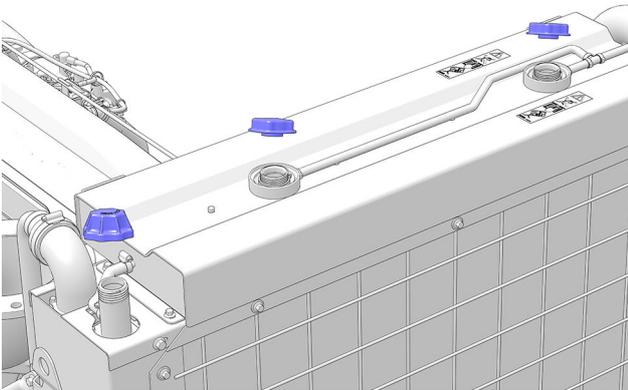
⚠ WARNING!

All coolant is hazardous and harmful to the environment. Do not consume. Coolant is flammable.

⚠ WARNING!

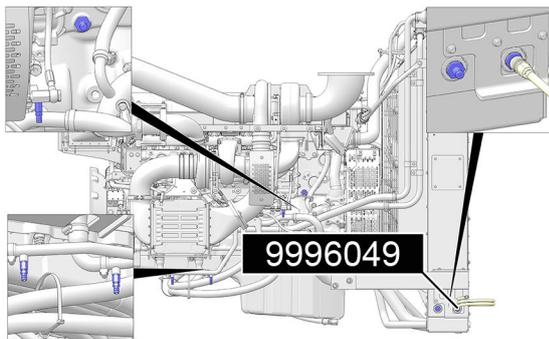
Do not open the coolant filler cap when the engine is hot. Steam or hot fluid could spray out, causing severe burns.

- 1 Remove the radiator pressure caps and filler cap.

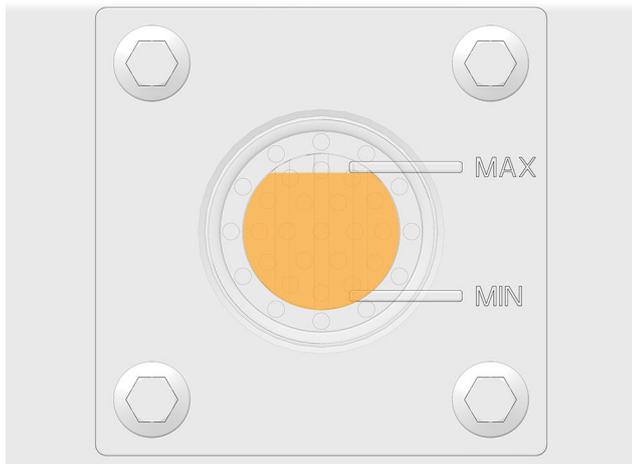


P0039586

- 2 Use the drain hose to drain the coolant out of the radiator and engine block. Check whether the installation has any further taps or plugs at the lowest points of the coolant lines.



P0039587



P0039585
Engine cooling circuit



P0040777
Charge air cooler cooling circuit

3 Engine cooling circuit

Fill with coolant, so that the level is between the MIN and MAX marks on the expansion tank for the engine cooling circuit. The circuit of the intercoolers must be filled to the top of the pressure cap.

NOTICE! The engine's cooling circuit is filled via the filler cap on the radiator. The charge air coolers circuit is filled via the pressure cap.

Charge air cooler cooling circuit

The charge air coolers circuit is filled via the pressure cap. Fill so that the level is all the way up to the pressure cap

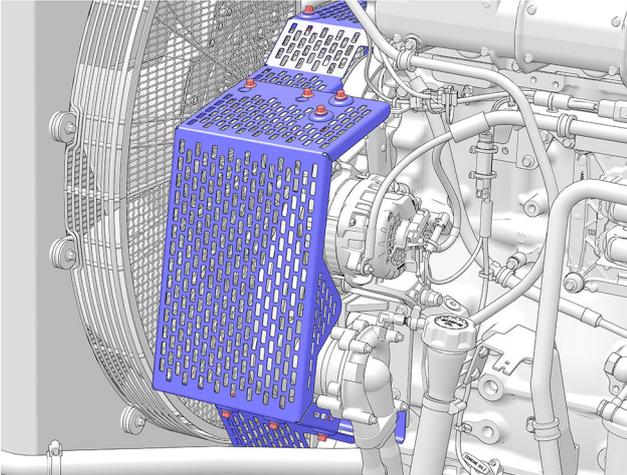
IMPORTANT:

Only use coolant recommended by Volvo Penta.

- 4 Install the pressure caps and filler cap.
- 5 Start the engine when the cooling system has been completely bled and filled. Open any venting taps shortly after start, to allow trapped air to escape.
- 6 Stop the engine after about an hour and check the coolant level. Top up as necessary.

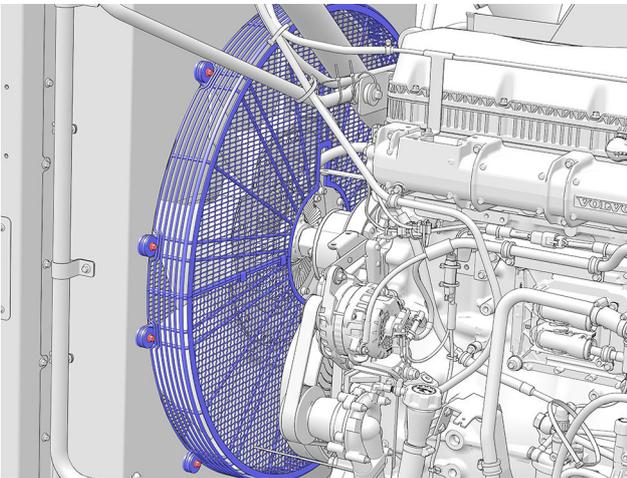
Drive Belts, Replace

- 1 Remove the belt protectors.



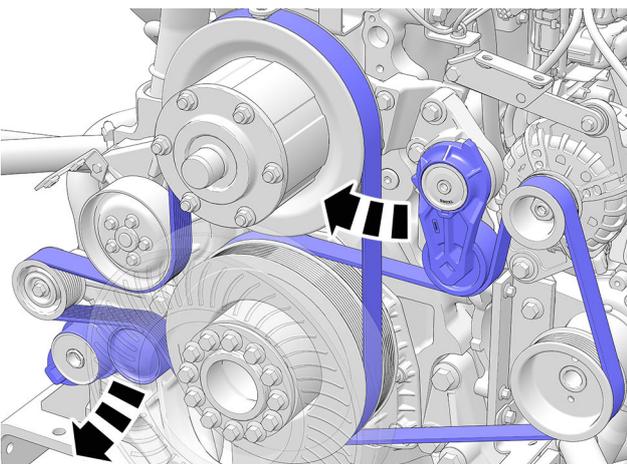
P0040053

- 2 Remove the fan guards.

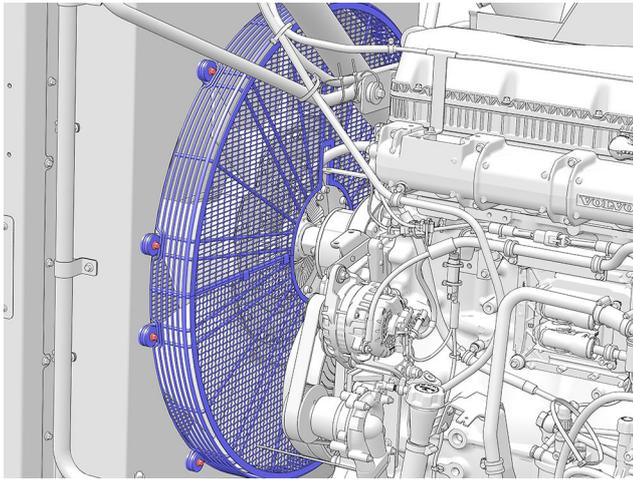


P0040052

- 3 Inspect belt tensioners and idlers.
Replace drive belts.

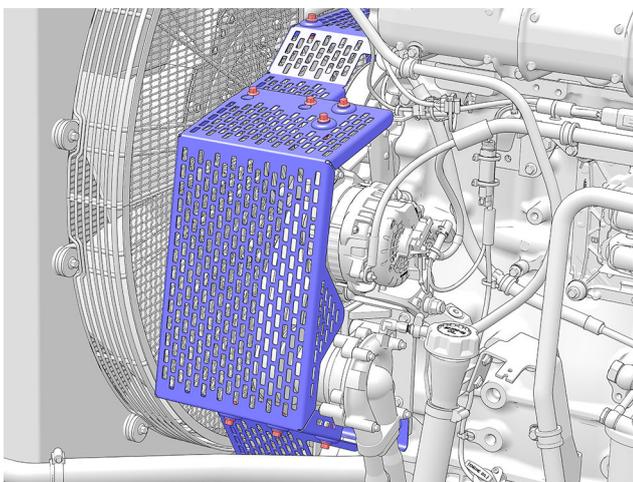


P0040051



P0040052

4 Fit the fan guard.



P0040053

5 Install the belt protectors.

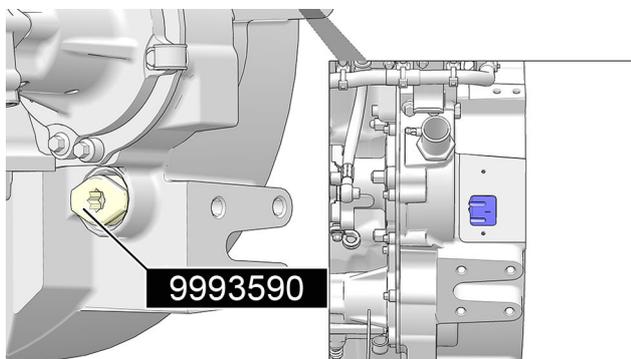
21-0 Engine Complete, General

Engine, to set TDC

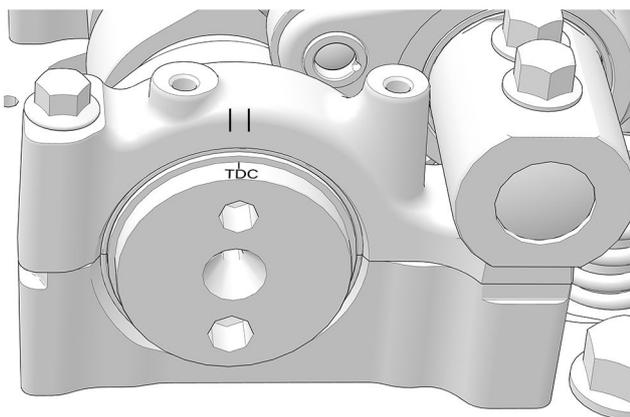
Tools:

9993590 Rotation tool

- 1 Remove the inspection cover on the timing gear casing. Turn the engine with P/N 9993590, until the marking on the flywheel matches the marking in the timing gear casing.

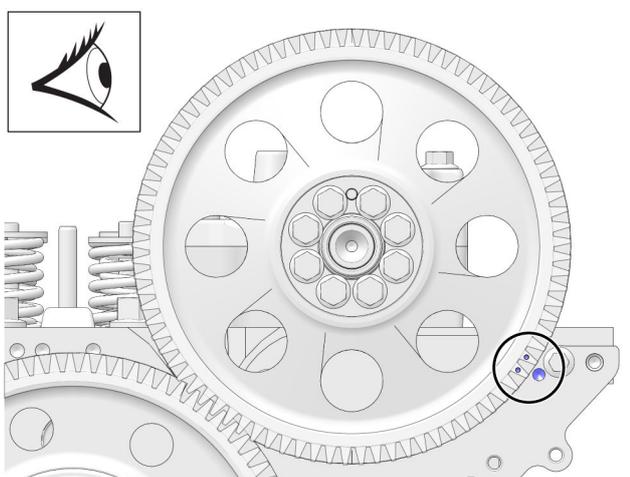


P0036600



- 2 Remove the valve cover.
- 3 Check that the camshaft TDC marking is between the two lines on the camshaft cover.

P0036599



P0040772

- 4 Remove the top timing gear casing and verify that the reference hole on the timing gear plate is between the markings on the drive.
- 5 Fit the upper timing gear casing, refer to *Cylinder Head, Replace*, page 91.

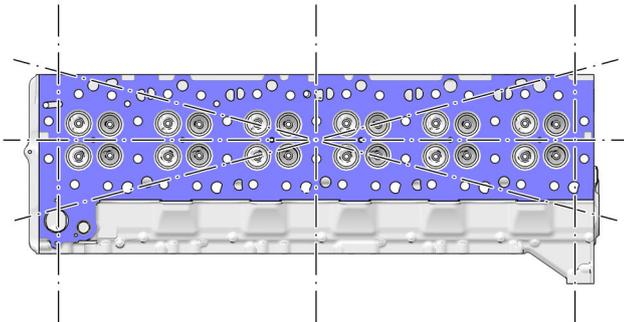
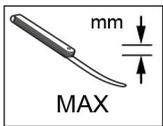
Check and Fault Trace

Cylinder Head, Check

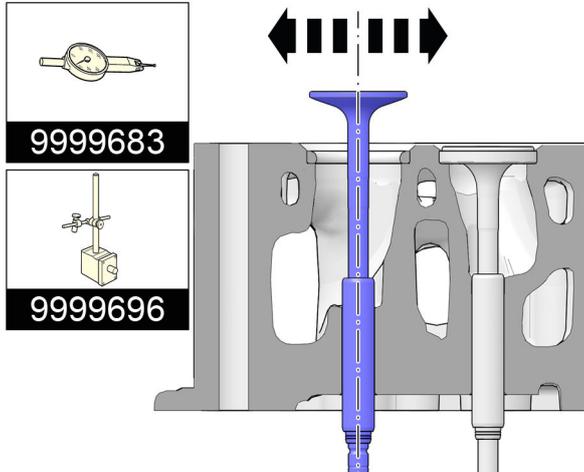
Tools:

- 9989876 Dial indicator
- 9992479 Holder for dial indicator
- 9999683 Dial indicator (short probe)
- 9999696 Magnetic stand

- 1 Perform the check with a feeler gauge and a straight edged ruler.
If the unevenness exceeds 0.1 mm, the cylinder head must be replaced.

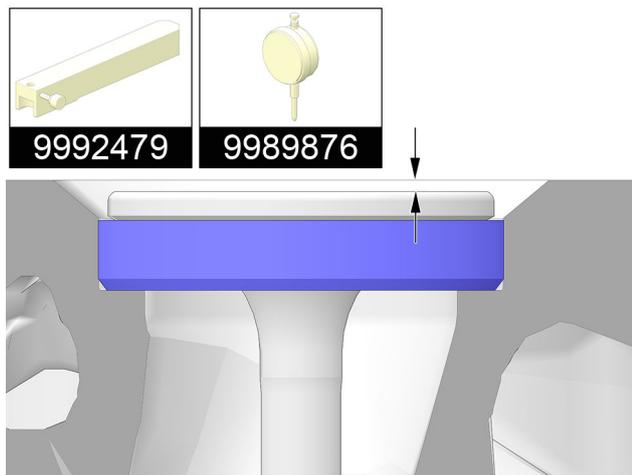


P0034836



P0038580

- 2 **Valve guides, check**
Lift the valve approx 20 mm from the seat.
Max permitted play is:
 - Inlet: **0.04 mm**
 - Outlet: **0.04 mm**



P0036305

3 Valve seats, check

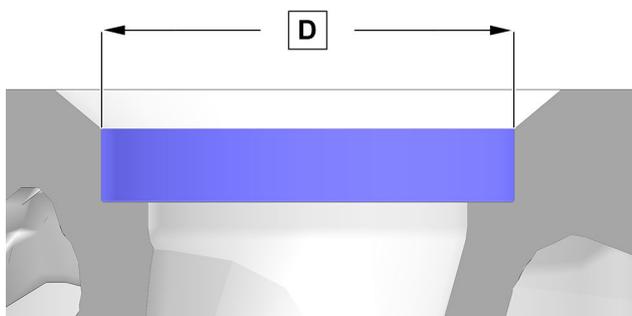
The valve seat should be replaced when dimension (L) exceeds:

- Inlet: **1.15 mm**
- Outlet: **1.65 mm**

4 Valve seat position, check

Check that no cracks are present. Measure valve seat diameter (D):

- Inlet: **52 mm**
- Outlet: **49 mm**



P0036307

Compression Test

Tools:

9988539 Compression meter
9998248 Adapter
9998665 Adapter

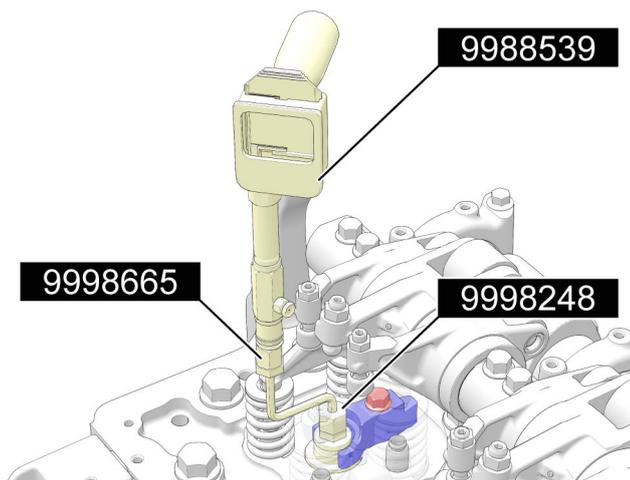
- Valve cover removed
- Rocker arm bridge, intermediate piece and injector removed, refer to *Injector, Replace, page 134*

NOTICE! The engines are fitted with a "keystone" type upper compression ring. This type of ring requires gas pressure to function optimally.

Measurement results with this type of compression test can therefore give erroneous indications.



A simpler and more reliable test can be performed with the VODIA tool.

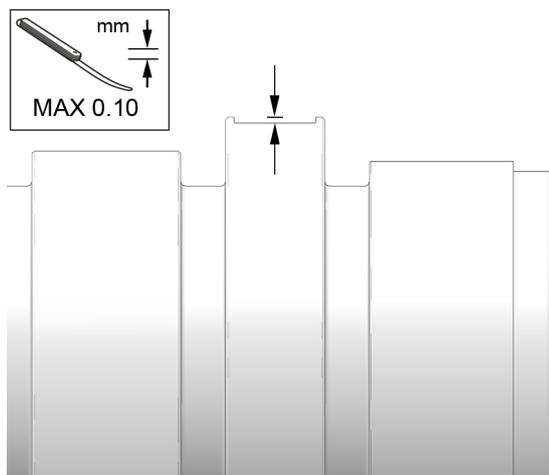


P0041411

- 1 Fit all the adapters to the cylinder head (to avoid repeated removal/fitting of the rocker arm bridge and fuel injectors and adjustment of the valve clearances six times).
- 2 Add rocker arm bridge and intermediate section, refer to *Injector, Replace, page 134*.
- 3 Crank the engine with the starter motor until the needle on the compression gauge stops moving (max. compression value) and read off the value. Repeat the test on all cylinders.

NOTICE! Do not run the starter motor for more than 15 seconds at a time, with a rest interval of a few minutes.

- 4 Remove adapters and re-fit the injectors, refer to *Injector, Replace, page 134*.



P0036775

Camshaft, Wear Check

Rocker bridge removed.

Put a steel rule across the camshaft lobes, parallel with the camshaft axis, to see if the cam profiles show signs of wear.

Compare the measured values with those specified in *Engine, page 32*.

Guidelines for replacement

In normal conditions, unevenness may be present on the surface of the engine camshaft lobes. This does not mean that the camshaft must be changed. These marks do not have any negative influence on either engine performance or the durability of the engine and its components.

Lighter scratching: The camshaft need not be changed.

Hard wear: The camshaft and associated rocker arms must be changed.

Connecting Rod, Check

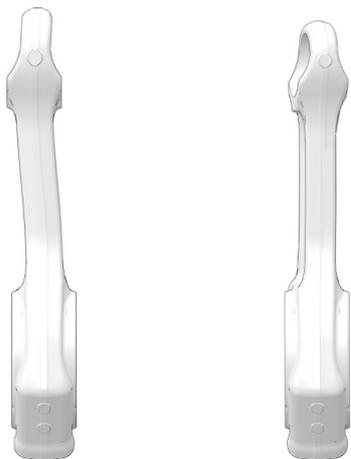
Check the connecting rod in respect of cracks, straightness and twist.

IMPORTANT! If the connecting rod or bearing cap are damaged, change the connecting rod.

Important to remember when removing/installing a "fracture-split" connecting rod.

When the cap is removed from the connecting rod, a chip may be missing or come loose. This entails no impairment of connecting rod function.

Handle the connecting rod and bearing cap carefully. Any impact marks that occur on the parting line may affect strength after torquing.



P0036777

Fitting the Fixture

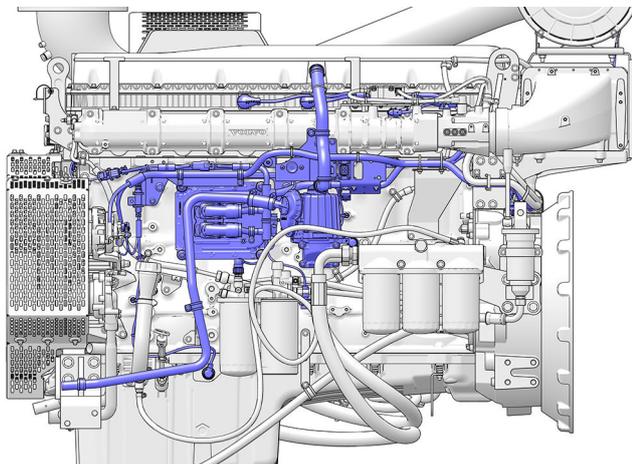
Engine Fixture, Installation

Tools:

88800123 Plate

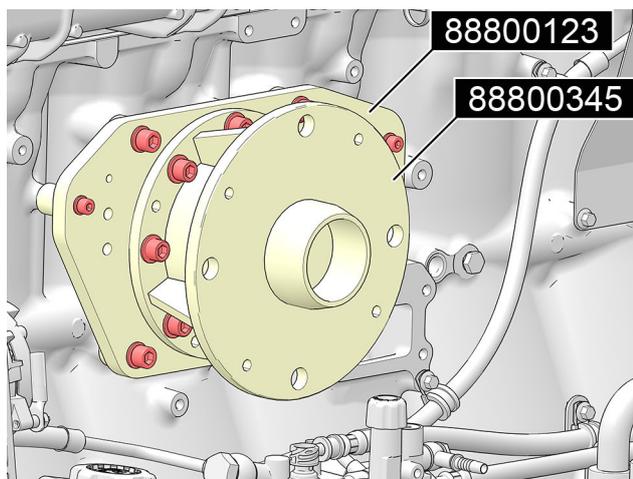
88800345 Adapter

- 1 Remove marked parts.



P0039711

- 2 Install the fixture and adapter to the engine.



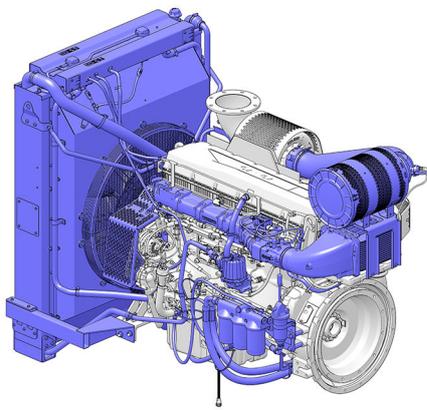
P0039712

Engine Disassembly

Tools:

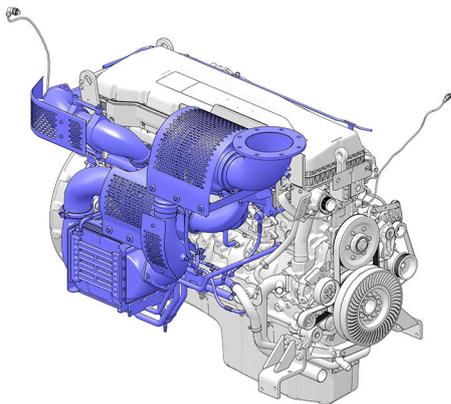
9989876 Dial indicator
9990013 Slide hammer
9990114 Puller
9990157 Press tool
9992479 Holder for dial indicator
9996394 Support
9996395 Support
9996645 Puller
9998511 Lever
88800501 Mounting tool
88800829 Extractor plate
88800831 Piston ring compressor

1 Remove marked parts.



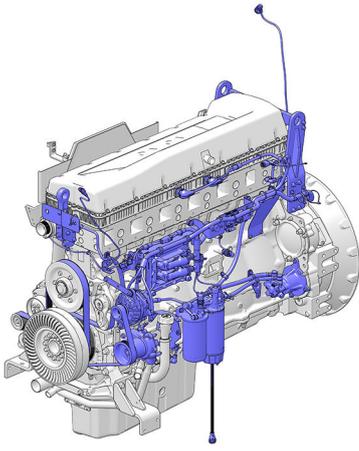
P0039626

2 Remove marked parts.



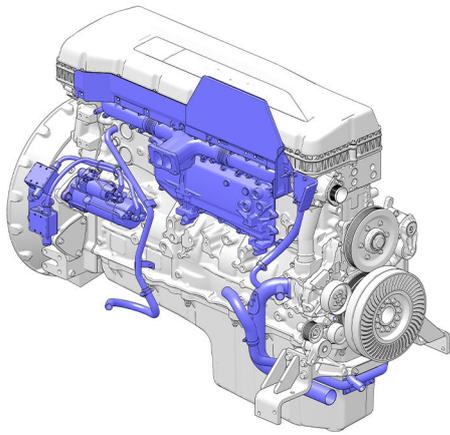
P0039627

3 Remove marked parts.



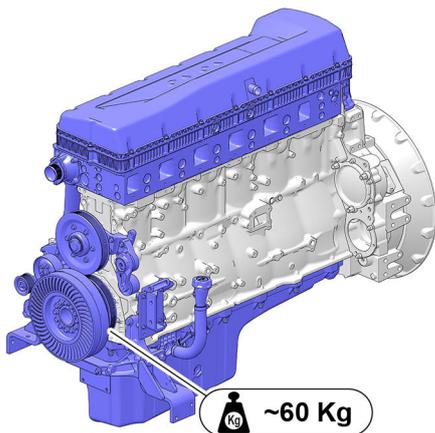
P0039628

4 Remove marked parts.

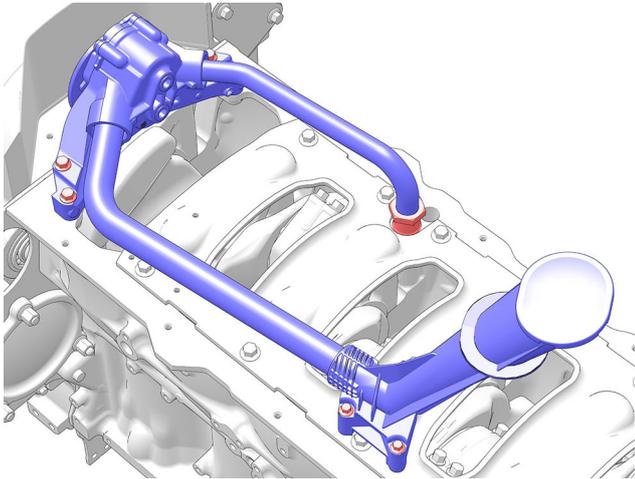


P0039629

5 Remove marked parts.

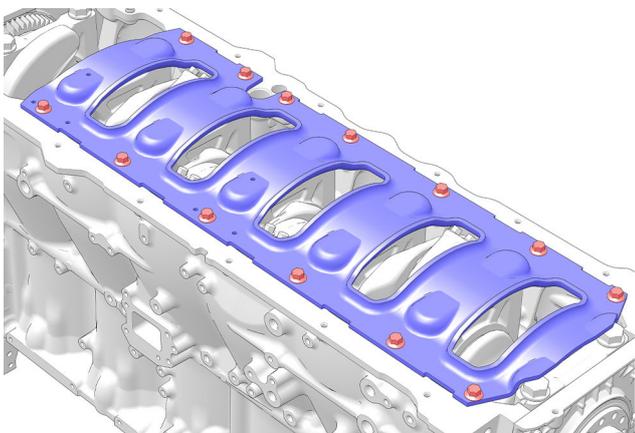


P0039630



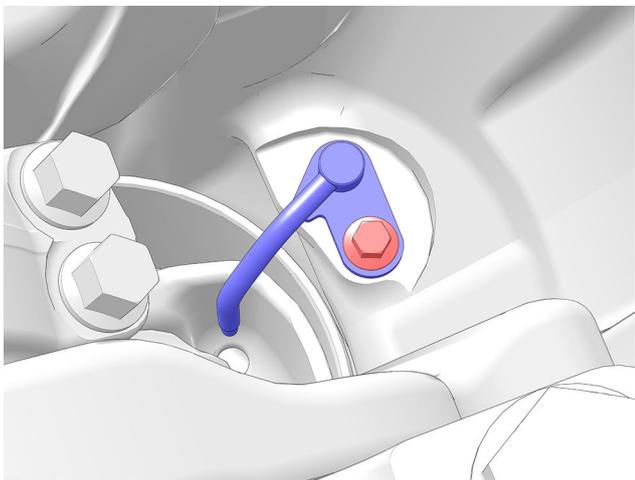
P0039615

- 6 Remove:
- suction pipe
 - pressure pipe
 - oil pump



P0039601

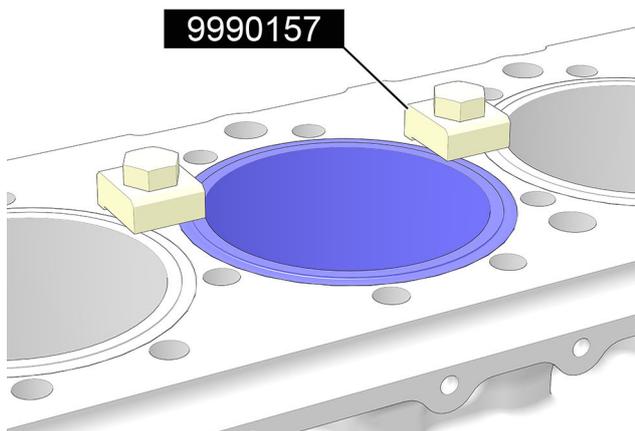
- 7 Remove the reinforcing plate.



P0039607

- 8 Remove the piston cooling jets.

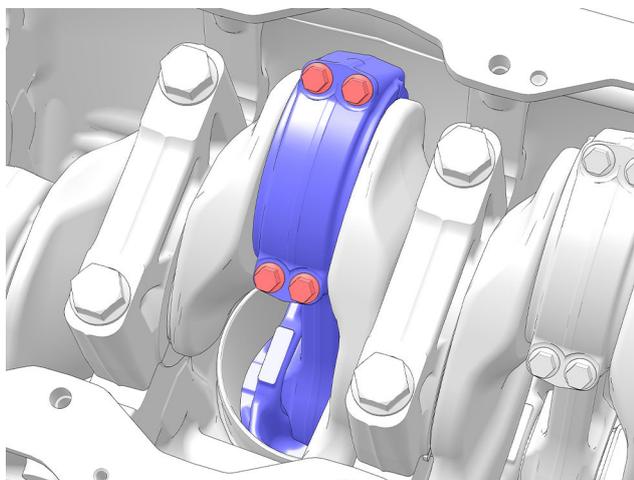
9 Hold the liner in place with press tools.



P0039602

10 Mark up the bearing cap and connecting rod. Remove:

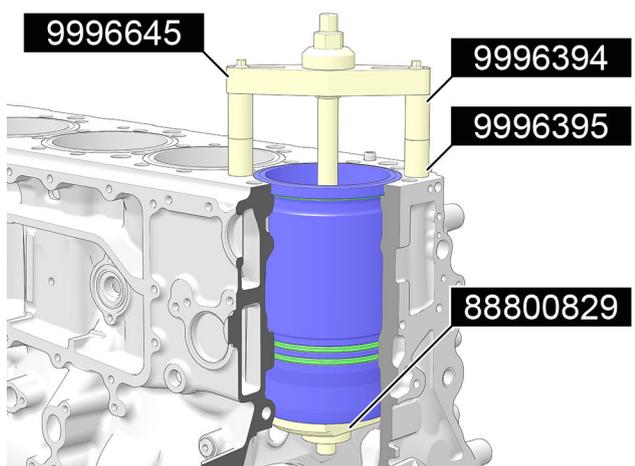
- bearing caps
- piston with connecting rod



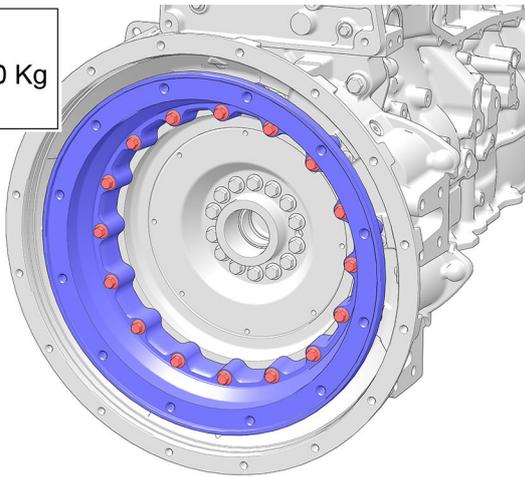
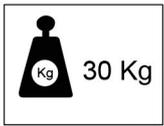
P0039644

11 Pull the cylinder liner out of the block.

NOTICE! The text "D17" on the puller plate should face upwards.

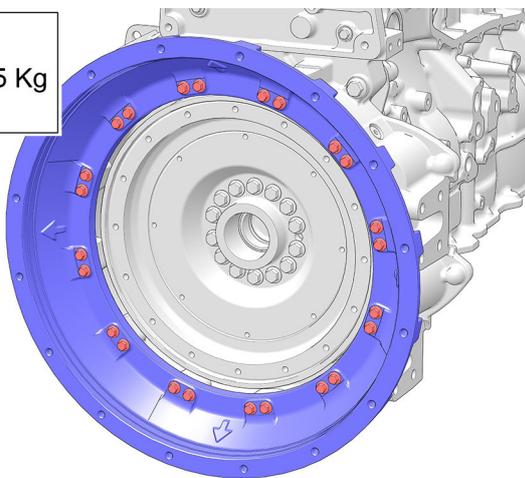
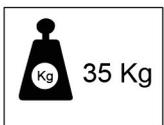


P0039593



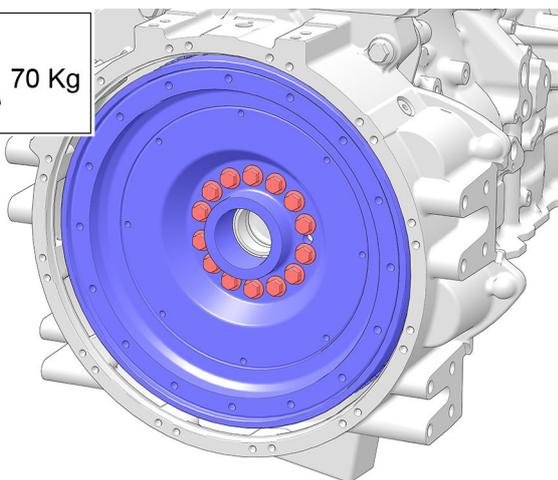
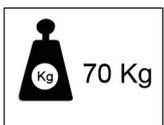
P0039646

12 Remove the flywheel.



P0039589

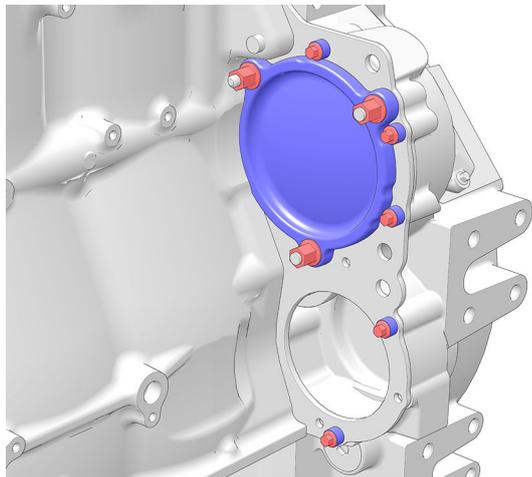
13 Remove the adapter housing.



P0039604

14 Remove the flywheel.

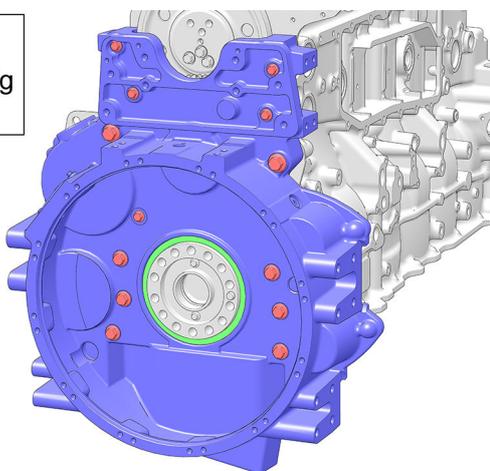
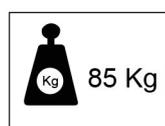
NOTICE! Make sure the flywheel sensor is removed before removing the flywheel.



P0039592

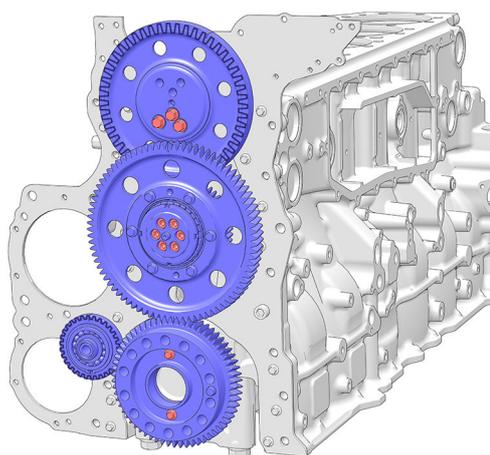
- 15 Remove the screws on the back of the timing gear casing.

NOTICE! Screws on both sides of the engine.



P0039634

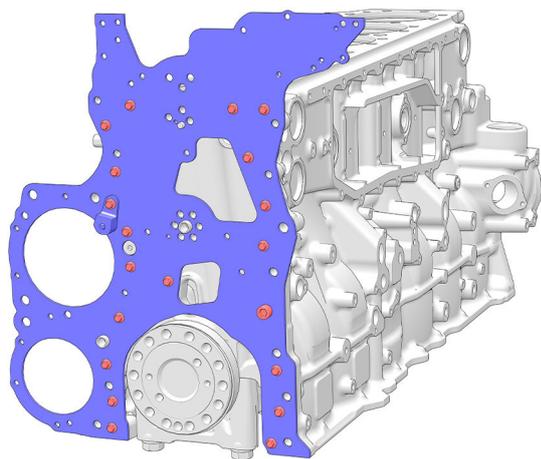
- 16 Remove the rear crankshaft seal, refer to *Crankshaft Seal, Replace (rear)*, page 117. Remove the timing gear casing.



P0039631

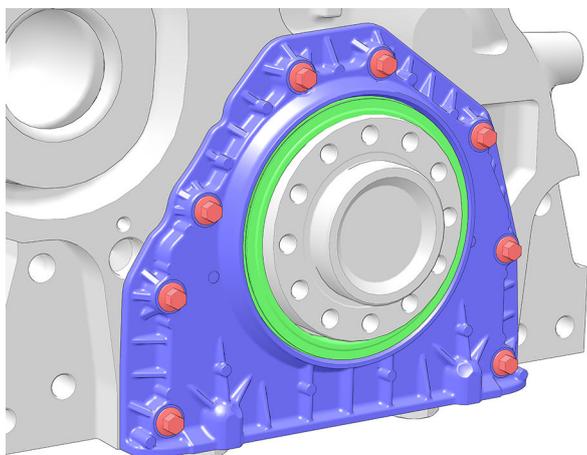
- 17 Remove the timing gear wheels.

18 Remove the timing gear plate.



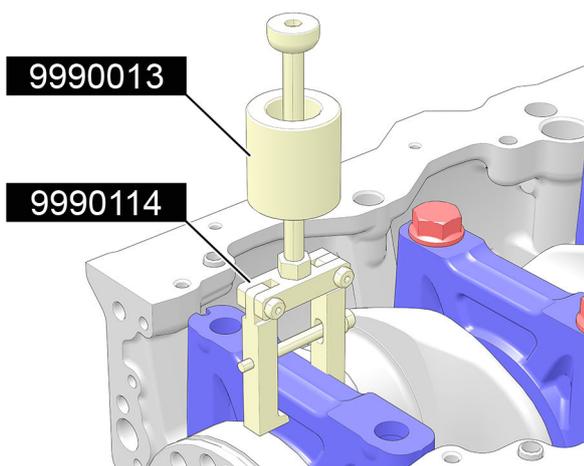
P0039636

19 Remove the front crankshaft seal, refer to *Crankshaft Seal, Replace (front)*, page 115. Remove the casing.



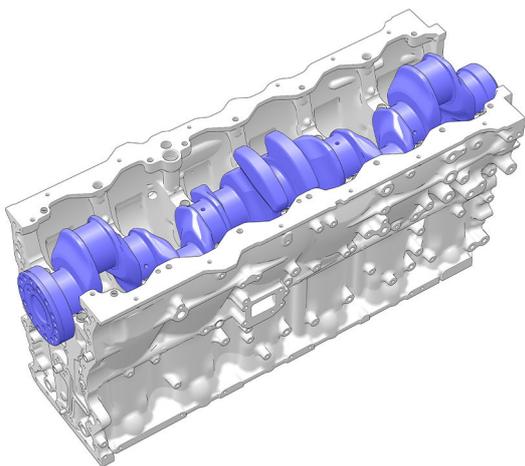
P0039598

20 Remove the main bearing caps.



P0039619

21 Remove the crankshaft.



P0039641

Engine Assembly



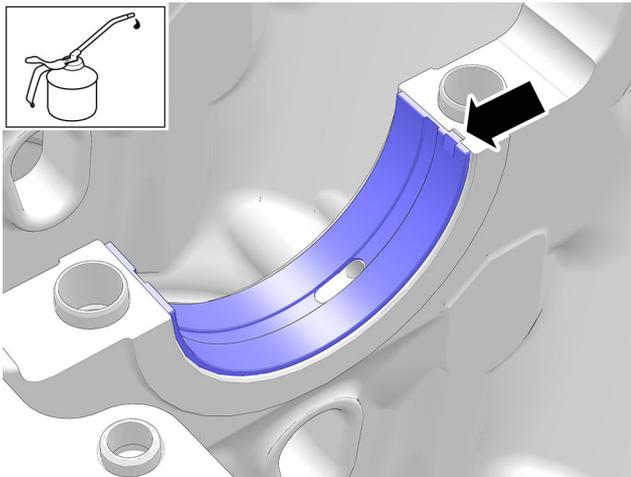
First read the instructions *Safety Instructions*, page 48.

