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1. ENGINE, GENERAL

1.1 GENERAL

BE/CE engine

Cold engine

A cold engine is an engine which, having reached operating temperature, has been allowed to cool down for at least **six hours**.

Warm engine

A warm engine is an engine which, having reached operating temperature, has not been at a standstill for more than **thirty minutes**.

Direction of rotation of the engine

The direction of rotation of the engine is clockwise, as seen from the vibration damper end.

First cylinder of the engine

The first cylinder of the engine is the cylinder at the vibration damper end of the engine.

Left-hand and right-hand side of the engine

The left-hand side of the engine is the side where the air compressor and electronic unit are mounted. The right-hand side of the engine is the side where the turbocharger and oil filter are mounted.

Engine identification

Engine number

The engine number is located in two places on the engine:

- stamped into the engine block, top of the oil cooler
- on the type plate, fitted on the timing gear case or on the flywheel housing (depending on the production date)

Engine type

The type number CE162C indicates:

C engine family

B = 3.92 ltr.

C = 5.88 ltr.

E engine version

E = electronic timing

162 engine output in kilowatt (kW)

C Euro emissions

C = Euro 3



1.2 BE ENGINE, GENERAL

Engine types

Coding BE 99 C
BE 110 C
BE 123 C

General specifications

Environmental standard Euro 3 (C)
Number of cylinders 4 cylinders in line
Valves 4 valves per cylinder
Bore x stroke 102 x 120 mm
Cubic capacity 3.9 litres

Compression ratio

BE 99 C 17.0 : 1
BE 110 C 17.0 : 1
BE 123 C 17.3 : 1

Fuel injection direct injection
Injection sequence 1-3-4-2
Air inlet system Turbocharger intercooling
Engine management system ECS-DC3
Cooling fluid
Weight approx. 400 kg

Engine speeds, BE engine

Engine type	Idling rpm	Maximum no-load rpm
BE 99 C	600 - 800	Approx. 2500
BE 110 C	600 - 800	Approx. 2500
BE 123 C	600 - 800	Approx. 2500

1.3 CE ENGINE, GENERAL

Engine types

Coding	CE 136 C
	CE 162 C
	CE 184 C

General specifications

Environmental standard	Euro 3 (C)
Number of cylinders	6 cylinders in line
Valves	4 valves per cylinder
Bore x stroke	102 x 120 mm
Cubic capacity	5.9 litres
Compression ratio	17,3 : 1
Fuel injection	direct injection
Injection sequence	1-5-3-6-2-4
Air inlet system	Turbocharger intercooling
Engine management system	ECS-DC3
Cooling	fluid
Weight	approx. 500 kg

Engine speeds, CE engine

Engine type	Idling rpm	Maximum no-load rpm
CE 136 C	600 - 800	approx. 2500
CE 162 C	600 - 800	approx. 2500
CE 184 C	600 - 800	approx. 2500

2. BE ENGINE FUEL SYSTEM

2.1 GENERAL

Fuel level element

Angular displacement 70°

Fuel fine filter

Maximum pressure drop across fuel fine filter 2.0 bar

Lift pump

Fuel lift pump pressure in front of fine filter (with engine at idling speed) 5 - 13 bar

Fuel lift pump pressure behind fine filter (with engine at idling speed) 3 - 11 bar

Pressure relief valve opening pressure 11 bar

Maximum underpressure on suction side of fuel lift pump 0.5 bar

High-pressure pump

Pump pressure (dependent on the operating mode of the engine and the electronic calibration) 300 - 1400 bar

Fuel rail

Fuel rail pressure (dependent on the operating mode of the engine and the electronic calibration) 300 - 1400 bar

Fuel rail pressure-limiting valve

Opening pressure 1650 bar

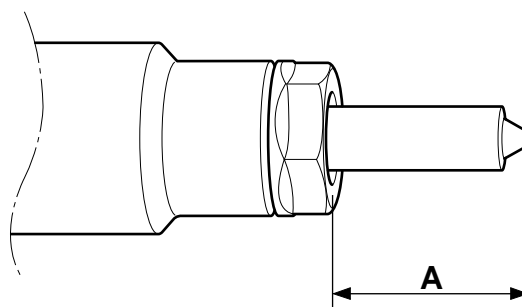
Injector

Number of holes in injector 8

Resistance of magnet coil 0,15 - 0,5 Ω

Injector washer

Nozzle length (distance A)	Washer thickness
21.5 ± 0.2 mm	1.5 mm
23.0 ± 0.2 mm	3.0 mm



i400693

0**Fuel return overflow valve**

Fuel return overflow valve opening pressure 1.2 - 2.0 bar

Fuel return pipe

Maximum return pipe pressure build-up 0.2 bar

Return fuel measurement

Maximum quantity of return fuel at idling speed 120 ml/min.

Minimum permitted time for filling a measuring beaker to a volume of 360 ml 3 min.

2.2 TIGHTENING TORQUES

The tightening torques specified in this section are different from the standard tightening torques cited in the overview of the standard tightening torques. The other threaded connections not specified must therefore be tightened to the torque cited in the overview of standard tightening torques.

When attachment bolts and nuts are replaced, it is important that - unless stated otherwise - these bolts and nuts are of exactly the same length and property class as those removed.

Electronic unit cooling plate

Attachment bolts holding the electronic unit to the cooling plate	10 Nm
Attachment bolts holding the cooling plate to the engine block	24 Nm
VOSS quick-release coupling fittings	18 Nm

Low-pressure fuel pipes

Banjo bolts	24 Nm
VOSS quick-release coupling fittings	24 Nm
Fuel return overflow valve in cylinder head	24 Nm

High-pressure pump

Attachment nuts holding the high-pressure pump to the timing gear case	25 Nm
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High-pressure fuel pipe

High-pressure pipe union nut	22 Nm
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Fuel rail

Attachment bolts	24 Nm
Pressure-limiting valve	100 Nm

Injector pipes

Injector pipe union nuts	22 Nm
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Fuel supply pipe

Fuel supply pipe nut	50 Nm
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Injectors

Injector clamping bracket attachment bolts	10 Nm
Injector electrical connection	1.5 Nm

3. CE ENGINE FUEL SYSTEM

3.1 GENERAL

Fuel level element

Angular displacement 70°

Fuel fine filter

Maximum pressure drop across fuel fine filter 2.0 bar

Lift pump

Fuel lift pump pressure in front of fine filter (with engine at idling speed) 5 - 13 bar

Fuel lift pump pressure behind fine filter (with engine at idling speed) 3 - 11 bar

Pressure relief valve opening pressure 11 bar

Maximum underpressure on suction side of fuel lift pump 0.5 bar

High-pressure pump

Pump pressure (dependent on the operating mode of the engine and the electronic calibration) 300 - 1400 bar

Fuel rail

Fuel rail pressure (dependent on the operating mode of the engine and the electronic calibration) 300 - 1400 bar

Fuel rail pressure-limiting valve

Opening pressure 1650 bar

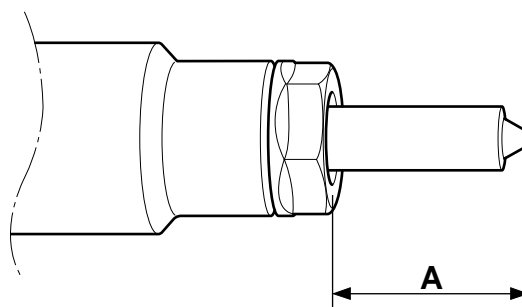
Injector

Number of holes in injector 8

Resistance of magnet coil 0,15 - 0,5 Ω

Injector washer

Nozzle length (distance A)	Washer thickness
21.5 ± 0.2 mm	1.5 mm
23.0 ± 0.2 mm	3.0 mm



i400693

0**Fuel return overflow valve**

Fuel return overflow valve opening pressure 1.2 - 2.0 bar

Fuel return pipe

Maximum return pipe pressure build-up 0.2 bar

Return fuel measurement

Maximum quantity of return fuel at idling speed 180 ml/min.

Time for filling a measuring beaker to a volume of 360 ml > 2 min.

3.2 TIGHTENING TORQUES

The tightening torques specified in this section are different from the standard tightening torques cited in the overview of the standard tightening torques. The other threaded connections not specified must therefore be tightened to the torque cited in the overview of standard tightening torques.

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VOSS quick-release coupling fittings	18 Nm

Low-pressure fuel pipes

Banjo bolts	24 Nm
VOSS quick-release coupling fittings	24 Nm
Fuel return overflow valve in cylinder head	24 Nm

High-pressure pump

Attachment nuts holding the high-pressure pump to the timing gear case	25 Nm
--	-------

High-pressure fuel pipe

High-pressure pipe union nut	22 Nm
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Fuel rail

Attachment bolts	24 Nm
Pressure-limiting valve	100 Nm

Injector pipes

Injector pipe union nuts	22 Nm
--------------------------	-------

Fuel supply pipe

Fuel supply pipe nut	50 Nm
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Injectors

Injector clamping bracket attachment bolts	10 Nm
Injector electrical connection	1.5 Nm

4. BE ENGINE INLET/EXHAUST SYSTEM

4.1 GENERAL

Turbocharger

BE 99 C

Holset HX 27 W

BE 110 C

Holset HX 27 W

BE 123 C

Holset HX 27 W

Minimum actuating pressure of wastegate capsule under which the control rod will move

2.0 bar

Axial bearing play of compressor shaft

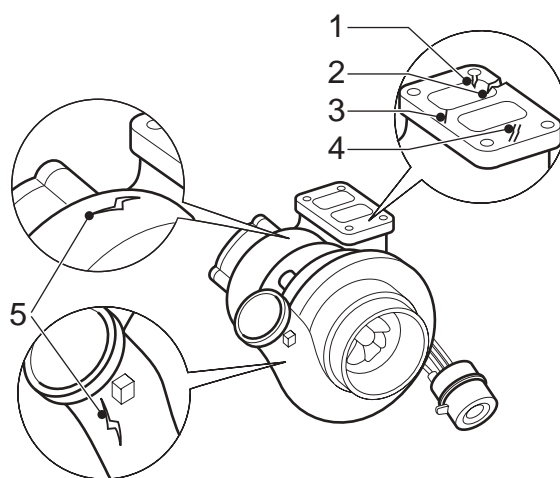
0.057 - 0.103 mm

Radial bearing play of compressor shaft

0.39 - 0.67 mm

Rejection standards for cracking

1. Cracks in the connector flange must not reach as far as the attachment holes.
2. Cracks in the connector flange must not reach from the channels as far as the exterior.
3. Cracks in the connector flange may not be longer than 15 mm.
4. Cracks in the connector flange must not be less than 6 mm apart.
5. There must be no cracks in the housing.



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Exhaust gas back pressure

At full-load engine speed

100 mbar

Maximum back pressure during engine brake application

4.3 bar

Inlet underpressure

At full-load engine speed (clean air filter)

25 mbar

At full-load engine speed (clogged air filter)

62 mbar

Glow element

Resistance value

180 - 220 mΩ

0

4.2 TIGHTENING TORQUES

The tightening torques specified in this section are different from the standard tightening torques cited in the overview of the standard tightening torques. The other threaded connections not specified must therefore be tightened to the torque cited in the overview of standard tightening torques.

When attachment bolts and nuts are replaced, it is important that - unless stated otherwise - these bolts and nuts are of exactly the same length and property class as those removed.

Turbocharger

Attachment nuts, exhaust manifold flange/turbocharger	43 Nm ⁽¹⁾
Oil discharge pipe attachment bolts	23 Nm
Oil supply pipe union	28 Nm
Turbocharger V-clamp	10 Nm

(1) Fasten with Copaslip

Intake manifold

Glow element attachment bolts	14 Nm
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Air cooler

Hose clamps	7 Nm
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5. CE ENGINE INLET/EXHAUST SYSTEM

5.1 GENERAL

Turbocharger

CE 136 C
CE 162 C
CE 184 C

Holset HY 35 W
Holset HY 35 W
Holset HX 35 W

Minimum actuating pressure of wastegate capsule under which the control rod will move

2.0 bar

Axial bearing play of compressor shaft

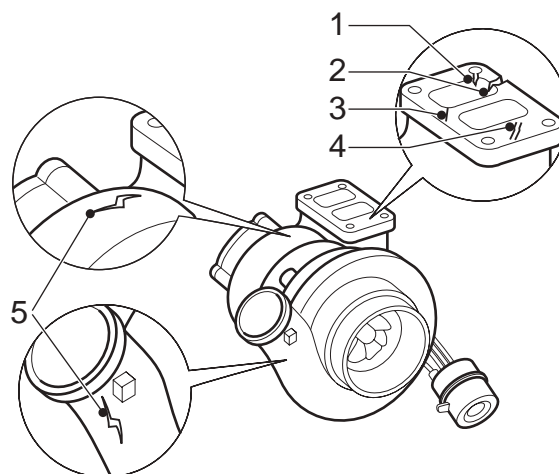
0.038 - 0.093 mm

Radial bearing play of compressor shaft

0.329 - 0.501 mm

Rejection standards for cracking

1. Cracks in the connector flange must not reach as far as the attachment holes.
2. Cracks in the connector flange must not reach from the channels as far as the exterior.
3. Cracks in the connector flange may not be longer than 15 mm.
4. Cracks in the connector flange must not be less than 6 mm apart.
5. There must be no cracks in the housing.



i400784

Exhaust gas back pressure

At full-load engine speed

100 mbar

Maximum back pressure during engine brake application

4.3 bar

Inlet underpressure

At full-load engine speed (clean air filter)

25 mbar

At full-load engine speed (clogged air filter)

62 mbar

Glow element

Resistance value

180 - 220 mΩ

0

5.2 TIGHTENING TORQUES

The tightening torques specified in this section are different from the standard tightening torques cited in the overview of the standard tightening torques. The other threaded connections not specified must therefore be tightened to the torque cited in the overview of standard tightening torques.

When attachment bolts and nuts are replaced, it is important that - unless stated otherwise - these bolts and nuts are of exactly the same length and property class as those removed.

Turbocharger

Attachment nuts, exhaust manifold flange/turbocharger	43 Nm ⁽¹⁾
Oil discharge pipe attachment bolts	23 Nm
Oil supply pipe union	28 Nm
Turbocharger V-clamp	10 Nm

(1) Fasten with Copaslip

Glow element

Attachment bolts	14 Nm
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Air cooler

Hose clamps	7 Nm
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1. TRACTIVE PROBLEMS

1.1 TRACTIVE PROBLEMS

The first test that has to be carried out when investigating tractive problems is the acceleration test.

2. FUEL SYSTEM

2.1 INTRODUCTION

If there is a fault in the system, it is usually detected by the electronic unit in the form of a fault code. This fault code can be read out using DAVIE. The fault-finding table contains possible causes of symptoms not detected by the electronic unit.

2.2 FAULT-FINDING TABLE

1

SYMPTOM: ENGINE CAN BE STARTED, BUT DOES NOT RUN	
Possible cause	Remedy
Poor fuel quality	Drain fuel, flush fuel system, replace the fuel filters and fill fuel tank with fuel
Air in fuel system	Check for drawing in of air: - via the suction pipe
Fuel fine filter/coarse filter clogged	Replace fuel fine filter and clean the system
No fuel supply/high-pressure pump or fuel lift pump defective; no delivery	Check: - the fuel level - the rail pressure - the pipes for blockage and leaks - the fuel lift pump - the high-pressure pump

SYMPTOM: ENGINE STALLS AND RUNS AGAIN AFTER RE-STARTING	
Possible cause	Remedy
Air in fuel system	Check for drawing in of air: - via the suction pipe

SYMPTOM: ENGINE STARTS POORLY	
Possible cause	Remedy
Poor fuel quality	Drain fuel, flush fuel system, replace the fuel filters and fill fuel tank with fuel
Air in fuel system	Check for drawing in of air: - via the suction pipe
Fuel fine filter/coarse filter clogged	Replace fuel fine filter and clean the system
Injector(s) mechanically defective or clogged	Replace the injectors
High-pressure pump or fuel lift pump delivery too low	Check: - the high-pressure pump - the fuel lift pump
Internal fuel leak between fuel supply pipe(s) and injector(s)	Check the quantity of return fuel

SYMPTOM: ENGINE RUNS AT (INCREASED) IDLING SPEED AND DOES NOT RESPOND TO ACCELERATOR PEDAL	
Possible cause	Remedy
Mechanical defect of accelerator pedal sensor	Check: - mechanical connection of sensor/accelerator pedal - accelerator pedal sensor

SYMPTOM: DIESEL KNOCK DURING ACCELERATION	
Possible cause	Remedy
Poor fuel quality	Drain fuel, flush fuel system, replace the fuel filters and fill fuel tank with fuel
Air in fuel system	Check for drawing in of air: - via the suction pipe
Injector defective	Check the injectors

SYMPTOM: IRREGULAR RUNNING OF ENGINE	
Possible cause	Remedy
Poor fuel quality	Drain fuel, flush fuel system, replace the fuel filters and fill fuel tank with fuel
Air in fuel system	Check for drawing in of air: - via the suction pipe
Fuel fine filter/coarse filter clogged	Replace fuel fine filter and clean the system
Injector(s) mechanically defective or clogged	Replace the injectors
Injector defective	Check the injectors
High-pressure pump or fuel lift pump delivery too low	Check: - the high-pressure pump - the fuel lift pump

SYMPTOM: REDUCED POWER AT ALL ENGINE SPEEDS	
Possible cause	Remedy
Poor fuel quality	Drain fuel, flush fuel system, replace the fuel filters and fill fuel tank with fuel
Fuel fine filter/coarse filter clogged	Replace fuel fine filter and clean the system
Injector(s) mechanically defective or clogged	Replace the injectors
Mechanical defect of accelerator pedal sensor	Check: - mechanical connection of sensor/accelerator pedal - accelerator pedal sensor
High-pressure pump or fuel lift pump delivery too low	Check: - the high-pressure pump - the fuel lift pump

SYMPTOM: REDUCED POWER ABOVE A CERTAIN ENGINE SPEED	
Possible cause	Remedy
Fuel fine filter/coarse filter partially clogged	Replace fuel fine filter and clean the system
Injector(s) mechanically defective or clogged	Replace the injectors
Air leak in inlet system	Pressure-test the inlet system

1

SYMPTOM: REDUCED POWER ABOVE A CERTAIN ENGINE SPEED	
Possible cause	Remedy
High-pressure pump or fuel lift pump delivery too low	Check: - the high-pressure pump - the fuel lift pump
Fault in electrical components/wiring of: - connectors	Check the electrical system

SYMPTOM: ENGINE SLUGGISH WHEN ACCELERATING OR UNDER HIGH LOAD	
Possible cause	Remedy
Internal fuel leak between fuel supply pipe(s) and injector(s)	Check the quantity of return fuel
High-pressure pump or fuel lift pump delivery too low	Check: - the high-pressure pump - the fuel lift pump

SYMPTOM: WHITE/BLUE SMOKE IS EMITTED	
Possible cause	Remedy
Poor fuel quality	Drain fuel, flush fuel system, replace the fuel filters and fill fuel tank with fuel
Air in fuel system	Check for drawing in of air: - via the suction pipe
Fuel fine filter/coarse filter clogged	Replace fuel fine filter and clean the system
Injector(s) mechanically defective or clogged	Replace the injectors
High-pressure pump or fuel lift pump delivery too low	Check: - the high-pressure pump - the fuel lift pump
Fault in electrical components/wiring of: - connectors	Check the electrical system

SYMPTOM: BLACK SMOKE IS EMITTED	
Possible cause	Remedy
Injector(s) mechanically defective or clogged	Replace the injectors

SYMPTOM: ENGINE OVERHEATED	
Possible cause	Remedy
Poor fuel quality	Drain fuel, flush fuel system, replace the fuel filters and fill fuel tank with fuel

SYMPTOM: FUEL CONSUMPTION TOO HIGH	
Possible cause	Remedy
Poor fuel quality	Drain fuel, flush fuel system, replace the fuel filters and fill fuel tank with fuel
Fuel fine filter/coarse filter clogged	Replace fuel fine filter and clean the system
Injector(s) mechanically defective or clogged	Replace the injectors
Leak in fuel system	Check for leaks

SYMPTOM: REDUCED MAXIMUM ENGINE SPEED	
Possible cause	Remedy
Air in fuel system	Check for drawing in of air: - via the suction pipe
Fuel fine filter/coarse filter clogged	Replace the fuel filter and clean the system
Injector(s) mechanically defective or clogged	Replace the injectors
High-pressure pump or fuel lift pump delivery too low	Check: - the high-pressure pump - the fuel lift pump

3. INLET/EXHAUST SYSTEM

3.1 INTRODUCTION

If there is a fault in the system, it is usually detected by the electronic unit in the form of a fault code. This fault code can be read out using DAVIE. The fault-finding table contains possible causes of symptoms not detected by the electronic unit.

3.2 FAULT-FINDING TABLE

1

SYMPTOM: REDUCED POWER AT ALL ENGINE SPEEDS	
Possible cause	Remedy
Air filter element blocked	Replace the air filter element
Turbocharger defective/wastegate control incorrect	Check the turbocharger/wastegate control
Air leak in inlet system	Pressure-test the inlet system

SYMPTOM: REDUCED POWER ABOVE A CERTAIN ENGINE SPEED	
Possible cause	Remedy
Air filter element partially blocked	Check/replace the air filter element
Air leak in inlet system	Pressure-test the inlet system

SYMPTOM: FUEL CONSUMPTION TOO HIGH	
Possible cause	Remedy
Turbocharger defective	Check the turbocharger
Air leak in inlet system	Pressure-test the inlet system

SYMPTOM: REDUCED MAXIMUM ENGINE SPEED	
Possible cause	Remedy
Turbocharger defective	Check the turbocharger

SYMPTOM: RISING AND FALLING TURBOCHARGER SOUNDS	
Possible cause	Remedy
Blocked turbocharger air intake	Check air intake and remove any obstacles
Compressor side of turbocharger contaminated	Clean compressor side with a non-corrosive cleaning agent or a soft brush. Check the intake side for carbon deposits or other contamination
Turbocharger damaged	Replace the turbocharger and identify the cause

SYMPTOM: BLACK SMOKE EMERGES FROM EXHAUST	
Possible cause	Remedy
Air filter element blocked	Replace the air filter element
Air leakage between turbocharger and inlet manifold	Check flexible pipes and pressurise intake unit
Air leakage between the inlet manifold and cylinder head	Check for leakage. Replace gaskets, if necessary

SYMPTOM: BLACK SMOKE EMERGES FROM EXHAUST	
Possible cause	Remedy
Compressor side of turbocharger contaminated	Clean compressor side with a non-corrosive cleaning agent or a soft brush. Check the intake side for carbon deposits or other contamination
Gas leak between the exhaust manifold and the cylinder head	Check the fixing bolts and gaskets
Gas leak between the exhaust manifold and the turbocharger	Check the fixing bolts and gaskets
Turbocharger damaged	Replace the turbocharger and identify the cause

SYMPTOM: BLUE SMOKE EMERGES FROM EXHAUST	
Possible cause	Remedy
Air filter element blocked	Replace the air filter element
Air leakage between turbocharger and inlet manifold	Check flexible pipes and pressurise intake unit
Air leakage between the inlet manifold and cylinder head	Check for leakage. Replace gaskets, if necessary
Compressor side of turbocharger contaminated	Clean compressor side with a non-corrosive cleaning agent or a soft brush. Check the intake side for carbon deposits or other contamination
Turbocharger oil discharge pipe clogged	Check oil pipe. Replace as necessary
Turbocharger damaged	Replace the turbocharger and identify the cause

SYMPTOM: OIL LEAK AT TURBINE SIDE OF TURBOCHARGER	
Possible cause	Remedy
Compressor side of turbocharger contaminated	Clean compressor side with a non-corrosive cleaning agent or a soft brush. Check the intake side for carbon deposits or other contamination
Turbocharger oil discharge pipe clogged	Check oil pipe. Replace as necessary
Turbocharger damaged	Replace the turbocharger and identify the cause

SYMPTOM: OIL LEAK AT COMPRESSOR SIDE OF TURBOCHARGER	
Possible cause	Remedy
Air filter element blocked	Replace the air filter element
Turbocharger oil pipe clogged	Check oil pipe. Replace as necessary
Turbocharger damaged	Replace the turbocharger and identify the cause

1

SYMPTOM: EXHAUST GAS BACK PRESSURE TOO HIGH	
Possible cause	Remedy
Incorrect butterfly valve adjustment	Check the adjustment of the butterfly valve
Butterfly valve incorrectly positioned	Check whether the butterfly valve has been positioned correctly
Butterfly valve partially operated by residual pressure in the operating cylinder	Check operating cylinder
Original exhaust silencer not fitted	Check exhaust silencer
Exhaust pipe crushed or internally blocked by a loose part	Check exhaust system for blockage and/or damage

SYMPTOM: INLET UNDERPRESSURE TOO HIGH	
Possible cause	Remedy
Air filter element blocked	Replace air filter element

4. ENGINE BRAKE

4.1 INTRODUCTION

If there is a fault in the system, it is usually detected by the electronic unit in the form of a fault code. This fault code can be read out using DAVIE. The fault-finding table contains possible causes of symptoms not detected by the electronic unit.

4.2 FAULT-FINDING TABLE

1

SYMPTOM: ENGINE BRAKE DOES NOT ENGAGE	
Possible cause	Remedy
Compressor delivering insufficient air pressure.	Check the operation of the compressor.
Air leak in the air pipe from air dryer to exhaust brake valve.	Check air pipe.
Butterfly valve stuck in butterfly valve housing.	Check free movement of butterfly valve.
Electrical fault.	Check electrical circuit.

SYMPTOM: ENGINE BRAKE REMAINS ENGAGED	
Possible cause	Remedy
Butterfly valve stuck in butterfly valve housing.	Check free movement of butterfly valve.
Electrical fault.	Check electrical circuit.

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1. SAFETY INSTRUCTIONS

1.1 SAFETY INSTRUCTIONS

Fuel



Diesel fuel is an extremely flammable liquid, and must not be exposed to naked flames or come into contact with hot surfaces. The diesel fuel fumes remaining in an empty fuel tank form an extremely explosive mixture.

When fuel system components are being removed, some fuel will escape. To keep this spillage to a minimum, unscrew the tank cap to release any overpressure.

Any spilled fuel must be collected, bearing in mind the risk of fire.

Exhaust gases

Do not run the engine in an enclosed or unventilated area. Make sure exhaust fumes are properly extracted.



Exhaust gases contain carbon monoxide. Carbon monoxide is a deadly colourless and odourless gas, which, when inhaled, deprives the body of oxygen, leading to asphyxiation. Serious carbon monoxide poisoning may result in brain damage or death.

Moving parts

Remain at a safe distance from rotating and/or moving components.

Various fluids

Various oils and lubricants used on the vehicle may constitute a health hazard. This also applies to engine coolant, windscreen washer fluid, refrigerant in air-conditioning systems, battery acid and clutch fluid. So avoid inhaling and direct contact.

Electrical short-circuit

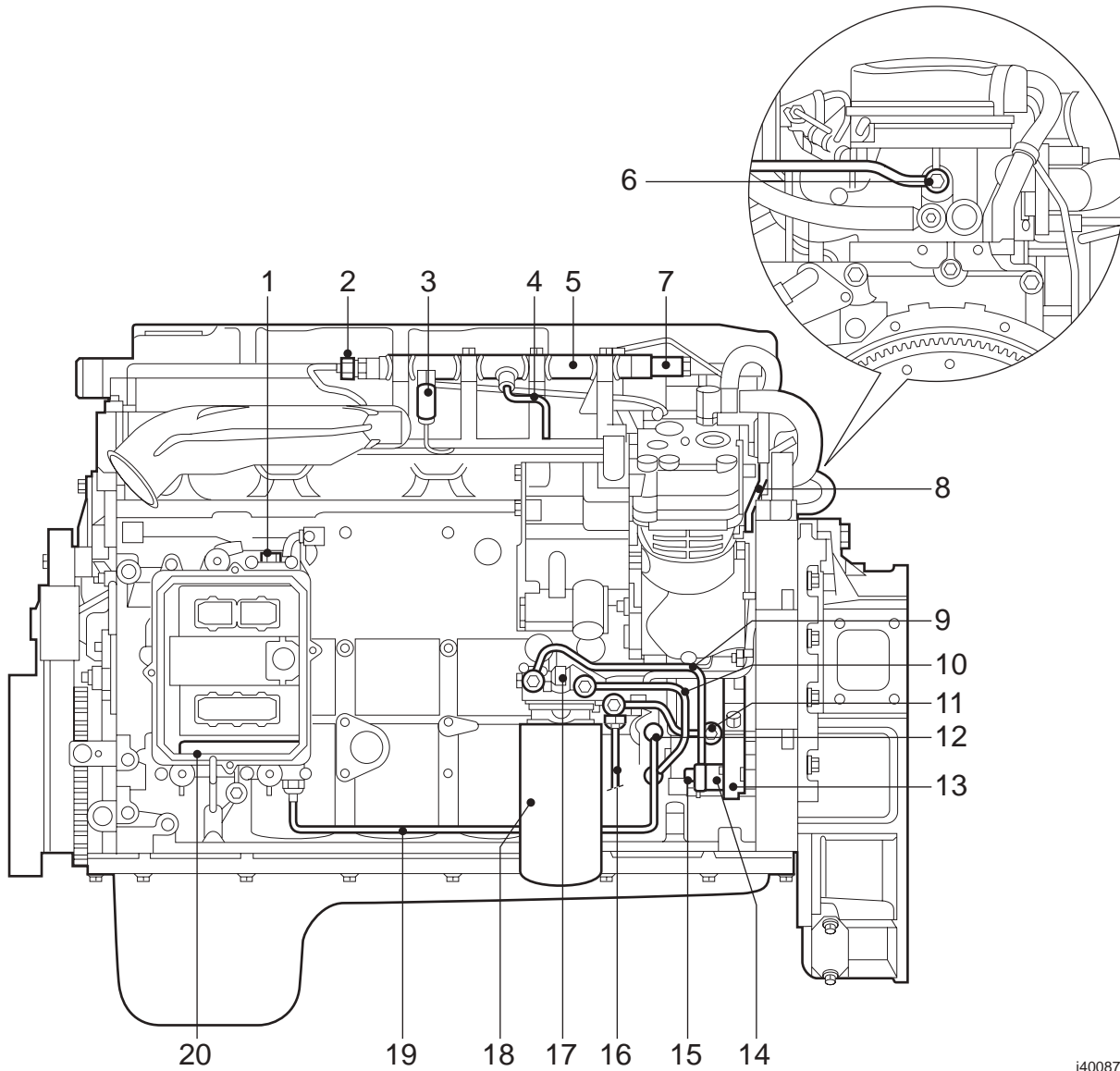
Always disconnect the battery's earth connection during repair or maintenance operations for which the electric power supply is not required.

2

2. GENERAL

2.1 LOCATION OF COMPONENTS

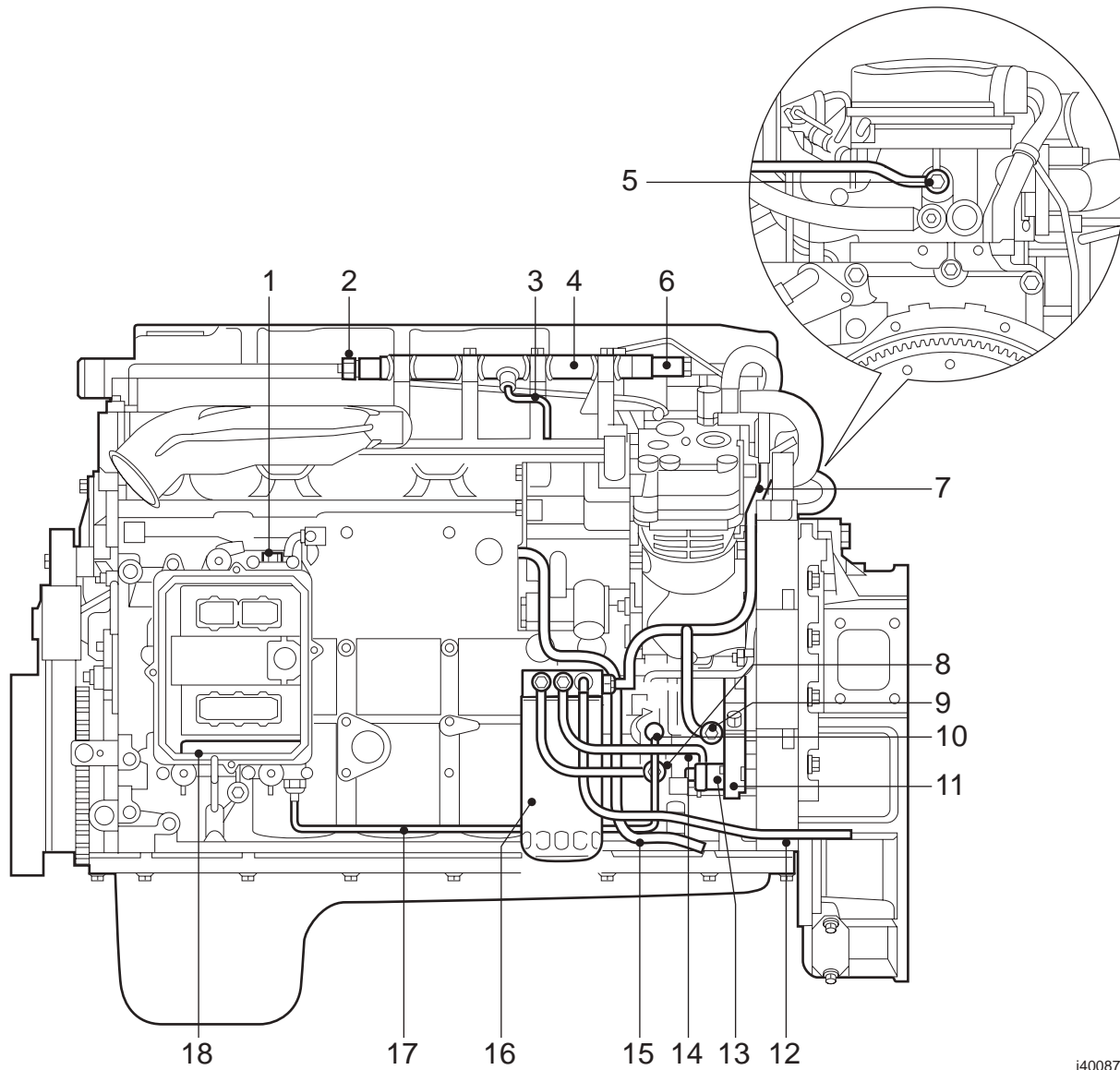
Location of components, production date < 2003-49 (chassis number < 0L253643)



i400870

1. Suction pipe to electronic unit cooling plate
2. Injector pipe
3. Fuel rail pressure sensor
4. Fuel pipe to fuel rail
5. Fuel rail
6. Fuel return overflow valve
7. Fuel rail pressure-limiting valve
8. Return pipe from fuel return overflow valve
9. Fuel pipe to high-pressure pump
10. Fuel pipe to fuel fine filter
11. High-pressure pump leak-off pipe
12. Fuel pipe to fuel lift pump
13. High-pressure pump
14. Fuel pump control solenoid valve
15. Fuel pipe to high-pressure pump
16. Return pipe to fuel tank
17. Fuel temperature sensor
18. Fuel fine filter
19. Fuel pipe from electronic unit cooling plate
20. ECS-DC3 electronic unit

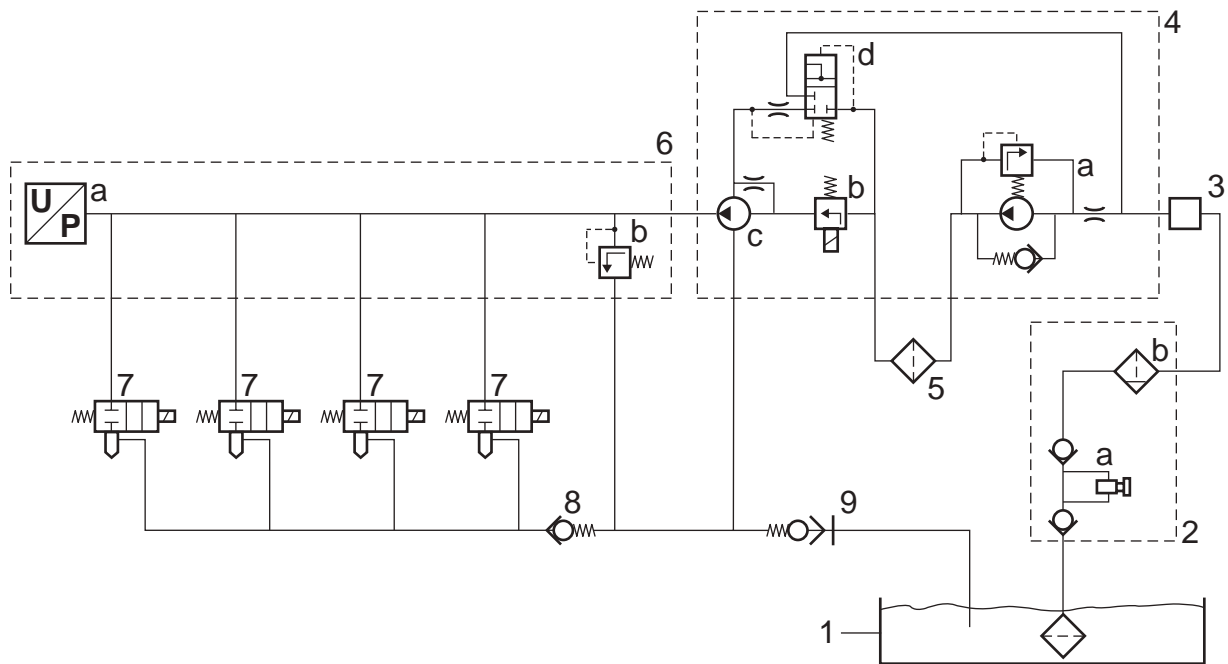
Location of components, production date
≥ 2003-49 (chassis number ≥ 0L253643)



i400872

1. Suction pipe to electronic unit cooling plate
2. Fuel rail pressure sensor
3. Fuel pipe to fuel rail
4. Fuel rail
5. Fuel return overflow valve
6. Fuel rail pressure-limiting valve
7. Return pipe from fuel return overflow valve
8. Fuel pipe to fuel fine filter
9. High-pressure pump leak-off pipe
10. Fuel pipe to fuel lift pump
11. High-pressure pump
12. Return pipe to fuel tank
13. Fuel pump control solenoid valve
14. Fuel pipe to high-pressure pump
15. Fuel supply pipe
16. Fuel fine filter
17. Fuel pipe from electronic unit cooling plate
18. ECS-DC3 electronic unit

2.2 SYSTEM DESCRIPTION, ECS-DC3 FUEL SYSTEM



I400828

The fuel lift pump (4a) draws the fuel from the fuel tank (1) through the cooling plate (2) of the electronic unit (3).

The purpose of the cooling plate (3) is to ensure that the electronic unit does not become too hot. The fuel lift pump (4a) is fitted against the high-pressure pump (4c) and is driven by the camshaft gear.

From the fuel lift pump, fuel is forced towards the fuel fine filter (5).

After the filter, the fuel enters the high-pressure pump (4c) via the fuel pump control solenoid valve (4b), which controls the amount of fuel going to the high-pressure pump. Fuel not taken in by the high-pressure pump returns via the bypass valve (4d) to the fuel lift pump supply pipe and part of it is used for lubricating the high-pressure pump.

The high-pressure pump forces the fuel under high pressure to the fuel rail (6). The fuel rail distributes the fuel among the injectors (7). The fuel rail (6) also functions as an accumulator to ensure that large fluctuations in pressure, resulting from injector openings and pump pressure pulses, are prevented as much as possible.

The pressure in the fuel rail is registered by the rail pressure sensor (6a). The electronic unit uses this data to control the high-pressure pump (via the fuel pump control solenoid valve), so that the rail pressure can be kept at the desired level. The desired pressure is not constant, but depends on the operating conditions.

A pressure relief valve (6b) is fitted at the end of the fuel rail. If the pressure in the fuel rail rises too high (in emergencies only), this valve ensures that the excess fuel flows back to the return pipe. The return pipe is connected with the return pipe to the fuel tank (1).

