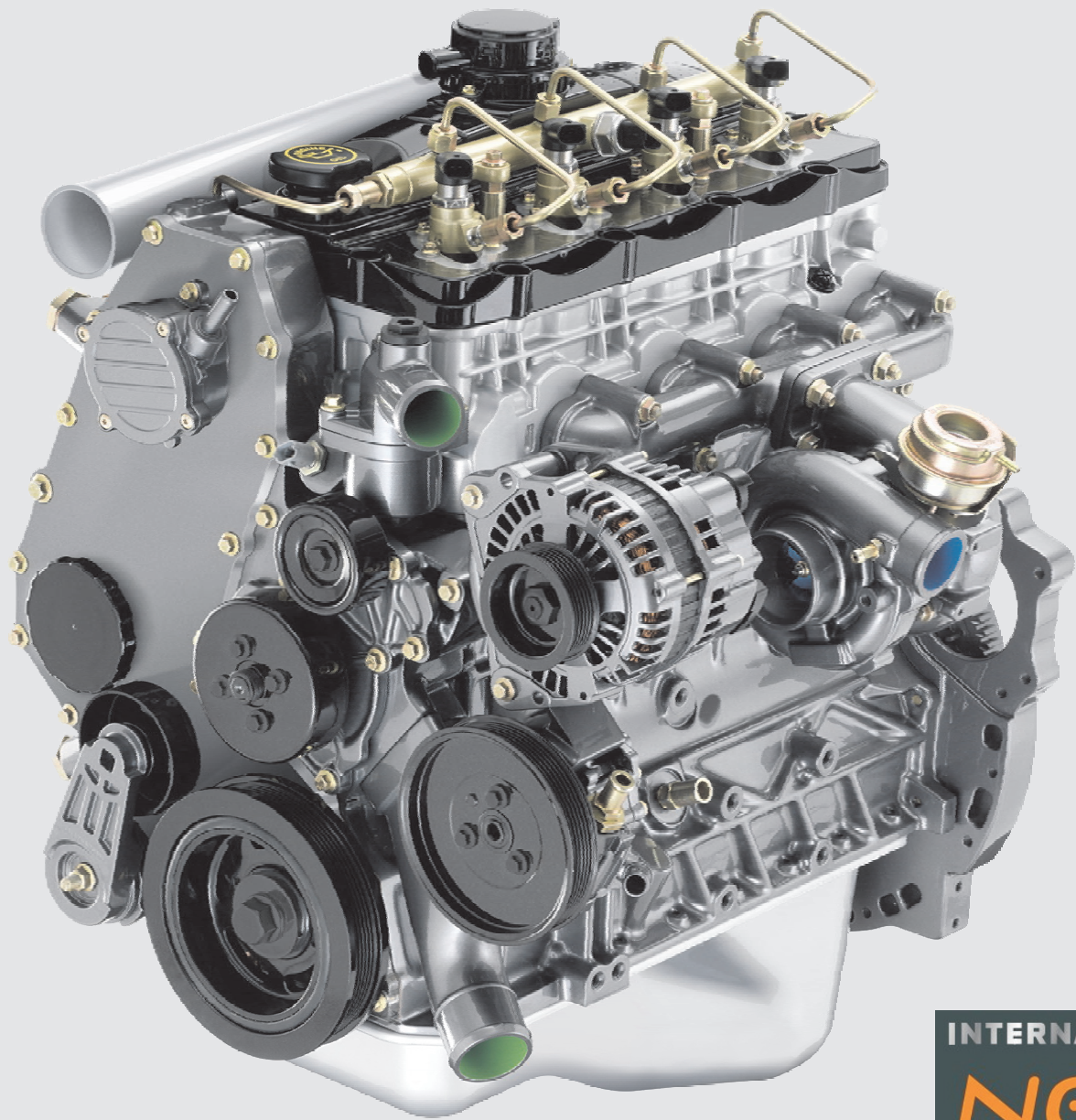


**MWM**



**INTERNATIONAL<sup>®</sup>**  
*Motores*

**SERVICE MANUAL**



**INTERNATIONAL**  
**NGD**  
**3.0**  
**ELECTRONIC**

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**Engine NGD 3.0E / Power Stroke 3.0E**



## PRESENTATION

This Service Manual contains the technical specifications necessary for the correct repair and maintenance of the MWM-International NGD 3.0E Engines. Written to be strictly technical literature, the inclusion of theoretical concepts and basic definitions was avoided, because they deflect from purpose of this publication.

It is very important to learn how to correctly operate, maintain and repair these engines, and to know the elements that can compromise the warranty due to improper use, unauthorized adaptations or any procedures which may affect it in any way.

By following the instructions and specifications contained in this Manual, the maintenance and repair operations will be accomplished in the safest and most correct way possible.

MWM-*International* Motores reserves the right to modify the content of this Publication without prior notice, whenever innovations are introduced in their products.

To check the existence of any revisions of this Manual, consult the site; [www.nav-international.com.br](http://www.nav-international.com.br), using as a reference the publication date.

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# Index

Safety Precautions .....	7
Environmental .....	13
Technical Characteristics .....	16
Operation and Maintenance .....	21
Cooling System .....	27
Fuel System .....	43
Lubrication System .....	65
Intake and Exhaust System .....	81
Cylinder Head .....	97
Cylinder Block .....	117
Pistons and Connecting Rods .....	123
Crankshaft.....	133
Distribution / Timing .....	143
Flywheel and Ring Gear.....	165
Accessories.....	173
Electronic Control.....	187
Failure Diagnosis .....	205

Technical Specifications..... 291

Torque Specifications ..... 299

Special Tools ..... 323

Remissive Index ..... 331

## *Safety Precautions*

## Safety Precautions

### Caution:

The text marked with the symbol above presents direct or indirect risks to personal safety.

Read this Manual carefully and always maintain it close at hand to eliminate any doubts.

Don't try to operate the equipment without prior knowledge of all its controls and full understanding of its functioning.

Use always the following safety precautions before proceeding with any work, because they are listed for your protection:

- Do not modify the characteristics of the engine;
- Do not smoke when filling up the fuel tank;
- Clean immediately any and all spilled fuel. Place all used material in a clean and safe area;
- Do not refuel an operating engine, unless it is absolutely necessary;
- Never clean, lubricate or adjust an engine while it is running;
- Do not make any adjustment, if you do not know how to do it correctly;
- Do not operate the engine within closed areas, because the exhaust gases are extremely poisonous;
- Do not allow people or animals near the engine, vehicle or equipment while it is running;
- Do not allow people with baggy clothing or with long, loosen hair to approach the movable parts;
- Maintain a safe distance from any rotating parts. Remember that fans, for example, cannot be seen distinctly while the engine is running;
- Do not remove the radiator cap if the engine is hot, because a spray of engine coolant, under pressure, is extremely dangerous and could cause serious burns;
- Do not use salt water or any other liquid that could cause corrosion in the cooling system;
- Avoid sparks and flames near the batteries, especially when they are being charged, because they can cause explosions. The battery electrolyte can boil and any contact with your skin and/or eyes is dangerous;
- Disconnect the battery terminals before doing any repair to the electrical system;
- Seek medical assistance immediately if the high-pressure diesel fuel penetrates into the skin.

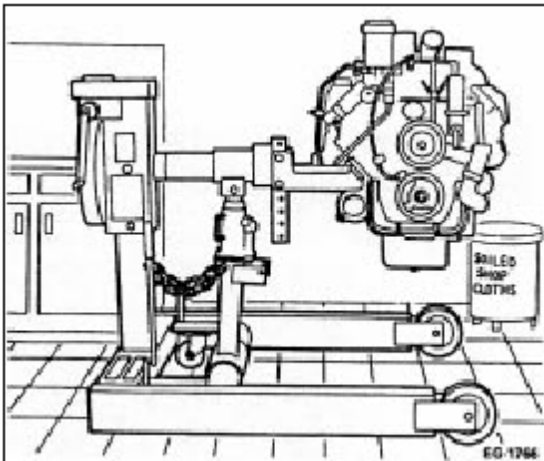
Considering the very high pressure (1600 bar) that may exist in the fuel system, the following instructions should be observed:

1. Smoking is absolutely prohibited near the fuel system while the same is being worked on;
- 2.. No work should be done near flames and sparks;
3. No work should be done in the injection system while the engine is running;
4. No work should be done in the engine within the minimum period of 60 seconds after turning off the engine.

**Note:** This waiting period is necessary so that the fuel pressure in the injection system will fall to ambient pressure.

For any additional explanation about the injection system, [see Fuel System page 43](#).

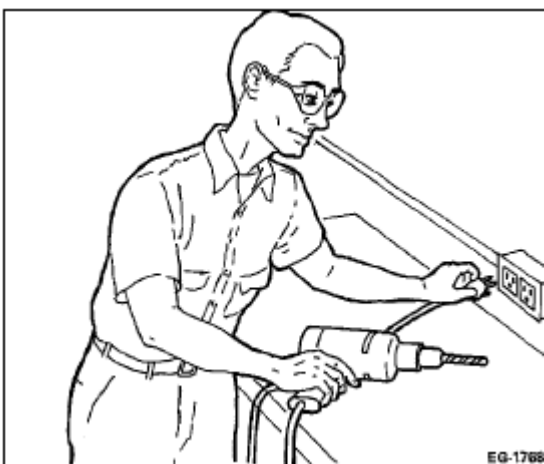




Maintain the work area clean and organized. Clean any oil drops or stains. Maintain all tools and parts at their appropriate location, avoid leaving them on the floor. Eliminate any chance of a fall that could result in serious injuries. Be sure to install all safety devices, protections, screens or covers, when adjusting and/or working on the engine. After executing the work, make sure that all tools, parts or auxiliary equipment are removed from vehicle and/or the engine.



Use proper clothing to work. They must be adjusted correctly for the body and in good condition. Don't use rings, wristwatches or baggy clothing, when you are working on any machine. They can be entangled at the moving parts, causing serious injuries. Use safety shoes to work. Never work in shops or near machines with bare feet, slippers, sandals or sneakers.



Do not use any malfunctioning portable power tool. Check the condition of all electric power supply cables before using them. Be sure that all machine tools are grounded. Serious injuries can be caused by malfunctioning electric equipment or its inappropriate use

Take care when using and working with compressed air. Never apply compressed air on any part of the body or clothes, because it can cause serious injuries.

Use an approved air nozzle and do not exceed the recommended pressure limit. Use always safety goggles and protective devices to avoid risks to yourself and to other people working in the area.

While refueling, maintain the hose and nozzle or funnel in contact with the metal of the fuel tank to avoid possibility of an electric spark setting fire to the fuel.

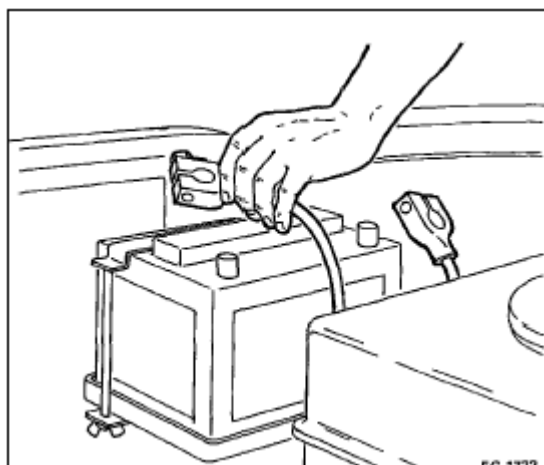
Don't exceed the capacity of the fuel tank; overfilling it creates the risk of a fire.

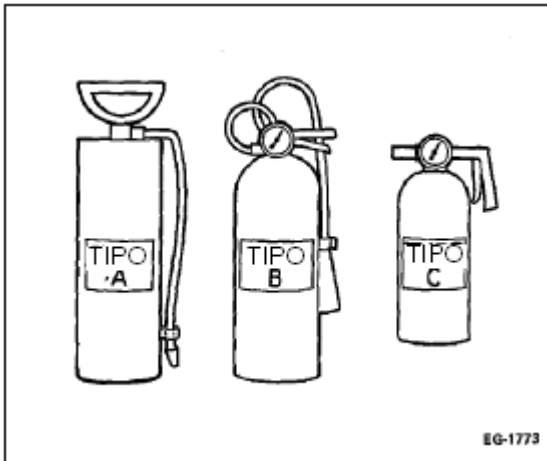
Do not smoke during refueling and never refuel a running engine.

Electric batteries liberate a highly inflammable hydrogen gas while they are being recharged and they continue to do so, for some time, after they have received a charge.

Do not allow under any circumstances the production of electrical sparks or flames close to the battery, because an explosion may occur.

Always remove the negative cable (-) from battery or both, positive (+) and negative (-), before working on the electrical system.





Maintain a fully charged fire extinguisher within your reach, in the work area, where a fire could possibly happen.

Also, have the proper extinguishers, according to the following situations:

**Type A:** Wood, paper, textiles and garbage.

**Type B:** Inflammable liquids.

**Type C:** Electrical equipment.



## *Environment*

## **Environmental Policy**

MWM-*International* Motores is committed with the continuous search of the environment preservation while producing Diesel engines for the worldwide market, through an efficient administration of its resources, processes and products.

### **Guidelines:**

- To attend the legislation, applicable environmental rules and other requirements that the Company has joined.
- To develop products and procedures to reduce environmental impacts and to avoid pollution.
- To apply an efficient administration system that promotes the continuous improvement to reach environmental objectives and targets.
- To promote, in the Company, the sense of individual responsibility in relation with the environment.
- To involve its suppliers and service suppliers in the development of habits which cooperate in the preservation of the environment.

## **Environment**

The environment preservation is a basic point in the MWM-*International* Motores companies' philosophy.

An actuation program has been approved, which includes activities such as natural resources preservation, elimination of residues and their recycling, water protection, noise reduction and acoustic insulation, air pureness conservation and elimination of contaminant residues.

Allse subjects constitute the mark of a wide environmental protection program, which is considered since the beginning of the project of a new product.

The systematic accomplishment of this philosophy can be appreciated especially in the main aspects, like disassembling easiness, lesser amount of materials, and using of easily recycling plastics.

It means, equally, that harmful to environment materials are not used, like asbestos, cadmium and fluor-chlorine hydrocarbon.


In the same way, gases and noise emissions reductions are considered, as well as the improvement of active and passive safety.


This environment protection program is not limited only to the production process, but it is extended to the complete engine life span cycle, considering also its wearing after a long operation period.

We have assumed a commitment with the planet we live in. A commitment that we take very seriously.

### Environmental pollution control

MWM-*International* Motores, through its Environmental Administration System, has improved more and more its engines contributing to pollution reduction (Programa de Controle da Poluição do Ar por Veículos Automotores - PROCONVE) and attending, in this way, to the resolutions of CONAMA (Conselho Nacional do Meio Ambiente).

 **Warning:** The engine adjustment values specified in this Manual must be strictly observed because, besides to offer a better performance to the vehicle, they also reduce noises and harmful gases emissions to the atmosphere.

 **Warning:** Any changing in the fuel injection or air intake systems, or even the exhaust system, may affect directly the homologated values.

### Destination of the used components of the engine

MWM-*International* Motores is applying in its engines, more and more, materials of easy recycling, facilitating this way, at the end of the component life, its sale or re-fusion.

### Plastic and metallic components / packing

This type of component must be sent to a Scrap Trade where the parts will be sold and re-melted.

### Lubricant oil

This fluid has a high polluting potential and it cannot be discarded, never, into the sewer.

Send it to reprocessing (re-refining) companies.

## **Technical Characteristics (Ford Ranger Application)**

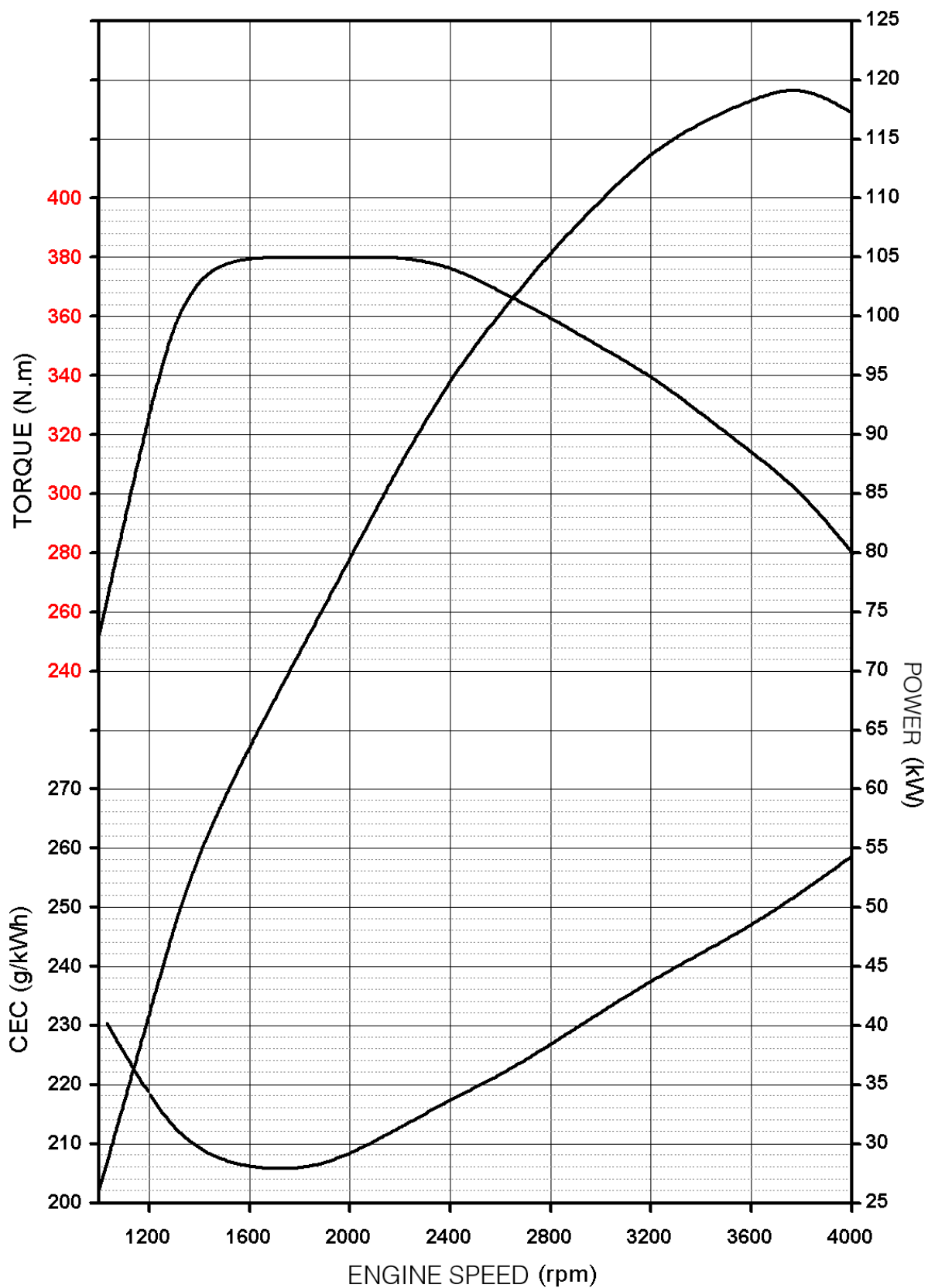
Engine Model	NGD 3.0E
LP Number	8C34
Turbocharger	Waste-gate
Number and cylinder arrangement	4 in line
Bore	96,00 mm
Stroke	102,50 mm
Cycle	Diesel, 4 stroke
Compression ratio	17.0 to 1
Displacement	3.0 l
Combustion system	Direct, electronic injection Common Rail
Direction of rotation (seen from front)	Clockwise
Firing Order	1 - 3 - 4 - 2
Opening beginning of thermostatic valve	86 - 90° C
Operating Temperature of thermostatic	86 - 102° C
Oil Pressure at idle speed with the engine at normal operating temperature	2,5 - 3,5 kgf/cm <sup>2</sup> (bar)
Oil Pressure at maximum specified speed with the engine at normal operating temperature	5,0 - 6,5 kgf/cm <sup>2</sup> (bar)
Maximum speed unloaded	4640 rpm
Idle speed	800 rpm
Static injection beginning at TDC	Not applicable (Electronic system)
Engine Cooling	Liquid coolant
Output (NBR5484)	163cv@3800 rpm
Torque (NBR5484)	380 Nm @ 1600-2200 rpm



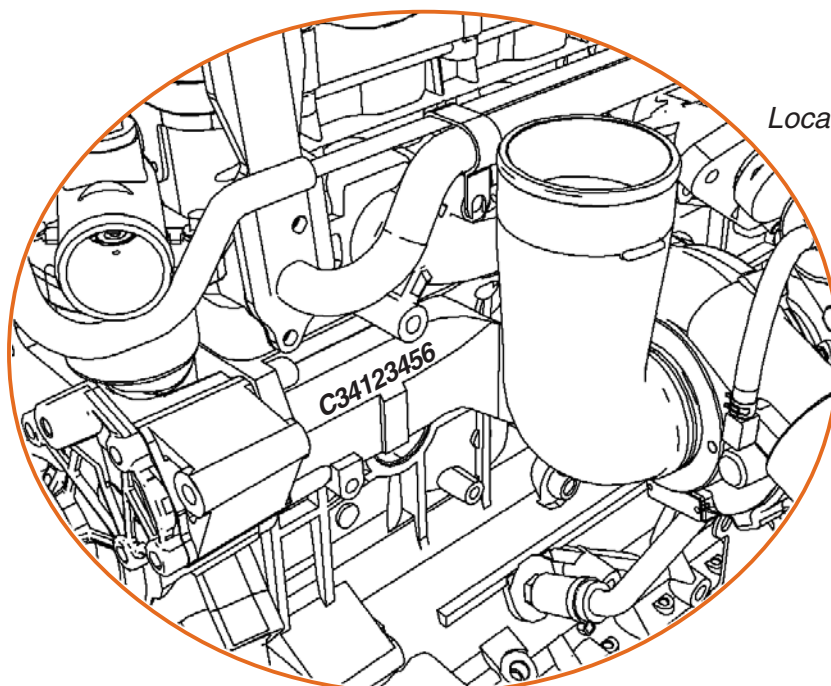
## **Technical Characteristics**

### **(Troller - T4/Pantanal Application)**

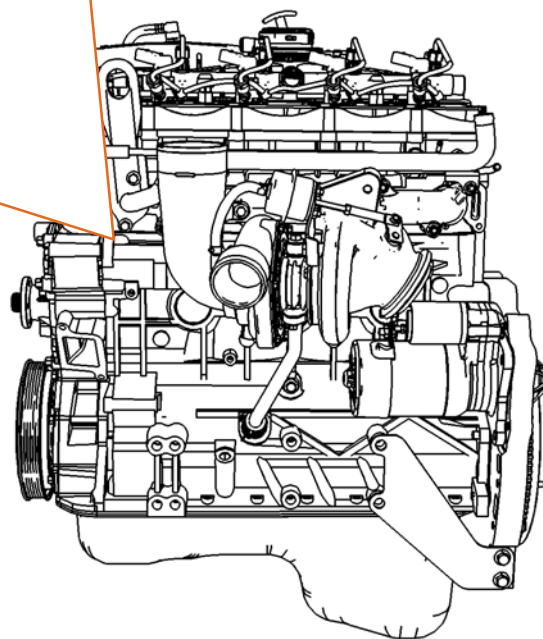
Engine Model	NGD 3.0E
LP Number	8C45 with air-conditioning
	8C46 without air-conditioning
Turbocharger	Waste-gate
Number and cylinder arrangement	4 in line
Bore	96,00 mm
Stroke	102,50 mm
Cycle	Diesel, 4 stroke
Compression Ratio	17.0 to 1
Displacement	3.0l
Combustion system	Direct, electronic injection Common Rail
Direction of rotation (seen from front)	Clockwise
Firing order	1 - 3 - 4 - 2
Opening beginning of thermostatic valve	86 - 90° C
Operating Temperature of thermostatic	86 - 102° C
Oil Pressure at idle speed with the engine at normal operating temperature	2,5 - 3,5 kgf/cm <sup>2</sup> (bar)
Oil Pressure at maximum specified speed with the engine at normal operating temperature	5,0 - 6,5 kgf/cm <sup>2</sup> (bar)
Maximum speed unloaded	4640 rpm
Idle speed	750 rpm
Static Injection Beginning at TDC	Not applicable (electronic system)
Engine Cooling	Liquid coolant
Output (NBR5484)	163cv@3800 rpm
Torque (NBR5484)	380 Nm @ 1600-2200 rpm



### Location and Engine Serial Number Identification



Located near the engine coolant inlet into the cylinder block (Behind the alternator)

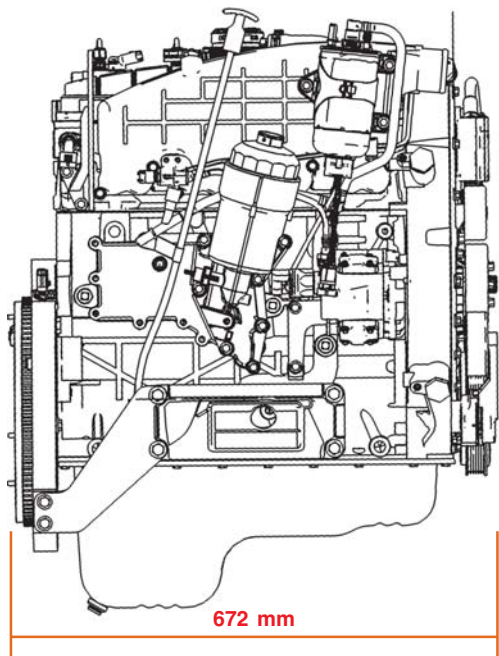


**C34 123456**

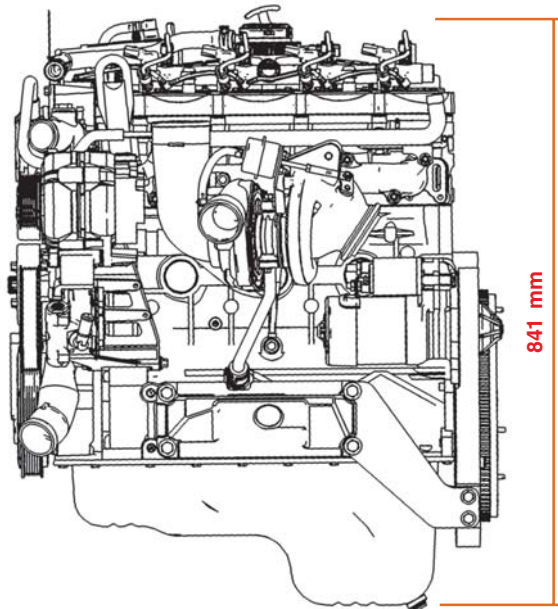
Serial number

Last three numbers of the parts list

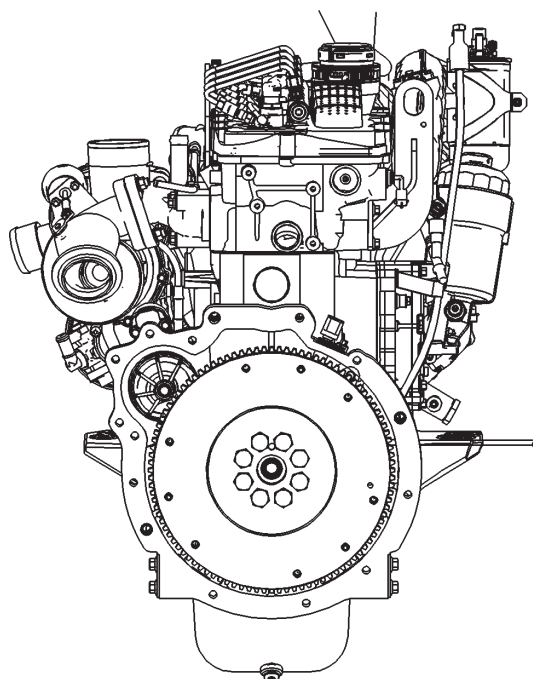
### Engine Side View (Right and left) Rear and Front



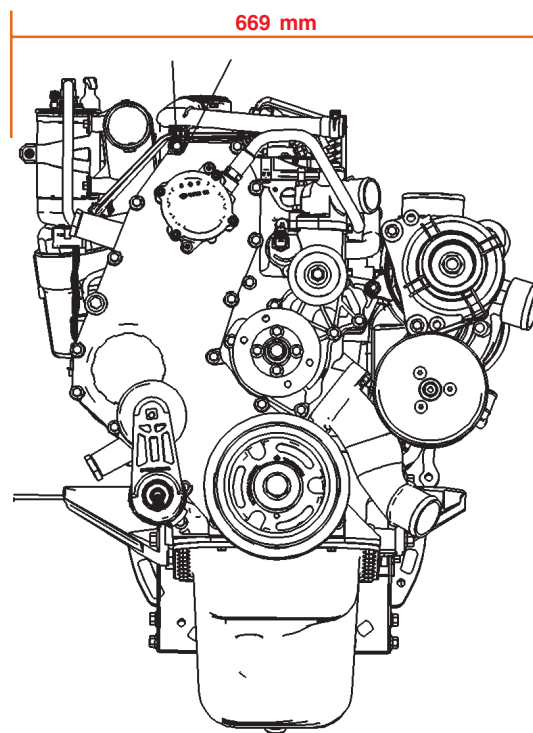
Right side view



Left side view



Rear view



Front view

# Operation and Maintenance


## Start and stop


### Before starting the engine

1. Make an inspection of the “**Daily Maintenance**” items, according to the Preventive Maintenance / Periods Chart in this chapter.