Tools:

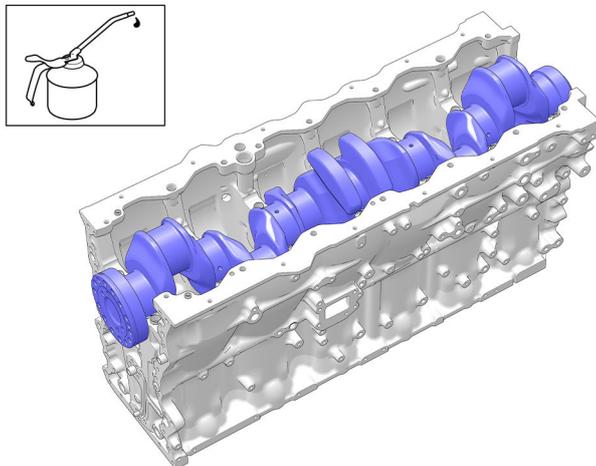
9989876 Dial indicator
9990013 Slide hammer
9990114 Puller
9990157 Press tool
9992479 Holder for dial indicator
9996239 Lifting tool
9996394 Support
9996395 Support
9996645 Puller
9998511 Lever
88800501 Mounting tool
88800829 Extractor plate
88800831 Piston ring compressor

Tools:

- 1 Install the bearings box.
Make sure that the guide pins on the bearings fit into the guides in the engine blocks and bearing caps.

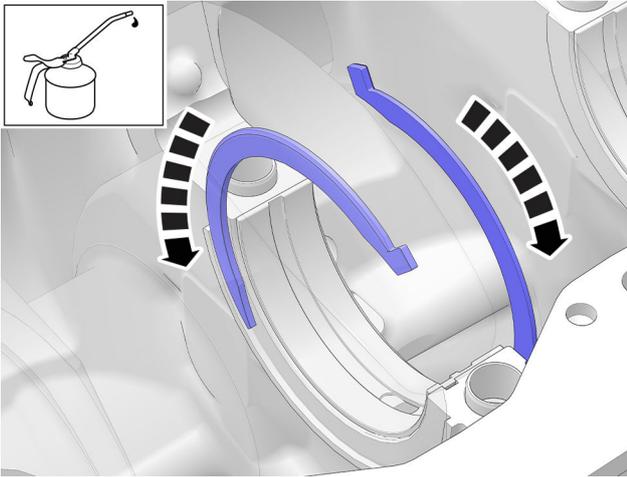


P0039618



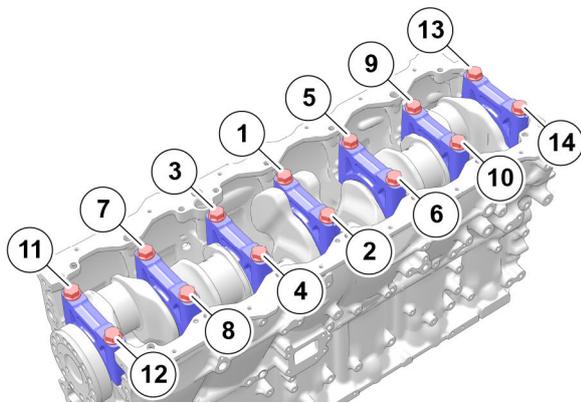
P0038934

- 2 Install the crankshaft.



P0038935

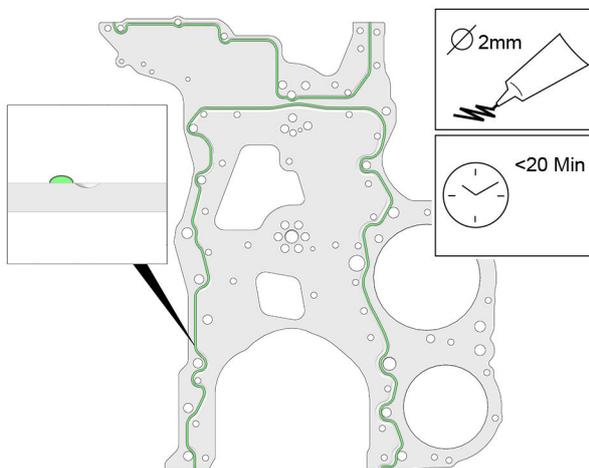
3 Insert the crankshaft thrust bearing.



P0039620

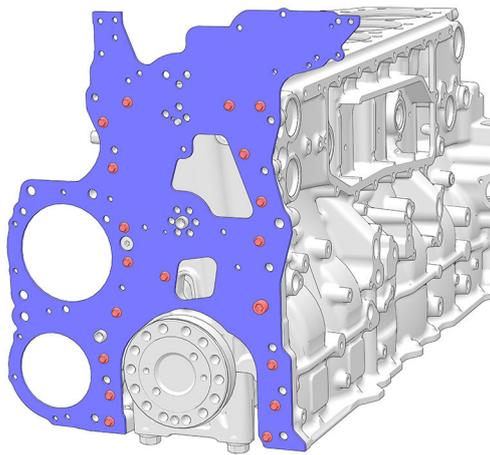
4 Install the main bearing cap.

- Step 1: **150 Nm**
- Step 2: **300 Nm**
- Step 3: Angle tightening **120°**



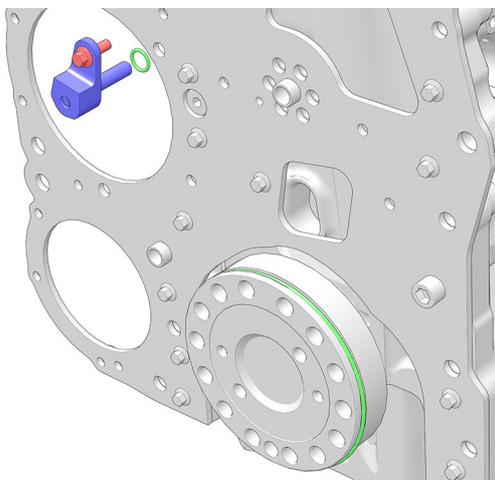
P0039622

5 **NOTICE!** Apply a strand of sealant P/N 1161231 with a diameter of approx. 2 mm, refer to illustration.



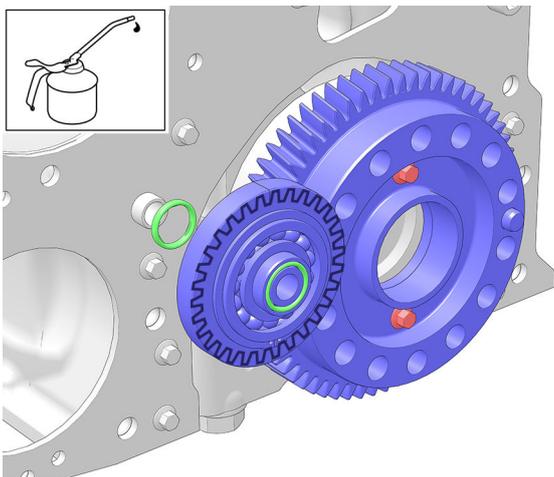
P0039635

- 6 Install the timing gear plate.
For tightening torque, refer to *Special Tightening Torques*, page 11.



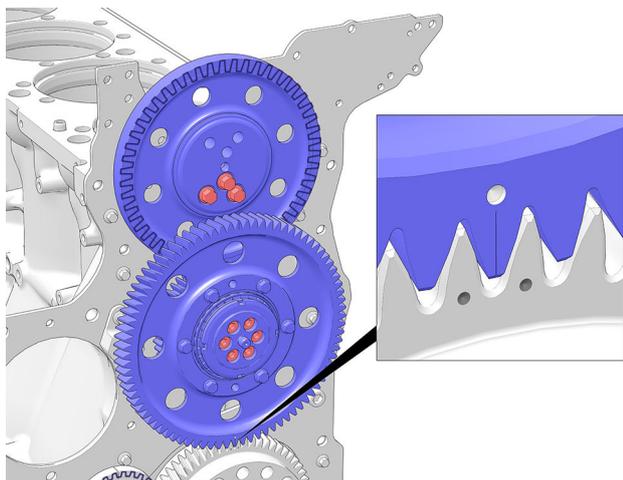
P0039639

- 7 Install:
- seals
 - retainers



P0039642

- 8 Install:
- crankshaft gear drive
 - idler wheel
- Refer to *Special Tightening Torques*, page 11.

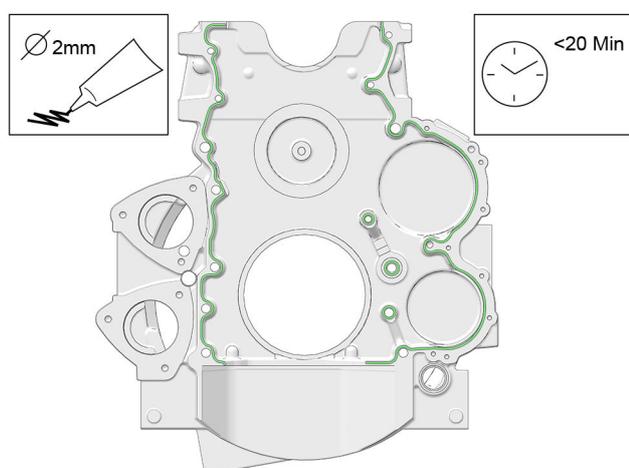


P0039613

- 9 Install the idler gear wheels.

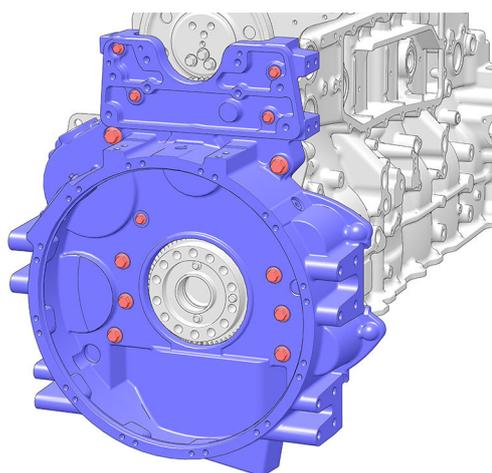
IMPORTANT:

Mount the double drive so that the marking matches the markings on the crankshaft gear drive.
For tightening torque, refer to *Special Tightening Torques, page 11*.



P0039633

- 10 **NOTICE!** Apply a string of sealant P/N 1161231 with a diameter of approx. **2 mm**, refer to illustration.



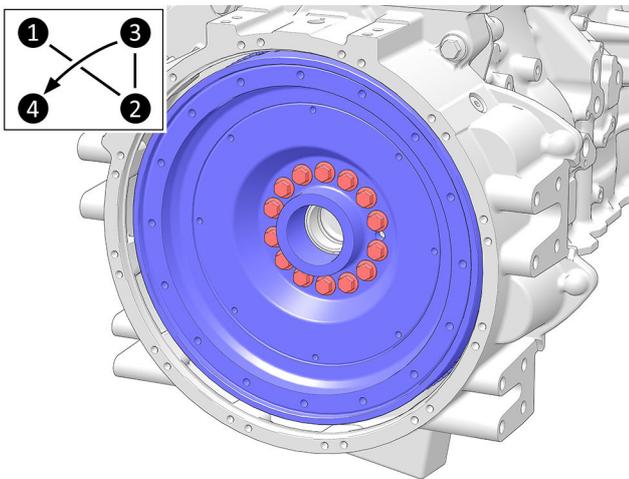
P0039632

- 11 Install the timing gear casing, refer to *Special Tightening Torques, page 11*.
- 12 Install the screws on the back of the timing gear casing.



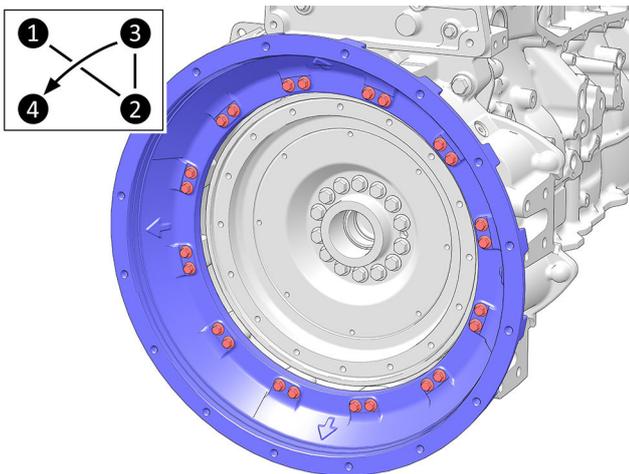
P0039591

- 13 Install the new crankshaft seal, refer to *Crankshaft Seal, Replace (rear)*, page 117.



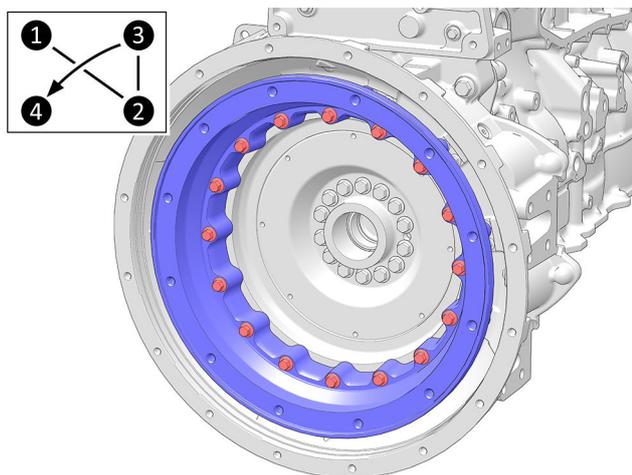
P0039603

- 14 Install the flywheel.
- Step 1: **60 Nm**
 - Step 2: Angle tightening **120°**



P0039588

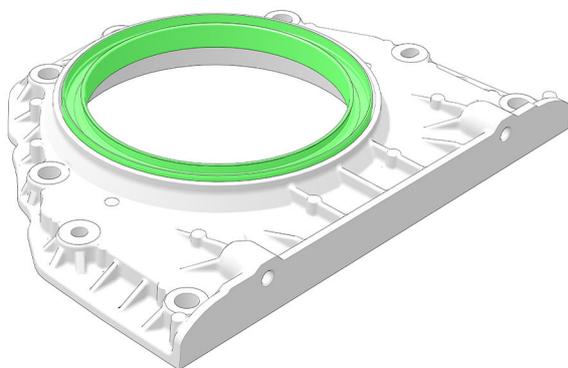
- 15 Install the adapter cover.
- Step 1: **24 Nm**
 - Step 2: **48 Nm**



P0039645

16 Install the flywheel adapter.

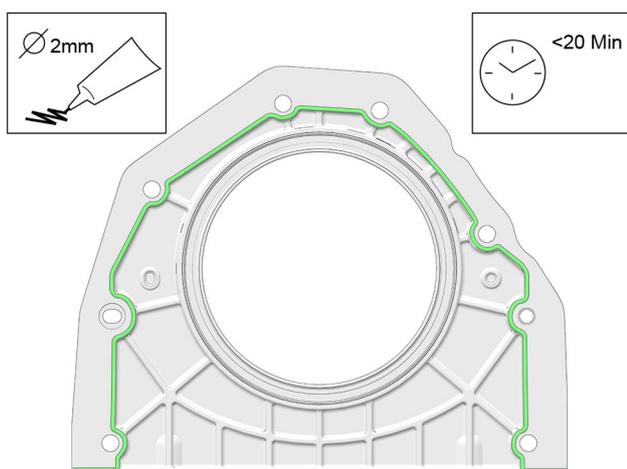
- Step 1: **24 Nm**
- Step 2: **125 Nm**



P0038936

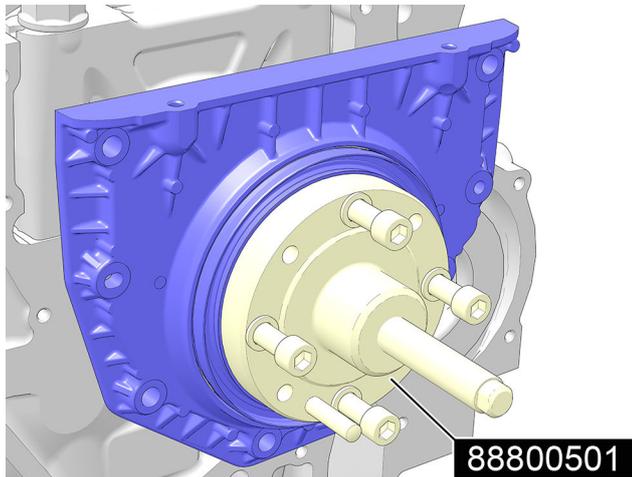
17 Press the seal gently into the casing by hand.

NOTICE! The metal side of the seal must face inwards.



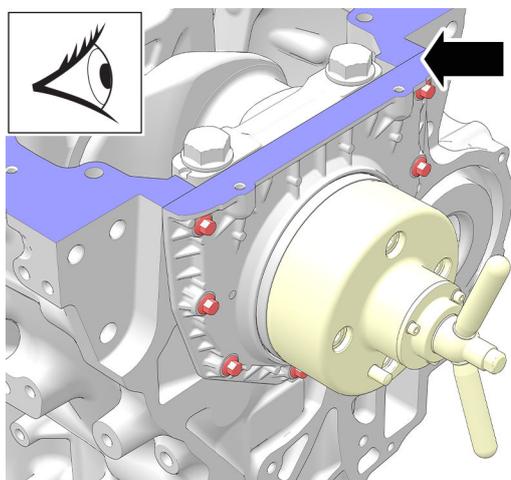
P0039621

18 **NOTICE!** Apply a string of sealant P/N 1161231 with a diameter of approx. 2 mm, refer to illustration.



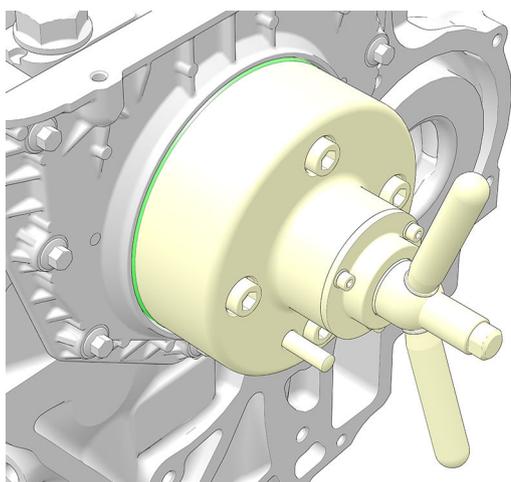
P0038937

- 19 Fit the cover onto the tool and screw the tool onto the crankshaft.



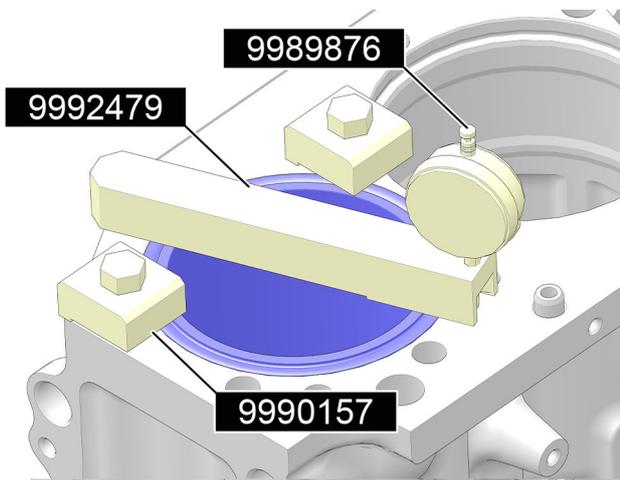
P0038938

- 20 Gently press the casing in using the tool. Make sure the bottom edge of the cover aligns with the plane of the engine block to center the cover against the crankshaft. Install the screws, tightening torque **24 Nm**.

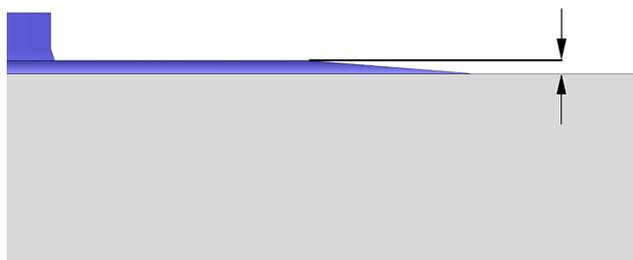
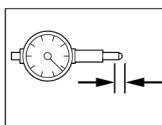


P0038939

- 21 Press in the crankshaft seal until the tool bottoms out. Hold for at least three seconds before removing the tool.



P0039614



P0039595



P0039596

- 22 Fit the cylinder liner without seal rings. Affix it with two press tools.
- 23 Insert the dial indicator in the retainer. Place the retainer across the cylinder liner. Zero the indicator with a couple millimeters of pre-load against the cylinder block plane.

- 24 Measure the height between the highest point of the cylinder liner and the plane of the cylinder block in two different places diagonal to each other and calculate the average value of the measurement results.
If the liner height above the block plane is outside specified tolerances, the liner shelf must be renovated (re-milled) and a shim shall be used when installing.
Refer to *Engine*, page 32.

- 25 Lubricate the seals with the included lubricant and attach them to the liner.

IMPORTANT:

The purple seal ring must sit in the lowest groove

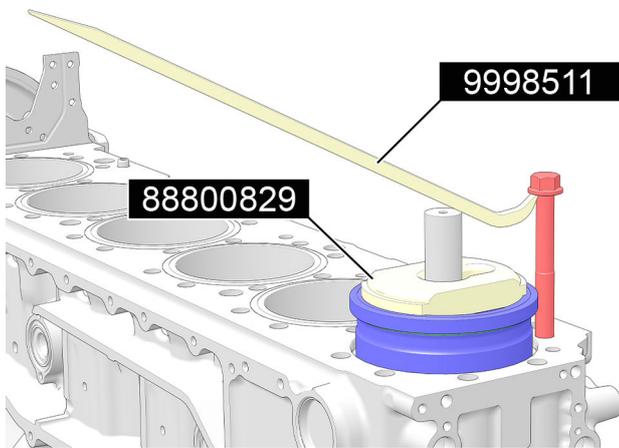


- 26 If the cylinder liner is fitted without shims, an even, approx 0.8 mm thick string of sealing compound P/N 1161231 must be placed on the underside of the cylinder liner collar.
If the cylinder liner is installed with shims, apply the sealant strand to the cylinder block liner seat. The inlet manifold must be installed within 20 minutes of sealant application.

NOTICE! Do not put the seal around the entire liner. Leave a 2 mm opening.

NOTICE! Sealant must not be used between the shims and the cylinder liner collar.

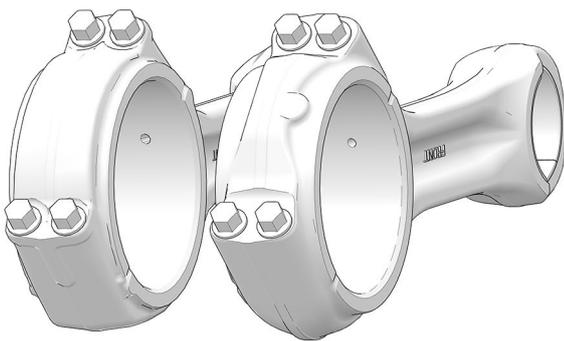
P0039638



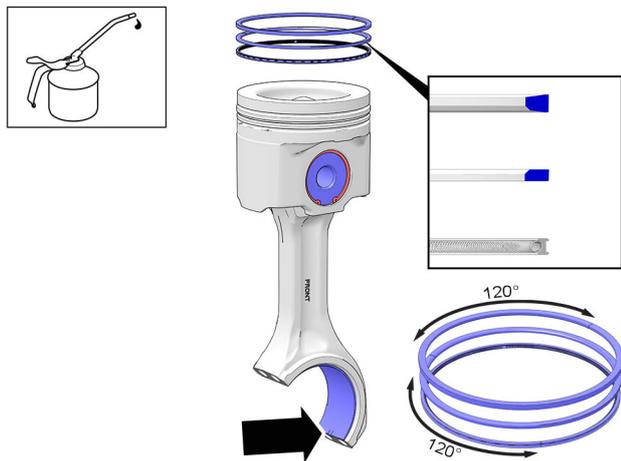
P0039594

- 27 Insert one of the cylinder head screws and press the cylinder liner down with a prybar and puller plate.
Use the appropriate spacer between plate and prybar. Secure the liner with the press tool.

- 28 **NOTICE!** If connecting rods are to be replaced, check that the same type of connecting rod is used.
Check castings in the bearing caps to identify which connecting rod to use.



P0040778



P0039609

- 29 Lubricate the piston pin and the piston bearing seat with engine oil and install the connecting rod.

IMPORTANT:

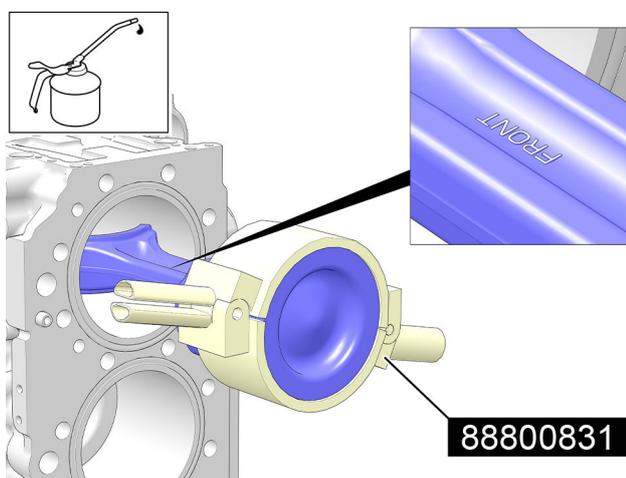
The marking "FRONT" on the connecting rod and the arrow on the piston must face the same direction.

Install the piston rings evenly spaced in relation to each other. The oil ring opening must be diametrically opposite the opening in the spring.

IMPORTANT:

The marking on the upper piston rings shall face upwards. The oil ring can be installed in both directions.

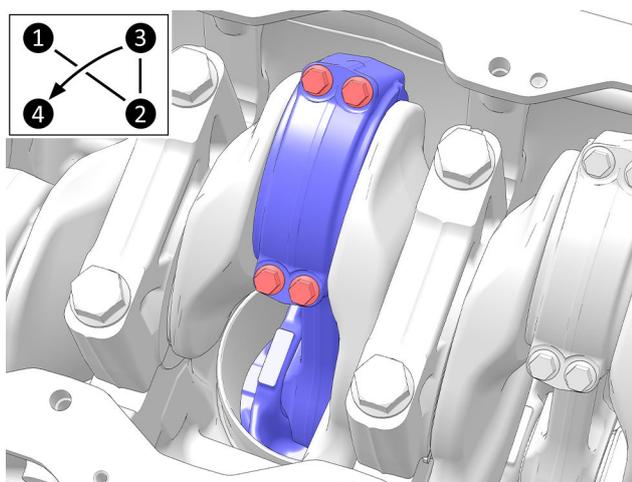
- 30 Install the crankshaft bearing. Make sure that the guide pins on the bearings fit into the guides in the engine blocks and bearing caps.
- 31 Install the piston and connecting rod. The marking "FRONT" on the connecting rod shall face the front of the engine.



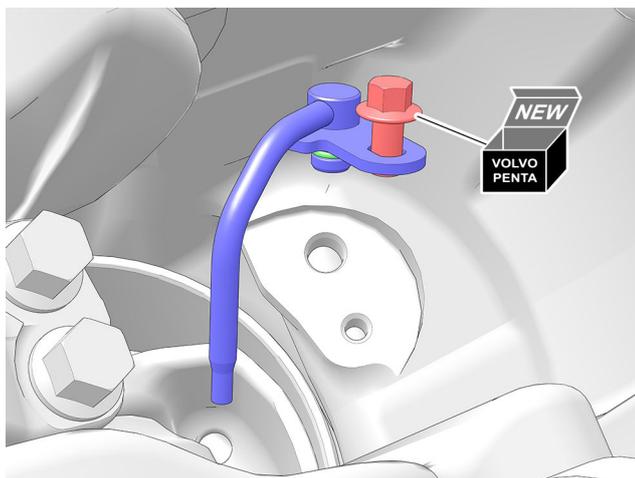
P0039605

- 32 Install the crankshaft connecting rod caps.

- Step 1: **20 Nm**
- Step 2: **60 Nm**
- Step 3: Angle tightening **90°**

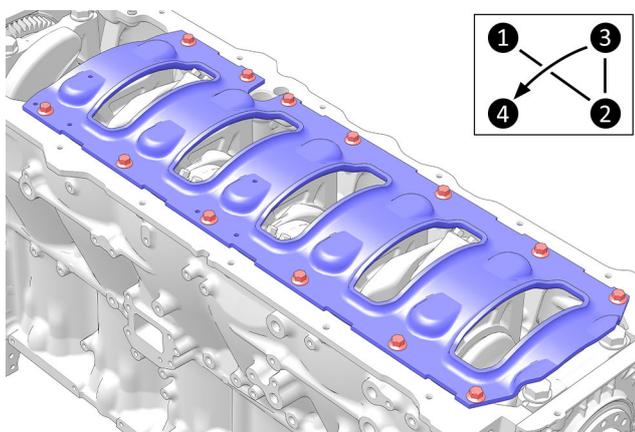


P0039643



P0039606

- 33 Install the piston cooling jets:
Tightening torque: **24 Nm**

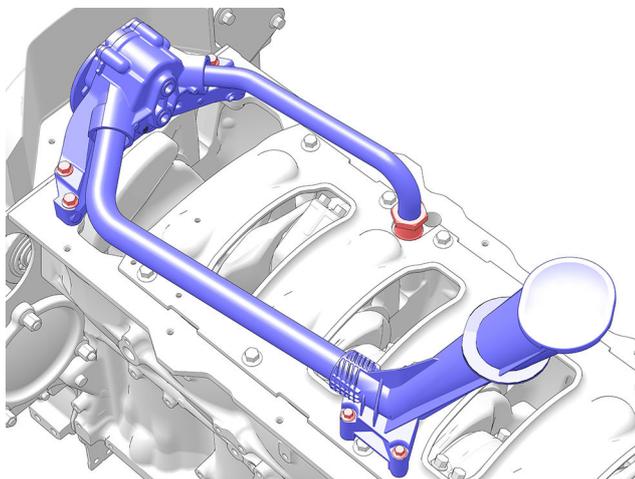


P0039600

- 34 Install the stiffening plate.

Tightening torque

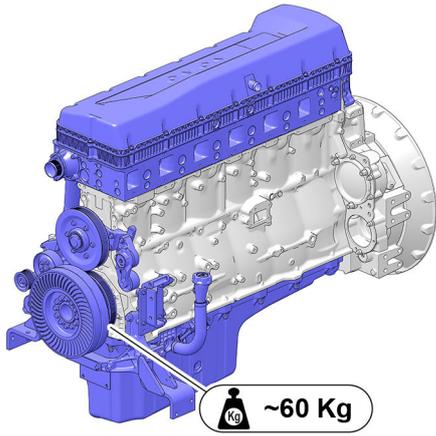
- 1 **65 Nm**
- 2 **90°**



P0039615

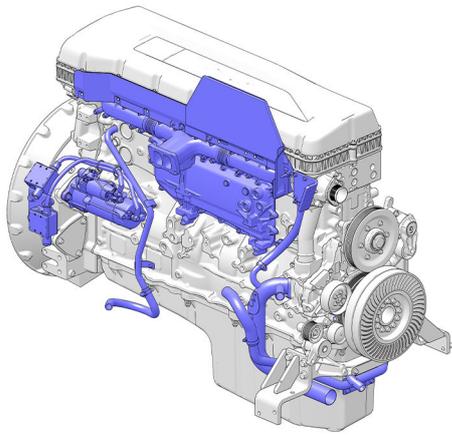
- 35 Install:
- oil pump
 - pressure pipe
 - suction pipe

36 Install marked parts.



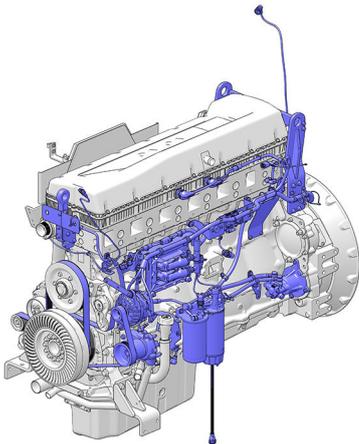
P0039630

37 Install marked parts.



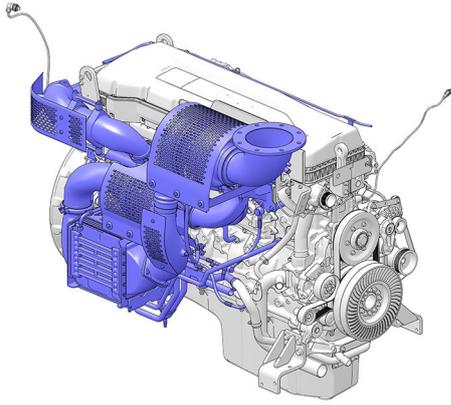
P0039629

38 Install marked parts.



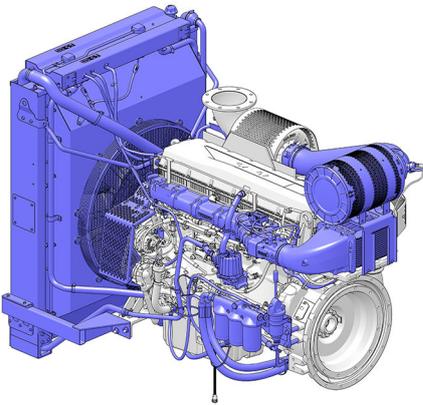
P0039628

39 Install marked parts.



P0039627

40 Install marked parts.



P0039626

21-1 Cylinder Head

Cylinder Head, Replace



First read the instructions *Safety Instructions, page 48*.

Tools:

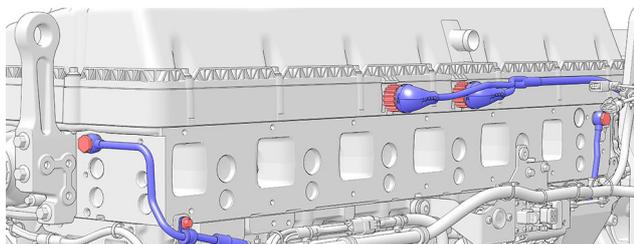
885810 Fixture
 9990006 Puller
 9990013 Slide hammer
 9990185 Lifting tool
 9990192 Puller
 9993590 Rotation tool
 9996239 Lifting tool
 9996400 Slide hammer
 9998249 Protective sleeve
 9998251 Protection plug
 9998264 Lifting tool
 9998601 Fixture
 9999683 Dial indicator (short probe)
 9999696 Magnetic stand

Remove:

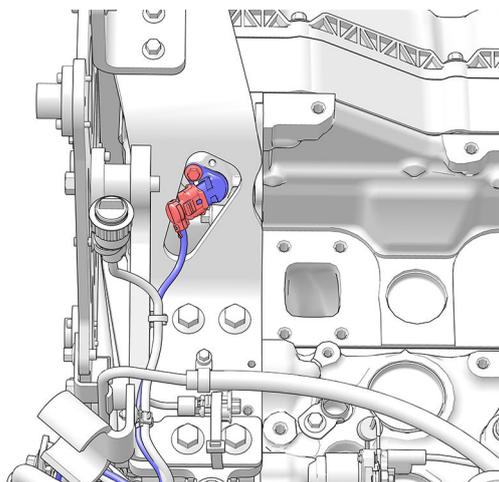
- Manifold; refer to *Exhaust Manifold, Replace, page 152*.
- Inlet piping, refer to *25-1, Intake Manifold, Replace*.
- Charge air cooler, refer to *Charge Air Cooler, Lower, Replace, page 185*.
- Strut cooling package, refer to *Radiator Assembly, Change, page 172*.
- Coolant drained; refer to *26-0, Coolant, Replace*.
- Carry out *Draining, Fuel Duct in Cylinder Head, page 127*.

1 Remove:

- fuel piping
- cable harness

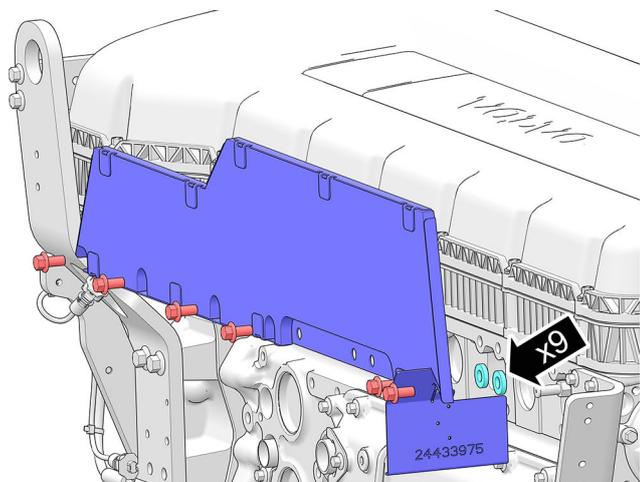


P0037668



P0038652

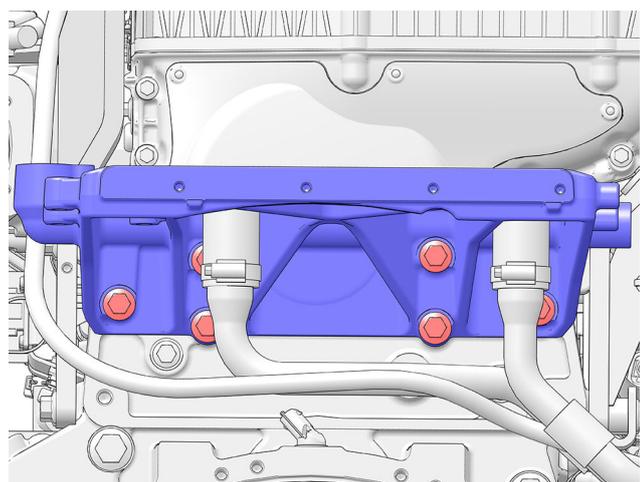
2 Remove the camshaft sensor.



P0040330

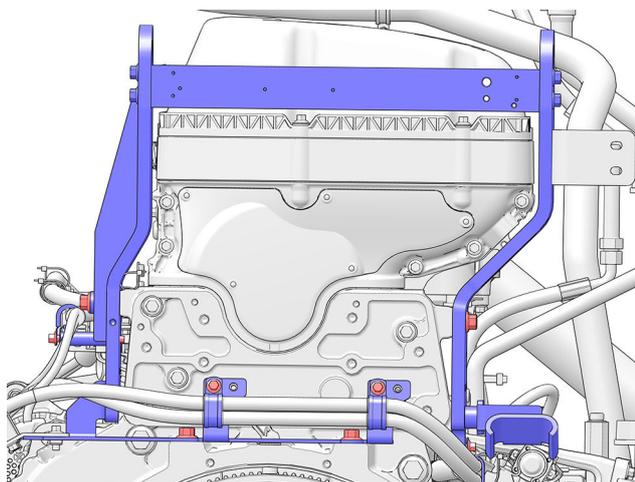
3 Remove heat shield.

NOTICE! 9 spacers behind heating plate.



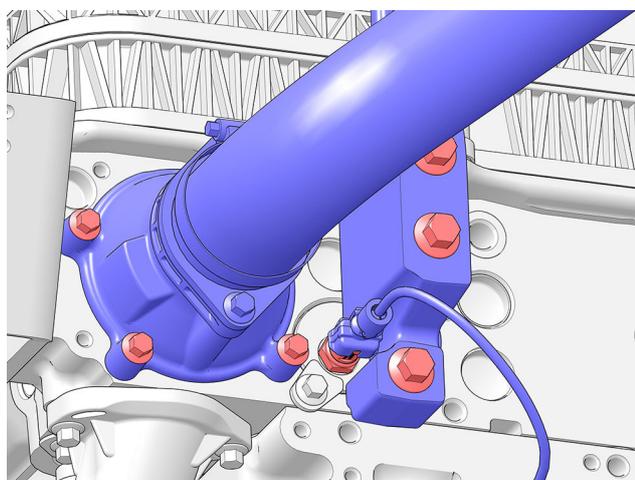
P0038655

4 Remove the charge air cooler bracket



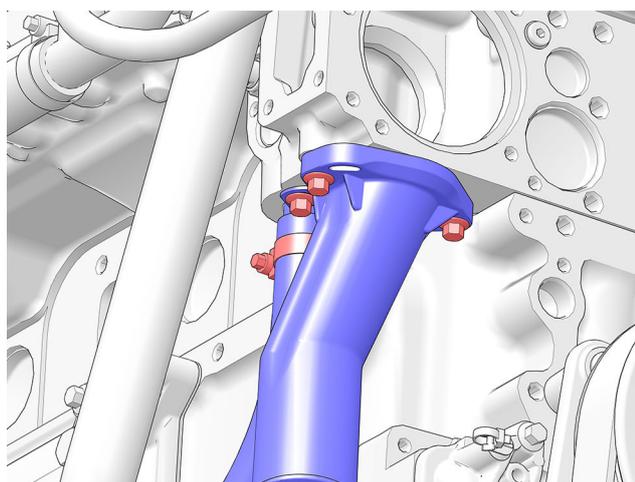
P0038656

- 5 Remove:
- rear lifting lugs
 - cable bracket



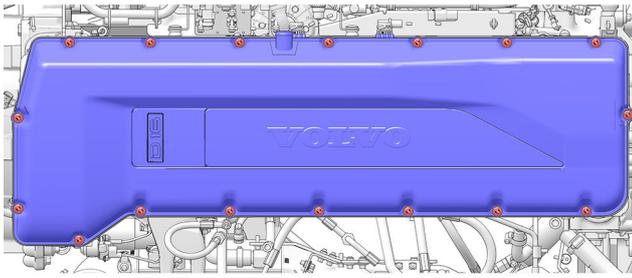
P0040329

- 6 Remove:
- water piping and thermostat
 - lifting eye
 - temperature sensor



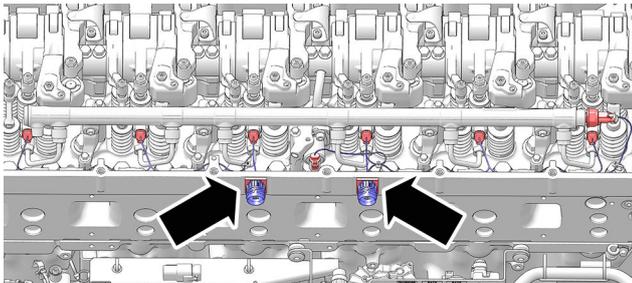
P0038658

- 7 Remove water piping.