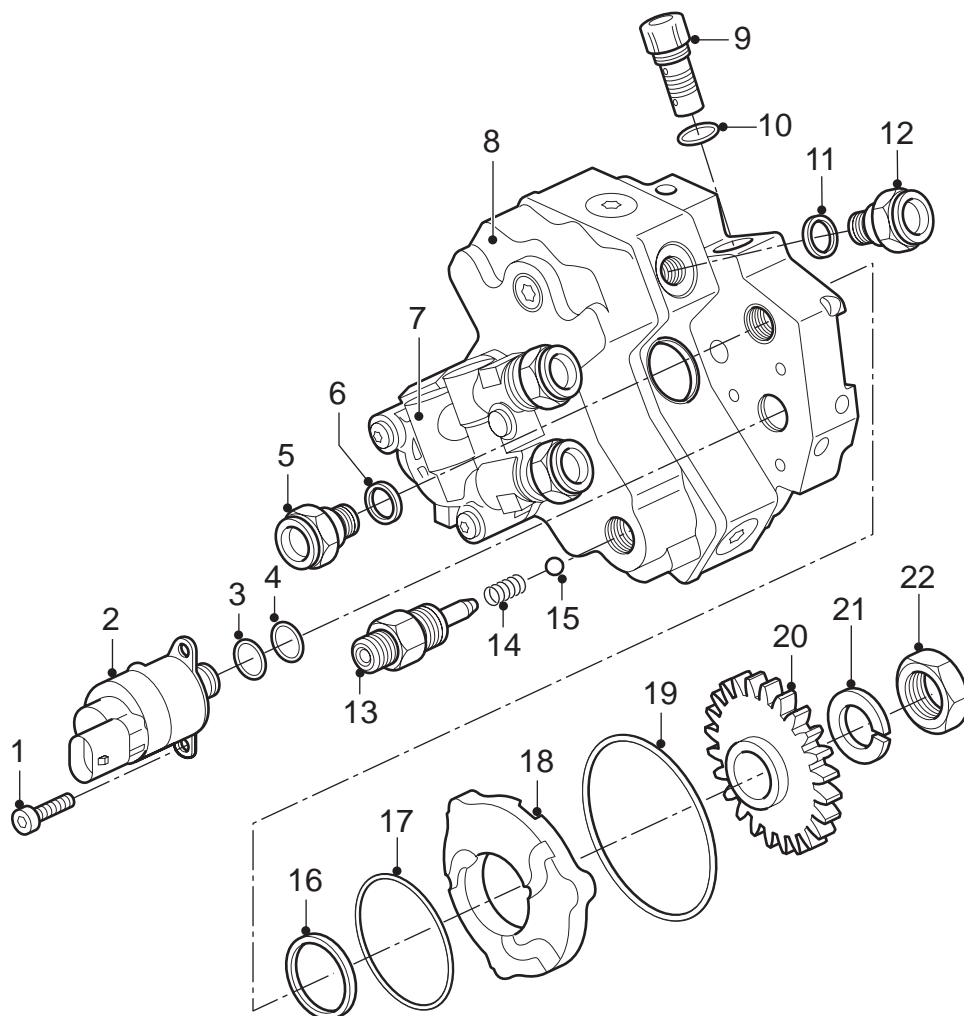
The electronic unit uses the present rail pressure to calculate the time during which the injector needs to be opened in order to obtain the desired injection quantity.

A pressure relief valve (8) connects the injector leak-off ducts in the cylinder head with the return pipe to the fuel tank (1). This pressure relief valve prevents the fuel from flowing out of the injectors when the engine has stopped running.

If the system has been "open", the fuel system can be bled using the primer pump (2a), which is integrated in the water separator/coarse filter (2b).

The return pipe to the tank contains a check valve (9), which is normally closed. As soon as the quick release coupling on the fine filter head is disconnected, the return pipe closes so that it cannot empty.

2.3 OVERVIEW DRAWING, FUEL PUMP



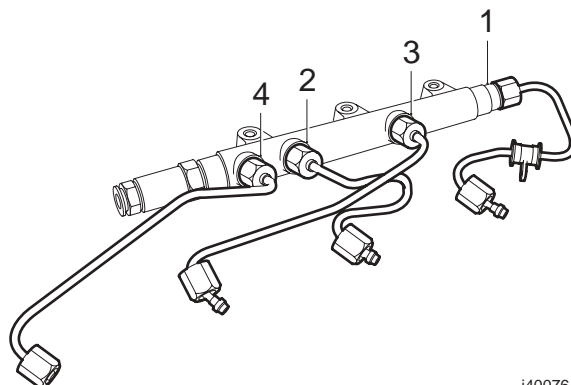
i400766

1. Attachment bolt
2. Fuel pump control solenoid valve
3. O-ring
4. O-ring
5. Fuel pipe connection
6. Copper ring
7. Lift pump
8. High-pressure pump
9. Circulation valve
10. O-ring
11. Copper ring
12. Fuel pipe connection
13. High-pressure pipe connection
14. Spring
15. Ball
16. Oil seal
17. O-ring
18. Adapter ring
19. O-ring
20. Gear wheel
21. Sealing ring
22. Nut

2.4 OVERVIEW DRAWING, FUEL RAIL

Overview drawing, fuel rail, < production date 2003-49 (chassis number < 0L253643)

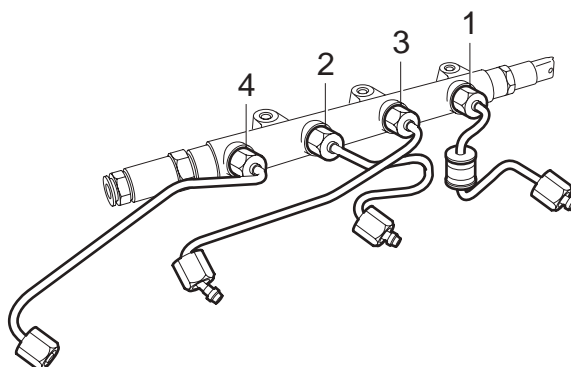
The figure shows the connections to the injector pipes. The numbers indicate the cylinder number of the connection.



i400764

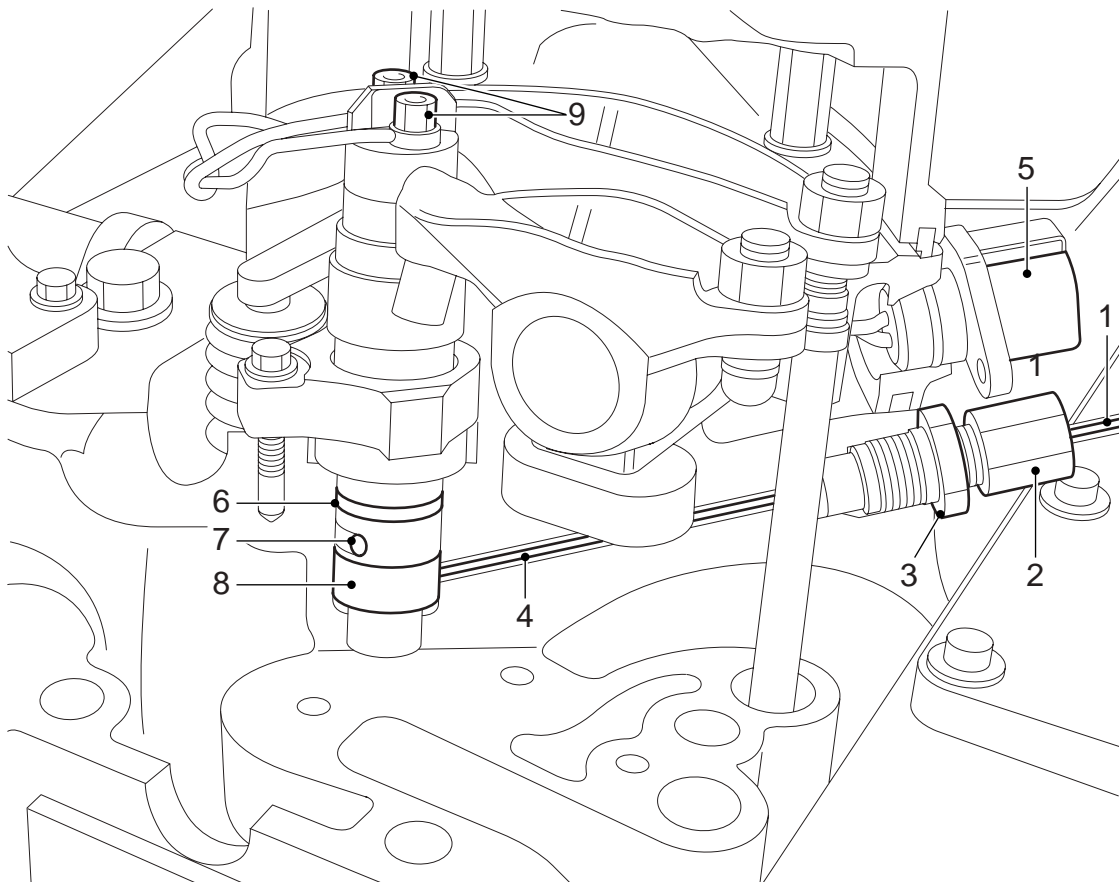
Overview drawing, fuel rail, production date ≥ 2003-49 (chassis number ≥ 0L253643)

The figure shows the connections to the injector pipes. The numbers indicate the cylinder number of the connection.



i400873

2.5 OVERVIEW DRAWING, FUEL SYSTEM, CYLINDER HEAD



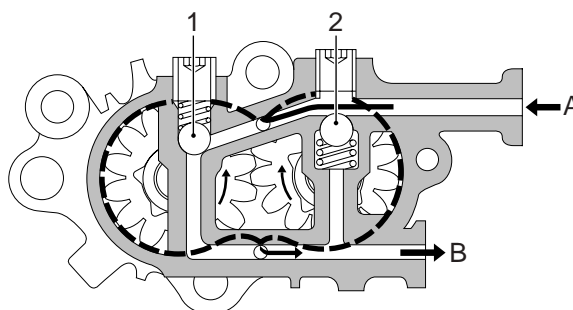
i400653

1. Injector pipe
2. Union
3. Nut
4. Fuel supply pipe
5. Connector to injectors
6. O-ring
7. Return opening
8. Injector
9. Electrical connection

3. DESCRIPTION OF COMPONENTS

3.1 HIGH-PRESSURE PUMP

The high-pressure pump is driven by the crankshaft by means of the camshaft gear. The pump shaft rotates at a speed 1.33 times the speed of the crankshaft. The pump shaft drives the fuel lift pump. The fuel drawn from the suction side by the gears is discharged through the exit by the gears due to the reduction in volume. The fuel lift pump has two added valves. The first valve (1) limits the pump pressure, for example if the fine filter is blocked. The second valve (2) opens the by-pass over the fuel lift pump when the primer pump is being used.

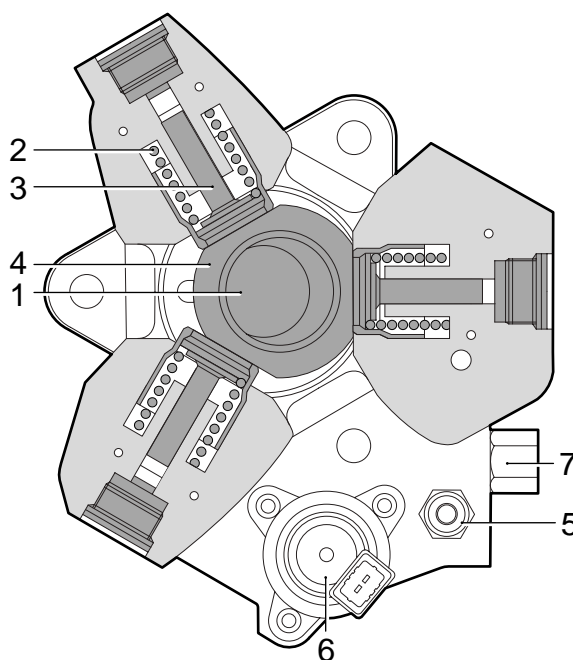


i400595

The high-pressure pump shaft (1) has an eccentric. The eccentric drives the eccentric ring (4). The pump plungers (3) are driven by the eccentric ring and pushed back by the spring (2).

The fuel is supplied via the connection (5) and then internally distributed among the three pump elements. Before it is distributed among the pump elements, the supplied fuel is dosed by means of the fuel pump control solenoid valve (6).

The fuel pump control solenoid valve is controlled by the electronic unit on the basis of the rail pressure sensor signal. This creates a closed control circuit. The fuel pump control solenoid valve is "normally open" and is activated via duty cycle control. The value when the engine is started is fixed. When the measured pressure deviates from the desired (programmed) pressure, the duty cycle value will be adapted until the measured and the desired values correspond. If this is impossible, the electronic unit will generate a warning and record a fault code.



i400589

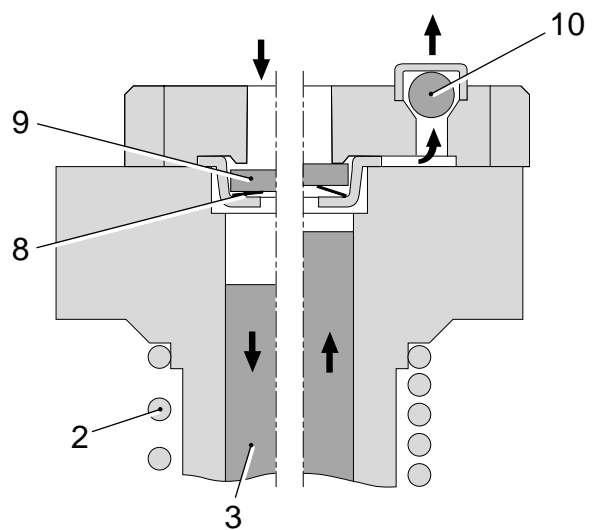
2

During the downward stroke, the fuel is supplied by the fuel lift pump via the suction valve (9) (see illustration on left). During the delivery stroke (illustration on right), the suction valve closes under the load of the spring (8) and the fuel pressure that has built up. The fuel leaves the pump element via the delivery valve (10). The compressed fuel from the three pump elements is collected in the pump housing and leaves the pump via a joint high-pressure connection.

Leaking fuel from the pump elements is discharged via the return connection.

The fuel lift pump has over-capacity in relation to the high-pressure pump. If there is only limited fuel off-take on the rail, the fuel pump control solenoid valve will be virtually closed. The over-supplied fuel will cause an increase in pressure at the inlet of the fuel pump control solenoid valve. The pressure is limited by the circulation valve (7). If the valve is open, the excess supplied fuel will be returned to the suction side of the fuel lift pump. A small amount of fuel is diverted via a restriction to the shaft and the eccentric of the high-pressure pump for lubrication.

When bleeding with the primer pump, any air bubbles will be carried along by the fuel through the low-pressure circuit. Fuel is forced inwards at the connection (5). The fuel pump control solenoid valve is opened fully without being energised, so that the fuel can pass. The pump elements create a high resistance to the fuel, so that the fuel will escape via the lubricating restriction in the pump. In this way the fuel, along with any air bubbles, is discharged to the return pipe.



i400590

3.2 FUEL PUMP CONTROL SOLENOID VALVE

The high-pressure pump has an over-capacity for normal operating conditions. This could lead to large quantities of fuel being forced at high pressure to the fuel rail and then directly being drained out to the return pipe via the pressure-limiting valve on the fuel rail. This produces too much unnecessary heat and loss of capacity because large amounts of fuel are flowing at high pressure.

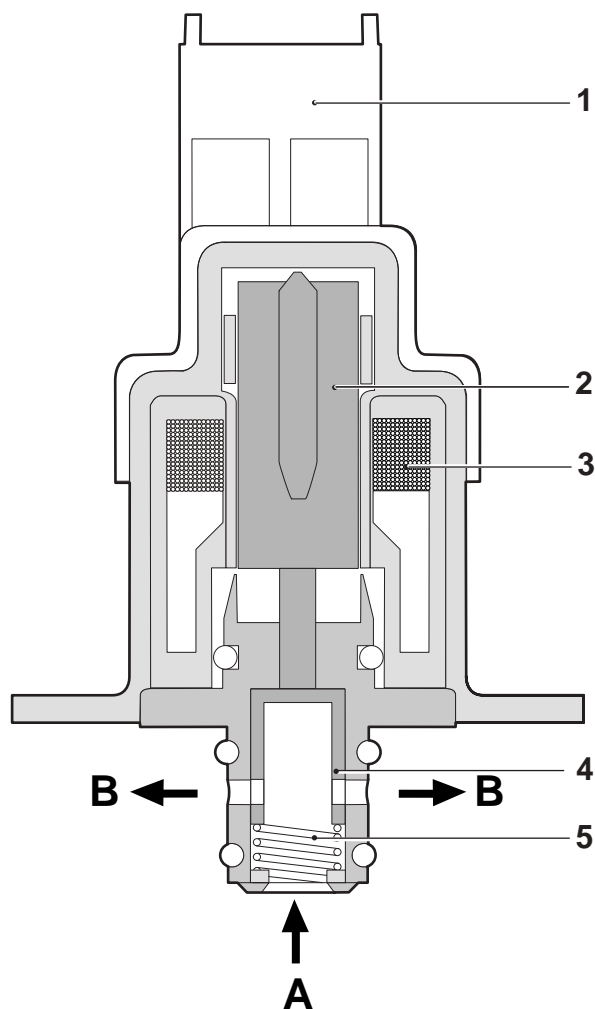
The system has been designed such that only fuel that will be used will be forced under high pressure to the rail. For this reason, a fuel pump control solenoid valve has been fitted at the suction side of the high-pressure pump. This solenoid valve is opened without being energised, so that the high-pressure pump elements can be filled in the normal manner.

If the fuel rail pressure becomes too high, for example because of lower fuel off-take on the rail, the solenoid valve will be energised by the electronic unit with a higher duty cycle, so that the plunger is pressed with a greater force against the spring pressure and the valve reveals a more constricted opening. This reduces the fuel supply to the pump elements and the pump output will thus fall. The fuel rail pressure will also fall as a consequence.

If the rail pressure is too low, the reverse is true.

The current is supplied to the coil (3) via the connector (1). The current pushes the core (2) with the plunger (4) against the pressure of the spring (5). This controls the fuel current from input A to output B.

Due to this valve, under normal circumstances very little fuel flows back from the rail. This improves performance and reduces the generation of heat.



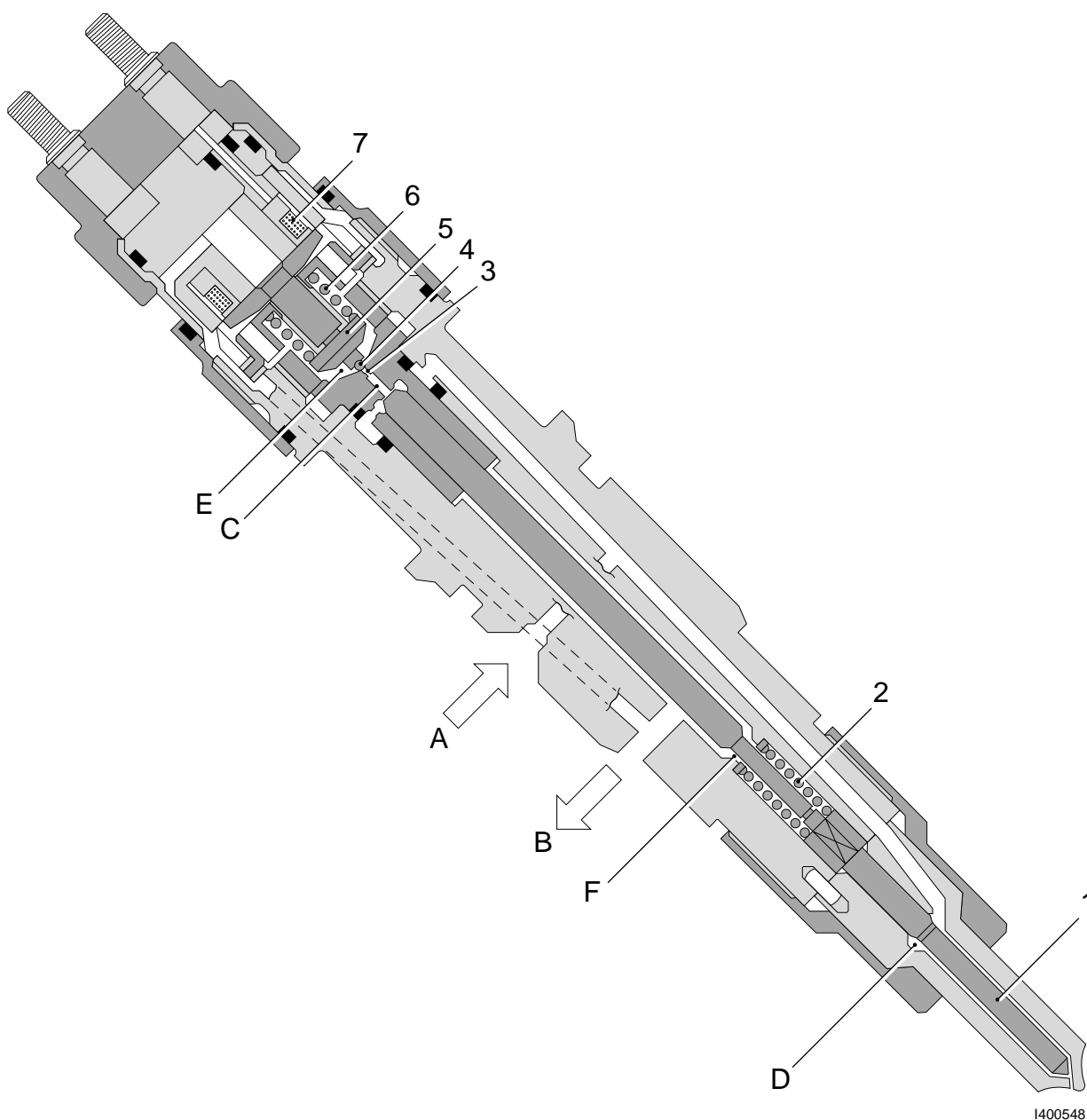
i400591

3.3 INJECTOR

The injectors can be opened and closed electrically. The injector is normally closed. The load of the spring (2) and the fuel rail pressure that controls chamber C ensure this.

The fuel is supplied from the fuel rail via A. The return fuel can flow back to the fuel tank via B.

When the coil (7) is energised, the armature housing (5) moves up. As a result the pressure in chamber C drops slightly and the injector needle (1) is forced up to chamber D by the rail pressure. The fuel can then be injected.



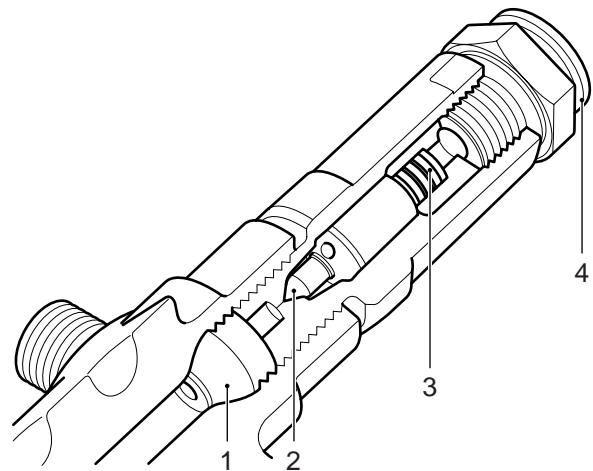
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3.4 FUEL RAIL PRESSURE-LIMITING VALVE

The fuel rail has a pressure-limiting valve so that the rail pressure is maintained at a safe value in emergency situations.

The fuel rail pressure control circuit is normally active. This consists of the fuel lift pump, fuel pump control solenoid valve, high-pressure pump, fuel rail, rail pressure sensor and electronic unit. If a fault occurs, the rail pressure can no longer be controlled. This can rise to the actuating pressure of the fuel rail pressure-limiting valve. This pressure is approx. 1650 bar. In the open position all surplus fuel flows without pressure to the fuel tank return connection.

The valve includes a sealing cone (1), a valve body (2), a spring (3) and a return connection with quick-release coupling (4).



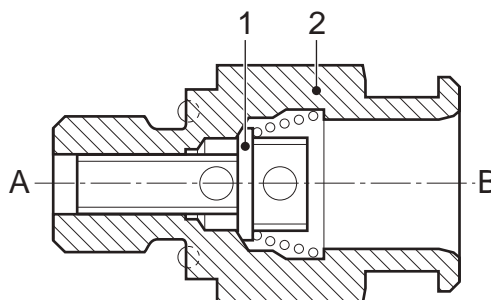
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i400592

3.5 FUEL RETURN OVERFLOW VALVE

The injectors are mounted in the cylinder head. The injectors do not have a separate return connection. In place of this there is a longitudinal bore in the cylinder head that meets the injector bores of all cylinders coinciding with the height of the return ports of the injectors. A pressure relief valve is mounted at the end of the bore to prevent vapour bubbles forming in it and to prevent it emptying after the engine is turned off. This valve maintains a residual pressure in relation to the return pressure of 1.2 to 2.0 bar.

The pressure relief valve consists of a spring-loaded plunger (1) and a housing (2) with quick-release inlet and outlet connections (A and B respectively).



i400861

4. INSPECTION AND ADJUSTMENT

4.1 BLEEDING THE FUEL SYSTEM

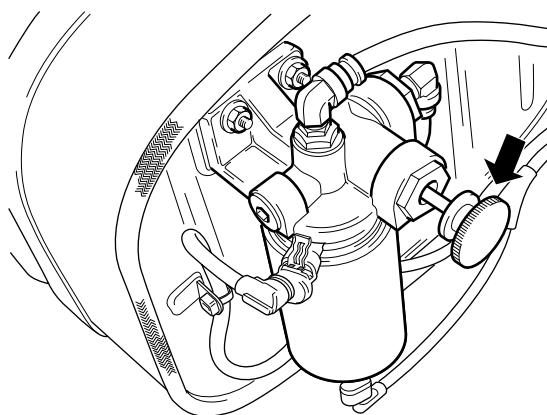


Stop pumping as soon as a greater resistance is felt. If you continue pumping, the fuel system may become internally damaged.

Note:

When the hand pump is used, the fuel system will be automatically bled. Air will be fed back to the tank through the return pipe.

1. Unscrew the button of the primer pump and pull it out.
2. Use the primer pump until a clearly higher resistance is perceptible.
3. Press the button and tighten it.



G0 00 209

4.2 CHECKING FUEL LIFT PUMP PRESSURES



When inspecting the fuel pressure, fuel will escape. Collect the fuel and avoid the risk of fire.

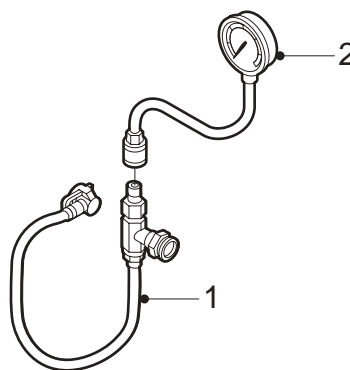


Dirt in the fuel system can lead to significant damage to parts of the system. Prevent this by cleaning the parts before disassembly and then sealing all open connections.

2

Checking underpressure on suction side of fuel lift pump

1. Disconnect the fuel pipe from the electronic unit cooling plate to the fuel lift pump on the suction side of the fuel lift pump; see "Removal and installation".
2. Fit the adapter (1), special tool (DAF no. 1329476), between the pipe which has been removed and the fuel lift pump and couple a pressure gauge (2) to this adapter.
3. Bleed the fuel system.
4. Measure the underpressure when the engine is idling. Compare the readings with the specified values. See "Technical data".
5. Remove the pressure gauge and the adapter and fit the fuel pipe.
6. Bleed the fuel system, start the engine and check the fuel system visually for leaks if no further measurements are to be carried out.

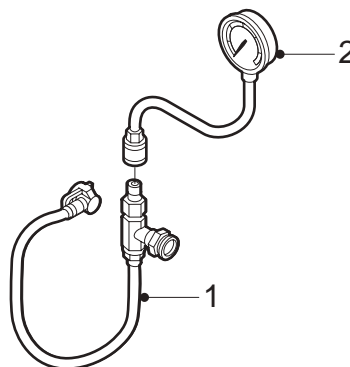


i400883

Checking fuel pressure in fuel lift pump in front of fuel fine filter

1. Disconnect the fuel pipe from the lift pump to the fuel fine filter on the delivery side of the lift pump; see "Removal and installation".

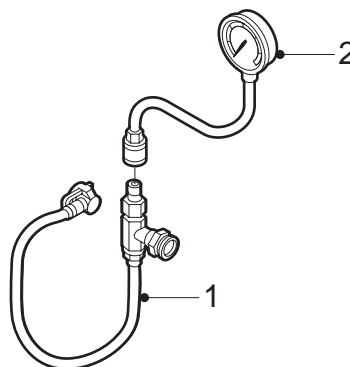
2. Fit the adapter (1), special tool (DAF no. 1329476), between the pipe which has been removed and the fuel lift pump and couple a pressure gauge (2) to this adapter.
3. Bleed the fuel system.
4. Start the engine and measure the pressure when the engine is idling. Compare the readings with the specified values. See "Technical data".
5. Remove the pressure gauge and the adapter and fit the fuel pipe.
6. Bleed the fuel system, start the engine and check the fuel system visually for leaks if no further measurements are to be carried out.



i400883

Checking fuel pressure in fuel lift pump after fuel fine filter

1. Disconnect the fuel pipe from the fuel fine filter to the high-pressure pump on the side of the high-pressure pump; see "Removal and installation".
2. Fit the adapter (1), special tool (DAF no. 1329476), between the pipe which has been removed and the high-pressure pump and couple a pressure gauge (2) to this adapter.
3. Bleed the fuel system.
4. Disconnect the electrical connectors of the injectors from the valve sleeve.
5. Start the engine and measure the pressure when the engine is idling. Compare the readings with the specified values. See "Technical data".
6. Connect the electrical connectors of the injectors to the valve sleeve.
7. Remove the pressure gauge and the adapter and reconnect the fuel pipe.
8. Bleed the fuel system, start the engine and check the fuel system visually for leaks if no further measurements are to be carried out.



i400883

Check pressure drop across fuel fine filter

1. Check the fuel pressure in front of the fuel fine filter.
2. Check the fuel pressure after the fuel fine filter at maximum engine speed.
3. Compare the measured pressure drop across the fuel fine filter with the specified value. See "Technical data". If the pressure drop is too great, the fuel fine filter must be replaced.

2

4.3 INSPECTION, INTERNAL FUEL LEAKS



When inspecting for internal fuel leaks, fuel will escape. Collect the fuel and avoid the risk of fire.



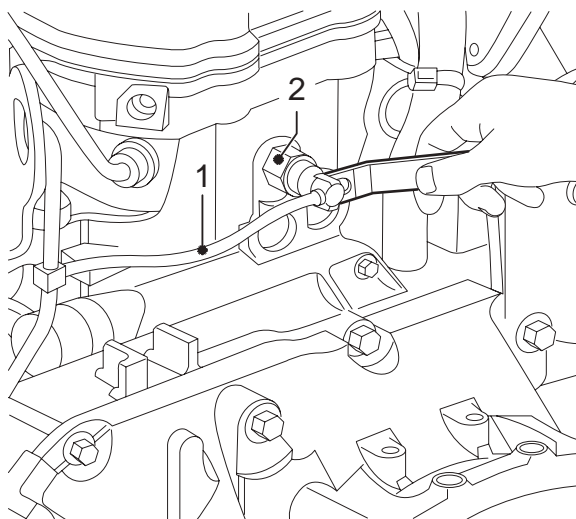
Dirt in the fuel system can lead to significant damage to parts of the system. All open connections must therefore be sealed.



The common rail system is under high pressure when the engine is running. This pressure can rise to approx. 1400 bar. Even when the engine is not running, there may be a high residual pressure in the fuel rail (approx. 50 bar). Depressurise the system before working on the common rail system by wrapping the coupling in a cloth and then unscrewing it and collecting the escaping fuel in a container.

Inspection, internal fuel leaks

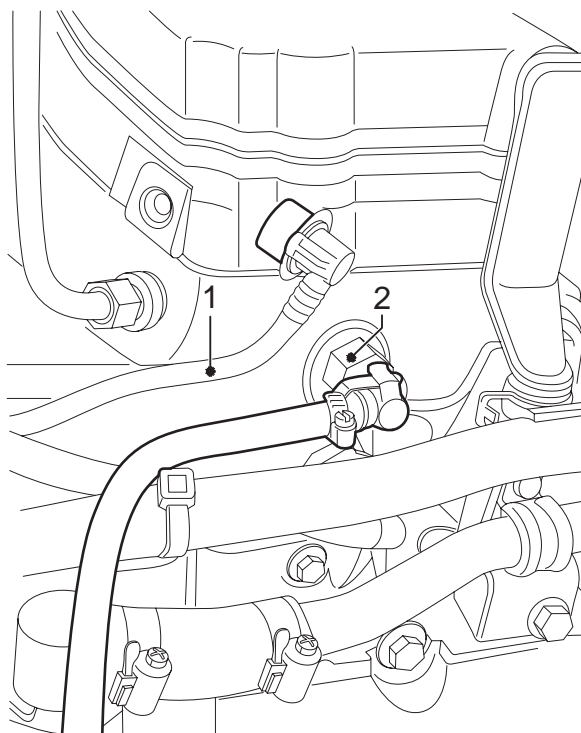
1. Check that all injector pipes have been tightened to the correct torque and that there are no external signs of fuel leakage; see "Technical data".
2. Disconnect the fuel return pipe (1) from the fuel return overflow valve (2) on the rear of the cylinder head.



i400679

2

3. Seal the disconnected fuel pipe (1) using the special tool (DAF no. 1453151) to prevent the return fuel escaping.
4. Fit the special tool (DAF no. 1329476) onto the fuel return overflow valve (2).

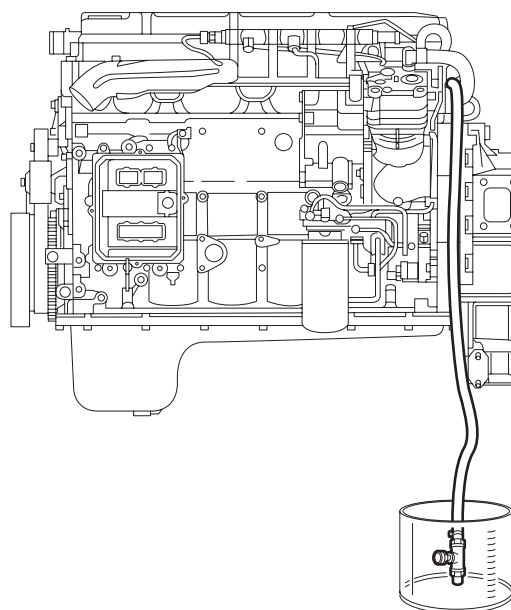


i400680

5. Place the free end of the special tool (DAF no. 1329476) in a container and start the engine.
6. While the engine is idling, measure the quantity of return fuel using a stop watch and a measuring beaker; see "Technical data" for the maximum quantity of return fuel.

Note:

If the quantity of return fuel is within the specified value there are no internal leaks. If the quantity of return fuel exceeds the specified value, the internal fuel leak must be located.



i400682

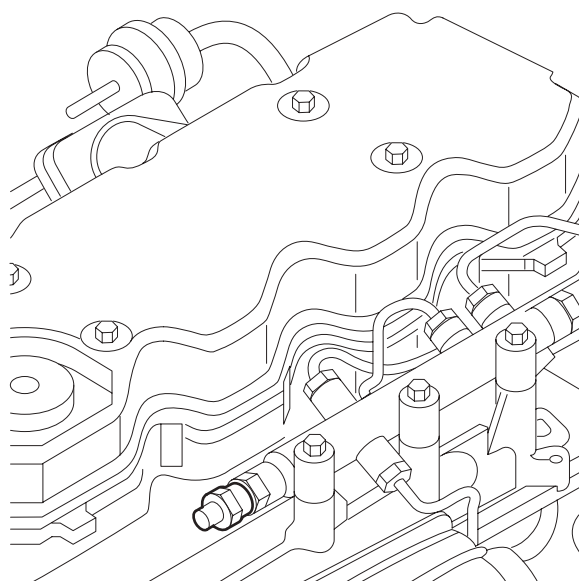
Locating internal fuel leak

1. Take the injector pipe out of cylinder 1.
2. Seal the connection of cylinder 1 on the fuel rail using the special tool (DAF no. 1453133). Tighten the plug to 30 Nm.
3. While the engine is idling, use a stop watch to measure the time required to fill a measuring beaker with 360 ml of return fuel. See "Technical data" for the minimum time permitted for filling the measuring beaker.

Note:

Use a measuring beaker with a mark at 360ml.

4. Remove the special tool (DAF no. 1453133) and reconnect the injector pipe.
5. Repeat the above steps for the other cylinders and note the values.



i400681

Note:

When the leaking cylinder has been plugged, the quantity of return fuel will decrease and, as a result, the time it takes to fill the measuring beaker to 360ml will increase. If several high values are measured, this indicates that there may be several leaks. If this is the case, first check the cylinders that give the highest values and then repeat the test.

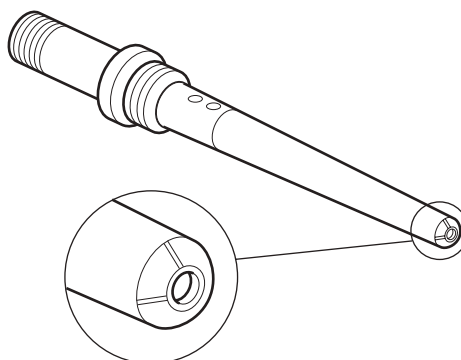
In the example shown in the table below there is an internal leak in the 3rd cylinder, which could be caused by a leak in the fuel supply pipe and/or a defective injector.

Example:

Leak test results				
Blocked cylinder	1	2	3	4
Time (s) to fill to 360ml	35	36	200	37

6. In the event of a leak, remove the fuel supply pipe and the injector of the cylinder in question; see "Removal and installation".

7. Check the fuel supply pipe for damage and signs of leakage.
Leakage in the fuel supply pipe can be recognised by erosion tracks (lines) on the nose of the supply pipe. If necessary or if in doubt, replace the fuel supply pipe.
8. Check that the injector fuel connection is not leaking.
Leakage in the injector fuel connection can be recognised by erosion tracks (lines) in the socket of the fuel connection . If necessary or if in doubt, replace the injector.



i400776

Note:

If fuel has been found in the lubricating oil, extra attention must be paid to the O-rings of the injectors, as these have most probably been damaged by increased pressure in the return circuit as a result of an internal leak.

Note:

The following guidelines must be adhered to:

- If the injector is defective, both the injector and the fuel supply pipe must be replaced.
 - If the fuel supply pipe is defective and in addition the sealing surface with the injector is damaged, both the injector and the fuel supply pipe must be replaced.
 - If the fuel supply pipe is defective and the sealing surface with the injector is not damaged, the fuel supply pipe must be replaced but the injector can be reused.
9. Fit the injector and fuel supply pipe. See "Removal and installation".
 10. Again inspect for internal fuel leaks to check that there is no leakage.

5. REMOVAL AND INSTALLATION

5.1 REMOVAL AND INSTALLATION, INJECTOR PIPE



Never bend injector pipes as they may kink or crack. The injector pipes form part of the high-pressure section of the fuel system. When the unions are unscrewed, fuel under high pressure may escape. Take measures to prevent fire and injury. Collect the escaping fuel in a suitable container.



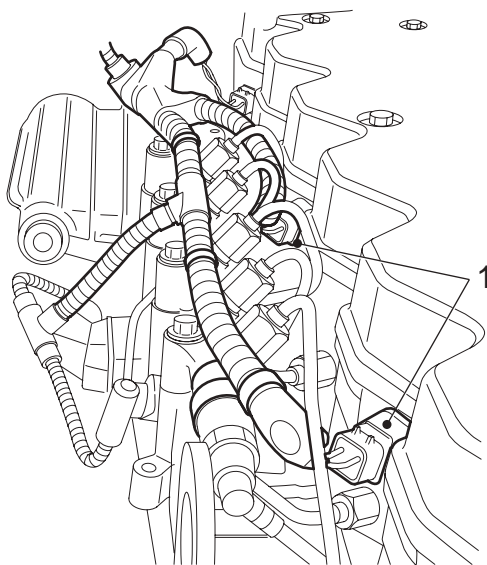
Dirt in the fuel system can lead to significant damage to parts of the system. Prevent this by cleaning the parts before disassembly and then sealing all open connections.