### Starting

1. Turn ignition key to “start” position for seven seconds at most. If the engine doesn't run, repeat the operation after 30 (thirty) seconds.
2. Turn the key to the “on” position and check if the warning lights are working correctly.

 **Caution:** Do not keep the key turned on too long, because it will damage the starter.

 **Caution:** The International NGD 3.0E engine is equipped with a turbocharger. So, after starting it, do not accelerate it over 1000 rpm during the first 45 (forty five) seconds. This allows the pressure equalization of turbocharger lubrication line.

3. Check the instruments panel and check the engine for abnormal noises and exhaust gases. In case of any irregularity, stop the engine and immediately look for our Distributors Network and / or Authorized Services.

 **Caution:** Do not apply an extreme load to the engine before it reaches its normal operating temperature.

### Stop

1. Before stopping it, maintain the engine at idle speed for 45 (forty five) seconds to avoid premature wearing of turbocharger.
2. Turn ignition key to “off” position.

### Running-in

The technology that MWM-*International* Motores uses on its engines production, as well as on tests in dynamometer, eliminates the necessity of large run-in periods. Generally, it is considered the first 2500 km (1550 mi) of work as the necessary period for the running-in, which can vary according to application of each product.

During running-in period, follow these recommendations:

- Do not exceed 3800 rpm.
- When in use, vary the rotation speed and avoid maintaining the engine at a constant speed during long periods.

### During engine life span:

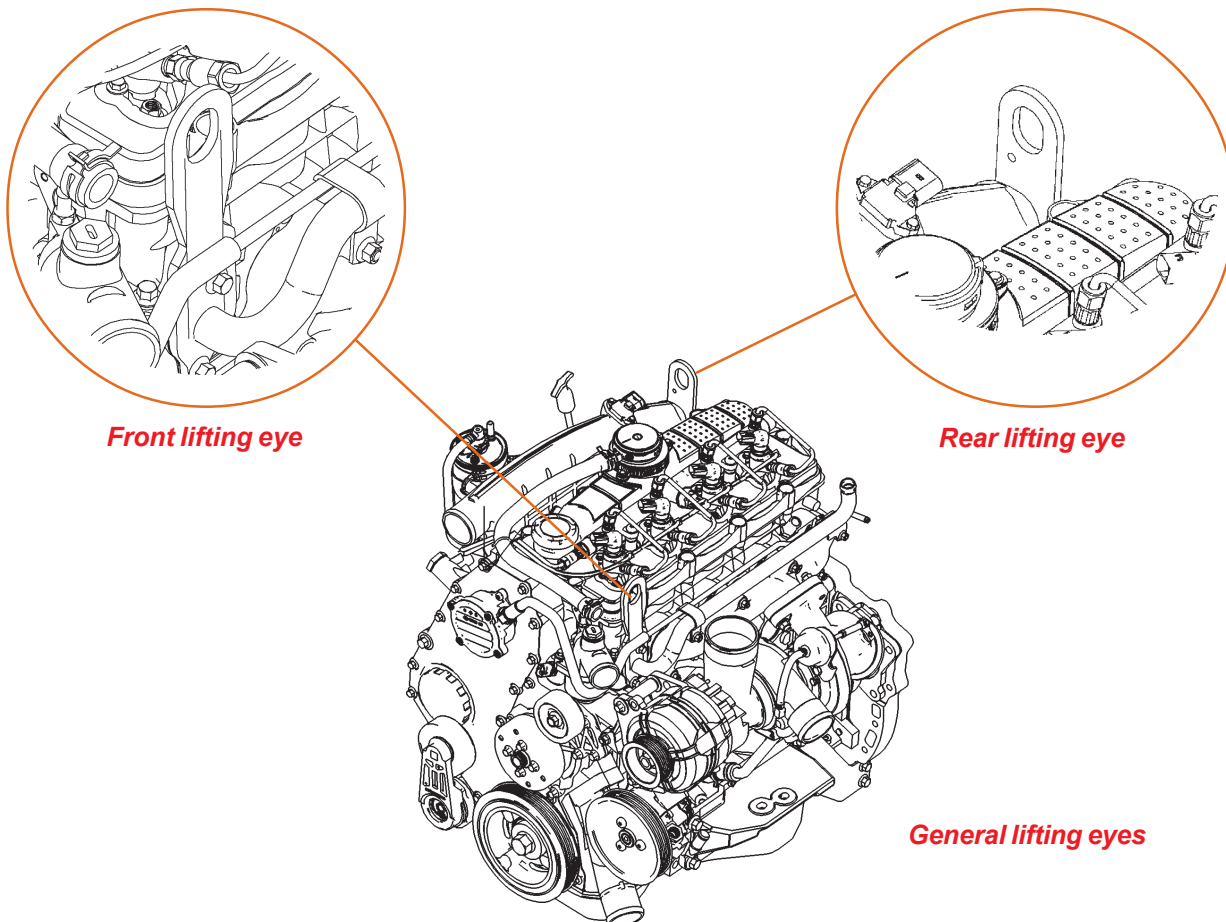
- Before starting the engine, check its lubricating oil, engine coolant and fuel levels.
- Do not warm up the engine in idle speed. Instead of it, vary its speed.
- To reach the normal operating temperature, move the vehicle without extremely loading it and without exceeding 3800 rpm.
- Do not let the engine running in idle speed unnecessarily.
- Always observe that operating temperature should remain between 86 and 102°C (187 and 216°F).

**⚠ Caution:** The operator is responsible for the correct usage of this product during running-in period. To ignore the recommendations above mentioned will cause a decrease of the product life span, with consequent increase of lubricating oil consumption to higher levels than those ones defined by project.

### Removal and handling vehicle's engine

For removal and handling of the engine, use always both lifting eyes as shown in the picture.

#### Lifting eyes



**! Caution:** Never submit the injection system to impact, and do not use it as a hanger to lift the engine, this action may cause hazardous leakages (system's pressure: 1600 bar).

**Revision programs**

The engine warranty is conditioned to the accomplishment of the delivery revisions, and more revisions mentioned in the Warranty Certificate. Our Distributors and/or Authorized Services Net must make all operations of mandatory and periodic revisions according to the instructions of this Manual.

The installation of optional, unoriginal market equipment will cancel warranty and may cause serious damages to the engine, with consequent decreasing of its life span.

For a better engine performance, use always genuine parts.

**Installation Revision** (These items apply to the OEM customer)

Item	Check
Alternator belt	Tension
Engine Oil	Level (Complete if necessary). <b>Note:</b> The MWM-International engine leaves the factory filled up with Repsol Extra Life Plus API - C14 oil. In case it is necessary to add more oil, this type of oil must be used. If not, drain all of the oil from system and refill it with a multigrade engine oil 15W40 API CH4 or upper.
Cooling system	Filling and level (Complete it as necessary). Fill it using a solution based on an additive ethylen-glycol (40%).
General performance	Operating temperature and speed at maximum load.
Intake system	Intake air temperature and restriction.
Fuel system circuit	Piping for any obstruction, vibration, extreme heat areas and leakage occurrences, and correct the assembly (clamps).
Exhaust system	That there are no restrictions for the exit of gases.
Cooling system	Check the condition of the radiator, hoses, pipelines, clamps and for any leakage.
Engine mounts	The alignment of the engine with its assembly.
Instruments panel	Functioning of indicators, warning lights and sensors.
Electronic system (sensor and actuators)	Use the diagnostic equipment to check the correct operation of all sensors and actuators of the electronic system.

**Periodic / Preventive Maintenance (Ford Ranger Application)**

Applicable to the Customer's Concessionaries / *International* Engine Service Centers

Check	Periods									
	20,000 km	40,000 km	60,000 km	80,000 km	100,000 km	120,000 km	140,000 km	160,000 km	180,000 km	200,000 km
Check engine oil level (complete it as necessary)	Daily *									
Check engine coolant level in the cooling expansion tank (fill it as required)	Daily *									
Drain fuel filter (water separator)	At every fill-up or when indicated on the Instrument panel * (which ever occurs first)									
Check engine cooling system and hoses	●	●	●	●	●	●	●	●	●	●
Check intake system ducts and its sealants	●	●	●	●	●	●	●	●	●	●
Check fuel system pipeline and hoses	●	●	●	●	●	●	●	●	●	●
Check the battery terminals	●	●	●	●	●	●	●	●	●	●
Change the engine oil ** (Use multigrade oil 15W40 API CH4 or superior)	At every 10,000 Km									
Replace oil filter **	At every 10,000 Km									
Replace fuel filter	●	●	●	●	●	●	●	●	●	●
Check the Poly-V belt	●	●	●	●	●	●	●	●	●	●
Check the sensors and actuators by testing the injection module, using the electronic diagnosis equipment	●	●	●	●	●	●	●	●	●	●
Replace cooling system fluid with a solution of 40% Ethylenglicol (replace it every 60,000 Km or 2 years)			●			●			●	
Replace the Poly-V belt						●				
Air filter	Follow the period recommended by the vehicle manufacture									

\* Instruct the vehicle's customer / owner to execute these services at his/hers residence.

\*\* In case of severe using, reduce maintenance period in a half.



**Periodic / Preventive Maintenance (Troller T4/Pantanal Application)**

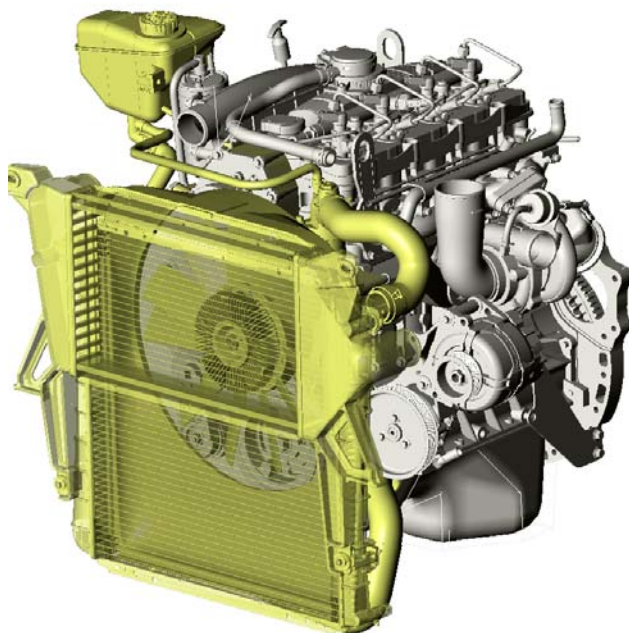
Applicable to the Customer's Dealers / International Engine Service Centers

Check	Periods												
	20,000 km	40,000 km	50,000 km	60,000 km	70,000 km	80,000 km	100,000 km	120,000 km	140,000 km	150,000 km	160,000 km	180,000 km	200,000 km
Check engine oil level (complete if necessary).	Daily *												
Check the level of cooling fluid in the cooling expansion tank (fill as required)	Daily *												
Drain fuel filter (water separator)	At every filling-up or when indicated on the Instruments panel * (which ever occurs first) *												
Check engine cooling system and hoses	●	●		●		●	●	●	●		●	●	●
Check intake system ducts and blocking	●	●		●		●	●	●	●		●	●	●
Check fuel system pipeline and hoses	●	●		●		●	●	●	●		●	●	●
Check the bateries terminals	●	●		●		●	●	●	●		●	●	●
Change the engine oil ** (Use oil multi-viscosity 15W40 API CH4 or superior)	At every 10,000 Km												
Replace oil filter **	At every 10,000 Km												
Replace fuel filter	●	●		●		●	●	●	●		●	●	●
Check the Polly "V" belt	●	●		●		●	●	●	●		●	●	●
Check the sensors and actuators testing the injection module, using the electronic diagnose equipment	●	●		●		●	●	●	●		●	●	●
Replace cooling system fluid with 40% Ethyleneglicol (replace every 60,000Km or 2 years)			●				●			●			●
Replace the Polly "V" belt					●				●				
Air filter	Follow the period recommended by the vehicle manufacturer.												

\* Instruct the vehicle's customer / owner to execute these services at his/hers residence.

\*\* In case of severe using, reduce maintenance period in a half.





## Cooling System

Preventive maintenance .....	28
Checking the level .....	28
Draining the cooling system .....	29
Filling up the cooling system .....	30
Recommended additives for the cooling system .....	33
Fan .....	34
Water pump .....	35
Housing cover and thermostatic valve .....	37
Thermostatic valve housing .....	38
Temperature sensor in the thermostatic valve housing .....	39
Water inlet pipe in the to water pump .....	40
Vehicle heating system pipe .....	40

### Preventive maintenance

The Cooling system is fundamental for the durability and good operation of the engine. Therefore, good maintenance of the system is of extreme importance, checking all items and verifications described in the periodic maintenance table for the vehicle.

**! Caution:** When this engine is operating in places with high temperature, frequently check the engine temperature meter.

### Checking the level

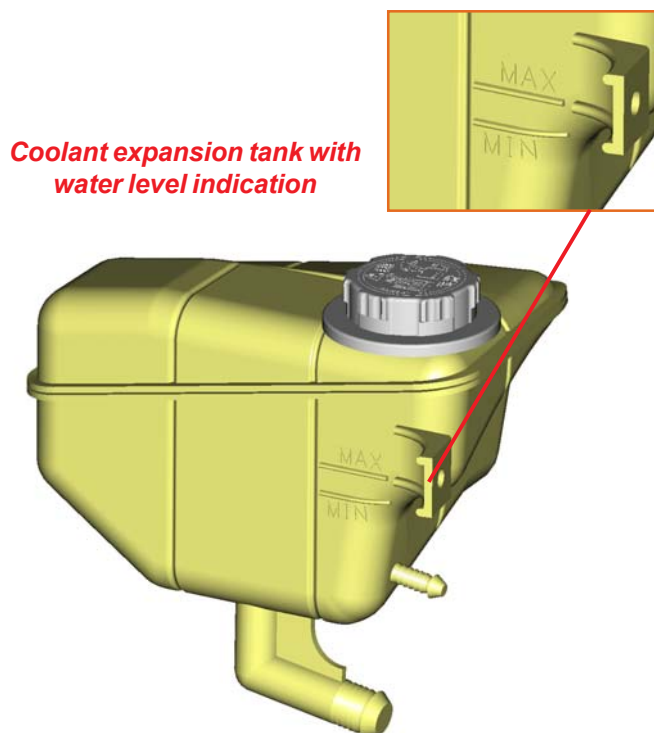
It is indispensable the daily checking of the engine coolant level. For this procedure use the following steps:

**! Caution:** Never check the engine coolant level immediately after the engine is stopped. The fluid is at high temperature and may cause burns.

1. Remove the cap of the coolant expansion tank.
2. Check the engine coolant level. If necessary, complete the level with clean water and recommended additive until the maximum level mark of the coolant expansion tank.

**! Caution:** Use the anti-freeze additive recommended in this chapter and follow the correct proportions of the engine coolant composition.

3. If the engine coolant level is low frequently, operate the engine and check the existence of leakages throughout the system.



4. Examine the condition of all hoses and replace them in case of damages or deformations.
5. Complete the coolant expansion tank with engine coolant until the maximum level.

**! Caution:** Complete the coolant expansion tank of a cold engine only.

### Cooling system draining

When the total draining of the engine coolant is necessary, follow the procedure:

**! Caution:** Never drain the engine coolant with engine stopped in case it is warm and the cooling system is under pressure.

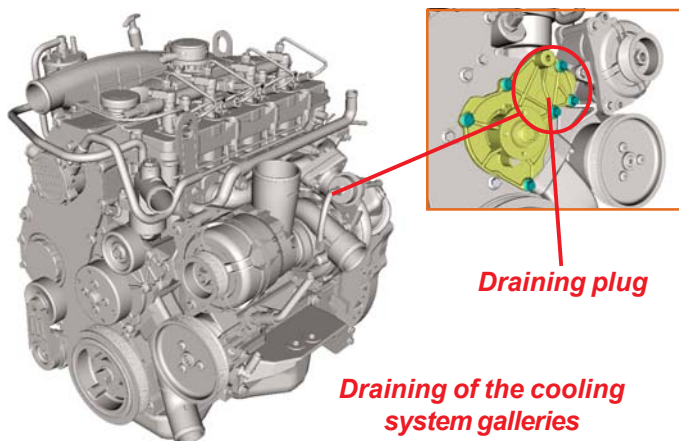
1. Remove the lower and upper hoses from radiator.

**Note:** On Ford Ranger application, there is a draining plug at radiator's bottom. Remove this plug and the cap of coolant expansion tank.

2. Using a 17 mm socket wrench, remove the draining plug from engine block. Make sure that the draining hole is not obstructed.

3. Drain all engine coolant from engine block.

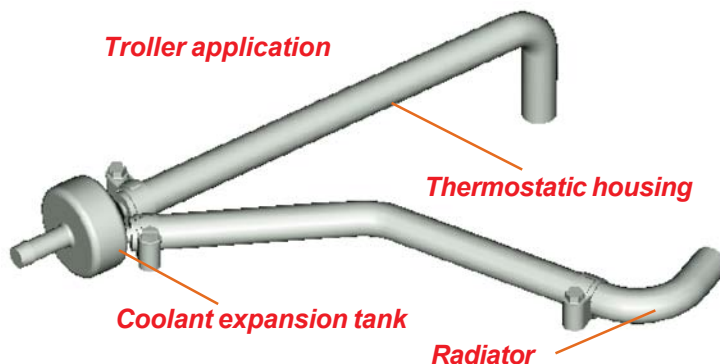
4. Examine the condition of the hoses and replace them if they present damages or deformations.



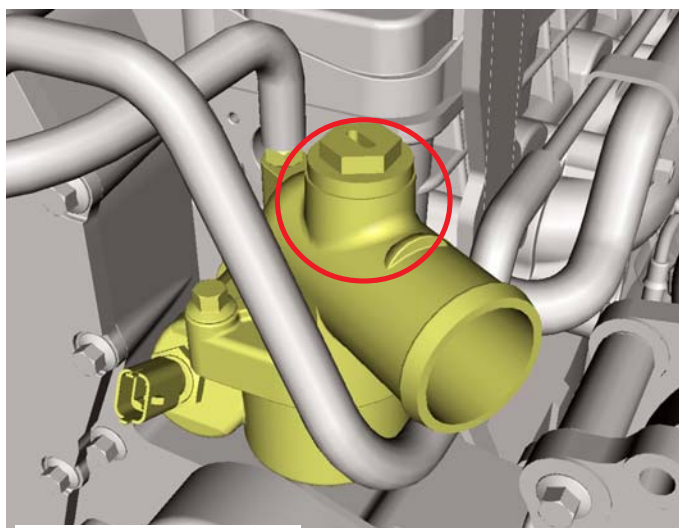
## Filling up the cooling system

1. Using a 17 mm socket wrench, fix the drain plug on engine block and tighten it with 13 - 17 Nm, using Precote® 80 sealant.
2. Install cooling system hoses and the upper and lower hoses on radiator.

**Note:** On Troller application, there is a “venturi” connecting the coolant expansion tank to the thermostatic housing and radiator, which improves the system's bleeding.





3. Check the Owner's Manual for the engine coolant capacity of the engine, radiator and coolant expansion tank assembly.
4. Remove the coolant expansion tank cap from cooling system.
5. Using a 21 mm socket wrench, remove the bleed plug located on top of thermostatic valve housing cover.




**Bleeding plug**

6. With the engine stopped, fill up the cooling system through the coolant expansion tank until the engine coolant leaks from bleeding hole of the thermostatic valve housing cover.

 **Caution:** Only complete the engine coolant level on expansion tank of a cold engine.

 **Caution:** The composition of the engine coolant should be as follows: 60% tap water and 40% anti-freezing additive.

 **Caution:** In areas with low temperatures, the engine coolant composition should be: 50% tap water and 50% anti-freezing additive.

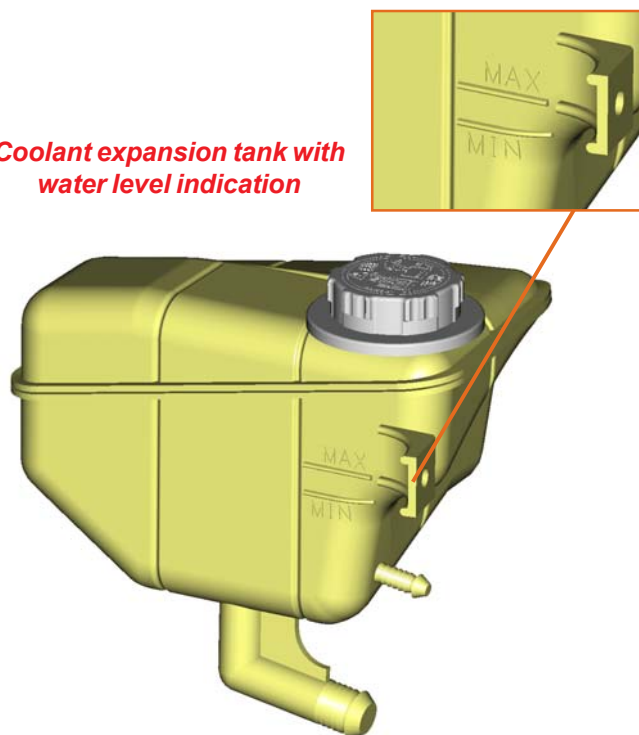
7. During the filling of the system with the engine coolant, squeeze the upper radiator hose to bleed the air. Do this procedure until the engine coolant flows without air bubbles from hole of the housing cover.
8. Refill the coolant expansion tank filler neck with engine coolant until the maximum level of the tank.
9. Close the tank filler neck with its cap and check it for any leakage throughout the system. If it occurs, do the following procedures. In case of leakage, repair or replace the damaged components.

10. Run the engine for 45 seconds at idle speed and let the engine coolant to leak from bleeding hole on thermostatic valve housing cover.
11. Using a 21 mm socket wrench, fix the bleed plug located at the top of thermostatic valve housing cover and tighten it with a torque of 4 - 8 Nm.
12. Run the engine at 2000 rpm, approximately half of the acceleration, for five minutes.
13. Increase the engine speed to 3500 rpm, approximately  $\frac{3}{4}$  of the acceleration, for more four minutes.
14. Decrease the engine speed to 2000 rpm, approximately half of the acceleration, for more tree minutes.
15. Maintain the engine idling for 45 seconds and turn off the engine. With the engine cold, check the engine coolant level in the coolant expansion tank.

**⚠ Caution:** Never check or complete the engine coolant level immediately after stopping the engine, because the liquid is at a high temperature and may cause burnings.

16. If it is necessary to complete the coolant expansion tank with more engine coolant, fill it up until the maximum level indication.

**Coolant expansion tank with water level indication**





17. Run the engine again and execute a drive test with the vehicle. After doing the test, proceed again according to items 15 and 16.

### Recommended cooling systems additives

Available brands in Domestic Market.

Manufacturer	Description
AGIP	Permanent Fluid
ELF	Glacelft
FL-Tutela	Paraflu
Promax Bardahl	Rad Cool Plus
Radiex Química	Radiex R1822 (applied to diesel engines)
Shell	Cooling System Fluid
Texaco	Havoline XLC 50/50
Tirreno	Fluid Cool 700A

## Fan

**Note:** On Ford applications, this item does not belong to the engine assembly; it is a vehicular item and Ford is responsible for it.

### Removal

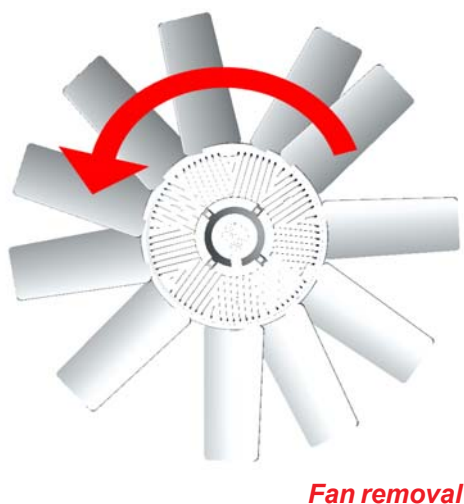
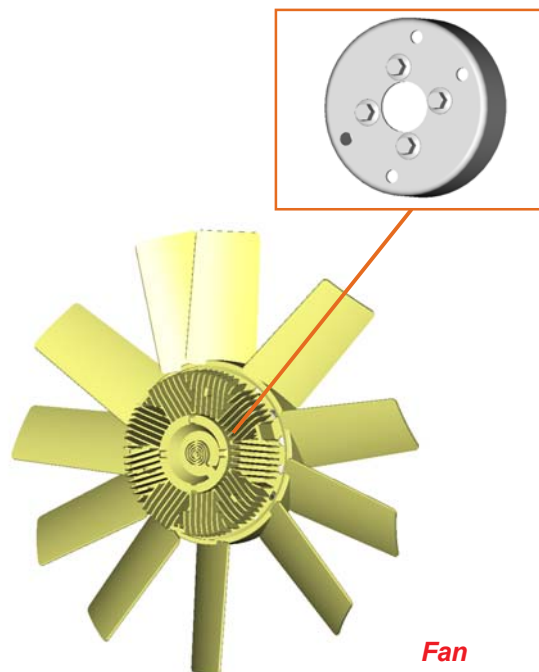
1. Using the MWM-International special tool nr. 8130651 to fix the water pump pulley and with a 1 ¼" wrench, turn the fan nut counterclockwise.