P0038659

8 Remove the valve cover.



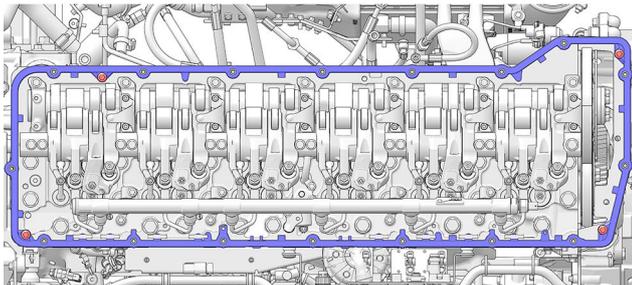
P0038660

9 Remove:

- connectors to injectors
- pressure sensor connector
- locking clip for the pass-through of the wiring grommet

Carefully pull the cable harness out of the cylinder head.

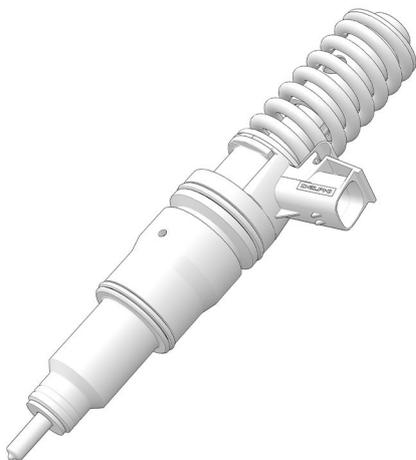
10 Remove the lower valve cover.



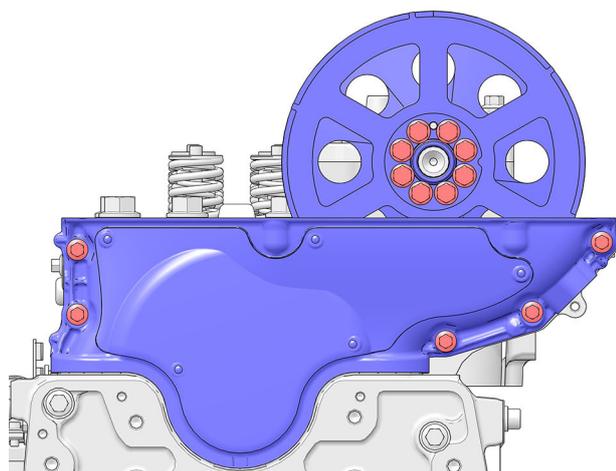
P0038661

11 Remove injectors, refer to *Injector, Replace, page 134*.

12 Put the engine in TDC, refer to *Engine, to set TDC, page 63*.



P0036478

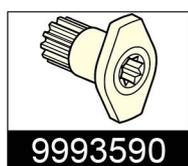


P0037674

13 Remove:

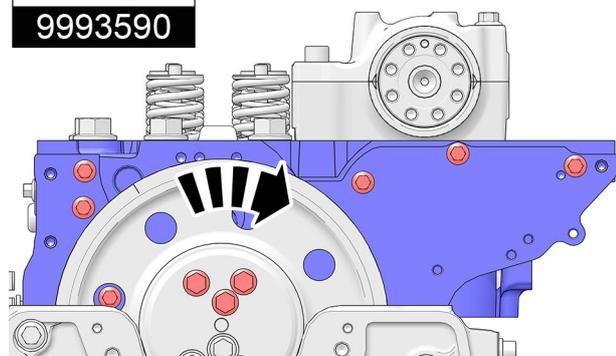
- upper timing gear casing
- oscillation damper

NOTICE! The oscillation damper is very sensitive to shocks.

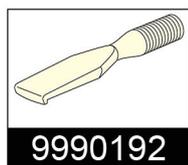


9993590

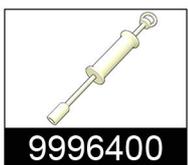
- 14 Remove screws in the timing gear plate. Screw behind the transmission gears is reached by turning the engine. Remove screws in transmission wheel.



P0038663



9990192



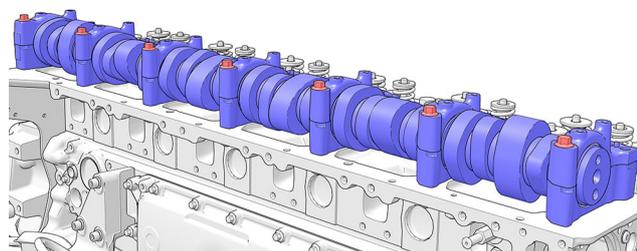
9996400



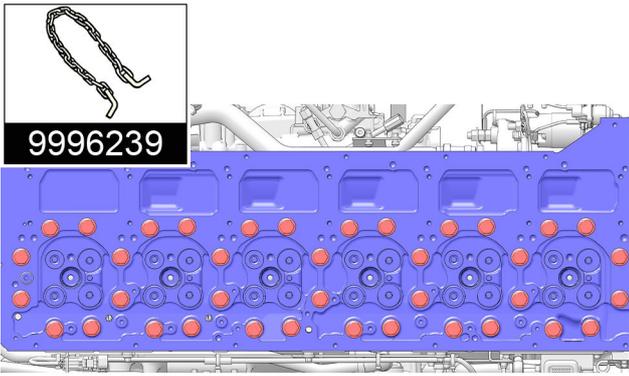
9998264

15 Remove:

- camshaft bearing cap
- camshaft
- bearing brackets

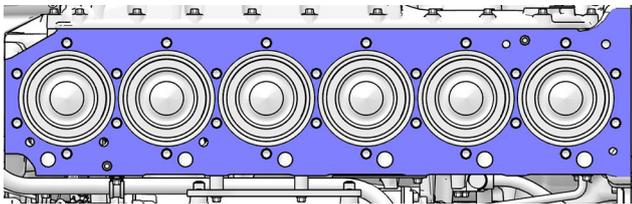


P0037675



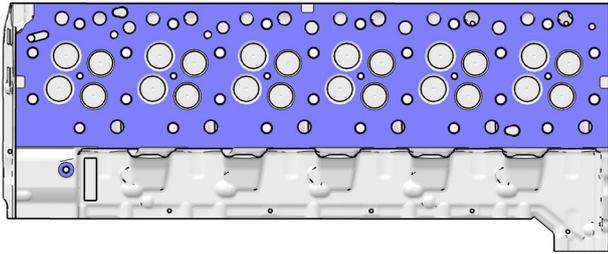
- 16 Remove the cylinder head, use 2 pcs P/N 9996239 to lift off the cylinder head.

P0036483



Installation

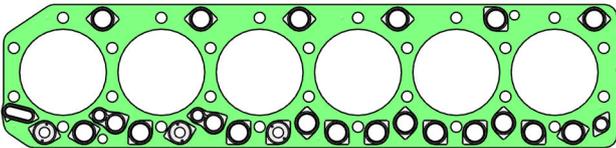
- 17 Clean contact surfaces.



P0036484

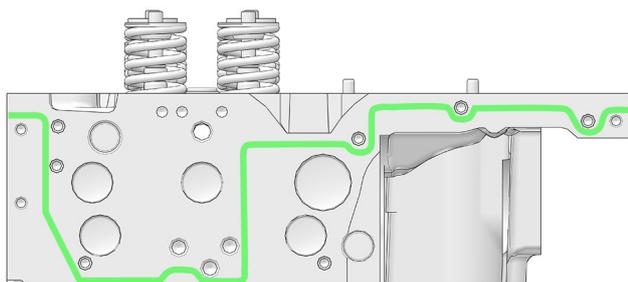


- 18 Install a new gasket.



P0036485

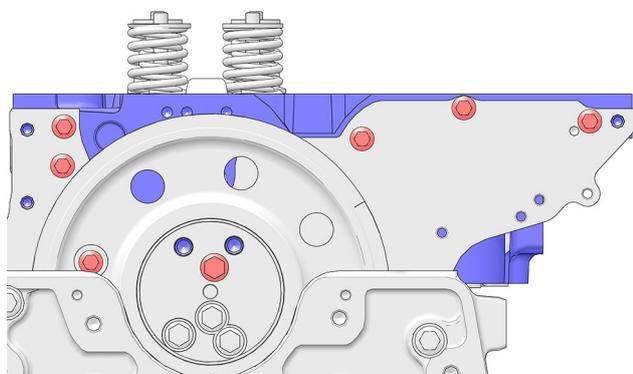
- 19 Apply a string of 2 mm with P/N 1161231 sealant to the rear edge of the timing gear plate.



P0038684

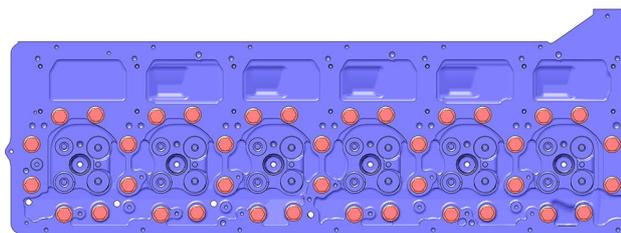
- 20 Install the cylinder head. Install screws to the transmission side to pull the cylinder head firmly against the timing gear plate so that sealant is applied. Tightening torque: **28 Nm**, then loosen the screws **1 turn**.

NOTICE! The cylinder head must not be moved after this operation.



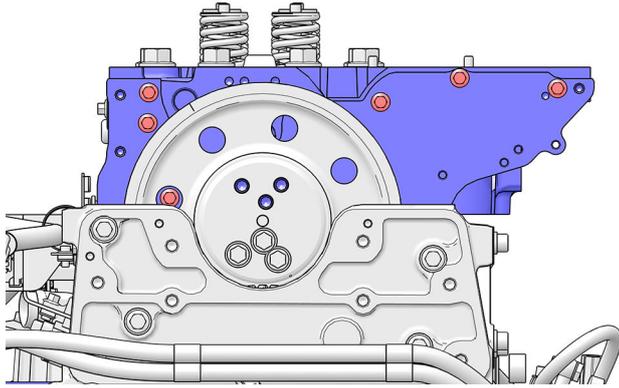
P0036487

- 21 Tighten the cylinder head, refer to *Special Tightening Torques*, page 11.



P0036488

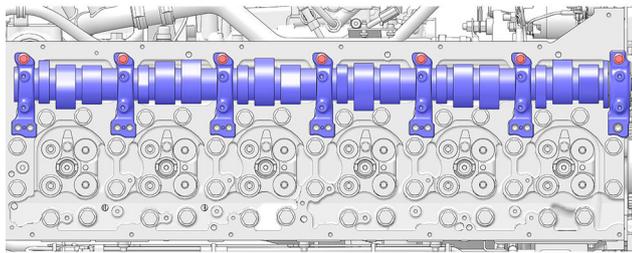
- 22 Tighten the screws in the timing gear plate.
Tightening torque: **28 Nm**



P0038665

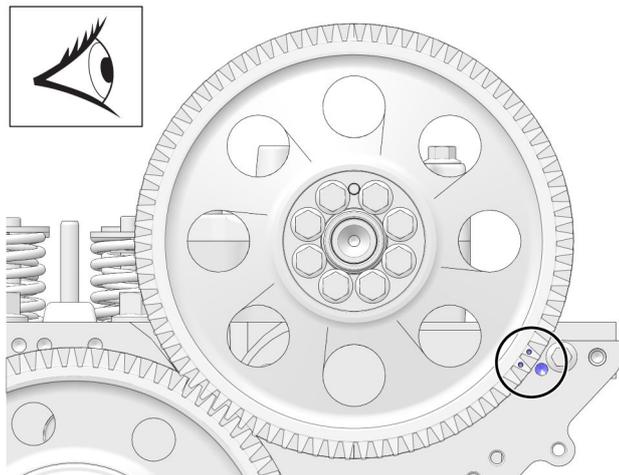
- 23 Install:
- bearing brackets
 - camshaft
 - camshaft bearing cap

Check the marking in the camshaft so that it is mounted in the TDC, refer to *Engine, to set TDC, page 63*.

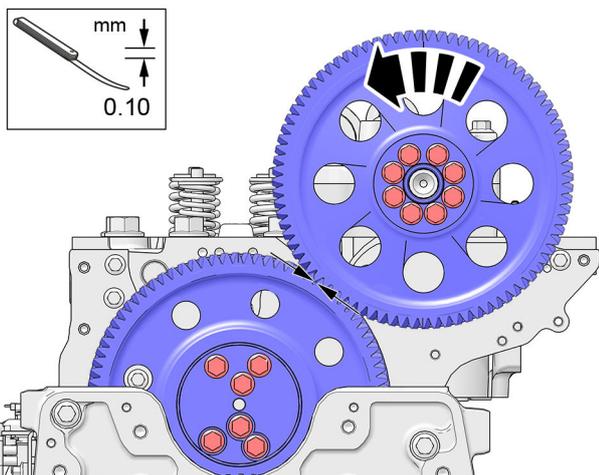


P0036491

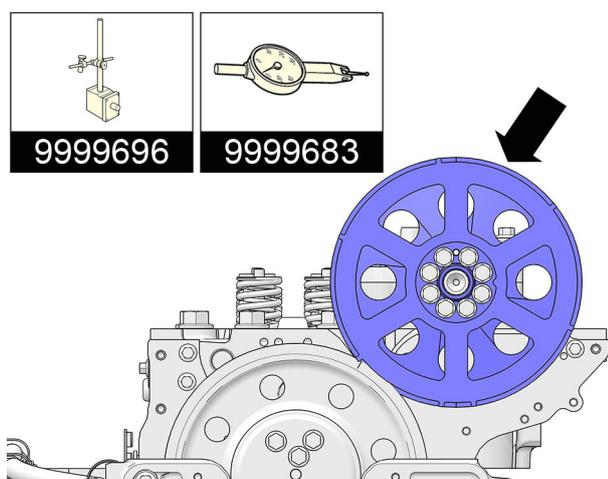
- 24 Remove the top timing gear casing and verify that the reference hole on the timing gear plate is between the markings on the drive.



P0040772



P0038666

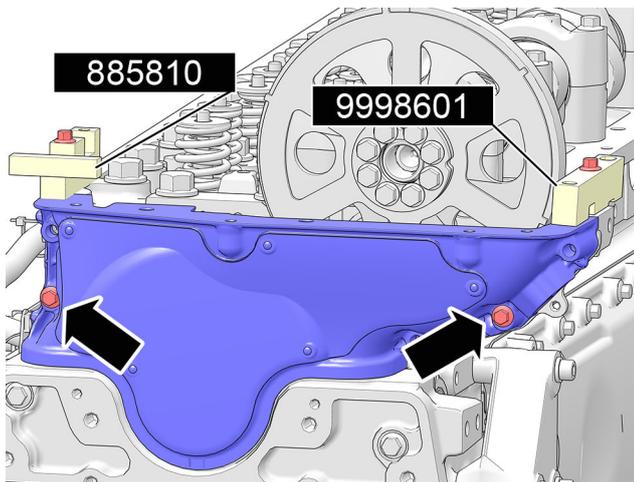


P0038667



P0036494

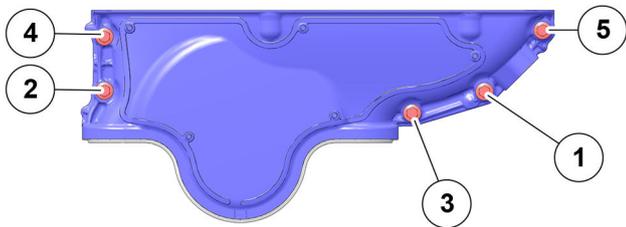
- 25 Install the camshaft gear with the oscillation damper.
Tightening torque: **10 Nm**
- 26 Loosen the two lower screws in the adjuster wheel.
Check that the upper screws are not tightened.
Place a feeler gauge on the pressure side and press the camshaft gear against the feeler gauge.
- 27 Tighten timing gear wheel:
 - **35 Nm**
 - Angle tighten **120°**
 Tighten the camshaft gear:
 - **45 Nm**
 - Angle tighten **90°**
- 28 Check the gear backlash play measurement.
Repeat the above steps if flank play is not correct.
Tooth flank play **0.05-0.15 mm**
- 29 Apply an approximately 2 mm string of sealant P/N 1161231.
Install new gaskets.



P0037678

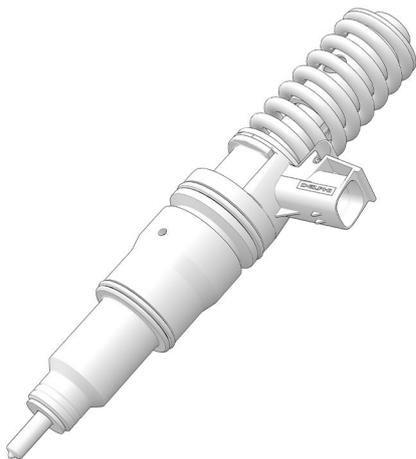
- 30 Install the timing gear casing with 2 screws, (loosely). The holes for the screws are oblong. Use tools to press down on the casing.

- 31 Tighten the screws in sequence. Tightening torque: **24 Nm**

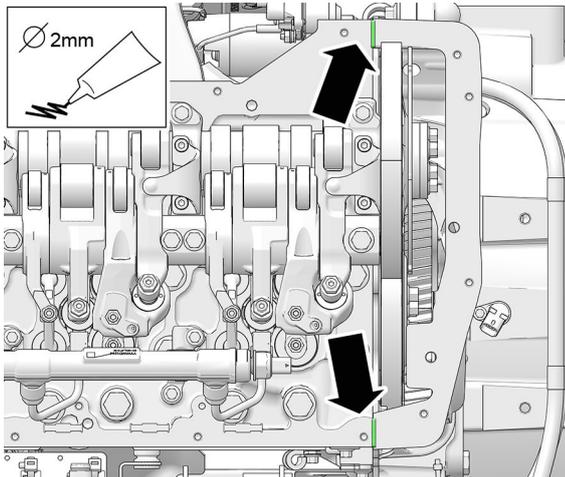


P0036496

- 32 Install injectors, refer to *Injector, Replace*, page 134.



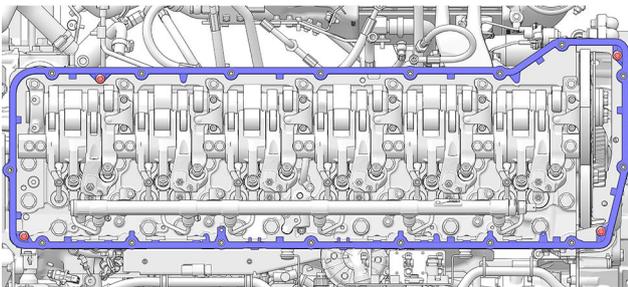
P0036478



P0038669

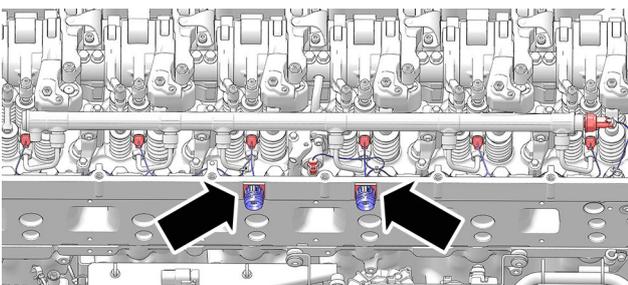
- 33 Apply a 2 mm string of sealant P/N 1161231 on the mating surface between the transmission casing and cylinder head.

- 34 Install the lower valve cover.
Tightening torque: **25 Nm**



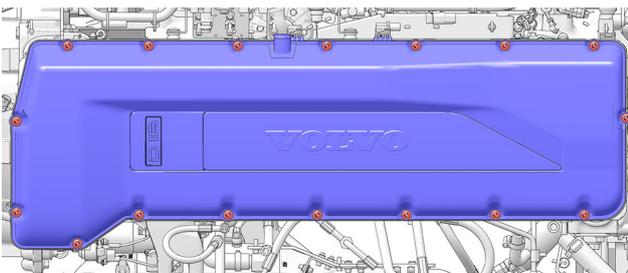
P0038661

- 35 Install:
- unit injector connectors
 - pressure transmitter connector
 - locking clips for wiring

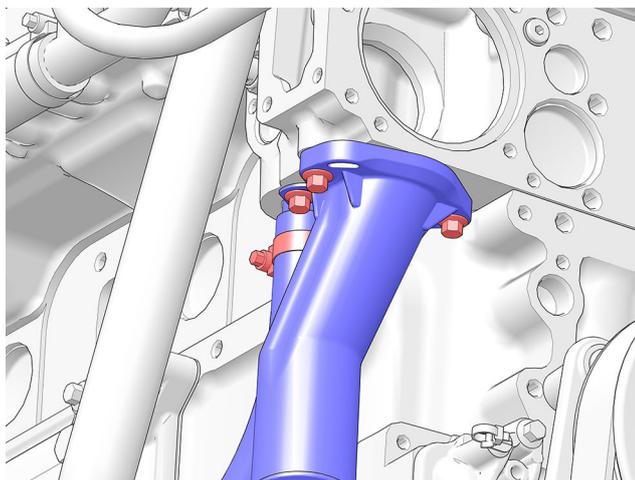


P0038660

- 36 Refit the valve cover.

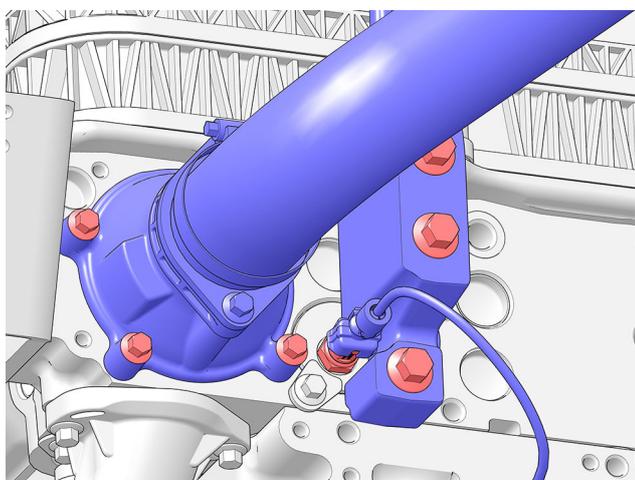


P0038659



P0038658

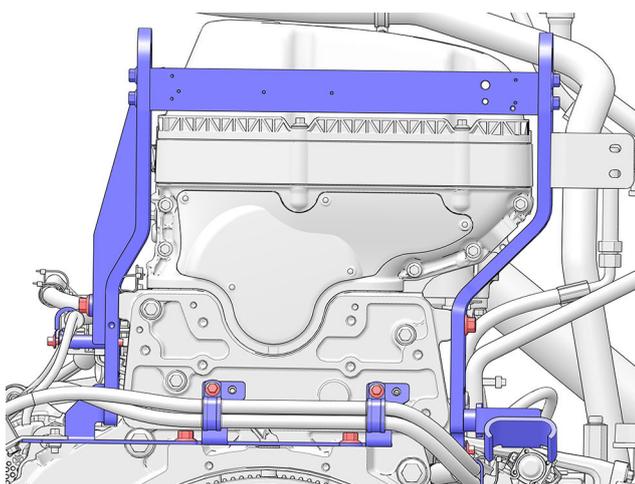
37 Install the water piping.



P0040329

38 Install:

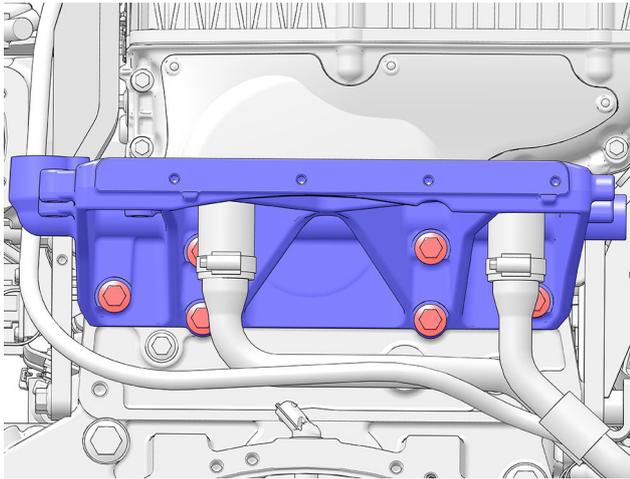
- thermostat with water pipe
- lifting eye



P0038656

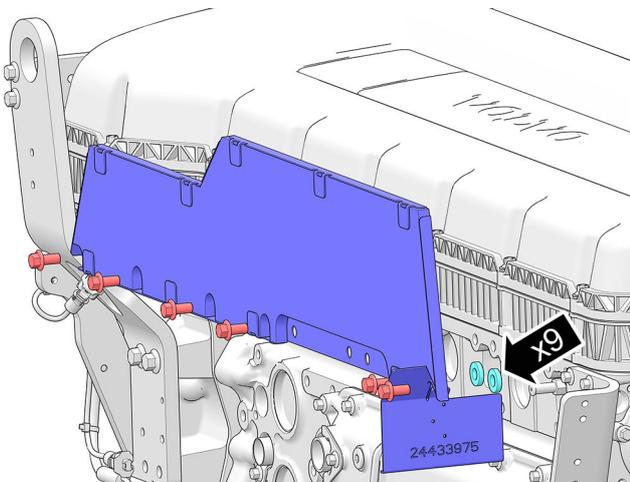
39 Install:

- rear lifting lugs
- cable bracket



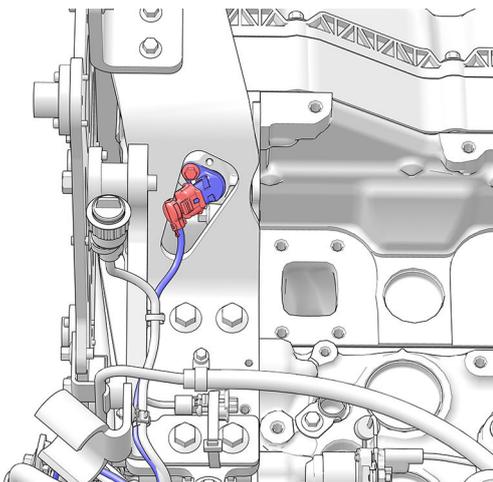
P0038655

40 Install bracket charge air cooler.



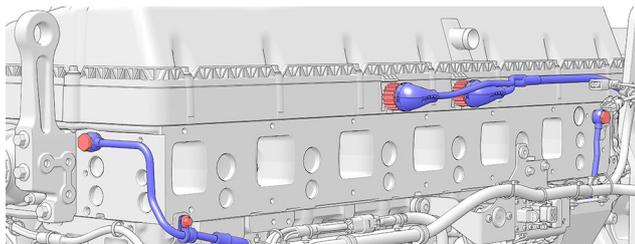
P0040330

41 Install the heat shield.



P0038652

42 Install the camshaft sensor.



P0037668

43 Install:

- connectors
- fuel piping

Reinstall:

- Manifold; refer to *Exhaust Manifold, Replace, page 152*.
- Inlet piping, refer to *Intake Manifold, Replace, page 154*.
- Rear charge air cooler, refer to *Charge Air Cooler, Lower, Replace, page 185*.
- Strut cooling package, refer to *Radiator Assembly, Change, page 172*.
- Fill coolant, refer to *26-0, Coolant, Replace*.
- Vent the fuel system; refer to *Fuel system, bleeding, page 126*.

Cylinder Head, Overhaul

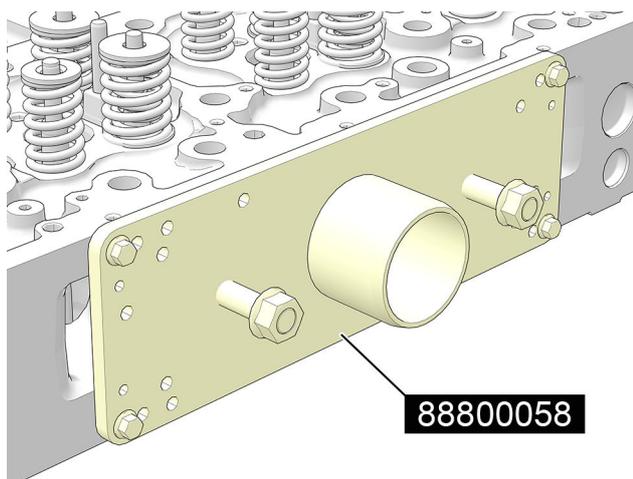
Tools:

9809726 Pneumatic hydraulic pump
 9809729 Hydraulic cylinder
 9990176 Press tool
 9990210 Valve spring compressor
 9992000 Handle
 9992671 Hydraulic cylinder
 9996159 Adapter
 9996180 Drift
 88800058 Stand
 88800064 Drift
 88800127 Drift
 88800147 Drift
 88800151 Drift
 88880175 Counterhold
 88880176 Guide pin
 88880199 Extractor
 88880200 Extractor

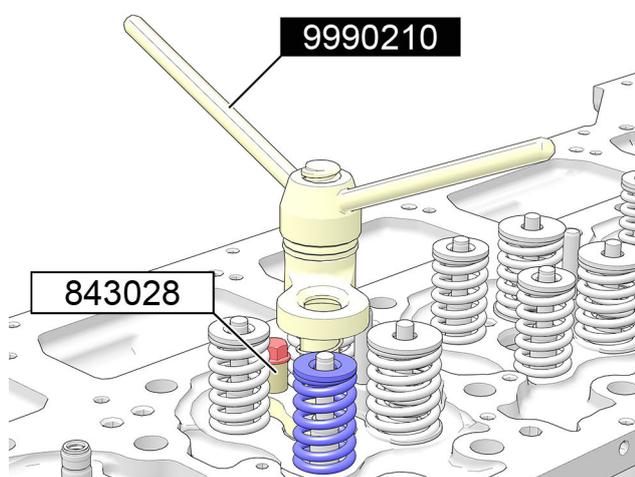
Tools:

Cylinder head removed, refer to *Cylinder Head, Replace, page 91*.

- 1 Install the fixture.



P0039695

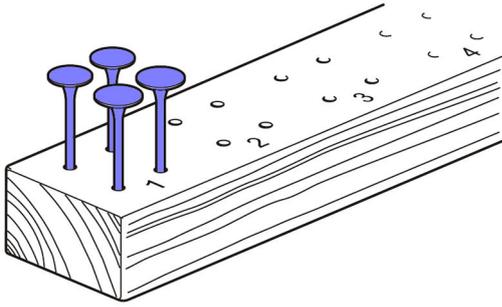


P0039702

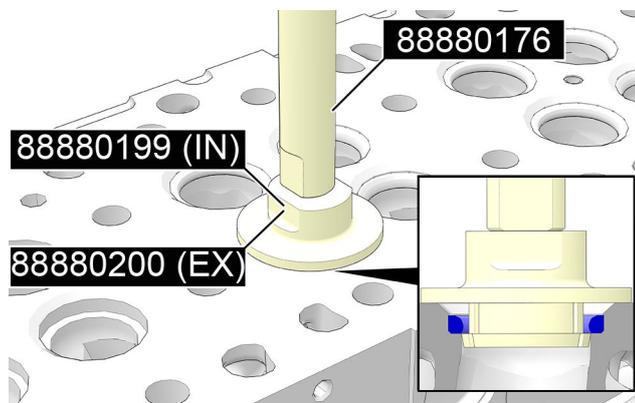
- 2 Fit the tool, using the appropriate spacer and screw for the unit injector fastening yoke. Remove:

- valve cotters (valve cones)
- spring washer and springs
- valves

- Place the valves in a stand, to allow reinstallation in their original positions.

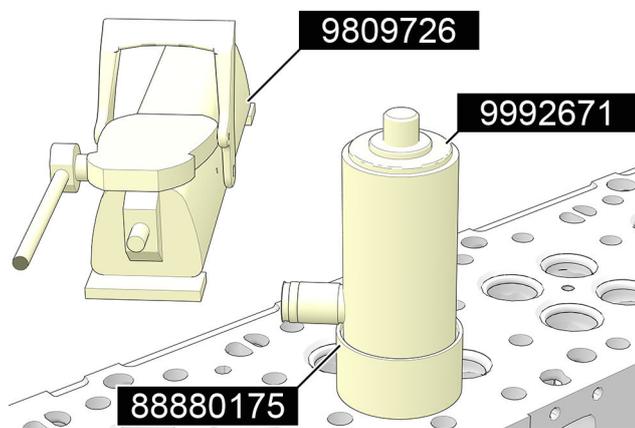


P0029360



- Hold the puller and tighten the shaft until the puller grazes the seat.

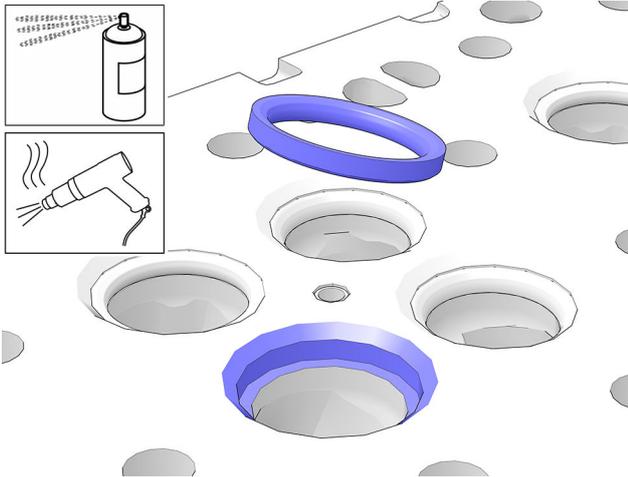
P0039704



- Insert the counterhold and screw the hydraulic cylinder into position. Pump until the valve seat detaches from the cylinder head.

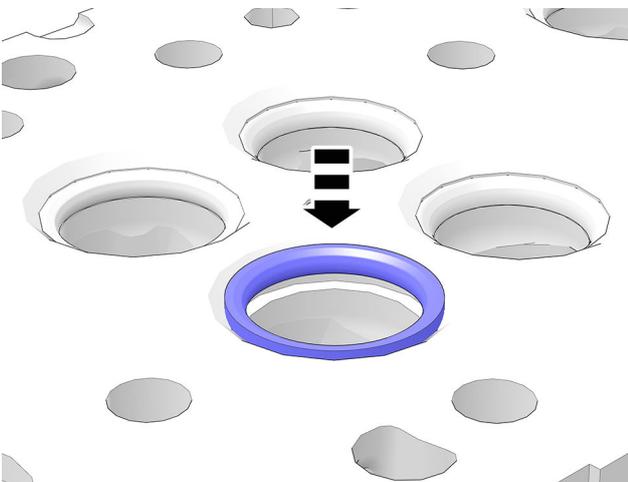
NOTICE! Stop pumping as soon as the seat is released so as not to damage the tool.

P0039705



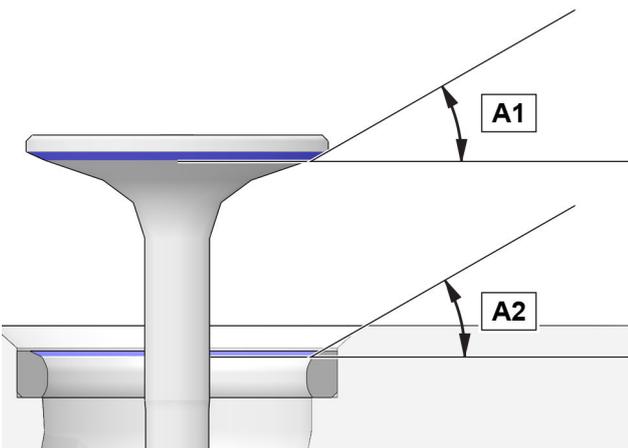
P0039696

- 6 Cool the valve seat and heat the seat location in the cylinder head.



P0039699

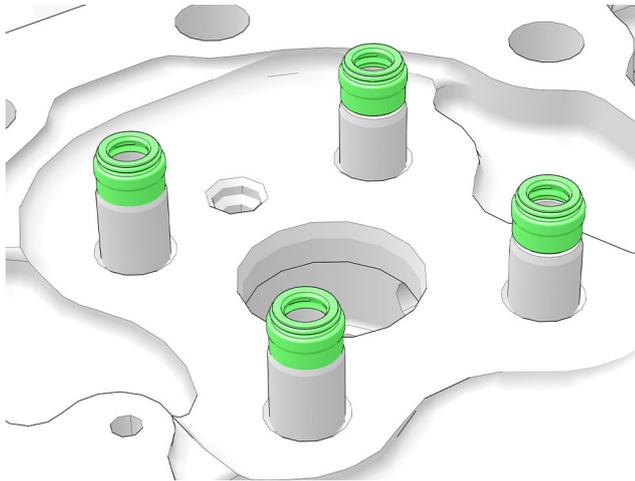
- 7 Tap the valve seat into place until it bottoms out in position.



P0029358

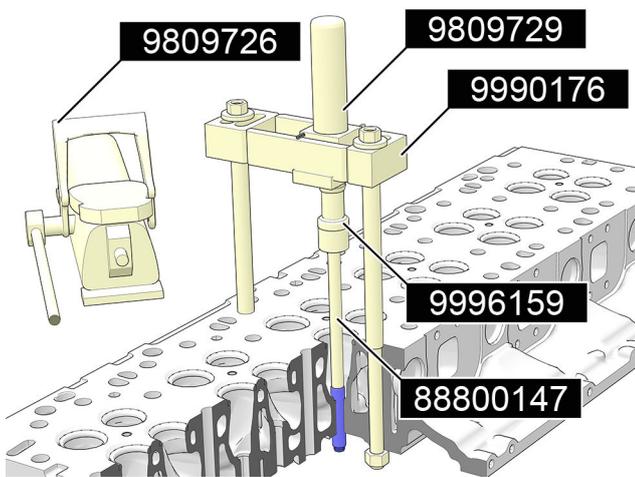
- 8 Grind valves and valve seats according to specification, refer to *Engine, page 32*.

NOTICE! Spare part valves are already machined, and do not need further grinding.



P0039701

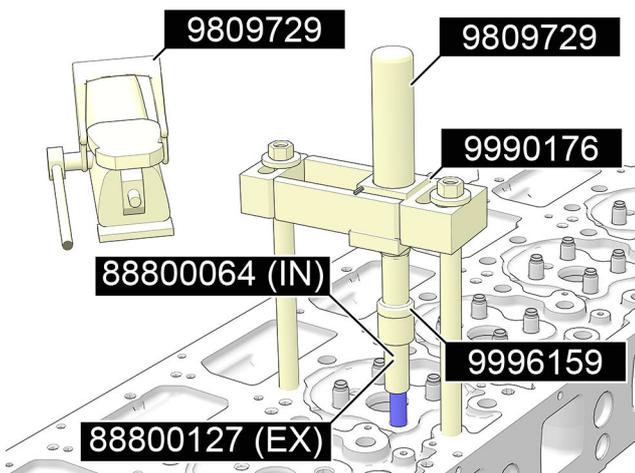
9 Remove the valve stem seals.



P0039697

10 Press out the valve guides.

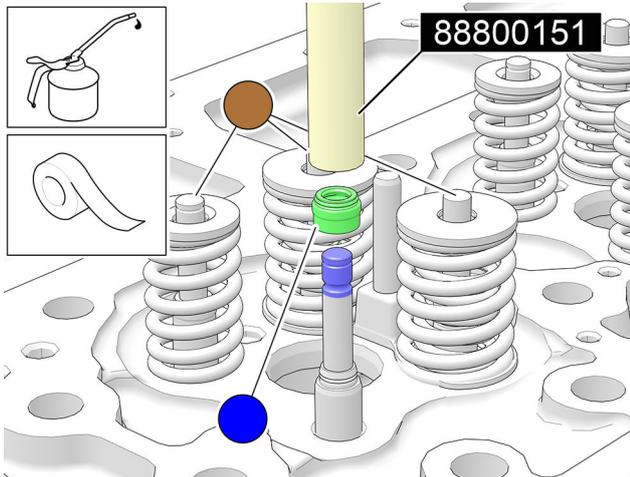
NOTICE! Use only nuts on tool 9990176.



P0039698

11 **NOTICE!** Oil the outside of the valve guides with engine oil before installation.

Press home new valve guides.

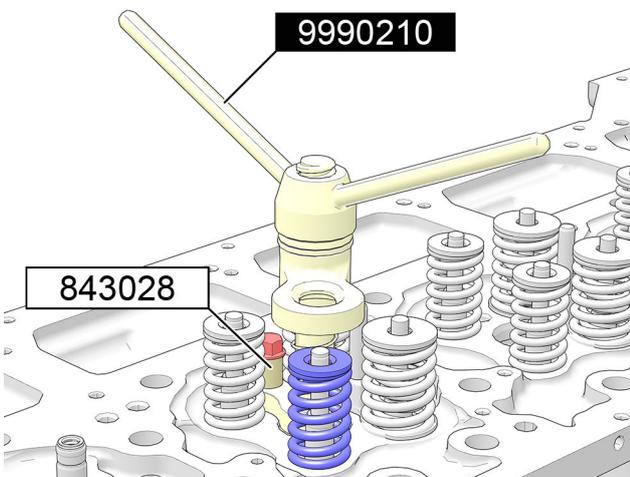


P0039706

- 12 Install a valve and tape the blue-marked area. Gently tap in new valve stem seal.

IMPORTANT:

Note the positioning of the seals.