Note:

Codes (1) are stamped in the injector pipe unions to enable correct positioning. The first figure is the number of cylinders of the engine followed by the fitting position.

Removing the injector pipe

1. Clean the area surrounding the unions, both near the injectors and near the fuel rail.
2. Remove the connectors (1) of the injectors from the valve sleeve.



i400852

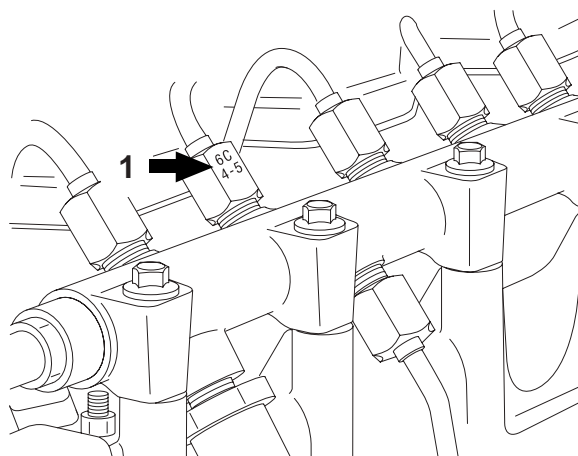
Note:

Note the sequence in which the injector pipes are removed. They should be re-fitted in precisely the reverse order.

3. Unscrew the unions on both sides of the pipe and remove the pipes.
4. Immediately plug the openings.

Installing the injector pipe

1. Clean the injector pipe and blow-clean it with dry compressed air.
2. Fit the injector pipes in reverse order and hand-tighten the unions. When all the pipes and unions are correctly fitted, the unions must be tightened to the specified torque. See "Technical data".
3. Fit the connectors of the injectors in the valve sleeve.
4. Start the engine to bleed the high-pressure section of the fuel system and inspect all fuel pipes for leaks.



i400482

5.2 REMOVAL AND INSTALLATION, FUEL SUPPLY PIPE



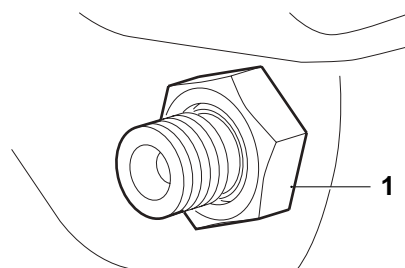
When removing a fuel pipe, fuel will escape. Collect the fuel and avoid the risk of fire.



Dirt in the fuel system can lead to significant damage to parts of the system. All open connections must therefore be sealed.

Removing the fuel supply pipe

1. Disconnect the injector pipes.
2. If necessary, remove the fuel rail.
3. Remove the nut (1) from the fuel supply pipe.



i400486

4. Mark the positions of the fuel supply pipe (1) and pull it out of the cylinder head with special tool (DAF no. 1329473) (2).

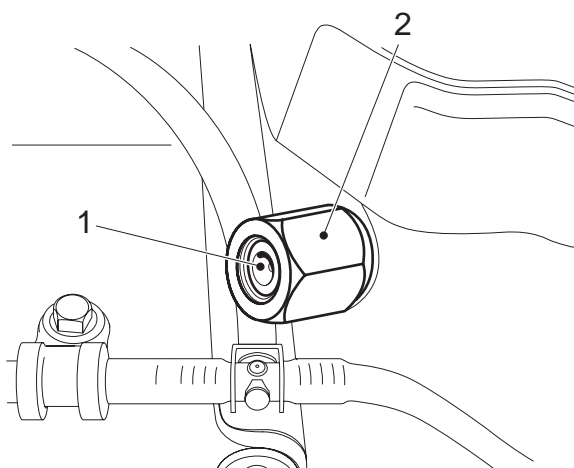
Note:

If the injector is **not** replaced, the fuel supply pipe may be re-used provided it is fitted with the original injector.

Installing the fuel supply pipe

The following guidelines must be adhered to:

- If the injector is defective, both the injector and the fuel supply pipe must be replaced.
- If the fuel supply pipe is defective and in addition the sealing surface with the injector is damaged, both the injector and the fuel supply pipe must be replaced.
- If the fuel supply pipe is defective and the sealing surface with the injector is not damaged, the fuel supply pipe must be replaced but the injector can be reused.



i400823

2

1. Check the fuel supply pipe for damage and signs of leakage.
Leakage in the fuel supply pipe can be recognised by erosion tracks (lines) on the nose of the supply pipe. If necessary or if in doubt, replace the fuel supply pipe.

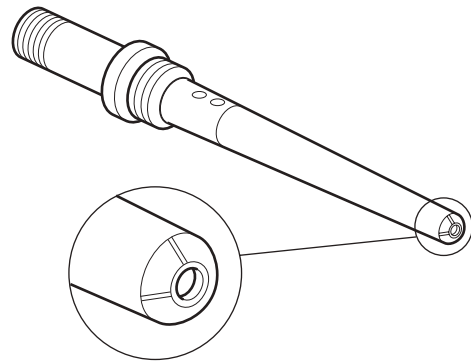
Note:

If any indications of leakage are visible, remove the injector and check the injector fuel connection for signs of leakage.

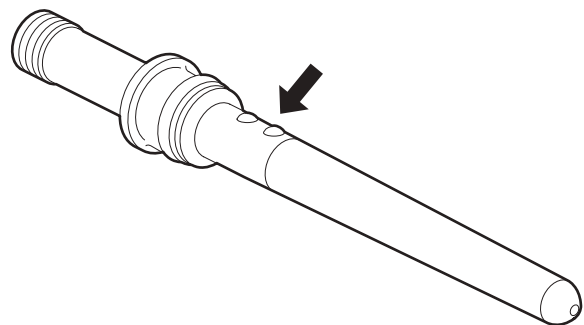
2. Fit a new O-ring on the fuel supply pipe.
3. Apply a thin layer of clean engine oil to the O-ring of the fuel supply pipe, the screw thread of the nut and the contact surface of the nut with the fuel supply pipe.
4. Check the bore of the fuel supply pipe for foreign matter and damage. Also check whether the supply bore in the injector is correctly positioned for the bore, because it is possible to mount the injector turned through 180°, so that the fuel supply port is on the other side.

Note:

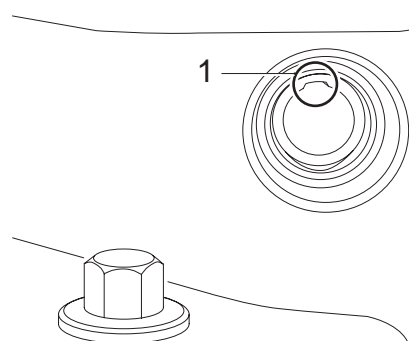
The fuel supply pipe has one or two positioning balls. The fuel supply pipe can only be installed with the ball(s) on top, as the bore in the cylinder head has a groove (1) at the top. Press the fuel supply pipe as far as possible into the bore, with the ball pointing upwards. Ensure that the O-ring is not damaged in this process.



i400776

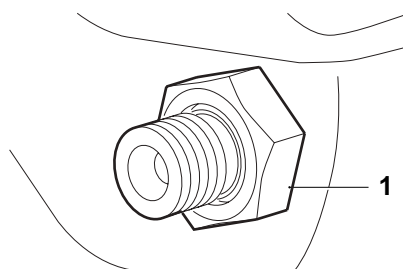


i400790



i400807

5. Install the nut (1) and tighten it to the specified torque. See "Technical data".
6. If the fuel rail was removed, re-fit it.
7. Fit the injector pipes.
8. Start the engine to bleed the high-pressure section of the fuel system and inspect the fuel system for leaks.



i400486

5.3 REMOVAL AND INSTALLATION, INJECTOR



When removing an injector, fuel will escape. Collect the fuel and avoid the risk of fire.



Dirt in the fuel system can lead to significant damage to parts of the system. All open connections must therefore be sealed.

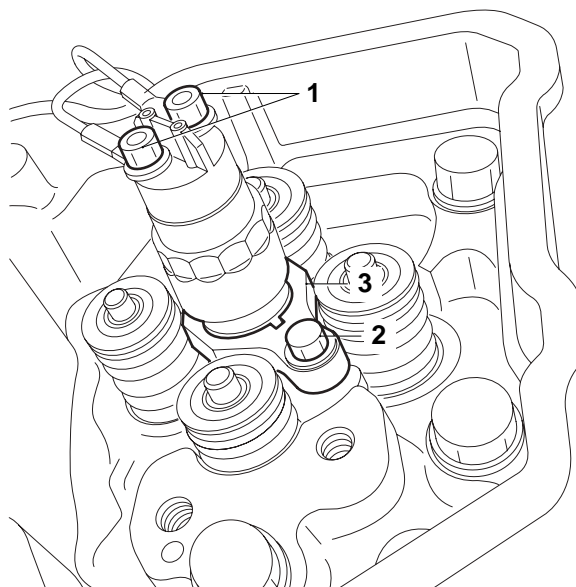
2

Removing the injector

1. Remove the fuel return overflow valve to let the return bore in the cylinder head empty to the fullest possible extent. Collect the escaping fuel.
2. Remove the injector pipe.
3. Remove the fuel supply pipe.

Note:

- If an injector is removed without the fuel supply pipe having first been removed, serious damage can ensue.
 - If the injectors are removed, they must be removed together with the fuel supply pipes.
4. Remove the valve cover.
 5. Remove the exhaust valve rockers.
 6. Remove the injector wiring (1).
 7. Remove the two attachment bolts (2) from the injector clamping bracket (3).



i400483

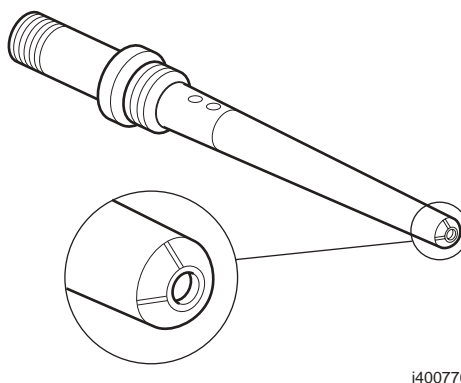
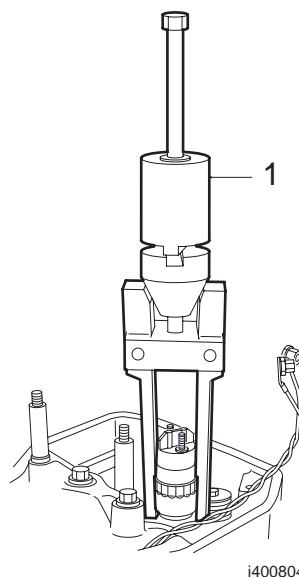
8. Fit the injector puller (1). This is the special tool (DAF no. 0192496). Carefully pull the injector vertically out of the cylinder head.
9. Remove the copper washer from the injector hole and plug the hole immediately.

Installing the injector

The following guidelines must be adhered to:

- If the injector is defective, both the injector and the fuel supply pipe must be replaced.
- If the fuel supply pipe is defective and in addition the sealing surface with the injector is damaged, both the injector and the fuel supply pipe must be replaced.
- If the fuel supply pipe is defective and the sealing surface with the injector is not damaged, the fuel supply pipe must be replaced but the injector can be reused.

1. Clean the injector if it has already been used. See "Cleaning".
2. Clean the injector hole in the cylinder head. The metal surface of the hole must not be touched.
3. Check the fuel supply pipe for damage and signs of leakage. Leakage in the fuel supply pipe can be recognised by erosion tracks (lines) on the nose of the supply pipe. If necessary or if in doubt, replace the fuel supply pipe.
4. Fit a new O-ring on the fuel supply pipe.
5. Check that the injector fuel connection is not leaking. Leakage in the injector fuel connection can be recognised by erosion tracks (lines) in the socket of the fuel connection. If necessary or if in doubt, replace the injector.

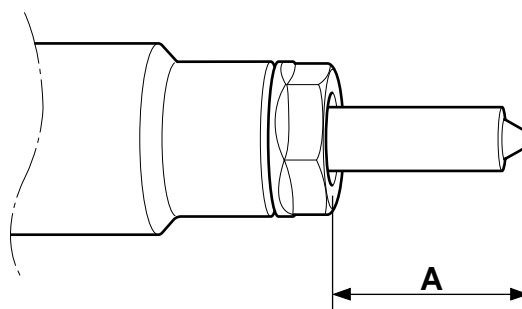


2

- Fit a new copper washer on the injector. Measure the length of the injector nozzle (A) **without** fitted washer in order to determine which washer must be used. Fit the correct washer; see "Technical data".

Note:

A wrong washer will cause an incorrect alignment between the fuel supply pipe and the injector. This will lead to internal fuel leaks that will in turn cause loss of power and/or engine damage.



i400693

- Fit a new O-ring on the injector.

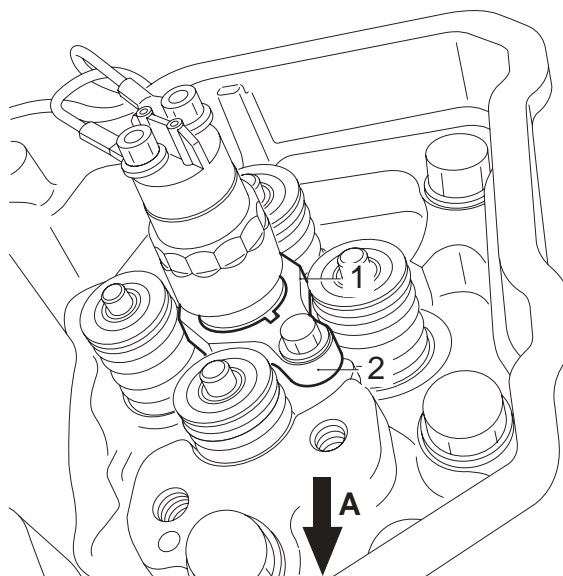
Note:

This O-ring should prevent returning fuel (1.2 - 2.0 bar) flowing via the top of the cylinder head to the oil sump and thinning the oil.

- Apply a thin layer of clean engine oil to the O-ring of the injector.
- Fit the injector with the copper washer. First press the injector into the hole as far as possible until a higher resistance can clearly be felt.

Note:

The injector must only be fitted one way. If it is fitted incorrectly, serious damage can ensue. The rounded side (2) of the injector clamping bracket (1) must point to the inlet side of the engine (A).



i400805

10. Fit the attachment bolts (1) in the injector clamping bracket (2) to secure the injector. Tighten the attachment bolts alternately to a torque of 2 Nm.

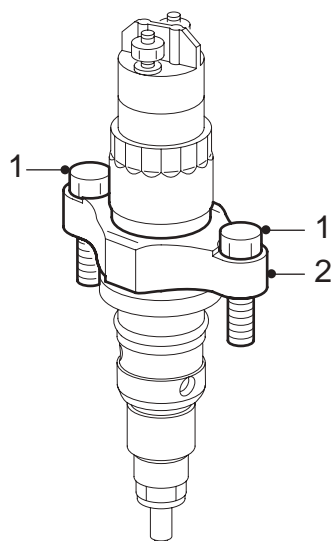
Note:

Pay special attention to the tightening of the attachment bolts (1). The tightening must be carried out alternately; ensure that the injector clamping bracket (2) is not fitted at an angle.

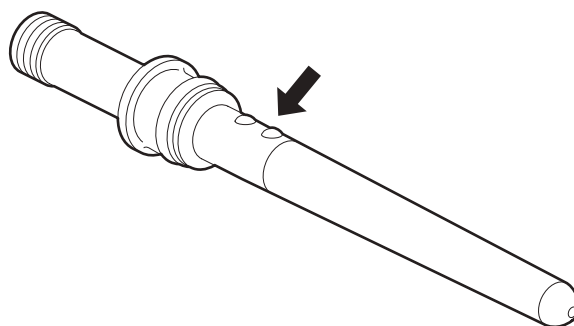
11. Apply a thin layer of clean engine oil to the O-ring of the fuel supply pipe, the screw thread of the nut and the contact surface of the nut with the fuel supply pipe.
12. Check the bore of the fuel supply pipe for foreign matter and damage. Also check whether the supply bore in the injector is correctly positioned for the bore, because it is possible to mount the injector turned through 180°, so that the fuel supply port is on the other side.
13. Fit the fuel supply pipe. Press the fuel supply pipe as far as possible into the bore, with the ball pointing upwards. Ensure that the O-ring is not damaged in this process.

Note:

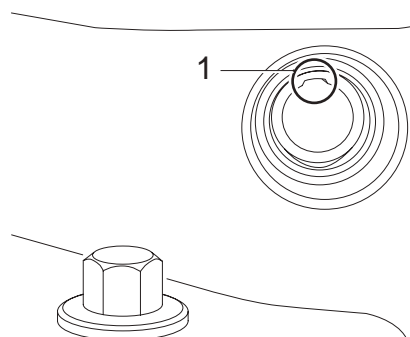
The fuel supply pipe has one or two positioning balls. The fuel supply pipe can only be installed with the ball(s) on top, as the bore in the cylinder head has a groove (1) at the top.



i400806



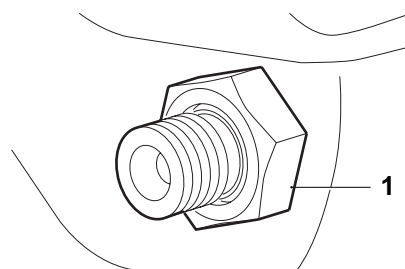
i400790



i400807

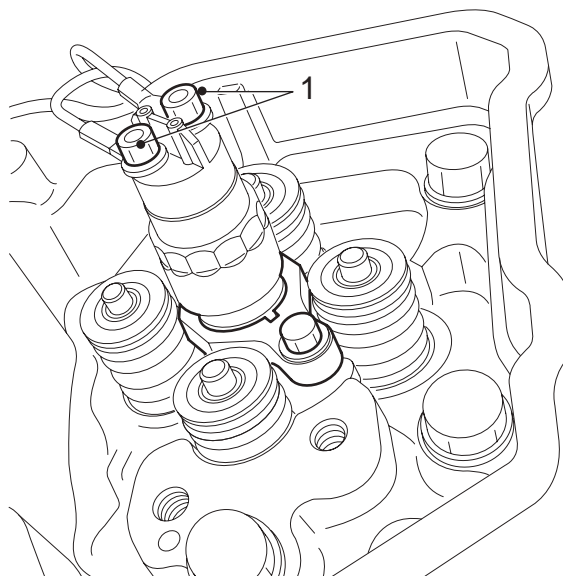
2

14. Fit the nut (1). Tighten the nut to a torque of 15 Nm.
15. Tighten the injector attachment bolts to the specified torque; see "Technical data".
16. Tighten the fuel supply pipe nut to the specified torque; see "Technical data".



i400486

17. Connect the injector wiring. Tighten the attachment bolts (1) to the specified torque. See "Technical data".
18. Fit the exhaust valve rockers.
19. Adjust the clearance of the exhaust valves.
20. Fit the valve cover.
21. If the fuel rail was removed, re-fit it.
22. Fit the injector pipe.
23. Fit the fuel return overflow valve to the cylinder head. For the specified tightening torque, see "Technical data".
24. Connect the return pipe to this valve.
25. Start the engine to bleed the high-pressure section of the fuel system and inspect the fuel system for leaks.



i400808

5.4 REMOVAL AND INSTALLATION, FUEL RAIL



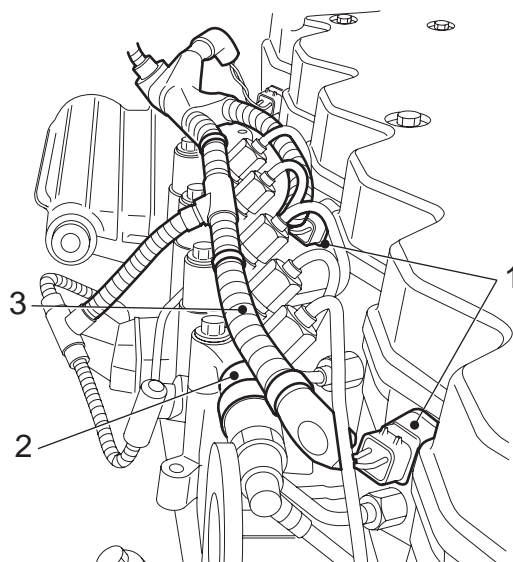
When removing the fuel rail, fuel will escape. Collect the fuel and avoid the risk of fire.



Dirt in the fuel system can lead to significant damage to parts of the system. Prevent this by cleaning the parts before disassembly and then sealing all open connections.

Removing the fuel rail

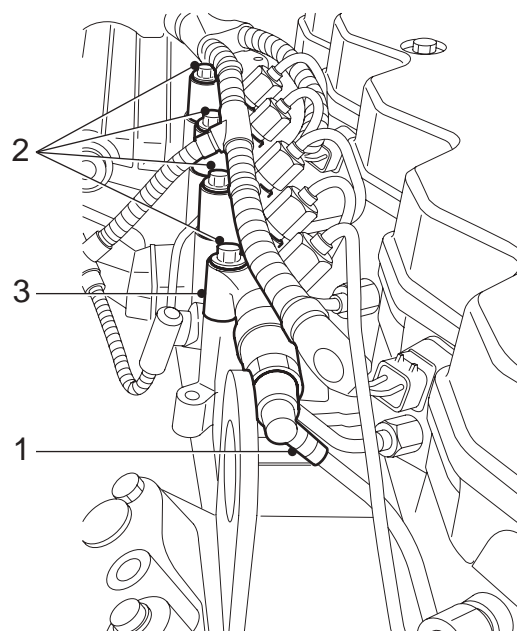
1. Remove the connector from the fuel rail pressure sensor.
2. If necessary, remove the plug of the inlet air temperature/boost pressure sensor by loosening the connector.
3. Remove the connectors of the injectors (1) from the valve sleeve.
4. Disconnect the cable harness (3) on the fuel rail (2) and bend the cable harness away from the fuel rail.



i400809

2

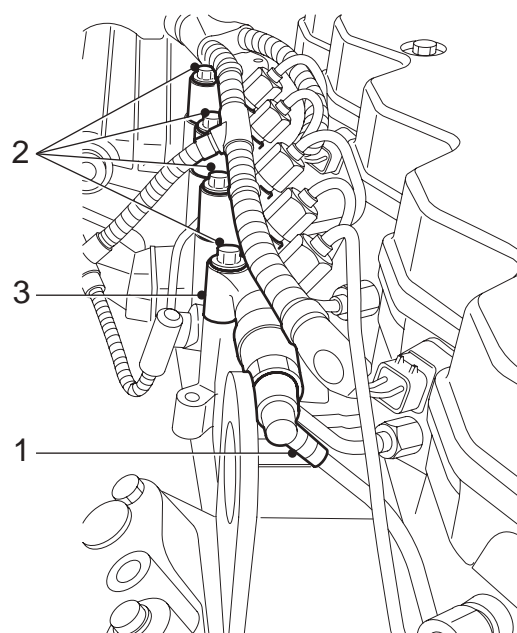
5. Remove the fuel return pipe from the pressure-limiting valve on the fuel rail
6. Loosen the pipe clamps from the high-pressure pipe to the fuel rail.
7. Loosen the high-pressure pipe from the high-pressure pump to the fuel rail on the fuel rail side by unscrewing the union.
8. Disconnect the injector pipes.
9. Remove the fuel rail attachment bolts (2).
10. Remove the fuel rail (3).



i400814

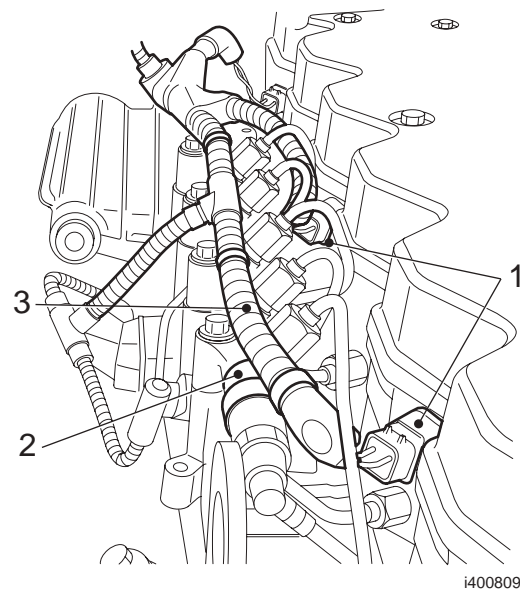
Installing the fuel rail

1. Ensure that the fuel rail is clean.
2. Fit the fuel rail (3) and hand-tighten the attachment bolts (2).
3. Fit the fuel return pipe (1) onto the pressure-limiting valve on the fuel rail.
4. Fit the injector pipes.
5. Fit the pipe clamps from the high-pressure pipe to the fuel rail. Do not tighten them yet.
6. Fit the high-pressure pipe unions from the high-pressure pump to the fuel rail. For the specified tightening torques of the unions, see "Technical data".
7. Tighten the attachment bolts (2) of the fuel rail to the specified torque. See "Technical data".
8. Tighten the bolt connections of the high-pressure pipe clamps.



i400814

9. Install the cable harness (3) to the fuel rail (2) and secure it using cable ties.
10. Fit the connectors of the injectors (1) in the valve sleeve.
11. If it has been removed, fit the plug of the inlet air temperature/boost pressure sensor to the sensor.
12. Fit the connector of the fuel rail pressure sensor.
13. Start the engine and check the fuel system for leaks.



i400809

5.5 REMOVAL AND INSTALLATION, FUEL RAIL PRESSURE-LIMITING VALVE

When removing the pressure-limiting valve, fuel will escape. Collect the fuel and avoid the risk of fire.



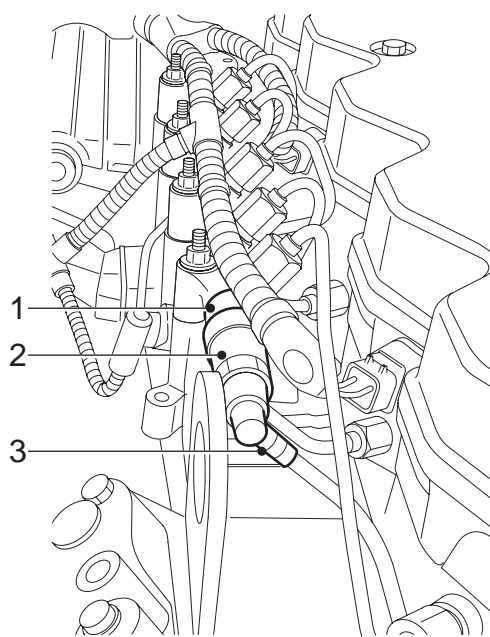
Dirt in the fuel system can lead to significant damage to parts of the system. Prevent this by cleaning the parts before disassembly and then sealing all open connections.

2**Removing fuel rail pressure-limiting valve**

1. Clean the pressure-limiting valve (2) and the surrounding area.
2. Remove the fuel return pipe (3) from the pressure-limiting valve (2).
3. Remove the pressure-limiting valve (2) from the fuel rail (1).

Installing fuel rail pressure-limiting valve

1. Check the sealing surface and the screw thread of the pressure-limiting valve and the fuel rail.
2. Install the pressure-limiting valve in the fuel rail and tighten the valve to the specified torque. See "Technical data".
3. Fit the fuel return pipe on the pressure-limiting valve.
4. Start the engine and check the pressure-limiting valve for leaks.



i400779

5.6 REMOVAL AND INSTALLATION, HIGH-PRESSURE PUMP



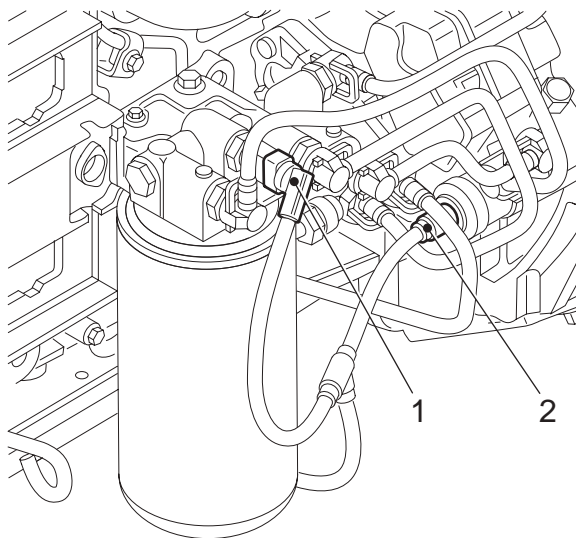
When removing the high-pressure pump, fuel will escape. Collect the fuel and avoid the risk of fire.



Dirt in the fuel system can lead to significant damage to parts of the system. Prevent this by cleaning the parts before disassembly and then sealing all open connections.

Removing the high-pressure pump

1. Clean the high-pressure pump and that part of the engine around it thoroughly with, for example, a steam cleaner. Cover the places at which leaks have been detected to prevent dirt getting into the fuel system.
2. Disconnect the fuel pipes from the high-pressure pump. Loosen the return pipe only on the high-pressure pump.
3. If fitted, uncouple the connector of the fuel temperature sensor (1) on the fuel fine filter head and the connector of the fuel pump control solenoid valve (2).
4. Remove the fuel fine filter together with the filter head.
5. Loosen both unions from the high-pressure pipe to the fuel rail as well as the pipe clamps. Remove the high-pressure pipe. Plug all openings.
6. Remove the three high-pressure pump attachment nuts and then the high-pressure pump.



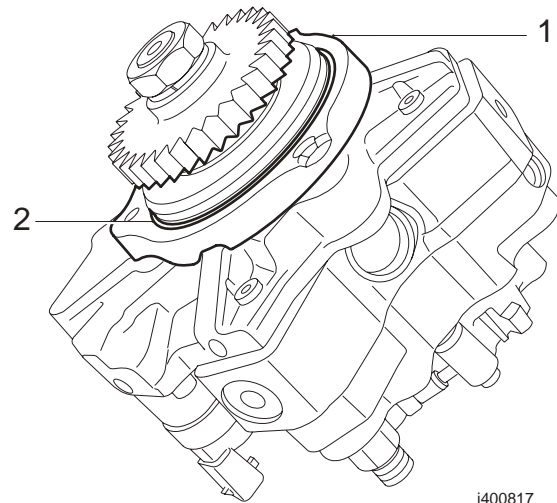
i400818

Note:

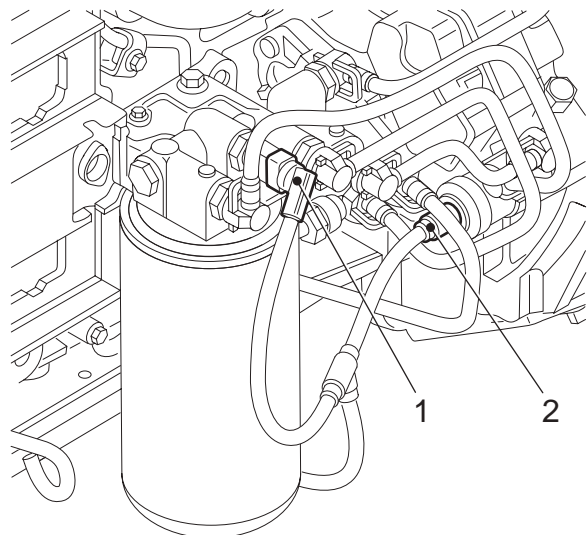
The high-pressure pump is fitted on the gear side with an adapter ring (1) and an O-ring (2) in the timing gear case. If the removal of the high-pressure pump is particularly difficult, it may be necessary to press the adapter ring (1) carefully out of the timing gear case using a small pry bar.

Installing the high-pressure pump

1. Clean the high-pressure pump. Make sure that no dirt or cleaner can get into the high-pressure pump ducts.
2. Check the high-pressure pump and the drive gear (externally) for wear and damage.
3. Fit a new O-ring (2) on the adapter ring (1) and apply a thin layer of engine oil to the O-ring.
4. Fit the high-pressure pump and press it into the timing gear case by means of the attachment nuts.
5. Tighten the attachment nuts to the specified torque. See "Technical data".
6. Fit the filter head and the fuel fine filter.
7. Fit the high-pressure pump to the fuel rail and tighten the unions. See "Technical data" for the specified tightening torques.
8. Tighten the pipe clamps.
9. If fitted, connect the connector of the fuel temperature sensor (1) on the fuel fine filter head and the connector of the fuel pump control solenoid valve (2).
10. Fit the fuel pipes to the high-pressure pump.
11. Bleed the fuel system. See "Inspection and adjustment".
12. Start the engine and check the fuel system for leaks.



i400817



i400818

5.7 REMOVAL AND INSTALLATION, FUEL FINE FILTER



When removing the fuel fine filter, a quantity of fuel will escape. Collect the fuel and avoid the risk of fire.

Removing the fuel fine filter

1. Place a container beneath the fuel fine filter and remove the filter.

Note:

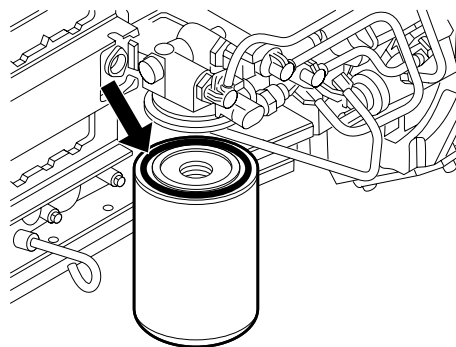
The fuel fine filter is a disposable filter and must therefore not be cleaned and re-used.

Installing the fuel fine filter

Note:

Do not fill the fine filter with fuel until it has been fitted. The fine filter is filled with fuel by the primer pump after it has been fitted. This considerably reduces the risk of dirt getting into the fuel system.

1. Check by hand whether the coupling piece for the filter attachment is securely attached.
2. Lightly lubricate the filter sealing ring with clean engine oil.
3. Fit the filter element onto the housing. Tighten the filter element until the sealing ring abuts. Tighten the filter element a further $\frac{1}{2}$ to $\frac{3}{4}$ turn by hand.
4. Bleed the fuel system. See "Inspection and adjustment".
5. Start the engine and check the fuel system for leaks. If necessary, retighten the filter by hand.



GO 00 201

5.8 REMOVAL AND INSTALLATION, FUEL PREFILTER/WATER SEPARATOR



When removing the fuel prefilter/water separator, a quantity of fuel will escape. Collect the fuel and avoid the risk of fire.

2

Removing the fuel prefilter/water separator filter element

1. Place a container under the filter.
2. Remove the plug (3) from the water sensor (2).
3. Remove the fuel prefilter/water separator filter element (1) by turning it anti-clockwise.
4. Remove the water sensor (2) from the filter element (1).

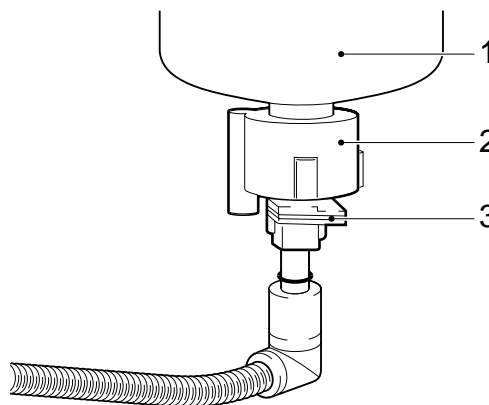
Installing the fuel prefilter/water separator filter element

1. Check by hand whether the coupling piece for the filter attachment is securely attached.
2. Lightly lubricate the sealing ring with engine oil.
3. Fit the fuel prefilter/water separator filter element (1) until the sealing ring abuts. Tighten the filter element a further $\frac{1}{2}$ to $\frac{3}{4}$ turn by hand.
4. Turn the water sensor (2) onto the filter element until it abuts. Tighten the water sensor by about a further $\frac{1}{8}$ - $\frac{1}{4}$ turn.

Note:

Over-tightening the water sensor (2) may damage the sensor and/or cause leakage.

5. Fit the plug (3) on the water sensor (2).
6. Bleed the fuel system. See "Inspection and adjustment".
7. Start the engine and check for leaks. If necessary, retighten the fuel prefilter/water separator filter element (1) by hand.



GO 00 220

5.9 REMOVAL AND INSTALLATION, FUEL LEVEL ELEMENT



When removing the fuel prefilter/water separator, a quantity of fuel will escape. Collect the fuel and avoid the risk of fire.



Dirt in the fuel system can lead to significant damage to parts of the system. All open connections must therefore be sealed.

Removing fuel level element

1. Disconnect the earth lead from the battery terminal.

Note:

To prevent dirt from entering, first clean the outside of the fuel tank.

2. Drain the fuel tank until it is less than 1/3 full.
3. Remove the connector from the fuel level element.
4. Remove the attachment bolts of the fuel level element and carefully remove the fuel level element from the fuel tank.
5. Remove the gasket.

Installing fuel level element

1. Clean the contact surface of the fuel tank and the fuel level element.
2. Fit a new gasket to the fuel level element and fit the fuel level element.
3. Fit the attachment bolts of the fuel level element.
4. Fit the connector of the fuel level element.
5. Fill the fuel tank with fuel to a level above the lip of the fuel level element and check the tank for leaks.

5.10 REMOVAL AND INSTALLATION, FUEL TANK

When the fuel tank is removed, a quantity of fuel will escape. Collect the fuel and avoid the risk of fire.



Dirt in the fuel system can lead to significant damage to parts of the system. Prevent this by cleaning the parts before disassembly and then sealing all open connections.

2**Removing fuel tank**

1. To prevent dirt from entering, first clean the outside of the fuel tank.
2. Drain the fuel tank until it is almost empty.
3. Remove the connector from the fuel level element.
4. Remove the fuel connections from the fuel tank.
5. Loosen the fuel pre-filter/water separator from the fuel tank and put it to the rear.
6. Loosen the tank straps.
7. Remove the fuel tank.

Installing the fuel tank

1. Check the fuel tank for damage.
2. Fit the fuel tank with the straps.
3. Fit the fuel pre-filter/water separator on the fuel tank.
4. Fit the fuel connections on the fuel tank.
5. Fit the connector of the fuel level element.
6. Fill the fuel tank with fuel.
7. Bleed the fuel system. See "Inspection and adjustment".
8. Check the tank and the fuel pipes for leaks.

5.11 REMOVAL AND INSTALLATION, ELECTRONIC UNIT COOLING PLATE



When removing the cooling plate, fuel will escape. Collect the fuel and avoid the risk of fire.



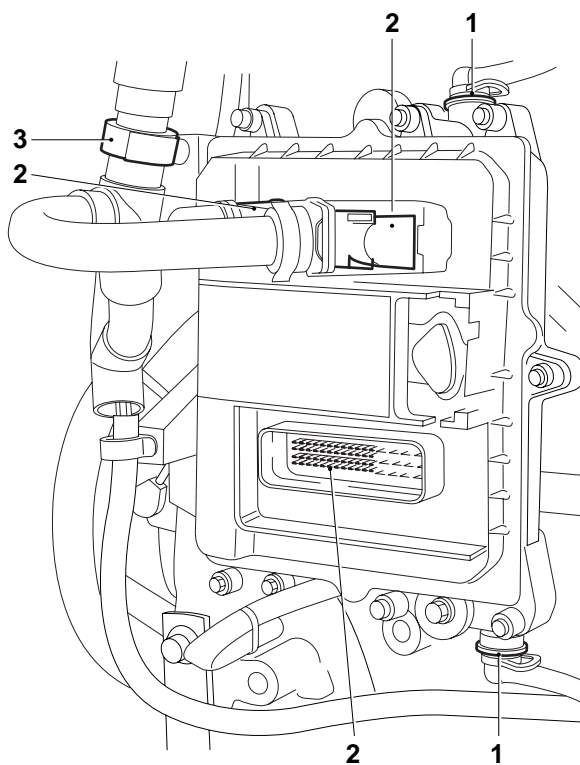
Dirt in the fuel system can lead to significant damage to parts of the system. Prevent this by cleaning the parts before disassembly and then sealing all open connections.

Note:

The electronic unit, together with the cooling plate, must first be removed from the engine block, after which the cooling plate must be demounted.