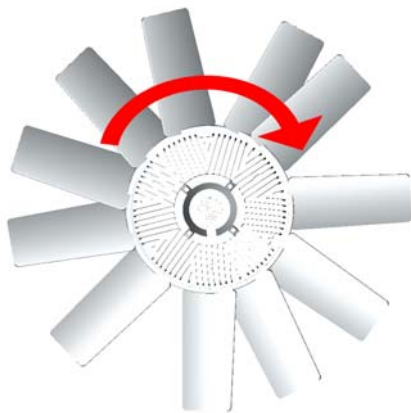
2. Remove the fan.

**⚠ Caution:** To remove the fan and the viscous coupling from a NGD 3.0E engine, it is necessary to turn the fan nut counterclockwise, differently from HS 2.5L and HS 2.8L engines.

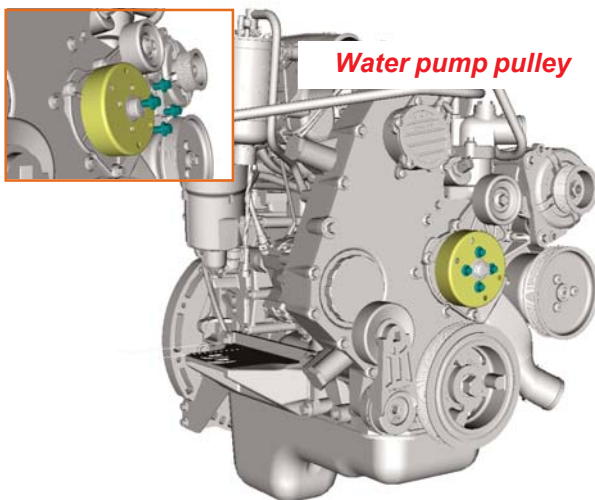
### Assembly

1. Using a MWM-International special tool nr. 8130651 to fix the water pump pulley, attach the fan on the central bolt thread of the water pump pulley, turning it clockwise.





Fastening the fan



Water pump pulley

2. Keep the special tool nr. 8130651 fixing the water pump pulley and tighten the fan using a 1 1/4" wrench.

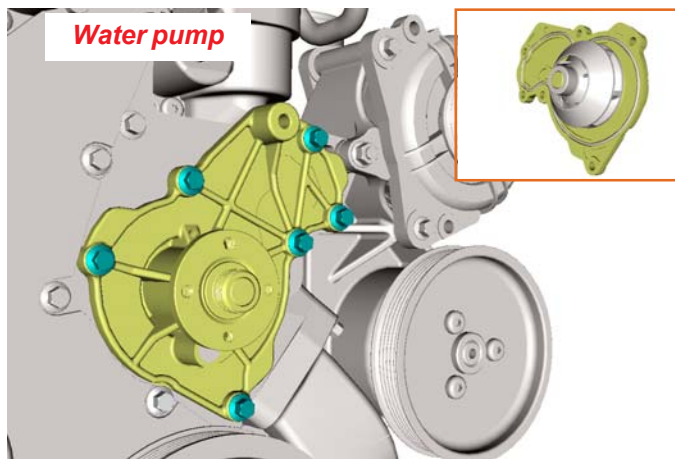
**Caution:** To tighten the viscous coupling and fan on a NGD 3.0E engine, it is necessary to turn the fan nut clockwise, differently from HS 2.5L and HS 2.8L engines.

## Water pump

### Removal

1. After totally draining of the engine cooling system, [see Cooling System - Preventive Maintenance](#), remove the water pump in the following way.
2. Using the MWM-International special tool nr. 8130651 to fix the water pump pulley and with a 10 mm socket wrench, remove the four bolts from pulley.
3. Remove the water pump pulley.
4. Remove idler pulley, [see Accessories - Idler Pulley](#).

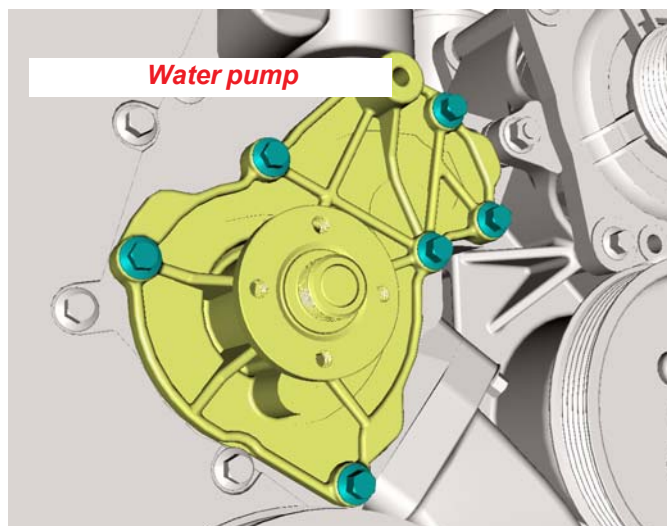
5. Using a 10 mm socket wrench, remove the six water pump mounting bolts.
6. Remove the water pump and gasket.



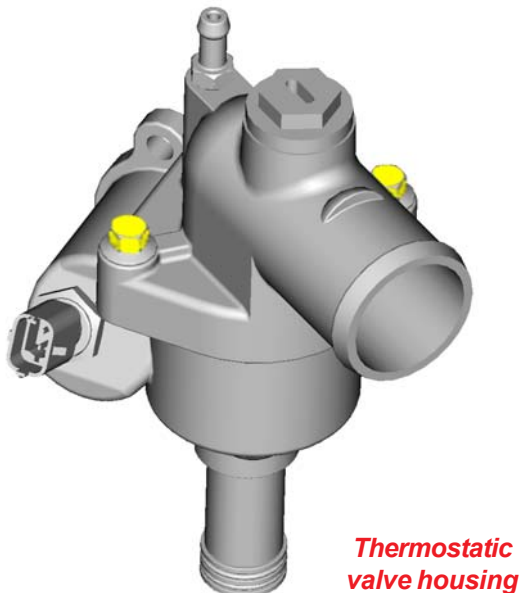
## Assembly

**Note:** Clean all components, removing residues and gaskets.

1. Using a 10 mm socket wrench, install water pump tighten the six mounting bolts with a torque of 22 - 28 Nm.  
Place a gasket at the contact surface between the distribution housing and the water pump.



2. Using a 15 mm socket wrench, install idler pulley and tighten the mounting bolt with a torque of 40 - 50 Nm.
3. Using a MWM-International special tool nr. 8130651 to fix the pulley and a 10 mm socket wrench, install water pump and tighten the four pulley mounting bolts with a torque of 22 - 28 Nm.
4. Fill up the system with engine coolant, [see Cooling System - Preventive Maintenance](#).



**⚠ Caution:** Use a genuine MWM-*International* gasket. MWM-*International* Motores is not responsible for the use of non genuine parts that cause warranty loss.

## Housing cover and thermostatic cover

### Removal

After totally draining of the engine cooling system, [see Cooling System - Preventive Maintenance](#), remove the housing cover and thermostatic valve in the following way.

1. Using a 10 mm socket wrench, remove the two housing cover mounting bolts from thermostatic valve.
2. Remove the housing cover and the thermostatic valve.

**⚠ Caution:** Note that the scale of the initial test for evaluation of the thermostatic functioning valve is 88°C. Put the thermostat in a recipient half filled with water, warm it and observe the temperature in which the thermostatic starts to open. The thermostat will be satisfactory if it opens between 86° and 90°C.

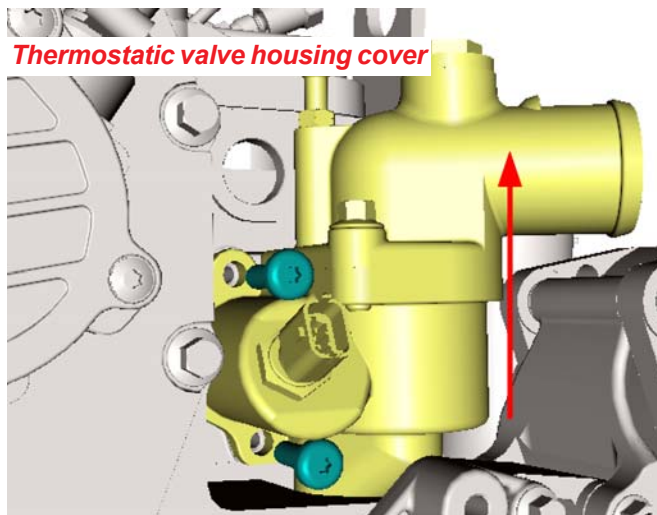
### Assembly

1. Using a 10 mm socket wrench, install housing cover on thermostatic valve housing, tighten the housing cover two bolts with a torque of 22 - 28 Nm.
2. Fill up the cooling system with engine coolant, [see Cooling System - Preventive Maintenance](#).

## Thermostatic housing valve

### Removal

1. After totally draining of the engine cooling system, [see Cooling System - Preventive Maintenance](#), remove the thermostatic valve housing in the following way.
2. Remove the housing cover and thermostatic valve, [see Cooling System - Preventive Maintenance - Housing Cover and Thermostatic Valve](#).
3. Remove the temperature sensor, [see Cooling System - Temperature Sensor in the Thermostatic Housing Cover](#).
4. Using a 10 mm socket wrench, remove the two thermostatic valve housing mounting bolts.
5. Remove the thermostatic valve housing.



### Assembly

**⚠ Caution:** Carefully connect the thermostatic valve housing connecting tube on the distribution housing to avoid damaging its O-ring. Do not use grease or solvents in the housing assembly.

1. Using a 10 mm socket wrench, install thermostatic valve housing on the cylinder head and tighten the mounting bolts with a torque of 22 - 28 Nm.

2. Install temperature sensor on thermostatic valve housing, [see Cooling System - Temperature Sensor in the Thermostatic Housing Valve](#).
3. Assembly the thermostatic valve and the housing cover, [see Cooling System - Housing Cover and Thermostatic Valve](#).
4. Fill up the system with engine coolant, [see Cooling System - Preventive Maintenance](#).

### Temperature sensor in the thermostatic housing cover

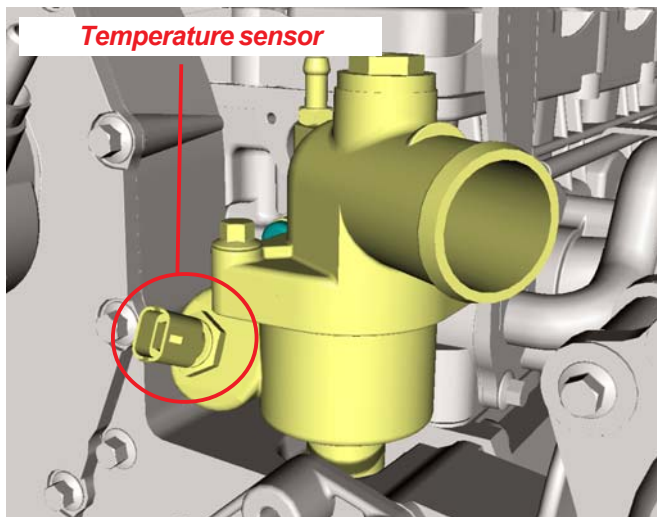
#### Removal

1. Remove the electric wire connector from temperature sensor.
2. Using a 22 mm socket wrench, remove the water temperature sensor from thermostatic valve housing cover.

**Note:** On Troller application, the temperature reading shown on the vehicle's instruments panel is done by the temperature sensor located in the vehicle's heating system tube.

#### Assembly

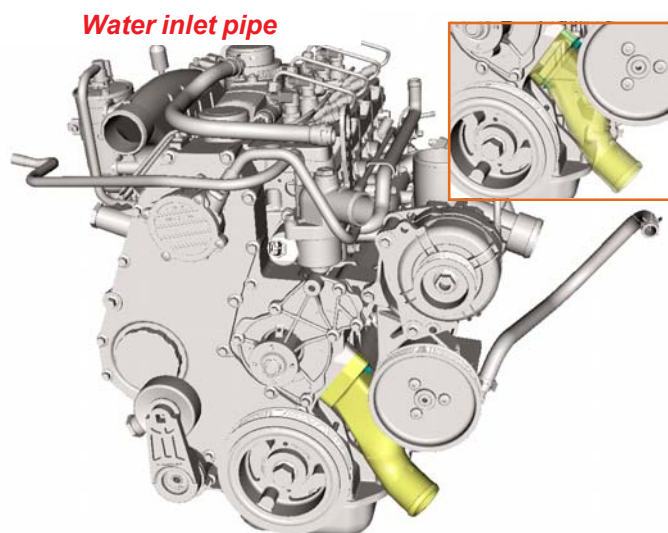
1. Using a 22 mm socket wrench, install temperature sensor on the thermostatic valve housing and tighten the sensor with a torque of 16 - 20 Nm.
2. Connect the electrical connector to the temperature sensor.



## Water pump inlet pipe

### Removal

1. After totally draining of the engine cooling system, [see Cooling System - Preventive Maintenance](#), remove the water pump inlet pipe in the following procedure.
2. Using a 10 mm socket wrench, remove the two water inlet pump mounting bolts.
3. Remove the water inlet pipe.



### Assembly

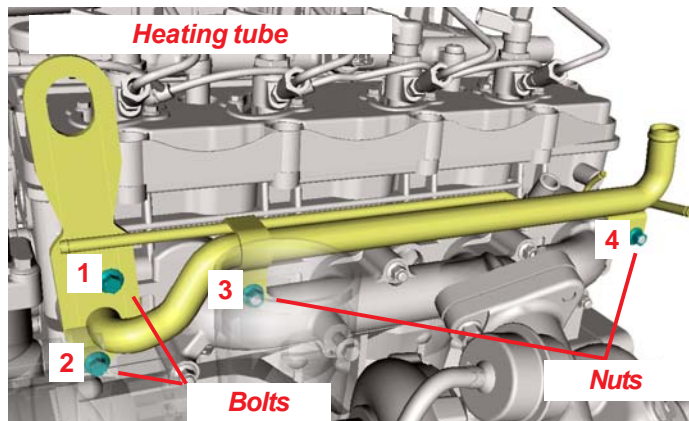
1. Using a 10 mm socket wrench, install water pump inlet pipe and tighten its mounting bolts with a torque of 22 - 28 Nm.
2. Fill up the cooling system with engine coolant, [see Cooling System - Preventive Maintenance](#).

## Vehicle heating system tube

### Removal

1. Using a flat screwdriver, loosen the hose clamp that secures the tube to the vacuum system.
2. Disconnect the hose from tube.
3. Using a 13 mm socket wrench, remove the assembly nuts from the vehicle's heating system tube.



**Ford Ranger Application**

4. Using a 10 mm socket wrench, remove the two mounting bolts from vehicle's heating system tube. These bolts are the same for the front engine lifting eyes.
5. Remove the system heating tube from vehicle.

**Assembly**

1. Install vehicle's heating system tube with a new gasket.

**! Caution:** Use genuine MWM-*International* gaskets. MWM-*International* Motores is not responsible for the using of non genuine parts that may cause warranty loss.

2. Using a 10 mm socket wrench, tighten the mounting bolts with a torque of 22 - 28 Nm.
3. Using a 13 mm socket wrench, tighten the assembly tube nuts with a torque of 22 - 28 Nm.

**! Caution:** The 10 mm bolts should be tightened first.

4. Connect the vacuum system hose to the tube. Using a flat screwdriver, fix it using a clamp.

**Note:** On Troller application, there is a temperature sensor in the heating system tube. Proceed in the following way:

## Removal

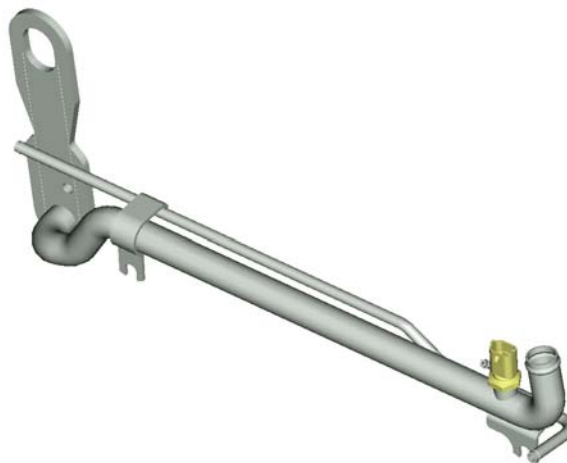
1. Remove the electrical connector from temperature sensor.
2. Using a 13 mm socket wrench, remove the water temperature sensor from vehicle's heating system tube.

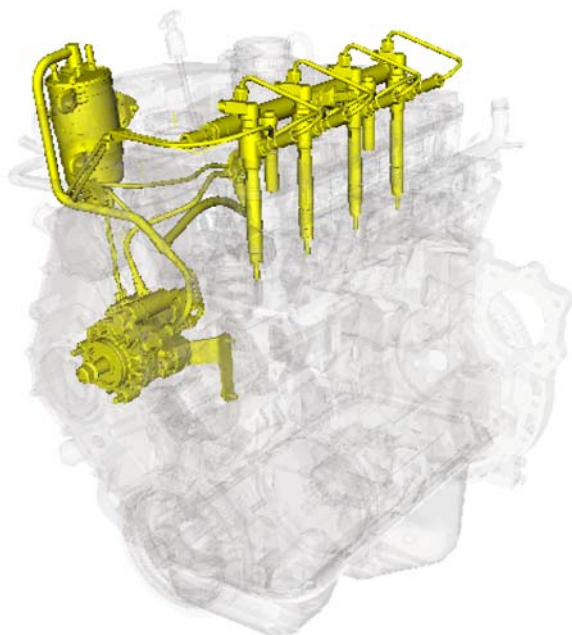
**Note:** This is the sensor that reads the temperature shown on the vehicle's instruments panel.

## Assembly

1. Using a 13 mm socket wrench, install temperature sensor on the vehicle's heating system and tighten it with a torque of 12 Nm.
2. Connect the electrical connector to the temperature sensor.

## Troller Application






## Fuel System

Directions about working on the fuel system .....	44
Information about components replacement and its steps .....	46
Preventive maintenance of the fuel system .....	47
Fuel filter .....	47
Fuel filter replacement .....	47
Fuel system draining .....	49
Fuel system bleeding .....	49
Fuel filter .....	50
High pressure tubes .....	50
Fuel injector .....	50
Common rail .....	53
Fuel pump .....	55
Fuel filter holder .....	60
Fuel temperature sensor housing .....	61

## Directions about working on the fuel system

### Recommendations

 **Caution:** The use of materials with additives like detergents for the fuel pipelines or metallic coatings is prohibited.

### Introduction

The following rules and observances are valid for any and all services performed on the fuel injection system:

1. Those concerning responsibilities from Public Health authorities.
2. Those concerning the prevention of occupational injuries.
3. Those concerning environmental protection.

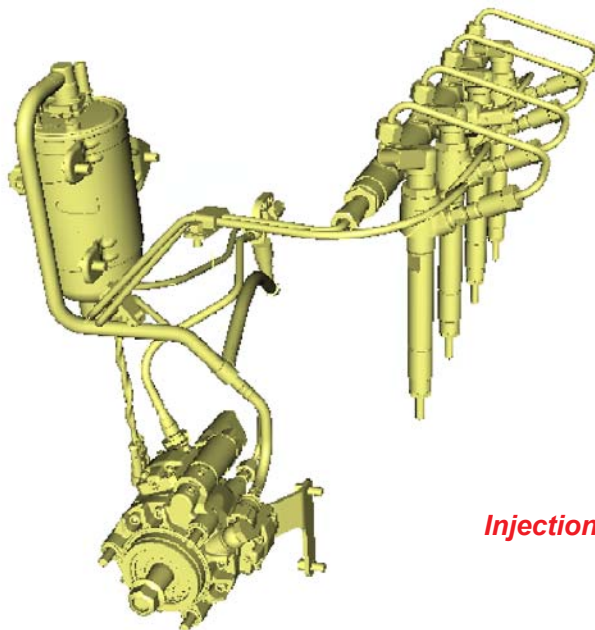
The work must be performed by professionals especially trained and familiarized with all of the safety regulations.

### Safety instructions

Considering the extremely high pressure (1600 bar) that might exist in the fuel system, the following safety instructions must be observed:

1. It is absolutely prohibited to smoke near the fuel system while any work is being performed.
2. No work should be performed near sparks and flames.
3. No work should be performed on the fuel injection system while the engine is running.
4. Wait a minimum of 60 seconds after turning-off the engine, before beginning any work on the injection system.

**Note:** This waiting period is necessary until the pressure in the injection system drops to the ambient pressure.



*Injection system*

**Operating Engine:**

- Always keep a safe distance away from any possible jets of fuel as these can cause serious wounds.
- Do not place your hand in an area where it may be occurring a fuel leakage under pressure.
- Do not disconnect the fuel injector connectors or the electronic control module, (ECU), because this can cause serious damage to the engine.

**Working area**

The working area (floor, table, tools and etc.) must be clean, and free of obstruction. The parts that are disassembled from engine for any repair should be protected and kept in an environment free from sludge, dirt, dust, shavings, humidity, etc

**Preparation**

Before any intervention on the injection system, it may be necessary to clean the sensitive components, (see the instructions below), which constitutes a preparation for the work.

The sensitive components of the injection system are:

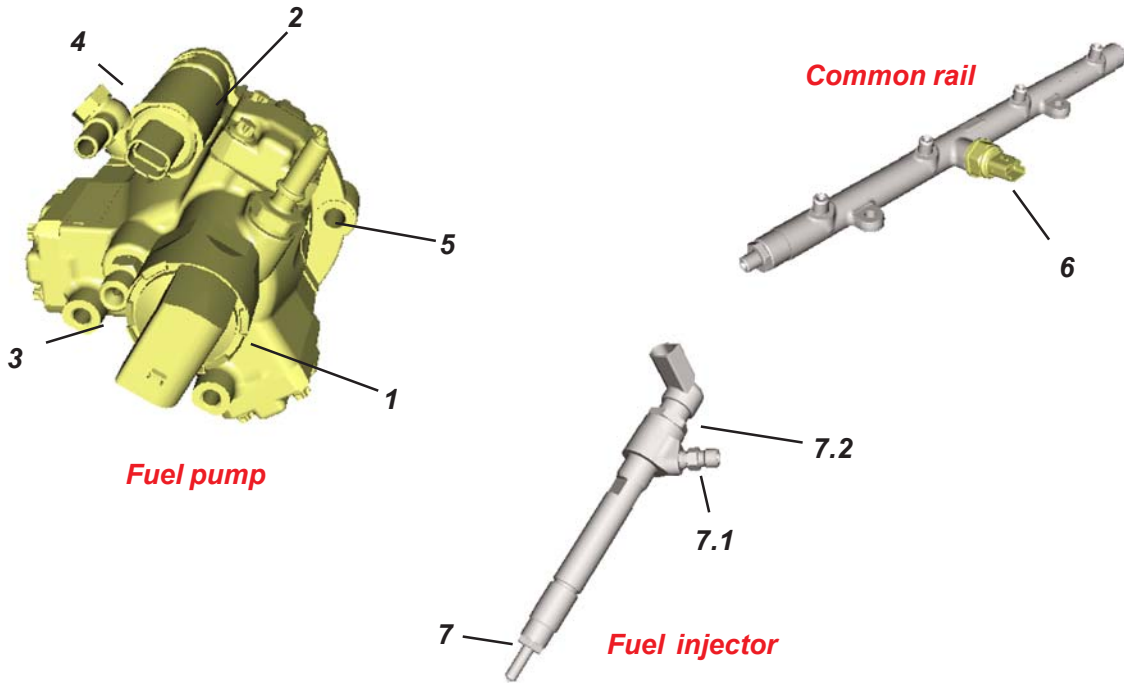
The sensitive components of the injection system are:

1. Fuel pump.
2. Common Rail.
3. High pressure tubes.
4. Fuel injectors.

**! Caution:** The rules for cleaning: The worker must use clean clothes.

**! Caution:** Shortly after disassembling of the high pressure system connectors, all of the openings must be protected, with plastic caps to prevent the entrance of debris into the system.

**! Caution:** Safety Torques: Always observe carefully the tightening torque of components of the injection system (tubes, fuel injector flange, common rail and high pressure pump). Use a torque wrench that is calibrated regularly.



**Information about components replacement and its steps**

Do not remove any of the following components from high pressure pump:

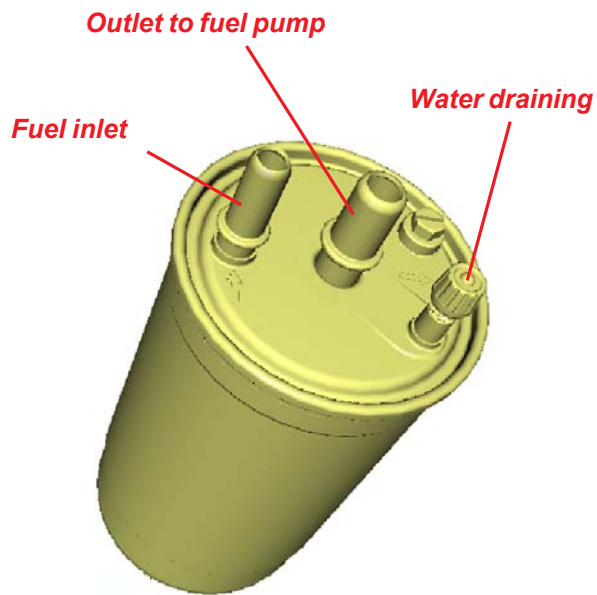
1. Pressure Control Valve (PCV).
2. Volume Control Valve (VCV).
3. High pressure connections.
4. Fuel inlet connection from filter.
5. Fuel outlet connection from pump fuel return.
6. Do not remove or loosen at the high pressure sensor located in the common rail.

7. Do not disassemble the fuel injector.
  - 7.1. Do not loosen the high pressure connection.
  - 7.2. Do not loosen the nut for the piezo-electric actuator.

**Note:** In case of reusing it, the fuel injector nozzle must be protected to avoid contamination. To avoid debris entering the injection holes, located at the nozzle tip, it should be cleaned mechanically (for example; by a cloth or brush).

**Caution:** No type of liquid should penetrate the electrical connections. For this reason, they should be protected with plastic caps after wiring removal.

**Caution:** If the high-pressure tubing is disassembled, it should be replaced.



## Preventive maintenance of the fuel system

### Fuel filter

The filter has the function to retain the debris to assure that the system receives a clean fuel, this way avoiding damages to the engine fuel injection pump and the fuel injectors.