P0039702

- 13 Install:

- spring and spring washer
- valve cotters (valve cones)

21-4 Valve Mechanism

Valves and Injectors, Adjustment

Tools:

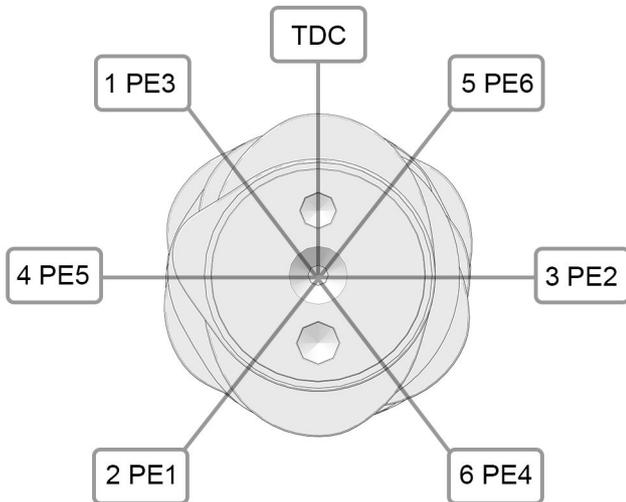
9993590 Rotation tool

- Valve cover removed

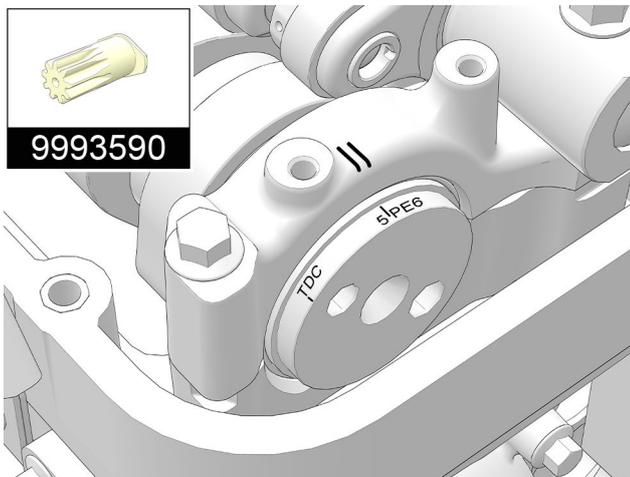
NOTICE! Markings 1 to 6 apply to the adjustment of intake valves.

PE1-PE6: Adjustment of exhaust valves and injectors.

NOTICE! It is important that the line marked on the camshaft is centered between the marks on the bearing cap when adjustment is carried out.

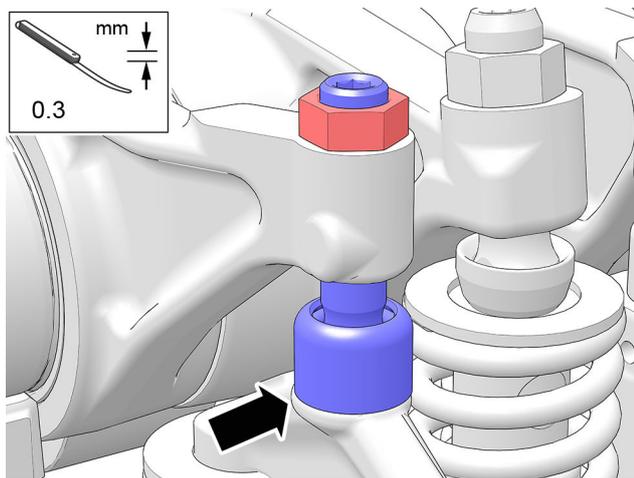


P0038991



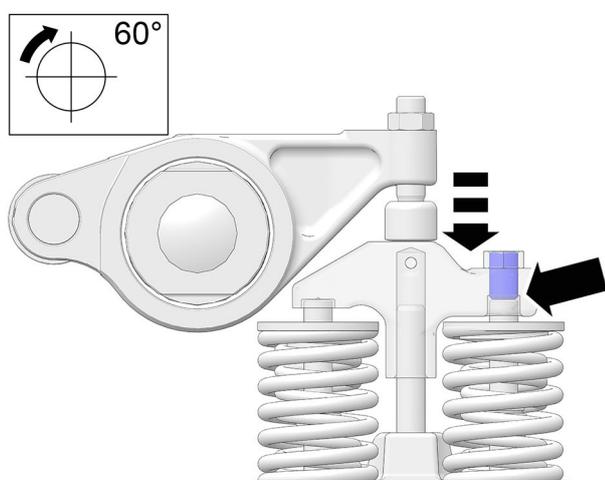
P0038985

- 1 Crank the engine in the direction of rotation to the next camshaft marking. In this case, the camshaft position indicates adjustment of:
5 = Inlet rocker arm cylinder 5.
PE6 = Exhaust and injector rocker arm, cylinder 6.



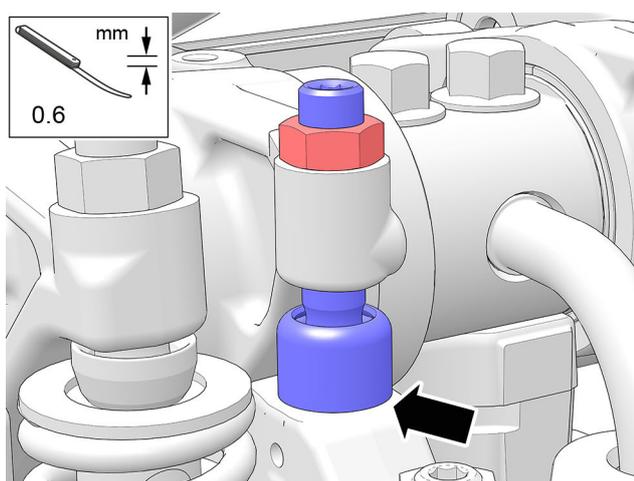
P0039732

- 2 Adjust the clearance of the intake valve to **0.3 mm**. Tighten the locknut according to the specification, refer to *Special Tightening Torques*, page 11.
- 3 Check the valve clearance.



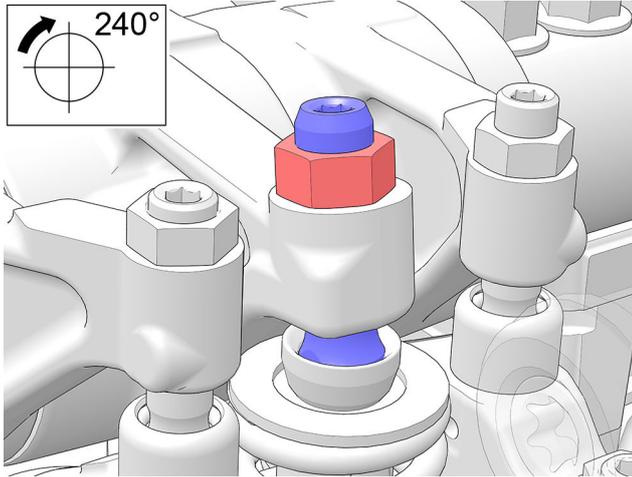
P0039733

- 4 Press the yoke down by hand as close to the adjusting screw as possible. Screw the adjustment screw on the valve yoke down so that it just touches the valve spindle, plus a further **60°**. Tighten the locknut according to the specification, refer to *Special Tightening Torques*, page 11.



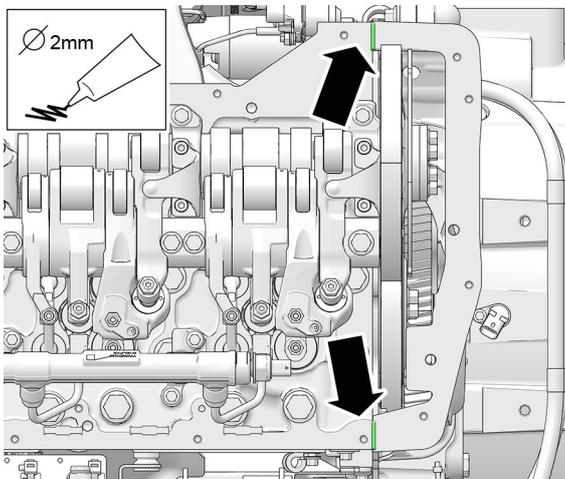
P0039730

- 5 Adjust the play of the exhaust valve to **0.6 mm**. Tighten the locknut according to the specification, refer to *Special Tightening Torques*, page 11.
- 6 Check the valve clearance.



P0039731

- 7 Adjust injector rocker arm pre-load by loosening the adjuster screw until a clearance is obtained on the injector.
Adjust the screw until the clearance disappears (by feel until the roller can no longer be turned). Tighten the adjusting screw a further **240°**.
Tighten the locknut according to the specification, refer to *Special Tightening Torques, page 11*.
Adjust the remaining valves and unit injectors as described above.



P0038669

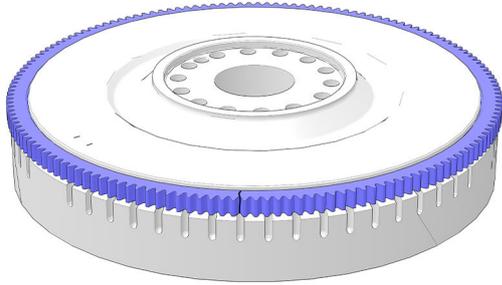
- 8 **NOTICE!** Apply two strands of sealant P/N 1161231 with a diameter of approx. 2 mm, refer to illustration.
- 9 Install the valve cover.

21-5 Timing Gears and Shaft

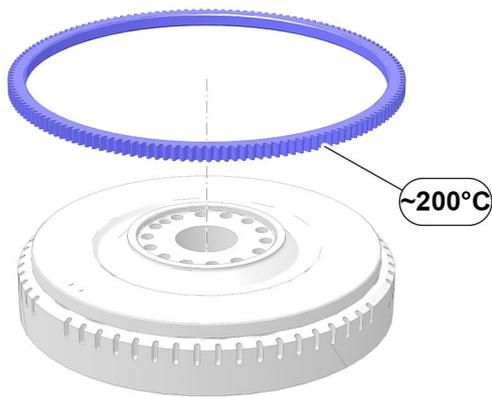
Gear Ring, Flywheel: Replace

Prerequisite flywheel removed.

- 1 Drill 1-2 holes in the gap between teeth on the ring gear.
Split the gear ring using a cold chisel.



P0028593



P0028594

- 2 Heat the gear ring.
Tap the gear ring into place using a copper drift.

21-6 Crank Mechanism

Crankshaft Seal, Replace (front)

SN2016120952 —

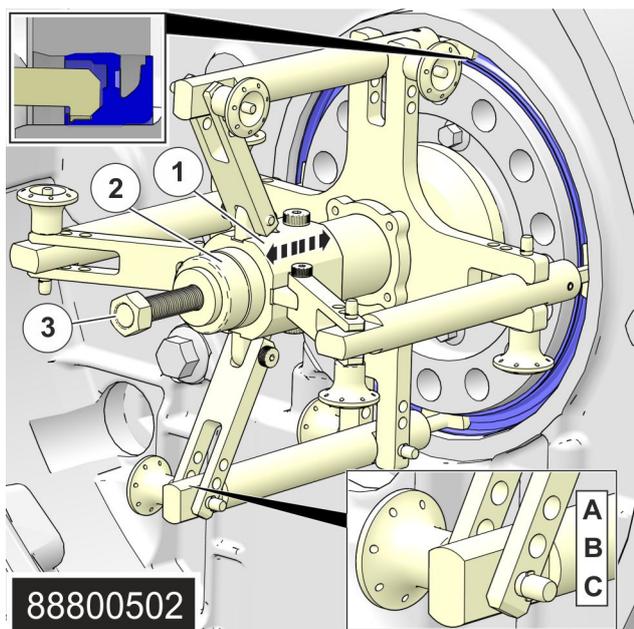
Tools:

88800501 Mounting tool

88800502 Puller

Removal

- 1 Adjust the arms on 88800501 Mounting tool and attach the tool.
Setting diameter: use A.
 - 1 Forward: The hooks release
Back: The hooks grip
 - 2 Tension nut
 - 3 Slowly pull the seal off.

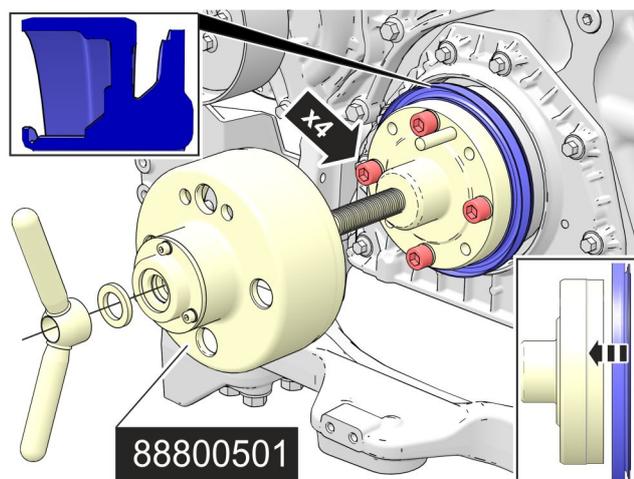


P0025163

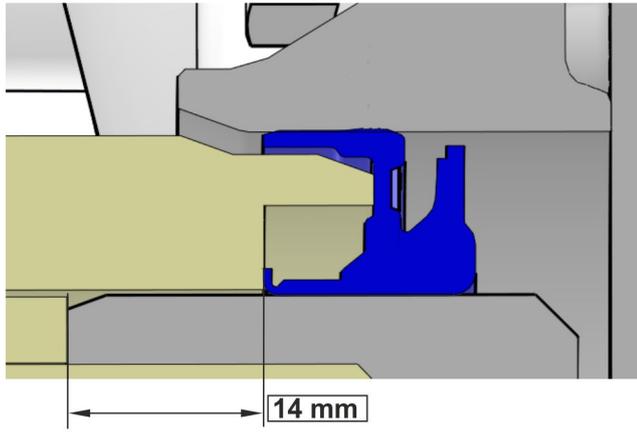
Installation

Important! The metal side of the seal ring must face inward.

- 2 Slide the seal ring onto the tool.
Screw the assembly tool with the seal onto the crankshaft.
Press the seal in until the cover touches the bottom. Hold in position for at least 3 seconds.



P0025195



- 3 Reference dimension for a correctly installed seal.

P0025197

Crankshaft Seal, Replace (rear)

SN 2016118293 –

Tools:

88800502 Puller

88800503 Mounting tool

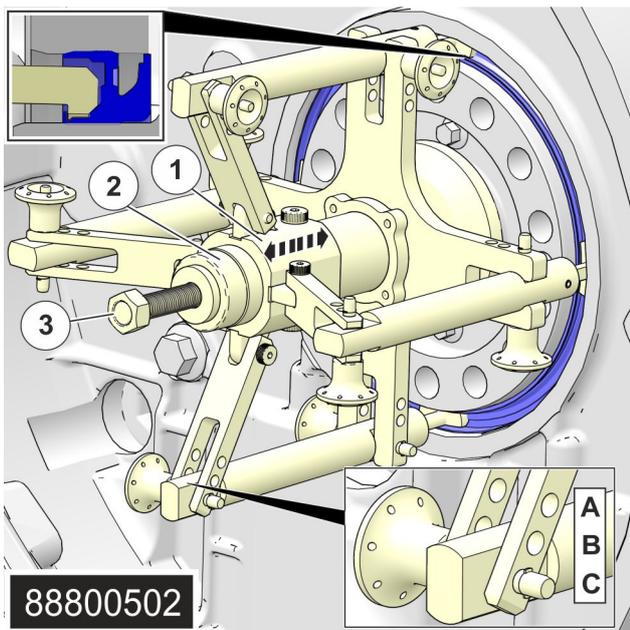
9990166 Mounting tool

Removal

- 1 Adjust the arms on 88800502 Puller and attach the tool.

Setting diameter: use C.

- 1 Forward: The hooks release
Back: The hooks grip
- 2 Tension nut
- 3 Slowly pull the seal off.

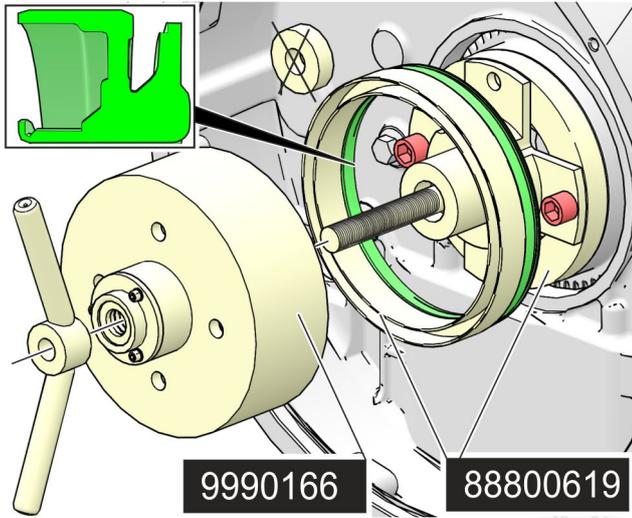


P0025163

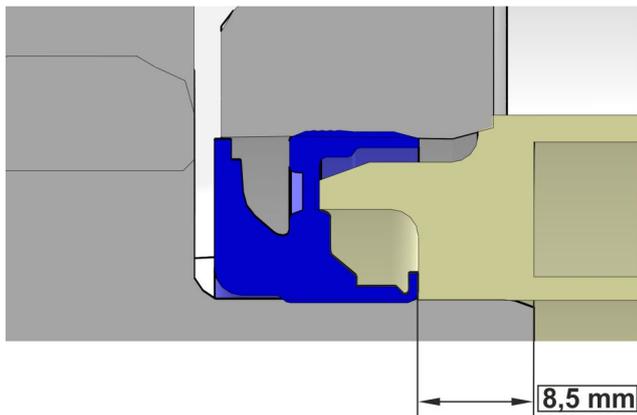
Installation

Important! The metal side of the seal ring must face inward.

- 2 Slide the seal ring onto the tool.
Screw the assembly tool with the seal onto the crankshaft.
Press the seal in until the cover touches the bottom. Hold in position for at least 3 seconds.



P0025171



P0025172

- 3 Reference dimensions for a correctly installed seal.

22-0 Lubricating and Oil System, General

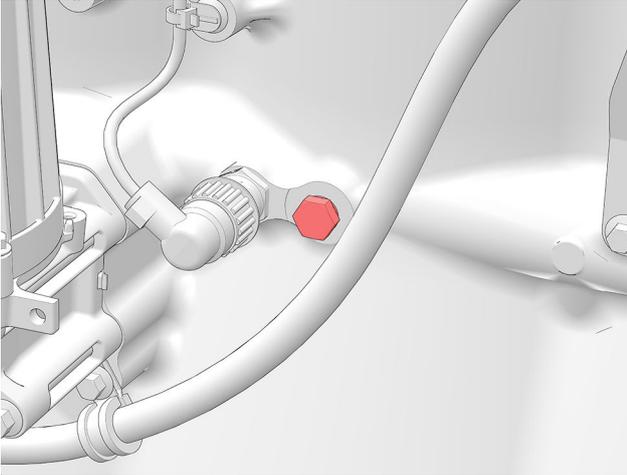
Engine Oil Pressure, Check

Tools:

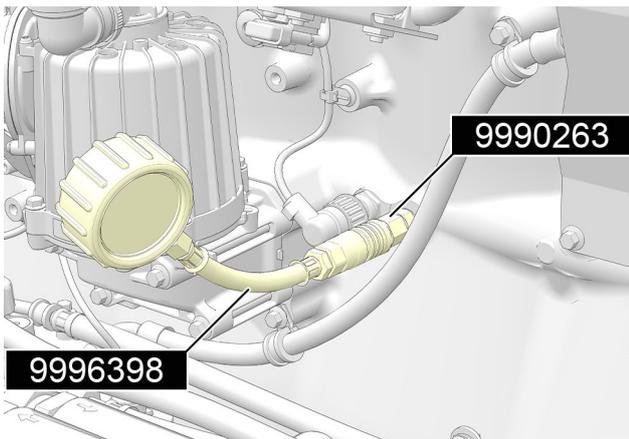
9990263 Nipple

9996398 Manometer

- 1 Remove the plug.



P0039468



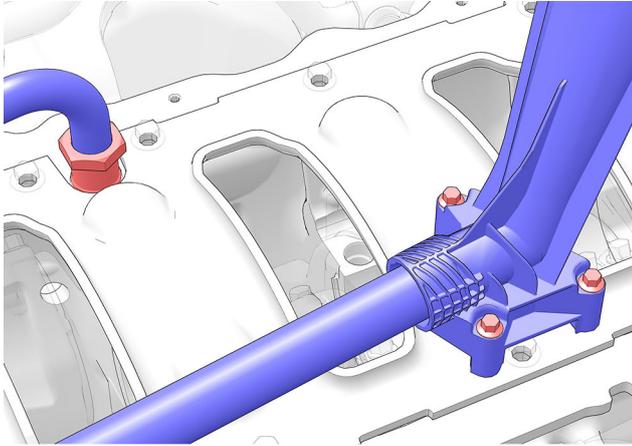
P0039469

- 2 Install:
 - nipple
 - manometer
- 3 Start the engine and check the oil pressure , refer to *Engine, page 32*.
- 4 Remove the tools, install the plug with a new sealing washer.

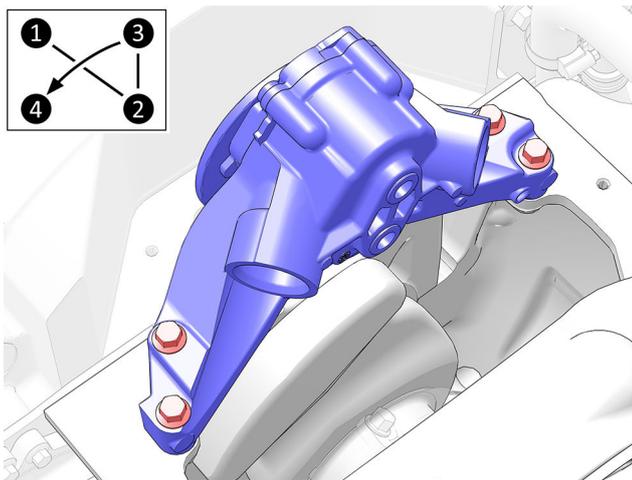
22-1 Oil pump and Line

Lube oil pump, Replace

- Engine oil drained
 - Oil pan removed
- 1 Remove:
 - suction pipe with oil strainer
 - pressure pipe

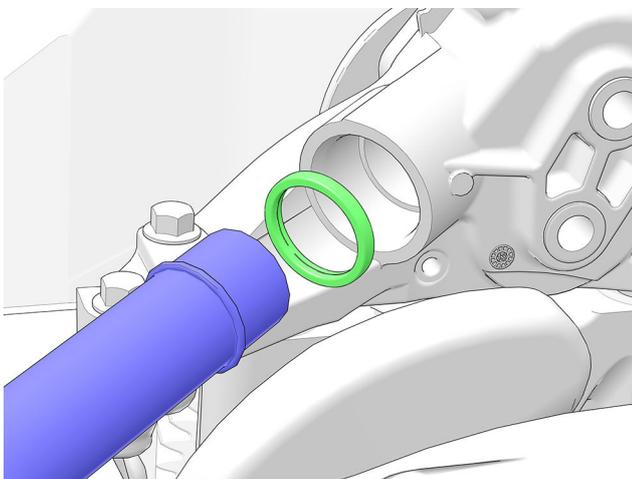


P0038696



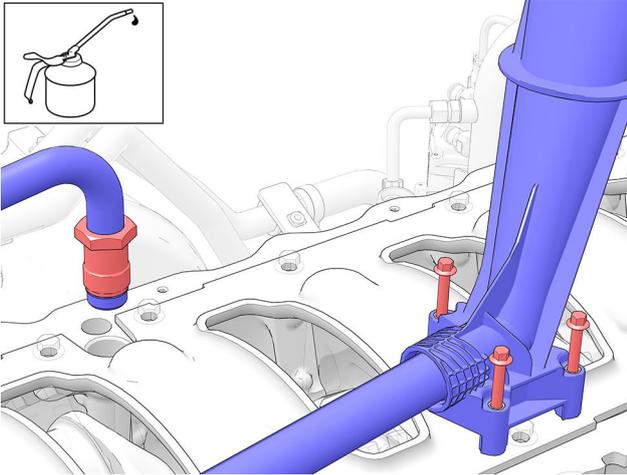
P0038695

- 2 Replace the oil pump.
Step 1: **35 Nm**
Step 2: **90°**



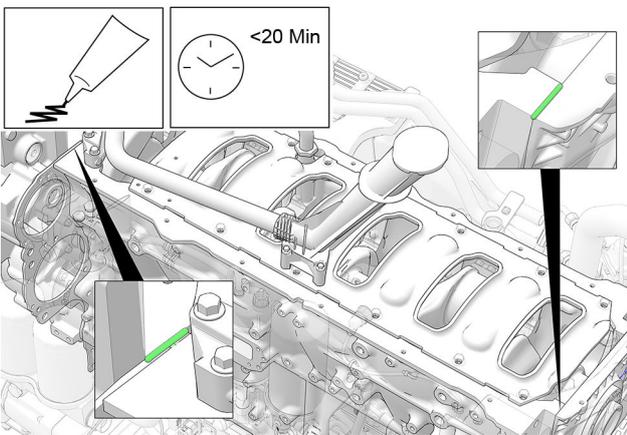
P0038697

- 3 Install the suction pipes and pressure pipes in the pump with new seals.



P0038698

- 4 Oil the sleeve and nipple of the pressure pipe. Tighten the oil strainer and pressure pipe. Tightening torque, pressure piping:
New parts: **180°**
Reused parts: **200 Nm**



P0038699

- 5 Scrape off any sealant residue.
- 6 Apply sealant P/N 1161231 to the dividing surfaces between the front cover and the engine block and the timing gear cover and engine block, respectively.

Install the oil sump. Fill engine oil.

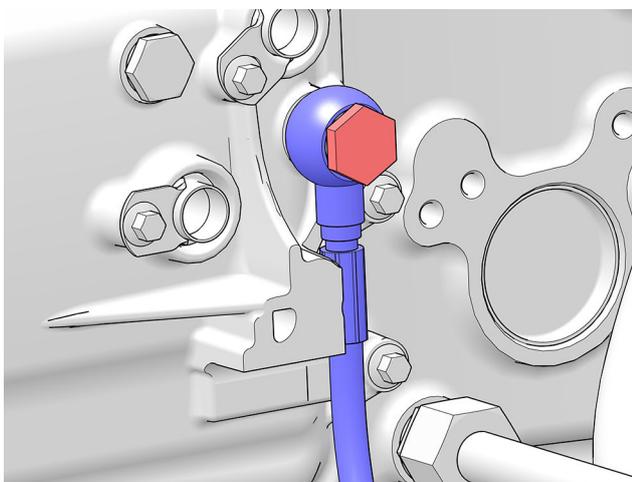
22-3 Oil cooler

Oil Cooler, Replace

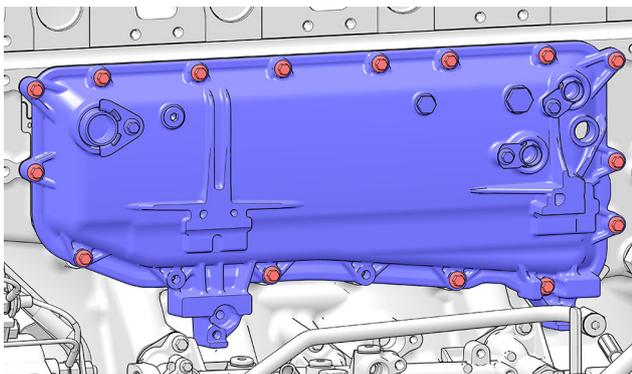
- Cooling system drained; refer to 26-0, *Draining the Cooling System*.
- High-pressure turbo removed, refer to *High-Pressure Turbo, Change, page 161*.
- Low-pressure turbo removed, refer to *Low-Pressure Turbo, Replace, page 157*.
- Charge air cooler removed; refer to *Charge Air Cooler, Lower, Replace, page 185*.
- Exhaust manifold removed; refer to *Exhaust Manifold, Replace, page 152*.

- 1 Remove coolant piping.

NOTICE! Be prepared to gather up fluid.

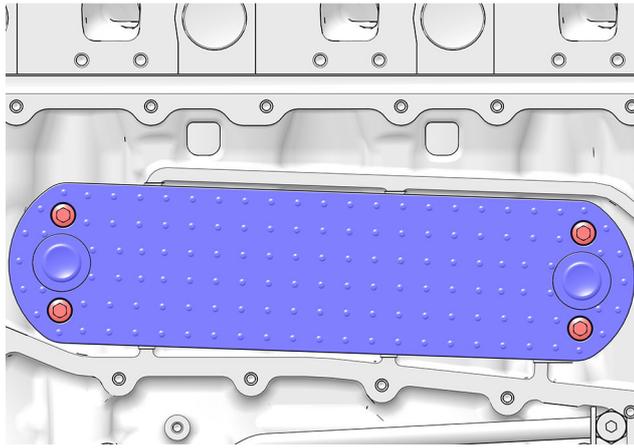


P0039797



P0039798

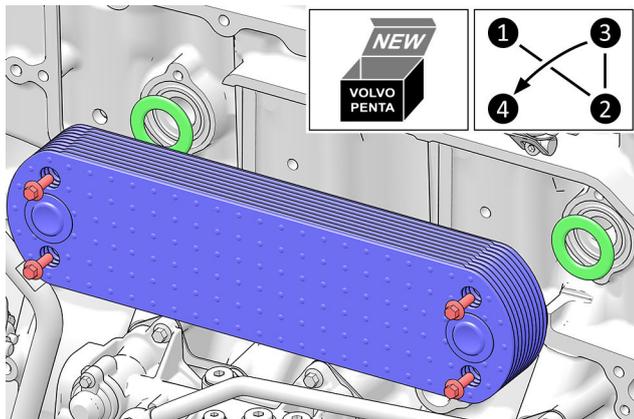
- 2 Remove the oil cooler cover.



P0039799

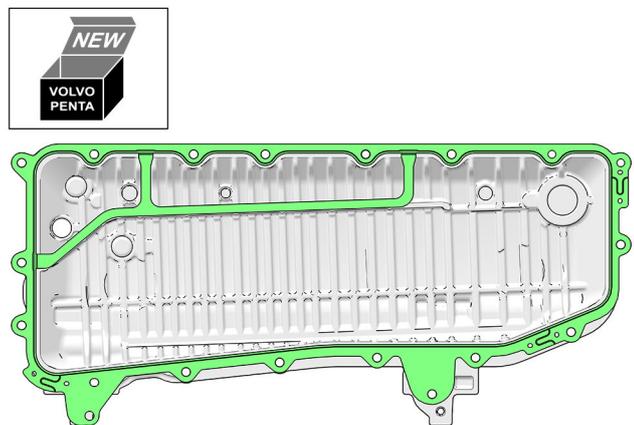
3 Remove the oil cooler.

NOTICE! Be prepared to gather up fluid.



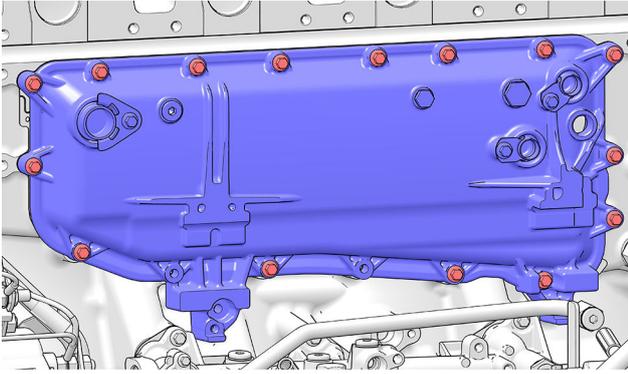
P0039800

4 Install the oil cooler with new seals, see *Special Tightening Torques*, page 11.



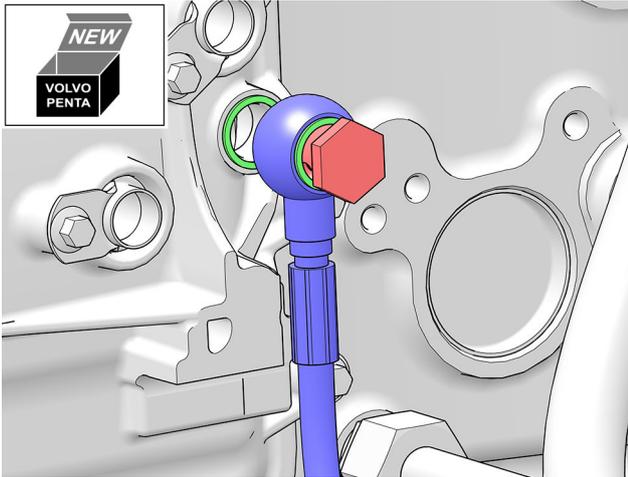
P0039801

5 Install a new coolant pump seal.



P0039798

- 6 Install the oil cooler cover, refer to *Special Tightening Torques*, page 11.



P0039802

- 7 Install the coolant piping.

23-0 Fuel System, General

Fuel system, bleeding

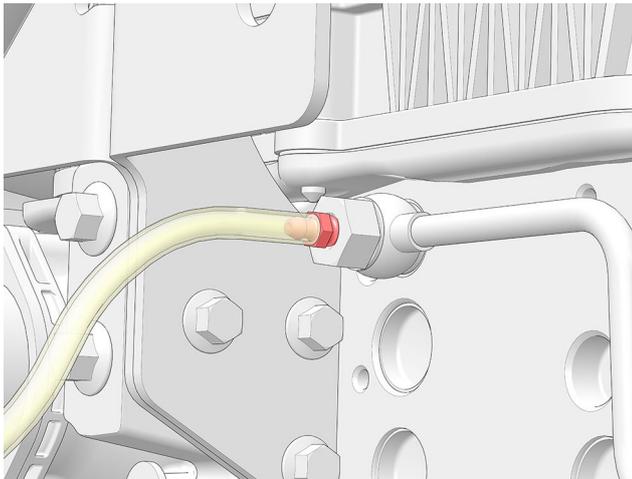
IMPORTANT:

Working with the fuel system requires special cleanliness.

Clean thoroughly before removal.

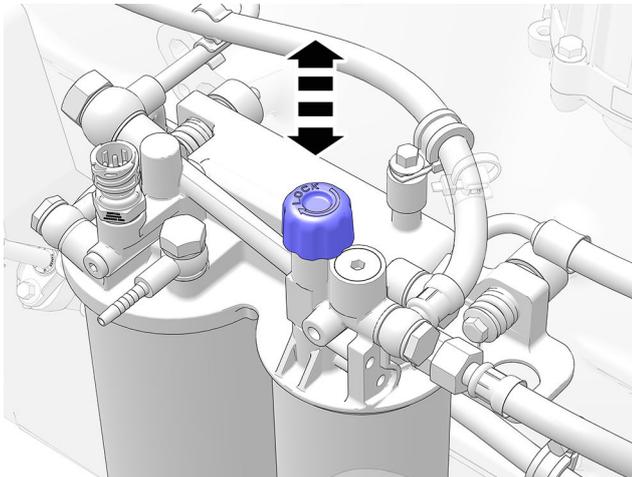
CAUTION!

The fuel system may be under pressure. When working on the fuel system, undo a closed system at the first point with caution.



P0039457

- 1 Connect a hose to the cylinder head fuel return line.
- 2 Open the venting nipple.



P0039234

- 3 Operate the hand pump until fuel without air bubbles comes out from the hose.
- 4 Tighten the air nipple.
Tightening torque: **3.5 Nm**
- 5 Run the engine at raised idle for about 10 minutes.

Draining, Fuel Duct in Cylinder Head

IMPORTANT:

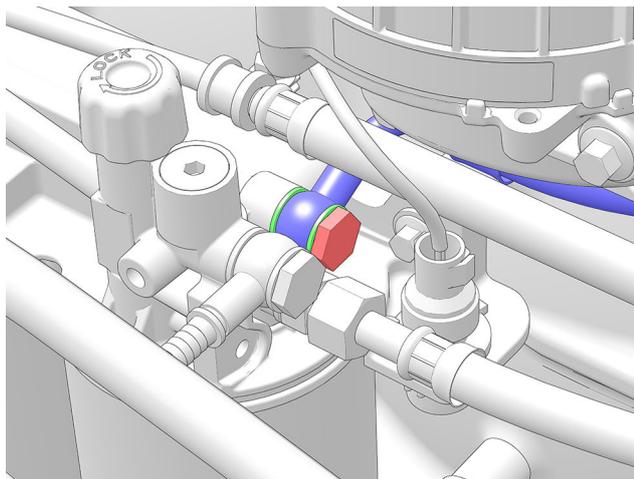
Working with the fuel system requires special cleanliness.

Clean thoroughly before removal.

CAUTION!

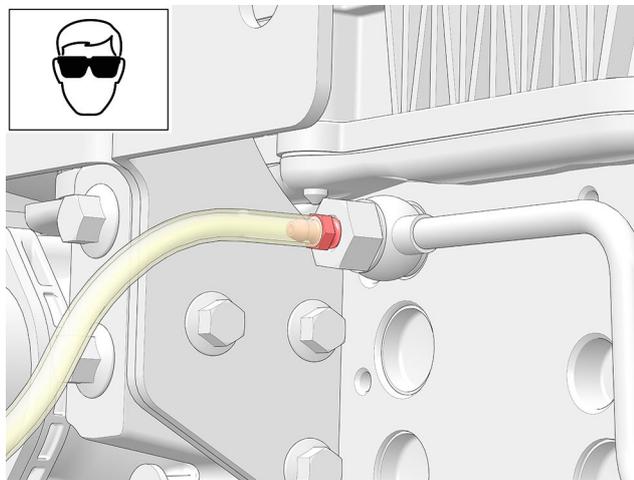
The fuel system may be under pressure. When working on the fuel system, undo a closed system at the first point with caution.

- 1 Close the fuel tap.
Disconnect the fuel connection between the cylinder head and filter housing and place the open connection in a vessel.



P0039460

- 2 Put a hose on the venting nipple.
- 3 Open the nipple and blow the fuel through the duct.
- 4 Install the venting nipple.
Tightening torque **3.5 Nm**
- 5 Install the fuel connection.



P0039459

Check and Fault Trace

Fuel Feed Pressure, Check

Tools:

Tools:

9996398 Manometer

9998494 Hose

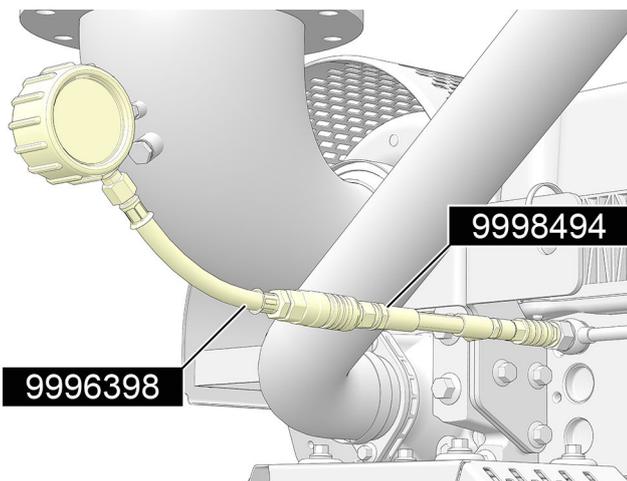
IMPORTANT:

Working with the fuel system requires special cleanliness.

Clean thoroughly before removal.

CAUTION!

The fuel system may be under pressure. When working on the fuel system, undo a closed system at the first point with caution.



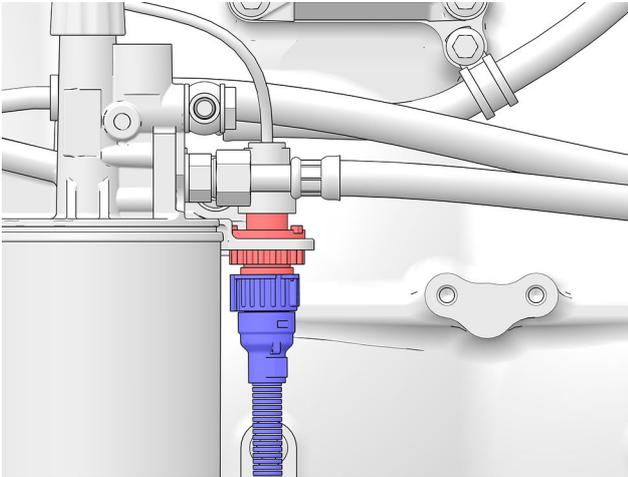
P0039458

- 1 Close the venting nipple.
Install the nipple belonging to the hose.
- 2 Install:
 - hose
 - manometer
- 3 Start the engine and check the fuel pressure ,
refer to *Engine, page 32*.
- 4 Remove the tools.
Install the venting nipple.

23-3 Fuel Feed Pump and Filter

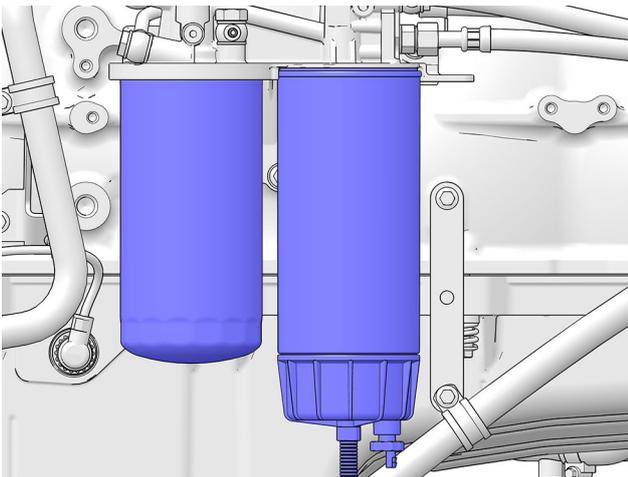
Fuel Filter Bracket, Change

- 1 Close the fuel tap.
- 2 Remove the connector to the water sensor.