Removing electronic unit cooling plate

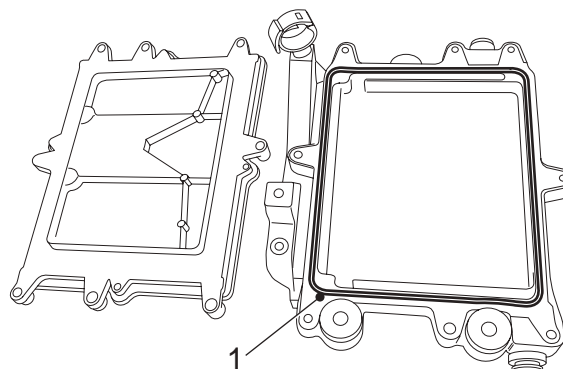
1. Disconnect the earth lead from the battery terminal.
2. To prevent dirt from entering, first clean the area around the fuel connections.
3. Remove the fuel pipes (1) on the cooling plate of the electronic unit.
4. Uncouple the electrical connectors (2) from the electronic unit and loosen the attachment clip (3) from the cable harness.
5. Remove the attachment bolts by which the electronic unit is fitted to the engine block.
6. Remove the electronic unit and cooling plate.
7. Remove the attachment bolts by which the electronic unit is fitted to the cooling plate and remove the cooling plate.



i400500

Installing electronic unit cooling plate

1. Clean the cooling side of the electronic unit and the cooling plate.
2. Inspect the sealing surfaces of the cooling plate and the electronic unit for damage and smoothness.
3. Fit a new sealing rubber (1) in the cooling plate.
4. Fit the cooling plate to the electronic unit and fit the bolts attaching the two parts. Tighten the attachment bolts to the specified torque. See "Technical data".
5. Fit the electronic unit and cooling plate to the engine block and fit the attachment bolts. Tighten the attachment bolts to the specified torque. See "Technical data".
6. Connect the electrical connectors to the electronic unit and attach the cable harness with the clips.
7. Connect the quick-release couplings of the fuel pipes to the electronic unit cooling plate.
8. Bleed the fuel system. See "Inspection and adjustment".
9. Fit the earth lead to the battery terminal.
10. Start the engine and check the fuel system for leaks.



i400819

5.12 REMOVAL AND INSTALLATION, FUEL RETURN OVERFLOW VALVE



When removing the fuel return overflow valve, fuel will escape. Collect the fuel and avoid the risk of fire.



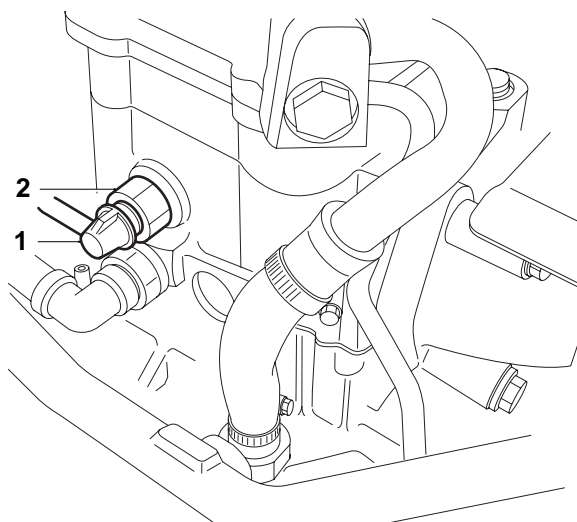
Dirt in the fuel system can lead to significant damage to parts of the system. Prevent this by cleaning the parts before disassembly and then sealing all open connections.

Removing the fuel return overflow valve

1. To prevent dirt from entering, first clean the area around the fuel return connection.
2. Remove the fuel return pipe (1) on the fuel return overflow valve (2) and plug the pipe.
3. Remove the fuel return overflow valve and collect the escaping fuel.

Installing the fuel return overflow valve

1. Install the fuel return overflow valve. Haal het brandstofretour-overstroomventiel aan met het voorgeschreven aanhaalmoment, zie hoofdgroep "Technische gegevens".
2. Connect the quick-release couplings of the fuel return pipe to the fuel return overflow valve.
3. Start the engine and check the fuel system for leaks.



i400502

5.13 REMOVAL AND INSTALLATION, LOW-PRESSURE FUEL PIPES



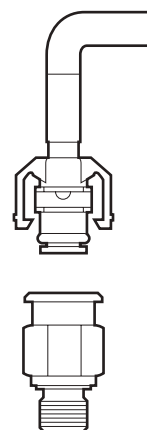
When removing the low-pressure fuel pipes, fuel will escape. Collect the fuel and avoid the risk of fire.



Dirt in the fuel system can lead to significant damage to parts of the system. All open connections must therefore be sealed.

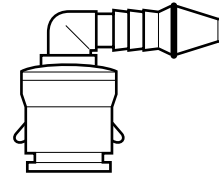
The low-pressure fuel pipes may have two different types of quick-release coupling.

VOSS quick-release coupling

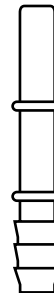
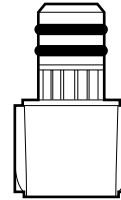


i400881

John Guest quick-release coupling



i400882



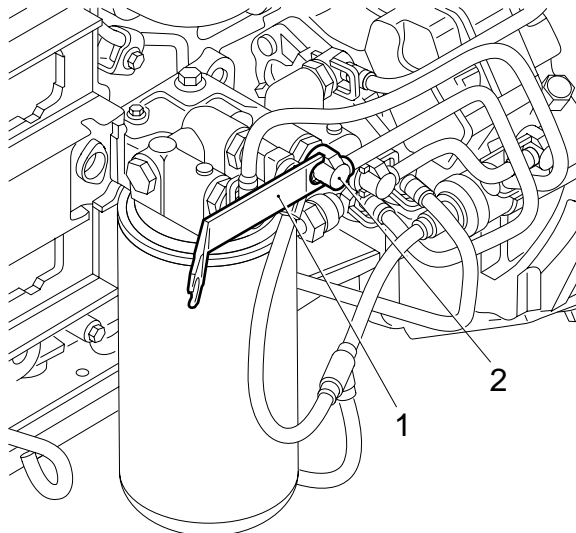
i400884

Low-pressure fuel pipes fitted with VOSS quick-release couplings**Removing low-pressure fuel pipes**

1. Disconnect the fuel pipe (2) by inserting the special tool (1)(DAF no. 1329470) into the quick-release coupling and removing the pipe from the coupling.
2. Remove the special tool from the quick-release coupling.
3. Plug the openings.

Fitting low-pressure fuel pipes

1. Clean the quick-release coupling parts and apply a thin layer of clean engine oil to the O-ring.
2. Fit the pipe on the quick-release coupling of the component and push the pipe onto it until a clear resistance can be felt and the quick-release coupling audibly clicks.
3. Bleed the fuel system. See "Inspection and adjustment".
4. Start the engine and check the fuel system for leaks.



i400473

Low-pressure fuel pipes fitted with John Guest quick-release couplings**Removing low-pressure fuel pipes**

1. Disconnect the fuel pipe by pressing in both lips of the quick-release coupling and removing the pipe from the quick-release coupling.
2. Plug the openings.

Fitting low-pressure fuel pipes

1. Clean the quick-release coupling parts.
2. Fit the pipe on the quick-release coupling of the component and push the pipe onto it until a clear resistance can be felt and the quick-release coupling audibly clicks.
3. Bleed the fuel system. See "Inspection and adjustment".
4. Start the engine and check the fuel system for leaks.

6. CLEANING

6.1 CLEANING INJECTOR



The injector must never be cleaned with a steel brush or pressure cleaning equipment. Never put the brush in the injector bores when cleaning the exterior of the injector nozzle. If this happens, the nozzle must be replaced. Before cleaning the nozzle, cover the injector bores. Only clean the injector with a brass hand brush.

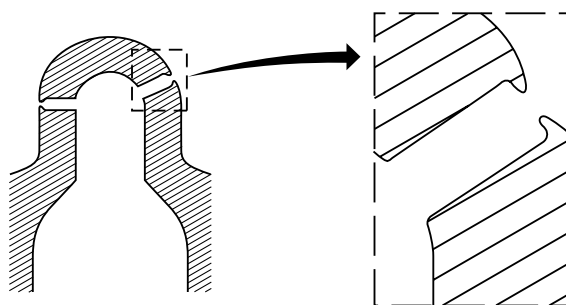
Note:

The use of steel brushes can cause deformation of the injector bores, with the result that the wrong amount of fuel is injected. This deformation cannot be ascertained by measurements or checks.

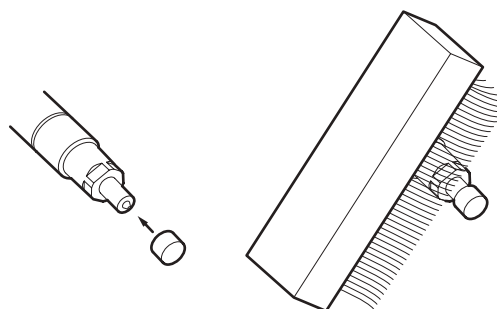
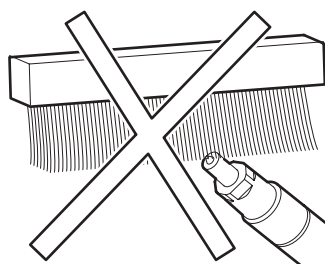
Note:

The disassembly and assembly of injectors is not permitted. Only external cleaning is permitted.

1. Remove the injector. See "Removal and installation".
2. Clean the injector hole in the cylinder head. The metal surface of the hole must not be damaged.
3. Wipe the exterior of the injector with a clean, lint-free cloth. In the case of heavy soiling the injector may be cleaned carefully with a brass hand brush (not the apertures in the injector nozzle!).
4. Fit the injector. See "Removal and installation".



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1. SAFETY INSTRUCTIONS

1.1 SAFETY INSTRUCTIONS

Fuel



Diesel fuel is an extremely flammable liquid, and must not be exposed to naked flames or come into contact with hot surfaces. The diesel fuel fumes remaining in an empty fuel tank form an extremely explosive mixture.

When fuel system components are being removed, some fuel will escape. To keep this spillage to a minimum, unscrew the tank cap to release any overpressure.

Any spilled fuel must be collected, bearing in mind the risk of fire.

Exhaust gases

Do not run the engine in an enclosed or unventilated area. Make sure exhaust fumes are properly extracted.



Exhaust gases contain carbon monoxide. Carbon monoxide is a deadly colourless and odourless gas, which, when inhaled, deprives the body of oxygen, leading to asphyxiation. Serious carbon monoxide poisoning may result in brain damage or death.

Moving parts

Remain at a safe distance from rotating and/or moving components.

Various fluids

Various oils and lubricants used on the vehicle may constitute a health hazard. This also applies to engine coolant, windscreen washer fluid, refrigerant in air-conditioning systems, battery acid and clutch fluid. So avoid inhaling and direct contact.

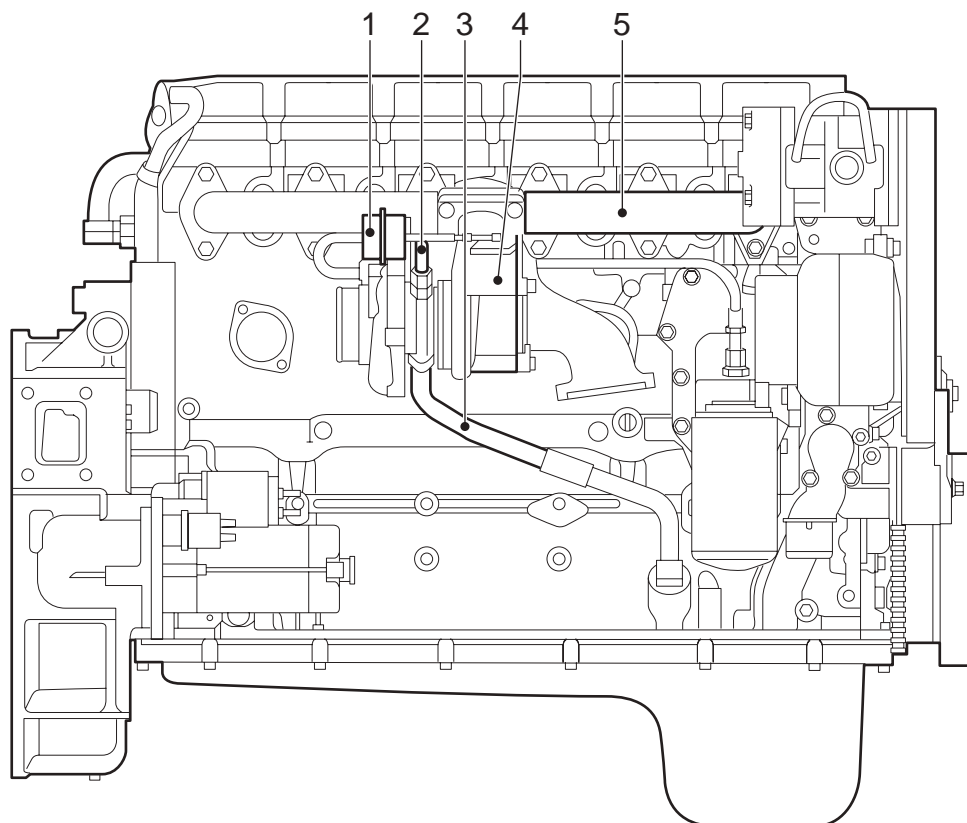
Electrical short-circuit

Always disconnect the battery's earth connection during repair or maintenance operations for which the electric power supply is not required.

3

2. GENERAL

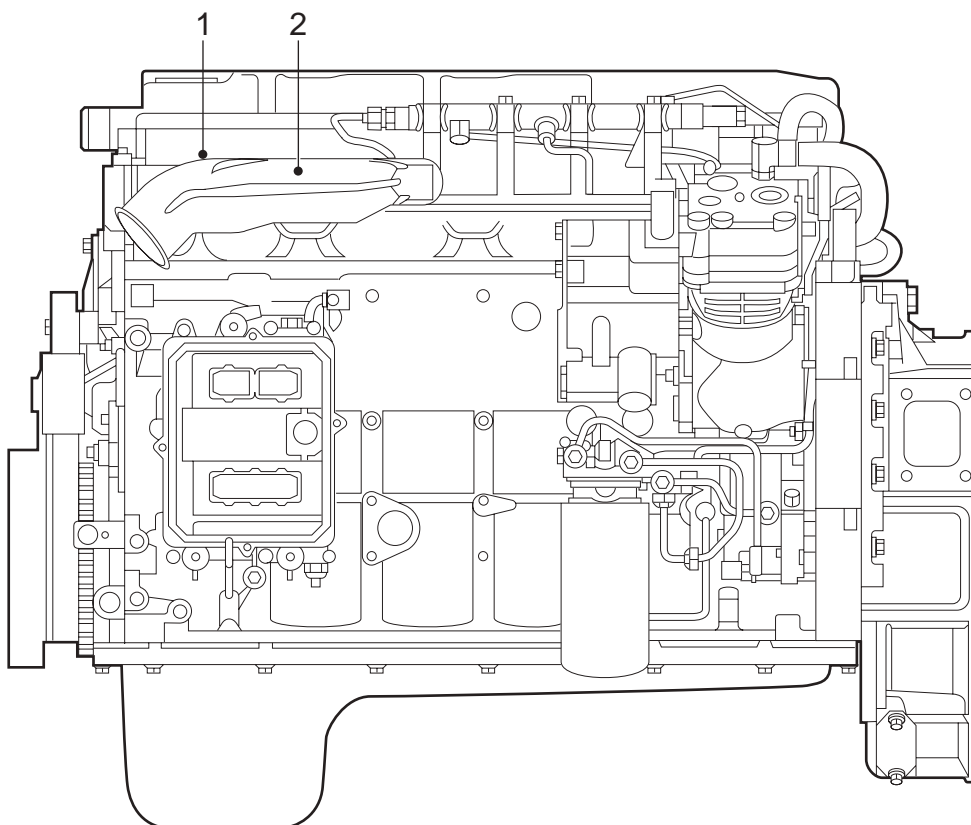
2.1 LOCATION OF COMPONENTS



1. Wastegate diaphragm box
2. Oil supply pipe
3. Oil discharge pipe
4. Turbocharger
5. Exhaust manifold

i400840

3



- 1. Glow element connections
- 2. Intake manifold

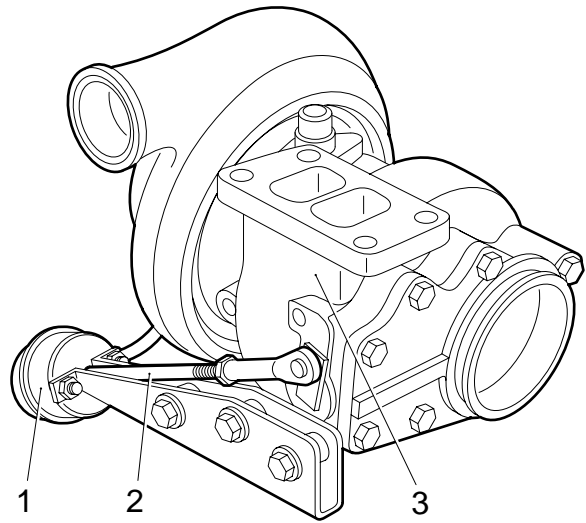
i400841

2.2 SYSTEM DESCRIPTION, TURBOCHARGER WITH WASTEGATE

To make the engine more responsive at lower engine speeds, a turbocharger is used that produces a better charge ratio at these speeds. Without provision having been made for this, the boost pressure yielded by this turbocharger would be too high at maximum engine speeds. Use of a wastegate prevents this.

The boost pressure is measured by a diaphragm box (1) on the delivery side of the turbocharger. The diaphragm is pushed back against the spring pressure by the boost pressure. The linked control rod (2) is also pushed back. The control rod operates a valve in the turbine housing (3). The valve in the turbine housing is opened when the maximum pre-set pressure has been reached.

When the valve is opened, some of the exhaust gases will be discharged directly to the exhaust pipe rather than being used to propel the turbine rotor of the turbocharger.



i400509

3. INSPECTION AND ADJUSTMENT

3.1 INSPECTING TURBOCHARGER WASTEGATE

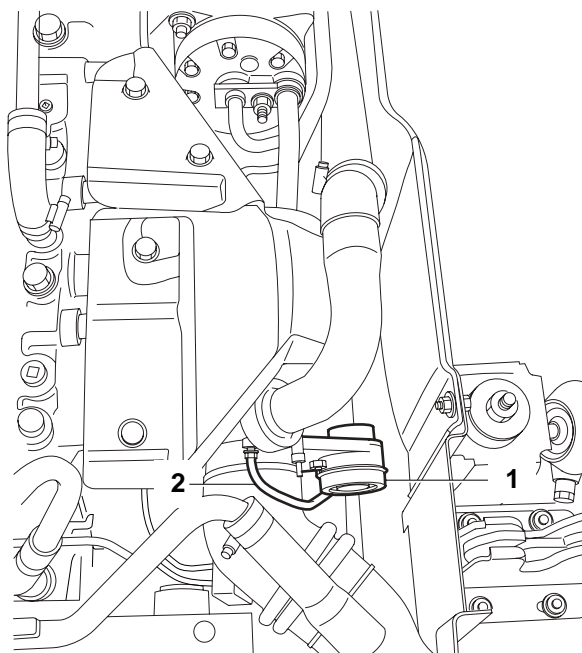
Note:

Depending on the fitting position of the turbocharger, it may be necessary to remove the turbocharger from the engine before this adjustment; see "Removal and installation".

Note:

The turbocharger is calibrated in the factory and must not be re-adjusted. The length of the control rod on the wastegate valve lever may only be changed when assembling a new turbocharger. After that, only an inspection of the actuating pressure of the wastegate may be carried out. If the result is negative, the turbocharger must be replaced.

1. Remove the flexible pipe (2) from the diaphragm box (1) of the wastegate.
2. Connect an air-pressure reducer valve to the diaphragm box of the wastegate. Set the reducer valve to max. 0.2 bar gauge pressure. Connect the reducer valve to a compressed air installation.
3. Set the reducer valve to exactly the same test pressure as listed in "Technical data".
4. Check the diaphragm in the diaphragm box for leaks by listening carefully for a hissing sound from the diaphragm box.
5. Check whether the control rod of the wastegate has moved. If it has not moved, the control rod must be loosened from the lever. Check again whether the control rod has moved. If it has not moved, the diaphragm box must be replaced. If it has moved, the wastegate valve must be made to move freely or, if that does not help sufficiently, the entire compressor unit must be replaced.
6. Remove the flexible pipe with the reducer valve and re-connect the flexible pipe of the compressor pump to the wastegate diaphragm box.

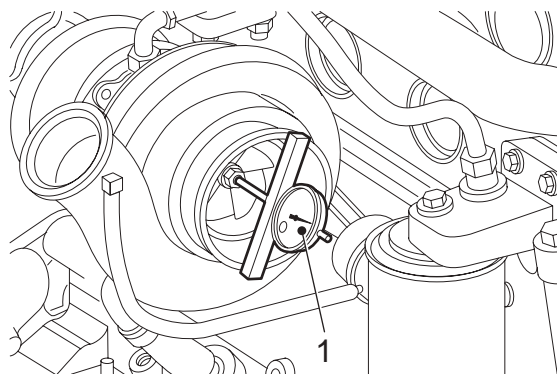


i400510

3.2 INSPECTING TURBOCHARGER AXIAL BEARING PLAY**Note:**

The turbocharger axial bearing play should only be checked when the engine is cold.

1. Remove the exhaust pipe from the turbocharger.
2. Remove the charge pipes from the turbocharger.
3. Fit a dial gauge (1) to the charge supply flange of the turbocharger.
4. Push the compressor shaft away from the dial gauge and set the gauge to zero.
5. Push the compressor shaft to the dial gauge and read off the axial play. Compare the reading with the specified value; see "Technical data". Replace the turbocharger if necessary.
6. Fit the charge pipes to the turbocharger.
7. Fit the exhaust pipe to the turbocharger.



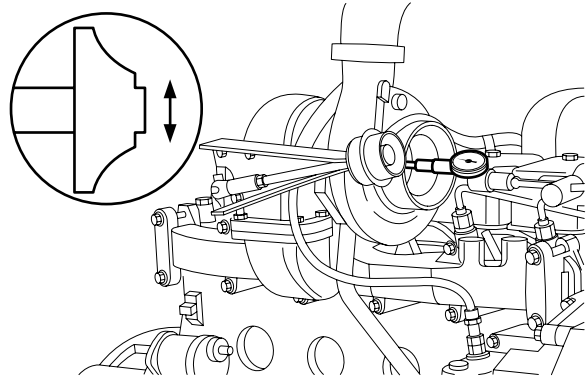
i400821

3.3 INSPECTING TURBOCHARGER RADIAL BEARING PLAY

Note:

The turbocharger radial bearing play should only be checked when the engine is cold.

1. Remove the turbocharger from the exhaust manifold. See "Removal and installation".
2. Fit a pressure gauge to the turbocharger housing and measure the radial play. Compare the reading with the specified value; see "Technical data". Replace the turbocharger if necessary.
3. Fit the turbocharger. See "Removal and installation".



i400650

3.4 CHECKING EXHAUST GAS BACK PRESSURE

Checking exhaust gas back pressure

1. Remove the plug from the exhaust elbow attachment or bore a hole and install a suitable coupling with a pipe. The first part of the pipe must be made of metal, to withstand the high temperatures.

Note:

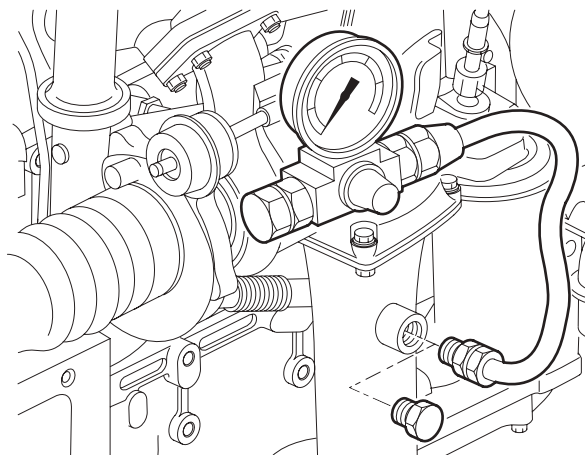
Use an attenuated gauge to prevent excessive shaking of the gauge needle.

2. Connect a pressure gauge to the pipe, with a range of at least 0.1 - 0.2 bar (10 - 20 kPa).

Note:

The engine brake must not be used during measurements. This is to protect the pressure gauge.

3. Measure the exhaust gas back pressure at full-load engine speed and compare the measurements to the specified value. See "Technical data". Check the exhaust system if the exhaust gas back pressure is too high.
4. Remove the pressure gauge and the coupling and fit the plug.



i400513

3.5 INSPECTION AND PRESSURE-TESTING, AIR INLET SYSTEM



When pressure-testing the air inlet system, the plugs may spring off if they are not properly secured. It is therefore important to check the attachment of the plugs before pressure-testing and keep people away from the area.

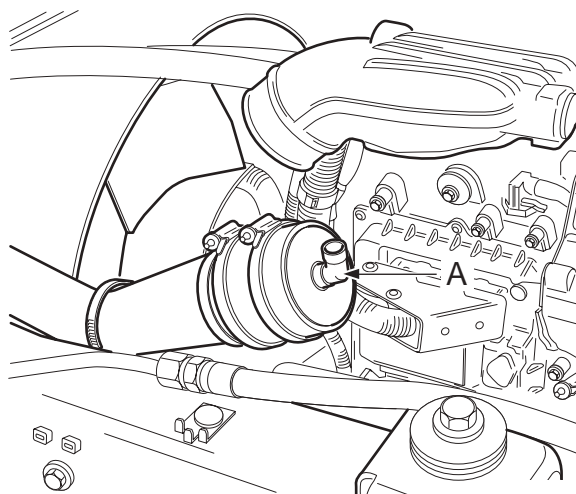
1. Check the condition and mounting of the air inlet channels/pipes of the air intake system.

Note:

In case of doubt as to the proper sealing of the air inlet system, which is indicated by the following:

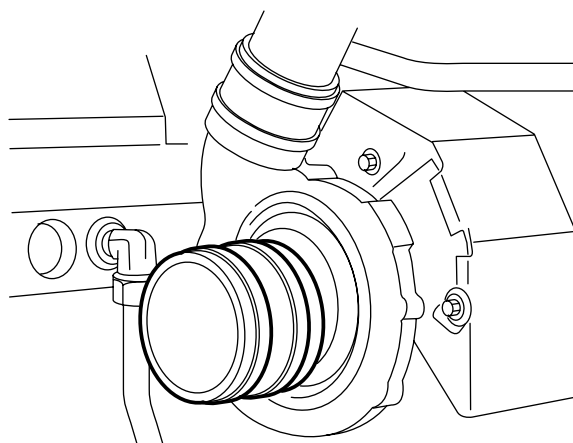
- loss of power
- high fuel consumption
- unusual noises
- lit engine fault symbol on the instrument panel, ???carry out a pressure test to check the air inlet system for leakage.

2. Remove the right-hand and rear engine encapsulations.
3. Loosen the inlet hose between the air cooler and the inlet manifold at the inlet manifold side.
4. Fit the special tool (DAF no. 1453171) in the hose.



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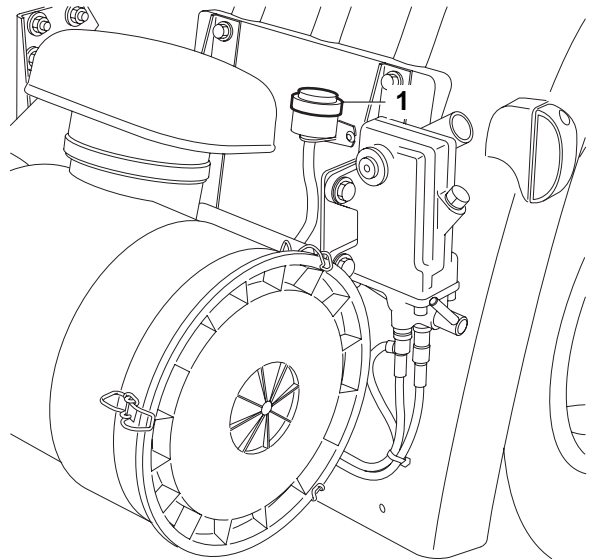
5. Loosen the plastic pipe between the air filter housing and the rubber suction hose on the turbocharger.
6. Install special tool (DAF no. 1453172) in the rubber intake port on the turbocharger.
7. Connect an air pipe with reducer valve to the sealing cap (A) and charge the system to approx. 1 bar.
8. Use a soapy solution to check the whole inlet system for air leaks. Also check whether the pressure gauge of the reducer valve drops.
9. Fit the loosened hoses of the inlet system and the engine encapsulation.



i 400376

3.6 CHECKING INLET UNDERPRESSURE

1. Remove the connection of the air intake pipe underpressure indicator (1) from between the air filter housing and turbocharger.
2. Connect a pressure gauge with a maximum rating of -100 mbar (-10 kPa) to the connection of the underpressure indicator.
3. Measure the inlet underpressure at full-load engine speed and compare the measurement to the specified value. See "Technical data".
4. Fit the connection of the air intake pipe underpressure indicator (1) between the air filter housing and turbocharger.



i400514

4. REMOVAL AND INSTALLATION

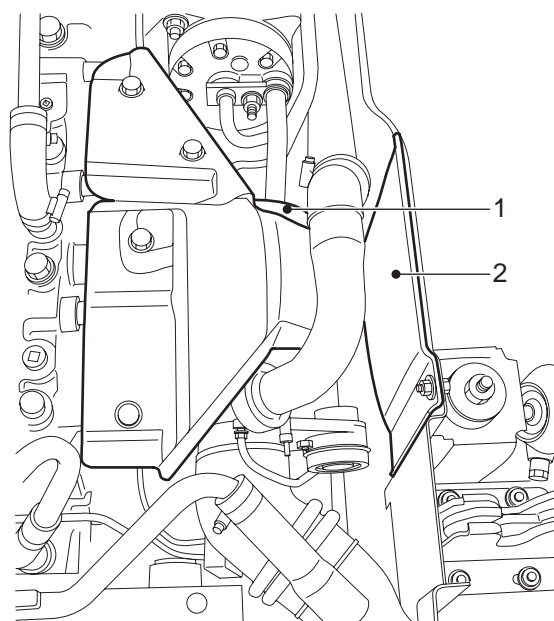
4.1 REMOVAL AND INSTALLATION, TURBOCHARGER



If the turbocharger to be replaced has been damaged to such an extent that parts of it are missing or lubricating oil has entered the inlet system, the inlet and exhaust systems must be checked and cleaned thoroughly in order to prevent serious damage to the engine.

Removing the turbocharger

1. Remove the right-hand engine encapsulation (2).
2. Remove the heat shield (1) from the oil filter.
3. Remove each charge pipe and the turbocharger exhaust pipe.
4. Remove the oil discharge pipe from the turbocharger.
5. Detach the entire oil supply pipe from the oil filter housing to the turbocharger.
6. Remove the attachment bolts from the turbocharger.
7. Remove the turbocharger.
8. Immediately plug the openings.



i400857

Installing the turbocharger

1. Clean the turbocharger and the oil supply and discharge pipes.
2. Before installing the turbocharger, check the following:
 - the turbocharger housing and connector flange for cracks. See "Technical data" for rejection standards;
 - the turbocharger shaft must be able to rotate freely;
 - the turbocharger shaft must not run out of true;
 - the turbocharger pump and turbine wheels must not be damaged;
 - there must not be an excessive amount of oil in the compressor side of the turbocharger. A small amount of oil on the inside walls of the compressor side is allowed.

3. Check the adjustment of the turbocharger wastegate. See "Inspection and adjustment".
4. Check the axial bearing play of the turbocharger; see "Inspection and adjustment".
5. Check the radial bearing play of the turbocharger; see "Inspection and adjustment".
6. Clean the sealing surfaces.

Note:

Always use new gaskets when installing the turbocharger.

7. Apply a layer of Copaslip to the exhaust manifold studs.
8. Fit the turbocharger to the exhaust manifold.
9. Fit the attachment nuts and tighten them to the specified torque. See "Technical data".
10. Check that the oil supply and discharge pipes are clean and not blocked, kinked or cracked. Replace the pipes if necessary.

Note:

If the turbocharger oil supply and/or discharge does not function properly, this may result in serious damage to the turbocharger and/or engine.

11. Fit new O-rings to the oil discharge pipe and apply a thin layer of engine oil to them. Fit the oil discharge pipe. For the specified tightening torque, see "Technical data".
12. Pour clean engine oil into the oil supply of the turbocharger and fit the oil supply pipe, after fitting a new copper ring, on the oil filter housing and the turbocharger. Tighten the pipe to the specified tightening torque; see "Technical data".

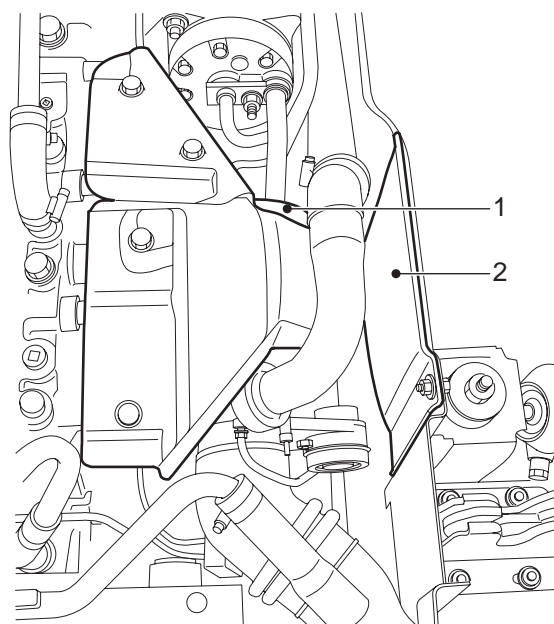
4

BE ENGINE INLET/EXHAUST SYSTEM

LF45/55 series

Removal and installation

13. Fit the exhaust pipe to the turbocharger.
14. Fit the charge pipes to the exhaust pipe.
15. Fit the heat shield (1) to the oil filter.
16. Install the engine encapsulation (2).

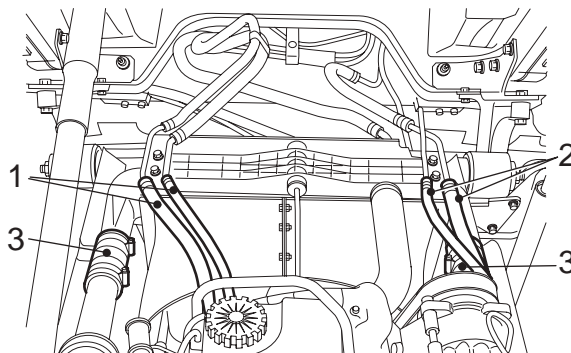


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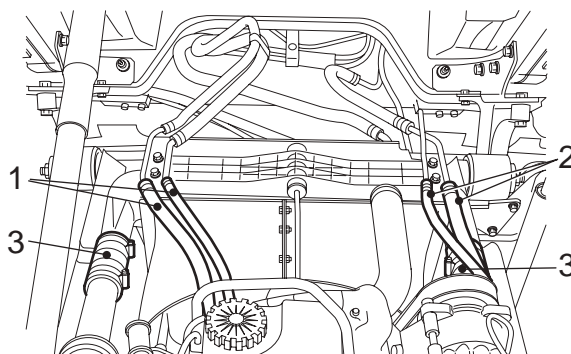
3

4.2 REMOVAL AND INSTALLATION OF AIR COOLER**Removing the air cooler**

1. Disconnect the earth lead from the battery terminal.
2. If the vehicle has air conditioning, loosen the support of the refrigerant pipes (2) on the radiator and remove the condenser from the air cooler supports.
3. Loosen the support of the coolant pipes (1) on the radiator.
4. Remove the charge pipes (3) from the air cooler and plug the openings.
5. Disconnect the air cooler.
6. Remove the air cooler.

**Installing the air cooler**

1. Clean the outside of the air cooler with compressed air.
2. Install the air cooler and tighten the air cooler attachments.
3. Fit the charge pipes (3) to the air cooler.
4. Fit the bracket of the coolant pipes (1) on the radiator.
5. If the vehicle has air conditioning, fit the condenser in the air cooler supports and tighten the support of the refrigerant pipes (2) on the radiator.
6. Connect the battery terminals.
7. Start the engine and check for leakage.



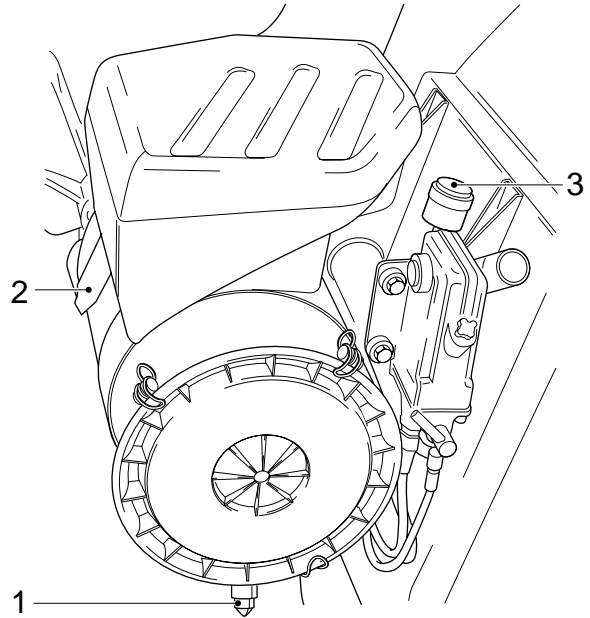
4.3 REMOVAL AND INSTALLATION, AIR FILTER ELEMENT

Removing the air filter element

1. Loosen all clamping brackets on the air filter cover.
2. Remove the air filter cover.
3. Remove the air filter element.
4. Clean the inside of the air filter housing and the air filter cover.
5. Clean the rubber sealing valves (1 and 2) on the filter housing. Check the sealing valve for damage.

Installing the air filter element

1. Fit the air filter element in the air filter housing.
2. Fit the air filter cover.
3. Install all the clamping brackets.
4. Reset the air filter indicator (3) by pressing the knob on the indicator.



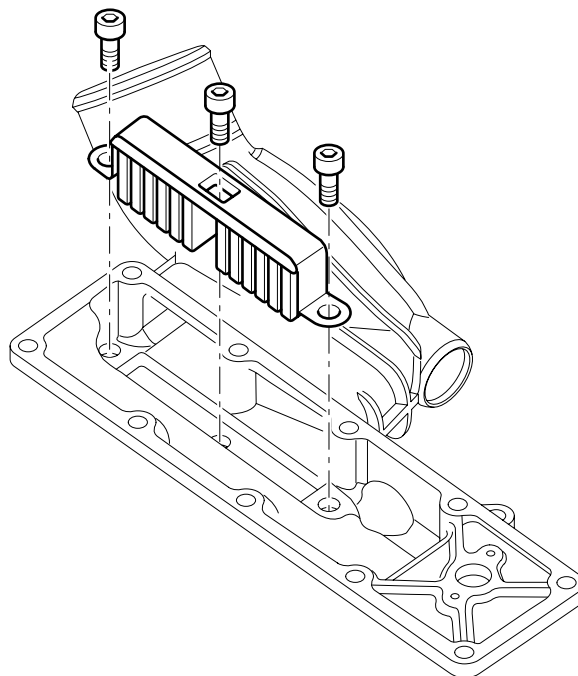
I4 00 535

4.4 REMOVAL AND INSTALLATION, GLOW PLUG**Removing the glow plug**

1. Remove the inlet manifold.
2. Remove the attachment bolts from the glow plug and remove the glow plug.

Installing the glow plug

1. Fit the glow plug and tighten the attachment bolts to the specified torque. See "Technical data".
2. Fit the inlet manifold.



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5. CLEANING

5.1 CLEANING THE EXTERIOR OF RADIATOR AND AIR COOLER



Inhalation of dust may have serious consequences for your health. Take the necessary precautions, such as wearing goggles and a facemask.

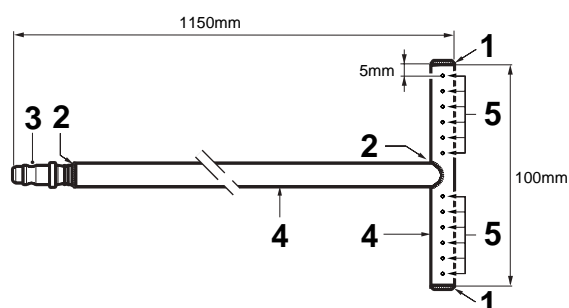
Note:

With the aid of a simple tool, the radiator and the air cooler can be blow-cleaned.