The filter also has the function of preventing the passage of any water present in the fuel.

**! Caution:** The filter for the injection system Common Rail presents special tolerance characteristics for retention of particles and water separation. The application of a non genuine part can result in the possibility of definite damages to the components of the system and consequent warranty loss.

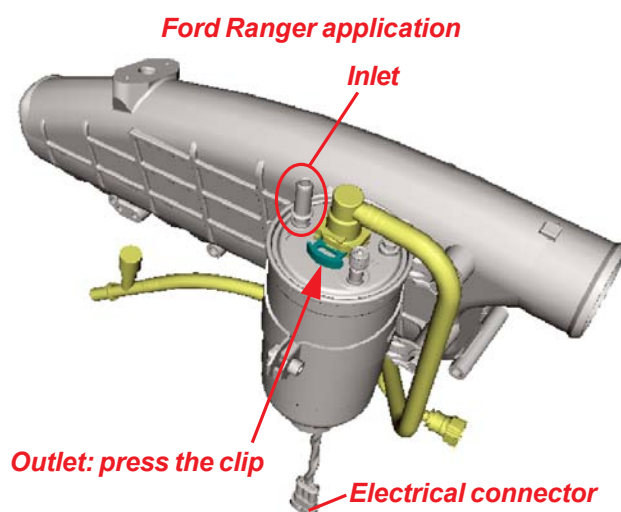
## Fuel filter replacement

**! Caution:** The period for fuel filter replacement should never exceed the specified limit of 20,000 Km, or it could result in damages to the engine.

Use the following procedures to replace the fuel filter.

### Removal

1. Loosen the inlet and outlet hoses located on top of the filter (quick release coupling).
2. Protect the hoses against possible contamination of the system.
3. Disconnect the electrical connector from water presence sensor located at the bottom of the filter.



**Note:** On Troller application there is not a connection on the filter outlet tube connected to the fuel temperature sensor.

4. Loosen the filter bolts using a 5 mm Allen wrench.
5. Remove the filter.

**! Caution:** It is not necessary to bleed the fuel system.

6. Remove the water presence sensor located at the bottom of the filter.

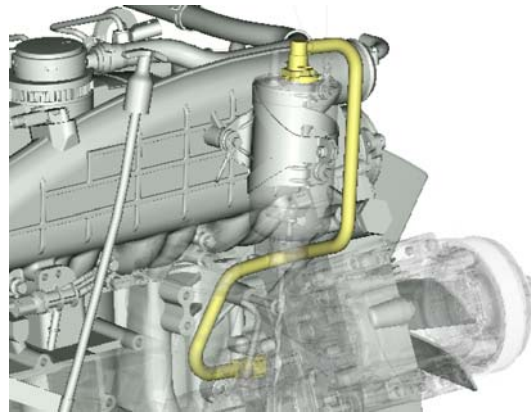
**! Caution:** During this operation it is normal for some fuel to leak. Before the assembly, clean the area to remove the fuel.

### Assembly

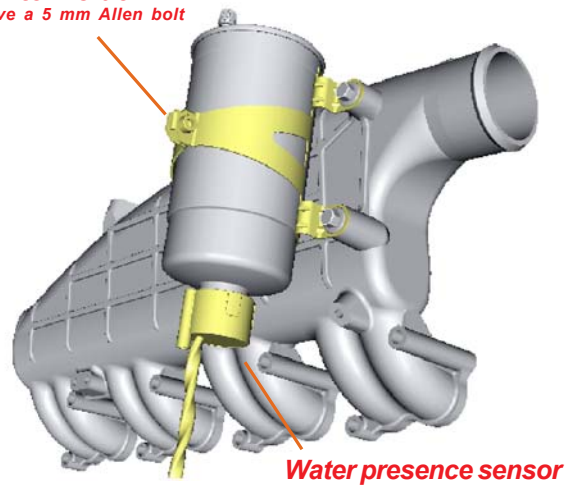
Utilize genuine MWM-*International* Motores parts.

1. Install water presence sensor, rotating it 1/4 to 1/2 turn.
2. Install filter on the holder, using a 5 mm Allen wrench, and tighten it with a torque of 4 - 6 Nm.
3. Connect the connector to the water presence sensor at the bottom of the filter.
4. Install inlet and outlet fuel hoses as indicated by arrows on the top of the filter.

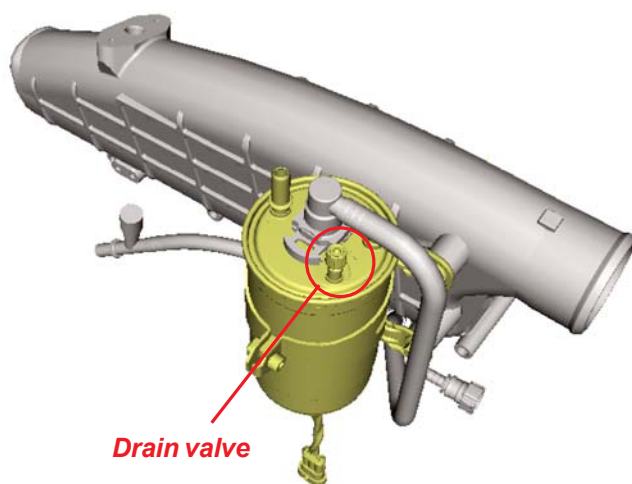
**Troller application**



**Filter holder**  
Remove a 5 mm Allen bolt







### Draining the system

**! Caution:** The water from fuel system should be drained at each refueling of the vehicle.

The indicator light on the instruments panel will turn on under a critical condition of water presence in the fuel system. If this condition occurs, the fuel system should be drained immediately.

### Draining procedure

To drain the fuel system, observe the following procedures.

1. Start the vehicle and keep the engine in idle speed.
2. Remove the drain valve cap and use the upper part of the cap to drain the fuel. Drain the fuel until it flows without water.
3. Close the drain valve with the cap.

**! Caution:** Use a clean cloth to avoid the contact with water or fuel.

### Bleeding the system

The Common Rail system does not need to be drained. In case of lacking fuel, it is necessary only to refuel the vehicle, turn-on the ignition, wait a few seconds and then start the engine.

## Removal and assembly of the system

### Fuel filter

Follow the removal and assembling procedures described in the section [Fuel System - Preventive Maintenance](#).

### High pressure tubes

**Caution:** After removing the high pressure tubes, they must be replaced by new components to avoid leakages at the connections.

For removal and assembling of the high pressure tubes use a 17 mm wrench.

Whenever the high pressure tubes are removed, you should:

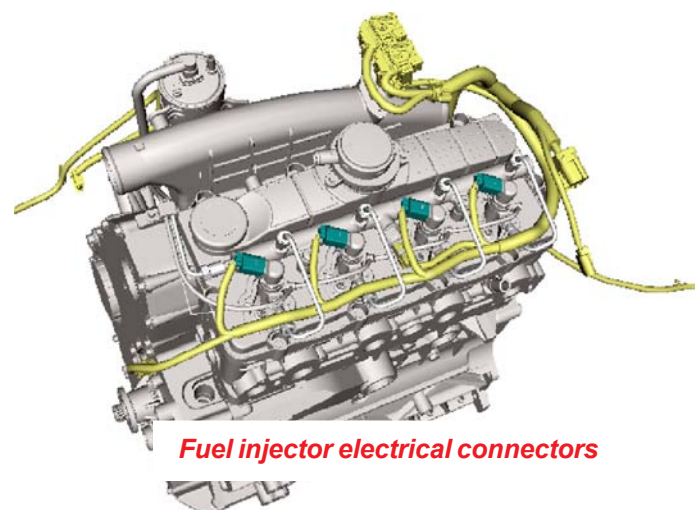
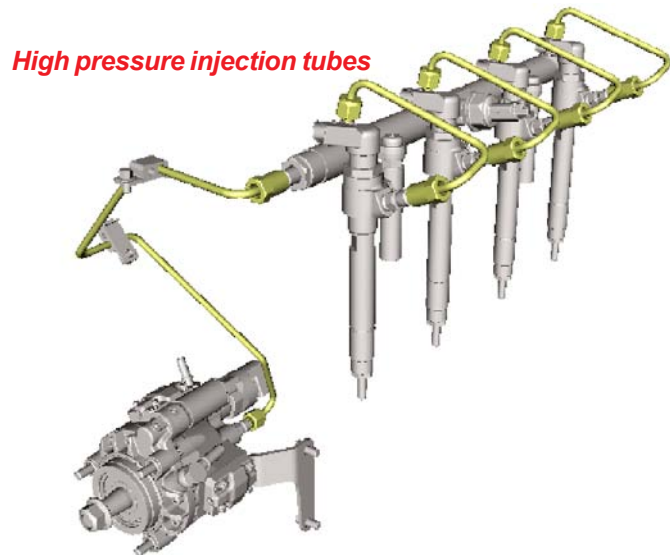
- Protect the pieces from other parts, (fuel injector, common rail or high pressure pump), with protective caps to eliminate the risk of contamination of the system.

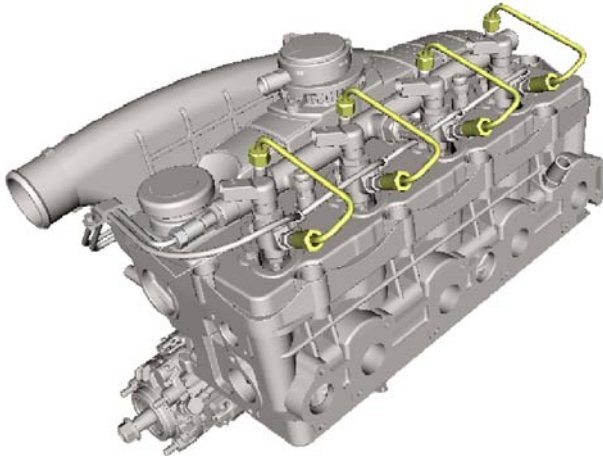
**Note:** In case of warranty parts, protect the components and store them in the protective packing of the installed pieces.

### Fuel injector

#### Removal

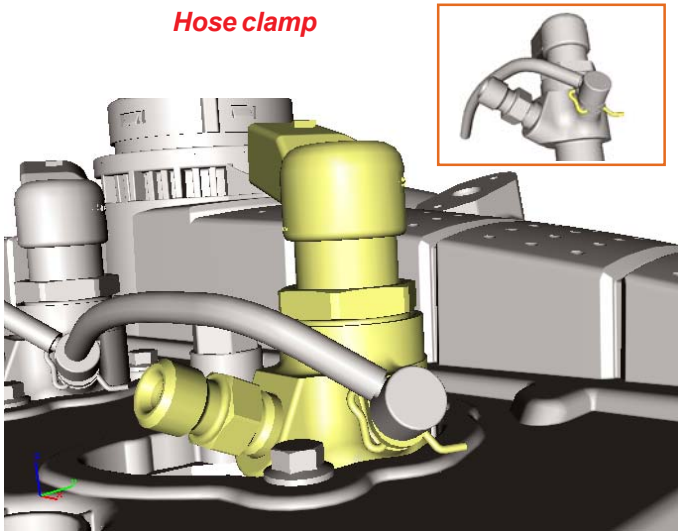
1. Remove the electrical connector from fuel injector.



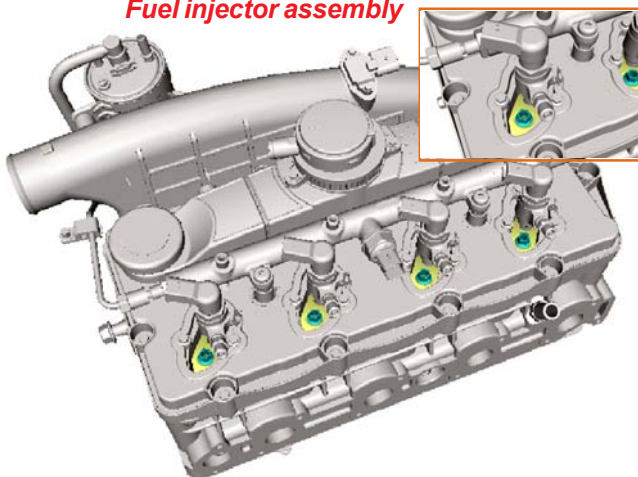


*High pressure injector tubes*

*Hose clamp*



*Fuel injector assembly*



2. Using a 17 mm wrench, remove the high pressure tubing (common rail / fuel injector).

**Note:** To loosen the high pressure injection tube it is necessary to use a 13 mm wrench to secure the nipple of the fuel injector.

3. Protect the common rail connections and the fuel injector with plastic caps to avoid contamination.
4. To remove other fuel injectors repeat steps 1 to 3 shown above.

5. Remove the fuel injector return hose. This procedure can be executed with the aid of a small, flat screwdriver to remove the hose clamp.

6. With the aid of a 10 mm wrench loosen the bolt fixing the fuel injector clamp holder.

7. With the aid of a magnet or a small, flat screwdriver, remove simultaneously the fuel injector and the fuel injector clamp.
8. Protect the tip of the fuel injector with a plastic cap.
9. Remove the sealing washer.

## Assembly

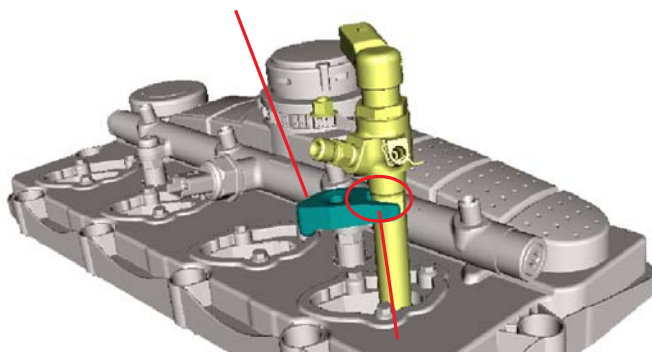
1. Install a new sealing washer.

**!** **Caution:** It is mandatory to use a new sealing washer whenever the fuel injector is removed, because once the washer is squeezed it suffers a deformation and does not seal anymore.

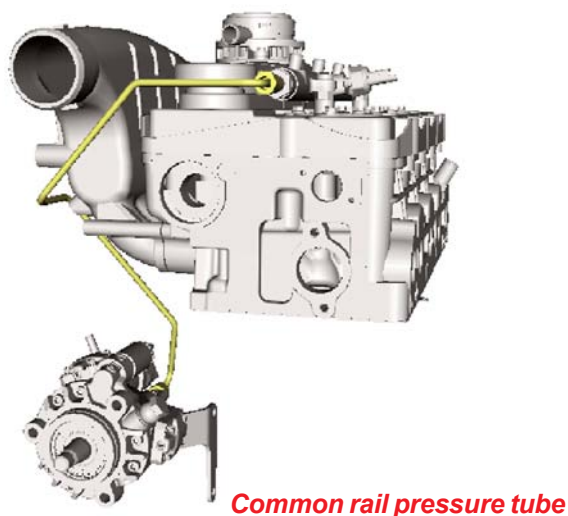
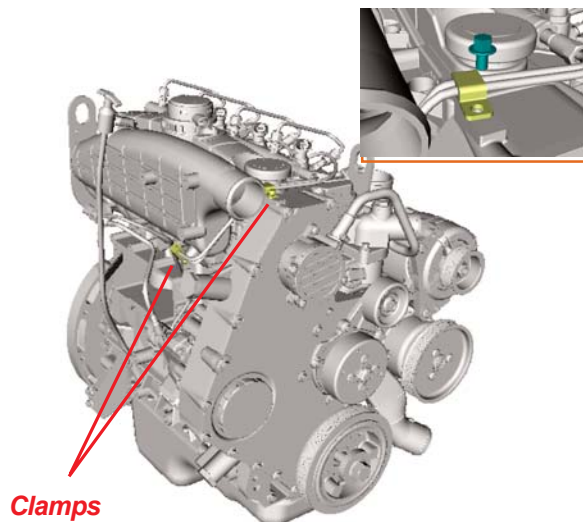
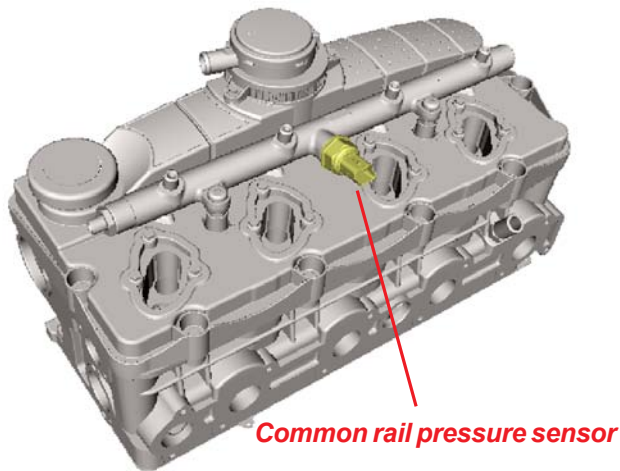
2. Install fuel injector and fuel injector clamp assembly.
3. Using a 10 mm socket wrench, fasten the fuel injector clamp applying the specified torque of 24 - 26 Nm.
4. Install hose clamp for the fuel injector return hose.
5. Install fuel return hose pressing on it, manually.
6. Manually install new high pressure tubing with the fuel injector and the common rail.
7. With a 17 mm wrench apply the specified torque of 25 - 28 Nm on the high pressure tube nuts between common rail and fuel injector.
8. Connect the electrical connector on the fuel injector.

**Note:** In case of warranty parts, protect the components and store them in the protective packing of the installed pieces.

*Fix a peg with a magnet and lift the assembly*



*Lock it with a small flat screwdriver and lift the assembly*



## Common rail

### Removal

1. Remove the electrical connector from high pressure sensor in the rail.

**⚠ Caution:** Remove the connector carefully so no damages will occur to the fixing lever.

2. Using an 8 mm wrench, loosen the high pressure tubing clamps from tube that connects the high pressure pump to the common rail.

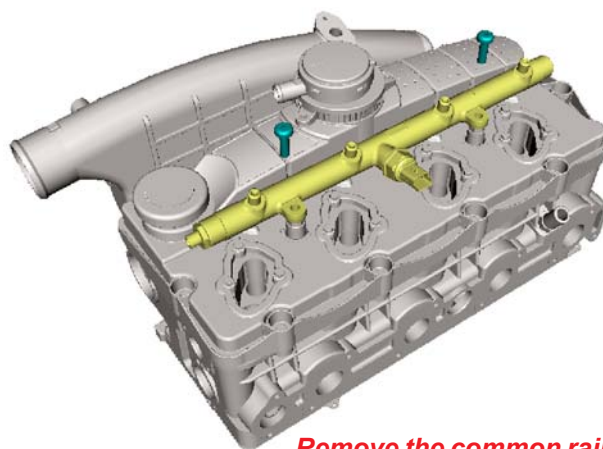
3. Using a 17 mm curved wrench, loosen the tube from high pressure pump.
4. Using a 17 mm wrench, loosen the high pressure tube on the common rail.
5. Remove the high pressure tube.
6. Place protective caps on the connections of fuel pump and common rail to avoid contamination.

7. With a 17 mm wrench, remove the high pressure tubing (common rail / fuel injector).

**Note:** To loosen the fuel injector from high pressure tubing it is necessary to use a 13 mm wrench to secure the nipple of the fuel injector.

8. Protect the connections of common rail and fuel injector with plastic caps to avoid contamination.
9. Repeat the steps 7 and 8 for the other fuel injectors.
10. Using a TORX T30 socket wrench, remove the 2 bolts from common rail.
11. Remove the common rail.

**Caution:** The high pressure sensor should never be removed from common rail, because there are risks of leakage and consequent warranty loss.



*Remove the common rail*

## Assembly

1. Using a TORX T30 socket wrench, install common rail to the holder applying the specified torque.
2. Manually assemble the new high pressure tubes, fuel injectors and common rail.
3. With a 17 mm wrench, apply the specified torque of 25 - 28 Nm on the high pressure tubes between common rail and fuel injectors.

**Note:** Secure the fuel injector nipple using a 13 mm wrench to apply the torque to fuel injector on high pressure tube.

4. Manually install new high pressure tube on common rail and on fuel pump.

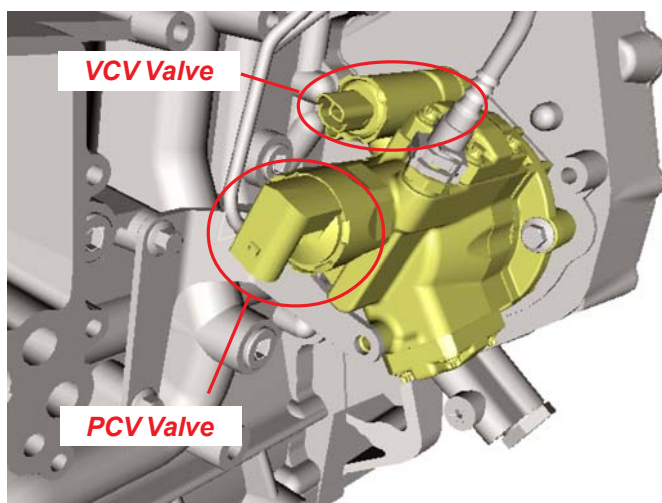
5. With a 17 mm wrench, apply the specified torque of 25 - 28 Nm to the high pressure tubes between the common rail and the fuel pump.
6. Using an 8 mm wrench, fasten the high pressure tubing clamps, applying a torque of 8 - 11 Nm.
7. Connect the electrical connector to the high pressure sensor on the common rail.

**Note:** In case of warranty parts, protect the components and store them in the protective packing of the installed pieces.

## Fuel pump

### Removal

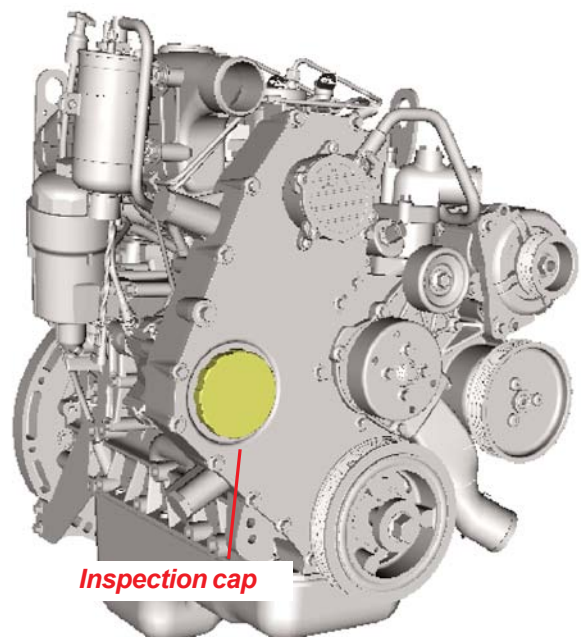
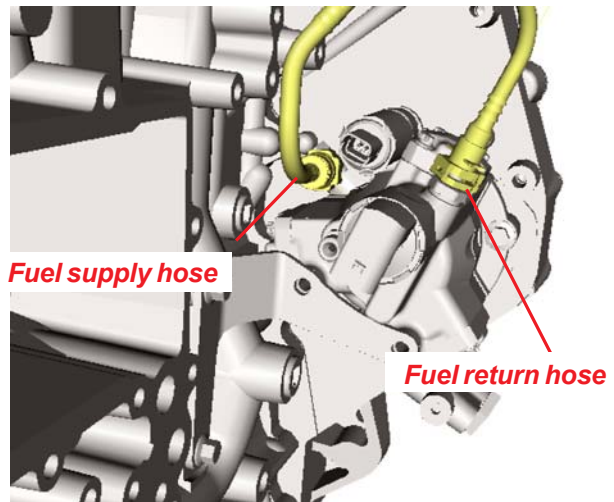
1. Remove the fan, [see Cooling System - Fan](#).
2. Remove the Poly-V belt, [see Accessories - Poly-V Belt](#).
3. Remove the Poly-V belt tensioner, [see Accessories - Poly-V Belt Tensioner](#).
4. In vehicles without air-conditioning, remove the idler pulley using a 13 mm wrench.
5. Remove air conditioning compressor and its holder (when available).
6. Disconnect the VCV and PCV valve electrical connectors from fuel pump.



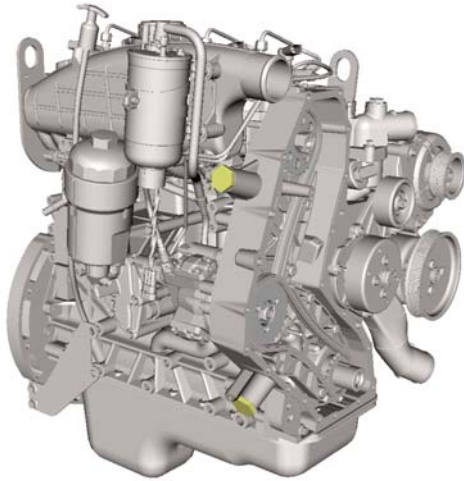
7. Remove the return fuel hose from fuel pump, pressing the hose clamp manually.
8. Remove the fuel supply hose from fuel pump, pressing the hose clamp manually (red).

**Note:** If necessary, press the other edge of the hose clamp with a small screwdriver.

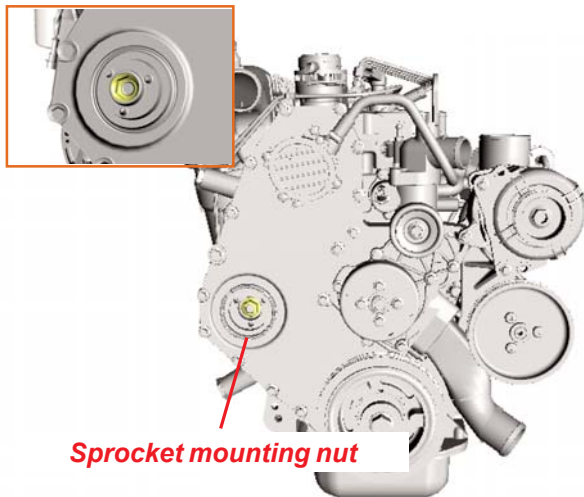
9. Using an 8 mm wrench, loosen the high pressure tubing clamps of the connection tube between the high pressure pump and the common rail.
10. Using a 17 mm, 90° curved wrench, loosen the high pressure tube on the fuel pump.
11. Using a 17 mm wrench, loosen the high pressure tube on the common rail.
12. Remove the high pressure tube.
13. Place protective caps on the connections of high pressure pump and common rail to avoid contamination.
14. Manually remove the inspection cap from distribution housing cover.