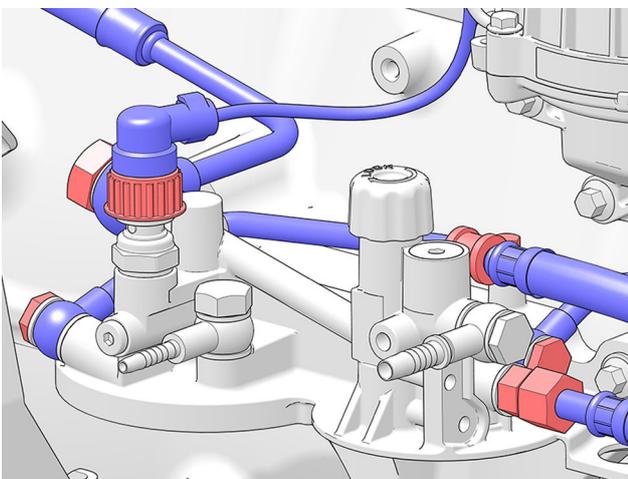
P0039471

- 3 Remove the fuel filter.

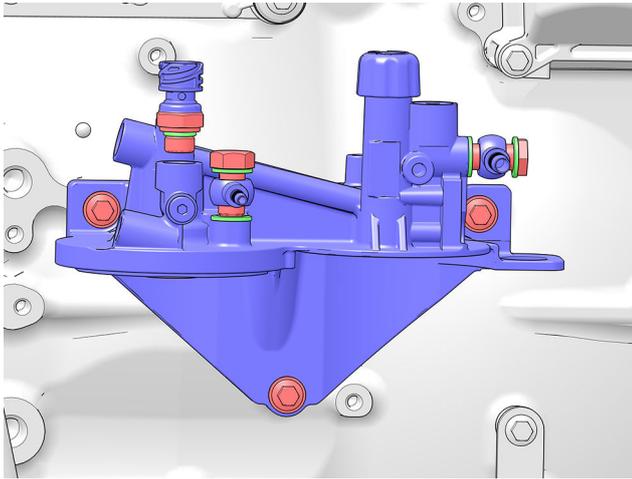


P0039472

- 4 Remove:
 - fuel piping
 - pressure transmitter connector
 - overflow valve

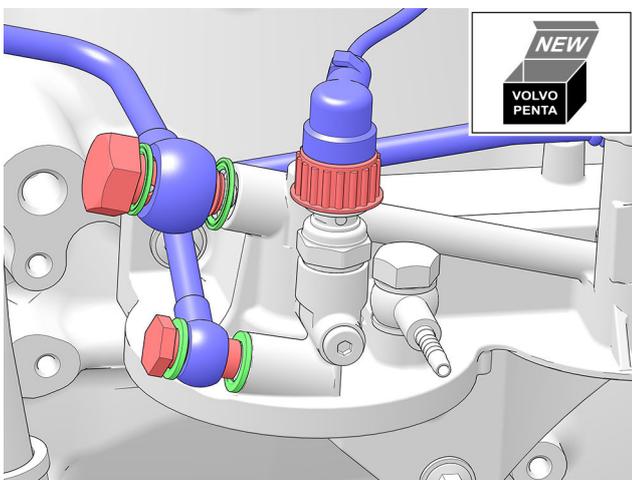


P0039473



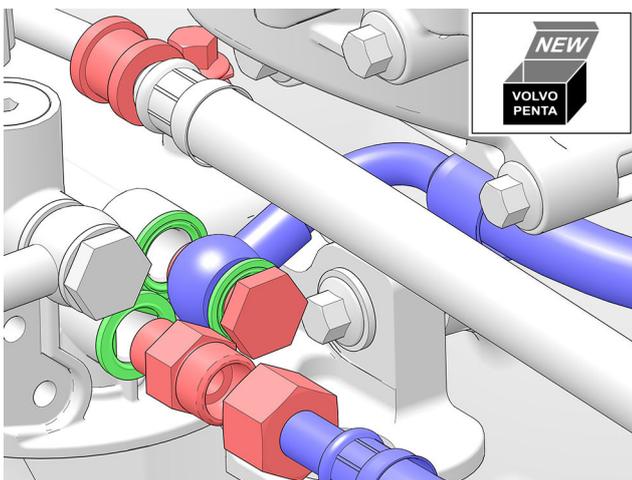
P0039474

- 5 Fuel filter bracket.
Move components to the new console.



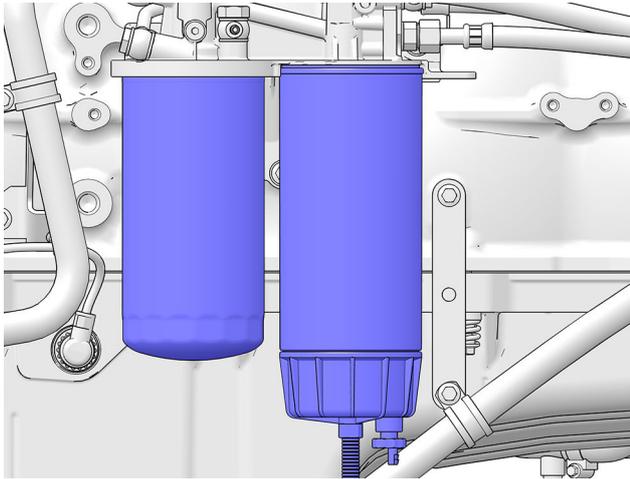
P0039475

- 6 Install:
- pressure transmitter connector
 - fuel piping
 - overflow valve



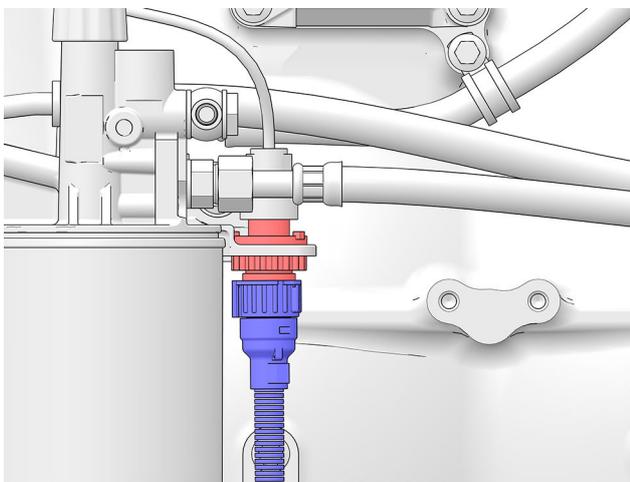
P0039476

- 7 Install fuel pipes.



P0039472

8 Install fuel filters.



P0039471

9 Install the water sensor plug.

10 Open the fuel tap

Fuel Feed Pump, Replace

IMPORTANT:

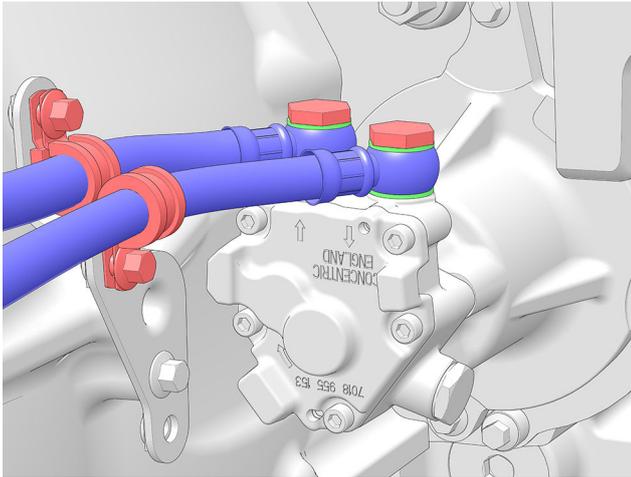
Working with the fuel system requires special cleanliness.

CAUTION!

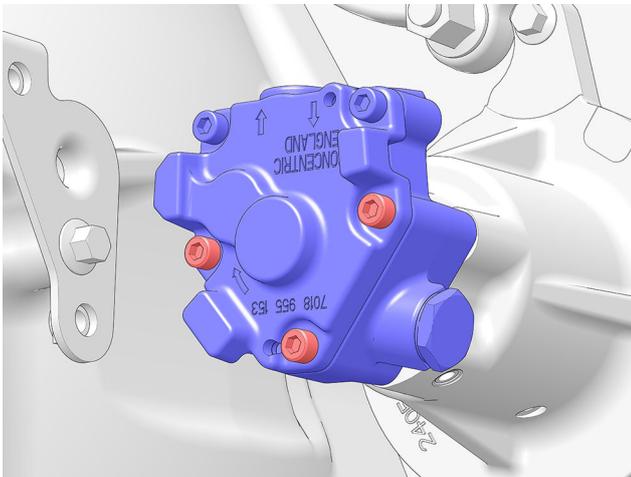
The fuel system may be under pressure. When working on the fuel system, undo a closed system at the first point with caution.

- 1 Close the fuel tap.
- 2 Remove the connections.

NOTICE! Be prepared to gather up fluid.

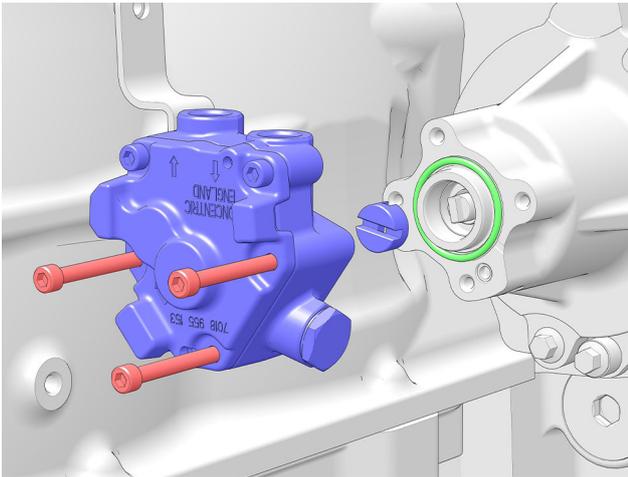


P0039756



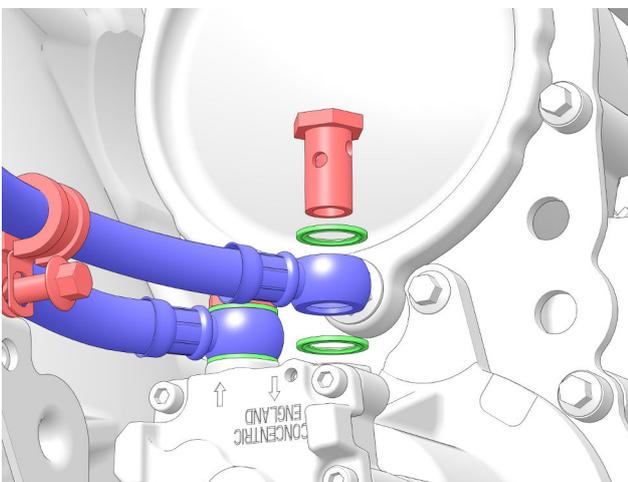
P0039757

- 3 Remove the pump.



P0039758

- 4 Check the connecting link.
Install the pump.
Tightening torque **10 Nm**.



P0039755

- 5 Attach the connections with new sealing washers.
- 6 Open the fuel tap.
Vent the fuel system; refer to 23-3, *Fuel system, bleeding*.

23-7 Injectors and Delivery Pipes

Injector, Replace

Tools:

9990006 Puller
 9990013 Slide hammer
 9998249 Protective sleeve
 88800352 Lifting tool
 88800474 Wrench
 88800550 Cleaning kit

IMPORTANT:

Working with the fuel system requires special cleanliness.

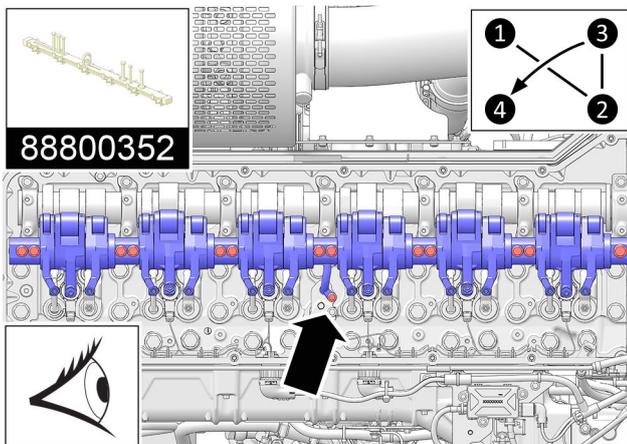
Clean thoroughly before removing.
 Install safety plugs in open connections.

CAUTION!

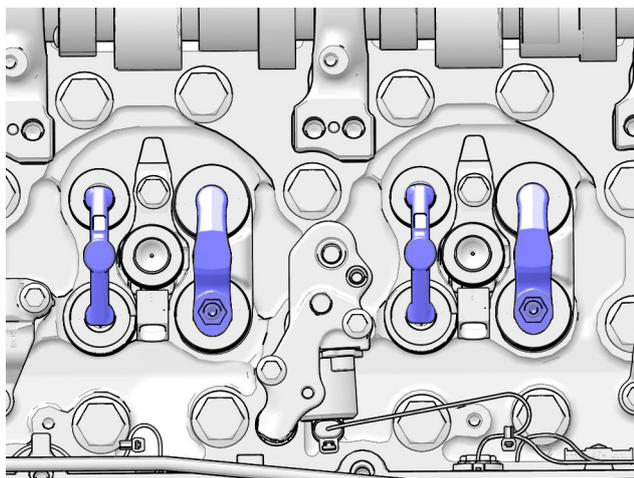
The fuel system may be under pressure.
 When working on the fuel system, undo a closed system at the first point with caution.

- Valve cover removed
- Common rail and pressure piping removed, refer to *Common Rail, Replace, page 144*
- Empty the cylinder head fuel channels, refer to *Draining, Fuel Duct in Cylinder Head, page 127*

- 1 Remove the screws, loosen them evenly and gradually.
 Position the tool.
 Remove the rocker arm bridge and piping.

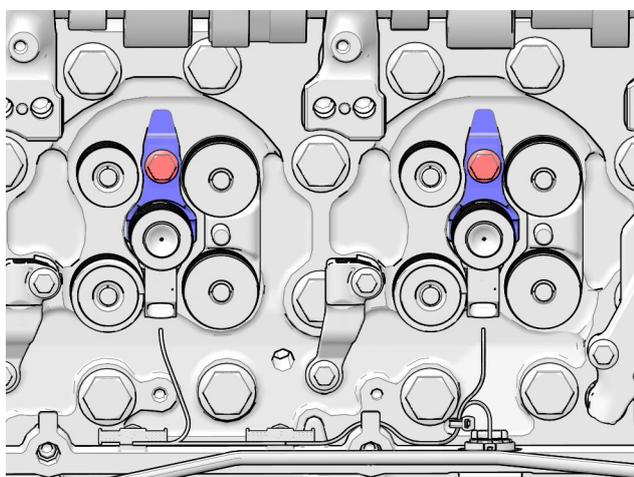


P0039941



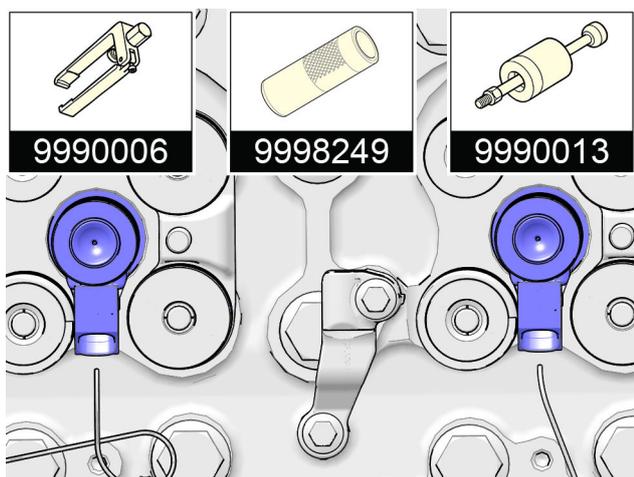
P0031713

- 2 Remove the valve yoke, and note the positioning, so that it can be refitted in the same position.



P0031709

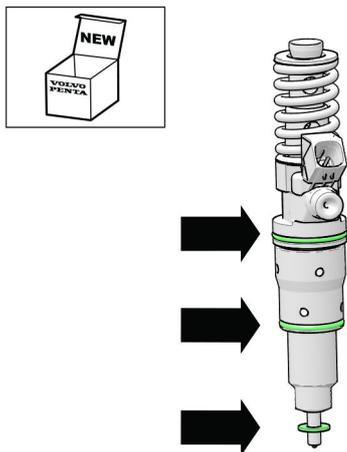
- 3 Remove the yoke.



P0031710

- 4 Position the tool.
Remove the injector.
Put on the protective plug.

NOTICE! Mark the injector locations for re-installation.



P0031708

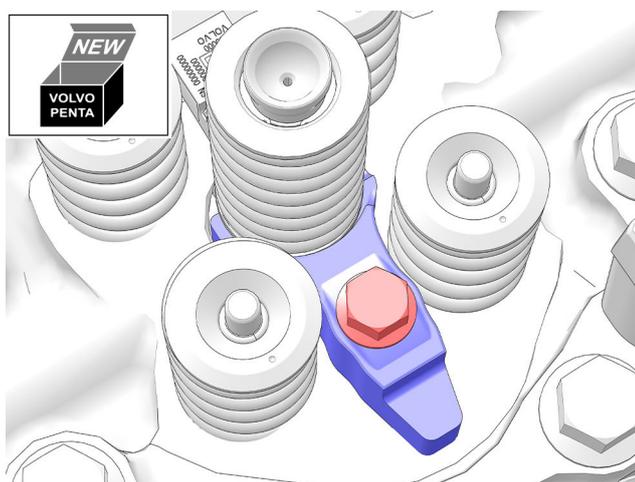
5 Insert new seals, lubricate with engine oil.

NOTICE! When replacing an injector, a new injector code must be programmed into the control unit. Make a note of the code before installing the injector as it can be difficult to see.



P0031704

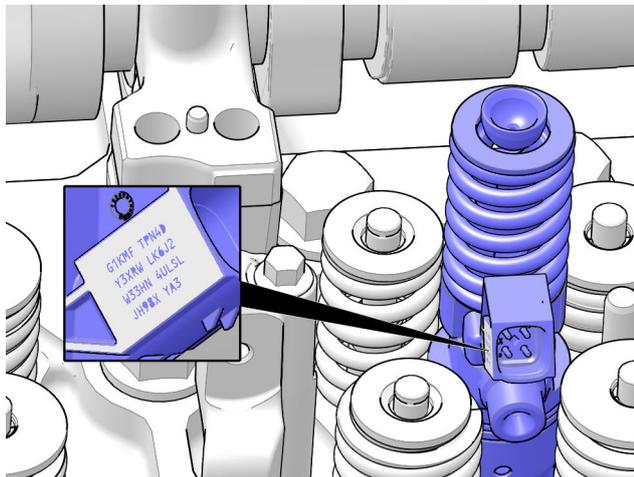
6 Clean the socket.



P0031705

7 Position the injector, tightening as follows:

- 1 **20 Nm**
- 2 **180°**
- 3 Loosen the screw
- 4 **25 Nm**
- 5 **90°**

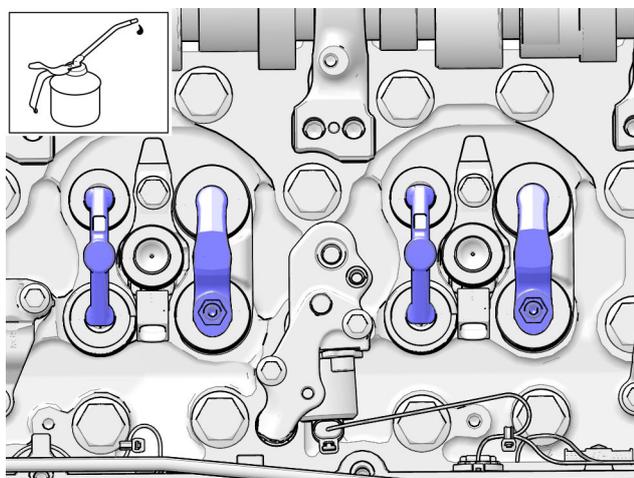


P0031707

8



NOTICE! When replacing an injector, a new injector code must be programmed into the control unit. The code is on the injector.



P0031714

9

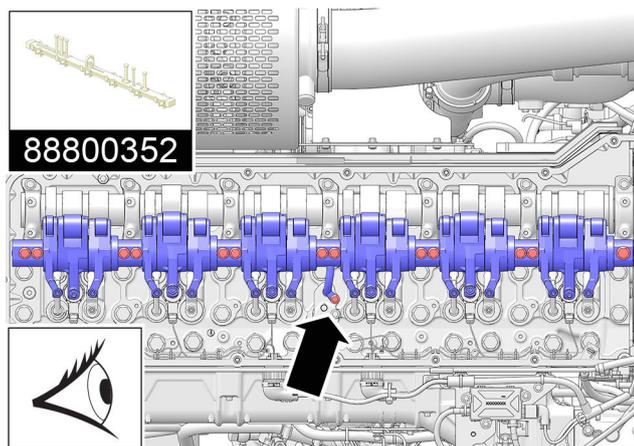
Install the valve yokes.
Lubricate the valve yokes and camshaft rocks with engine oil.



10

Always replace with a new pipe with new seals.

P0031711



P0039942

- 11 Attach the rocker arm bridge and piping at the same time.
For tightening torque, refer to *Special Tightening Torques*, page 11.

Install:

- Common rail and pressure pipes, refer to *Common Rail, Replace*, page 144
- Valve cover

Sleeve for unit injector, replace

Tools:

9998250 Sealing ring
 9998251 Protection plug
 88800387 Puller
 88800460 Sleeve
 88800513 Drift
 88800550 Cleaning kit

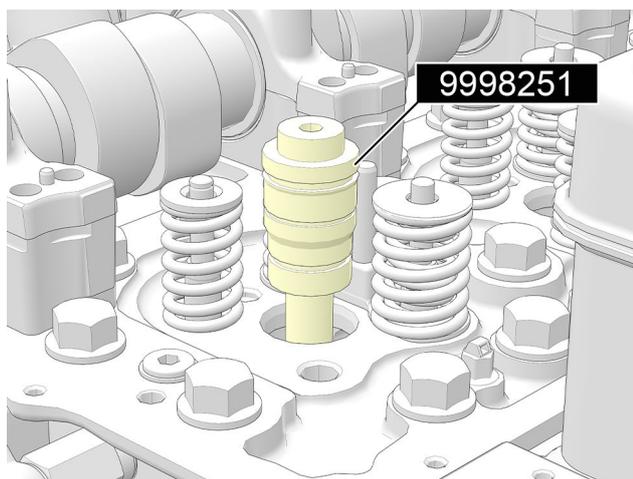
- Valve cover removed
- Rocker arm bridge and unit injector removed, refer to *Injector, Replace, page 134*.
- Cooling system, emptied.

IMPORTANT! Working with the fuel system requests special cleanliness.

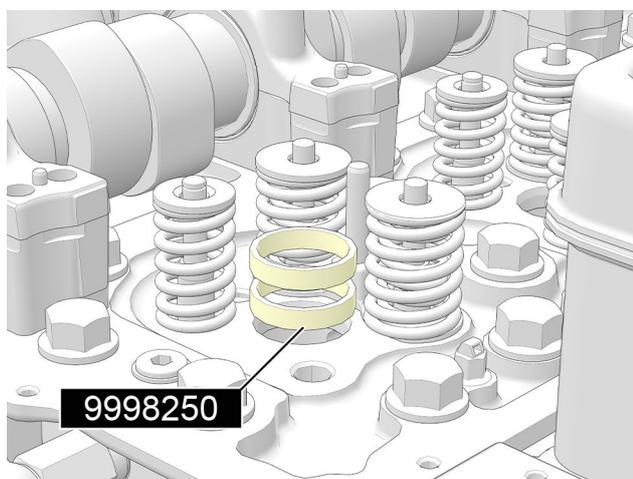
IMPORTANT! Install safety plugs in open connections.

CAUTION! The fuel system may be pressurized. Exercise caution when disconnecting the first location in a closed system.

- 1 Remove any protective plugs.

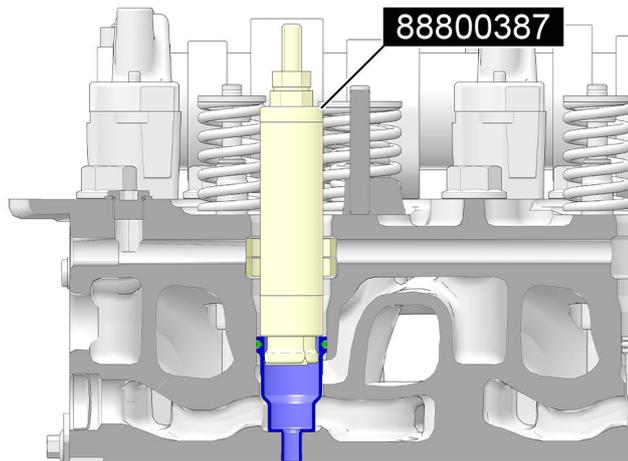


P0036666



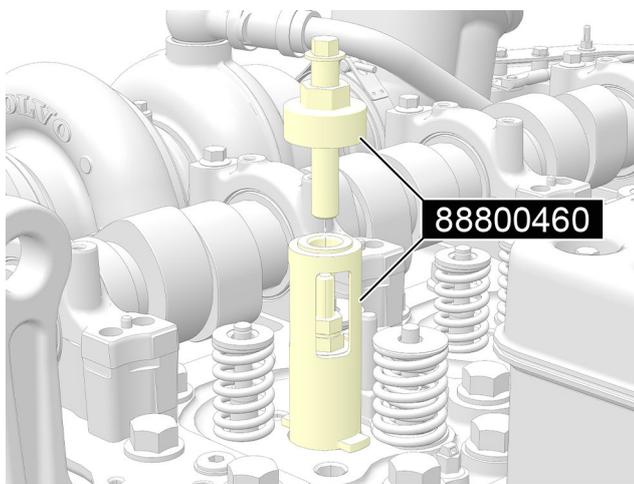
P0036668

- 2 Fit seal rings to prevent dirt from entering the fuel galleries.



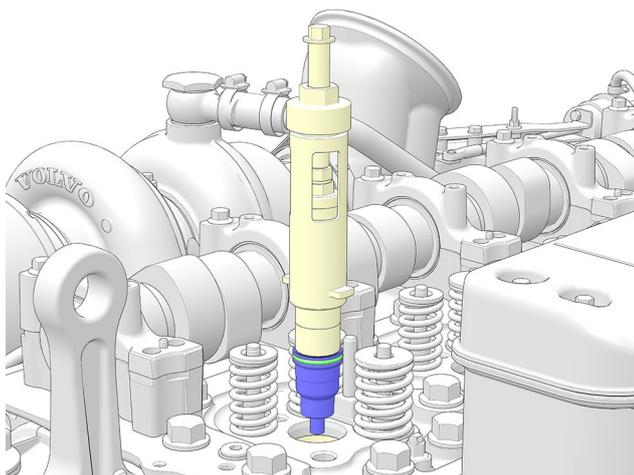
P0036661

- 3 Press down on the puller until it bottoms out against the injector sleeve. Tighten the nut until the expander grips the sleeve.



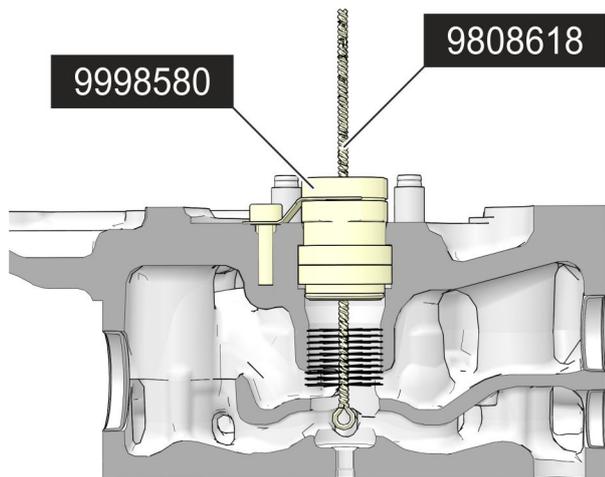
P0036660

- 4 Thread the sleeve over and screw on the puller. Screw on the nut with bearing to extract the injector sleeve.



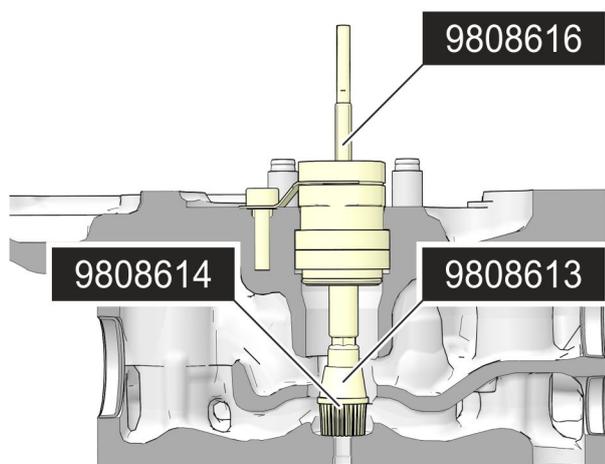
P0036669

- 5 Lift out the tooling and sleeve.



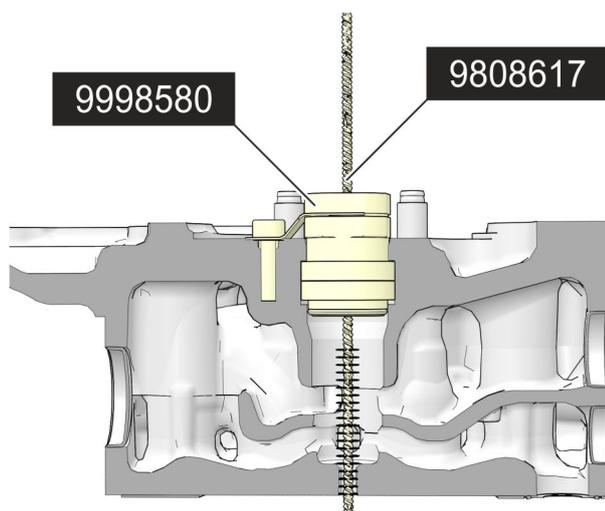
P0030396

- 6 Use brushes from the cleaning kit, P/N 88800550 before installing a new sleeve. Install the protective sleeve in the injector well and affix it. Clean the cylinder head walls.



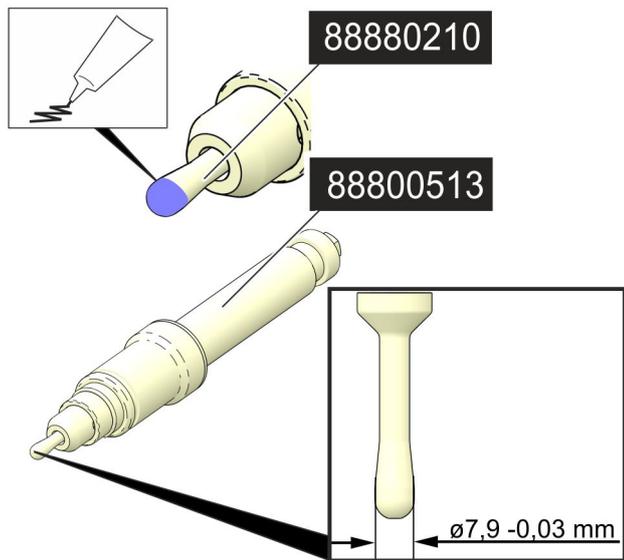
P0030397

- 7 Clean the sleeve seat.



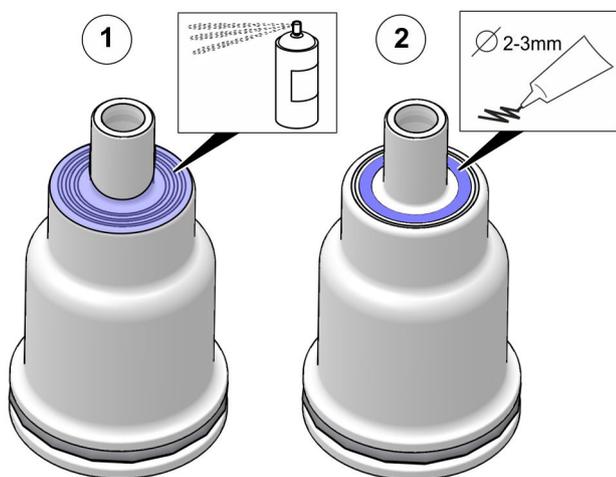
P0030398

- 8 Clean the cylinder head wells. **IMPORTANT!** Check that the piston is in its lower position in the cylinder to avoid damage.



P0025230

9 Lubricate the tap with engine oil.

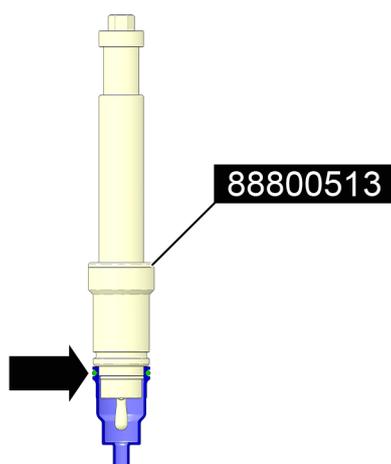


P0030394

10 **IMPORTANT:**

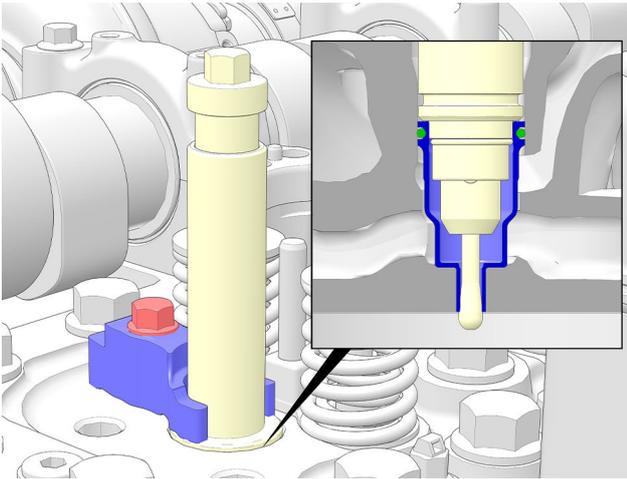
Steel sleeve: Apply activating primer, Loctite 7649 (1). Apply a 2-3 mm string of sealant P/N 1161059 (2).

Copper sleeve: No sealant may be used.



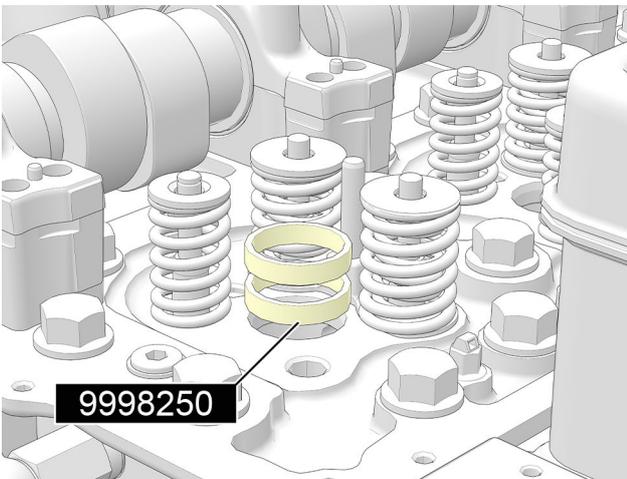
P0036662

11 Put the injector sleeve on the mandrel and lubricate the O-ring with soapy water.



P0036665

- 12 Press down on the mandrel and affix it with the attachment yoke of the unit injector.
Tightening torque: **80 Nm**
- 13 Drift the tap down through the tip of the sleeve.
Remove the mandrel.



P0036668

- 14 Remove the sealing rings.
- 15 Insert injector and rocker arm bridge, refer to *Injector, Replace, page 134*.
- 16 Install the valve cover.
- 17 Fill coolant, refer to 26-0, *Coolant, Replace*.

Common Rail, Replace

IMPORTANT:

Working with the fuel system requires special cleanliness.

IMPORTANT:

Clean thoroughly before removal.

⚠ DANGER!

Install protective plugs in open connections

⚠ CAUTION!

The fuel system may be under pressure. When working on the fuel system, undo a closed system at the first point with caution.

Tools:

88800474 Wrench

88840290 Plugs

- Valve cover removed
- Drain the cylinder head fuel channels, refer to *Draining, Fuel Duct in Cylinder Head, page 127*

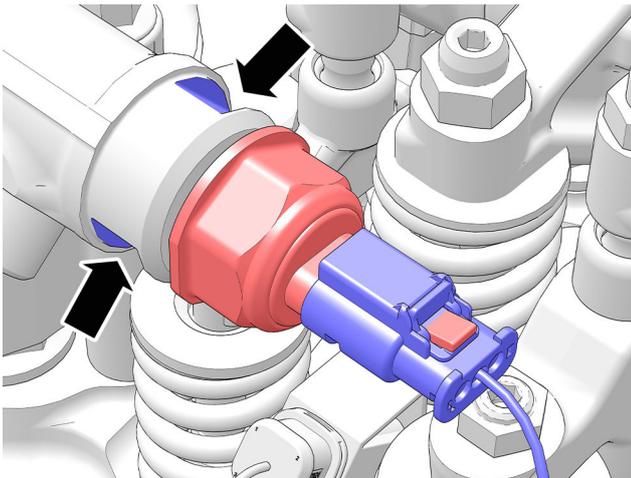
1 Remove:

- connector
- pressure sensor

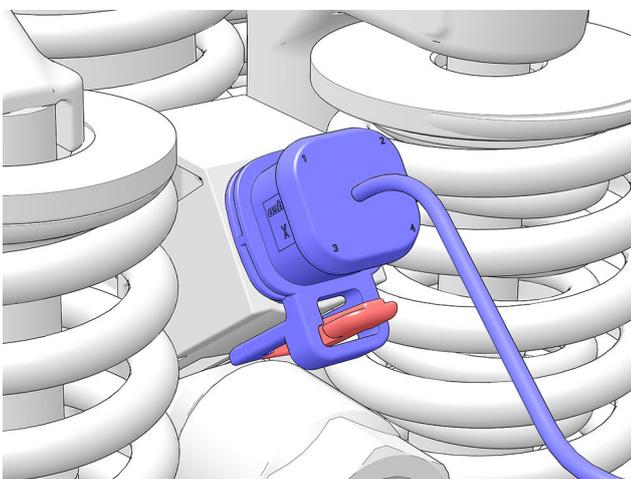


Use a spanner as a counterhold.

NOTICE! Be prepared to gather up fluid.

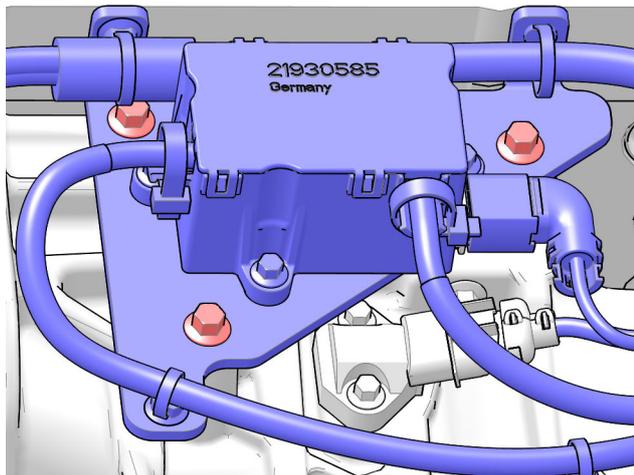


P0039766



P0039767

2 Remove the fuel injector wiring.

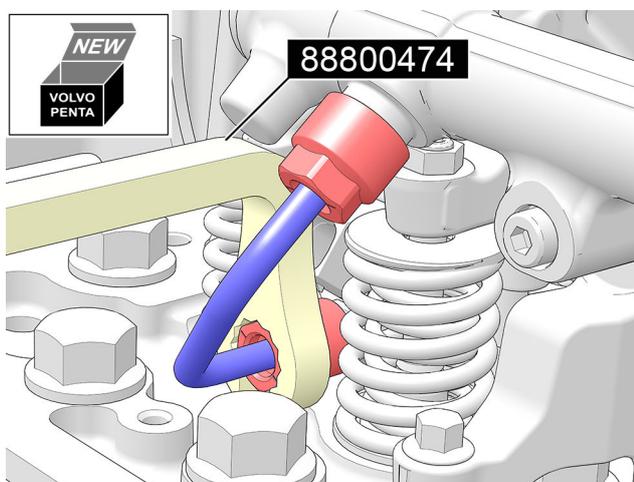


P0031722

3

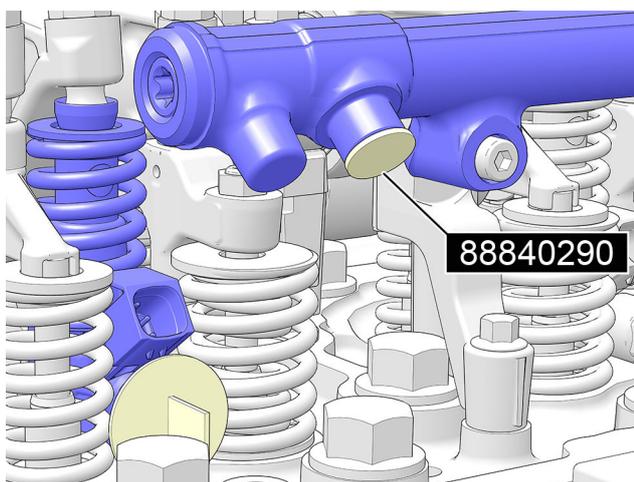


Loosen and fold away the bracket, in order to more easily torque the pressure pipes when installing.