The tool (radiator cleaner) cannot be ordered from DAF. It should be manufactured by yourself according to the drawing.

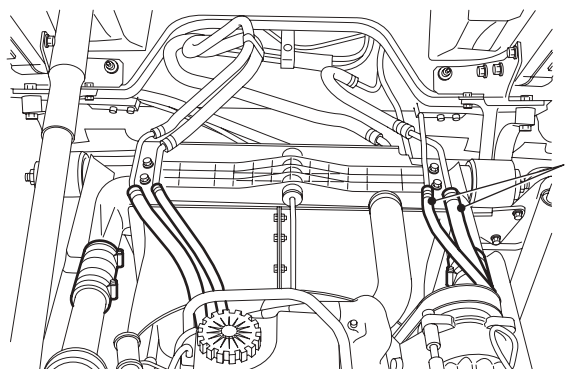
Key to drawing:

- 1 Solder up
- 2 Solder
- 3 Quick-release coupling for air hose
- 4 Steel pipe, \varnothing 10 mm
- 5 6 x \varnothing 1.5 mm between holes, with a centre-to-centre distance between the holes of 7 mm, drilled on one side



M2108

1. If the vehicle has air conditioning, loosen the support of the refrigerant pipes (1) on the radiator and remove the condenser from the air cooler supports. Push the condenser as far as possible forwards.

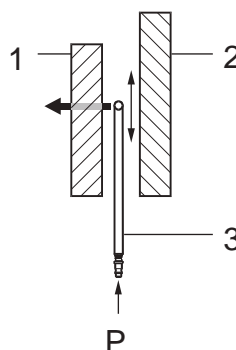


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Cleaning

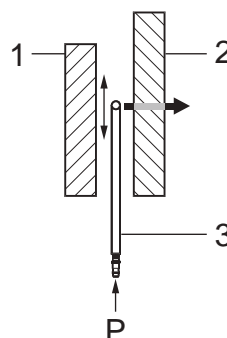
LF45/55 series

2. Insert the radiator cleaner (3) between the air cooler (1) and radiator (2) from underneath, with the air holes facing the air cooler (1).
3. Apply air pressure to the radiator cleaner (3) and continue blow-cleaning the air cooler (1) until no more dirt comes out.



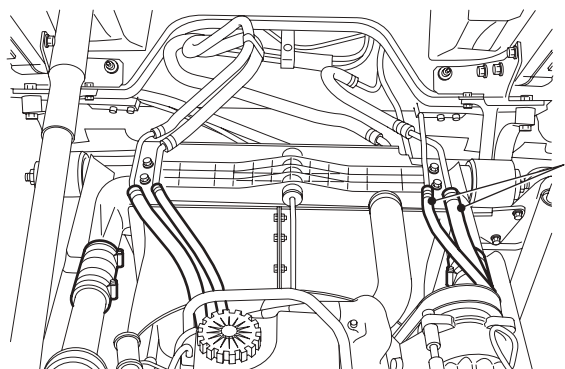
M201351

4. Turn the radiator cleaner (3) over, turning the holes towards the radiator (2), and blow-clean the radiator (2).



M201352

5. If the vehicle has air conditioning, fit the condenser in the air cooler supports and tighten the support of the refrigerant pipes (1) on the radiator.



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4. REMOVAL AND INSTALLATION	4-1	200416
4.1 Removal and installation of exhaust brake	4-1	200416

1. SAFETY INSTRUCTIONS

1.1 SAFETY INSTRUCTIONS

Fuel



Diesel fuel is an extremely flammable liquid, and must not be exposed to naked flames or come into contact with hot surfaces. The diesel fuel fumes remaining in an empty fuel tank form an extremely explosive mixture.

When fuel system components are being removed, some fuel will escape. To keep this spillage to a minimum, unscrew the tank cap to release any overpressure.

Any spilled fuel must be collected, bearing in mind the risk of fire.

Exhaust gases

Do not run the engine in an enclosed or unventilated area. Make sure exhaust fumes are properly extracted.



Exhaust gases contain carbon monoxide. Carbon monoxide is a deadly colourless and odourless gas, which, when inhaled, deprives the body of oxygen, leading to asphyxiation. Serious carbon monoxide poisoning may result in brain damage or death.

Moving parts

Remain at a safe distance from rotating and/or moving components.

Various fluids

Various oils and lubricants used on the vehicle may constitute a health hazard. This also applies to engine coolant, windscreen washer fluid, refrigerant in air-conditioning systems, battery acid and clutch fluid. So avoid inhaling and direct contact.

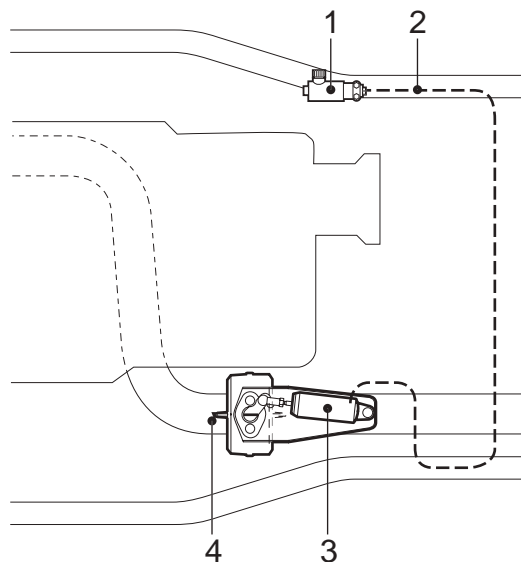
Electrical short-circuit

Always disconnect the battery's earth connection during repair or maintenance operations for which the electric power supply is not required.

2. GENERAL

2.1 LOCATION OF EXHAUST BRAKE COMPONENTS

1. Exhaust brake valve
2. Air pipe
3. Operating cylinder, exhaust brake
4. Butterfly valve

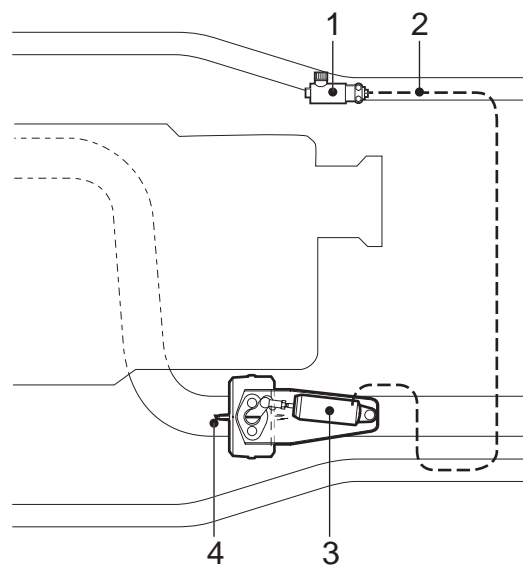


2.2 SYSTEM DESCRIPTION, EXHAUST BRAKE

1. Exhaust brake valve
2. Air pipe
3. Butterfly valve operating cylinder
4. Butterfly valve

Note:

The engine brake is an exhaust brake.



i400858

Switching on the exhaust brake

The exhaust brake consists of an engine brake operating switch fitted to the steering column and an operating cylinder (3) connected to the butterfly valve (4) in the exhaust pipe.

If the exhaust brake operating switch is activated, a signal is passed to the engine management system's electronic unit. The operating switch has the positions "off" and "automatic". In the "automatic" position the engine management system's electronic unit engages the exhaust brake whenever this is appropriate and possible. Of course, the electronic unit disengages the exhaust brake when required.

If the exhaust brake is engaged by the electronic unit, the unit energises the exhaust brake valve (1), causing supply pressure to flow to the operating cylinder. The cylinder closes the butterfly valve in the butterfly valve housing. The exhaust pipe is then almost completely closed off. The engine management system's electronic unit also interrupts the fuel supply to the various cylinders. The engine now acts as a compressor, creating a braking action.

The higher the engine speed, the greater the braking action of the engine brake.

Switching off the exhaust brake

If the engine brake control switch is pushed back, the butterfly valve will be re-opened and the fuel supply to the various cylinders will be re-instated.

3. INSPECTION AND ADJUSTMENT

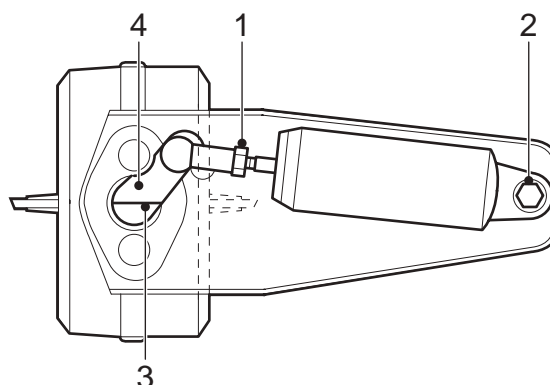
3.1 INSPECTION AND ADJUSTMENT, EXHAUST BRAKE

Checking exhaust brake

1. Check the exhaust brake for smooth operation by pressurising the exhaust brake cylinder yourself.

Setting the exhaust brake

1. Remove the air pipe from the operating cylinder.
2. Slacken lock nut (1) on the piston rod.
3. Remove the attachment nut (2) from the operating cylinder and take the operating cylinder off the support.
4. Open the butterfly valve fully (exhaust brake inactive), indicated by the mark (3) on the butterfly valve shaft, and press the lever (4) against the stop.
5. Set the piston rod length by rotating the operating cylinder in such a way that it can be fitted on the support.
6. Turn the piston rod one more full turn in the ball joint to give the operating cylinder the correct pre-tension.
7. Fit the operating cylinder on the support using the attachment nut (2) and fit the air pipe.
8. Tighten the lock nut (1).
9. Connect the air pipe to the operating cylinder.



i400859

4. REMOVAL AND INSTALLATION

4.1 REMOVAL AND INSTALLATION OF EXHAUST BRAKE

Removing the exhaust brake

1. Loosen the air pipe of the operating cylinder.
2. Remove the exhaust pipe from the exhaust brake.
3. Remove the entire exhaust brake.

Installing exhaust brake

1. Check the butterfly valve for smooth operation.
2. Clean and check the sealing faces of the butterfly valve housing and of the exhaust pipes.
3. Clean the attachment bolts and apply heat-resistant grease to the threads.
4. Fit the exhaust brake.
5. Fit the exhaust pipe.
6. Connect the air pipe.
7. Check the operation of the exhaust brake.

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1. SAFETY INSTRUCTIONS

1.1 SAFETY INSTRUCTIONS

Fuel



Diesel fuel is an extremely flammable liquid, and must not be exposed to naked flames or come into contact with hot surfaces. The diesel fuel fumes remaining in an empty fuel tank form an extremely explosive mixture.

When fuel system components are being removed, some fuel will escape. To keep this spillage to a minimum, unscrew the tank cap to release any overpressure.

Any spilled fuel must be collected, bearing in mind the risk of fire.

Exhaust gases

Do not run the engine in an enclosed or unventilated area. Make sure exhaust fumes are properly extracted.



Exhaust gases contain carbon monoxide. Carbon monoxide is a deadly colourless and odourless gas, which, when inhaled, deprives the body of oxygen, leading to asphyxiation. Serious carbon monoxide poisoning may result in brain damage or death.

Moving parts

Remain at a safe distance from rotating and/or moving components.

Various fluids

Various oils and lubricants used on the vehicle may constitute a health hazard. This also applies to engine coolant, windscreen washer fluid, refrigerant in air-conditioning systems, battery acid and clutch fluid. So avoid inhaling and direct contact.

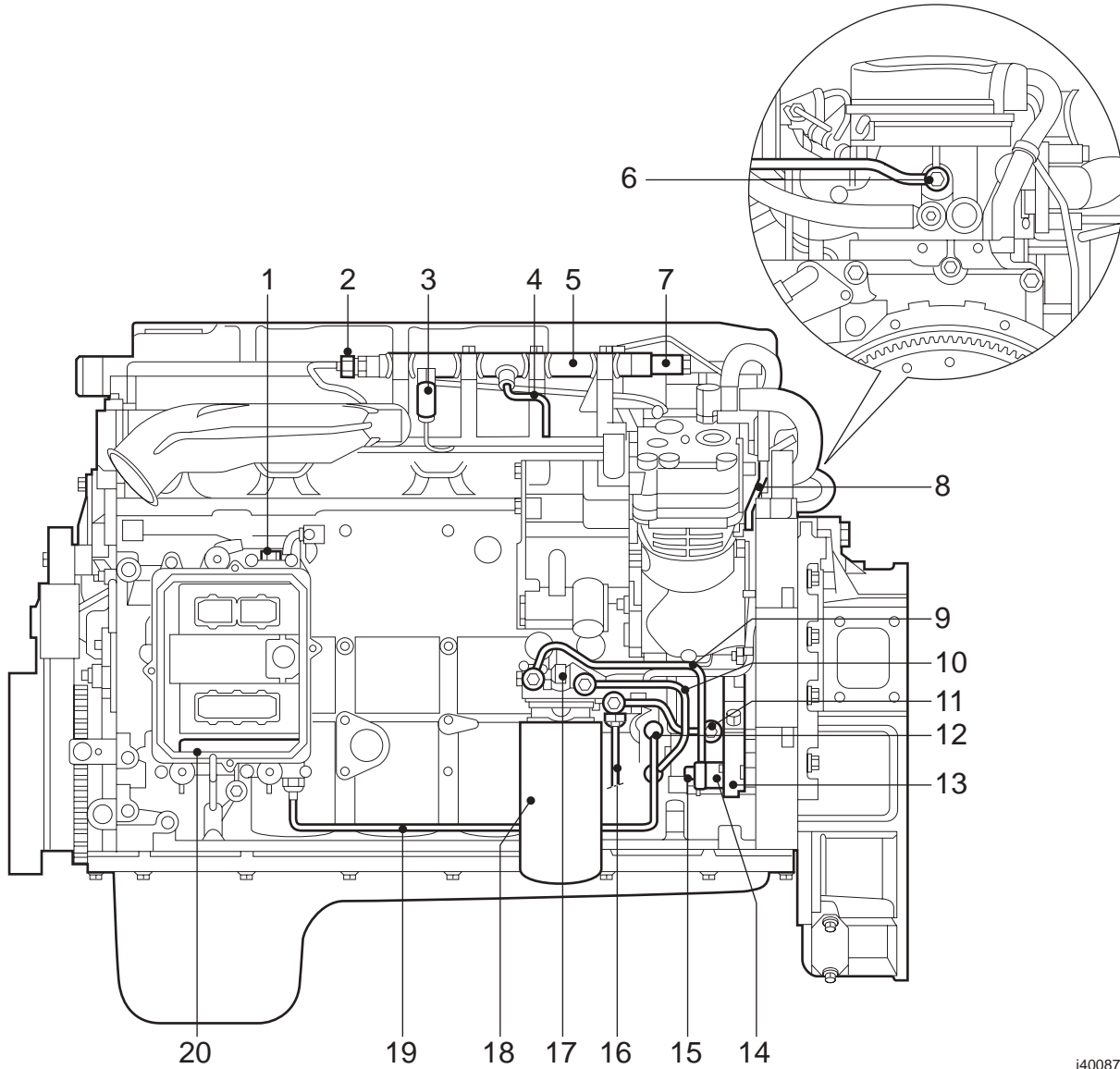
Electrical short-circuit

Always disconnect the battery's earth connection during repair or maintenance operations for which the electric power supply is not required.

2. GENERAL

2.1 LOCATION OF COMPONENTS

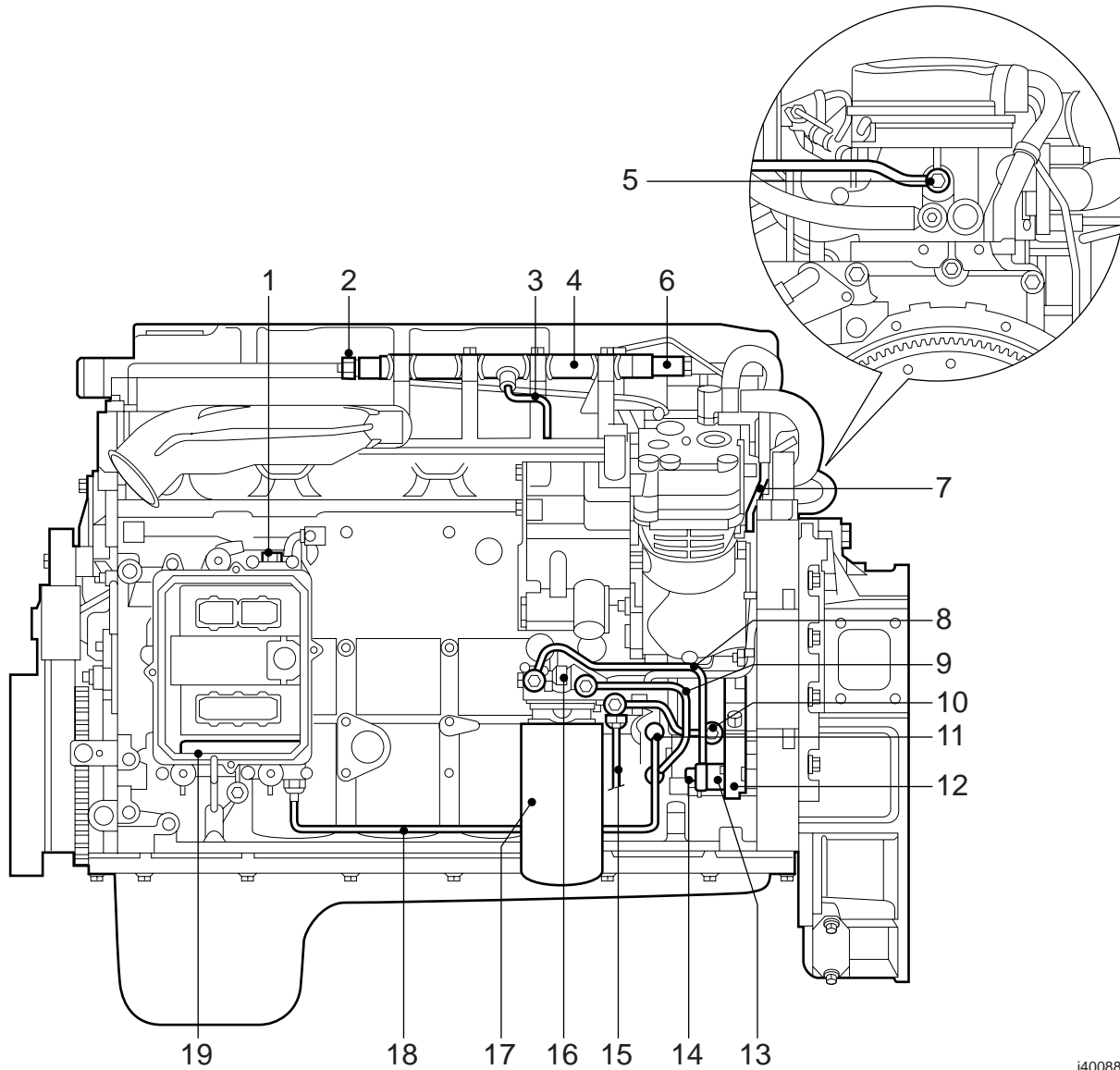
Location of components, production date < 2003-21 (chassis number < 0L248550)



i400870

1. Suction pipe to electronic unit cooling plate
2. Injector pipe
3. Fuel rail pressure sensor
4. Fuel pipe to fuel rail
5. Fuel rail
6. Fuel return overflow valve
7. Fuel rail pressure-limiting valve
8. Return pipe from fuel return overflow valve
9. Fuel pipe to high-pressure pump
10. Fuel pipe to fuel fine filter
11. High-pressure pump leak-off pipe
12. Fuel pipe to fuel lift pump
13. High-pressure pump
14. Fuel pump control solenoid valve
15. Fuel pipe to high-pressure pump
16. Return pipe to fuel tank
17. Fuel temperature sensor
18. Fuel fine filter
19. Fuel pipe from electronic unit cooling plate
20. ECS-DC3 electronic unit

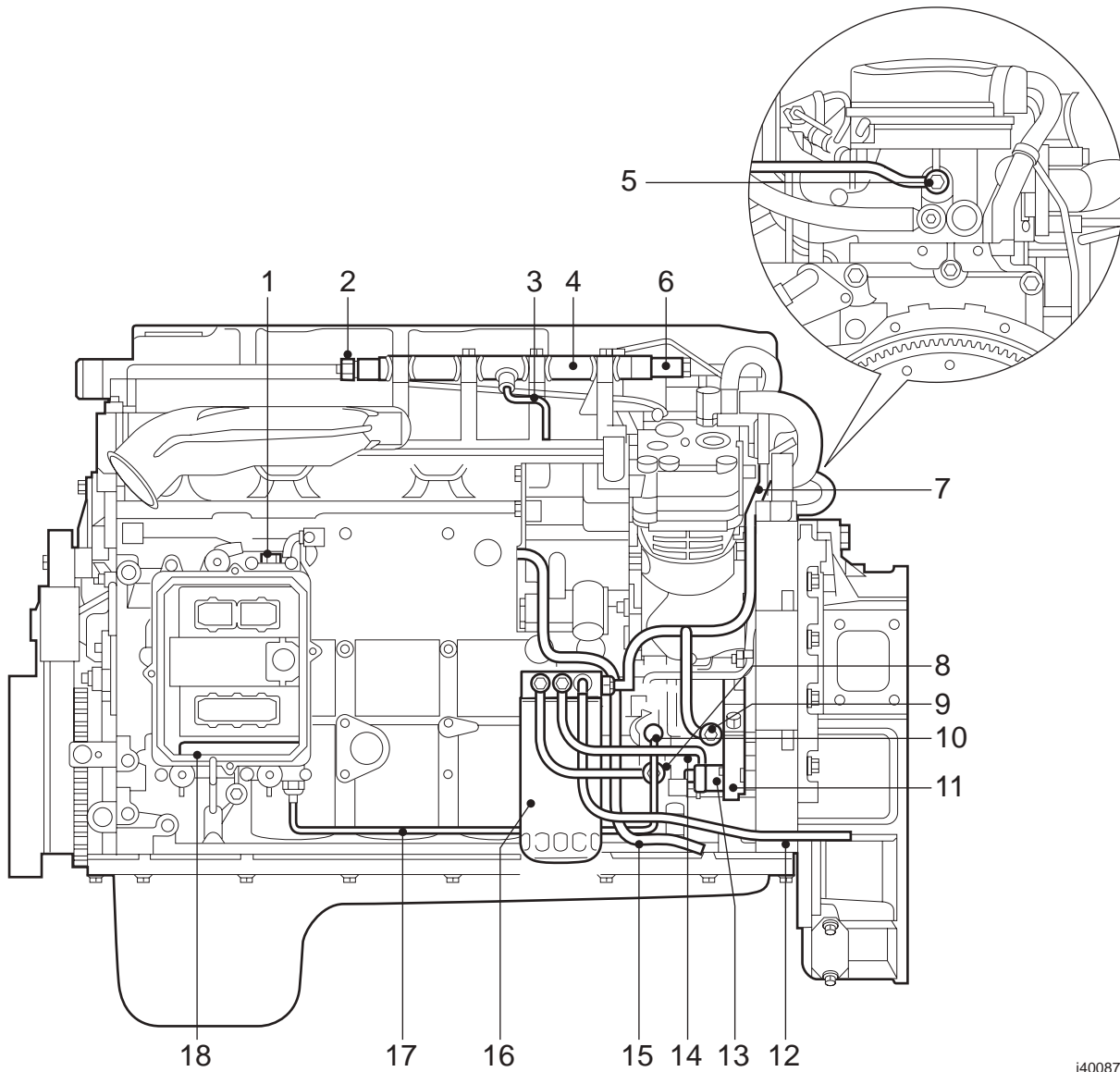
Location of components, production date
≥ 2003-21 (chassis number ≥ 0L248550) and
production date < 2003-49 (chassis number
< 0L253643)



i400880

1. Suction pipe to electronic unit cooling plate
2. Fuel rail pressure sensor
3. Fuel pipe to fuel rail
4. Fuel rail
5. Fuel return overflow valve
6. Fuel rail pressure-limiting valve
7. Return pipe from fuel return overflow valve
8. Fuel pipe to high-pressure pump
9. Fuel pipe to fuel fine filter
10. High-pressure pump leak-off pipe
11. Fuel pipe to fuel lift pump
12. High-pressure pump
13. Fuel pump control solenoid valve
14. Fuel pipe to high-pressure pump
15. Return pipe to fuel tank
16. Fuel temperature sensor
17. Fuel fine filter
18. Fuel pipe from electronic unit cooling plate
19. ECS-DC3 electronic unit

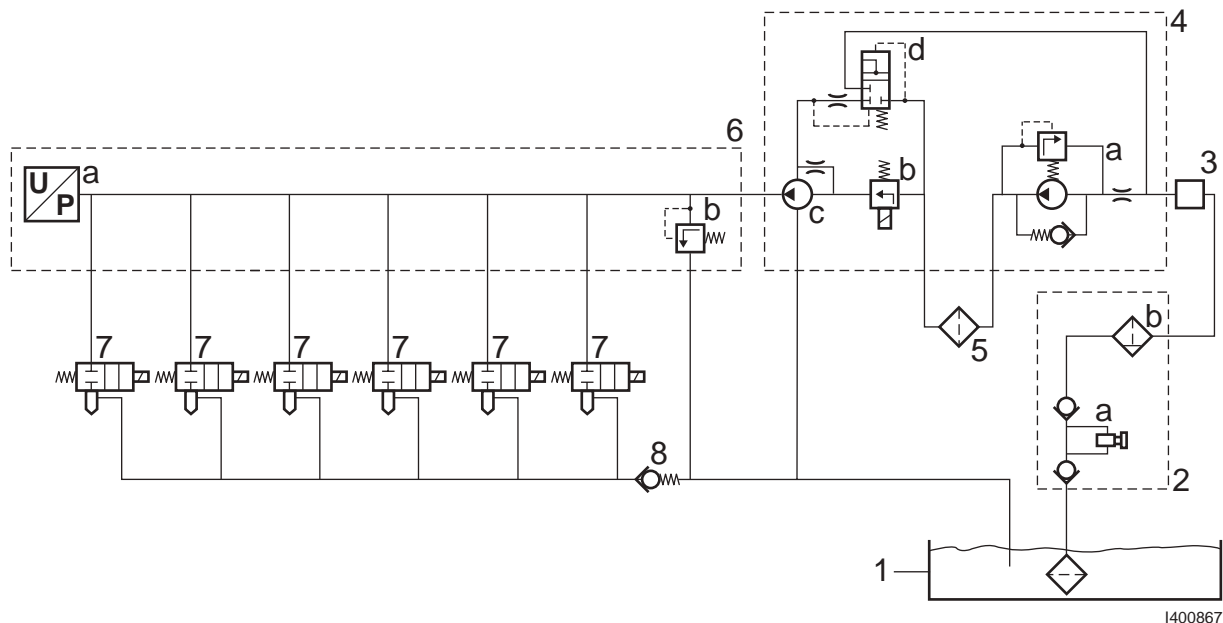
Location of components, production date
≥ 2003-49 (chassis number ≥ 0L253643)



i400872

1. Suction pipe to electronic unit cooling plate
2. Fuel rail pressure sensor
3. Fuel pipe to fuel rail
4. Fuel rail
5. Fuel return overflow valve
6. Fuel rail pressure-limiting valve
7. Return pipe from fuel return overflow valve
8. Fuel pipe to fuel fine filter
9. High-pressure pump leak-off pipe
10. Fuel pipe to fuel lift pump
11. High-pressure pump
12. Return pipe to fuel tank
13. Fuel pump control solenoid valve
14. Fuel pipe to high-pressure pump
15. Fuel supply pipe
16. Fuel fine filter
17. Fuel pipe from electronic unit cooling plate
18. ECS-DC3 electronic unit

2.2 SYSTEM DESCRIPTION, ECS-DC3 FUEL SYSTEM



The fuel lift pump (4a) draws the fuel from the fuel tank (1) through the cooling plate of the electronic unit (3).

The purpose of the cooling plate (3) is to ensure that the electronic unit does not become too hot. The fuel lift pump (4a) is fitted against the high-pressure pump (4c) and is driven by the camshaft gear.

From the fuel lift pump, fuel is forced towards the fuel fine filter (5).

After the filter, the fuel enters the high-pressure pump (4c) via the fuel pump control solenoid valve (4b), which controls the amount of fuel going to the high-pressure pump. Fuel not taken in by the high-pressure pump returns via the bypass valve (4d) to the fuel lift pump supply pipe and part of it is used for lubricating the high-pressure pump.

The high-pressure pump forces the fuel under high pressure to the fuel rail (6). The fuel rail distributes the fuel among the injectors (7). The fuel rail (6) also functions as an accumulator to ensure that large fluctuations in pressure, resulting from injector openings and pump pressure pulses, are prevented as much as possible.

The pressure in the fuel rail is registered by the rail pressure sensor (6a). The electronic unit uses this data to control the high-pressure pump (via the fuel pump control solenoid valve), so that the rail pressure can be kept at the desired level. The desired pressure is not constant, but depends on the operating conditions.

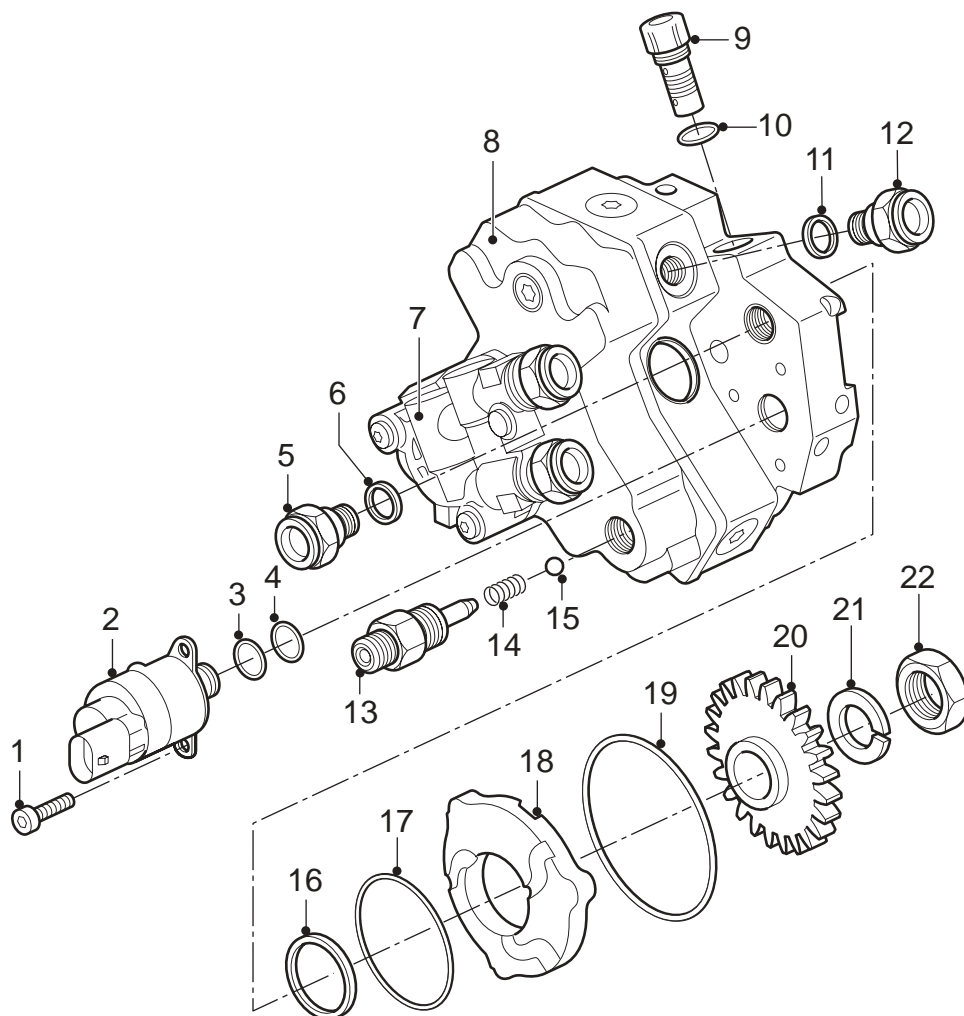
A pressure relief valve (6b) is fitted at the end of the fuel rail. If the pressure in the fuel rail rises too high (in emergencies only), this valve ensures that the excess fuel flows back to the return pipe. The return pipe is connected with the return pipe to the fuel tank (1).

The electronic unit uses the present rail pressure to calculate the time during which the injector needs to be opened in order to obtain the desired injection quantity.

A pressure relief valve (8) connects the injector leak-off ducts in the cylinder head with the return pipe to the fuel tank (1). This pressure relief valve prevents the fuel from flowing out of the injectors when the engine has stopped running.

If the system has been "open", the fuel system can be bled using the primer pump (2a), which is integrated in the water separator/coarse filter (2b).

2.3 OVERVIEW DRAWING, FUEL PUMP



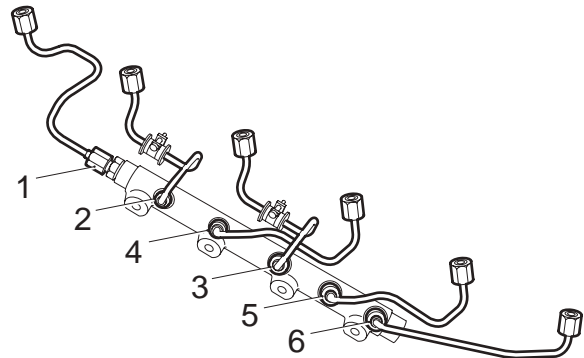
1. Attachment bolt
2. Fuel pump control solenoid valve
3. O-ring
4. O-ring
5. Fuel pipe connection
6. Copper ring
7. Lift pump
8. High-pressure pump
9. Circulation valve
10. O-ring
11. Copper ring
12. Fuel pipe connection
13. High-pressure pipe connection
14. Spring
15. Ball
16. Oil seal
17. O-ring
18. Adapter ring
19. O-ring
20. Gear wheel
21. Sealing ring
22. Nut

i400766

2.4 OVERVIEW DRAWING, FUEL RAIL

Overview drawing, fuel rail, production date < 2003-21 (chassis number < 0L248550)

The figure shows the connections to the injector pipes. The numbers indicate the cylinder number of the connection.

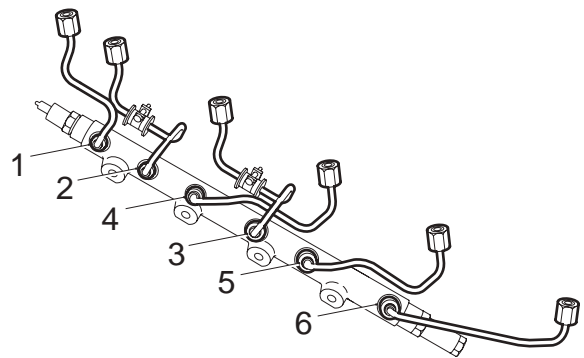


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5

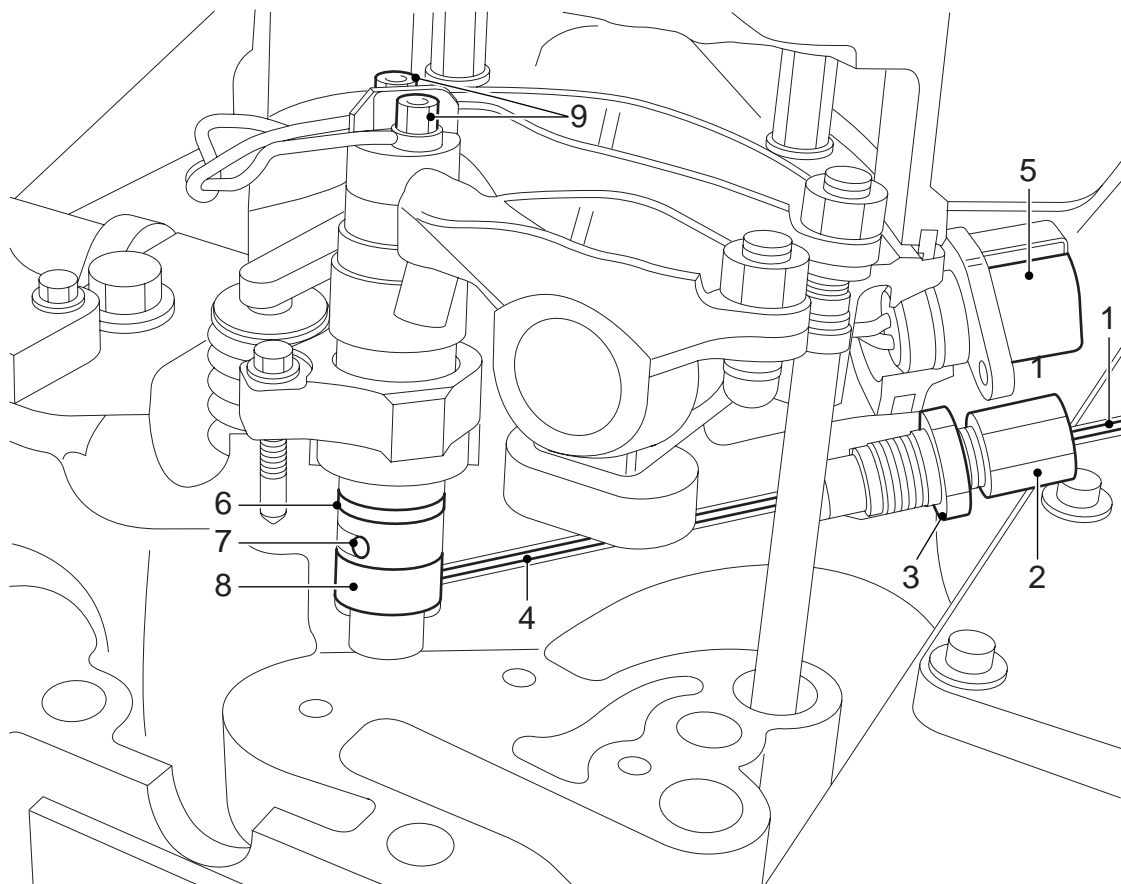
Overview drawing, fuel rail, production date ≥ 2003-21 (chassis number ≥ 0L248550)

The figure shows the connections to the injector pipes. The numbers indicate the cylinder number of the connection.



i400874

2.5 OVERVIEW DRAWING, FUEL SYSTEM, CYLINDER HEAD



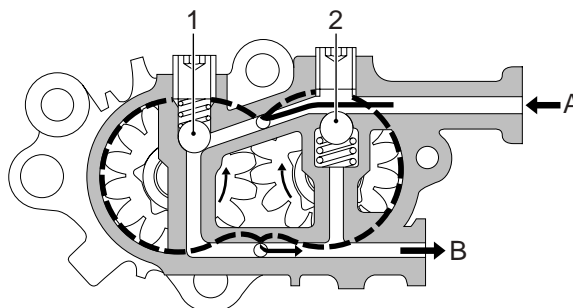
i400653

1. Injector pipe
2. Union
3. Nut
4. Fuel supply pipe
5. Connector to injectors
6. O-ring
7. Return opening
8. Injector
9. Electrical connection

3. DESCRIPTION OF COMPONENTS

3.1 HIGH-PRESSURE PUMP

The high-pressure pump is driven by the crankshaft by means of the camshaft gear. The pump shaft rotates at a speed 1.33 times the speed of the crankshaft. The pump shaft drives the fuel lift pump. The fuel drawn from the suction side by the gears is discharged through the exit by the gears due to the reduction in volume. The fuel lift pump has two added valves. The first valve (1) limits the pump pressure, for example if the fine filter is blocked. The second valve (2) opens the by-pass over the fuel lift pump when the primer pump is being used.