**Tensioner plugs**



**Sprocket mounting nut**



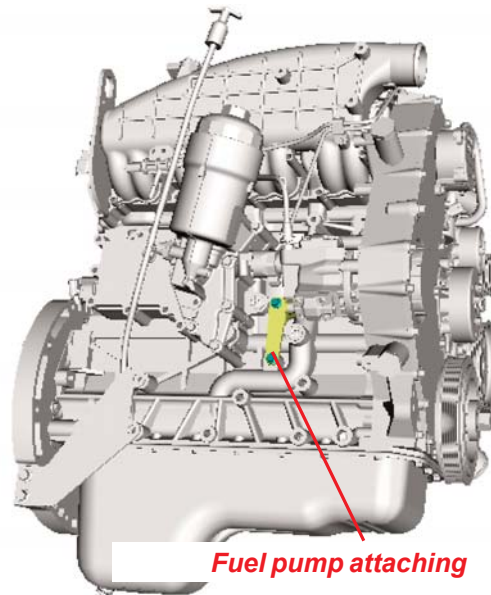
**Tool nr. 8130012**

15. Loosen the upper chain tensioner plug.

16. Using a 22 socket wrench, loosen the fuel pump sprocket mounting nut.

17. Attach the MWM-International Engines Tool nr. 8130012 on the high pressure pump sprocket using the three M6 tapped holes.

- Using a 10 mm wrench, remove the four mounting bolts from fuel pump holder.



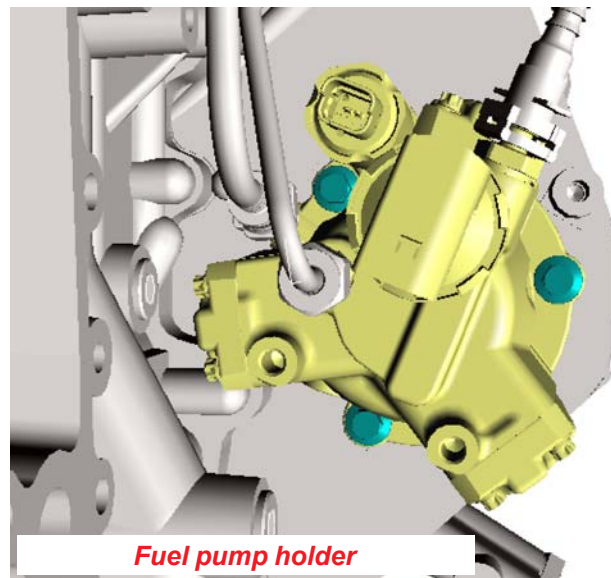
- Using a 10 mm socket wrench with an extension, remove the three mounting bolts from fuel pump.

**⚠ Caution:** To remove the bolt located behind the fuel pump, it is necessary to use a 3/8" extension that will allow access to the bolt avoiding interference between the wrench and the lubricating oil module.

- Turn the threaded central bolt of MWM-International Tool nr. 8130012, until the high pressure pump comes off the sprocket.

**⚠ Caution:** When removing the fuel pump, use extra caution so that the pump does not fall.

- Remove the fuel pump.



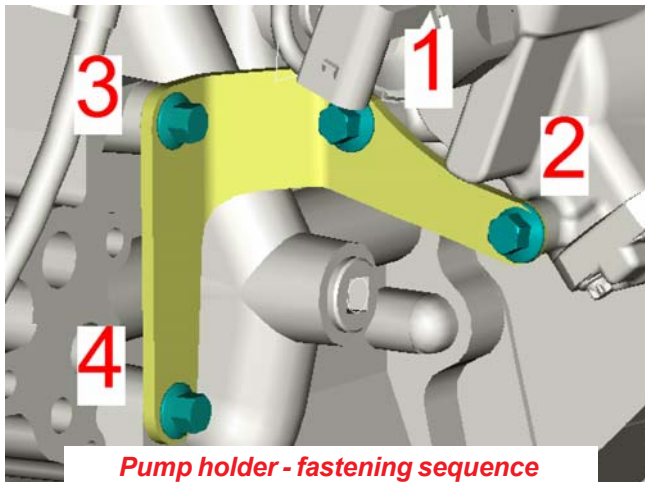
**Assembly**

1. Totally loosen the central bolt of MWM-International Tool nr. 8130012.
2. Be careful to insert the fuel pump shaft into the sprocket, while installing the fuel pump in its place.
3. Using a 10 mm socket wrench with an extension, fasten the 3 bolts of the fuel pump and tighten them to the specified torque of 22 - 28 Nm using Loctite® 242 or TB1345T sealant.

**⚠ Caution:** Whenever removing the fuel pump, always replace the pump sealing O-rings.

4. Using the three mounting bolts, remove the MWM-International Tool nr. 8130012.
5. Using a 22 mm socket wrench to fasten the fuel pump sprocket nut, and tighten it to the specified torque of 15 -20 Nm.
6. Close the inspection cap of the distribution housing cover, tightening it manually. Rotate it an extra 1/4 turn after it has seated on the housing cover.
7. Using a 10 mm socket wrench, install four bolts of the fuel pump holder and tighten them with the specified torque of 22 - 28 Nm.

**⚠ Caution:** Observe the fastening sequence and tighten the bolts with a previous torque of 5 - 8 Nm.



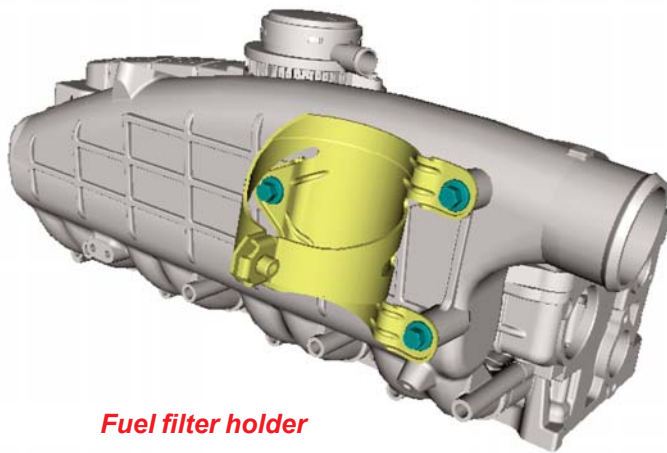
**Pump holder - fastening sequence**

8. Assemble manually the new high pressure tube on the common rail and fuel pump.
9. With a 17 mm wrench, tighten the mounting nuts of the high pressure tube between the common rail and the fuel pump to a specified torque of 25 - 28 Nm.
10. Using an 8 mm wrench, fasten the clamps of the high pressure tube.
11. Fasten the fuel supply hose on the fuel pump (quick release coupling).
12. Fasten the fuel return hose on the fuel pump, locking the plug manually.
13. Connect the VCV and PCV valves electrical connectors.
14. Install compressor holder and the air conditioning compressor (when available).
15. In a vehicle without air-conditioning, fasten the idler pulley using a 13 mm wrench and tighten it with a specified torque of 40 - 50 Nm.
16. Install Poly-V belt tensioner, [see Accessories - Poly-V Belt Tensioner](#).
17. Install Poly-V belt, [see Accessories - Poly-V Belt](#).
18. Install fan, [see Cooling System - Fan](#).

## Fuel filter holder

### Removal

1. Remove the fuel filter, [see Fuel System - Preventive Maintenance](#).



**Fuel filter holder**

2. Using an 8 mm wrench, loosen the three mounting bolts.
3. Remove the holder.

### Assembly

1. Using an 8 mm wrench, install three mounting bolts with the specified torque of 8 - 11 Nm.

**!** **Caution:** Do not forget to install fuel filter holder insulators.

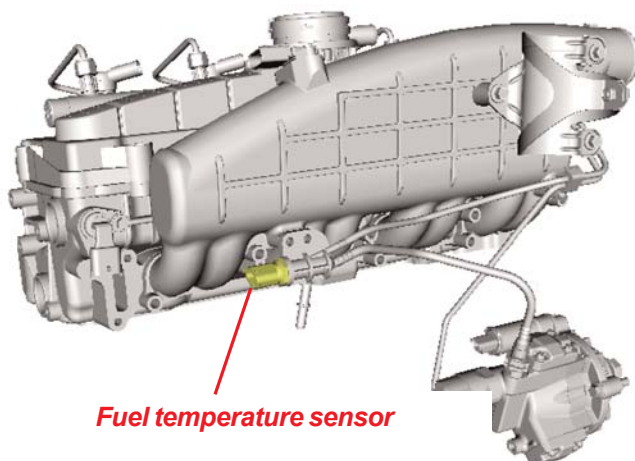
2. Install fuel filter, [see Fuel System - Preventive Maintenance](#).

### Fuel temperature sensor housing

**Note:** For procedures involving the fuel temperature sensor, [see Electronic Control](#).

### Removal

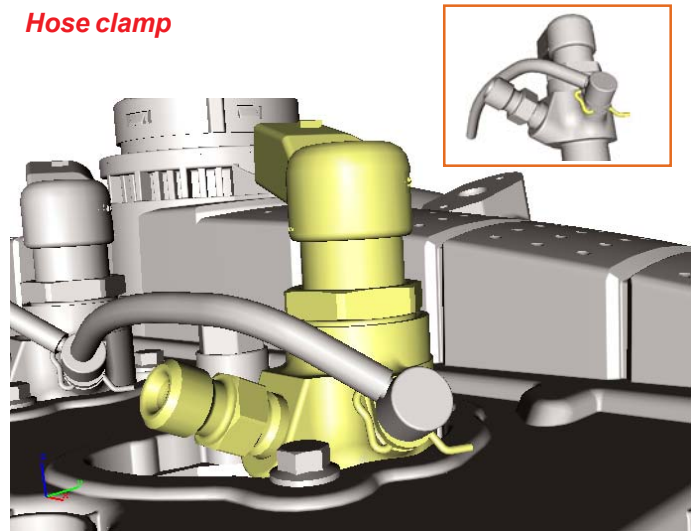
1. Remove the electrical connector from fuel temperature sensor.
2. Remove the fuel temperature sensor.



**Fuel temperature sensor**

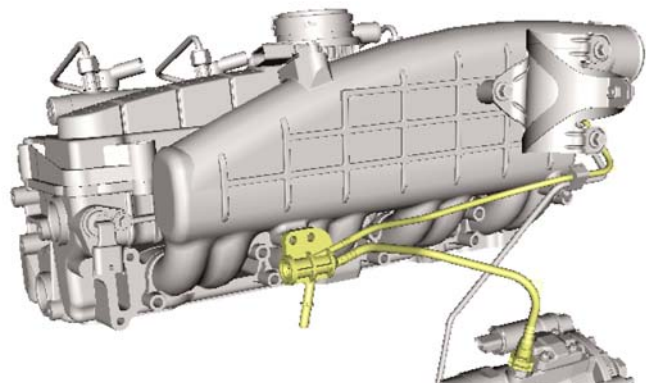
3. Remove the return hose from fuel injector. This procedure must be performed using a small screwdriver to remove the mounting clamps from hose.
4. Remove the fuel injectors return hose from mounting clamps.

**Hose clamp**



5. Loosen the fuel return hose on the fuel pump, pressing the clamp manually.
6. Loosen the fuel return hose from fuel injectors mounting clamps.
7. Using an 8 mm wrench, loosen the fuel temperature sensor housing.

**⚠ Caution:** Never loosen the injectors and fuel pump return hoses from fuel temperature sensor housing, because this may cause leakage and consequently warranty lose.



**Fuel temperature sensor housing**

**Note:** Do not remove the return hoses from fuel injectors and pump.

## Assembly

**⚠ Caution:** In this procedure, you should be very careful with the return line assembly, making sure that there is no interference with any engine component.

1. Using an 8 mm wrench, fasten the fuel temperature sensor housing on the intake manifold and tighten it with a torque of 8-11 Nm.

2. Fasten the return hose from to the fuel pump, locking the plug manually.
3. Fasten the return hose to the fuel injectors with the mounting clamps.
4. Install fuel return hose on the fuel injectors pressing it manually and using the mounting clamps located on the fuel injectors.
5. Fasten the return hose to the fuel injectors with the mounting clamps.

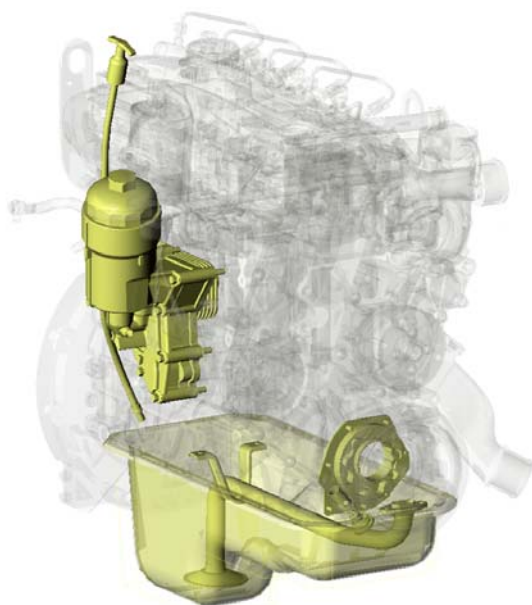


**Caution:** Install mounting clamps on the return line.

6. Install fuel temperature sensor.
7. Connect the electrical connector.







## Lubrication System

Preventive maintenance of the lubrication system .....	66
Oil level .....	66
Changing the lubricating oil and filter element .....	67
Oil pan capacity .....	69
Oil filter .....	69
Oil dipstick tube .....	69
Oil pressure sensor .....	70
Oil module .....	71
Oil filter head .....	72
Oil pan .....	73
Oil suction pipe .....	74
Oil pump .....	76
Jet cooler .....	77
Distribution housing oil sprayer .....	78
Distribution chain guide hydraulic tensioners .....	79
Distribution housing oil check valve .....	80

## Preventive maintenance of the lubrication system

The lubrication system is fundamental for the durability and internal cleanliness of the engine. Besides the lubricating action, the oil also aids the heat exchanging between the components, therefore, it is extremely necessary for the good maintenance of the lubrication system, to follow all items and verifications described in the vehicle's periodic maintenance chart.

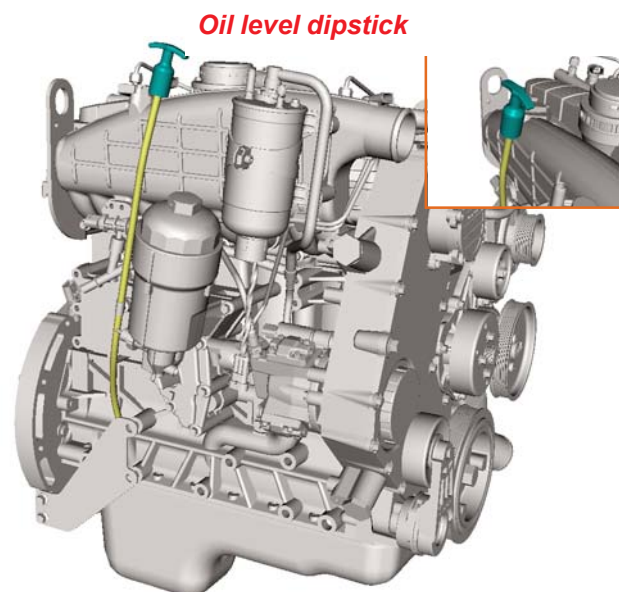
### Oil level

It is necessary to check daily the oil level, using the oil level dipstick located at the side of the engine. For this procedure, do as follows.

1. Park the vehicle on a level ground.
2. After turning off the engine, wait an average of 10 to 15 minutes until the oil in the engine upper part returns to the oil pan.
3. Check the oil level using the oil level dipstick.

Complete the oil level only if the oil mark is below the dipstick's lower mark.

**⚠ Caution:** If oil level is frequently low, look for a *MWM-International Motores* Service Center.



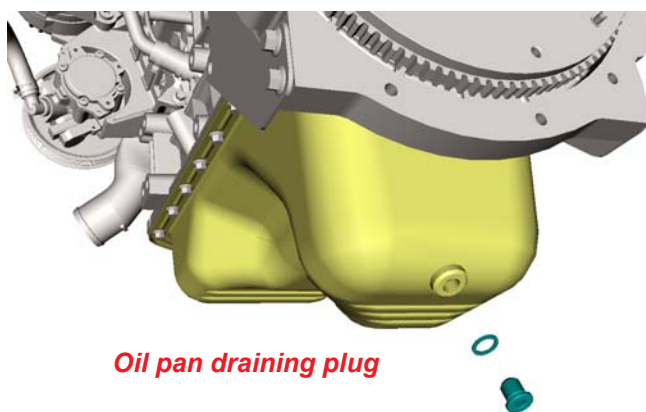
### Changing the lubricating oil and filter element

For this operation, always follow the period indicated on the Preventive maintenance chart. If the engine operates under severe conditions (areas with large concentrations of dust, or other conditions harmful to the good operation of the engine), it will be necessary to reduce the maintenance periods of the filter element and lubricating oil to half of the specified kilometers.

#### Procedure

To change the lubricating oil and filter element, use the following procedure:

1. Run the engine until it reaches the ideal operating temperature.
2. Turn off the engine.
3. Remove the lubricating oil filter cap.



4. Clean the oil filler cap and the oil pan plug. Remove them and let the oil drain freely.

**⚠ Caution:** To completely drain the lubrication system, it is mandatory that the oil cap in the oil filter head be removed.

5. Remove the oil filter element.

**Note:** The lubricating oil filter of NGD 3.0E engine is an ecological filter, that is, oriented to attend all environmental norms, including the disposal of used components. Therefore, it is important to remove and replace only the internal filter element (paper).

6. Install a new filter element in the oil filter housing.

**Caution:** When changing the oil filter element, always replace the O-ring on the top of the oil filter housing.

7. Using a 36 mm socket wrench, install cap and tighten the bolts with the specified torque of 22,5 - 27,5 Nm.
8. Install oil pan plug, using a new sealing washer and tighten it with the specified torque of 30 - 40 Nm.
9. Refill and install oil filler cap.
10. Run the engine.



Oil filter



O-ring



- Turn off the engine and wait a few minutes, then check the oil level and inspect it for any leakage.

**Caution:** Use only recommended lubricating oils: **Multigrad 15W40 API CH4**.

Follow the preventive maintenance charts for the oil change.

Never use an API category oil inferior than CG4.

#### Oil pan capacity

Without filter change: 8 liters

With filter change: 9 liters

## Removal and assembly of the system

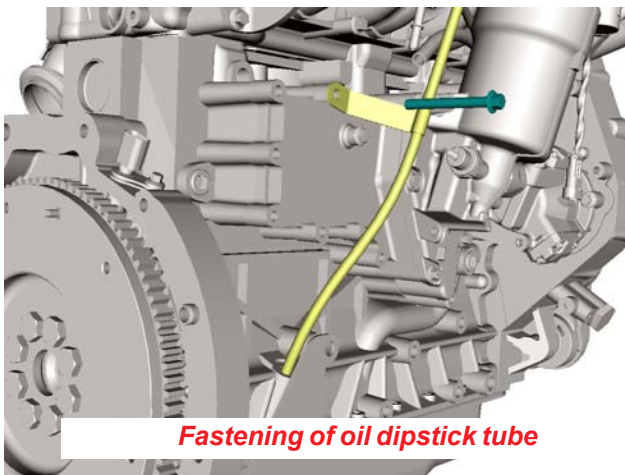
### Oil filter

For the removal and assembly procedures see [Lubrication System - Preventive Maintenance](#).

### Dipstick tube

#### Removal

- With the aid of a 10 mm socket wrench, loosen the dipstick tube mounting bolt.
- Manually remove the dipstick tube, pulling the tube upward.



**Fastening of oil dipstick tube**

## Assembly

**!** **Caution:** Whenever removing the dipstick tube, always replace its O-ring.

1. Place the dipstick tube into the hole on the engine block.
2. Using a 10 mm socket wrench, tighten the dipstick mounting bolt to specified torque of 22 - 28 Nm.

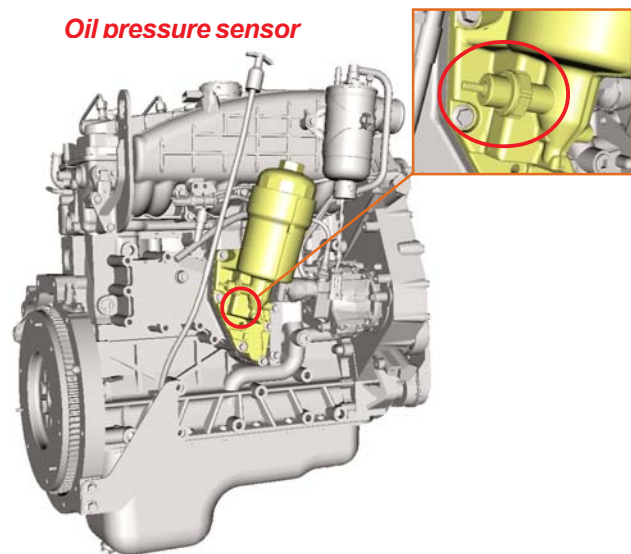
## Oil pressure sensor

### Removal

1. Using a 26 mm wrench, remove the oil pressure sensor.

### Assembly

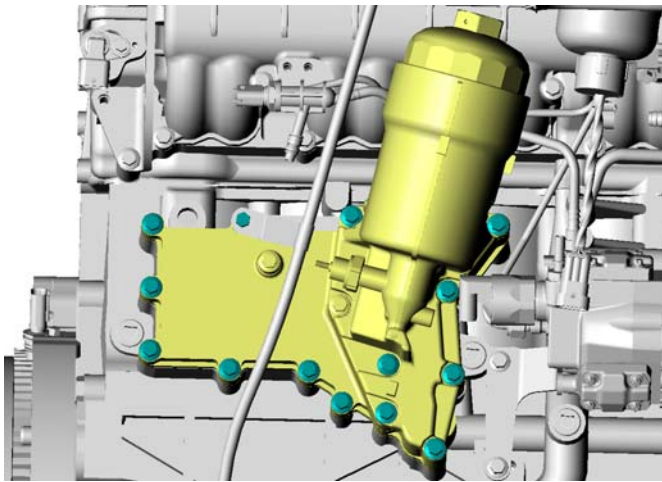
1. Fasten the pressure sensor on the module using a 26 mm wrench, with a specified torque of 9 - 13 Nm, using Three Bond® 1134B or Loctite® 5671570 sealant.



**Oil module****Removal**

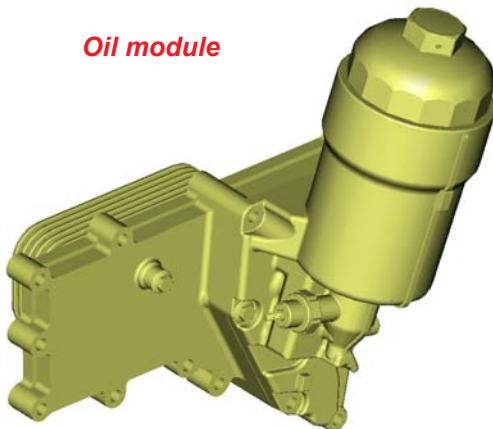
Remove the complete oil module (heat exchanger + oil filter head) following the procedure.

1. Drain the lubrication system, [see Lubrication System - Preventive Maintenance](#).
2. Drain the cooling system, [see Cooling System - Preventive Maintenance](#).
3. Using a 10 mm socket wrench, loosen the 14 bolts as indicated in the picture. (To remove the oil module, it is necessary to remove the dipstick tube that is fastened by one of the bolts of the oil module).



**Oil module mounting bolts**

**Oil module**



4. Remove the oil module.

## Assembly

1. Install a new gasket.

**⚠ Caution:** Always replace the oil module gasket using genuine MWM-*International* Motores parts.

2. Using a 10 mm socket wrench, tighten the 14 bolts from oil module applying the specified torque of 22 - 28 Nm.

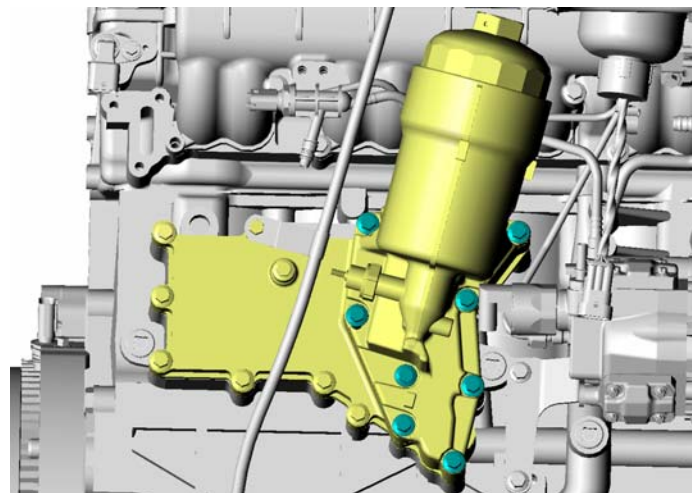
## Oil filter head

### Removal

To remove the lubricating oil filter head without removing the oil cooler, use the following procedure.

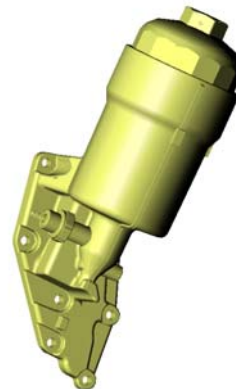
1. Using a 10 mm socket wrench, remove the 7 bolts as indicated in the picture.

2. Remove the oil filter head.



**10 mm bolts oil filter head**

**Oil filter head**



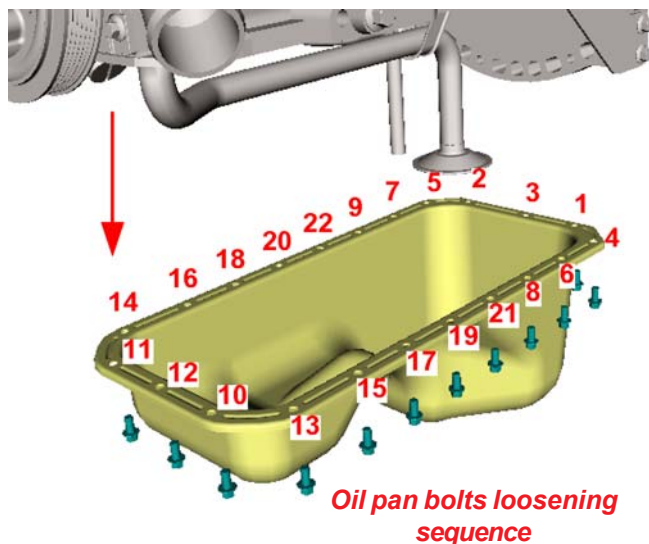


**Assembly**

1. Place the lubricating oil filter head on the module.
2. With a 10 mm socket wrench, tighten the 7 bolts of lubricating oil filter head applying the specified torque of 22 - 28 Nm.

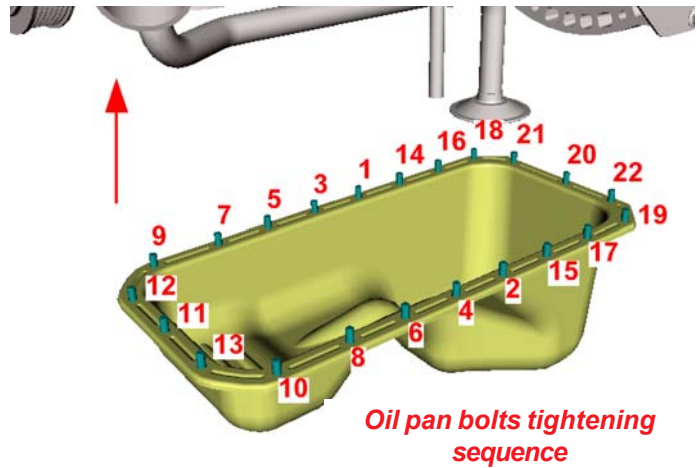
**Oil pan****Removal**

1. Drain the lubricating lubrication system, [see Lubrication System - Changing the Lubricating Oil and Oil Filter Element](#).
2. Using a 10 mm socket wrench , remove the 22 bolts following the loosening sequence in the picture.
3. With the aid of a scraper to break the gasket material, remove the oil pan.