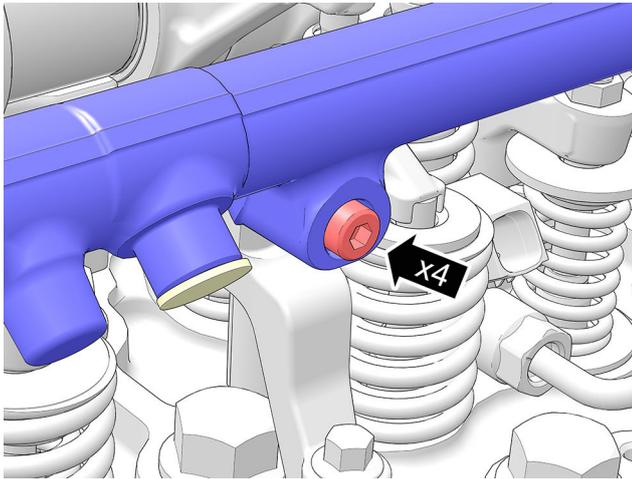
P0039768

4 Remove the pressure pipes.



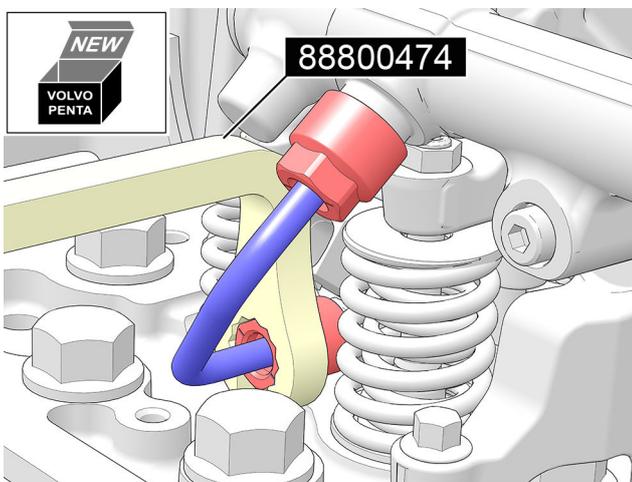
P0039769

5 Seal all open connections.



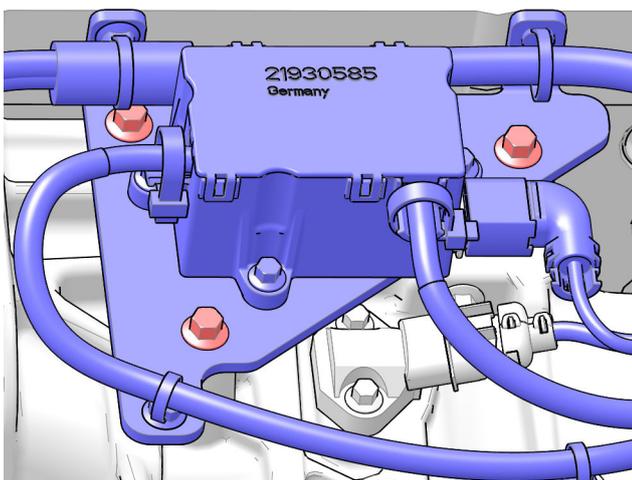
P0039770

- 6 Replace the distributor common rail.
Tightening torque **20 Nm**.



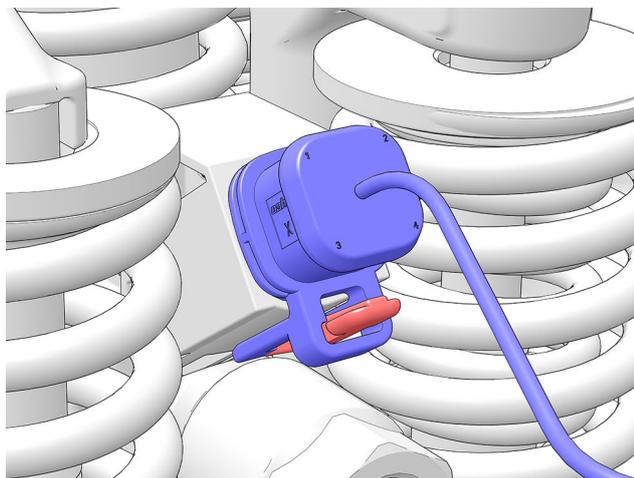
P0039768

- 7 Install:
- pressure pipe, tightening torque **20 Nm** and angle tighten **30°**.



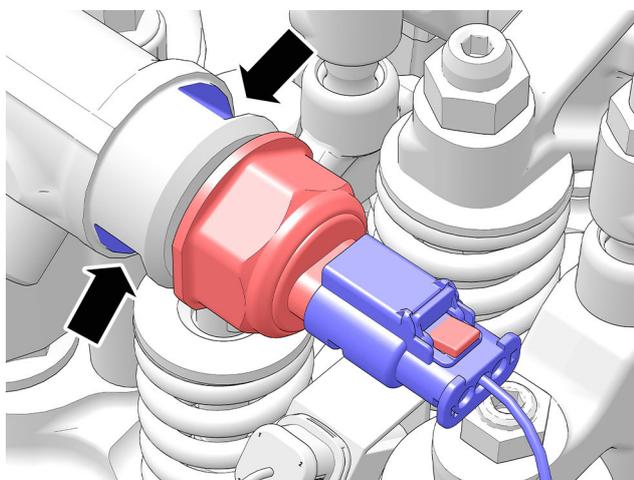
P0031722

- 8 Insert the bracket.



P0039767

- 9 Install the fuel injector wiring.



P0039766

- 10 Install:
- pressure sensor
 - connector

Tightening torque: **90 Nm**



Use a spanner as a counterhold.

- 11 Install the valve cover.
- 12 Bleed the fuel system; refer to *Fuel system, bleeding*, page 126.

Rail Pressure Sensor, Replace

IMPORTANT:

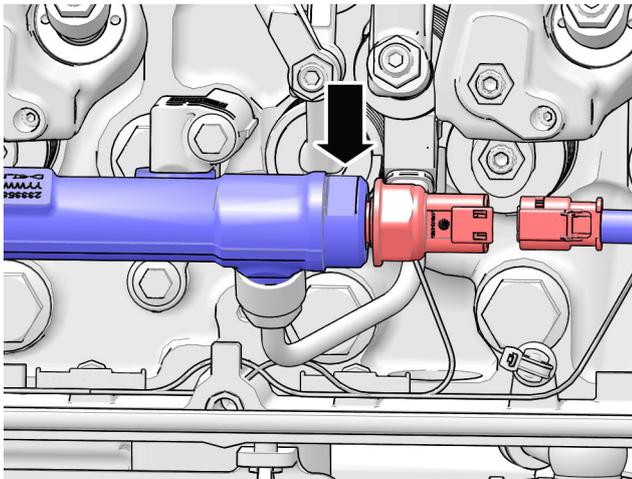
Working with the fuel system requires special cleanliness.

IMPORTANT:

Clean thoroughly before removal.

⚠ CAUTION!

The fuel system may be under pressure. When working on the fuel system, undo a closed system at the first point with caution.



P0031624

- Valve cover removed

- 1 Loosen the connector.
Remove the sensor.



Use a spanner as a counterpoint.

- 2 Install the sensor, tightening torque 90 Nm.



Use a spanner as a counterpoint.

- 3 Install the connector.

- Refit the valve cover.

23-8 Control System, ECM, Data Sets

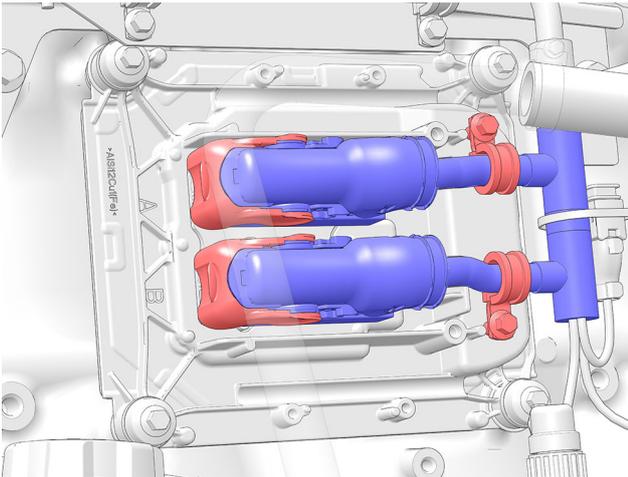
Control Unit, Replace

- Fuel system, drained, refer to
- Disconnect the power

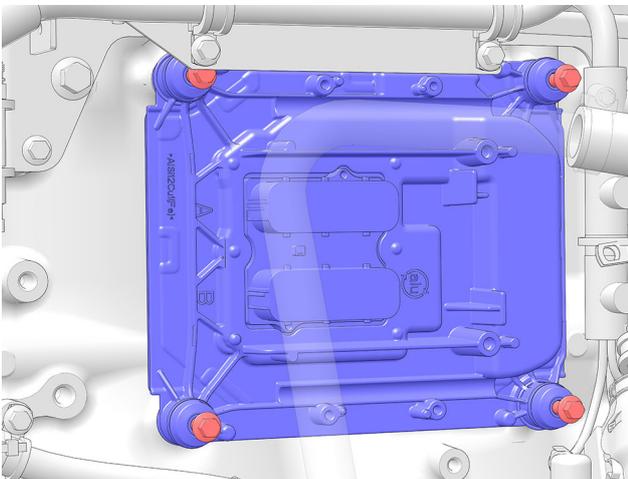
IMPORTANT:

The system must be de-energized and the starter key(s) must be in position 0 when the engine control unit connectors are removed or connected.

- 1 Remove:
 - clamps
 - connectors

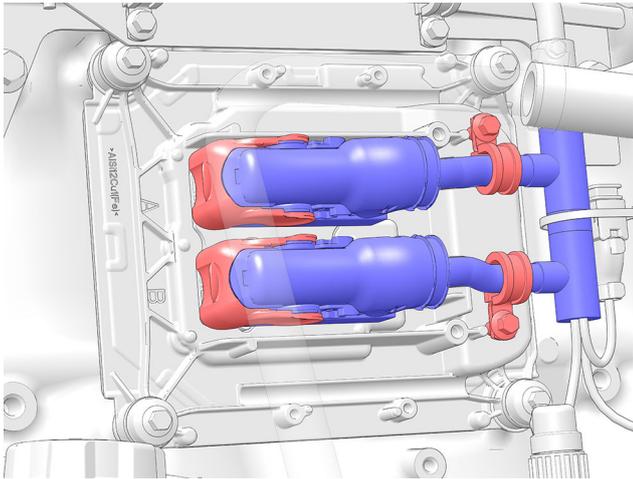


P0039737



P0039738

- 2 Replace control unit.



P0039737

- 3 Install:
 - connectors
 - clamps
- 4 Switch the power on.

25-0 Inlet and Exhaust System, General

Check and Fault Trace

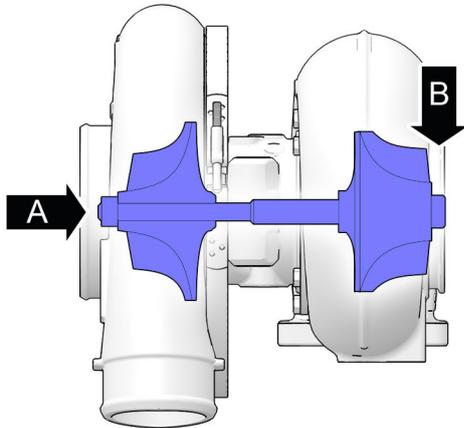
Turbocharger, check

Check:

- That no visible external damage to the compressor wheel/turbine wheel is present.
- Press the turbine wheel/compressor wheel axially and radially while rotating the shaft. No contact between the turbine wheel or compressor wheel and their housings may occur.

Bear in mind:

- Oil accumulation in the intake system downstream of the turbocharger may indicate a worn turbocharger.
- Heavy carbon deposits on the turbine blades may indicate a worn turbocharger.

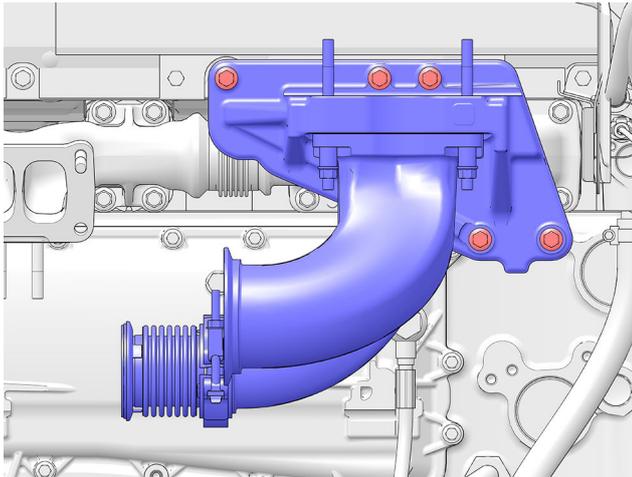


P0034831

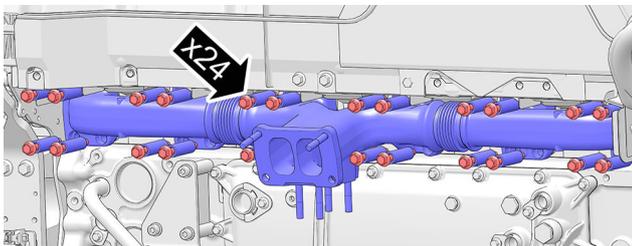
25-1 Inlet and Exhaust Manifolds

Exhaust Manifold, Replace

- Coolant drained
 - Turbocharger removed, refer to *Low-Pressure Turbo, Replace, page 157*
 - Turbocharger removed, refer to *High-Pressure Turbo, Change, page 161*
 - Remove the wastegate valve, refer to *Wastegate Valve, Replace, page 166*
- 1 Remove Y-pipe with bracket.



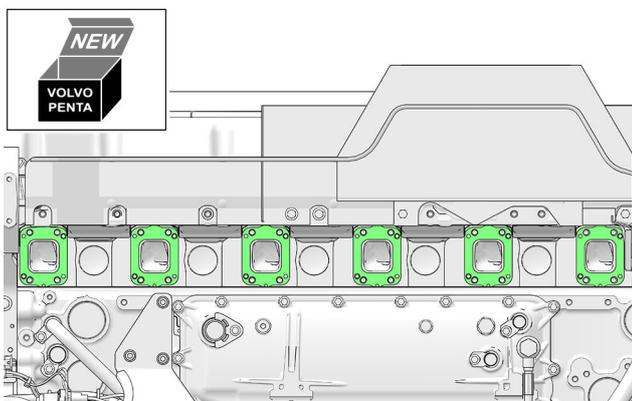
P0039945



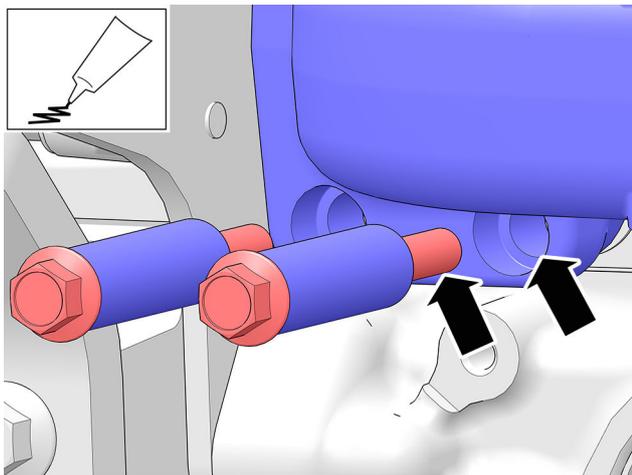
P0039748

- 2 Remove the exhaust manifold.

- 3 Install new gaskets.

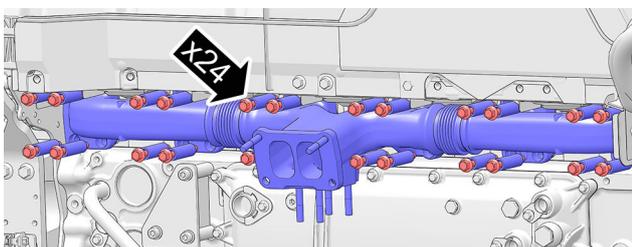


P0039749



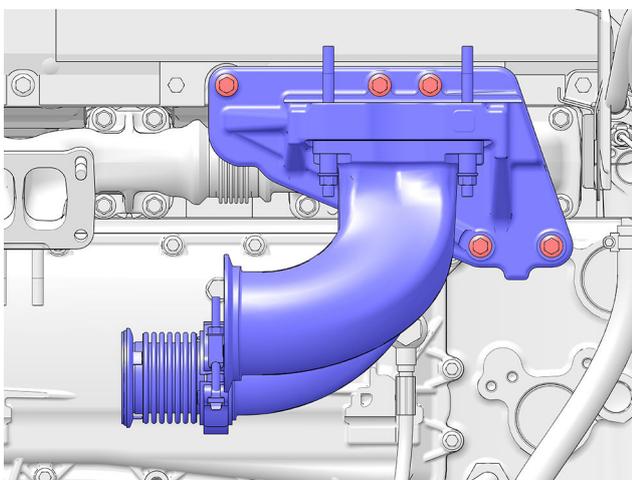
P0039750

- 4 Apply mounting paste P/N 1161929 to screw joints.



P0039748

- 5 Install the exhaust manifold pipe, refer to *Special Tightening Torques, page 11*.



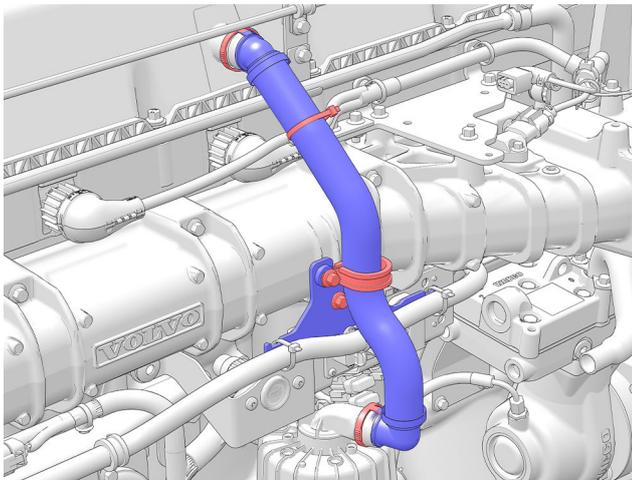
P0039945

- 6 Install Y-pipe with bracket.
Apply mounting paste P/N 1161929 to screw joints.
- 7 Install:
- Wastegate valve, refer to *Wastegate Valve, Replace, page 166*
 - Turbocharger, refer to *High-Pressure Turbo, Change, page 161*
 - Turbocharger, refer to *Low-Pressure Turbo, Replace, page 157*
- 8 Fill coolant, refer to 26-0, *Coolant, Replace*.

Intake Manifold, Replace

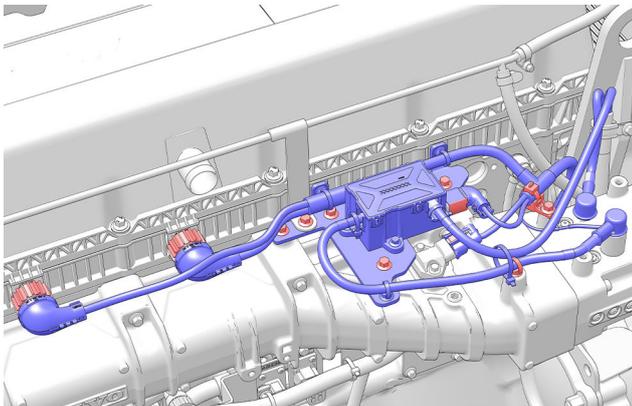
Removal

- 1 Remove:
 - the hose between valve cover and CCV unit
 - bracket



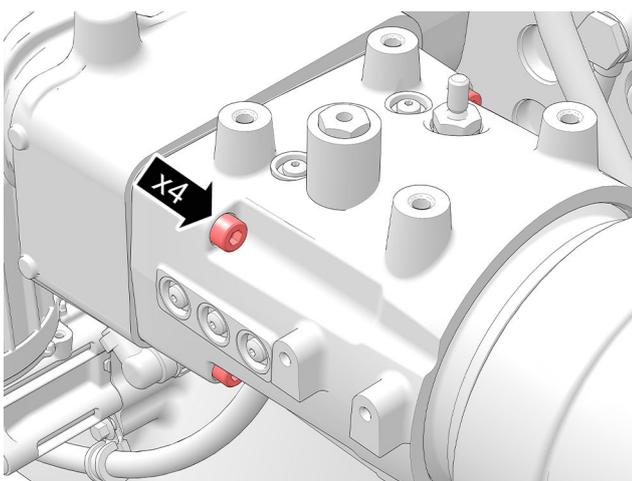
P0038587

- 2 Remove:
 - connectors
 - cable connections
 - bracket

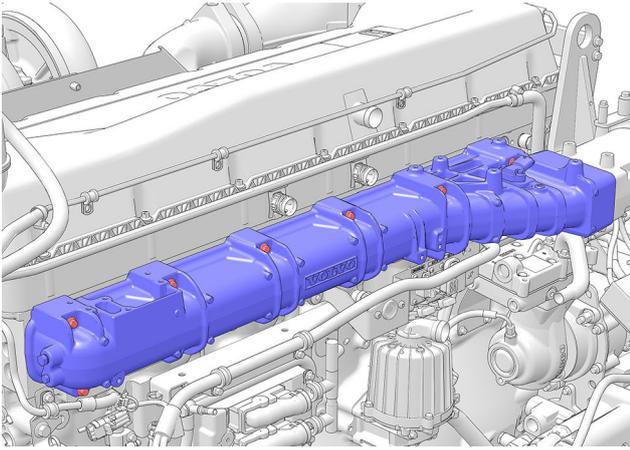


P0040047

- 3 Loosen the inlet pipe from the preheating element/piping.

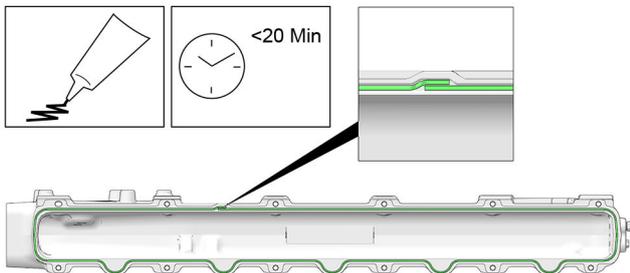


P0040048



P0038589

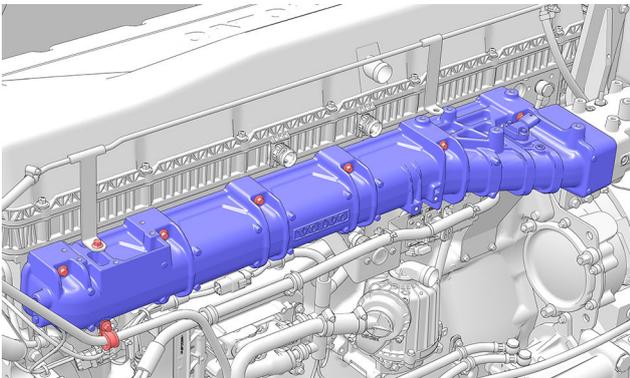
- 4 Remove the inlet pipe.



P0038594

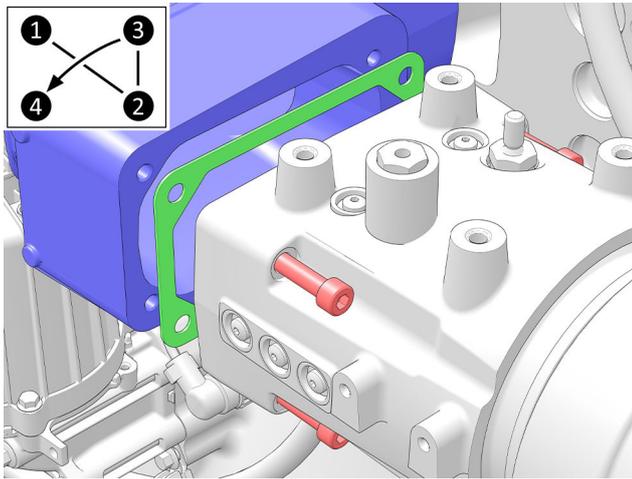
Installation

- 5 Apply a thin strand of sealant P/N 1161231 in the groove.
- 6 Install the seal.



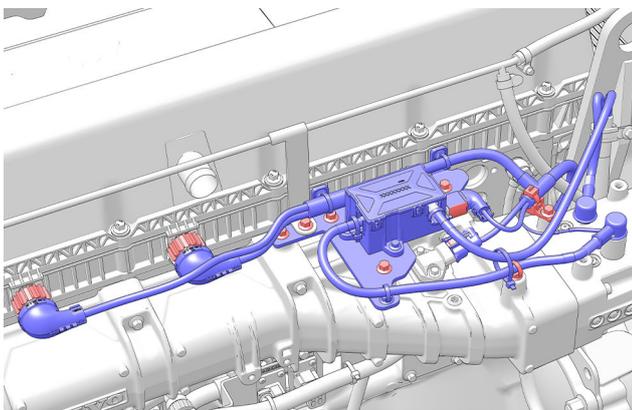
P0040049

- 7 Install the inlet manifold.
Refer to *Special Tightening Torques*, page 11.



P0040050

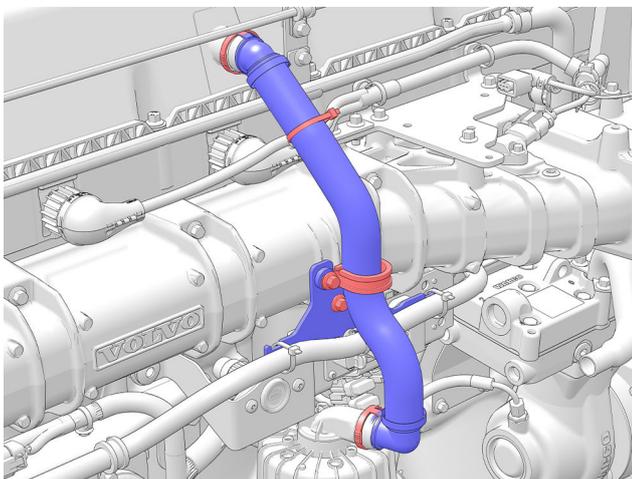
8 Tighten the inlet pipe to the preheating element/
piping.



P0040047

9 Install:

- bracket
- cable connections
- connectors



P0038587

10 Install:

- bracket
- the hose between valve cover and CCV unit

25-5 Turbo and supercharger

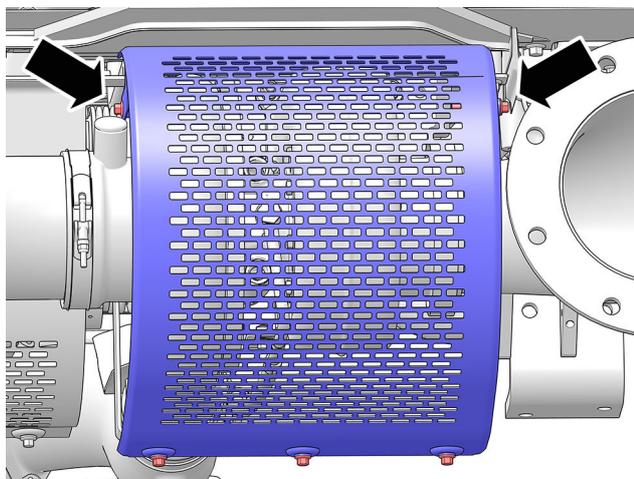
Low-Pressure Turbo, Replace

IMPORTANT:

If a breakdown of turbocharger or EGR has occurred. Always ensure that the intake and exhaust systems are free of metal and oil residue before starting the engine. An oil-contaminated SCR / DPF must always be replaced.

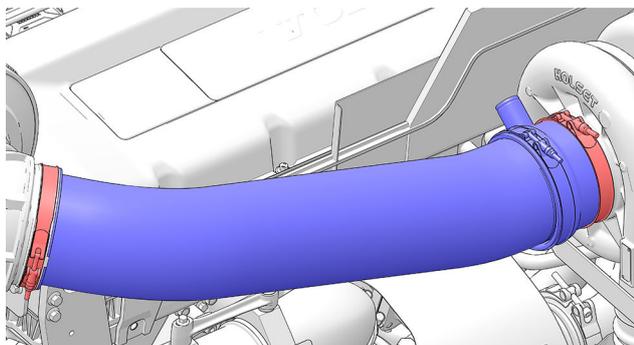
Always identify and correct the cause of turbocharger failure before fitting a new turbocharger. Check and rectify in accordance with *Turbocharger, check, page 151*.

- 1 Remove the protective plate.

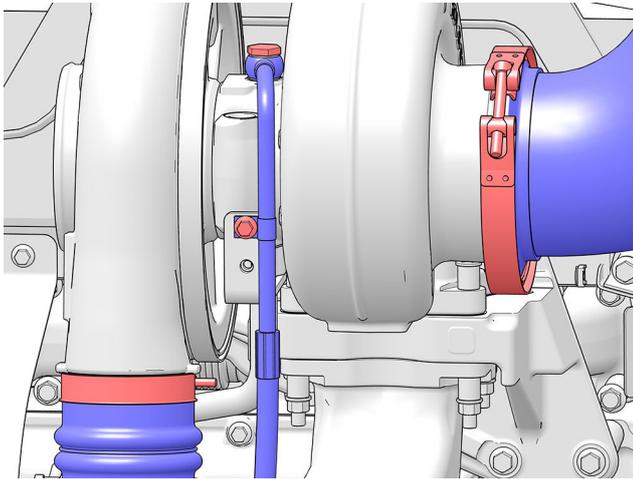


P0039818

- 2 Remove intake manifold.



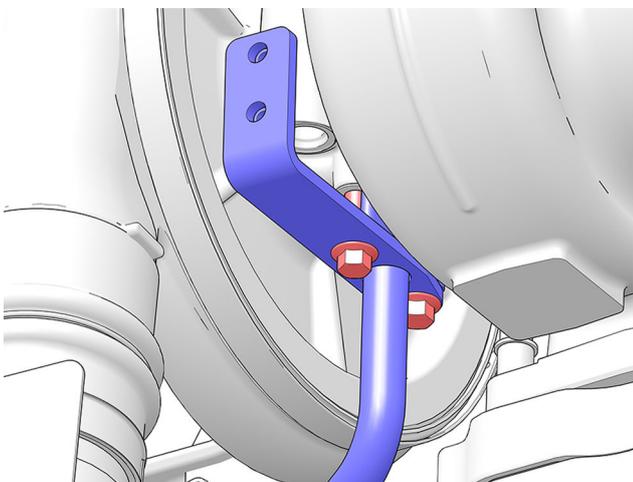
P0039819



P0039820

- 3 Remove:
- exhaust system
 - oil piping
 - charging air pipe clamp

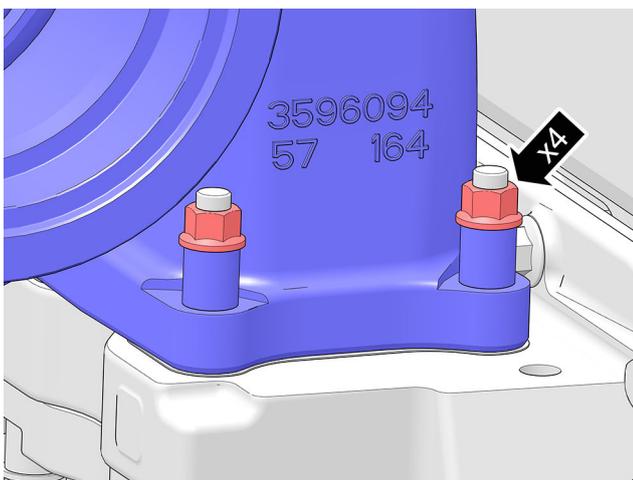
NOTICE! Be prepared to gather up fluid.



P0039821

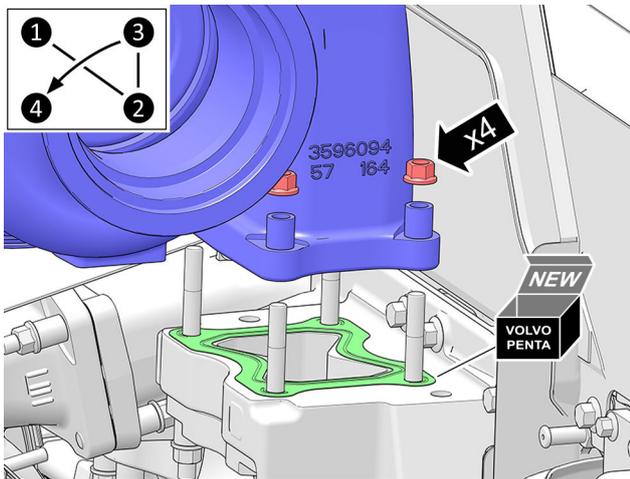
- 4 Remove the oil piping.

NOTICE! Be prepared to gather up fluid.



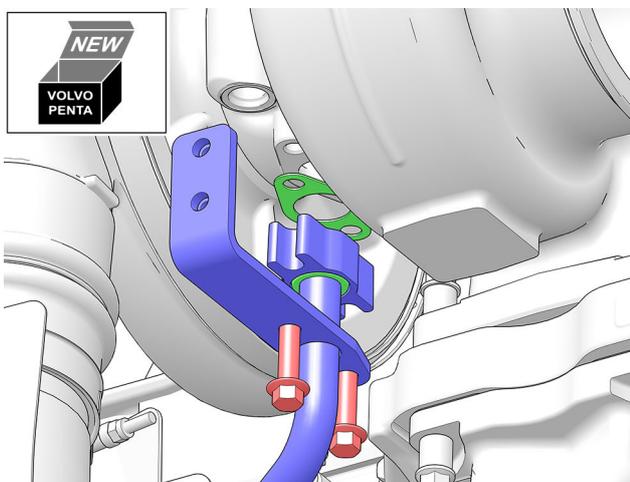
P0039822

- 5 Remove the nuts.



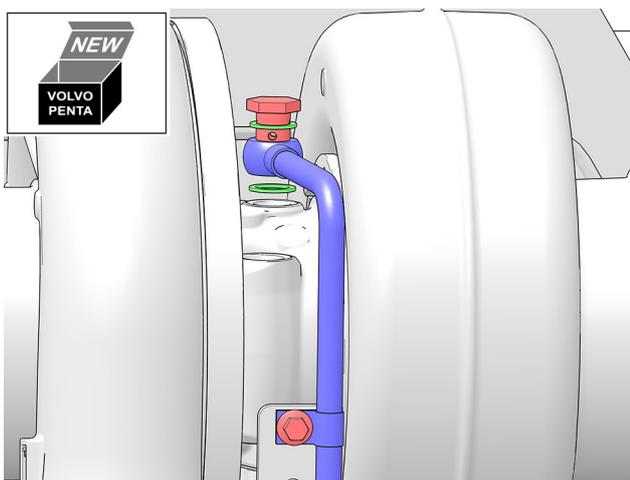
P0039823

- 6 Remove turbocharger, install a new turbocharger gasket.
Apply mounting paste P/N 1161929 to screw joints.
For tightening torque, refer to *Special Tightening Torques*, page 11.



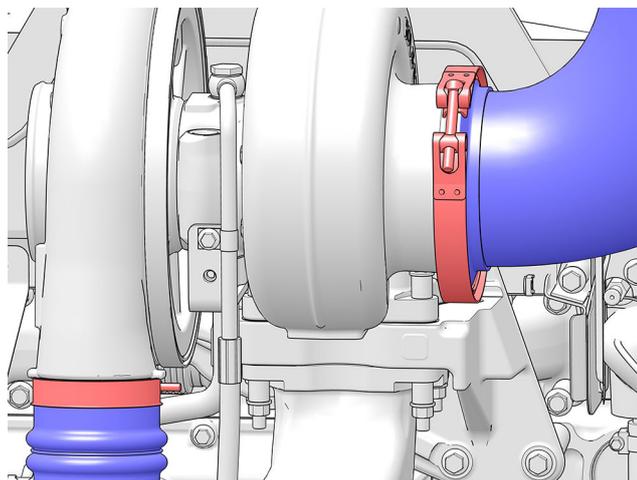
P0039824

- 7 Install the oil piping.
For tightening torque, refer to *Special Tightening Torques*, page 11.



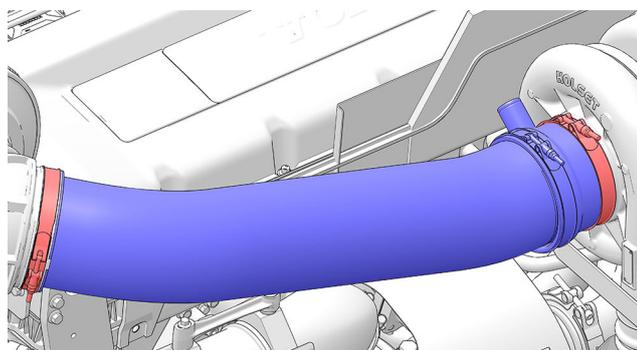
P0039825

- 8 Install the oil piping.
For tightening torque, refer to *Special Tightening Torques*, page 11.



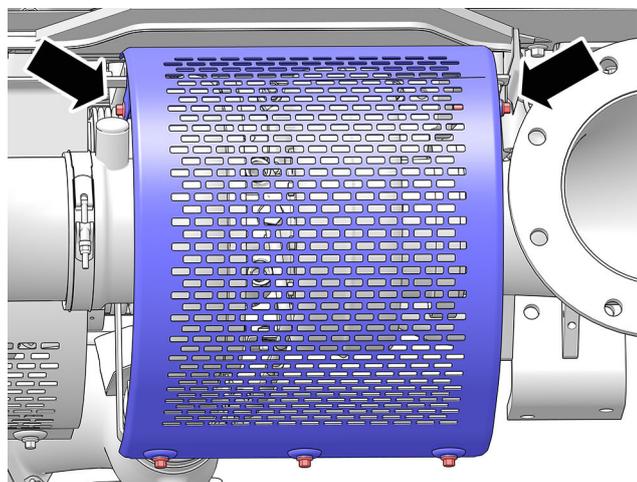
P0039826

- 9 Install:
- clamp, charge air
 - exhaust pipe



P0039819

- 10 Install intake piping.



P0039818

- 11 Install the protective cover.

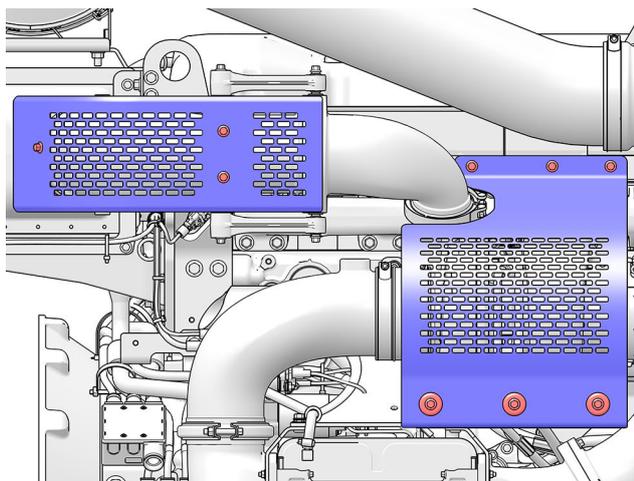
High-Pressure Turbo, Change

IMPORTANT:

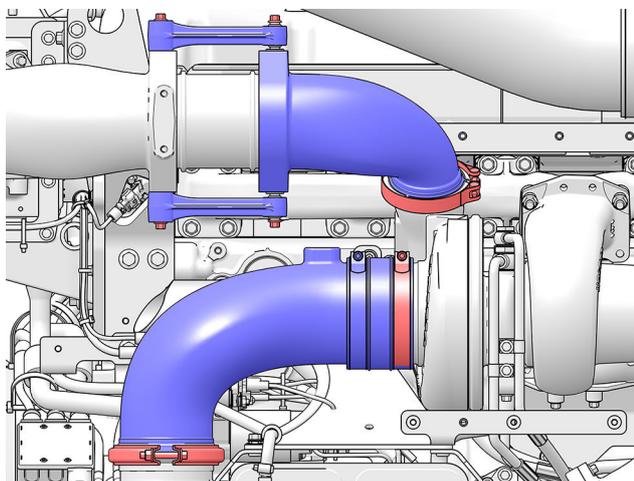
If a breakdown of turbocharger or EGR has occurred. Always ensure that the intake and exhaust systems are free of metal and oil residue before starting the engine. An oil-contaminated SCR / DPF must always be replaced.

Always identify and correct the cause of turbocharger failure before fitting a new turbocharger. Check and rectify in accordance with *Turbocharger, check, page 151*.

- 1 Remove protecting plate.

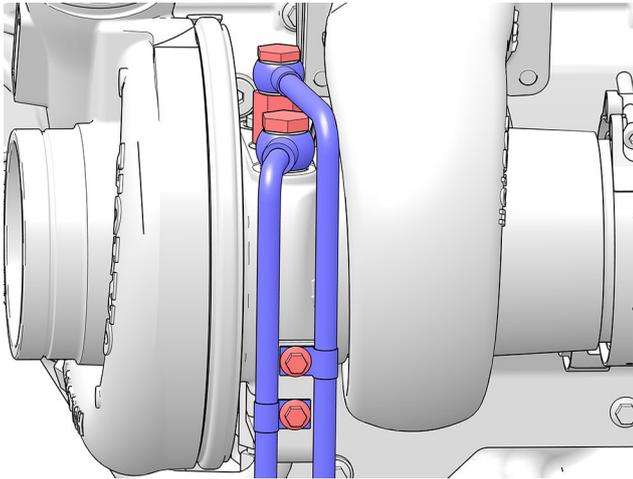


P0039804



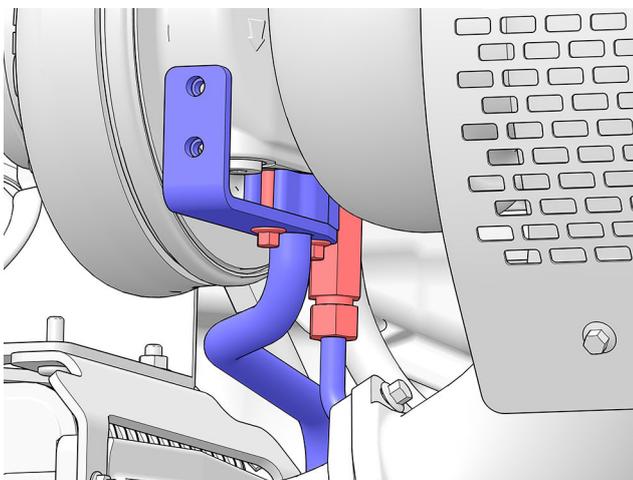
P0039805

- 2 Remove the charge air piping.