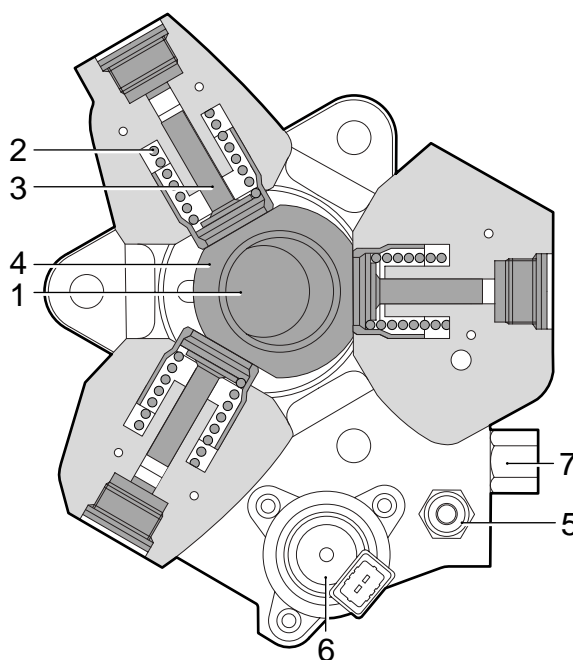


i400595

The high-pressure pump shaft (1) has an eccentric. The eccentric drives the eccentric ring (4). The pump plungers (3) are driven by the eccentric ring and pushed back by the spring (2).

The fuel is supplied via the connection (5) and then internally distributed among the three pump elements. Before it is distributed among the pump elements, the supplied fuel is dosed by means of the fuel pump control solenoid valve (6).

The fuel pump control solenoid valve is controlled by the electronic unit on the basis of the rail pressure sensor signal. This creates a closed control circuit. The fuel pump control solenoid valve is "normally open" and is activated via duty cycle control. The value when the engine is started is fixed. When the measured pressure deviates from the desired (programmed) pressure, the duty cycle value will be adapted until the measured and the desired values correspond. If this is impossible, the electronic unit will generate a warning and record a fault code.



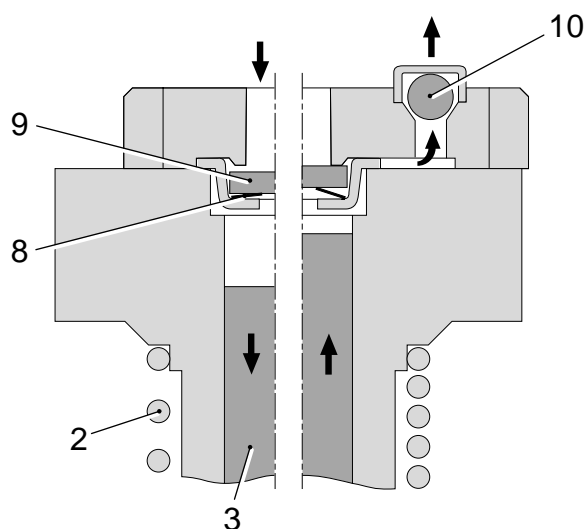
i400589

During the downward stroke, the fuel is supplied by the fuel lift pump via the suction valve (9) (see illustration on left). During the delivery stroke (illustration on right), the suction valve closes under the load of the spring (8) and the fuel pressure that has built up. The fuel leaves the pump element via the delivery valve (10). The compressed fuel from the three pump elements is collected in the pump housing and leaves the pump via a joint high-pressure connection.

Leaking fuel from the pump elements is discharged via the return connection.

The fuel lift pump has over-capacity in relation to the high-pressure pump. If there is only limited fuel off-take on the rail, the fuel pump control solenoid valve will be virtually closed. The over-supplied fuel will cause an increase in pressure at the inlet of the fuel pump control solenoid valve. The pressure is limited by the circulation valve (7). If the valve is open, the excess supplied fuel will be returned to the suction side of the fuel lift pump. A small amount of fuel is diverted via a restriction to the shaft and the eccentric of the high-pressure pump for lubrication.

When bleeding with the primer pump, any air bubbles will be carried along by the fuel through the low-pressure circuit. Fuel is forced inwards at the connection (5). The fuel pump control solenoid valve is opened fully without being energised, so that the fuel can pass. The pump elements create a high resistance to the fuel, so that the fuel will escape via the lubricating restriction in the pump. In this way the fuel, along with any air bubbles, is discharged to the return pipe.



i400590

3.2 FUEL PUMP CONTROL SOLENOID VALVE

The high-pressure pump has an over-capacity for normal operating conditions. This could lead to large quantities of fuel being forced at high pressure to the fuel rail and then directly being drained out to the return pipe via the pressure-limiting valve on the fuel rail. This produces too much unnecessary heat and loss of capacity because large amounts of fuel are flowing at high pressure.

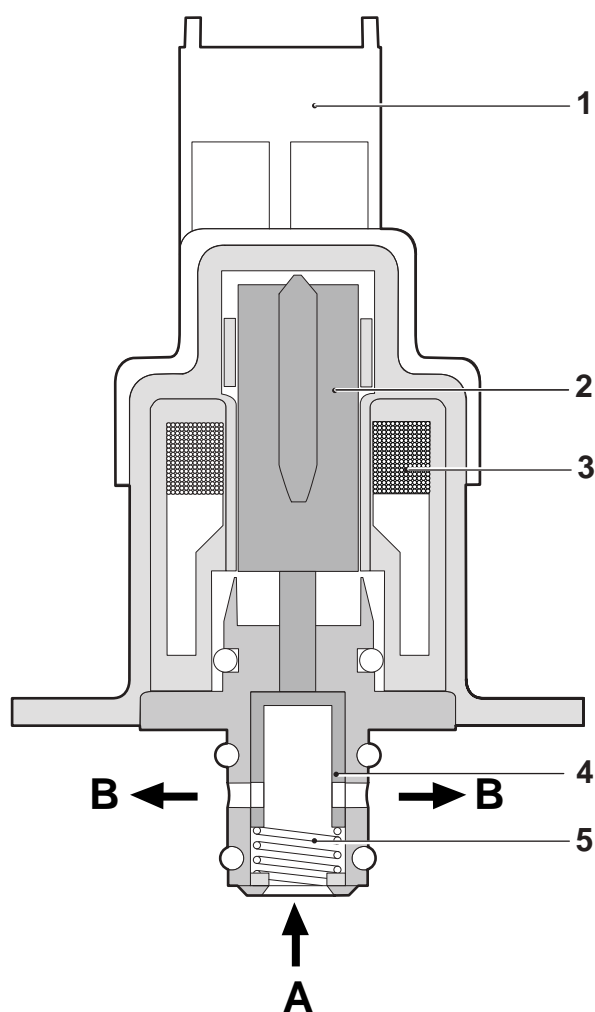
The system has been designed such that only fuel that will be used will be forced under high pressure to the rail. For this reason, a fuel pump control solenoid valve has been fitted at the suction side of the high-pressure pump. This solenoid valve is opened without being energised, so that the high-pressure pump elements can be filled in the normal manner.

If the fuel rail pressure becomes too high, for example because of lower fuel off-take on the rail, the solenoid valve will be energised by the electronic unit with a higher duty cycle, so that the plunger is pressed with a greater force against the spring pressure and the valve reveals a more constricted opening. This reduces the fuel supply to the pump elements and the pump output will thus fall. The fuel rail pressure will also fall as a consequence.

If the rail pressure is too low, the reverse is true.

The current is supplied to the coil (3) via the connector (1). The current pushes the core (2) with the plunger (4) against the pressure of the spring (5). This controls the fuel current from input A to output B.

Due to this valve, under normal circumstances very little fuel flows back from the rail. This improves performance and reduces the generation of heat.



i400591

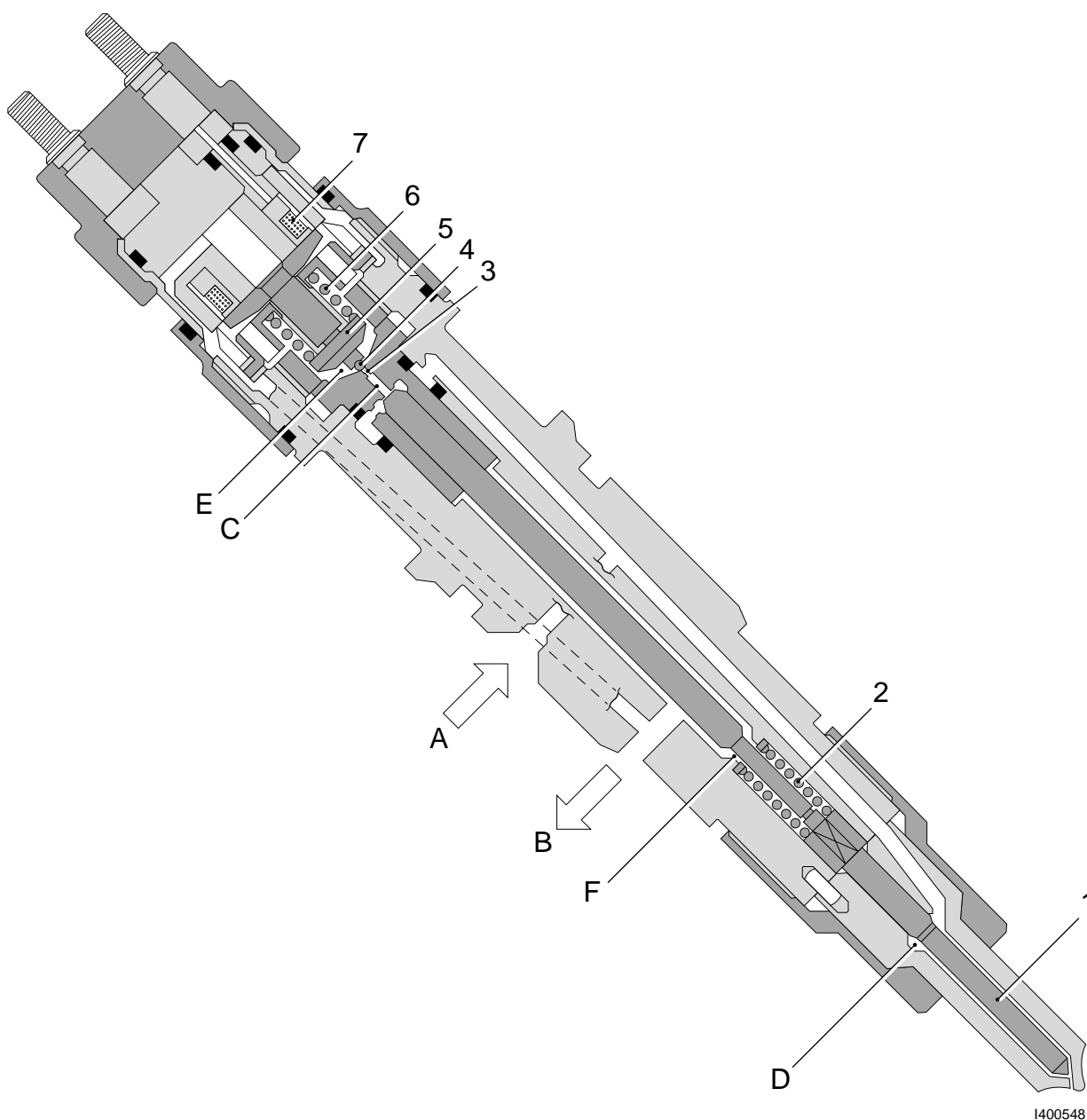
3.3 INJECTOR

The injectors can be opened and closed electrically. The injector is normally closed. The load of the spring (2) and the fuel rail pressure that controls chamber C ensure this.

The fuel is supplied from the fuel rail via A. The return fuel can flow back to the fuel tank via B.

When the coil (7) is energised, the armature housing (5) moves up. As a result the pressure in chamber C drops slightly and the injector needle (1) is forced up to chamber D by the rail pressure. The fuel can then be injected.

5

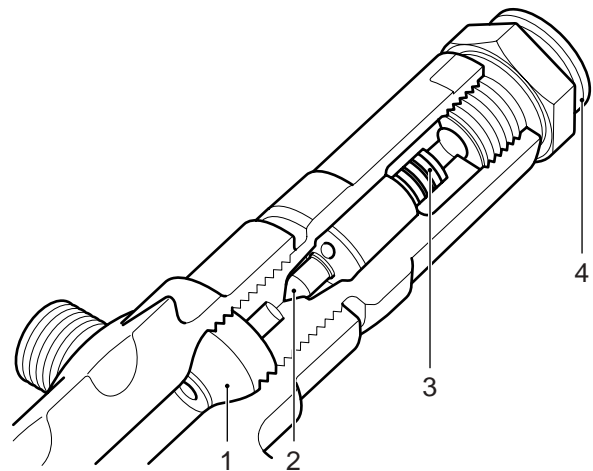


3.4 FUEL RAIL PRESSURE-LIMITING VALVE

The fuel rail has a pressure-limiting valve so that the rail pressure is maintained at a safe value in emergency situations.

The fuel rail pressure control circuit is normally active. This consists of the fuel lift pump, fuel pump control solenoid valve, high-pressure pump, fuel rail, rail pressure sensor and electronic unit. If a fault occurs, the rail pressure can no longer be controlled. This can rise to the actuating pressure of the fuel rail pressure-limiting valve. This pressure is approx. 1650 bar. In the open position all surplus fuel flows without pressure to the fuel tank return connection.

The valve includes a sealing cone (1), a valve body (2), a spring (3) and a return connection with quick-release coupling (4).

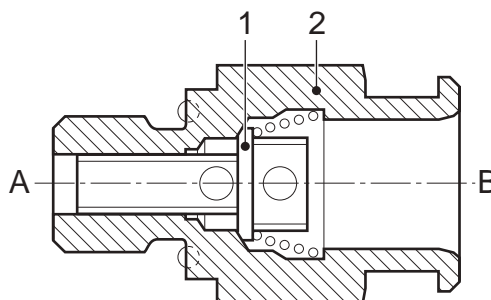


i400592

3.5 FUEL RETURN OVERFLOW VALVE

The injectors are mounted in the cylinder head. The injectors do not have a separate return connection. In place of this there is a longitudinal bore in the cylinder head that meets the injector bores of all cylinders coinciding with the height of the return ports of the injectors. A pressure relief valve is mounted at the end of the bore to prevent vapour bubbles forming in it and to prevent it emptying after the engine is turned off. This valve maintains a residual pressure in relation to the return pressure of 1.2 to 2.0 bar.

The pressure relief valve consists of a spring-loaded plunger (1) and a housing (2) with quick-release inlet and outlet connections (A and B respectively).



i400861

4. INSPECTION AND ADJUSTMENT

4.1 BLEEDING THE FUEL SYSTEM

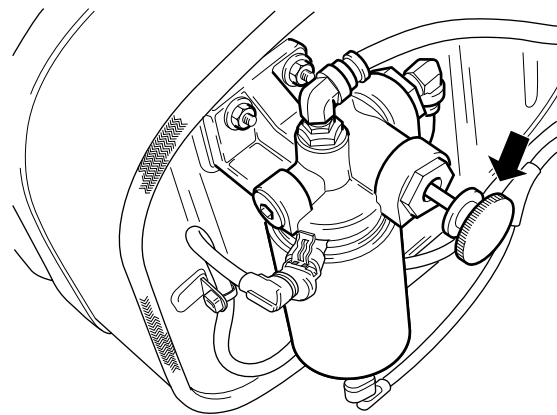


Stop pumping as soon as a greater resistance is felt. If you continue pumping, the fuel system may become internally damaged.

Note:

When the hand pump is used, the fuel system will be automatically bled. Air will be fed back to the tank through the return pipe.

1. Unscrew the button of the primer pump and pull it out.
2. Use the primer pump until a clearly higher resistance is perceptible.
3. Press the button and tighten it.



G0 00 209

4.2 CHECKING FUEL LIFT PUMP PRESSURES



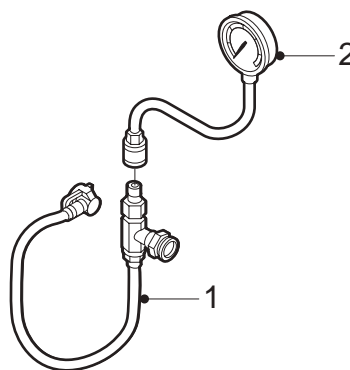
When inspecting the fuel pressure, fuel will escape. Collect the fuel and avoid the risk of fire.



Dirt in the fuel system can lead to significant damage to parts of the system. Prevent this by cleaning the parts before disassembly and then sealing all open connections.

Checking underpressure on suction side of fuel lift pump

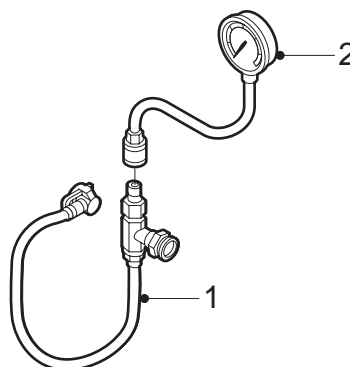
1. Disconnect the fuel pipe from the electronic unit cooling plate to the fuel lift pump on the suction side of the fuel lift pump; see "Removal and installation".
2. Fit the adapter (1), special tool (DAF no. 1329476), between the pipe which has been removed and the fuel lift pump and couple a pressure gauge (2) to this adapter.
3. Bleed the fuel system.
4. Measure the underpressure when the engine is idling. Compare the readings with the specified values. See "Technical data".
5. Remove the pressure gauge and the adapter and fit the fuel pipe.
6. Bleed the fuel system, start the engine and check the fuel system visually for leaks if no further measurements are to be carried out.



i400883

Checking fuel pressure in fuel lift pump in front of fuel fine filter

1. Disconnect the fuel pipe from the lift pump to the fuel fine filter on the delivery side of the lift pump; see "Removal and installation".
2. Fit the adapter (1), special tool (DAF no. 1329476), between the pipe which has been removed and the fuel lift pump and couple a pressure gauge (2) to this adapter.
3. Bleed the fuel system.
4. Start the engine and measure the pressure when the engine is idling. Compare the readings with the specified values. See "Technical data".
5. Remove the pressure gauge and the adapter and fit the fuel pipe.

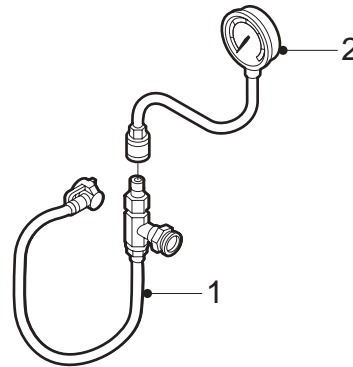


i400883

- Bleed the fuel system, start the engine and check the fuel system visually for leaks if no further measurements are to be carried out.

Checking fuel pressure in fuel lift pump after fuel fine filter

- Disconnect the fuel pipe from the fuel fine filter to the high-pressure pump on the side of the high-pressure pump; see "Removal and installation".
- Fit the adapter (1), special tool (DAF no. 1329476), between the pipe which has been removed and the high-pressure pump and couple a pressure gauge (2) to this adapter.
- Bleed the fuel system.
- Disconnect the electrical connectors of the injectors from the valve sleeve.
- Start the engine and measure the pressure when the engine is idling. Compare the readings with the specified values. See "Technical data".
- Connect the electrical connectors of the injectors to the valve sleeve.
- Remove the pressure gauge and the adapter and reconnect the fuel pipe.
- Bleed the fuel system, start the engine and check the fuel system visually for leaks if no further measurements are to be carried out.



i400883

Check pressure drop across fuel fine filter

- Check the fuel pressure in front of the fuel fine filter.
- Check the fuel pressure after the fuel fine filter at maximum engine speed.
- Compare the measured pressure drop across the fuel fine filter with the specified value. See "Technical data". If the pressure drop is too great, the fuel fine filter must be replaced.

4.3 INSPECTION, INTERNAL FUEL LEAKS



When inspecting for internal fuel leaks, fuel will escape. Collect the fuel and avoid the risk of fire.



Dirt in the fuel system can lead to significant damage to parts of the system. All open connections must therefore be sealed.

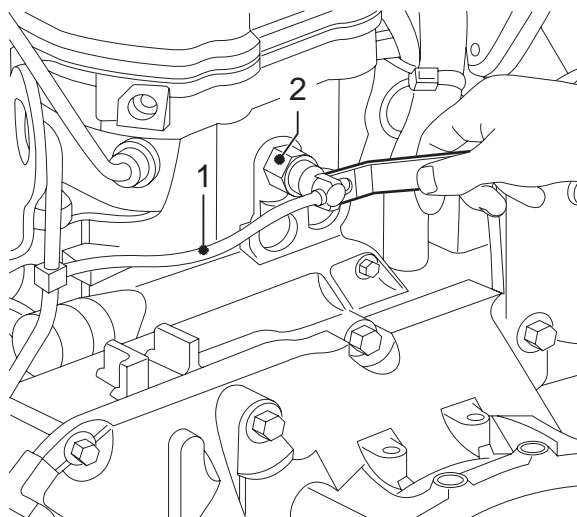


The common rail system is under high pressure when the engine is running. This pressure can rise to approx. 1400 bar. Even when the engine is not running, there may be a high residual pressure in the fuel rail (approx. 50 bar). Depressurise the system before working on the common rail system by wrapping the coupling in a cloth and then unscrewing it and collecting the escaping fuel in a container.

5

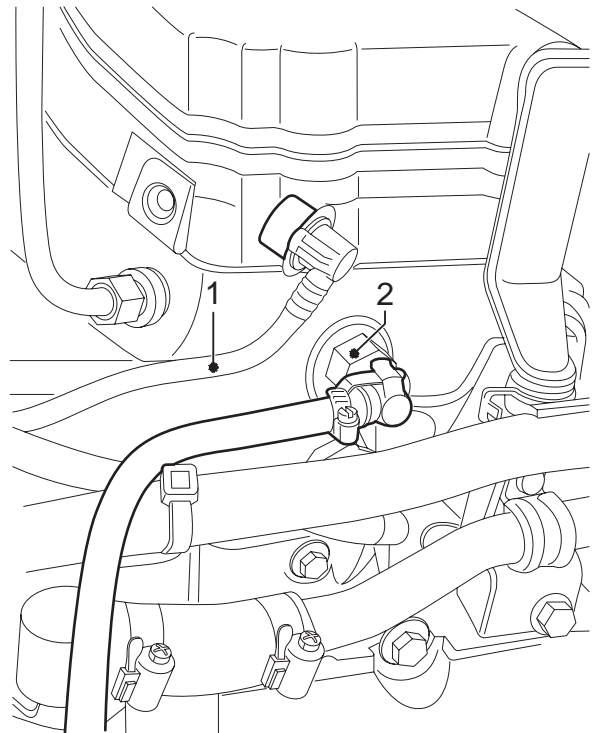
Inspection, internal fuel leaks

1. Check that all injector pipes have been tightened to the correct torque and that there are no external signs of fuel leakage; see "Technical data".
2. Disconnect the fuel return pipe (1) from the fuel return overflow valve (2) on the rear of the cylinder head.



i400679

3. Seal the disconnected fuel pipe (1) using the special tool (DAF no. 1453151) to prevent the return fuel escaping.
4. Fit the special tool (DAF no. 1329476) onto the fuel return overflow valve (2).

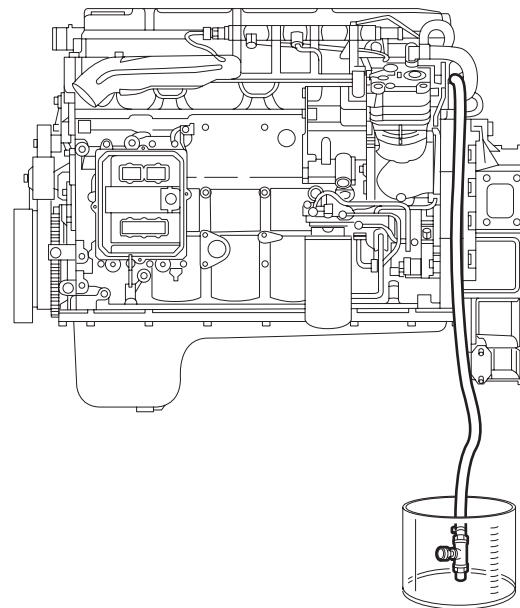


i400680

5. Place the free end of the special tool (DAF no. 1329476) in a container and start the engine.
6. While the engine is idling, measure the quantity of return fuel using a stop watch and a measuring beaker; see "Technical data" for the maximum quantity of return fuel.

Note:

If the quantity of return fuel is within the specified value there are no internal leaks. If the quantity of return fuel exceeds the specified value, the internal fuel leak must be located.



i400682

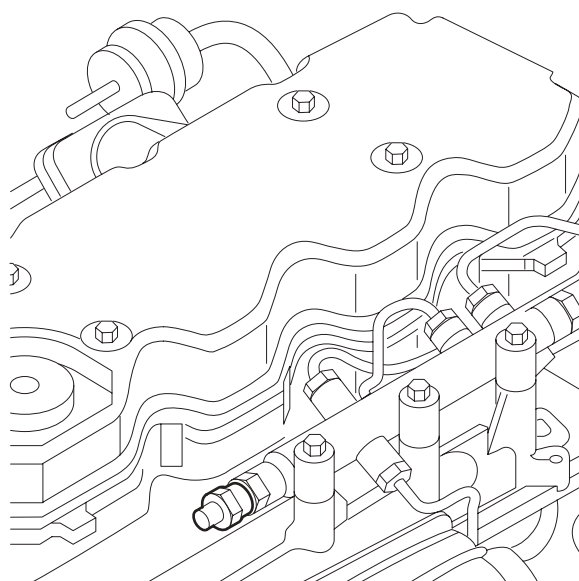
Locating internal fuel leak

1. Take the injector pipe out of cylinder 1.
2. Seal the connection of cylinder 1 on the fuel rail using the special tool (DAF no. 1453133). Tighten the plug to 30 Nm.
3. While the engine is idling, use a stop watch to measure the time required to fill a measuring beaker with 360 ml of return fuel. See "Technical data" for the minimum time permitted for filling the measuring beaker.

Note:

Use a measuring beaker with a mark at 360ml.

4. Remove the special tool (DAF no. 1453133) and reconnect the injector pipe.
5. Repeat the above steps for the other cylinders and note the values.



i400681

Note:

When the leaking cylinder has been plugged, the quantity of return fuel will decrease and, as a result, the time it takes to fill the measuring beaker to 360ml will increase. If several high values are measured, this indicates that there may be several leaks. If this is the case, first check the cylinders that give the highest values and then repeat the test.

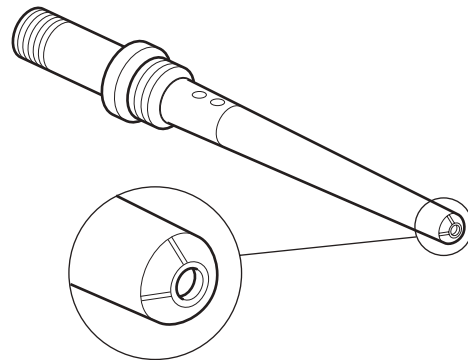
In the example shown in the table below there is an internal leak in the 5th cylinder, which could be caused by a leak in the fuel supply pipe and/or a defective injector.

Example:

Leak test results						
Blocked cylinder	1	2	3	4	5	6
Time (s) to fill to 360ml	35	36	35	37	150	38

6. In the event of a leak, remove the fuel supply pipe and the injector of the cylinder in question; see "Removal and installation".

7. Check the fuel supply pipe for damage and signs of leakage.
Leakage in the fuel supply pipe can be recognised by erosion tracks (lines) on the nose of the supply pipe. If necessary or if in doubt, replace the fuel supply pipe.
8. Check that the injector fuel connection is not leaking.
Leakage in the injector fuel connection can be recognised by erosion tracks (lines) in the socket of the fuel connection . If necessary or if in doubt, replace the injector.



i400776

Note:

If fuel has been found in the lubricating oil, extra attention must be paid to the O-rings of the injectors, as these have most probably been damaged by increased pressure in the return circuit as a result of an internal leak.

Note:

The following guidelines must be adhered to:

- If the injector is defective, both the injector and the fuel supply pipe must be replaced.
 - If the fuel supply pipe is defective and in addition the sealing surface with the injector is damaged, both the injector and the fuel supply pipe must be replaced.
 - If the fuel supply pipe is defective and the sealing surface with the injector is not damaged, the fuel supply pipe must be replaced but the injector can be reused.
9. Fit the injector and fuel supply pipe. See "Removal and installation".
 10. Again inspect for internal fuel leaks to check that there is no leakage.

5. REMOVAL AND INSTALLATION

5.1 REMOVAL AND INSTALLATION, INJECTOR PIPE



Never bend injector pipes as they may kink or crack. The injector pipes form part of the high-pressure section of the fuel system. When the unions are unscrewed, fuel under high pressure may escape. Take measures to prevent fire and injury. Collect the escaping fuel in a suitable container.



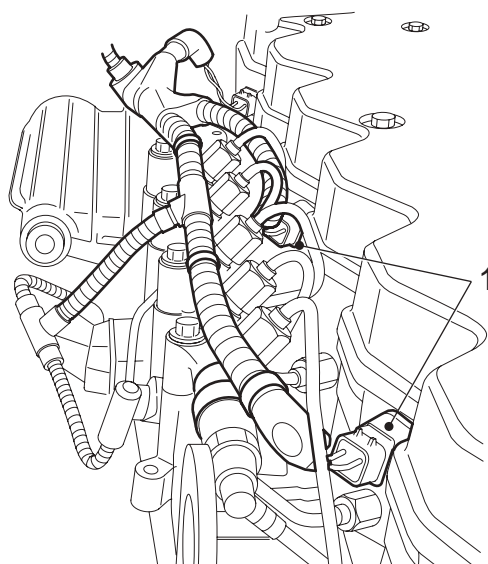
Dirt in the fuel system can lead to significant damage to parts of the system. Prevent this by cleaning the parts before disassembly and then sealing all open connections.

Note:

Codes (1) are stamped in the injector pipe unions to enable correct positioning. The first figure is the number of cylinders of the engine followed by the fitting position.

Removing the injector pipe

1. Clean the area surrounding the unions, both near the injectors and near the fuel rail.
2. Remove the connectors (1) of the injectors from the valve sleeve.



i400852

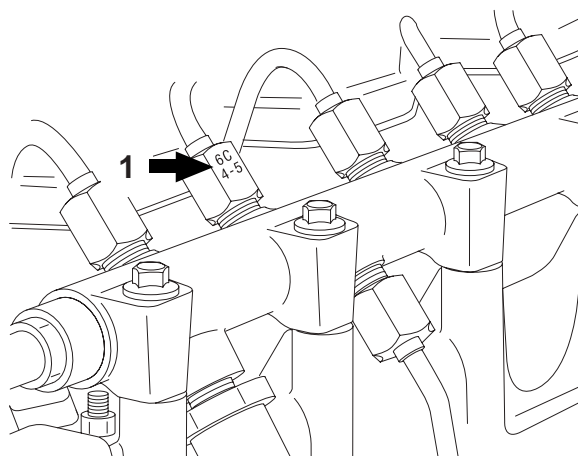
Note:

Note the sequence in which the injector pipes are removed. They should be re-fitted in precisely the reverse order.

3. Unscrew the unions on both sides of the pipe and remove the pipes.
4. Immediately plug the openings.

Installing the injector pipe

1. Clean the injector pipe and blow-clean it with dry compressed air.
2. Fit the injector pipes in reverse order and hand-tighten the unions. When all the pipes and unions are correctly fitted, the unions must be tightened to the specified torque. See "Technical data".
3. Fit the connectors of the injectors in the valve sleeve.
4. Start the engine to bleed the high-pressure section of the fuel system and inspect all fuel pipes for leaks.



i400482

5.2 REMOVAL AND INSTALLATION, FUEL SUPPLY PIPE



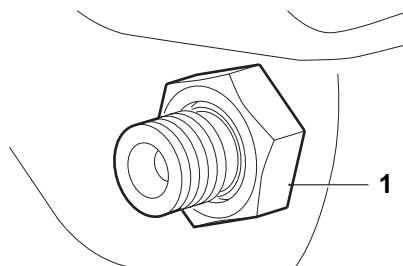
When removing a fuel pipe, fuel will escape. Collect the fuel and avoid the risk of fire.



Dirt in the fuel system can lead to significant damage to parts of the system. All open connections must therefore be sealed.

Removing the fuel supply pipe

1. Disconnect the injector pipes.
2. If necessary, remove the fuel rail.
3. Remove the nut (1) from the fuel supply pipe.



i400486

4. Mark the positions of the fuel supply pipe (1) and pull it out of the cylinder head with special tool (DAF no. 1329473) (2).

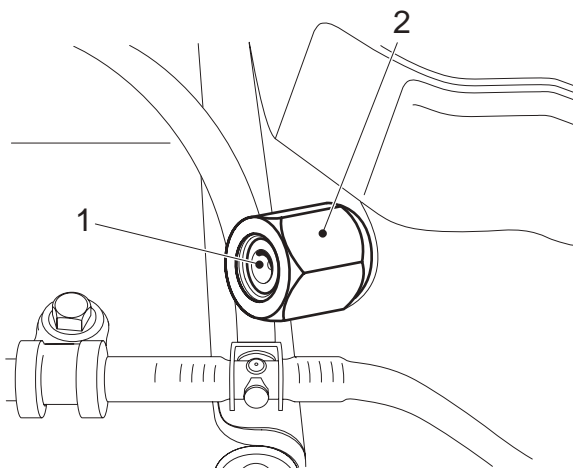
Note:

If the injector is **not** replaced, the fuel supply pipe may be re-used provided it is fitted with the original injector.

Installing the fuel supply pipe

The following guidelines must be adhered to:

- If the injector is defective, both the injector and the fuel supply pipe must be replaced.
- If the fuel supply pipe is defective and in addition the sealing surface with the injector is damaged, both the injector and the fuel supply pipe must be replaced.
- If the fuel supply pipe is defective and the sealing surface with the injector is not damaged, the fuel supply pipe must be replaced but the injector can be reused.



i400823

1. Check the fuel supply pipe for damage and signs of leakage.
Leakage in the fuel supply pipe can be recognised by erosion tracks (lines) on the nose of the supply pipe. If necessary or if in doubt, replace the fuel supply pipe.

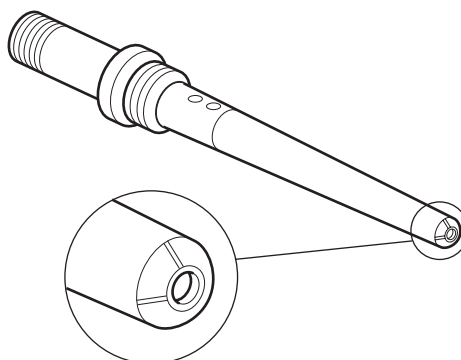
Note:

If any indications of leakage are visible, remove the injector and check the injector fuel connection for signs of leakage.

2. Fit a new O-ring on the fuel supply pipe.
3. Apply a thin layer of clean engine oil to the O-ring of the fuel supply pipe, the screw thread of the nut and the contact surface of the nut with the fuel supply pipe.
4. Check the bore of the fuel supply pipe for foreign matter and damage. Also check whether the supply bore in the injector is correctly positioned for the bore, because it is possible to mount the injector turned through 180°, so that the fuel supply port is on the other side.

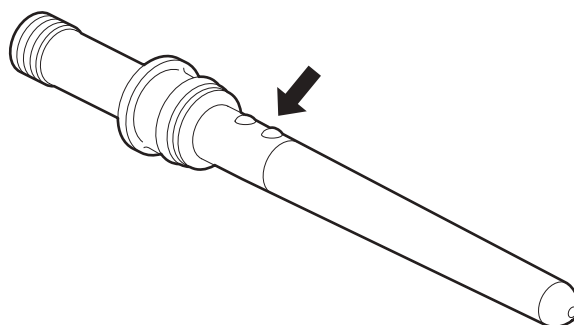
Note:

The fuel supply pipe has one or two positioning balls. The fuel supply pipe can only be installed with the ball(s) on top, as the bore in the cylinder head has a groove (1) at the top. Press the fuel supply pipe as far as possible into the bore, with the ball pointing upwards. Ensure that the O-ring is not damaged in this process.

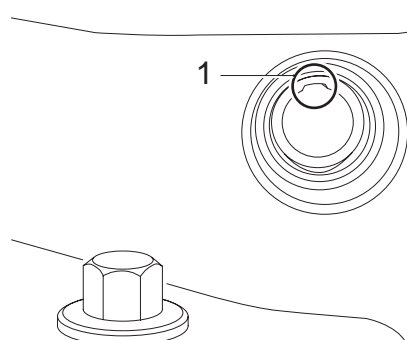


i400776

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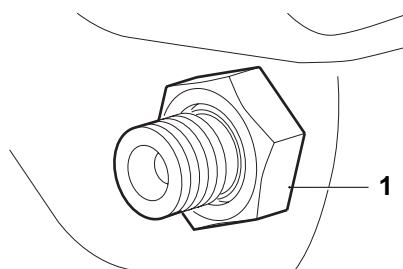


i400790



i400807

5. Install the nut (1) and tighten it to the specified torque. See "Technical data".
6. If the fuel rail was removed, re-fit it.
7. Fit the injector pipes.
8. Start the engine to bleed the high-pressure section of the fuel system and inspect the fuel system for leaks.



i400486

5.3 REMOVAL AND INSTALLATION, INJECTOR



When removing an injector, fuel will escape. Collect the fuel and avoid the risk of fire.



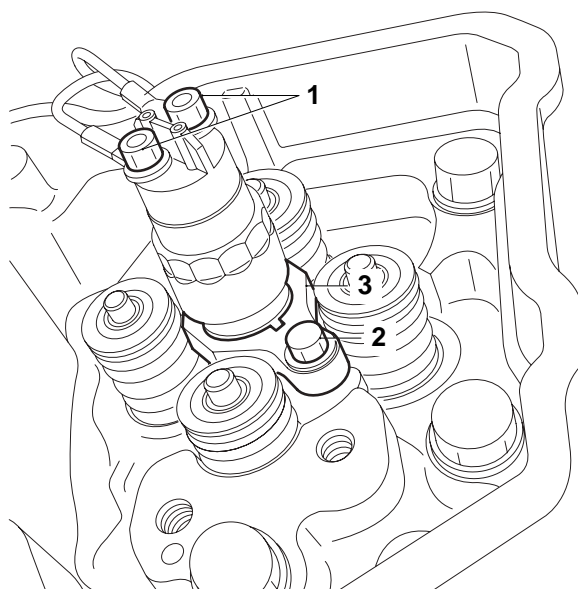
Dirt in the fuel system can lead to significant damage to parts of the system. All open connections must therefore be sealed.

Removing the injector

1. Remove the fuel return overflow valve to let the return bore in the cylinder head empty to the fullest possible extent. Collect the escaping fuel.
2. Remove the injector pipe.
3. Remove the fuel supply pipe.

Note:

- If an injector is removed without the fuel supply pipe having first been removed, serious damage can ensue.
 - If the injectors are removed, they must be removed together with the fuel supply pipes.
4. Remove the valve cover.
 5. Remove the exhaust valve rockers.
 6. Remove the injector wiring (1).
 7. Remove the two attachment bolts (2) from the injector clamping bracket (3).



i400483

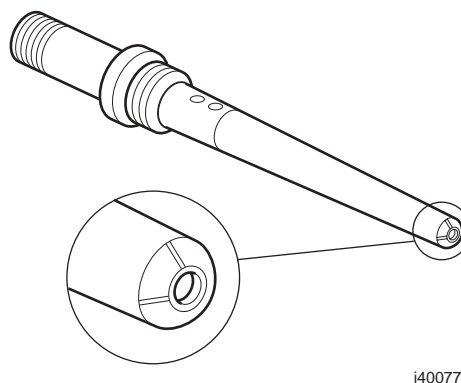
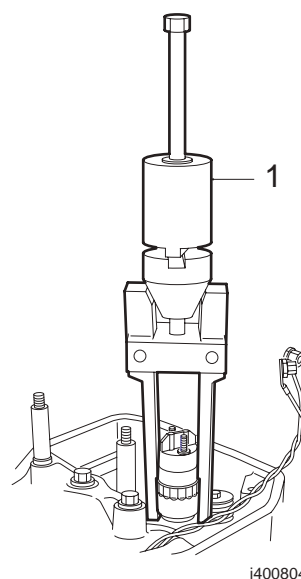
8. Fit the injector puller (1). This is the special tool (DAF no. 0192496). Carefully pull the injector vertically out of the cylinder head.
9. Remove the copper washer from the injector hole and plug the hole immediately.

Installing the injector

The following guidelines must be adhered to:

- If the injector is defective, both the injector and the fuel supply pipe must be replaced.
- If the fuel supply pipe is defective and in addition the sealing surface with the injector is damaged, both the injector and the fuel supply pipe must be replaced.
- If the fuel supply pipe is defective and the sealing surface with the injector is not damaged, the fuel supply pipe must be replaced but the injector can be reused.