**Assembly**

1. Clean the contact surfaces of the oil pan, distribution housing and cylinder block using a gasket remover and a degreaser.
2. Apply a new sealant (Three Bond® 1217F sealant).

- Fasten the oil pan bolts, observing the tightening sequence shown in the picture and apply the specified torque of 22 - 28 Nm.

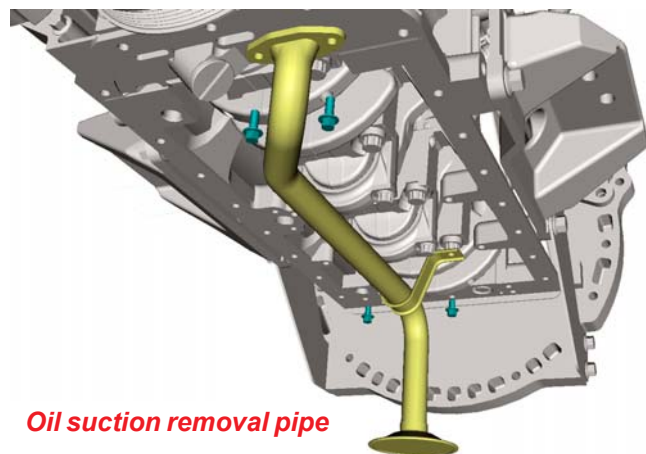


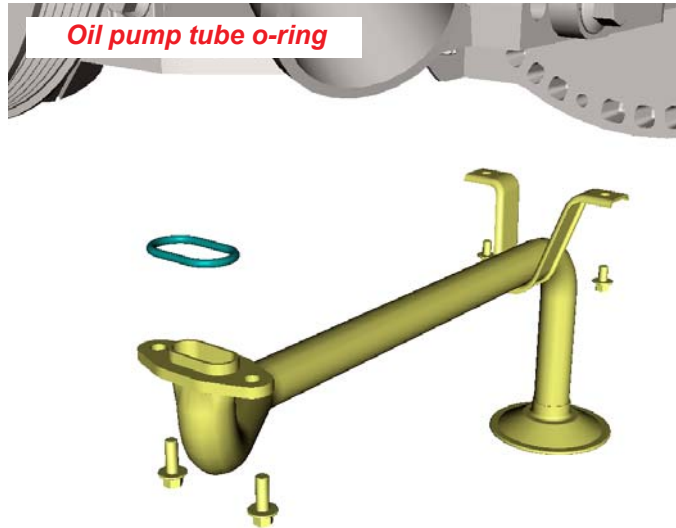
**Note:** For the correct installation of the engine oil pan it is of extreme importance the correct application of a uniform fillet of sealant (of about 5 mm thick) on the entire contact surface of the oil pan, being careful to also fill the contours of the oil pan bolt holes.

## Oil suction pipe

### Removal

- Remove the oil pan according to the procedure, [see Oil Pan, in this System.](#)
- Using an 8 mm socket wrench, remove the four mounting bolts from suction pipe.





3. Remove the O-ring from oil suction pipe and oil pump.

#### Assembly

1. Install a new O-ring for the oil suction pipe assembly on the distribution housing.
2. Place the oil suction pipe in the assembly position.
3. Using an 8 mm socket wrench, fasten the oil suction pipe with Loctite® 242 or TB1345T sealant and apply the specified torque of 8 - 11 Nm.
4. Install oil pan according to the procedure, [see Oil Pan - in this System](#).
5. Refill the lubrication system according to the procedure, [see Lubrication System - Preventive Maintenance](#).

## Oil pump

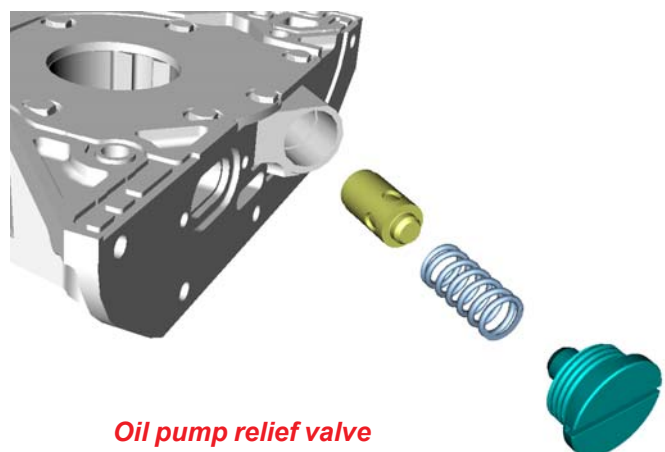
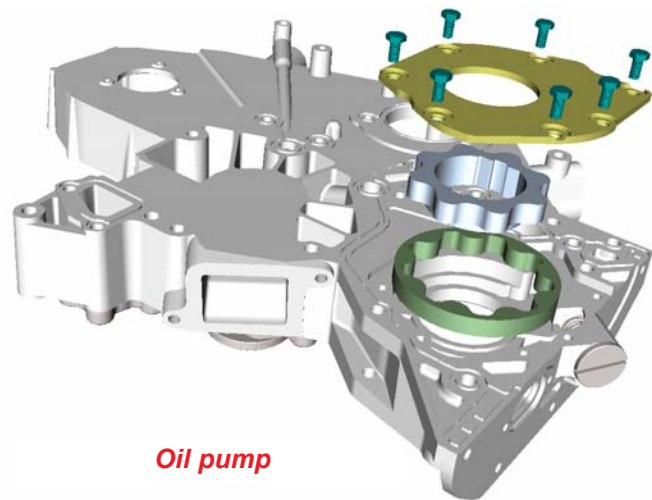
### Removal

The oil pump of NGD 3.0E engine is incorporated into the distribution housing.

1. Remove the oil pan, [see Oil Pan, in this System.](#)
2. Remove the oil suction pipe, [see Oil Suction Pipe, in this System.](#)
3. Remove the distribution housing, [see Distribution / Timing - Distribution Housing.](#)
4. Using a 10 mm socket wrench, remove the seven bolts from oil pump cover. Then, remove the pump cover, the inner and outer rotors.
5. Using a screwdriver, loosen and remove the relief valve.

**⚠ Caution:** It is advised not to remove the relief valve, as it results in warranty loss.

**⚠ Caution:** When it is necessary to repair the oil pump, a critical evaluation of distribution housing should be done. In case of damage or leakage found in the housing, it is mandatory to replace the complete distribution housing.



**Assembly**

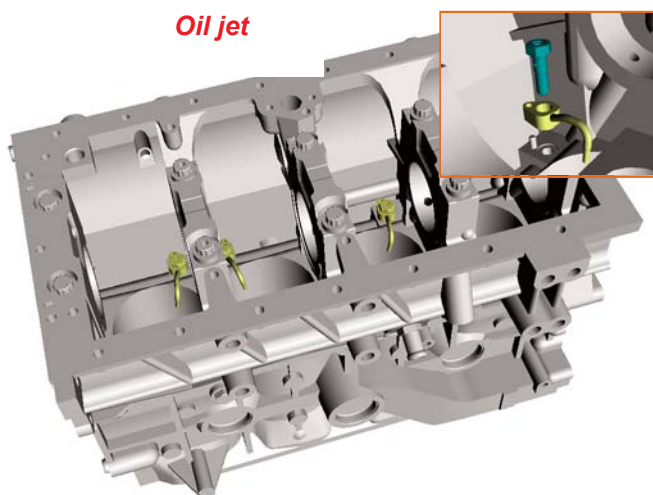
1. Using a screwdriver, install relief valve applying a specified torque of 15 - 25 Nm.
2. Install inner and outer rotors to the oil pump. Using a 10 mm socket wrench, fasten the oil pump cover applying a specified torque of 9 - 12 Nm on the seven bolts.
3. Install distribution housing, [see Distribution / Timing - Distribution Housing](#).
4. Install oil suction pipe, [see Oil Suction Pipe, in this System](#).
5. Install oil pan, [see Oil Pan, in this System](#).

**Jet cooler****Removal**

1. Remove the oil pan, [see Oil Pan, in this System](#).
2. Using a 14 mm socket wrench, remove the jet cooler.
3. Repeat the 2nd operation for all jet coolers.

**Assembly**

1. Using a 14 mm socket wrench, fasten all jet coolers to the cylinder block applying the specified torque of 14 - 20 Nm.



**Caution:** The jet cooler mounting bolts contain a valve for pressurizing the oil for the jet cooler; therefore, never replace them for conventional bolts.

2. Install oil pan, [see Oil Pan, in this System.](#)

### Distribution housing oil sprayer

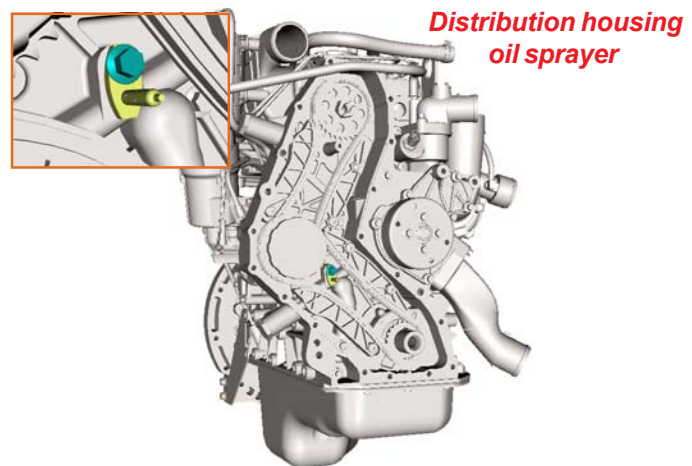
The NGD 3.0E engine also has a double oil sprayer located inside the distribution housing, which is fastened by one of the bolts that fix the distribution housing to the block.

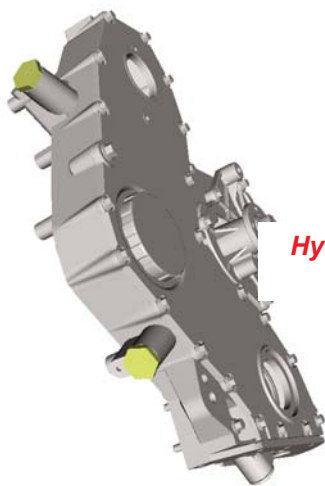
#### Removal

1. Remove the distribution housing cover according to the procedure, [see Distribution / Timing - Distribution Housing Cover.](#)
2. Using a 10 mm socket wrench, remove the oil sprayer from distribution housing.

#### Assembly

1. Using a 10 mm socket wrench, fasten the oil sprayer to the distribution housing applying the specified torque of 22 - 28 Nm.
2. Install distribution housing cover, [see Distribution / Timing - Distribution Housing Cover.](#)





Hydraulic tensioner from  
distribution chain

### Distribution chain guide hydraulic tensioners

The distribution system of NGD 3.0E engine is accomplished by chains and these are maintained tensioned by hydraulic tensioners.

#### Removal

1. Remove the distribution housing cover, [see Distribution / Timing - Distribution Housing Cover](#).
2. Using a 1 1/4" or 32 mm socket wrench, loosen the plug from hydraulic tensioner.
3. Remove the piston from tensioner.
4. Repeat operations 2 and 3 for the other tensioner.

#### Assembly

1. Install piston on the distribution housing.
2. Using a 1 1/4" or 32 mm socket wrench, fasten the chain guide tensioner plug applying the specified torque of 50-60 Nm.

**⚠ Caution:** Always replace the sealing washer when removing the bolt from hydraulic tensioner.

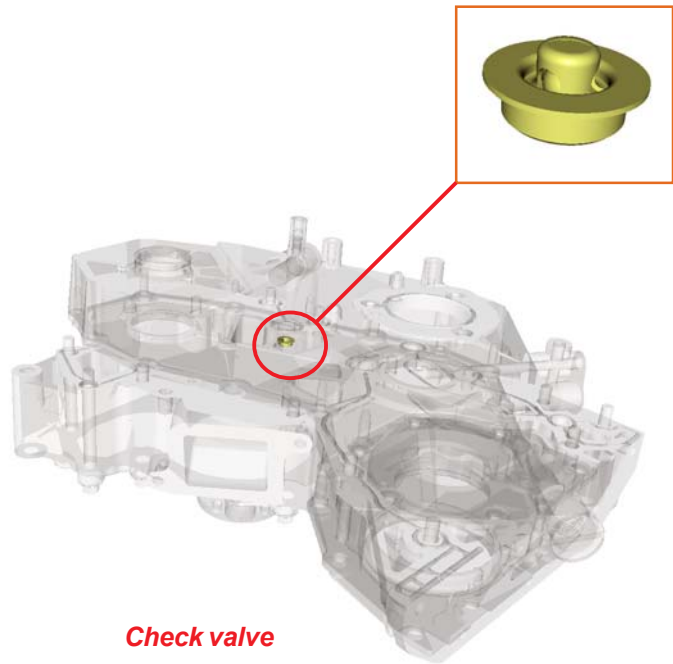
3. Repeat operations 2 and 3 for the other tensioner.
4. Install distribution housing cover, [see Distribution / Timing - Distribution Housing Cover](#).

## Distribution housing oil check valve

In the upper oil gallery of the distribution housing, the NGD 3.0E engine has a lubricating oil check valve with the function of maintaining the oil supply in the upper gallery of the hydraulic tensioner unit. This action avoids noise during cold starting until the tensioner unit is fed with lubricating oil.

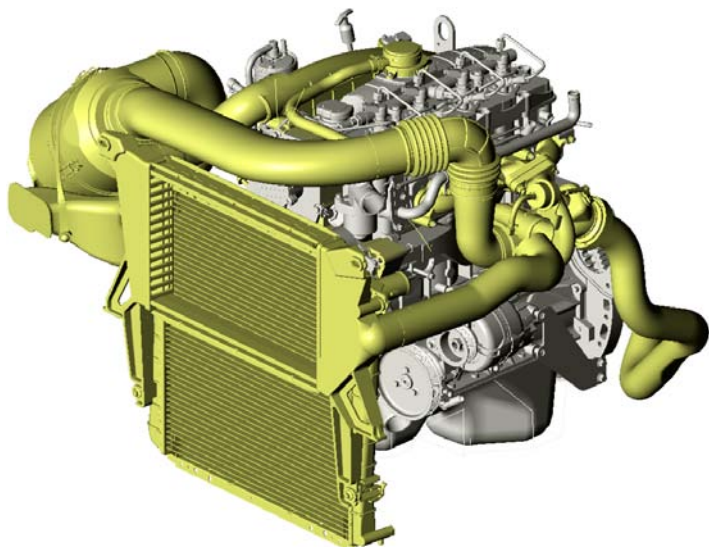
This valve is spiked into the distribution housing and it cannot be repaired. Therefore, in case of damage to this valve, the distribution housing should be replaced.

**Note:** The non-operation of this valve does not imply consequential damages to the engine or reduction of its life span. As mentioned above, its only function is to reduce noise that can happen during cold starting until the oil fills the hydraulic tensioner unit, (a few seconds), so this valve is intended to avoid discomfort to the customer.



**Check valve**





## Intake and Exhaust

Turbocharger .....	82
Turbocharger lubrication pipe .....	84
Turbocharger oil return pipe .....	85
Intake ducts and hoses .....	86
Turbocharger .....	87
Engine breath .....	88
Valve cover and breath valve .....	89
Breath return .....	92
Intake manifold .....	92
Exhaust manifold .....	95

The essential care referred to in this section is regarded to the use MWM-International genuine parts, the observance of the accomplishment of preventive maintenance as described in this manual, and to the cares quoted in this chapter referring to the turbocharger.

## Intake and exhaust

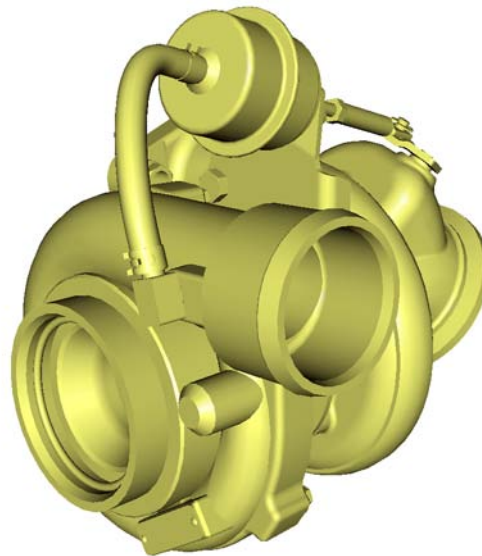
### Turbocharger

The turbocharger is composed of a turbine and a rotating air compressor on opposite sides of the same shaft. The compressor rotor and the turbine rotor are involved in separate housings, one for the compressor and one for the turbine, whose function is directing the flow of gases through the fan blades of the rotors. The exhaust gases circulate in the turbine rotor (hot side), and the intake atmospheric air circulates in the compressor rotor (cold side).

The exhaust gases have energy in form of pressure, temperature and speed. They cause turbine rotor and consequently the compressor rotor to rotate.

With the rotation, the atmospheric air (that must be properly filtered and free from particles) intakes the turbocharger, and it is then compressed by the compressor rotor from where it advances to the Intercooler. The intercooler is composed of an air-air heat exchanger which cools the compressed air to increase the density of oxygen molecules and consequently allows the increase in the amount of fuel injected for combustion.

The turbocharger for the NGD 3.0E engine has a Waste-Gate valve that controls the maximum pressure to be exerted by the compressor, to avoid damages to the engine.



*Turbocharger*

**Turbocharger precautions**

The operation of an engine equipped with a turbocharger has some special procedures.

**Always, after starting the engine, maintain it at idle speed for 45 seconds.**

1. Accelerating the engine immediately after starting it will damage the turbocharger, because it requires a high speed rotation before the oil flow reaches the shaft.
2. Accelerating the engine just before turning it off also damages the turbocharger because the lubrication will stop while the shaft rotation is still high.
3. The intake of foreign objects, even very small, will cause damages to the compressor rotor, harming the operation of the turbocharger. For this reason, it is recommended to evaluate the air filter system within the time periods specified.
4. By working at high speeds and temperatures, the turbocharger requires a lubricating oil that accomplishes to these requirements, and should never be used a lubricating oil that does not accomplishes to specification multigrade 15W40 API / CH4.
5. Always follow the Instructions of the Periodic / Preventive Maintenance chart.



**Caution:** The non-observance of the above items, besides causing damages to the turbocharger and the engine, will also be a reason for the warranty loss.

### Turbocharger lubrication pipe

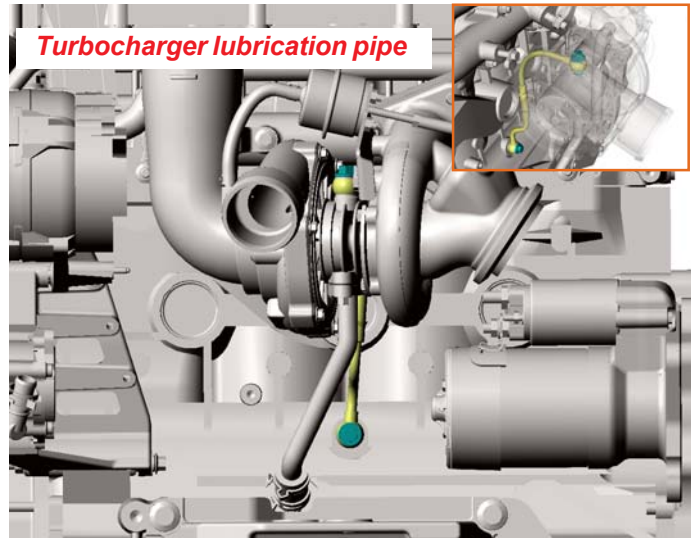
1. Using a 11 mm socket wrench, remove the two banjo bolts from pipe.

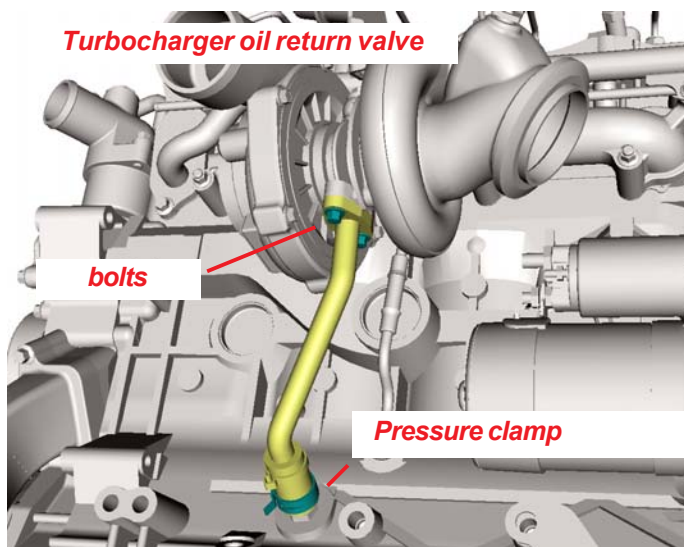
### Assembly

1. Place the pipe and, using a 11 mm socket wrench, apply a torque of 22 - 28 Nm on the banjo bolt located on the engine turbocharger.

**Note:** Never forget to install new sealant washer along with the lubrication pipe (One on each side of the banjo).

2. Using a 11 mm socket wrench, apply a torque of 22 - 28 Nm on the banjo bolt located on the pipe end closer to the engine block.
3. Fill the lubrication system according to the procedure, [see Preventive Maintenance - Changing Lubricating Oil.](#)





## Turbocharger oil return pipe

### Removal

- 1 Using an 8 mm socket wrench, loosen the two bolts from pipe flange.
- 2 Using a pliers, loosen the hose spring clamp from pipe end closer to the engine block.
- 3 Remove the oil return pipe from turbocharger.

### Assembly

To install turbocharger return pipe, follow this procedure:

1. Place the engine block connection tube hose.
2. Place the tube and using an 8 mm socket wrench, apply a torque of 8 - 11 Nm on the two flange bolts of the turbocharger tube.

**⚠ Caution:** Replace the turbocharger oil return tube sealing gasket.

3. With the hose already placed on the engine block connection, fit the spring clamp.
4. Fill the lubrication system, [see Periodic Maintenance - Changing the Lubricating Oil](#).

## Hoses and intake duct

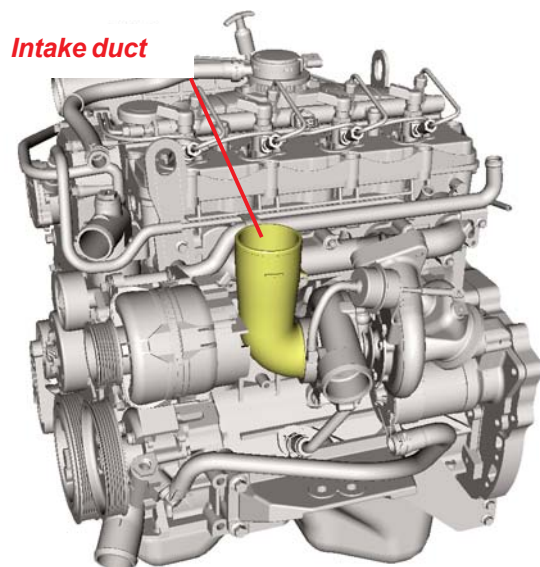
### Removal

1. Remove the air filter housing intake hose from intake duct.
2. Remove the intercooler air intake hose from intake manifold.
3. Using a 10 mm socket wrench, loosen the intake duct bolt next to the exhaust manifold.
4. Remove the intake duct.

### Assembly

1. Using a new O-ring, place the intake duct inside the turbine compressor opening.

**Caution:** For this procedure, it is very important to take the proper care with the positioning and with the duct sealing O-ring. If assembled with an O-ring in bad conditions, damaged at the moment of the assembling or with the duct displaced, this will allow the intake of unfiltered air into the turbine, which can cause serious damage to the engine (entrance of abrasives).



2. Using a 10 mm socket wrench, apply a torque of 22 - 28 Nm on the bolt fixing the intake duct to the exhaust manifold.
3. Install air intake hose on the intake manifold.
4. Install intake hose (air filter housing / intake duct).

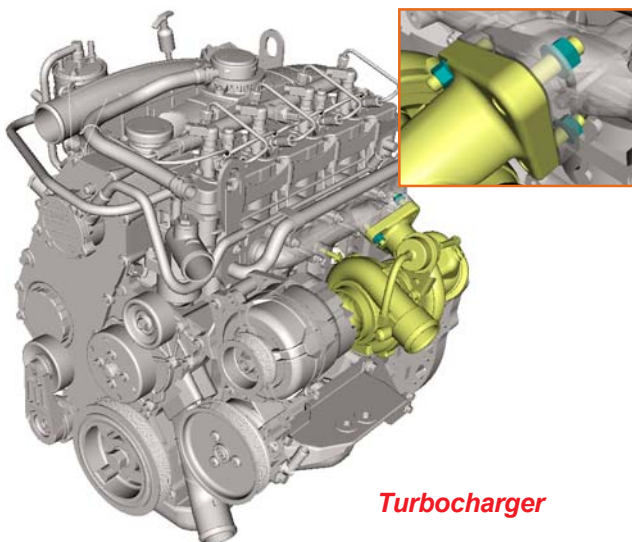
## Turbocharger

### Removal

1. Drain the lubrication system from engine, [see Lubrication System - Preventive Maintenance](#).
2. Remove the turbocharger hoses, taking off the clamps.
3. Remove the turbocharger lubrication pipe, [see Turbocharger Lubrication Pipe in this System](#).
4. Remove the air intake duct, [see Intake and Exhaust - Intake Duct](#).
5. Remove the turbocharger lubrication breath pipe, [see Intake and Exhaust - Turbocharger Oil Breath Pipe](#).
6. Remove the three turbocharger nuts using a 15 mm socket wrench.

**⚠ Caution:** It is important to be careful handling the turbocharger, avoiding the entrance of debris and consequential damages to the rotors.

**⚠ Caution:** The turbocharger is a "Black Box" item, therefore it should not be violated. All warranty services should be sent directly to the manufacturer's authorized dealers.