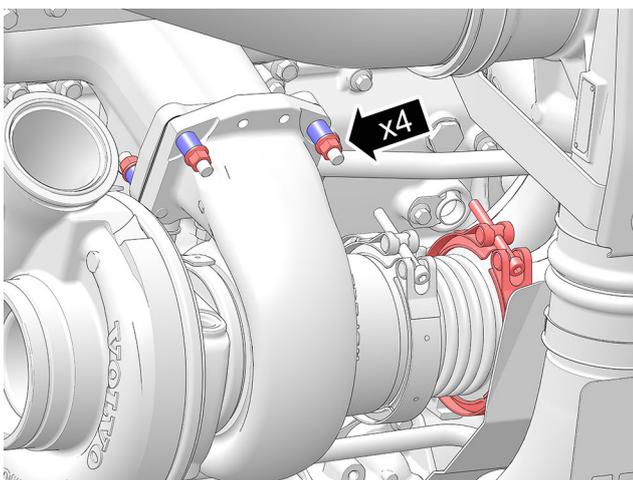
P0039806

- 3 Remove oil and water piping.
NOTICE! Be prepared to gather up fluid.



P0039807

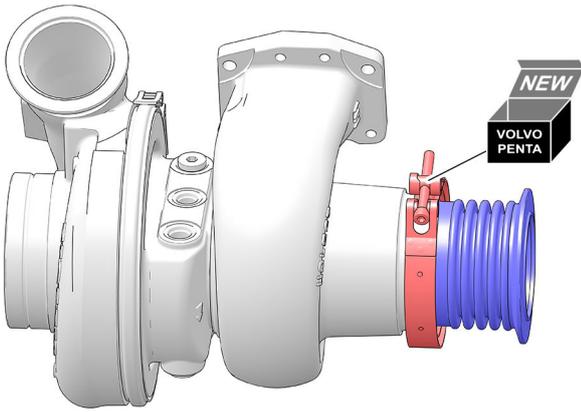
- 4 Remove oil and water piping.
NOTICE! Be prepared to gather up fluid.



P0039808

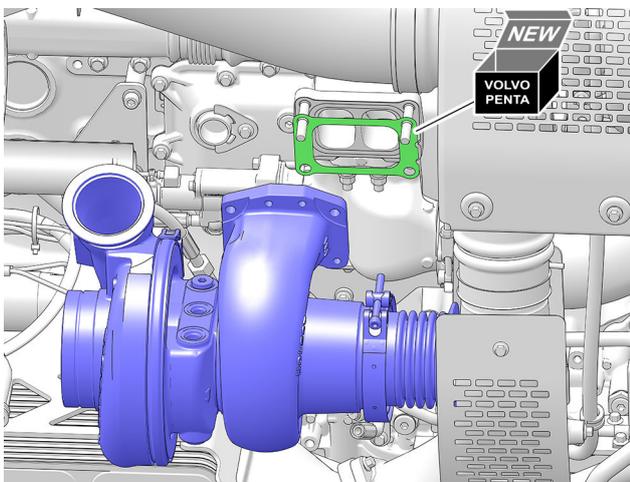
- 5 Remove:
- nuts with spacers
 - clamp

- 6 Move the flex piping to the new turbo.



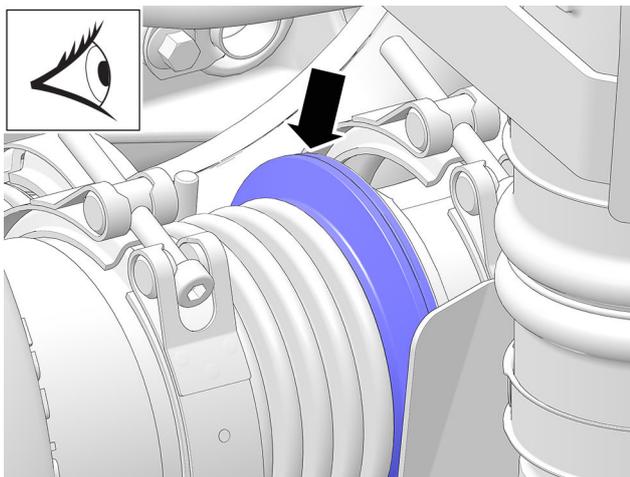
P0039803

- 7 Install the turbocharger with a new gasket. Apply mounting paste P/N 1161929 to screw joints.

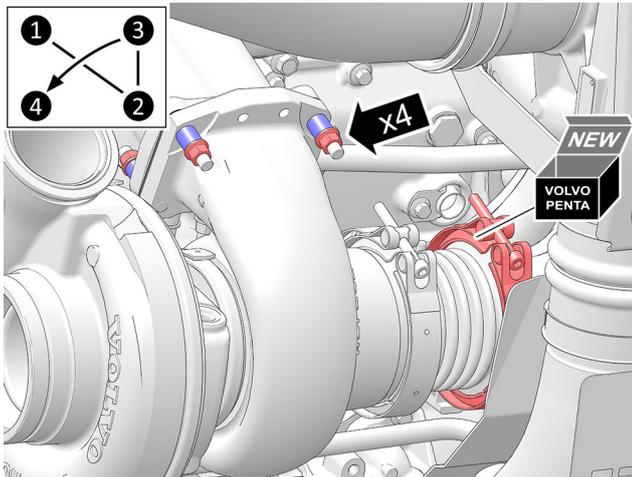


P0039809

- 8 Check that the flanges are centered against each other before applying the clamp.

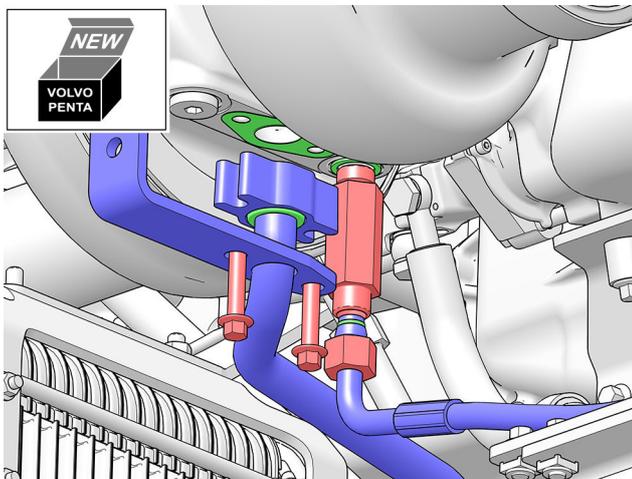


P0039815



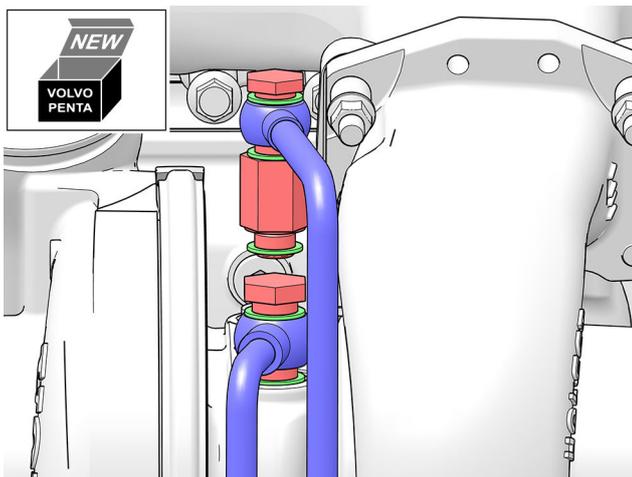
P0039810

- 9 Install:
- clamp, use a new clamp
 - nuts with spacers
- For tightening torque, refer to *Special Tightening Torques, page 11*.



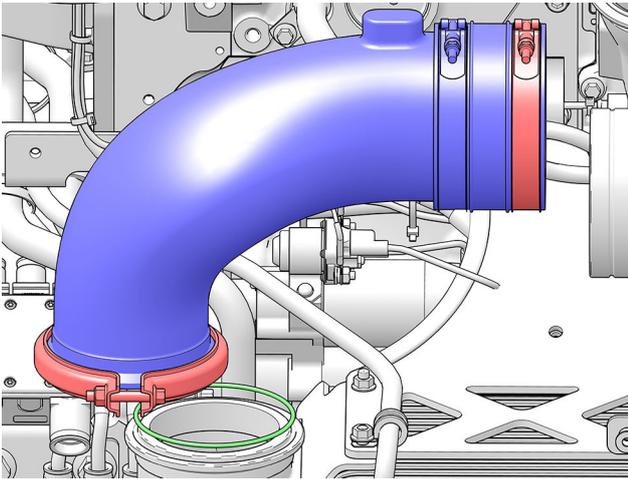
P0039811

- 10 Install oil and water piping.
- For tightening torque, refer to *Special Tightening Torques, page 11*.



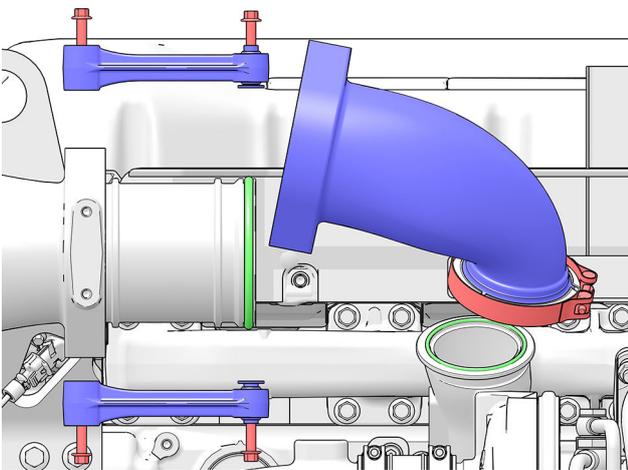
P0039812

- 11 Install oil and water piping.
- For tightening torque, refer to *Special Tightening Torques, page 11*.



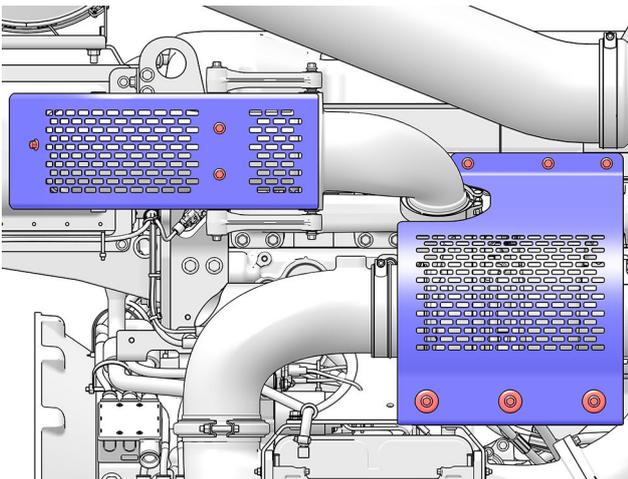
P0039813

12 Install the charge air pipe.



P0039814

13 Install the charge air pipe.



P0039804

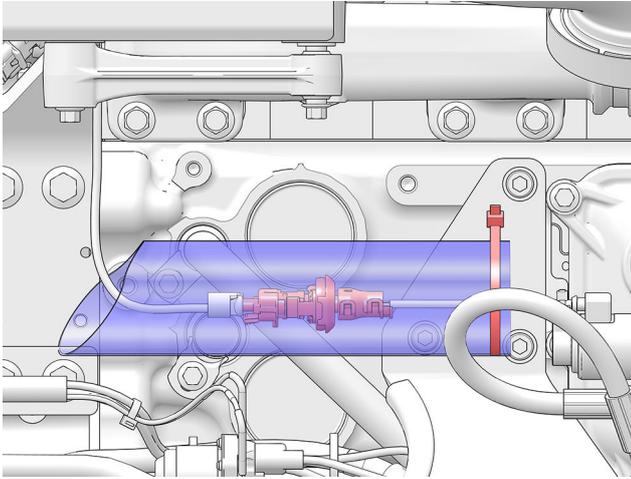
14 Install the protective plating.

Wastegate Valve, Replace

- High-pressure turbo, removed, refer to *High-Pressure Turbo, Change*, page 161.

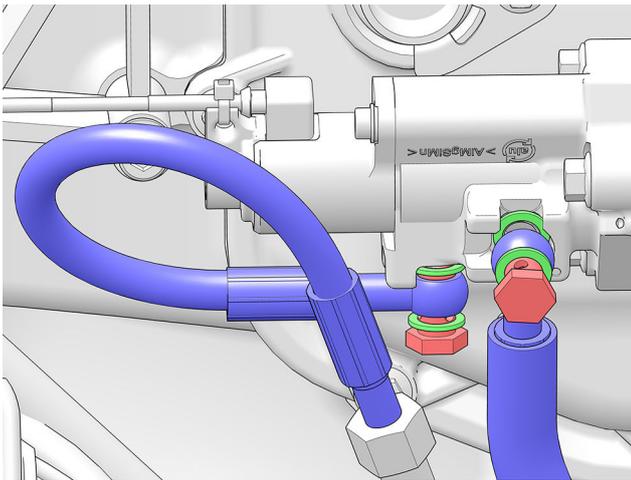
Removal

- 1 Remove cable ties to the heat protection. Move aside the heat protection. Remove heat shield. Disconnect the connector.



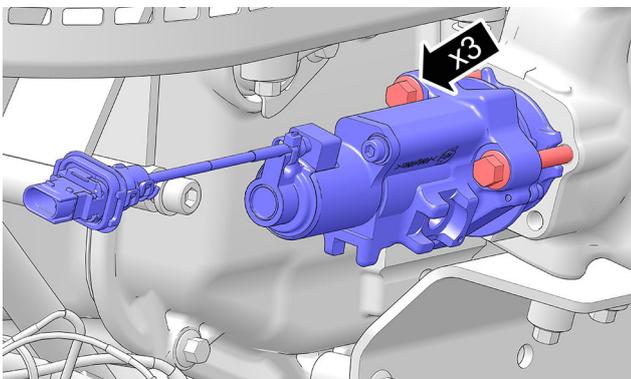
P0039720

- 2 Remove the oil piping.

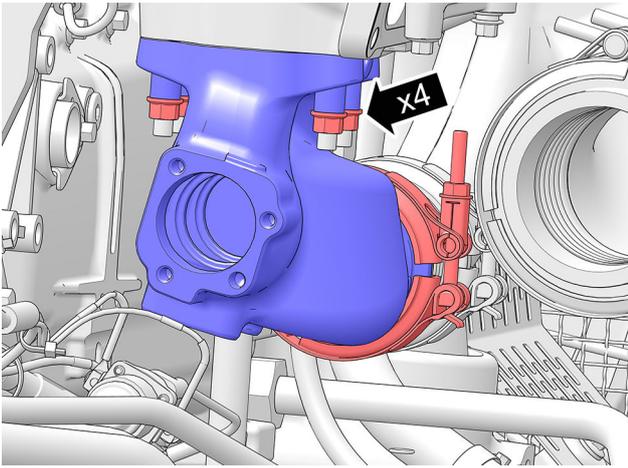


P0039721

- 3 Remove:
 - screw
 - valve



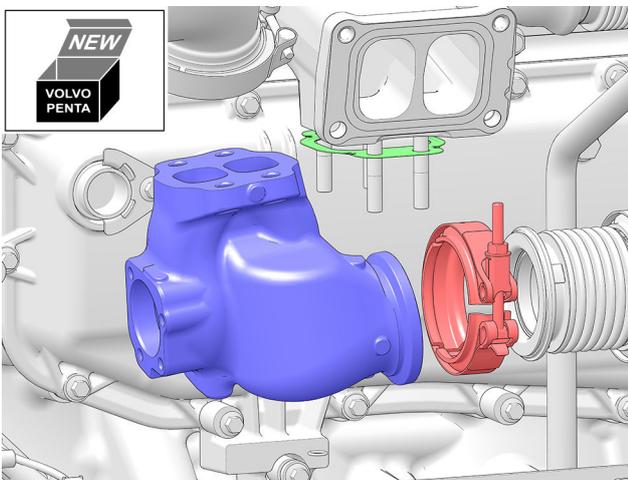
P0039722



P0039724

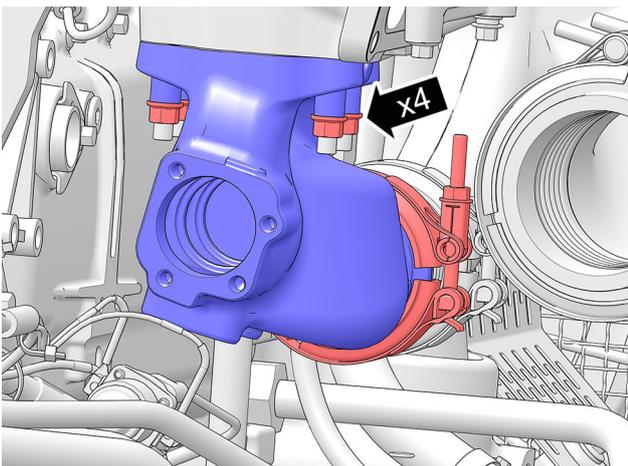
- 4 Remove:
- nuts
 - clamp
 - valve housing

Installation



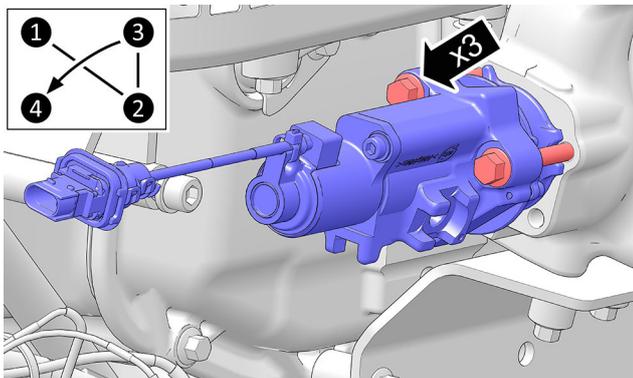
P0039944

- 5 Install the valve housing with new gaskets and clamps



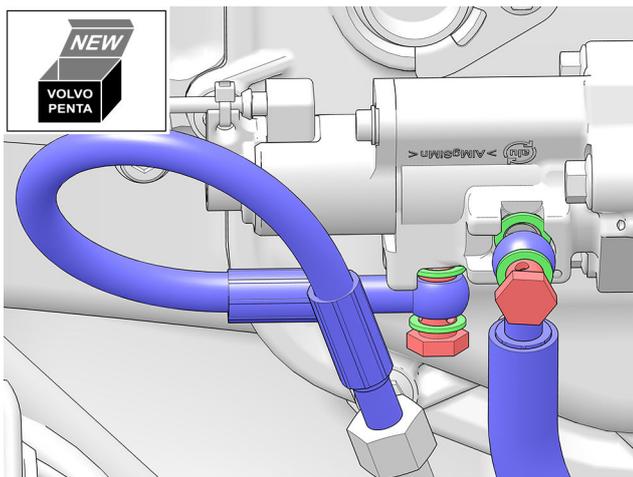
P0039724

- 6 Apply mounting paste P/N 1161929 to screw joints.
Install nuts.
Tightening torque:
- Step 1: **10 Nm**
 - Step 2: **25 Nm**
 - Step 3: **60 Nm**
- 7 Tighten the clamp.
Tightening torque: **12 Nm**



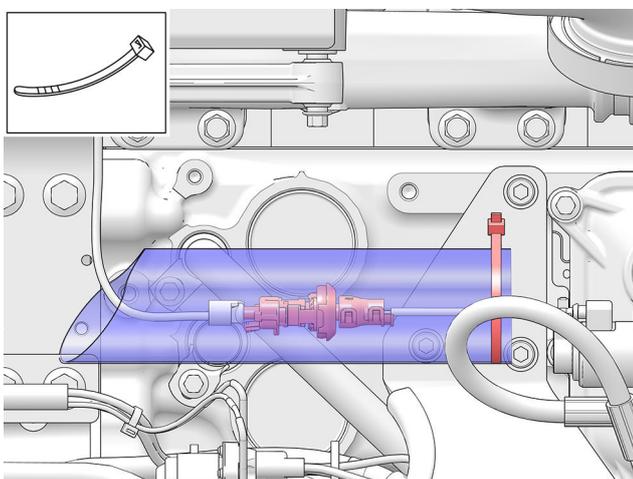
P0039727

- 8 Install the valve.
Step 1: **10 Nm**
Step 2: **24 Nm**



P0039728

- 9 Install the oil piping with new gaskets.
Tightening torque: **26 Nm**



P0039729

- 10 Install the heat shield.
Connect the connector.
Secure the heat shield with cable ties.
- 11 Install the high pressure turbocharger
in accordance with *High-Pressure Turbo, Change, page 161*.

26-0 Cooling System, General

Cooling System, Cleaning

Internal cooling system

▲ WARNING!

All coolant is hazardous and harmful to the environment. Do not consume. Coolant is flammable.

- 1 Mix cleaning liquid and neutralization liquid according to the volume of the current cooling system.
 - Cleaning agent: Citric acid ($C_6H_8O_7$) 30 grams to 1 liter of water (preferably distilled water).
 - Neutralization fluid: Bicarbonate ($NaHCO_3$) 6 grams to 1 liter of water.
- 2 Drain the cooling system (all draining points and low-placed hoses etc).
 - Fill the cooling system with cleaning agent.
 - Run the engine for about 8 hours with relatively high load (to open the thermostats fully).
- 3 Drain the cooling system (all draining points and low-placed hoses etc).
 - Fill the cooling system with neutralization fluid.
 - Run the engine for about 1 hour with relatively high load.
- 4 Drain the cooling system (all draining points and low-placed hoses etc).
 - Fill the cooling system with approximately 10% glycol mixture.
 - NOTICE!** Use the correct type of coolant. Refer to the engine specifications.
 - Run the engine for about 2 hours with relatively high load.
- 5 Drain the cooling system (all draining points and low-placed hoses etc).
 - Fill the cooling system with ready-mixed coolant. Refer to the engine specifications.

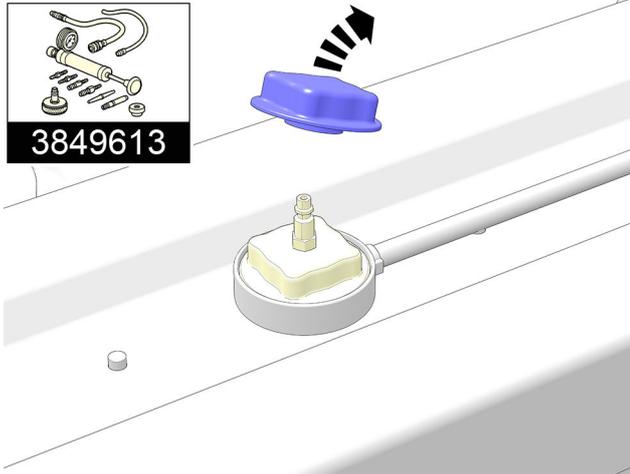
Cooling System, Pressure Testing

Tools:

3849613 Pressure testing kit

⚠ WARNING!

Do not open the coolant filler cap when the engine is hot. Steam or hot fluid could spray out, causing severe burns.



P0039456

- 1 Check the coolant level in the expansion tank.
- 2 Replace the pressure cap with the cap from the pressure test kit. Connect the pump and increase the pressure to **0.7 bar**. The pressure must not drop during a **2 minute** period.

NOTICE! If the pressure drops, check the engine cooling hoses and connections for leakage.

- 3 Check coolant level after pressure testing.

Check and Fault Trace

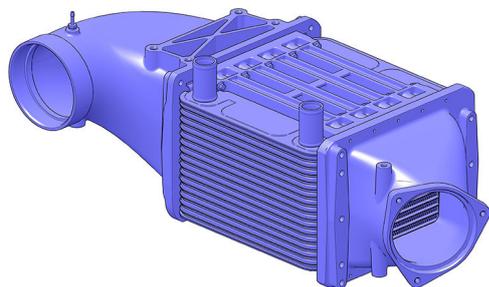
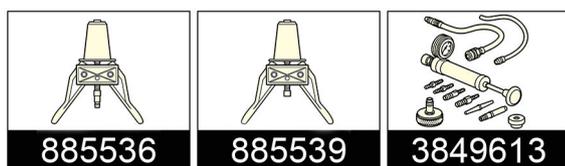
Charge Air Cooler, Pressure Testing

Tools:

885536 Plug

885539 Plug

3849613 Pressure testing kit



P0036604

- 1 Plug the bleed hose.
- 2 Connect the expander plug to the cooling connections on the charge air cooler.
- 3 Pump up a pressure of **1 bar**. Pressure must not fall during a **5 minute** period.



NOTICE! If the pressure drops, troubleshoot the leak with the aid of soapy water around connections and seals.

26-1 Radiator, Heat Exchanger

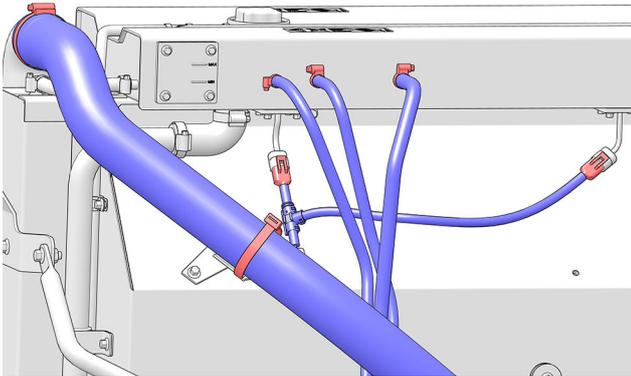
Radiator Assembly, Change

- Coolant drained; refer to 26-0, *Coolant, Replace*.

Removal

1 Remove:

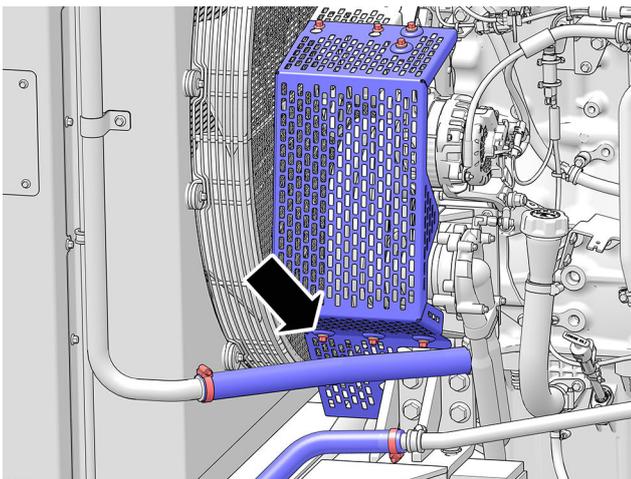
- hoses
- connectors for level sensors



P0039577

2 Remove:

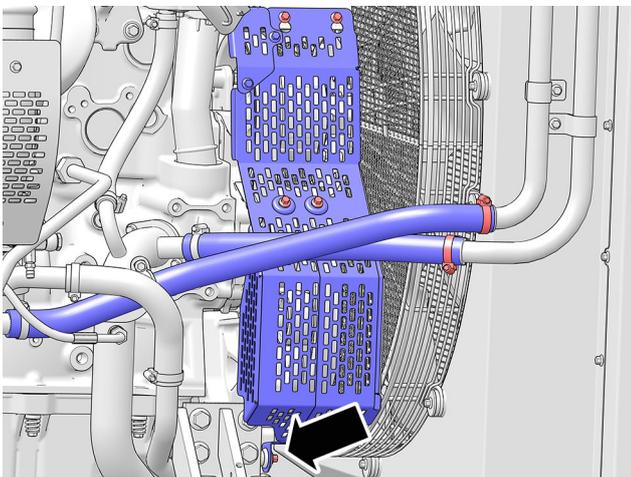
- hose
- belt guard



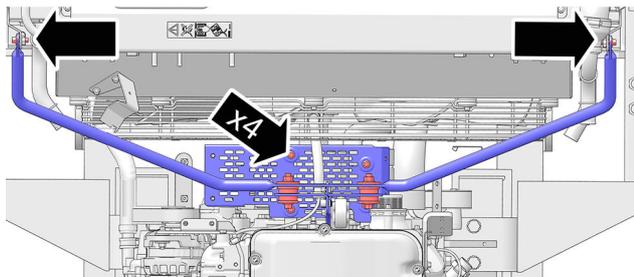
P0039578

3 Remove:

- hoses
- belt guard

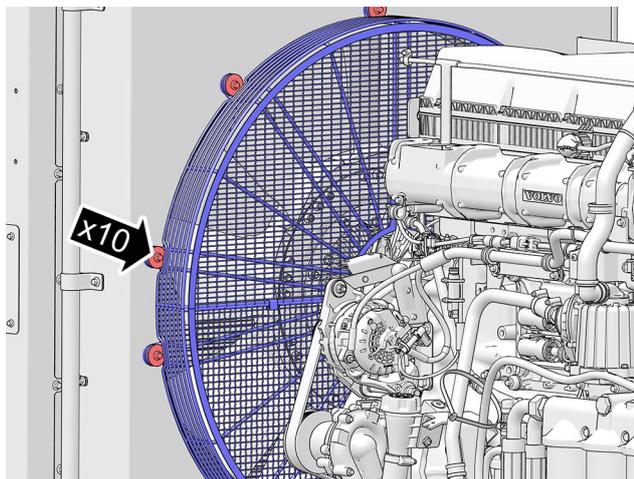


P0039579



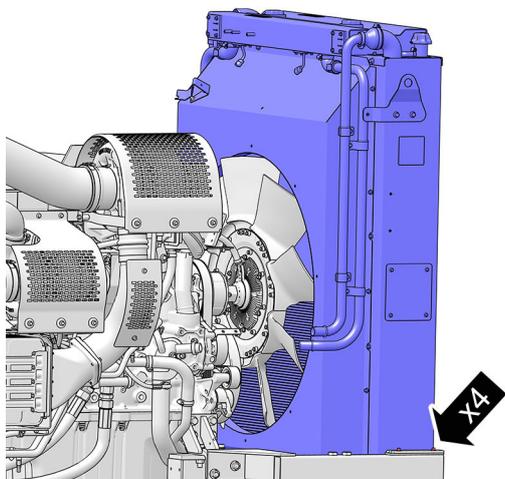
P0039580

- 4 Remove:
- strut
 - upper belt guard



P0039581

- 5 Remove lower and upper fan guards.



P0039582

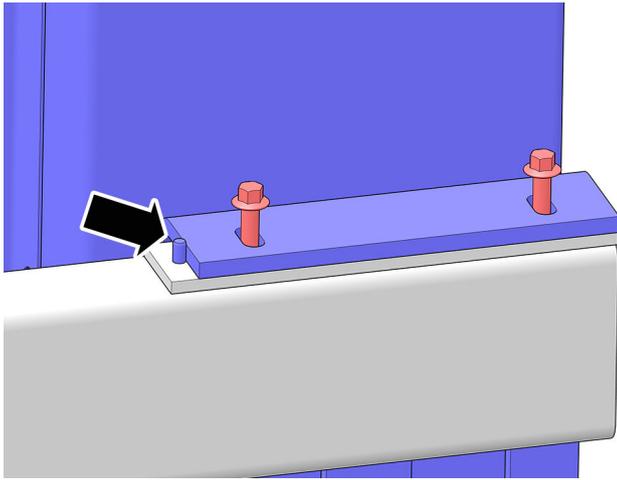
- 6 Attach lifting straps in the lifting lugs and remove the cooling package.

NOTICE! Mind the fan.

Installation

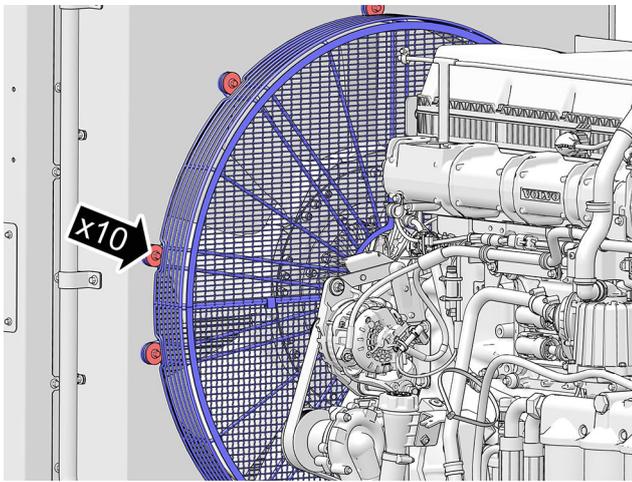
- 7 Lift the cooling package to the correct position and fasten the screws at the bottom.

NOTICE! Mind the fan.



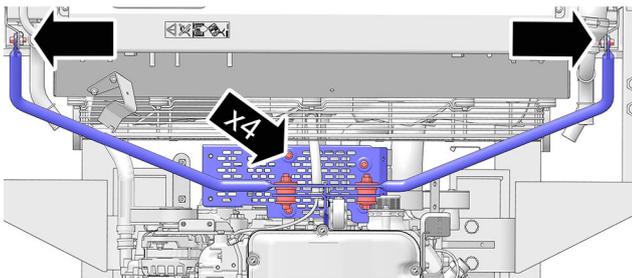
P0039583

- 8 Install lower and upper fan guards.



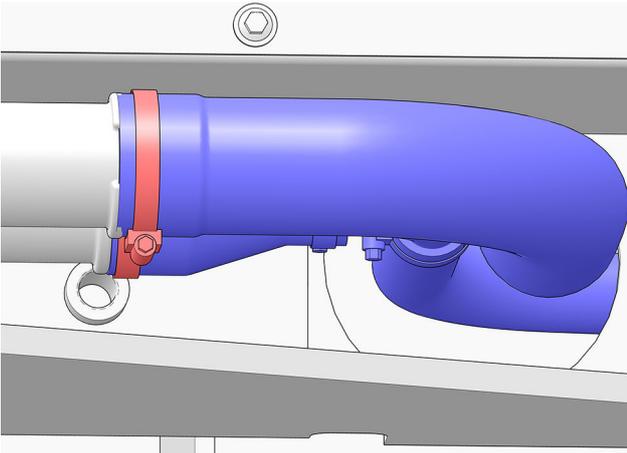
P0039581

- 9 Install:
 - upper belt guard
 - strut



P0039580

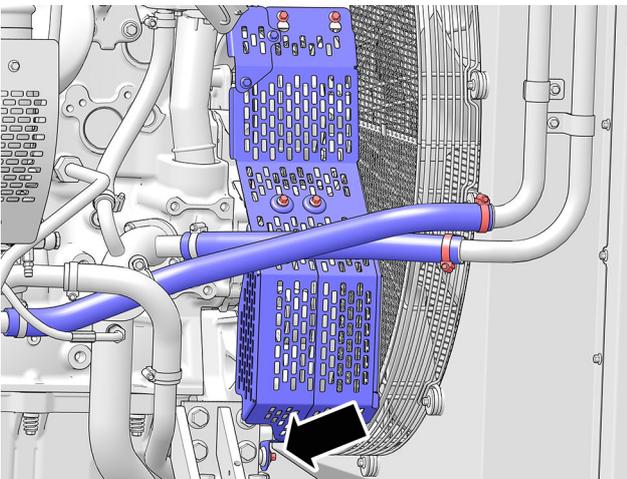
10 Install the hoses.



P0039584

11 Install:

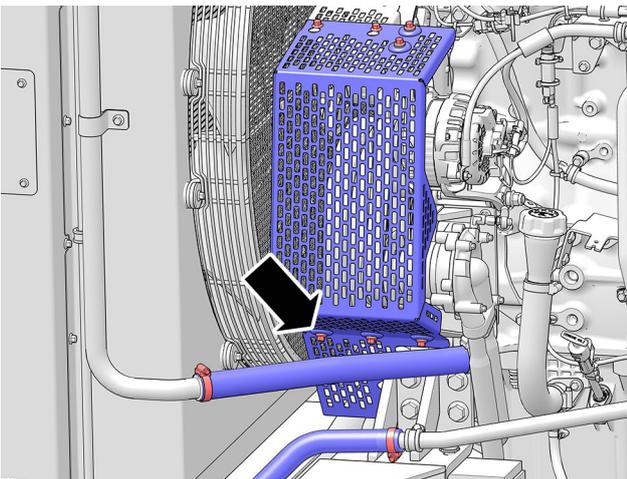
- belt guard
- hoses



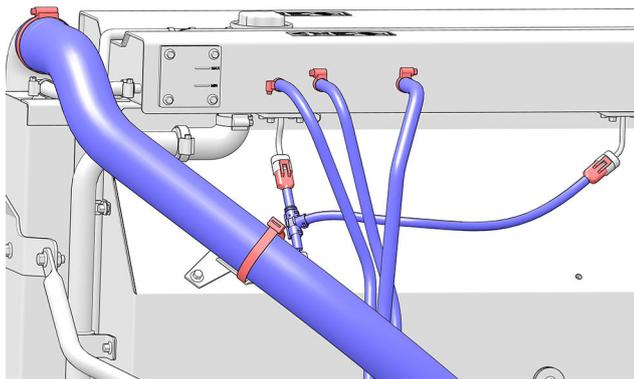
P0039579

12 Install:

- belt guard
- hose



P0039578



P0039577

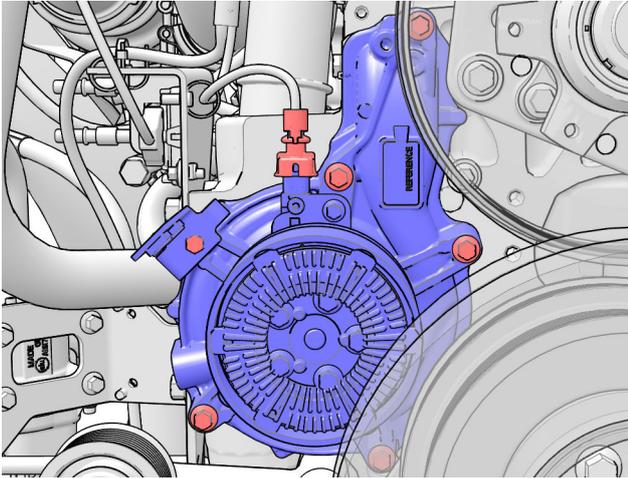
13 Install:

- connectors for level sensors
- hoses
- Fill the system with coolant; refer to 26-0, *Coolant, Replace*.

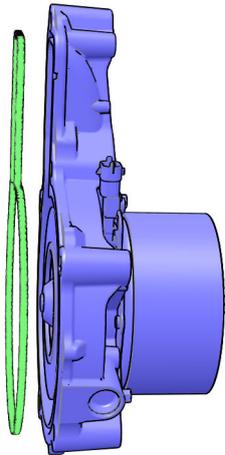
26-2 Coolant Pump, Thermostat

Coolant Pump, Replace

- 1 Drain the coolant. Refer to 26-0, *Draining the Cooling System*.
- 2 Remove drive belt protection.
- 3 Remove the drive belt.
- 4 Remove:
 - connector
 - water pump

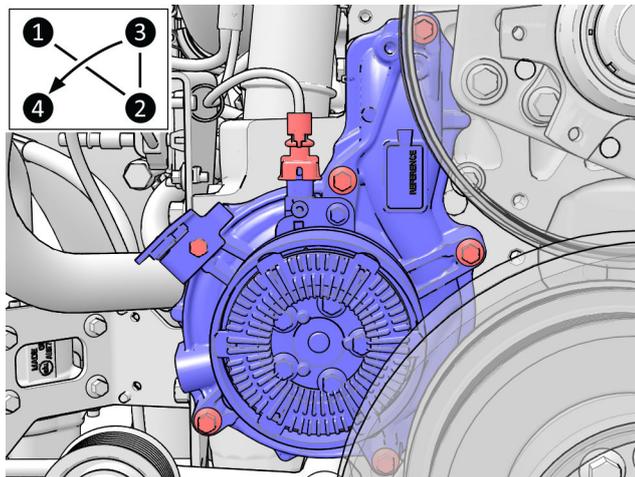


P0031227



P0031226

5



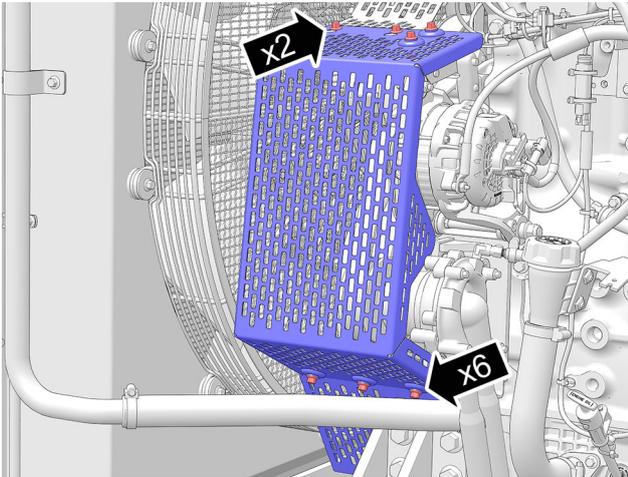
P0031277

- 6 Install:
 - water pump, tightening torque **24 Nm**
 - connector
- 7 Install:
 - drive belt
 - drive belt protection
- 8 Fill coolant; refer to 26-0, *Coolant, Replace*.

Coolant Pump, Intercooler Circuit, replacement

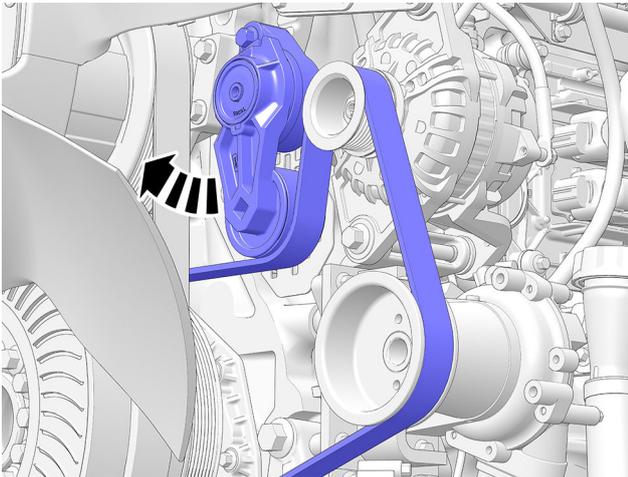
- Coolant drained; refer to 26-0, *Coolant, Replace*.