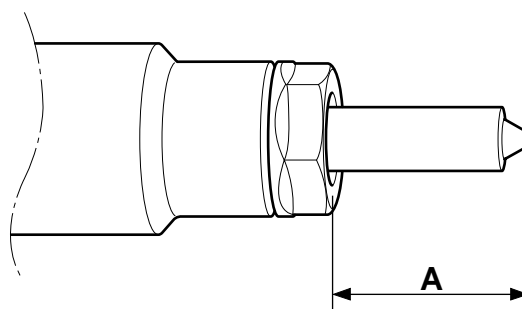
1. Clean the injector if it has already been used. See "Cleaning".
2. Clean the injector hole in the cylinder head. The metal surface of the hole must not be touched.
3. Check the fuel supply pipe for damage and signs of leakage. Leakage in the fuel supply pipe can be recognised by erosion tracks (lines) on the nose of the supply pipe. If necessary or if in doubt, replace the fuel supply pipe.
4. Fit a new O-ring on the fuel supply pipe.
5. Check that the injector fuel connection is not leaking. Leakage in the injector fuel connection can be recognised by erosion tracks (lines) in the socket of the fuel connection. If necessary or if in doubt, replace the injector.



- Fit a new copper washer on the injector. Measure the length of the injector nozzle (A) **without** fitted washer in order to determine which washer must be used. Fit the correct washer; see "Technical data".

Note:

A wrong washer will cause an incorrect alignment between the fuel supply pipe and the injector. This will lead to internal fuel leaks that will in turn cause loss of power and/or engine damage.



i400693

- Fit a new O-ring on the injector.

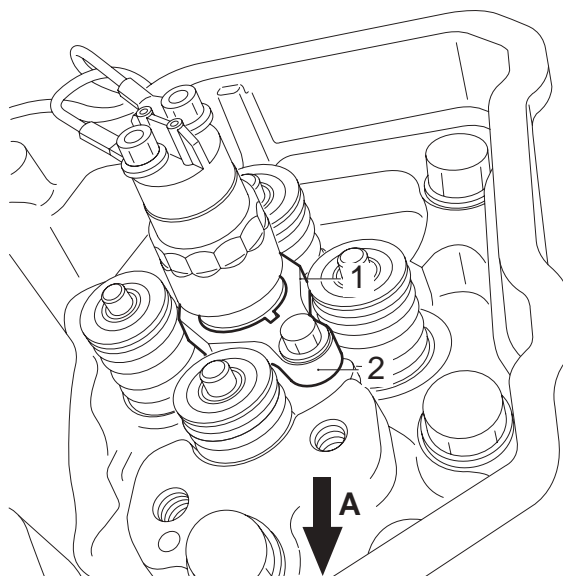
Note:

This O-ring should prevent returning fuel (1.2 - 2.0 bar) flowing via the top of the cylinder head to the oil sump and thinning the oil.

- Apply a thin layer of clean engine oil to the O-ring of the injector.
- Fit the injector with the copper washer. First press the injector into the hole as far as possible until a higher resistance can clearly be felt.

Note:

The injector must only be fitted one way. If it is fitted incorrectly, serious damage can ensue. The rounded side (2) of the injector clamping bracket (1) must point to the inlet side of the engine (A).



i400805

10. Fit the attachment bolts (1) in the injector clamping bracket (2) to secure the injector. Tighten the attachment bolts alternately to a torque of 2 Nm.

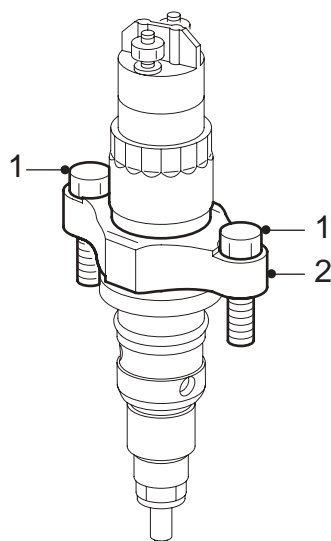
Note:

Pay special attention to the tightening of the attachment bolts (1). The tightening must be carried out alternately; ensure that the injector clamping bracket (2) is not fitted at an angle.

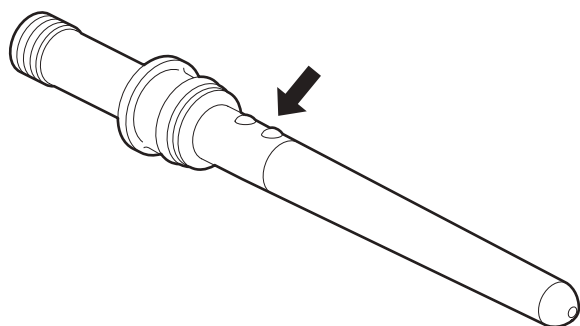
11. Apply a thin layer of clean engine oil to the O-ring of the fuel supply pipe, the screw thread of the nut and the contact surface of the nut with the fuel supply pipe.
12. Check the bore of the fuel supply pipe for foreign matter and damage. Also check whether the supply bore in the injector is correctly positioned for the bore, because it is possible to mount the injector turned through 180°, so that the fuel supply port is on the other side.
13. Fit the fuel supply pipe. Press the fuel supply pipe as far as possible into the bore, with the ball pointing upwards. Ensure that the O-ring is not damaged in this process.

Note:

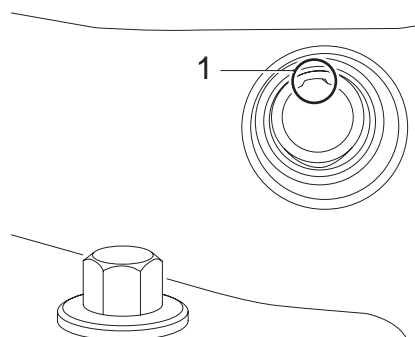
The fuel supply pipe has one or two positioning balls. The fuel supply pipe can only be installed with the ball(s) on top, as the bore in the cylinder head has a groove (1) at the top.



i400806

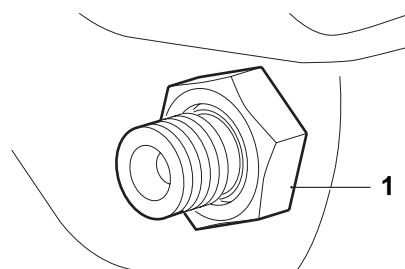


i400790



i400807

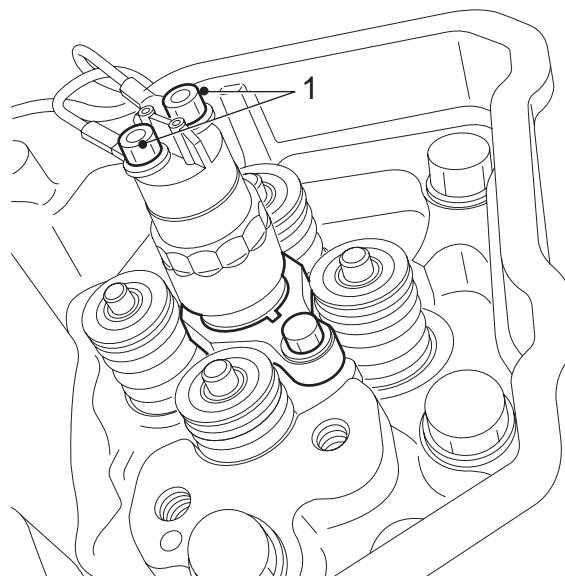
14. Fit the nut (1). Tighten the nut to a torque of 15 Nm.
15. Tighten the injector attachment bolts to the specified torque; see "Technical data".
16. Tighten the fuel supply pipe nut to the specified torque; see "Technical data".



i400486

17. Connect the injector wiring. Tighten the attachment bolts (1) to the specified torque. See "Technical data".

18. Fit the exhaust valve rockers.
19. Adjust the clearance of the exhaust valves.
20. Fit the valve cover.
21. If the fuel rail was removed, re-fit it.



i400808

22. Fit the injector pipe.
23. Fit the fuel return overflow valve to the cylinder head. For the specified tightening torque, see "Technical data".
24. Connect the return pipe to this valve.
25. Start the engine to bleed the high-pressure section of the fuel system and inspect the fuel system for leaks.

5.4 REMOVAL AND INSTALLATION, FUEL RAIL



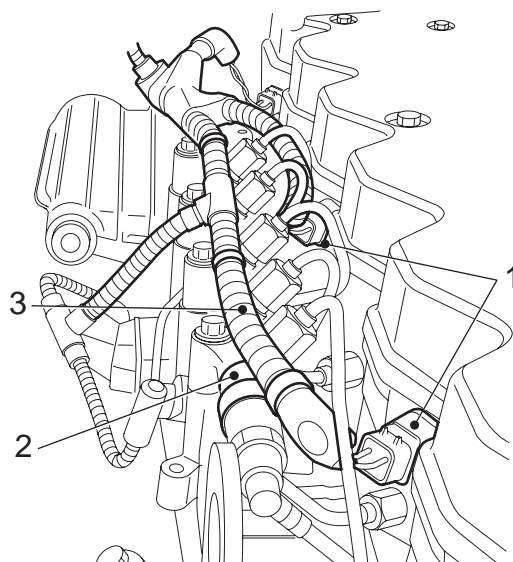
When removing the fuel rail, fuel will escape. Collect the fuel and avoid the risk of fire.



Dirt in the fuel system can lead to significant damage to parts of the system. Prevent this by cleaning the parts before disassembly and then sealing all open connections.

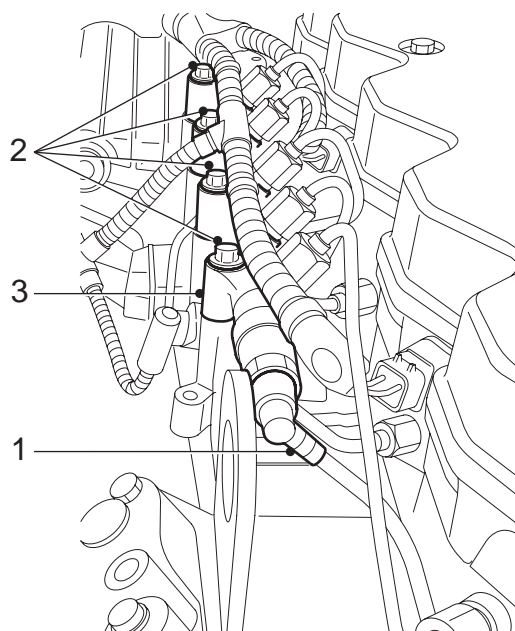
Removing the fuel rail

1. Remove the connector from the fuel rail pressure sensor.
2. If necessary, remove the plug of the inlet air temperature/boost pressure sensor by loosening the connector.
3. Remove the connectors of the injectors (1) from the valve sleeve.
4. Disconnect the cable harness (3) on the fuel rail (2) and bend the cable harness away from the fuel rail.



i400809

5. Remove the fuel return pipe from the pressure-limiting valve on the fuel rail
6. Loosen the pipe clamps from the high-pressure pipe to the fuel rail.
7. Loosen the high-pressure pipe from the high-pressure pump to the fuel rail on the fuel rail side by unscrewing the union.
8. Disconnect the injector pipes.
9. Remove the fuel rail attachment bolts (2).
10. Remove the fuel rail (3).

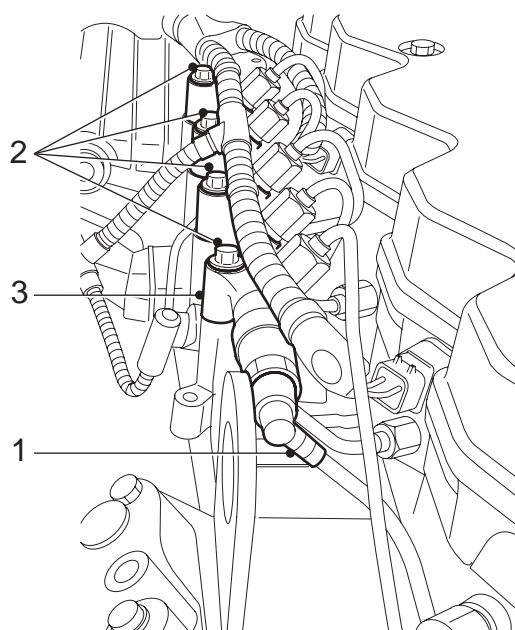


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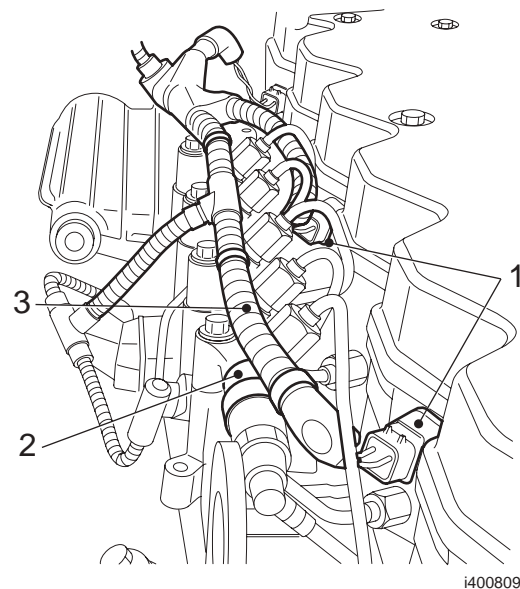
Installing the fuel rail

1. Ensure that the fuel rail is clean.
2. Fit the fuel rail (3) and hand-tighten the attachment bolts (2).
3. Fit the fuel return pipe (1) onto the pressure-limiting valve on the fuel rail.
4. Fit the injector pipes.
5. Fit the pipe clamps from the high-pressure pipe to the fuel rail. Do not tighten them yet.
6. Fit the high-pressure pipe unions from the high-pressure pump to the fuel rail. For the specified tightening torques of the unions, see "Technical data".
7. Tighten the attachment bolts (2) of the fuel rail to the specified torque. See "Technical data".
8. Tighten the bolt connections of the high-pressure pipe clamps.



i400814

9. Install the cable harness (3) to the fuel rail (2) and secure it using cable ties.
10. Fit the connectors of the injectors (1) in the valve sleeve.
11. If it has been removed, fit the plug of the inlet air temperature/boost pressure sensor to the sensor.
12. Fit the connector of the fuel rail pressure sensor.
13. Start the engine and check the fuel system for leaks.



5.5 REMOVAL AND INSTALLATION, FUEL RAIL PRESSURE-LIMITING VALVE

When removing the pressure-limiting valve, fuel will escape. Collect the fuel and avoid the risk of fire.



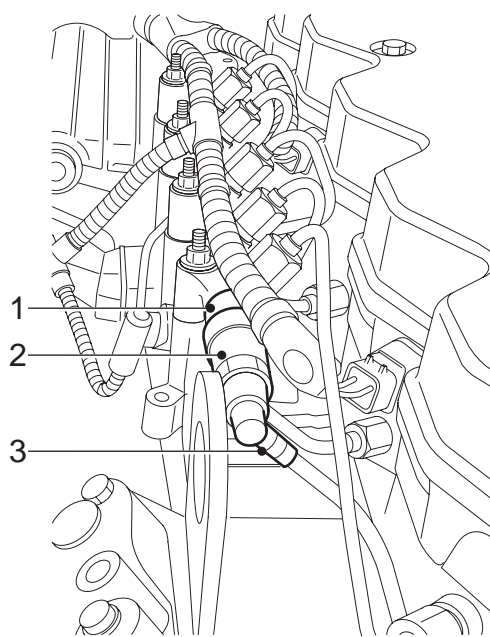
Dirt in the fuel system can lead to significant damage to parts of the system. Prevent this by cleaning the parts before disassembly and then sealing all open connections.

Removing fuel rail pressure-limiting valve

1. Clean the pressure-limiting valve (2) and the surrounding area.
2. Remove the fuel return pipe (3) from the pressure-limiting valve (2).
3. Remove the pressure-limiting valve (2) from the fuel rail (1).

Installing fuel rail pressure-limiting valve

1. Check the sealing surface and the screw thread of the pressure-limiting valve and the fuel rail.
2. Install the pressure-limiting valve in the fuel rail and tighten the valve to the specified torque. See "Technical data".
3. Fit the fuel return pipe on the pressure-limiting valve.
4. Start the engine and check the pressure-limiting valve for leaks.



i400779

5.6 REMOVAL AND INSTALLATION, HIGH-PRESSURE PUMP



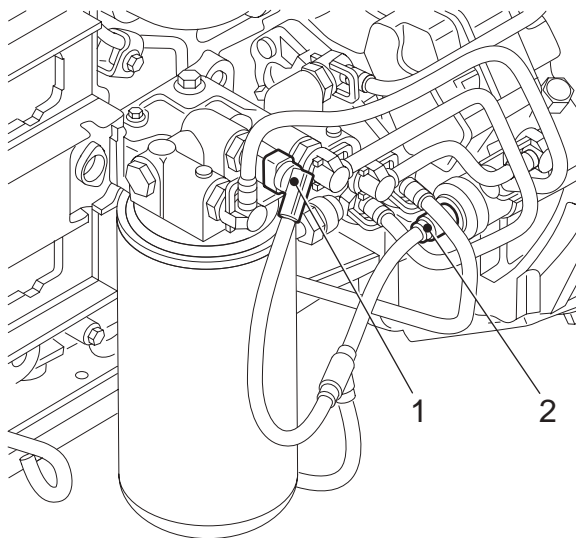
When removing the high-pressure pump, fuel will escape. Collect the fuel and avoid the risk of fire.



Dirt in the fuel system can lead to significant damage to parts of the system. Prevent this by cleaning the parts before disassembly and then sealing all open connections.

Removing the high-pressure pump

1. Clean the high-pressure pump and that part of the engine around it thoroughly with, for example, a steam cleaner. Cover the places at which leaks have been detected to prevent dirt getting into the fuel system.
2. Disconnect the fuel pipes from the high-pressure pump. Loosen the return pipe only on the high-pressure pump.
3. If fitted, uncouple the connector of the fuel temperature sensor (1) on the fuel fine filter head and the connector of the fuel pump control solenoid valve (2).
4. Remove the fuel fine filter together with the filter head.
5. Loosen both unions from the high-pressure pipe to the fuel rail as well as the pipe clamps. Remove the high-pressure pipe. Plug all openings.
6. Remove the three high-pressure pump attachment nuts and then the high-pressure pump.



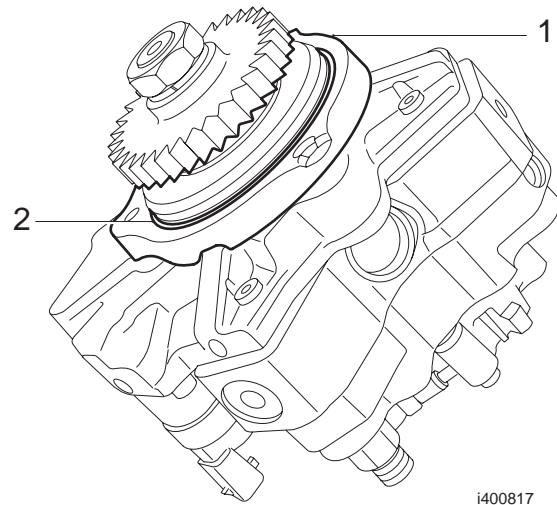
i400818

Note:

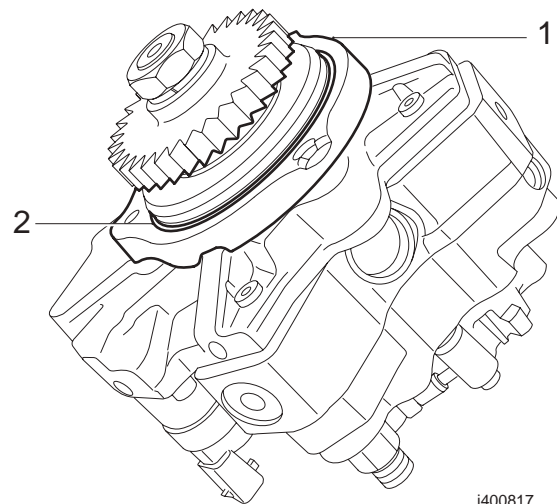
The high-pressure pump is fitted on the gear side with an adapter ring (1) and an O-ring (2) in the timing gear case. If the removal of the high-pressure pump is particularly difficult, it may be necessary to press the adapter ring (1) carefully out of the timing gear case using a small pry bar.

Installing the high-pressure pump

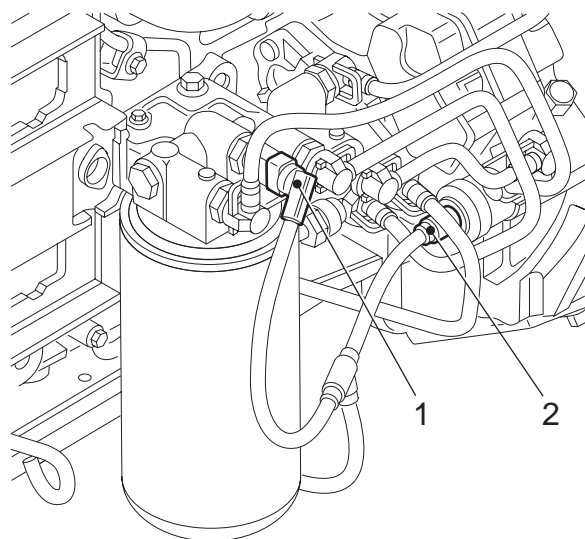
1. Clean the high-pressure pump. Make sure that no dirt or cleaner can get into the high-pressure pump ducts.
2. Check the high-pressure pump and the drive gear (externally) for wear and damage.
3. Fit a new O-ring (2) on the adapter ring (1) and apply a thin layer of engine oil to the O-ring.
4. Fit the high-pressure pump and press it into the timing gear case by means of the attachment nuts.
5. Tighten the attachment nuts to the specified torque. See "Technical data".
6. Fit the filter head and the fuel fine filter.
7. Fit the high-pressure pump to the fuel rail and tighten the unions. See "Technical data" for the specified tightening torques.
8. Tighten the pipe clamps.
9. If fitted, connect the connector of the fuel temperature sensor (1) on the fuel fine filter head and the connector of the fuel pump control solenoid valve (2).
10. Fit the fuel pipes to the high-pressure pump.
11. Bleed the fuel system. See "Inspection and adjustment".
12. Start the engine and check the fuel system for leaks.



i400817



i400817



i400818

5.7 REMOVAL AND INSTALLATION, FUEL FINE FILTER



When removing the fuel fine filter, a quantity of fuel will escape. Collect the fuel and avoid the risk of fire.

Removing the fuel fine filter

1. Place a container beneath the fuel fine filter and remove the filter.

Note:

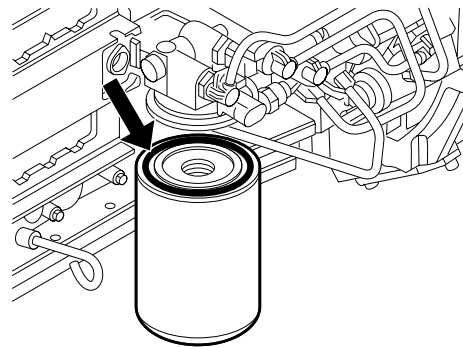
The fuel fine filter is a disposable filter and must therefore not be cleaned and re-used.

Installing the fuel fine filter

Note:

Do not fill the fine filter with fuel until it has been fitted. The fine filter is filled with fuel by the primer pump after it has been fitted. This considerably reduces the risk of dirt getting into the fuel system.

1. Check by hand whether the coupling piece for the filter attachment is securely attached.
2. Lightly lubricate the filter sealing ring with clean engine oil.
3. Fit the filter element onto the housing. Tighten the filter element until the sealing ring abuts. Tighten the filter element a further $\frac{1}{2}$ to $\frac{3}{4}$ turn by hand.
4. Bleed the fuel system. See "Inspection and adjustment".
5. Start the engine and check the fuel system for leaks. If necessary, retighten the filter by hand.



GO 00 201

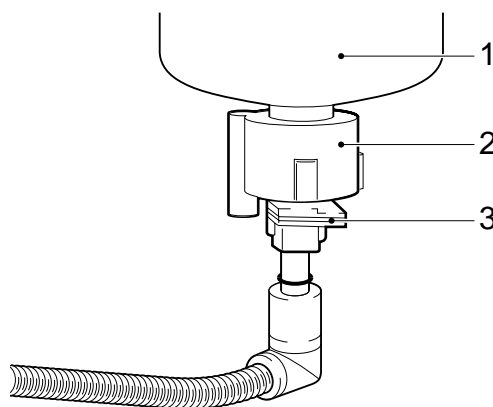
5.8 REMOVAL AND INSTALLATION, FUEL PREFILTER/WATER SEPARATOR



When removing the fuel prefilter/water separator, a quantity of fuel will escape. Collect the fuel and avoid the risk of fire.

Removing the fuel prefilter/water separator filter element

1. Place a container under the filter.
2. Remove the plug (3) from the water sensor (2).
3. Remove the fuel prefilter/water separator filter element (1) by turning it anti-clockwise.
4. Remove the water sensor (2) from the filter element (1).



GO 00 220

Installing the fuel prefilter/water separator filter element

1. Check by hand whether the coupling piece for the filter attachment is securely attached.
2. Lightly lubricate the sealing ring with engine oil.
3. Fit the fuel prefilter/water separator filter element (1) until the sealing ring abuts. Tighten the filter element a further $\frac{1}{2}$ to $\frac{3}{4}$ turn by hand.
4. Turn the water sensor (2) onto the filter element until it abuts. Tighten the water sensor by about a further $\frac{1}{8}$ - $\frac{1}{4}$ turn.

Note:

Over-tightening the water sensor (2) may damage the sensor and/or cause leakage.

5. Fit the plug (3) on the water sensor (2).
6. Bleed the fuel system. See "Inspection and adjustment".
7. Start the engine and check for leaks. If necessary, retighten the fuel prefilter/water separator filter element (1) by hand.

5.9 REMOVAL AND INSTALLATION, FUEL LEVEL ELEMENT



When removing the fuel prefilter/water separator, a quantity of fuel will escape. Collect the fuel and avoid the risk of fire.



Dirt in the fuel system can lead to significant damage to parts of the system. All open connections must therefore be sealed.

Removing fuel level element

1. Disconnect the earth lead from the battery terminal.

Note:

To prevent dirt from entering, first clean the outside of the fuel tank.

2. Drain the fuel tank until it is less than 1/3 full.
3. Remove the connector from the fuel level element.
4. Remove the attachment bolts of the fuel level element and carefully remove the fuel level element from the fuel tank.
5. Remove the gasket.

Installing fuel level element

1. Clean the contact surface of the fuel tank and the fuel level element.
2. Fit a new gasket to the fuel level element and fit the fuel level element.
3. Fit the attachment bolts of the fuel level element.
4. Fit the connector of the fuel level element.
5. Fill the fuel tank with fuel to a level above the lip of the fuel level element and check the tank for leaks.

5.10 REMOVAL AND INSTALLATION, FUEL TANK



When the fuel tank is removed, a quantity of fuel will escape. Collect the fuel and avoid the risk of fire.



Dirt in the fuel system can lead to significant damage to parts of the system. Prevent this by cleaning the parts before disassembly and then sealing all open connections.

Removing fuel tank

1. To prevent dirt from entering, first clean the outside of the fuel tank.
2. Drain the fuel tank until it is almost empty.
3. Remove the connector from the fuel level element.
4. Remove the fuel connections from the fuel tank.
5. Loosen the fuel pre-filter/water separator from the fuel tank and put it to the rear.
6. Loosen the tank straps.
7. Remove the fuel tank.

Installing the fuel tank

1. Check the fuel tank for damage.
2. Fit the fuel tank with the straps.
3. Fit the fuel pre-filter/water separator on the fuel tank.
4. Fit the fuel connections on the fuel tank.
5. Fit the connector of the fuel level element.
6. Fill the fuel tank with fuel.
7. Bleed the fuel system. See "Inspection and adjustment".
8. Check the tank and the fuel pipes for leaks.

5.11 REMOVAL AND INSTALLATION, ELECTRONIC UNIT COOLING PLATE



When removing the cooling plate, fuel will escape. Collect the fuel and avoid the risk of fire.



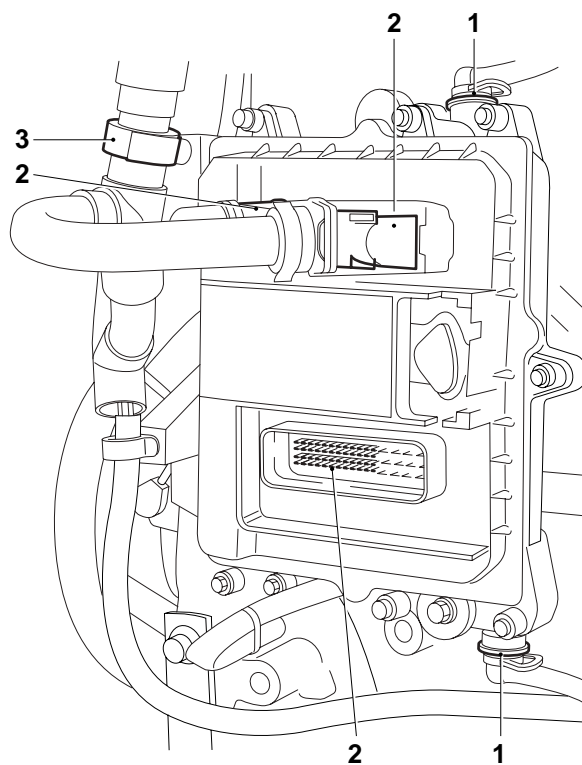
Dirt in the fuel system can lead to significant damage to parts of the system. Prevent this by cleaning the parts before disassembly and then sealing all open connections.

Note:

The electronic unit, together with the cooling plate, must first be removed from the engine block, after which the cooling plate must be demounted.

Removing electronic unit cooling plate

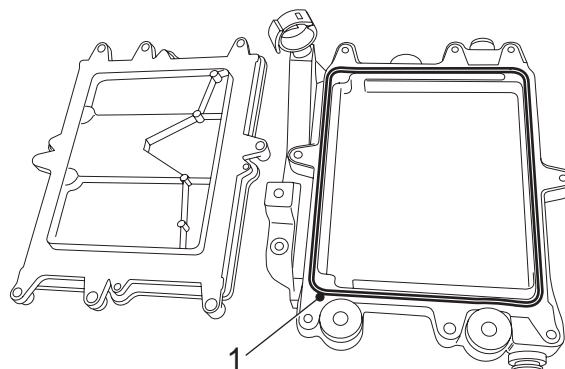
1. Disconnect the earth lead from the battery terminal.
2. To prevent dirt from entering, first clean the area around the fuel connections.
3. Remove the fuel pipes (1) on the cooling plate of the electronic unit.
4. Uncouple the electrical connectors (2) from the electronic unit and loosen the attachment clip (3) from the cable harness.
5. Remove the attachment bolts by which the electronic unit is fitted to the engine block.
6. Remove the electronic unit and cooling plate.
7. Remove the attachment bolts by which the electronic unit is fitted to the cooling plate and remove the cooling plate.



i400500

Installing electronic unit cooling plate

1. Clean the cooling side of the electronic unit and the cooling plate.
2. Inspect the sealing surfaces of the cooling plate and the electronic unit for damage and smoothness.
3. Fit a new sealing rubber (1) in the cooling plate.
4. Fit the cooling plate to the electronic unit and fit the bolts attaching the two parts. Tighten the attachment bolts to the specified torque. See "Technical data".
5. Fit the electronic unit and cooling plate to the engine block and fit the attachment bolts. Tighten the attachment bolts to the specified torque. See "Technical data".
6. Connect the electrical connectors to the electronic unit and attach the cable harness with the clips.
7. Connect the quick-release couplings of the fuel pipes to the electronic unit cooling plate.
8. Bleed the fuel system. See "Inspection and adjustment".
9. Fit the earth lead to the battery terminal.
10. Start the engine and check the fuel system for leaks.



i400819

5.12 REMOVAL AND INSTALLATION, FUEL RETURN OVERFLOW VALVE



When removing the fuel return overflow valve, fuel will escape. Collect the fuel and avoid the risk of fire.



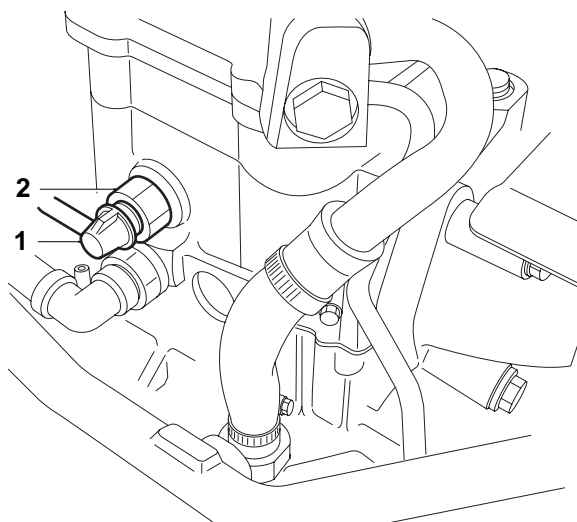
Dirt in the fuel system can lead to significant damage to parts of the system. Prevent this by cleaning the parts before disassembly and then sealing all open connections.

Removing the fuel return overflow valve

1. To prevent dirt from entering, first clean the area around the fuel return connection.
2. Remove the fuel return pipe (1) on the fuel return overflow valve (2) and plug the pipe.
3. Remove the fuel return overflow valve and collect the escaping fuel.

Installing the fuel return overflow valve

1. Install the fuel return overflow valve. Haal het brandstofretour-overstroomventiel aan met het voorgeschreven aanhaalmoment, zie hoofdgroep "Technische gegevens".
2. Connect the quick-release couplings of the fuel return pipe to the fuel return overflow valve.
3. Start the engine and check the fuel system for leaks.



i400502

5.13 REMOVAL AND INSTALLATION, LOW-PRESSURE FUEL PIPES



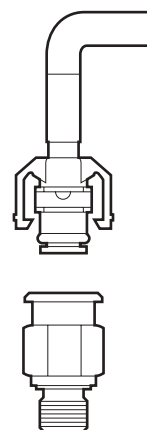
When removing the low-pressure fuel pipes, fuel will escape. Collect the fuel and avoid the risk of fire.



Dirt in the fuel system can lead to significant damage to parts of the system. All open connections must therefore be sealed.

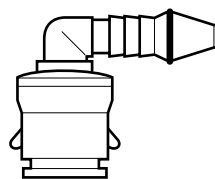
The low-pressure fuel pipes may have two different types of quick-release coupling.

VOSS quick-release coupling

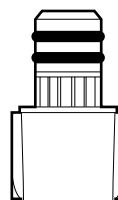


i400881

John Guest quick-release coupling



i400882



i400884

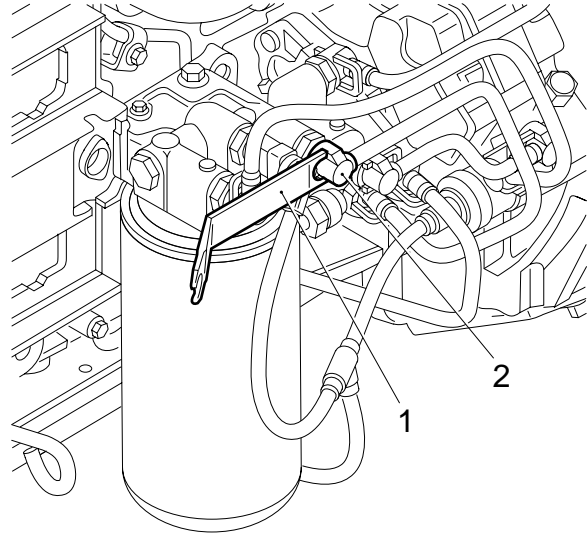
Low-pressure fuel pipes fitted with VOSS quick-release couplings

Removing low-pressure fuel pipes

1. Disconnect the fuel pipe (2) by inserting the special tool (1)(DAF no. 1329470) into the quick-release coupling and removing the pipe from the coupling.
2. Remove the special tool from the quick-release coupling.
3. Plug the openings.

Fitting low-pressure fuel pipes

1. Clean the quick-release coupling parts and apply a thin layer of clean engine oil to the O-ring.
2. Fit the pipe on the quick-release coupling of the component and push the pipe onto it until a clear resistance can be felt and the quick-release coupling audibly clicks.
3. Bleed the fuel system. See "Inspection and adjustment".
4. Start the engine and check the fuel system for leaks.



i400473

Low-pressure fuel pipes fitted with John Guest quick-release couplings**Removing low-pressure fuel pipes**

1. Disconnect the fuel pipe by pressing in both lips of the quick-release coupling and removing the pipe from the quick-release coupling.
2. Plug the openings.

Fitting low-pressure fuel pipes

1. Clean the quick-release coupling parts.
2. Fit the pipe on the quick-release coupling of the component and push the pipe onto it until a clear resistance can be felt and the quick-release coupling audibly clicks.
3. Bleed the fuel system. See "Inspection and adjustment".
4. Start the engine and check the fuel system for leaks.

6. CLEANING

6.1 CLEANING INJECTOR



The injector must never be cleaned with a steel brush or pressure cleaning equipment. Never put the brush in the injector bores when cleaning the exterior of the injector nozzle. If this happens, the nozzle must be replaced. Before cleaning the nozzle, cover the injector bores. Only clean the injector with a brass hand brush.

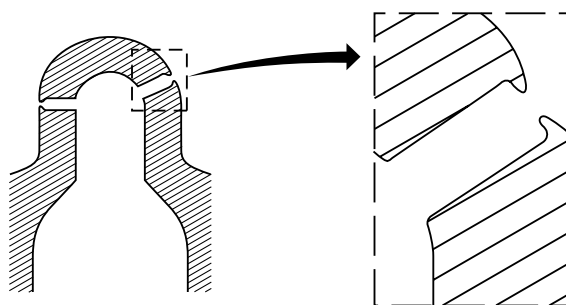
Note:

The use of steel brushes can cause deformation of the injector bores, with the result that the wrong amount of fuel is injected. This deformation cannot be ascertained by measurements or checks.

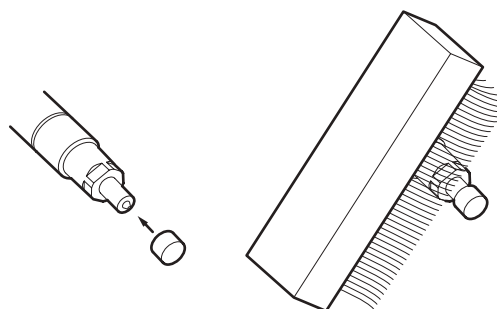
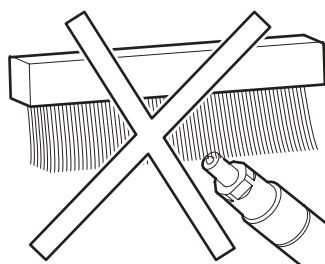
Note:

The disassembly and assembly of injectors is not permitted. Only external cleaning is permitted.

1. Remove the injector. See "Removal and installation".
2. Clean the injector hole in the cylinder head. The metal surface of the hole must not be damaged.
3. Wipe the exterior of the injector with a clean, lint-free cloth. In the case of heavy soiling the injector may be cleaned carefully with a brass hand brush (not the apertures in the injector nozzle!).
4. Fit the injector. See "Removal and installation".



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i 400413

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1. SAFETY INSTRUCTIONS

1.1 SAFETY INSTRUCTIONS

Fuel



Diesel fuel is an extremely flammable liquid, and must not be exposed to naked flames or come into contact with hot surfaces. The diesel fuel fumes remaining in an empty fuel tank form an extremely explosive mixture.

When fuel system components are being removed, some fuel will escape. To keep this spillage to a minimum, unscrew the tank cap to release any overpressure.

Any spilled fuel must be collected, bearing in mind the risk of fire.

Exhaust gases

Do not run the engine in an enclosed or unventilated area. Make sure exhaust fumes are properly extracted.



Exhaust gases contain carbon monoxide. Carbon monoxide is a deadly colourless and odourless gas, which, when inhaled, deprives the body of oxygen, leading to asphyxiation. Serious carbon monoxide poisoning may result in brain damage or death.

Moving parts

Remain at a safe distance from rotating and/or moving components.