**Turbocharger**

### Assembly

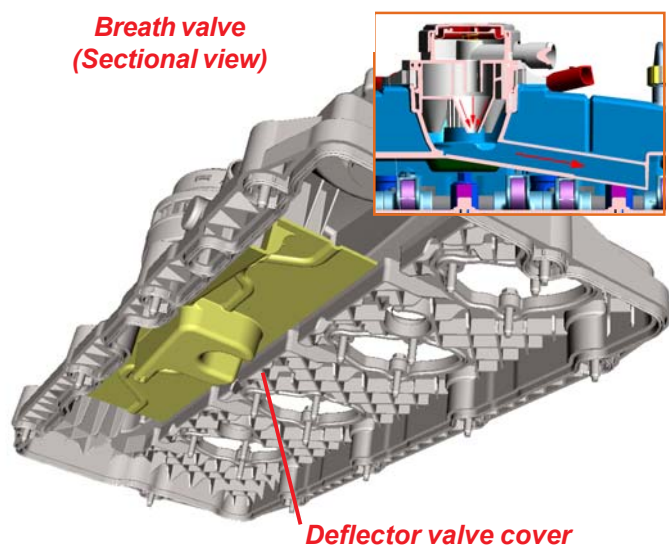
1. Install turbocharger on the exhaust manifold positioning the retainers correctly on the exhaust manifold flange.
2. Using a 15 mm socket wrench, tighten the three self-locking nuts, applying a torque of 45 - 55 Nm.
3. Install air inlet pipe on the turbocharger compressor housing and tighten the clamp.
4. Install air exhaust pipe on the turbocharger turbine housing and tighten the clamp.
5. Install oil breath pipe, [see Intake and Exhaust - Turbocharger Oil Breath Pipe](#).
6. Install turbocharger lubrication pipe, [see Intake and Exhaust - Turbocharger Lubrication Pipe](#).
7. Fill the oil lubrication system, [see Lubrication System - Preventive Maintenance](#).

**!** **Caution:** Always that it is necessary to replace the turbocharger, change the lubricating oil and lubricating oil filter.

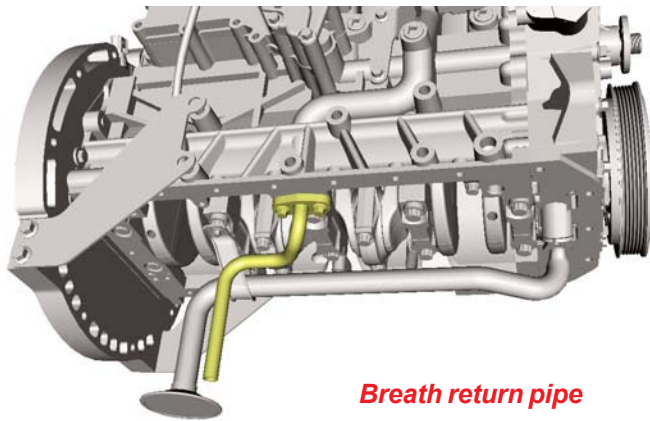
### Engine breath

The pressure formed by the gases due to evaporation of lubricating oil inside the engine needs to be minimized, so these gases are directed to the engine air intake. However these gases contain lubricating oil in suspension that should be recycled.

Therefore, the NGD 3.0E engines present a closed engine breath system that reduces the oil draw to the intake.







Breath return pipe

The valve cover for the NGD 3.0E engines have, besides a deflector to minimize of oil draw into the air system, includes a whirlpool type breath valve that promotes the condensation of the oil in suspension present at the gases, liberating evaporative gases for engine intake with a minimum of oil droplets, reducing the engine lubricating oil consumption.

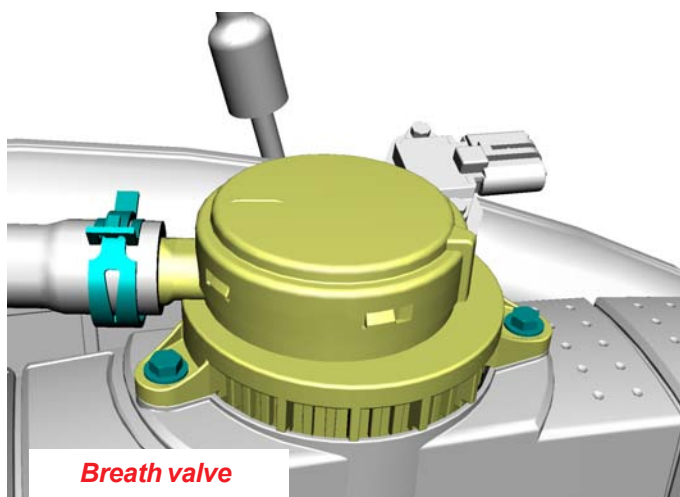
The oil condensed by the breath valve is directed to the oil pan through internal galleries in the cylinder head and engine block until the breath return. The breath return tube is fastened on one end to the lower part of the engine block and its other end immerses in the oil pan.

**! Caution:** Even with the breath valve, a small amount of evaporated oil can reach the intake. Thus, the appearance of an oil film in the engine intake is normal and does not indicate problems with the valve.

### Valve cover and breath valve

#### Removal

1. Remove the fuel injectors, [see Fuel System - Fuel injectors](#).
2. Remove the common rail, [see Fuel System - Common Rail](#).
3. Remove the breath hose loosening the clamp with a pliers.
4. Using an 8 mm socket wrench, remove the two bolts from breath valve.



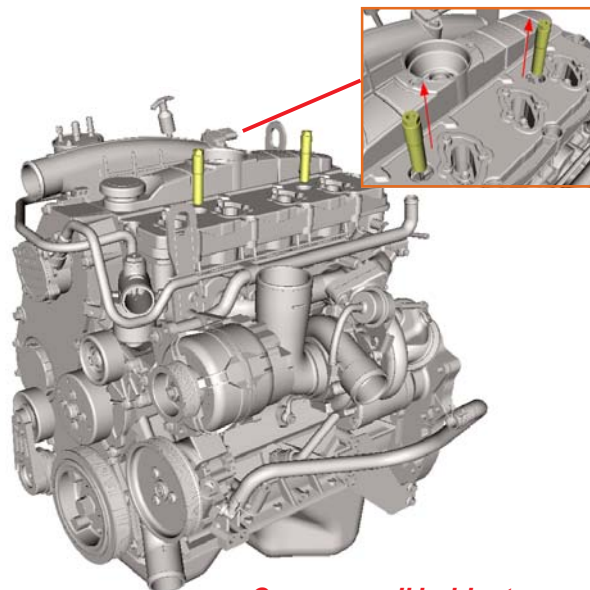
Breath valve

5. Clean the breath valve housing with a lint free cloth.

**! Caution:** The breath valve is a "Black box" item. It is not allowed to open it, which would cause warranty loss.

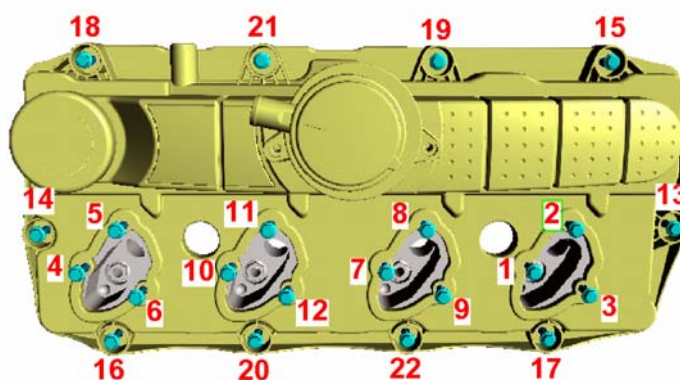
**! Caution:** The breath valve can be removed along with the valve cover.

6. Using a 15 mm socket wrench, remove the two common rail holder towers.

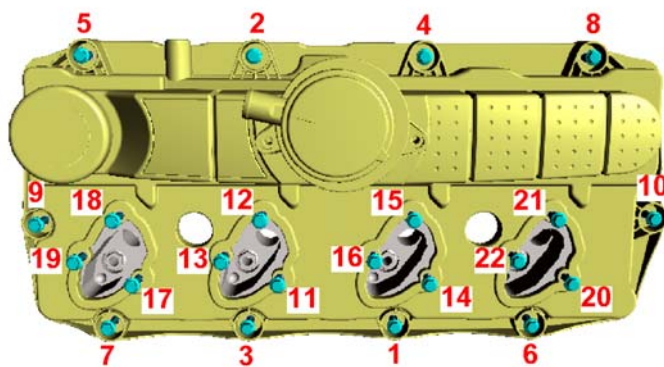


*Common rail holder towers*

7. Using an 8 mm socket wrench, remove the twenty two valve cover bolts.



*Valve cover loosening sequence*



Valve cover tightening sequence

### Assembly

**⚠ Caution:** Replace the valve cover rubber gasket and the breath valve O-ring.

1. Install valve cover and install twenty two bolts without tightening them.
2. Using a 15 mm socket wrench, install two common rail holder towers applying a torque of 35 - 40 Nm.
3. Apply a torque of 5 - 6 Nm on the twenty two bolts of the valve cover following the indicated order.

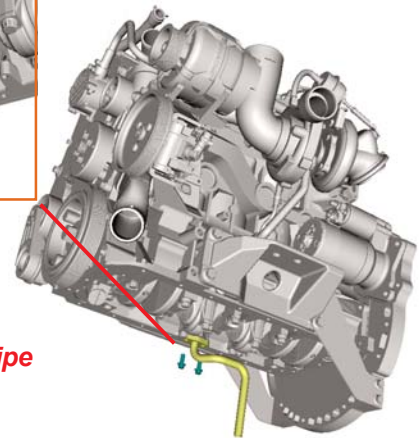
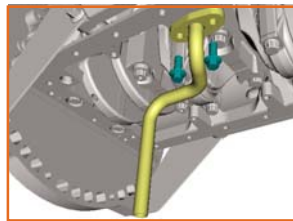
4. Install breath valve applying a torque of 5 - 6 Nm using an 8 mm socket wrench.

**⚠ Caution:** The breath valve bolts have self-tapping screws; so be careful not to create a new thread and neither stripping the threads of the valve cover.

5. Install common rail, [see Fuel System - Common Rail](#).
6. Install fuel injectors, [see Fuel System - Fuel injectors](#).
7. Install hose and hose clamp for the breath valve using a pliers for the clamp.

**Breath return****Removal**

1. Drain the lubrication system, [see Lubrication System - Draining.](#)
2. Remove the oil pan, [see Lubrication System - Oil Pan.](#)
3. Using a 10 mm socket wrench, remove the breath return pipe.

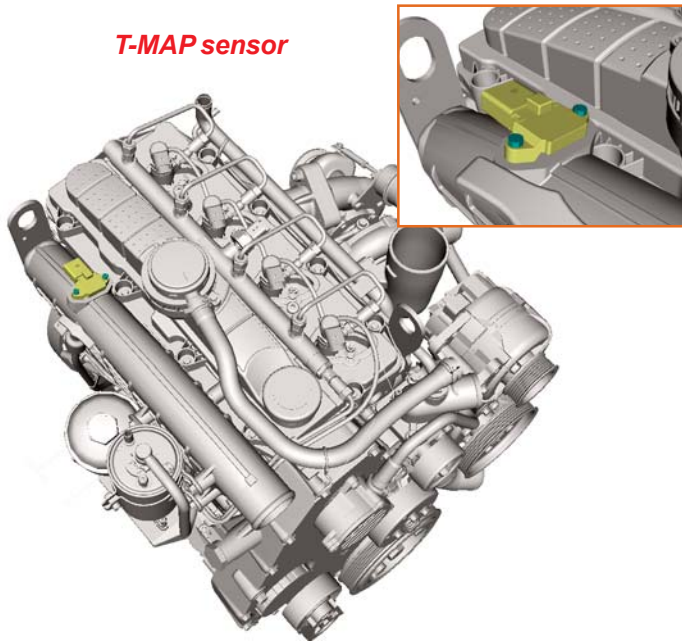
**Breath return pipe****Assembly**

1. Using a 10 mm socket wrench, install breath return pipe applying a torque of 22 - 28 Nm to the bolts.
2. Install oil pan, [see Lubrication System - Oil Pan.](#)
3. Refill the oil lubrication system, [see Lubrication System - Refill.](#)

**Intake manifold****Removal**

1. Remove the air inlet hose from intercooler.
2. Disconnect the wiring connectors from fuel temperature sensor and from T-MAP sensor.

T-MAP sensor



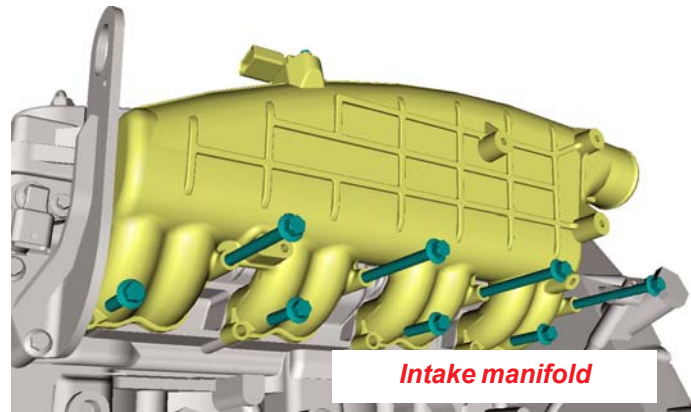
3. Using a 6 mm socket wrench, remove the T-MAP sensor.

**Note:** For more details on the T-MAP sensor, [see Electronic Control.](#)

4. Remove the fuel filter, [see Fuel System - Preventive Maintenance.](#)
5. Using an 8 mm socket wrench, remove the three bolts securing the fuel filter holder and remove the filter.
6. Remove the oil dipstick tube, [see Lubrication System - Dipstick Tube.](#)
7. Using an 8 mm socket wrench, remove the tubing clamps that secure the high pressure pump fuel tube and the fuel injectors return tube.
8. Using a 17 mm wrench, remove the fuel tube from high pressure pump.
9. Using an 8 mm socket wrench, remove the fuel temperature sensor housing sensor removing the two bolts, [see Fuel System - Temperature Sensor Housing.](#)

**Note:** For more details about the fuel temperature sensor, [see Electronic Control.](#)

- Using a 10 mm socket wrench, remove the intake manifold removing the eight intake manifold bolts.
- Remove the four gaskets from intake manifold.



### Assembly

- Install four new gaskets on the cylinder head. Check that the markings on the gasket are facing to the manifold with their arrows pointing downward.
- Install intake manifold applying a torque of 22 - 28 Nm on eight bolts. Four bolts have a length of 85 mm and the other four have a length of 35 mm.
- Install oil dipstick tube, [see Lubrication System - Dipstick Tube](#).
- Install air intake hose to the Intercooler.
- Using a 6 mm socket wrench, install T-MAP sensor applying a torque of 3 - 4 Nm and replacing the washers.
- Install fuel temperature housing sensor, [see Fuel System - Temperature Sensor Housing](#).
- Connect the fuel temperature wiring terminal to the fuel temperature sensor.
- Install fuel filter holder and the fuel filter, [see Fuel System - Preventive Maintenance](#).

9. Install fuel supply tube on the high pressure pump (quick release coupling).

**! Caution:** Use genuine MWM-*International Motores* gaskets. MWM-*International Motores* does not take responsibility for the use of non genuine parts that cause the warranty loss.

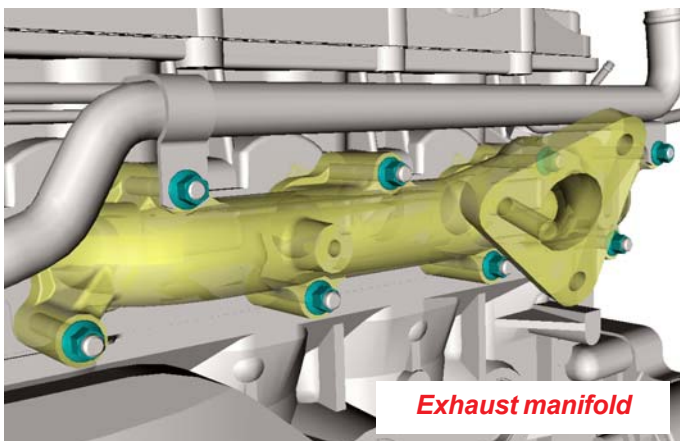
## Exhaust manifold

### Removal

1. Remove the turbocharger, [see Intake and Exhaust - Turbocharger](#).

**Note:** The intake manifold can be removed along with the turbocharger.

2. Remove the vacuum system hoses, loosening the clamps.
3. Remove the pipe from vehicle's heating system, [see Heating System - Heating System Pipe](#).
4. Using a 13 mm socket wrench, remove the other nuts securing the exhaust manifold.
5. Remove the exhaust manifold.
6. Remove the exhaust manifold gaskets.



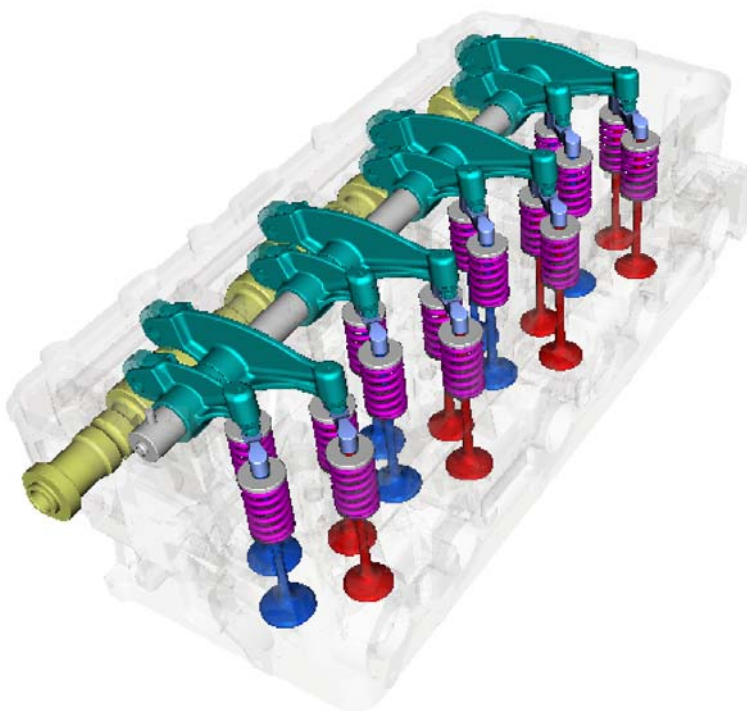
**Assembly**

1. Install four new gaskets on the cylinder head.
2. Install exhaust manifold and turbocharger assembly on the engine, first fitting it on the cylinder head studs and then, fitting the return pipe hose into the block connection.
3. Install turbocharger, [see Intake and Exhaust - Turbocharger](#).
4. Install hose clamp.
5. Install pipe of the vehicle's heating system, [see Heating System - Heating System Pipe](#).
6. Using a 13 mm socket wrench, tighten the other nuts, applying a torque of 22 - 28 Nm.
7. Refill the lubrication system, [see Lubrication System - Periodic / Preventive Maintenance](#).
8. Install air intake duct, [see Intake and Exhaust - Air Intake Duct](#).
9. Install intake and exhaust system hoses.
10. Install vacuum pump tube to the hoses, and tighten the clamps.



**Caution:** Use genuine MWM-*International* Motores gaskets. MWM-*International* Motores does not take responsibility for the use of non genuine parts that cause the warranty loss.





**Cylinder Head**

Cylinder head .....	98
Intake and exhaust valve, bridges, retainers and valve springs .....	105
Valve stem seal and valve springs .....	107
Cylinder head gasket .....	109
Rocker arm shaft .....	110
Camshaft .....	112
Cylinder head mounting bolts .....	114
Valve adjustment .....	115

## Removal and system assembly

### Cylinder head

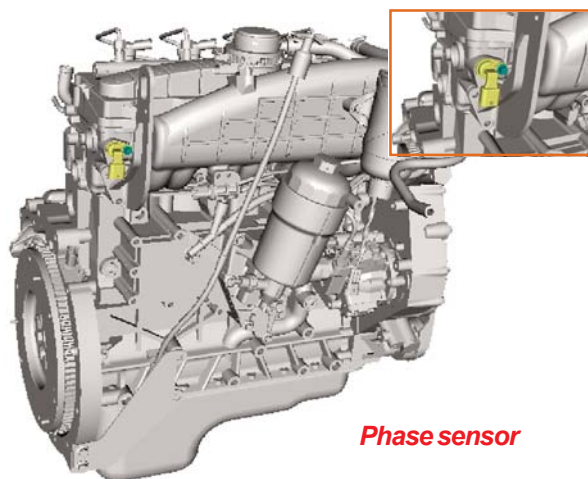
#### Removal

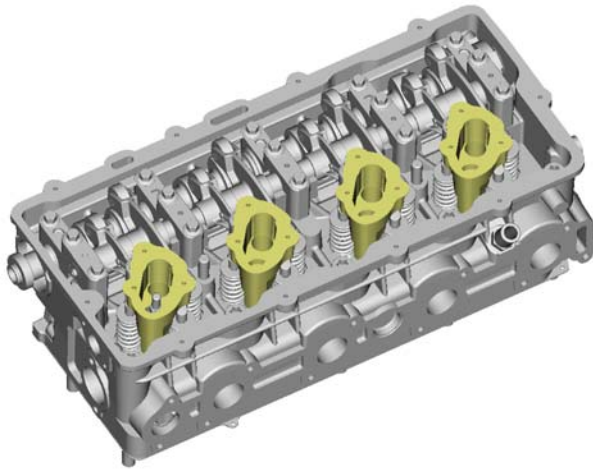
1. Drain the cooling system - [see Cooling System - Preventive maintenance.](#)
2. Remove the electrical connector from phase sensor.

3. Using the International Engines special tool nr. 8130632, fix the crankshaft to assure the engine timing before removal, [see Distribution and Timing - Engine Timing.](#)
4. Using a 7 mm wrench, disconnect the plug from phase sensor on the cylinder head.

**Note:** The phase sensor indicates the camshaft position in function of intake and exhaust valves opening.

5. Remove the breath valve hose, loosening the constant pressure clamp.
6. Remove the intake manifold; [see Intake and Exhaust - Intake Manifold.](#)
7. Remove the exhaust manifold; [see Intake and Exhaust - Exhaust Manifold.](#)
8. Remove the valve cover; [see Intake and Exhaust - Valve cover and Breath Valve.](#)



*Fuel injector adapter assembly*

9. Using a 13 mm socket wrench, remove the four fuel injector adapters.

10. Remove the fan, [see Cooling System - Fan](#).

11. Remove the engine front cover; [see Distribution / Timing - Distribution Housing Cover](#).

12. Remove the poly-V belt tensioner unit; [see Accessories - Poly-V Belt Tensioner](#).

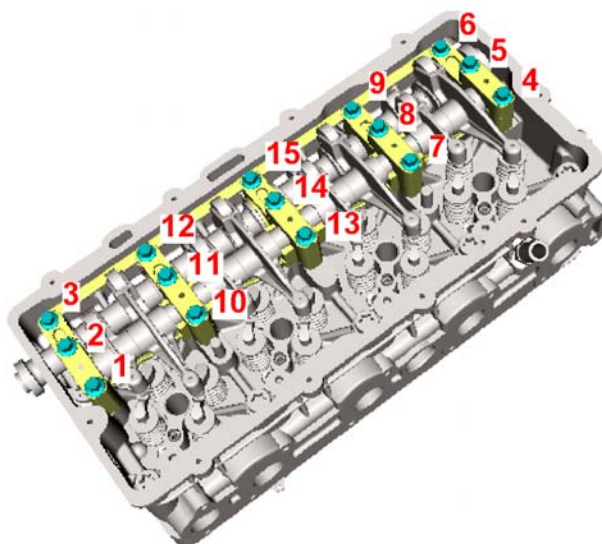
13. Remove the thermostatic valve housing; [see Cooling System - Thermostatic Valve Housing](#).

14. Remove the distribution chain system; [see Distribution / Timing System - Chain System](#).

15. Using a 30 mm Torx socket wrench, remove the coupling sleeve mounting bolts.

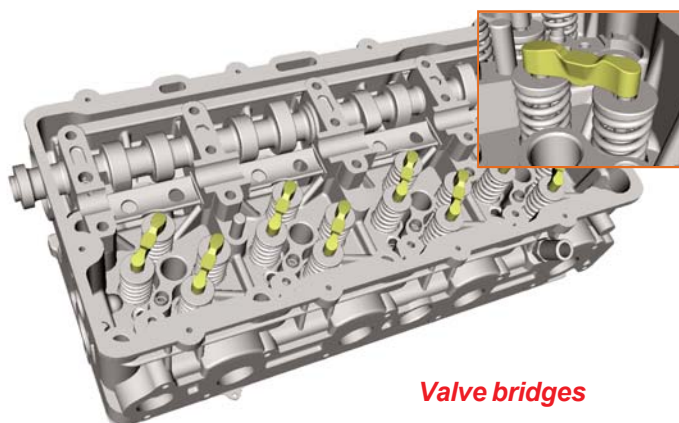
*Coupling Sleeve*

- 16. Remove the coupling sleeve.
- 17. Using a 10 mm socket wrench, loosen the bearings' mounting bolts from rocker arm shaft holder (frame) following the untightening sequence shown in the illustration (from both ends to the center).



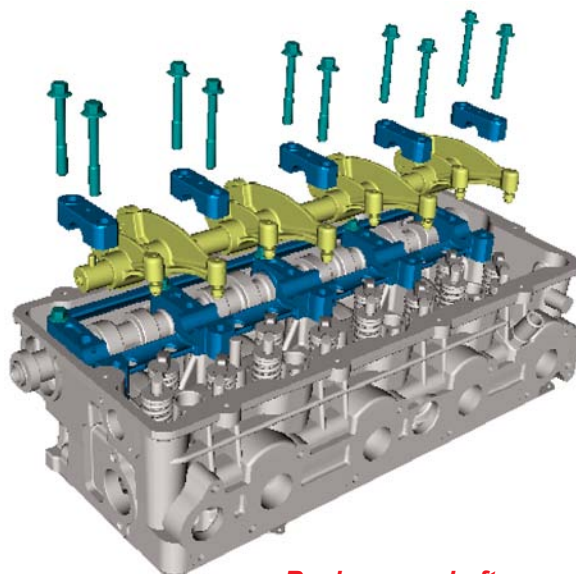
**Frame bolts untightening sequence**

- 18. Remove the rocker arm shaft bearings.
- 19. Remove the valve bridges.

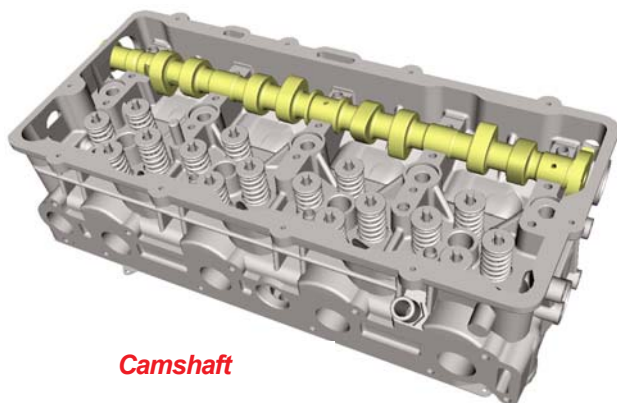


**Valve bridges**

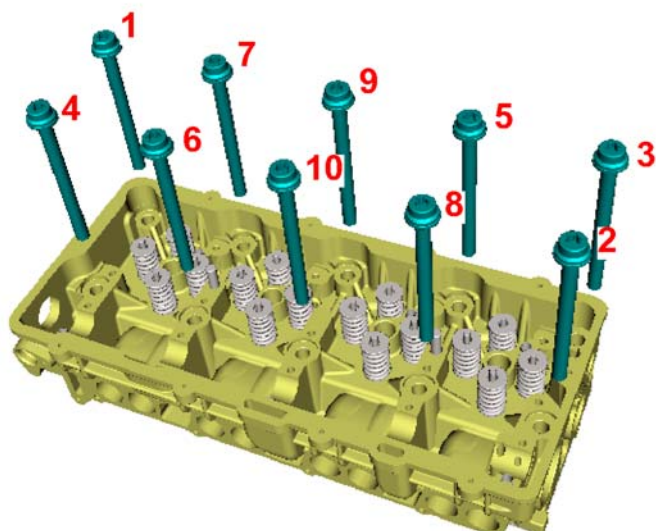
- 20. Remove the rocker arm shaft and its holder (frame).