- 1 Loosen the two upper screws (x2).
Remove the remaining screws.
Slide the belt guard inwards and remove.



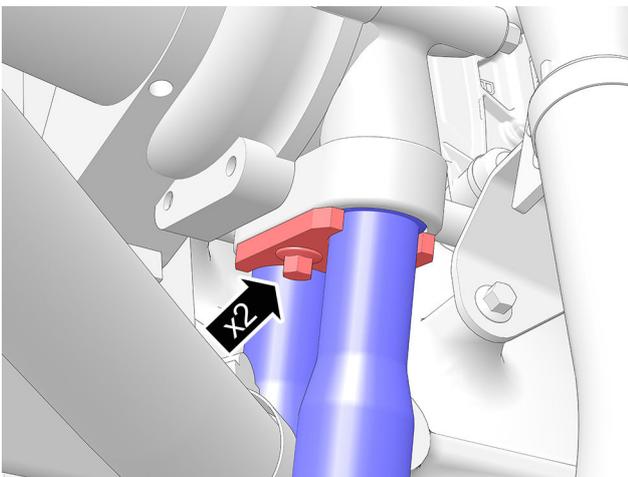
P0039780

- 2 Hang off the pump drive belt.

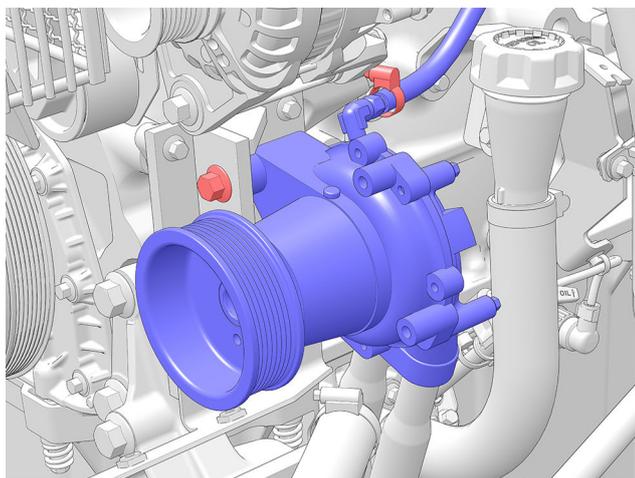


P0039776

- 3 Remove coolant piping bracket.
NOTICE! Be prepared to gather up fluid.

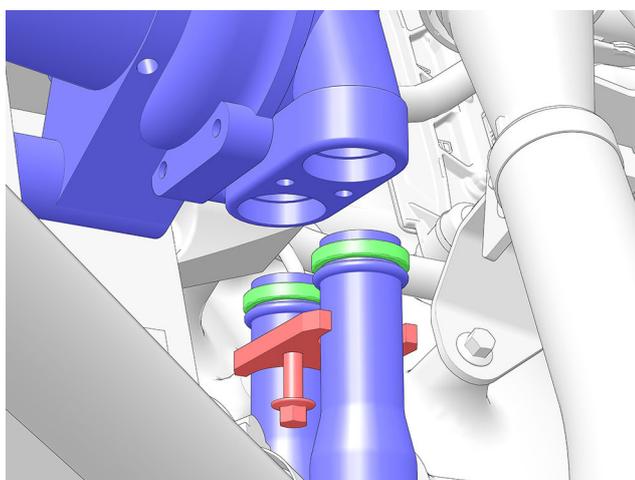


P0039778



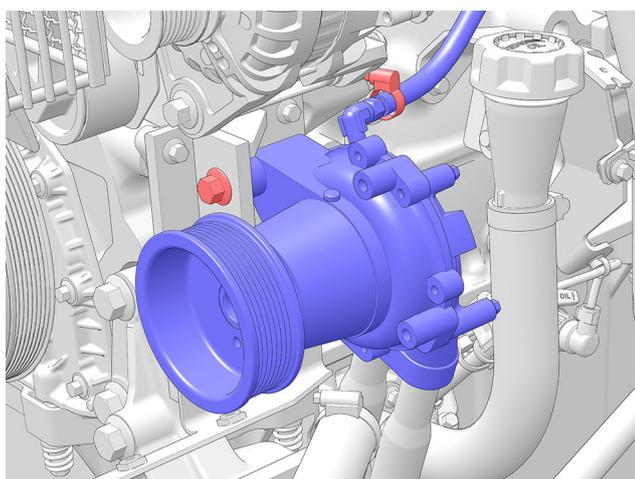
P0039777

- 4 Remove:
- hose
 - coolant pump



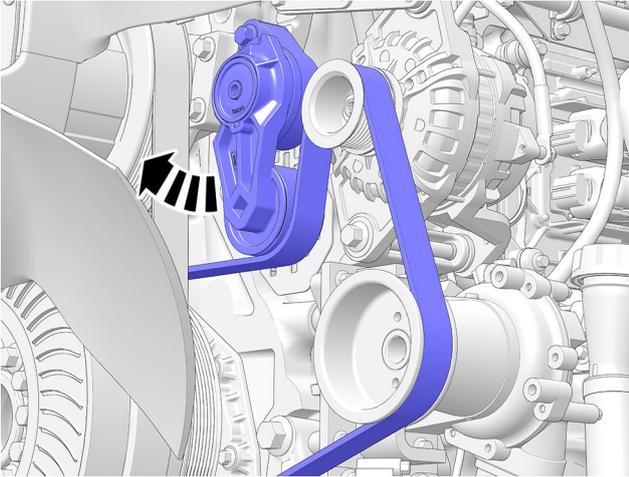
P0039779

- 5 Lubricate the new seals with soapy water. Install the coolant pump and tighten the fastening cap.



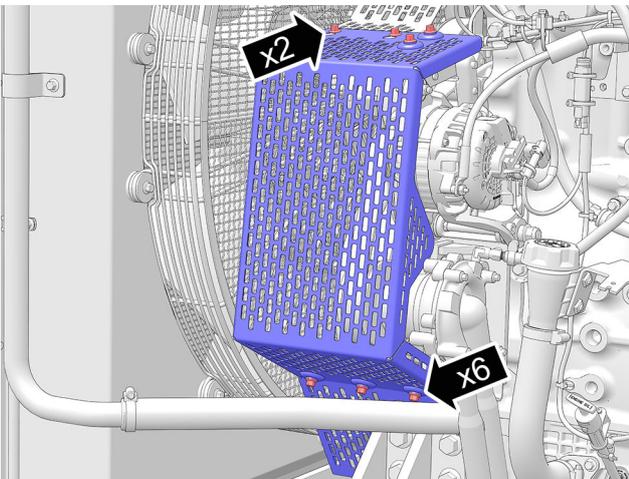
P0039777

- 6 Tighten the coolant pump.



P0039776

7 Install the drive belt.



P0039780

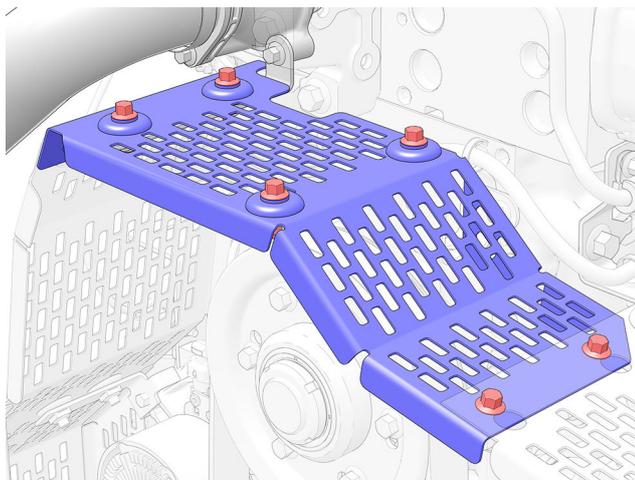
8 Install the belt protectors.

9 Fill coolant; refer to 26-0, *Coolant, Replace*.

Thermostat, Replace

- Cooling system drained; refer to 26-0, *Draining the Cooling System*.

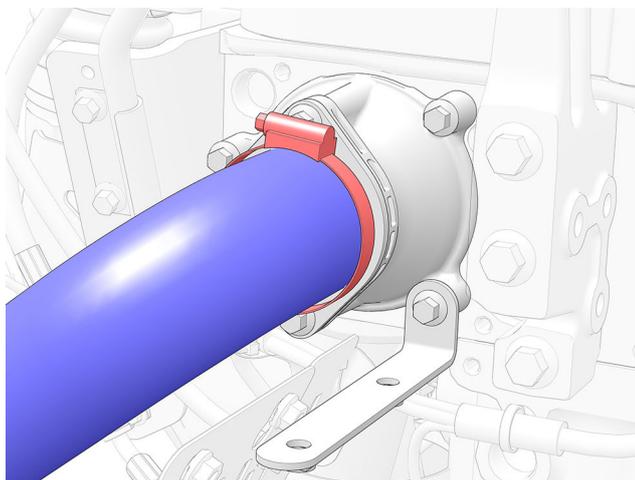
1 Remove the upper belt protector.



P0039235

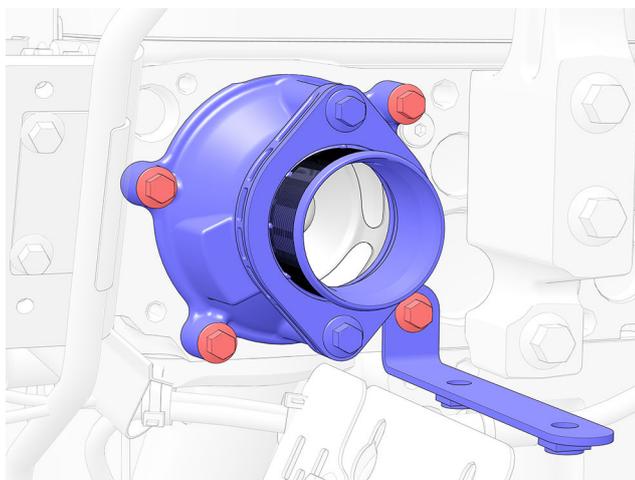
2 Remove the coolant hose.

NOTICE! Be prepared to gather up fluid.

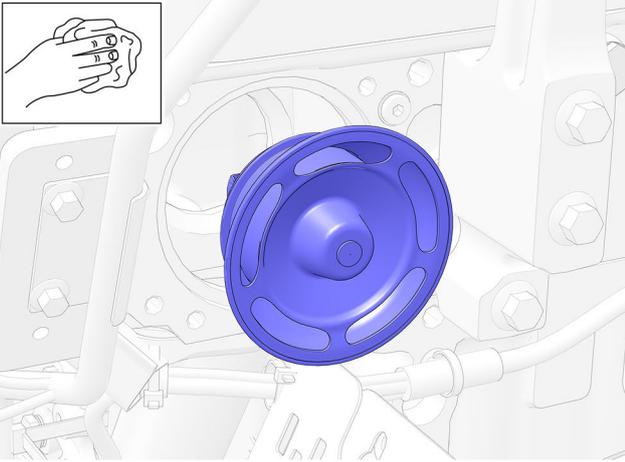


P0039236

3 Remove the thermostat housing cover.

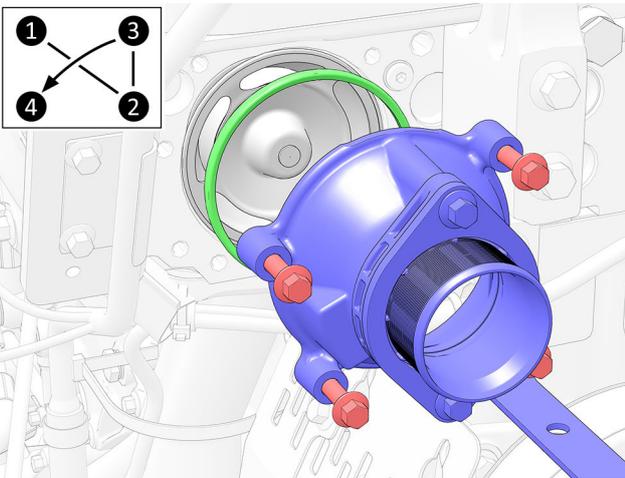


P0039239



P0039237

- 4 Replace the thermostat.
Clean the contact surfaces of the thermostat and cover.

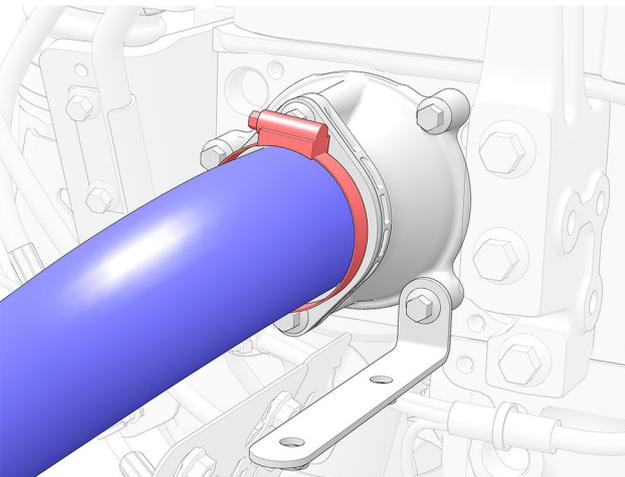


P0039238

- 5 Install the thermostat housing cover.

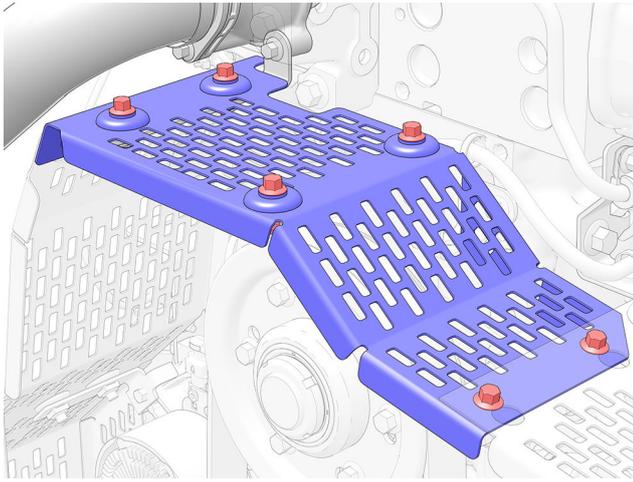
IMPORTANT:

Ensure that engine wiring is not pinched.



P0039236

- 6 Install the coolant hose.



P0039235

- 7 Install the upper belt protector.
- 8 Fill the system with coolant.

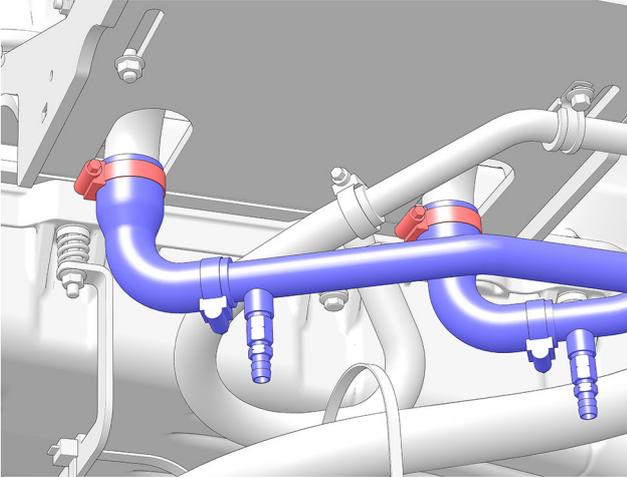
26-5 Charge Air Cooler with Connections

Charge Air Cooler, Lower, Replace

- Coolant drained; refer to 26-0, *Coolant, Replace*.

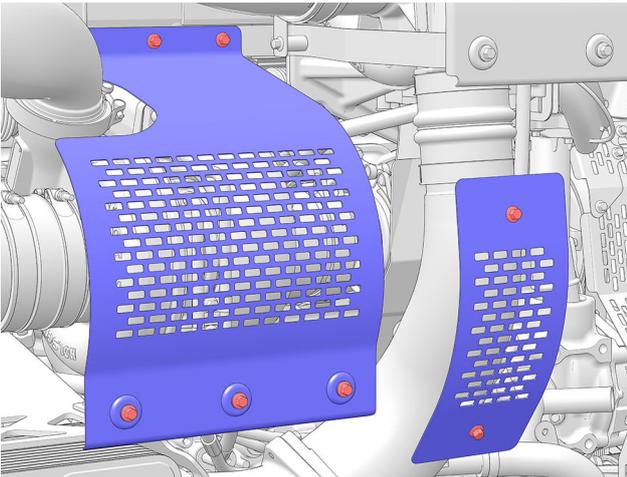
- 1 Detach the hose connections from the underside of the intercooler.

NOTICE! Be prepared to gather up fluid.



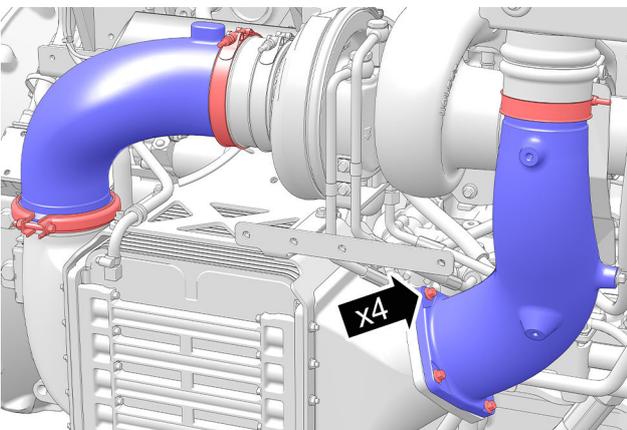
P0039786

- 2 Remove protective plates.

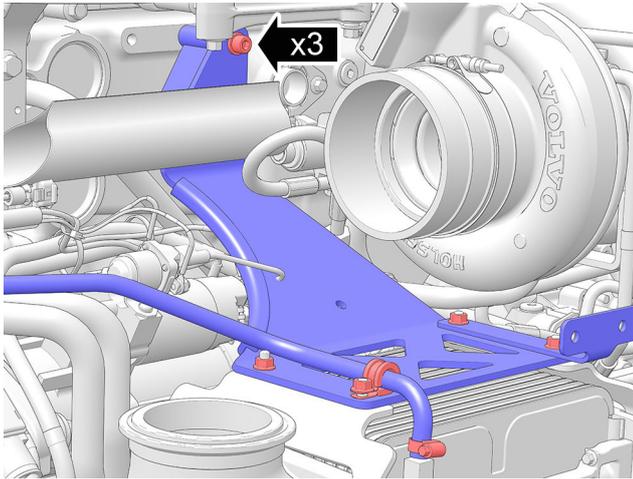


P0039787

- 3 Remove charge air pipes.

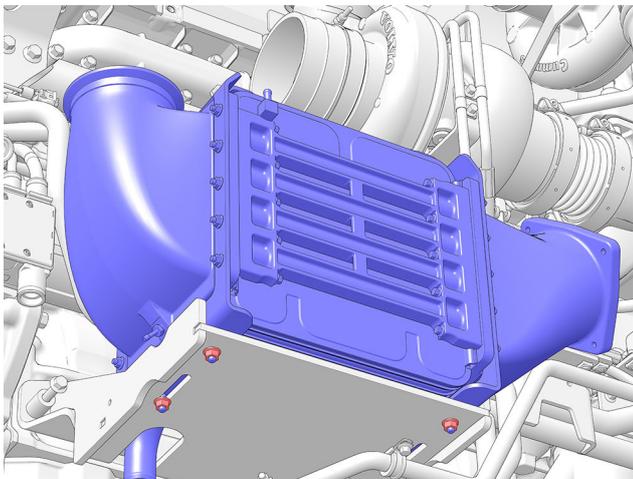


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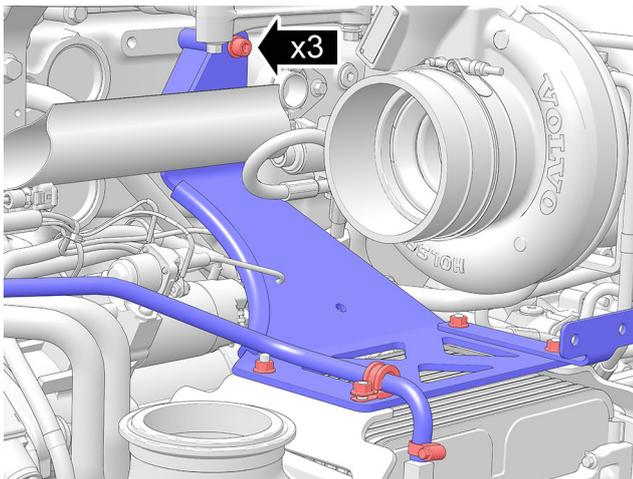
P0039781

- 4 Remove:
- hose
 - bracket



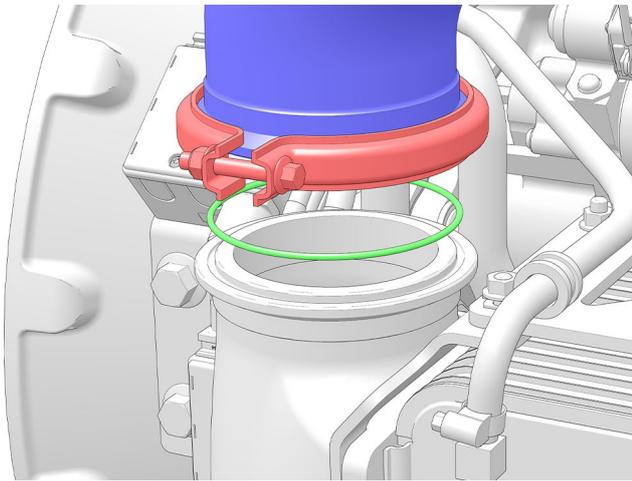
P0039782

- 5 Charge air cooler.



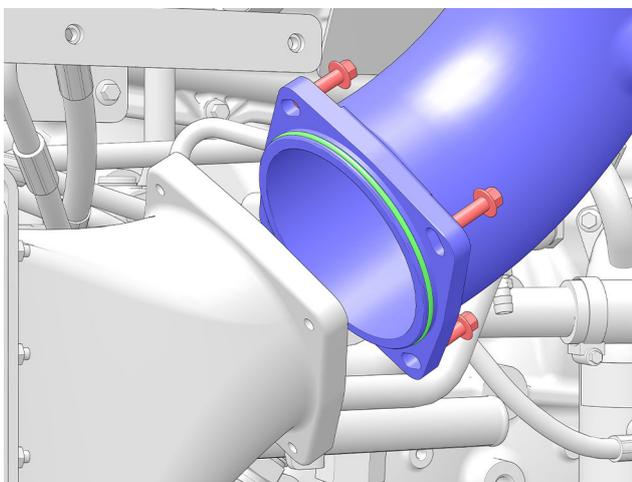
P0039781

- 6 Install:
- bracket
 - hose



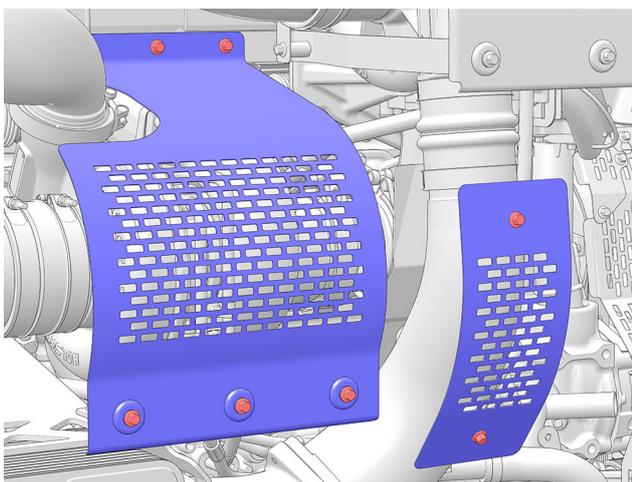
P0039783

7 Install the charge air pipe.



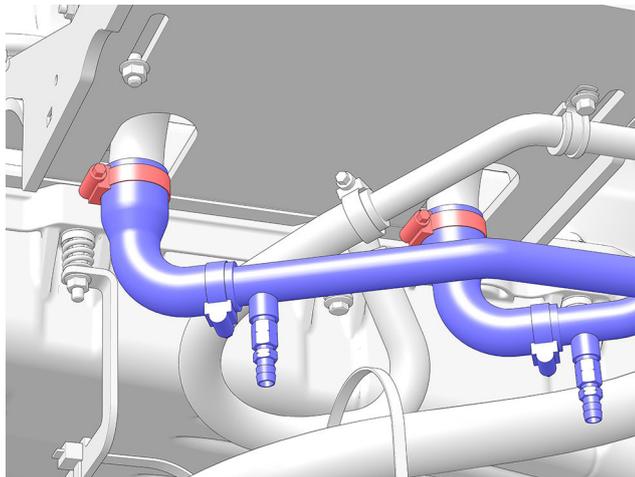
P0039784

8 Install the charge air pipe.



P0039787

9 Install the protective plating.



P0039786

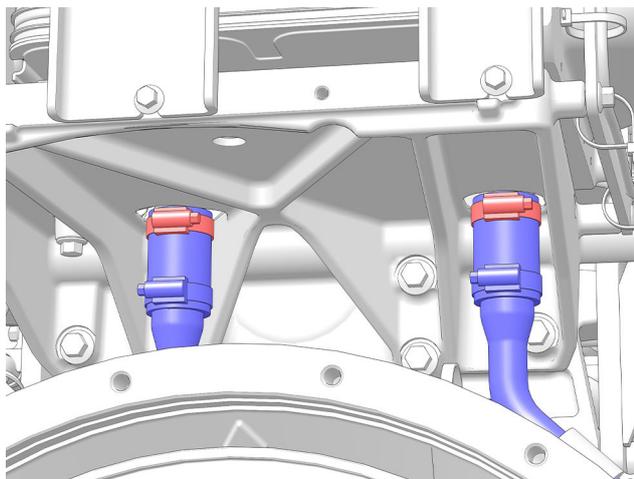
- 10 Install the hoses.
- 11 Fill the system with coolant; refer to 26-0, *Coolant, Replace*.

Charge Air Cooler, Upper, Replace

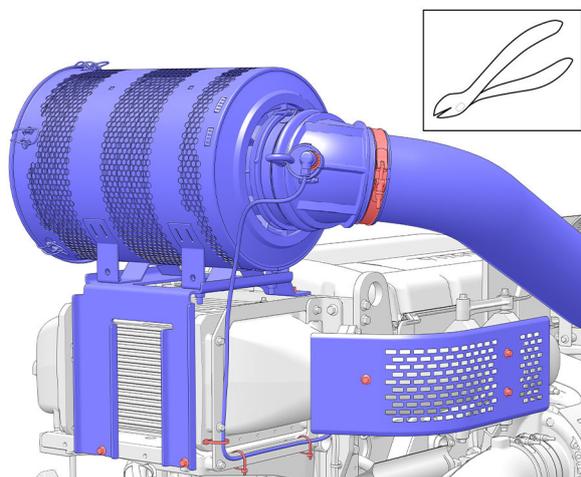
- Coolant drained; refer to 26-0, *Coolant, Replace*.

- 1 Detach the hose connections from the underside of the charge air cooler.

NOTICE! Be prepared to gather up fluid.



P0039788

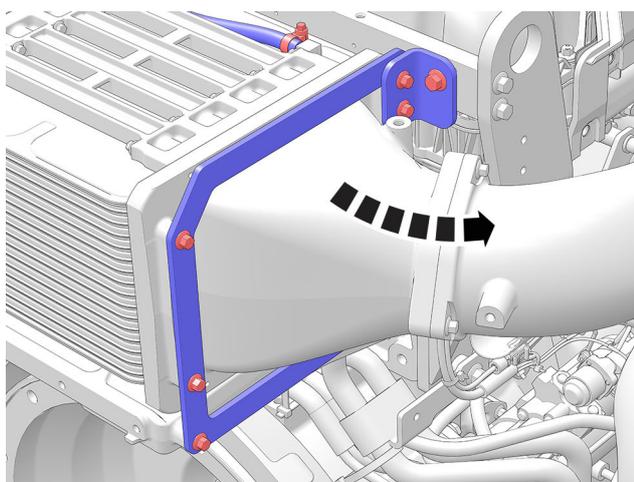


P0039794

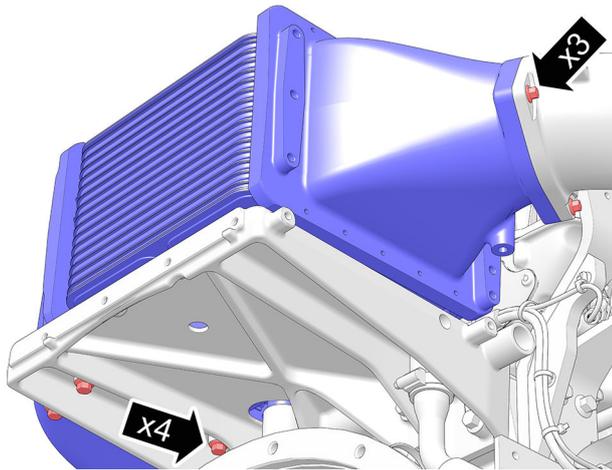
- 2 Remove:

- protective plating
- connector
- air inlet manifold
- air filter housing with bracket

- 3 Remove the hose.
Remove the bracket and move it aside.

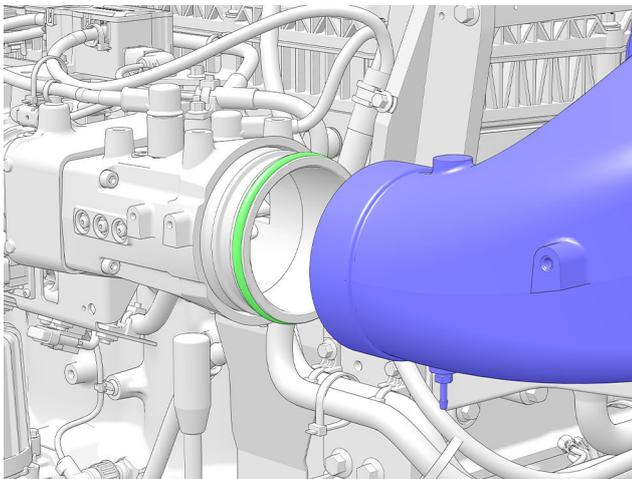


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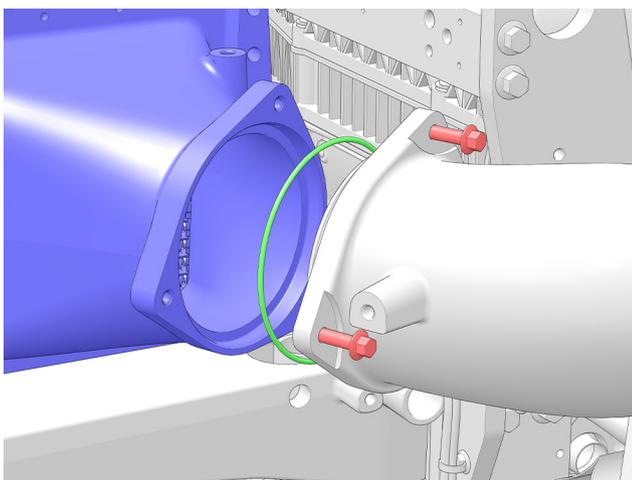
P0039791

- 4 Remove the charge air cooler.



P0039792

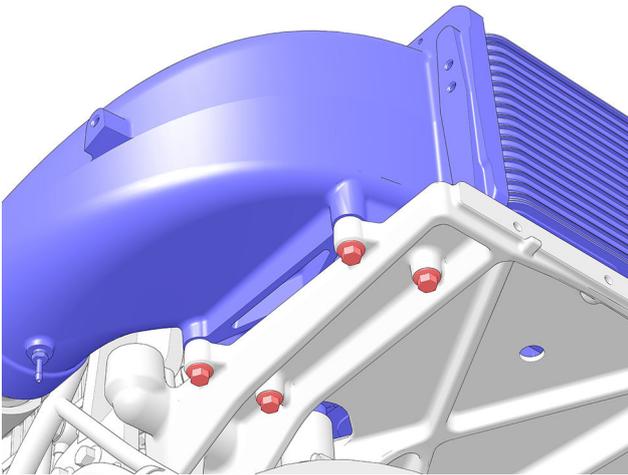
- 5 Install the charge air cooler.



P0039793

- 6 Tighten the charge air pipe connection.

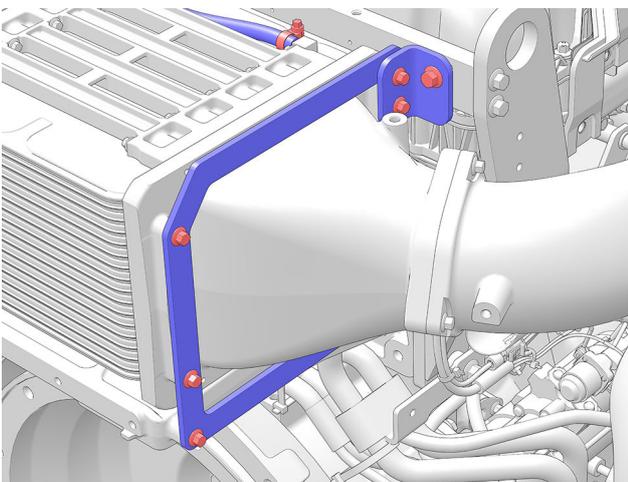
7 Tighten the charge air cooler.



P0039796

8 Install:

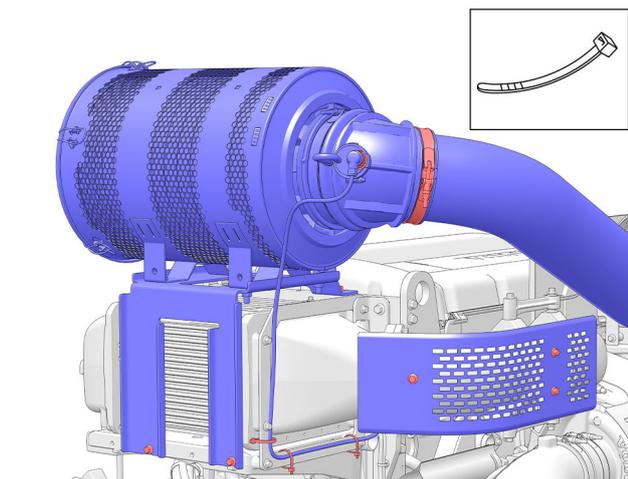
- bracket
- hose



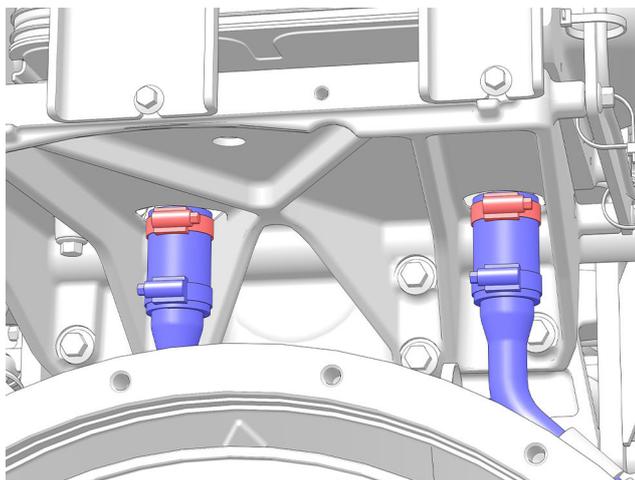
P0039789

9 Install:

- air filter housing with bracket
- air inlet manifold
- connector
- protective plating



P0039795



P0039788

- 10 Install the hoses.
- 11 Fill the system with coolant; refer to 26-0, *Coolant, Replace*.

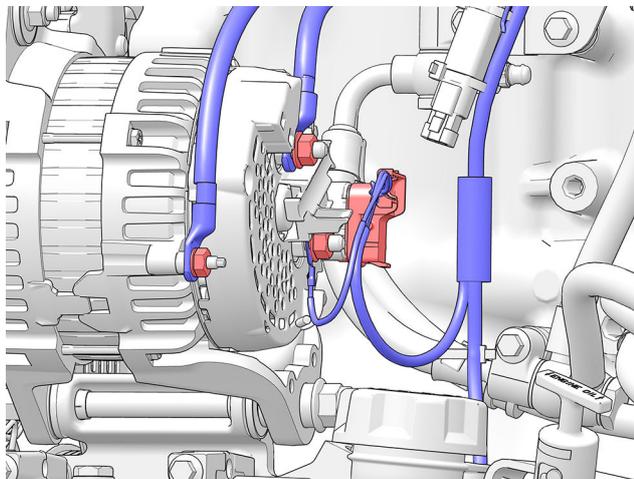
32-1 Alternator

Alternator, Replace

- Switch off the power.

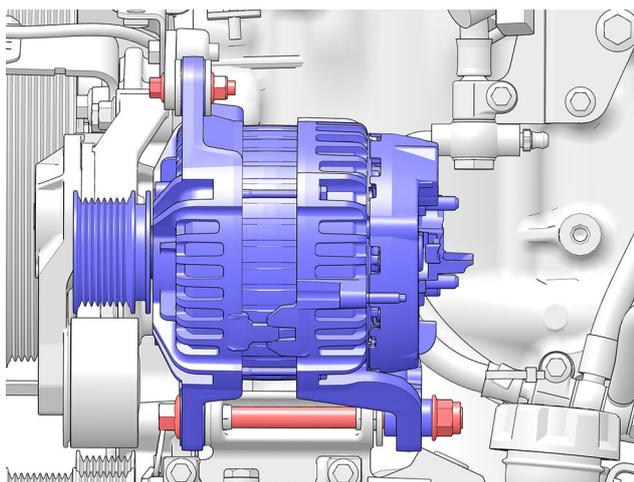
1 Remove:

- positive cable
- negative cable
- connector to alternator



P0038596

2 Replace the alternator.



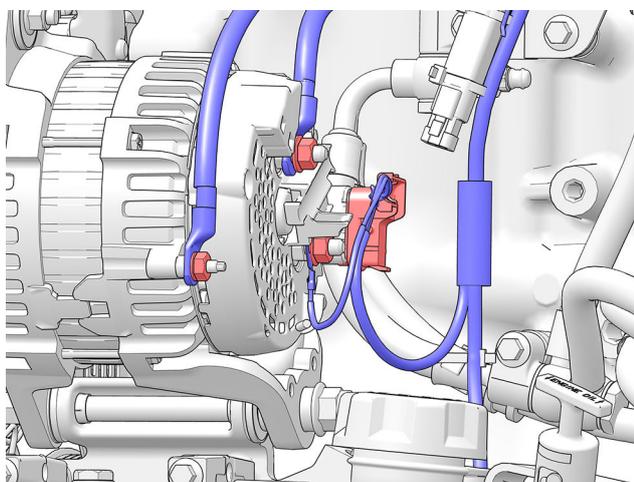
P0038597

3 Install:

- positive cable
- negative cable
- connector to alternator

4 Install drive belt, refer to *Drive Belts, Replace*, page 61.

- Turn the ignition on



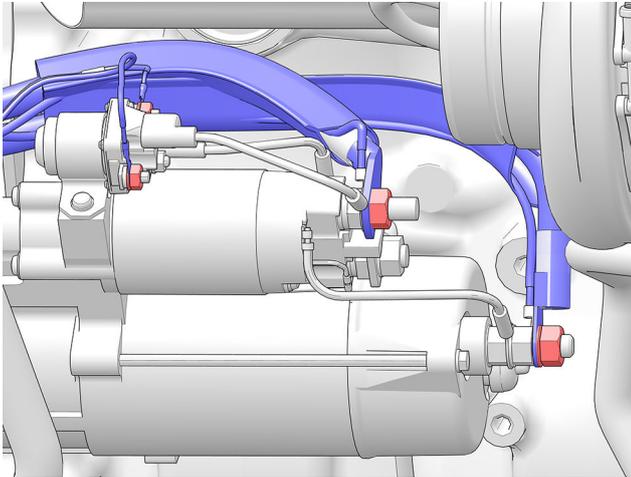
P0038596

33-1 Starter Motor

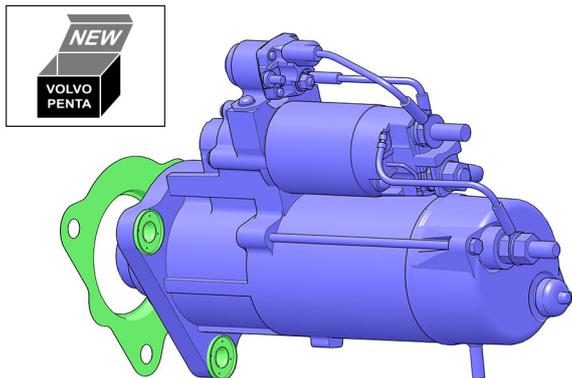
Starter Motor, Replace

- Switch off the power.
- Remove the lower charge air cooler; refer to *Charge Air Cooler, Lower, Replace*, page 185.

1 Remove the wiring.



P0038626



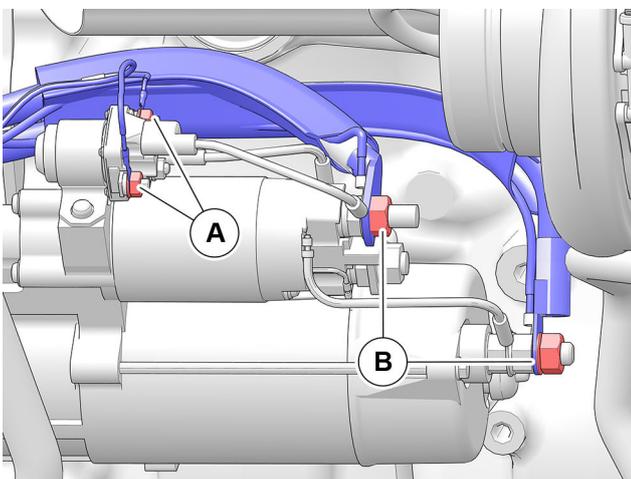
P0038628

2 Replace the starter motor.

3 Install:

- A Cable connection (A): **5 Nm**
- B Cable connection (B): **25 Nm**

- Switch the power on.



P0038625



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