Various fluids

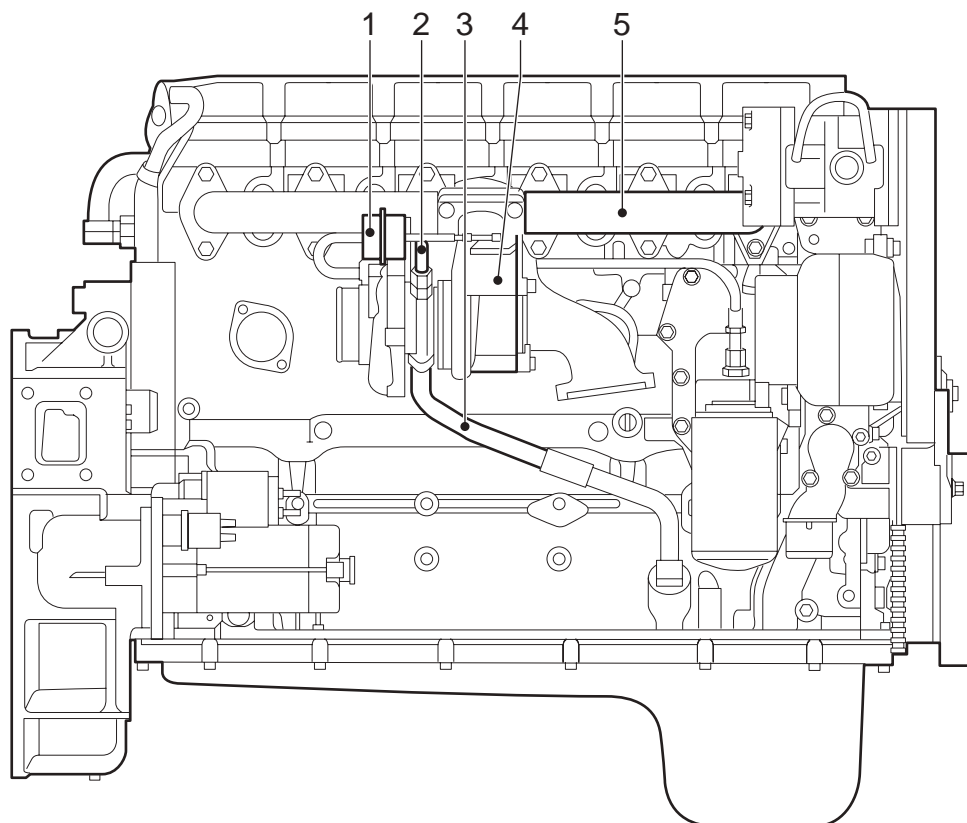
Various oils and lubricants used on the vehicle may constitute a health hazard. This also applies to engine coolant, windscreen washer fluid, refrigerant in air-conditioning systems, battery acid and clutch fluid. So avoid inhaling and direct contact.

Electrical short-circuit

Always disconnect the battery's earth connection during repair or maintenance operations for which the electric power supply is not required.

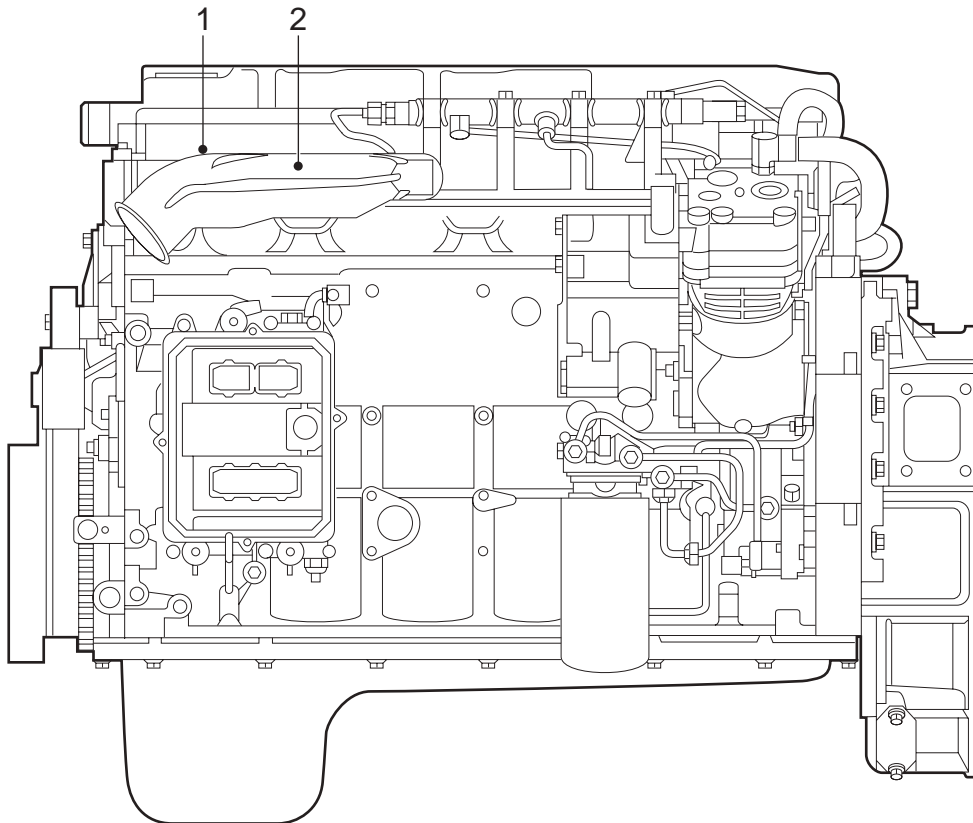
2. GENERAL

2.1 LOCATION OF COMPONENTS



1. Wastegate diaphragm box
2. Oil supply pipe
3. Oil discharge pipe
4. Turbocharger
5. Exhaust manifold

i400840



6

1. Glow element connections
2. Intake manifold

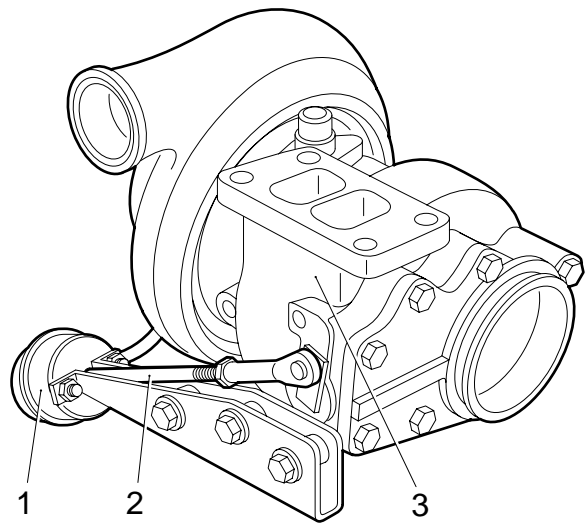
i400841

2.2 SYSTEM DESCRIPTION, TURBOCHARGER WITH WASTEGATE

To make the engine more responsive at lower engine speeds, a turbocharger is used that produces a better charge ratio at these speeds. Without provision having been made for this, the boost pressure yielded by this turbocharger would be too high at maximum engine speeds. Use of a wastegate prevents this.

The boost pressure is measured by a diaphragm box (1) on the delivery side of the turbocharger. The diaphragm is pushed back against the spring pressure by the boost pressure. The linked control rod (2) is also pushed back. The control rod operates a valve in the turbine housing (3). The valve in the turbine housing is opened when the maximum pre-set pressure has been reached.

When the valve is opened, some of the exhaust gases will be discharged directly to the exhaust pipe rather than being used to propel the turbine rotor of the turbocharger.



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3. INSPECTION AND ADJUSTMENT

3.1 INSPECTING TURBOCHARGER WASTEGATE

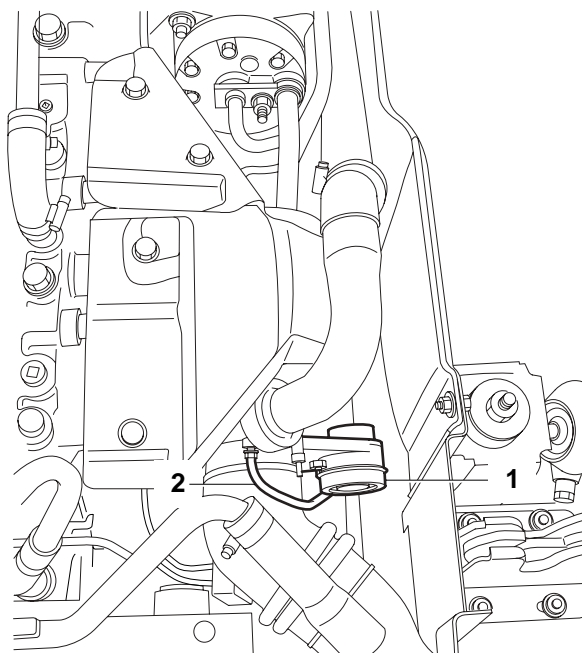
Note:

Depending on the fitting position of the turbocharger, it may be necessary to remove the turbocharger from the engine before this adjustment; see "Removal and installation".

Note:

The turbocharger is calibrated in the factory and must not be re-adjusted. The length of the control rod on the wastegate valve lever may only be changed when assembling a new turbocharger. After that, only an inspection of the actuating pressure of the wastegate may be carried out. If the result is negative, the turbocharger must be replaced.

1. Remove the flexible pipe (2) from the diaphragm box (1) of the wastegate.
2. Connect an air-pressure reducer valve to the diaphragm box of the wastegate. Set the reducer valve to max. 0.2 bar gauge pressure. Connect the reducer valve to a compressed air installation.
3. Set the reducer valve to exactly the same test pressure as listed in "Technical data".
4. Check the diaphragm in the diaphragm box for leaks by listening carefully for a hissing sound from the diaphragm box.
5. Check whether the control rod of the wastegate has moved. If it has not moved, the control rod must be loosened from the lever. Check again whether the control rod has moved. If it has not moved, the diaphragm box must be replaced. If it has moved, the wastegate valve must be made to move freely or, if that does not help sufficiently, the entire compressor unit must be replaced.
6. Remove the flexible pipe with the reducer valve and re-connect the flexible pipe of the compressor pump to the wastegate diaphragm box.



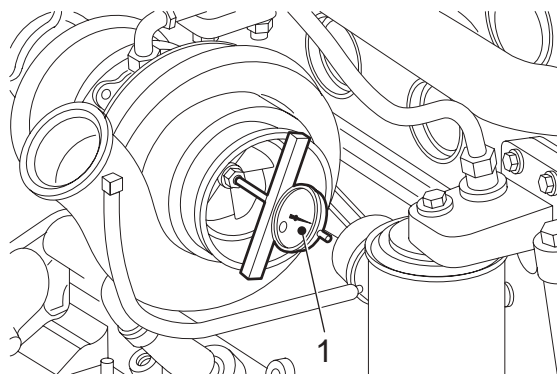
i400510

3.2 INSPECTING TURBOCHARGER AXIAL BEARING PLAY

Note:

The turbocharger axial bearing play should only be checked when the engine is cold.

1. Remove the exhaust pipe from the turbocharger.
2. Remove the charge pipes from the turbocharger.
3. Fit a dial gauge (1) to the charge supply flange of the turbocharger.
4. Push the compressor shaft away from the dial gauge and set the gauge to zero.
5. Push the compressor shaft to the dial gauge and read off the axial play. Compare the reading with the specified value; see "Technical data". Replace the turbocharger if necessary.
6. Fit the charge pipes to the turbocharger.
7. Fit the exhaust pipe to the turbocharger.



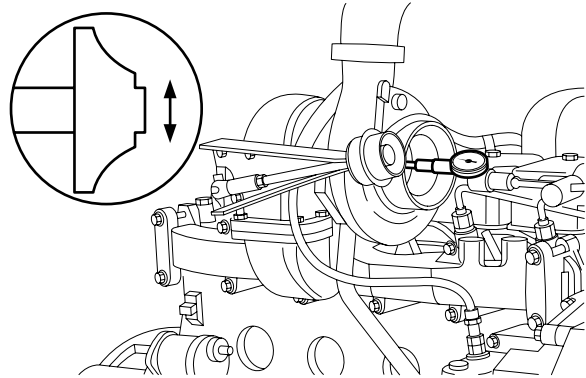
i400821

3.3 INSPECTING TURBOCHARGER RADIAL BEARING PLAY

Note:

The turbocharger radial bearing play should only be checked when the engine is cold.

1. Remove the turbocharger from the exhaust manifold. See "Removal and installation".
2. Fit a pressure gauge to the turbocharger housing and measure the radial play. Compare the reading with the specified value; see "Technical data". Replace the turbocharger if necessary.
3. Fit the turbocharger. See "Removal and installation".



i400650

3.4 CHECKING EXHAUST GAS BACK PRESSURE

Checking exhaust gas back pressure

1. Remove the plug from the exhaust elbow attachment or bore a hole and install a suitable coupling with a pipe. The first part of the pipe must be made of metal, to withstand the high temperatures.

Note:

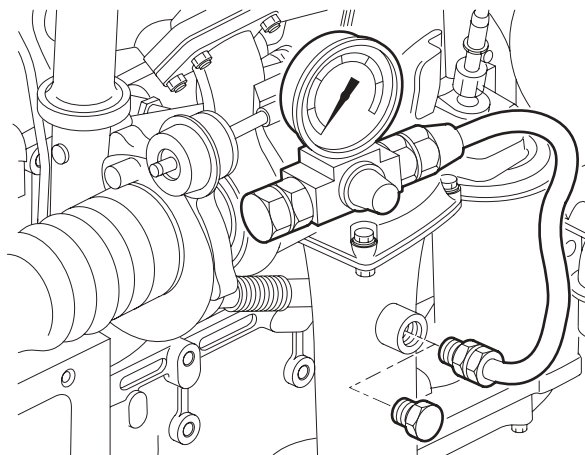
Use an attenuated gauge to prevent excessive shaking of the gauge needle.

2. Connect a pressure gauge to the pipe, with a range of at least 0.1 - 0.2 bar (10 - 20 kPa).

Note:

The engine brake must not be used during measurements. This is to protect the pressure gauge.

3. Measure the exhaust gas back pressure at full-load engine speed and compare the measurements to the specified value. See "Technical data". Check the exhaust system if the exhaust gas back pressure is too high.
4. Remove the pressure gauge and the coupling and fit the plug.



i400513

3.5 INSPECTION AND PRESSURE-TESTING, AIR INLET SYSTEM



When pressure-testing the air inlet system, the plugs may spring off if they are not properly secured. It is therefore important to check the attachment of the plugs before pressure-testing and keep people away from the area.

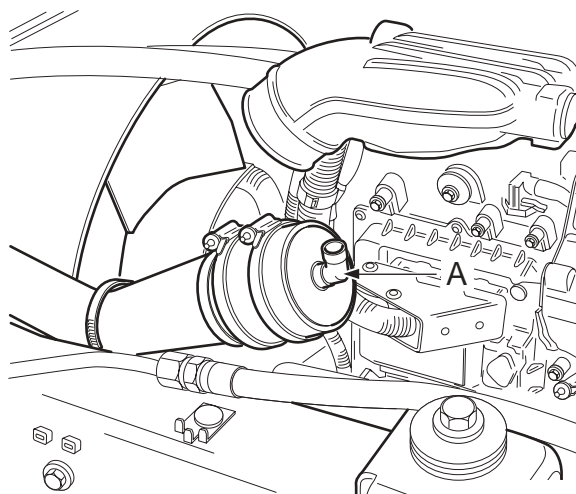
1. Check the condition and mounting of the air inlet channels/pipes of the air inlet system.

Note:

In case of doubt as to the proper sealing of the air inlet system, which is indicated by the following:

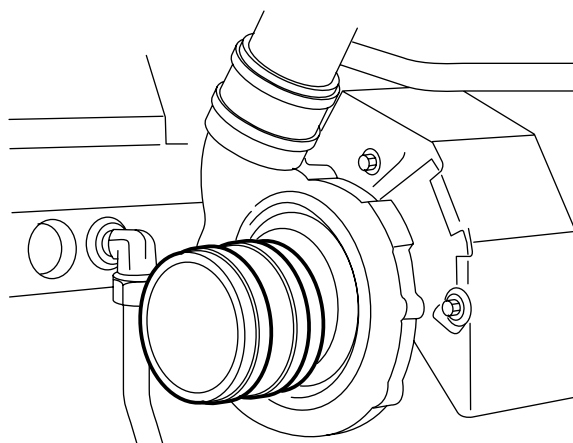
- loss of power
- high fuel consumption
- unusual noises
- lit engine fault symbol on the instrument panel, ???carry out a pressure test to check the air inlet system for leakage.

2. Remove the right-hand and rear engine encapsulations.
3. Loosen the inlet hose between the air cooler and the inlet manifold at the inlet manifold side.
4. Fit the special tool (DAF no. 1453171) in the hose.



i400856

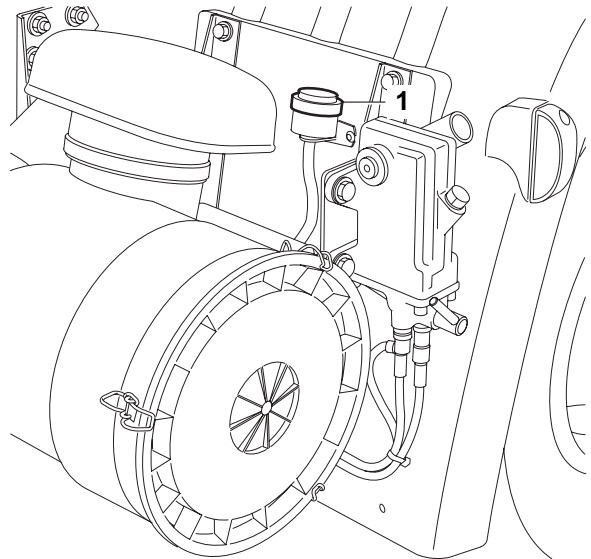
5. Loosen the plastic pipe between the air filter housing and the rubber suction hose on the turbocharger.
6. Install special tool (DAF no. 0694831) in the rubber intake port on the turbocharger.
7. Connect an air pipe with reducer valve to the sealing cap (A) and charge the system to approx. 1 bar.
8. Use a soapy solution to check the whole inlet system for air leaks. Also check whether the pressure gauge of the reducer valve drops.
9. Fit the loosened hoses of the inlet system and the engine encapsulation.



i 400376

3.6 CHECKING INLET UNDERPRESSURE

1. Remove the connection of the air intake pipe underpressure indicator (1) from between the air filter housing and turbocharger.
2. Connect a pressure gauge with a maximum rating of -100 mbar (-10 kPa) to the connection of the underpressure indicator.
3. Measure the inlet underpressure at full-load engine speed and compare the measurement to the specified value. See "Technical data".
4. Fit the connection of the air intake pipe underpressure indicator (1) between the air filter housing and turbocharger.



i400514

4. REMOVAL AND INSTALLATION

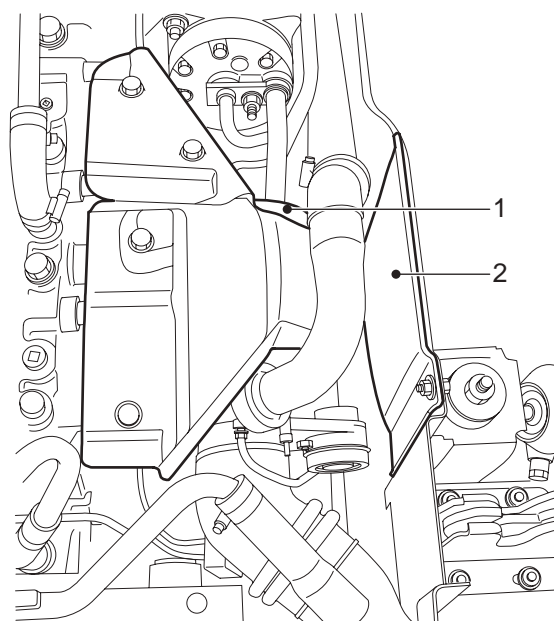
4.1 REMOVAL AND INSTALLATION, TURBOCHARGER



If the turbocharger to be replaced has been damaged to such an extent that parts of it are missing or lubricating oil has entered the inlet system, the inlet and exhaust systems must be checked and cleaned thoroughly in order to prevent serious damage to the engine.

Removing the turbocharger

1. Remove the right-hand engine encapsulation (2).
2. Remove the heat shield (1) from the oil filter.
3. Remove each charge pipe and the turbocharger exhaust pipe.
4. Remove the oil discharge pipe from the turbocharger.
5. Detach the entire oil supply pipe from the oil filter housing to the turbocharger.
6. Remove the attachment bolts from the turbocharger.
7. Remove the turbocharger.
8. Immediately plug the openings.



i400857

Installing the turbocharger

1. Clean the turbocharger and the oil supply and discharge pipes.
2. Before installing the turbocharger, check the following:
 - the turbocharger housing and connector flange for cracks. See "Technical data" for rejection standards;
 - the turbocharger shaft must be able to rotate freely;
 - the turbocharger shaft must not run out of true;
 - the turbocharger pump and turbine wheels must not be damaged;
 - there must not be an excessive amount of oil in the compressor side of the turbocharger. A small amount of oil on the inside walls of the compressor side is allowed.

3. Check the adjustment of the turbocharger wastegate. See "Inspection and adjustment".
4. Check the axial bearing play of the turbocharger; see "Inspection and adjustment".
5. Check the radial bearing play of the turbocharger; see "Inspection and adjustment".
6. Clean the sealing surfaces.

Note:

Always use new gaskets when installing the turbocharger.

7. Apply a layer of Copaslip to the exhaust manifold studs.
8. Fit the turbocharger to the exhaust manifold.
9. Fit the attachment nuts and tighten them to the specified torque. See "Technical data".
10. Check that the oil supply and discharge pipes are clean and not blocked, kinked or cracked. Replace the pipes if necessary.

Note:

If the turbocharger oil supply and/or discharge does not function properly, this may result in serious damage to the turbocharger and/or engine.

11. Fit new O-rings to the oil discharge pipe and apply a thin layer of engine oil to them. Fit the oil discharge pipe. For the specified tightening torque, see "Technical data".
12. Pour clean engine oil into the oil supply of the turbocharger and fit the oil supply pipe, after fitting a new copper ring, on the oil filter housing and the turbocharger. Tighten the pipe to the specified tightening torque; see "Technical data".

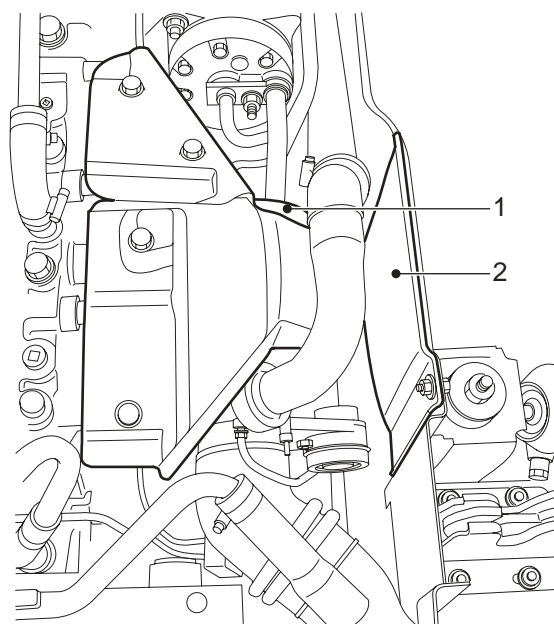
4

CE ENGINE INLET/EXHAUST SYSTEM

LF45/55 series

Removal and installation

13. Fit the exhaust pipe to the turbocharger.
14. Fit the charge pipes to the exhaust pipe.
15. Fit the heat shield (1) to the oil filter.
16. Install the engine encapsulation (2).

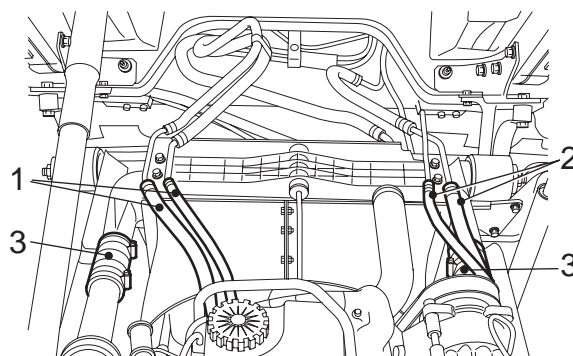


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4.2 REMOVAL AND INSTALLATION OF AIR COOLER

Removing the air cooler

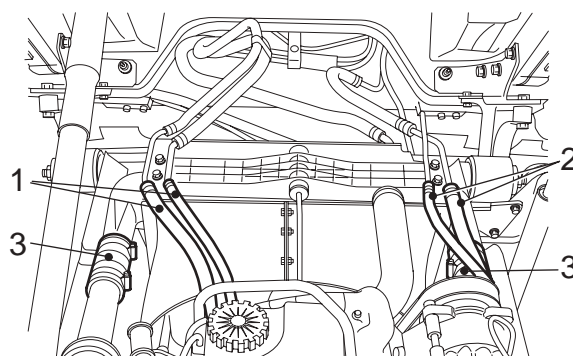
1. Disconnect the earth lead from the battery terminal.
2. If the vehicle has air conditioning, loosen the support of the refrigerant pipes (2) on the radiator and remove the condenser from the air cooler supports.
3. Loosen the support of the coolant pipes (1) on the radiator.
4. Remove the charge pipes (3) from the air cooler and plug the openings.
5. Disconnect the air cooler.
6. Remove the air cooler.



i400822

Installing the air cooler

1. Clean the outside of the air cooler with compressed air.
2. Install the air cooler and tighten the air cooler attachments.
3. Fit the charge pipes (3) to the air cooler.
4. Fit the bracket of the coolant pipes (1) on the radiator.
5. If the vehicle has air conditioning, fit the condenser in the air cooler supports and tighten the support of the refrigerant pipes (2) on the radiator.
6. Connect the battery terminals.
7. Start the engine and check for leakage.



i400822

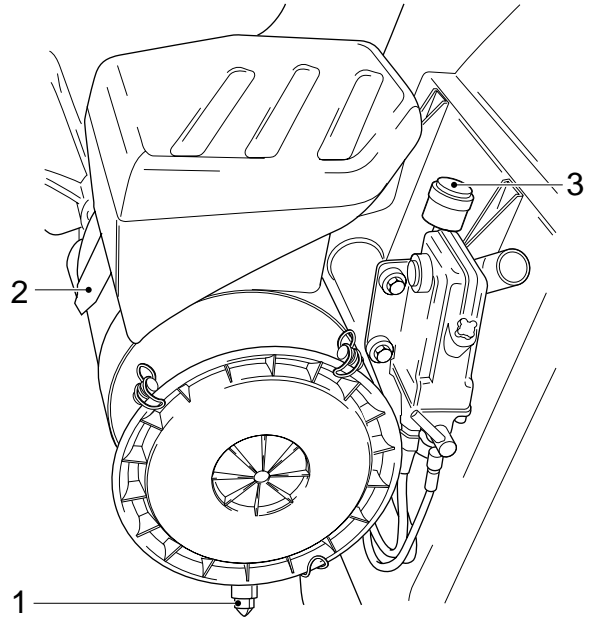
4.3 REMOVAL AND INSTALLATION, AIR FILTER ELEMENT

Removing the air filter element

1. Loosen all clamping brackets on the air filter cover.
2. Remove the air filter cover.
3. Remove the air filter element.
4. Clean the inside of the air filter housing and the air filter cover.
5. Clean the rubber sealing valves (1 and 2) on the filter housing. Check the sealing valve for damage.

Installing the air filter element

1. Fit the air filter element in the air filter housing.
2. Fit the air filter cover.
3. Install all the clamping brackets.
4. Reset the air filter indicator (3) by pressing the knob on the indicator.



I4 00 535

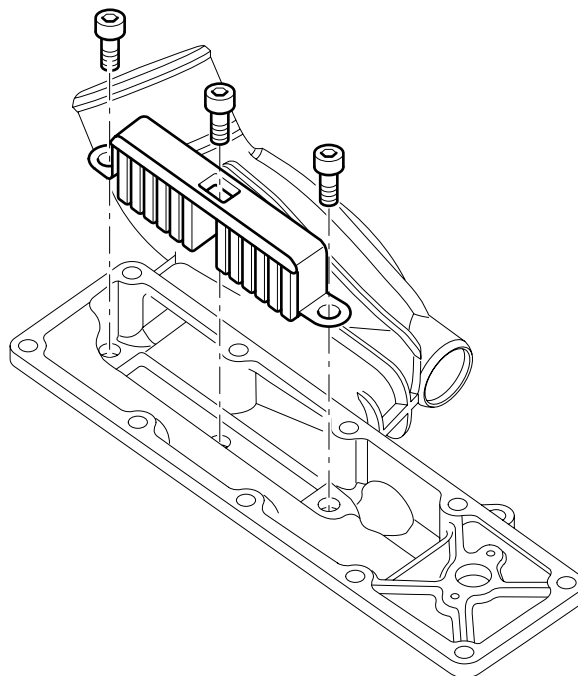
4.4 REMOVAL AND INSTALLATION, GLOW PLUG

Removing the glow plug

1. Remove the inlet manifold.
2. Remove the attachment bolts from the glow plug and remove the glow plug.

Installing the glow plug

1. Fit the glow plug and tighten the attachment bolts to the specified torque. See "Technical data".
2. Fit the inlet manifold.



M201155

5. CLEANING

5.1 CLEANING THE EXTERIOR OF RADIATOR AND AIR COOLER



Inhalation of dust may have serious consequences for your health. Take the necessary precautions, such as wearing goggles and a facemask.

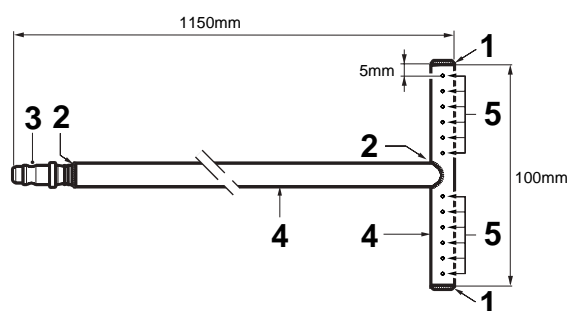
Note:

With the aid of a simple tool, the radiator and the air cooler can be blow-cleaned.

The tool (radiator cleaner) cannot be ordered from DAF. It should be manufactured by yourself according to the drawing.

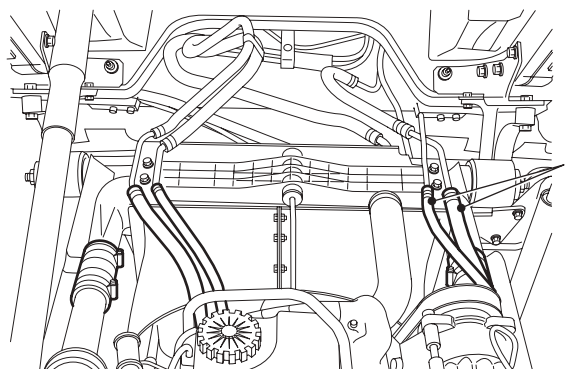
Key to drawing:

- 1 Solder up
- 2 Solder
- 3 Quick-release coupling for air hose
- 4 Steel pipe, \varnothing 10 mm
- 5 6 x \varnothing 1.5 mm between holes, with a centre-to-centre distance between the holes of 7 mm, drilled on one side



M2108

1. If the vehicle has air conditioning, loosen the support of the refrigerant pipes (1) on the radiator and remove the condenser from the air cooler supports. Push the condenser as far as possible forwards.

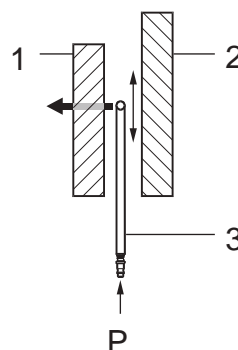


i400824

Cleaning

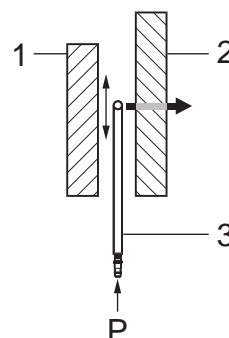
LF45/55 series

2. Insert the radiator cleaner (3) between the air cooler (1) and radiator (2) from underneath, with the air holes facing the air cooler (1).
3. Apply air pressure to the radiator cleaner (3) and continue blow-cleaning the air cooler (1) until no more dirt comes out.



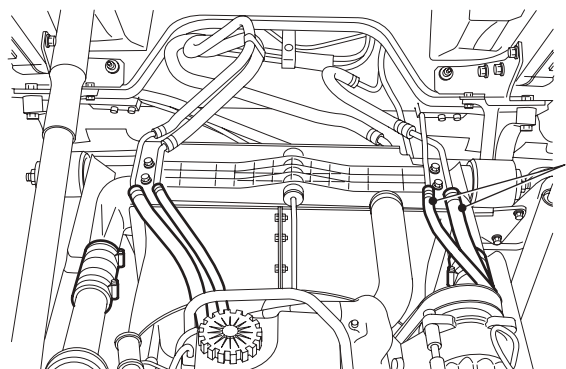
M201351

4. Turn the radiator cleaner (3) over, turning the holes towards the radiator (2), and blow-clean the radiator (2).



M201352

5. If the vehicle has air conditioning, fit the condenser in the air cooler supports and tighten the support of the refrigerant pipes (1) on the radiator.



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1. SAFETY INSTRUCTIONS

1.1 SAFETY INSTRUCTIONS

Fuel



Diesel fuel is an extremely flammable liquid, and must not be exposed to naked flames or come into contact with hot surfaces. The diesel fuel fumes remaining in an empty fuel tank form an extremely explosive mixture.

When fuel system components are being removed, some fuel will escape. To keep this spillage to a minimum, unscrew the tank cap to release any overpressure.

Any spilled fuel must be collected, bearing in mind the risk of fire.

Exhaust gases

Do not run the engine in an enclosed or unventilated area. Make sure exhaust fumes are properly extracted.



Exhaust gases contain carbon monoxide. Carbon monoxide is a deadly colourless and odourless gas, which, when inhaled, deprives the body of oxygen, leading to asphyxiation. Serious carbon monoxide poisoning may result in brain damage or death.

Moving parts

Remain at a safe distance from rotating and/or moving components.

Various fluids

Various oils and lubricants used on the vehicle may constitute a health hazard. This also applies to engine coolant, windscreen washer fluid, refrigerant in air-conditioning systems, battery acid and clutch fluid. So avoid inhaling and direct contact.

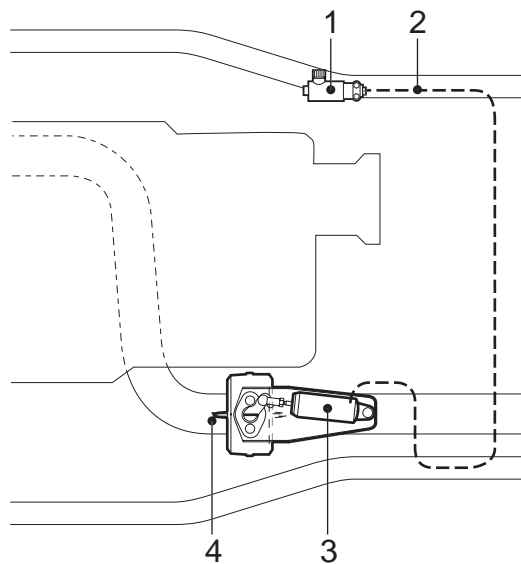
Electrical short-circuit

Always disconnect the battery's earth connection during repair or maintenance operations for which the electric power supply is not required.

2. GENERAL

2.1 LOCATION OF EXHAUST BRAKE COMPONENTS

1. Exhaust brake valve
2. Air pipe
3. Operating cylinder, exhaust brake
4. Butterfly valve



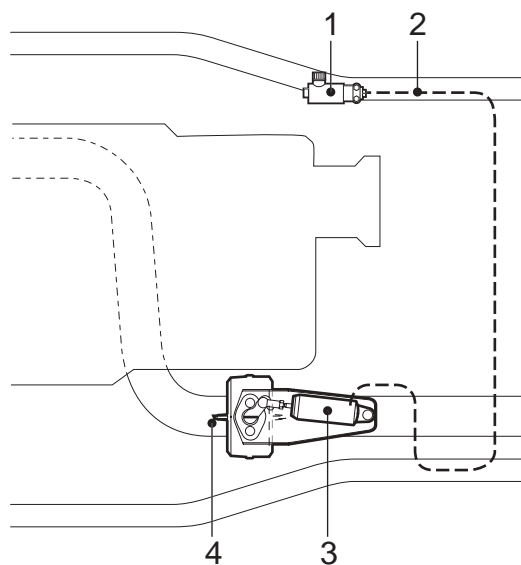
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2.2 SYSTEM DESCRIPTION, EXHAUST BRAKE

1. Exhaust brake valve
2. Air pipe
3. Butterfly valve operating cylinder
4. Butterfly valve

Note:

The engine brake is an exhaust brake.



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Switching on the exhaust brake

The exhaust brake consists of an engine brake operating switch fitted to the steering column and an operating cylinder (3) connected to the butterfly valve (4) in the exhaust pipe.

If the exhaust brake operating switch is activated, a signal is passed to the engine management system's electronic unit. The operating switch has the positions "off" and "automatic". In the "automatic" position the engine management system's electronic unit engages the exhaust brake whenever this is appropriate and possible. Of course, the electronic unit disengages the exhaust brake when required.

If the exhaust brake is engaged by the electronic unit, the unit energises the exhaust brake valve (1), causing supply pressure to flow to the operating cylinder. The cylinder closes the butterfly valve in the butterfly valve housing. The exhaust pipe is then almost completely closed off. The engine management system's electronic unit also interrupts the fuel supply to the various cylinders. The engine now acts as a compressor, creating a braking action.

The higher the engine speed, the greater the braking action of the engine brake.

Switching off the exhaust brake

If the engine brake control switch is pushed back, the butterfly valve will be re-opened and the fuel supply to the various cylinders will be re-instated.

3. INSPECTION AND ADJUSTMENT

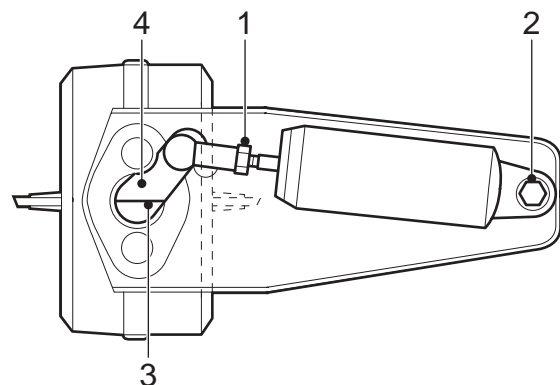
3.1 INSPECTION AND ADJUSTMENT, EXHAUST BRAKE

Checking exhaust brake

1. Check the exhaust brake for smooth operation by pressurising the exhaust brake cylinder yourself.

Setting the exhaust brake

1. Remove the air pipe from the operating cylinder.
2. Slacken lock nut (1) on the piston rod.
3. Remove the attachment nut (2) from the operating cylinder and take the operating cylinder off the support.
4. Open the butterfly valve fully (exhaust brake inactive), indicated by the mark (3) on the butterfly valve shaft, and press the lever (4) against the stop.
5. Set the piston rod length by rotating the operating cylinder in such a way that it can be fitted on the support.
6. Turn the piston rod one more full turn in the ball joint to give the operating cylinder the correct pre-tension.
7. Fit the operating cylinder on the support using the attachment nut (2) and fit the air pipe.
8. Tighten the lock nut (1).
9. Connect the air pipe to the operating cylinder.



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4. REMOVAL AND INSTALLATION

4.1 REMOVAL AND INSTALLATION OF EXHAUST BRAKE

Removing the exhaust brake

1. Loosen the air pipe of the operating cylinder.
2. Remove the exhaust pipe from the exhaust brake.
3. Remove the entire exhaust brake.

Installing exhaust brake

1. Check the butterfly valve for smooth operation.
2. Clean and check the sealing faces of the butterfly valve housing and of the exhaust pipes.
3. Clean the attachment bolts and apply heat-resistant grease to the threads.
4. Fit the exhaust brake.
5. Fit the exhaust pipe.
6. Connect the air pipe.
7. Check the operation of the exhaust brake.