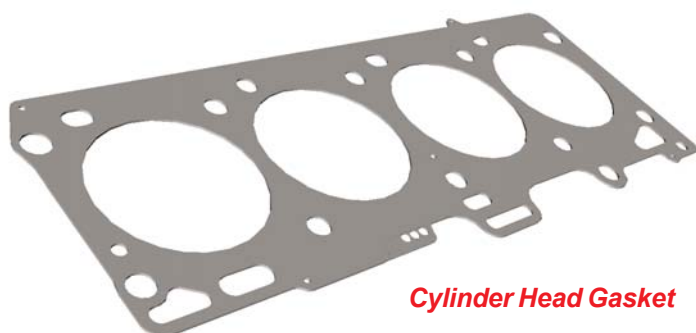
**Rocker arm shaft removal**



Camshaft



Cylinder head bolts untightening sequence



Cylinder Head Gasket

21. Carefully remove the camshaft.

**Note:** The camshaft for Troller application differs from that one used on Ranger application; they are not interchangeable pieces.

22. Using a T60 Torx socket wrench, loosen the cylinder head mounting bolts from cylinder block. Make it by strictly reversing the cylinder head bolts tightening sequence.

23. Remove the cylinder head and the gasket.

**Caution:** Carefully remove the cylinder head, maintaining the two dowel pins positioned on the cylinder block.

**Assembly**

1. Select a new cylinder head gasket with the correct thickness according to the piston height chart, *see below*:

Head Gasket Thickness		
Holes	Thickness (mm)	Piston Height (mm)
● ○ ○	1.31	from 0.58 up to 0.69
● ● ○	1.41	from 0.70 up to 0.79
● ● ●	1.51	from 0.80 up to 0.89
● ○ ●	1.61	from 0.90 up to 0.99

2. Fit the new gasket on the cylinder block dowel pins, with the indication TOP facing upward.
3. Place the cylinder head on the cylinder block, making sure that it fits perfectly on the cylinder block dowel pins.
4. Place and fasten the cylinder head bolts on the cylinder block, [see Mounting Bolts on this System.](#)

**! Caution:** Always check the cylinder head bolts length before reusing them. In case the length is longer than the maximum specified (141,9 mm), it is mandatory to use a new set of bolts.

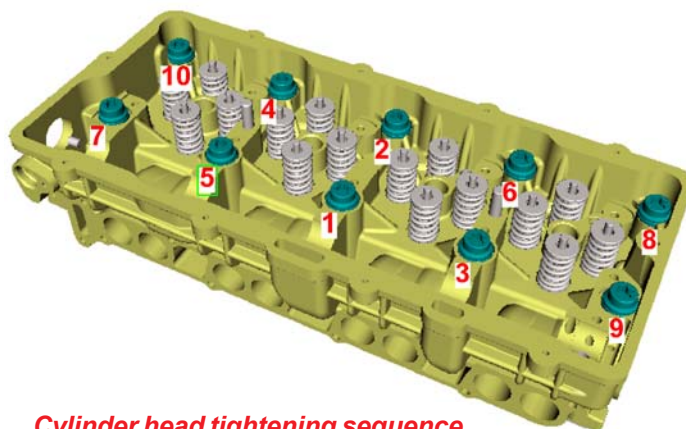
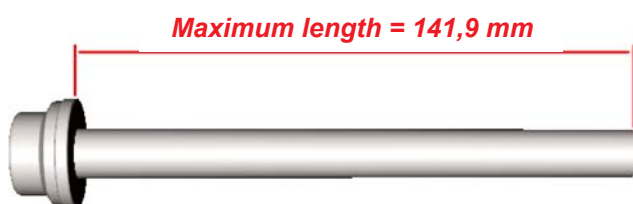
5. Using a T60 Torx socket wrench and an angle gage, apply the specified torque to the mounting bolts according to the tightening sequence, [see Mounting Bolts in this System.](#)

Description	Quantity
Torx Bolt M12 x 1,5 x 140	10

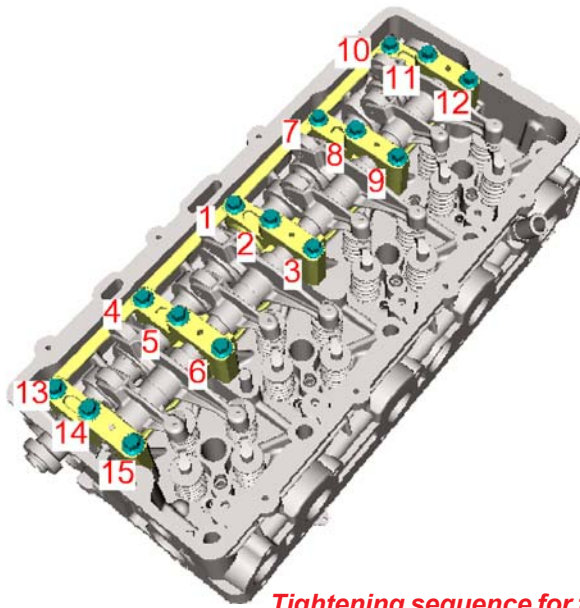
Torque Specification	
1st Step - Torque (Nm)	50 to 55
2nd Step - Torque (Nm)	50 to 55
3rd Step - Torque Angle	90° to 93°
4th Step - Torque Angle	180° to 185°

**Note:** 2nd step only to check the torque.

6. Place the valve bridges.
7. Install camshaft; [see Camshaft - Assembly, in this System.](#)
8. Place the rocker arm shaft holder (frame).
9. Install rocker arm shaft, [see Rocker Arm Shaft - Assembly in this System.](#)



**Cylinder head tightening sequence**



*Tightening sequence for the frame*

10. Using a 10 mm socket wrench, apply a torque of 18-22 Nm on the mounting bolts for the rocker arm shaft; follow the assembly order (from center to both sides). Repeat the operation to assure that the specified torque is applied to all bolts.

11. Using a 13 mm socket wrench, fasten the fuel injector adapters applying a torque of 22 - 25 Nm.

**⚠ Caution:** Replace the injection adapters O-rings only with original International Engines Parts.

12. Install valve cover; [see Intake and Exhaust - Valve Cover and Breath Valve.](#)

13. Install common rail; [see Fuel System - Common Rail.](#)

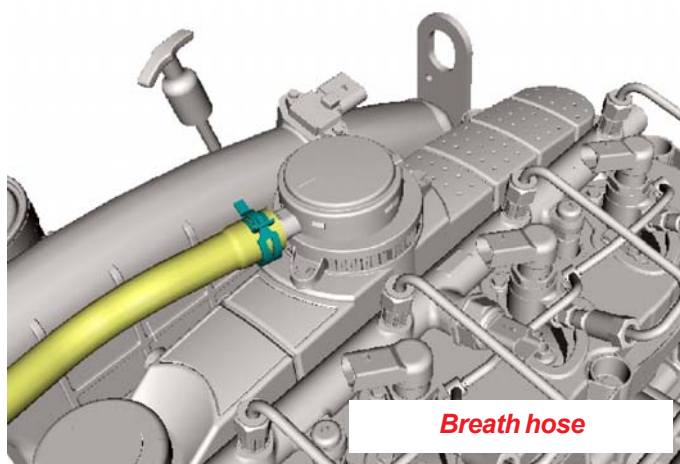
14. Install fuel injectors; [see Fuel System - Fuel injectors.](#)

15. Install intake manifold; [see Intake and Exhaust - Intake Manifold.](#)

16. Install exhaust manifold; [see Intake and Exhaust - Exhaust Manifold.](#)

17. Using a 30 mm Torx socket wrench, fasten the coupling sleeve applying a torque of 4 - 6 Nm on the mounting bolts.

18. Install sprockets driving chain system; [see Distribution / Timing - Chain System](#).
19. Unlock the camshaft.
20. Install distribution housing cover and the external front pulley train; [see Distribution/ Timing System - Distribution Housing Cover](#).
21. Install thermostatic valve housing; [see Cooling System - Thermostatic Valve Housing](#).
22. Connect the breath hose to the breath valve.
23. Using a vise-grip type pliers, install breath hose constant pressure clamp on the breath valve.



24. Using a 7 mm socket wrench, connect the phase sensor plug located on the cylinder head.
25. Unlock the engine flywheel.
26. Connect the electrical connector of the phase sensor.
27. Refill the cooling system, [see Cooling System - Preventive Maintenance](#).
28. Refill the engine with lubricating oil, [see Lubrication System - Preventive Maintenance](#).

**Caution:** Do not forget to remove the timing and flywheel locker tools.

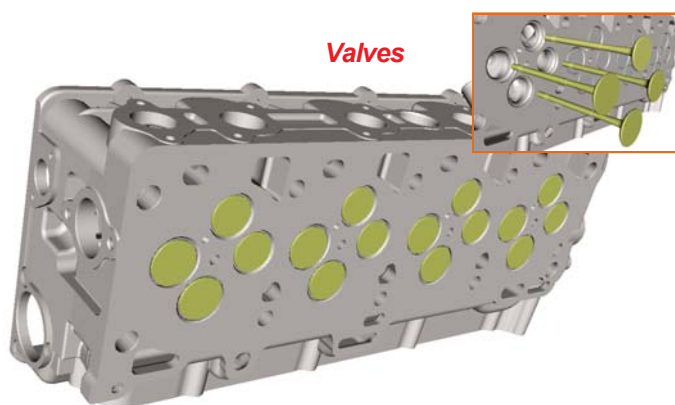
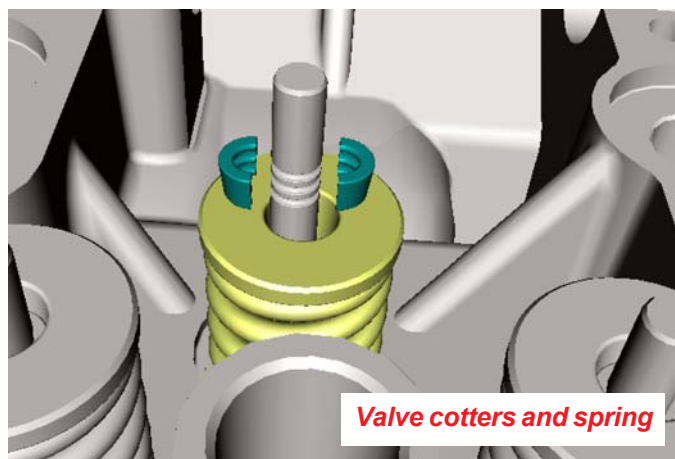


**! Caution:** In case it is necessary to remove and assemble the cylinder head, use the following procedures for the cylinder head sub-items.

### Intake and exhaust valve, bridges, valve stem oil seals and valve springs

#### Disassembling on workbench

1. Remove the cylinder head, [see Cylinder Head - Removal](#).
2. Using a special International Engines tool nr. 8130001 or nr. 8130002, compress the intake and exhaust valves.
3. Remove the cotters and springs from intake and exhaust valves.
4. Remove all cylinder head valves identifying them with their respective cylinders.



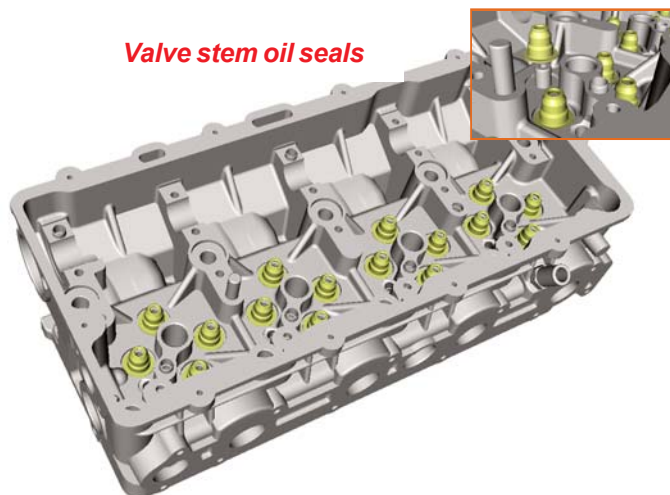
5. Remove manually all the valves stem oil seals.

**Note:** If necessary, replace the intake and exhaust valves.

#### Assembling on workbench


1. Lubricate with engine oil all valve guides before assembling the valve stem oil seals.
2. Lubricate with engine oil all cylinder head valves.
3. Install intake and exhaust valves into the cylinder head valve guides.
4. Install new valve stem oil seals on the valve guides, using the plastic protection caps supplied with the International Engines "Replacement Kit".
5. Install valve springs, seats and valve cotters.
6. Compress the valve springs and install respective valve cotters using the International Engines special tool nr. 8130001 or nr. 813 0002.
7. Install cylinder head, [see Cylinder Head - Assembly](#).

Valve stem oil seals



**Valve springs and valve stem oil seals****Disassembling on vehicle**

1. Remove the valve cover, [see Intake and Exhaust - Valve Cover and Breath Valve](#).
2. Rotate the crankshaft and place the piston corresponding to the valve removal on top dead center (TDC).
3. Remove the rocker arm shaft.
4. Remove the rocker arms from rocker arm shaft.
5. Install rocker arm shaft without the rocker arms.
6. Remove the valve bridges manually.
7. Using the International Engines special tool nr. 810002, remove the valve cotters and seats.
8. Replace the spring and the valve stem oil seal, if necessary.

 **Caution:** If necessary, use this procedure for the other cylinders. When this procedure is to be used for more than one cylinder, follow the sequence:

- 1st and 3rd cylinder on TDC using the standard procedure;
- Place 2nd and 4th cylinder on TDC using the procedure starting from step 3.

**Assembling on vehicle**

**!** **Caution:** For the valve stem oil seal installation, use the valve stem plastic protection cap supplied with the International Engines "Replacement Kit".

1. Install new valve oil stem seals on the valve guides.
2. Place the valve springs, seats and cotters.
3. Compress the valve spring and install respective valve cotters, using the International Engines special tool nr. 81300002.

**Note:** Use this procedure for the other cylinders, if necessary.

4. Install valve bridges.
5. Install rocker arm shaft, placing the rocker arms on the valve bridges, [see Rocker Arm Shaft in this System.](#)
6. Install valve cover; [see Intake / Exhaust - Valve Cover and Breath Valve.](#)
7. Fasten the breath hose with the constant pressure hose clamp using a vise grip pliers.

**Protection cap for the valve stem oil seal installation**

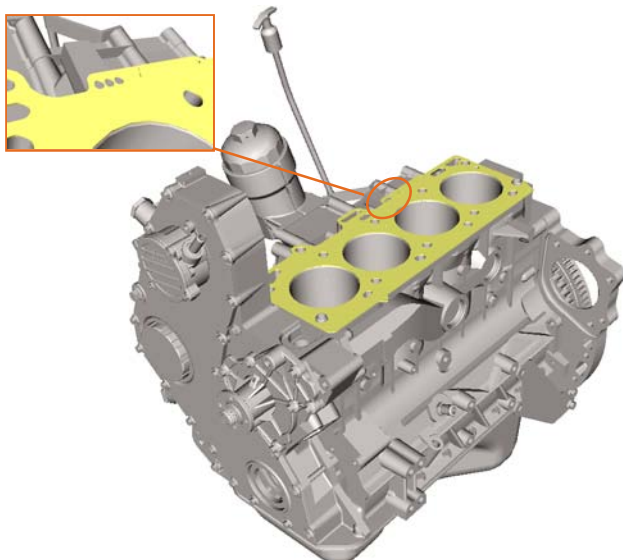


Cylinder head gasket

**! Caution:** There are four types of cylinder head gasket available for assembling, identified by the holes on the left side of the gasket.

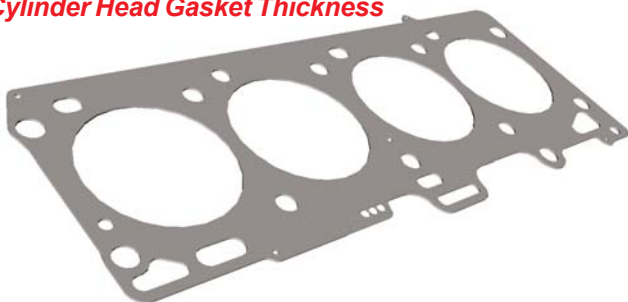
1. Select the new gasket with the correct thickness according to the piston height and the machined face of the cylinder block (see chart below).

Location of thickness identification



Thickness of the cylinder head		
Holes	Thickness (mm)	Piston height (mm)
● ○ ○	1.31	from 0.58 up to 0.69
● ● ○	1.41	from 0.70 up to 0.79
● ● ●	1.51	from 0.80 up to 0.89
● ○ ●	1.61	from 0.90 up to 0.99

Cylinder Head Gasket Thickness



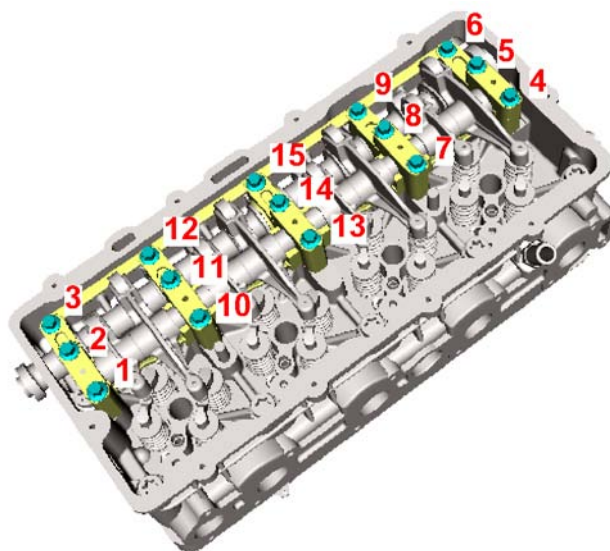
2. Place the new gasket on the cylinder block with the marking TOP facing upward, fitting it on the two dowel pins.

**! Caution:** Use genuine MWM-*International* Motores parts. The MWM-*International* Motores is not responsible for the use of non genuine parts and will result in a warranty loss.

## Rocker arm shaft

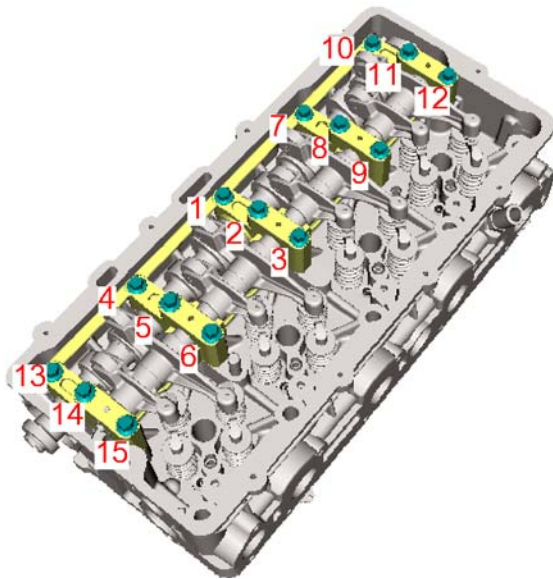
### Removal

1. Using a vise-grip type pliers, loosen the constant pressure clamp and remove the breath hose from breath valve.
2. Remove the valve cover; [see Intake and Exhaust - Valve Cover and Breath Valve.](#)
3. Using a 13 mm socket wrench, remove the four fuel injector adapters.
4. Lock the camshaft, using a 7 mm diameter pin with a minimum 200 mm length at the timing position.
5. Using a 10 mm socket wrench, remove the fifteen mounting bolts from rocker arm shaft holder, following the untightening sequence from ends to center.



*Frame bolts untightening sequence*

6. Remove the rocker arm shaft bearings.
7. Remove the rocker arm shaft.



**Frame bolts untightening sequence**

### Assembly

1. Place the rocker arm shaft on the cylinder head.
2. Using a 10 mm socket wrench, apply a torque of 18-22 Nm on the rocker arm shaft holder mounting bolts in the following tightening sequence (from center to both ends).

3. Using a 13 mm socket wrench, apply a torque of 22 - 25 Nm on the mounting nuts of the four fuel injector adapters.


**⚠ Caution:** Replace the sealing O-rings of the adapters with MWM-*International* Motores original parts.

4. Install valve cover; [see Intake and Exhaust - Valve Cover and Breath Valve.](#)
5. Install common rail, [see Fuel System - Common Rail.](#)
6. Install fuel injectors, [see Fuel System - Fuel injectors.](#)
7. Connect the breath hose to the breath valve.
8. Using a vise-grip type pliers, install breath hose constant pressure clamp on the breath valve.

## Camshaft

### Removal

1. Using a vise-grip type pliers, loosen the constant pressure hose clamp and remove the breath hose from breath valve.
2. Remove the valve cover; [see Intake and Exhaust - Valve cover and Breath Valve.](#)

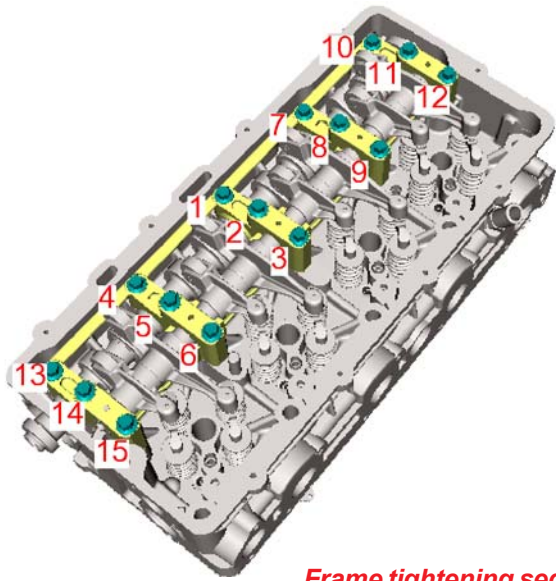
 **Caution:** After the valve cover removal, lock the camshaft for the next removal step, [see Distribution / Timing - Removal.](#)

3. Using a 13 mm socket wrench, remove the four fuel injector adapters.
4. Remove the engine front cover; [see Distribution / Timing - Distribution Housing Cover.](#)
5. Remove the engine chain system; [see Distribution / Timing - Chain System.](#)
6. Remove the rocker arm shaft and its holder (frame), [see Rocker Arm Shaft - Removal in this System.](#)
7. Carefully remove the camshaft.

### Assembly

1. Lubricate the camshaft.
2. Carefully install camshaft on the cylinder head.
3. Place the rocker arm holder (frame) and the valve bridges.
4. Lock the camshaft using a 7 mm diameter pin and a minimum 200 mm length at the timing position.
5. Place the rocker arm shaft on its frame.





*Frame tightening sequence*

6. Using a 10 mm socket wrench, apply a torque of 18 - 22 Nm on the fifteen holder (frame) mounting bolts according to the tightening sequence, from center to ends, according to illustration. Tighten the rocker arm shaft and camshaft bearing bolts. Repeat the operation to assure that the specified torque is applied to all bolts.

7. Install engine chain system; [see Distribution / Timing - Chain System](#).
8. Unlock the camshaft and the engine flywheel.
9. Rotate the crankshaft manually and check that the idler pulley rotates smoothly.
10. Install distribution housing cover and the frontal external pulley train, [see Distribution / Timing - Distribution Housing Cover](#).
11. Using a 13 mm socket wrench, fasten the fuel injector adapters applying a torque of 22 - 25 Nm.
12. Install valve cover; [see Intake and Exhaust - Valve Cover and Breath Valve](#).
13. Install fuel injectors, [see Injection System - Fuel injector](#).
14. Install common rail, [see Injection System - Common Rail](#).
15. Place the breath hose on the breath cover.
16. Using a vise-grip type pliers, install clamp to the breath hose.

17. Refill the engine with engine coolant; [see Cooling System - Preventive Maintenance](#).
18. Refill the engine with lubricating oil; [see Lubrication System - Preventive Maintenance](#).

## Cylinder head mounting bolts

**! Caution:** After removal, check the cylinder head mounting bolts for deformation using a measuring instrument and check the bolt nominal length.

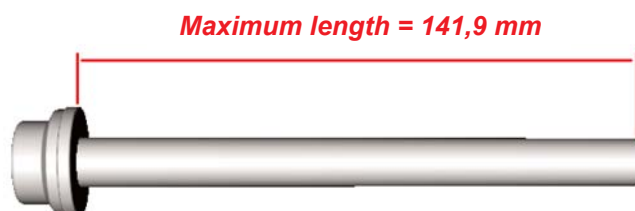
If the nominal length exceeds 141,9 mm, discard the bolt and replace it.

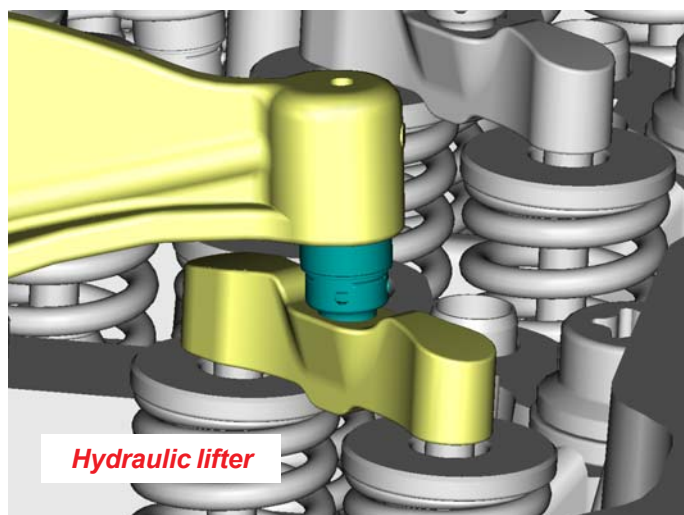
1. Check the nominal length of the bolts before assembling.
2. Lubricate the cylinder head mounting bolts before assembling.
3. Place the bolts on the cylinder head, without tightening them.
4. Apply the specified torque according to the chart bellow.

Description	Quantity
Torx Bolt M12 x 1,5 x 140	10

Torque Specification	
1st Step - Torque (Nm)	50 to 55
2nd Step - Torque (Nm)	50 to 55
3rd Step - Torque Angle	90° to 93°
4th Step - Torque Angle	180° to 185°

**Note:** 2nd Step only to check the torque.

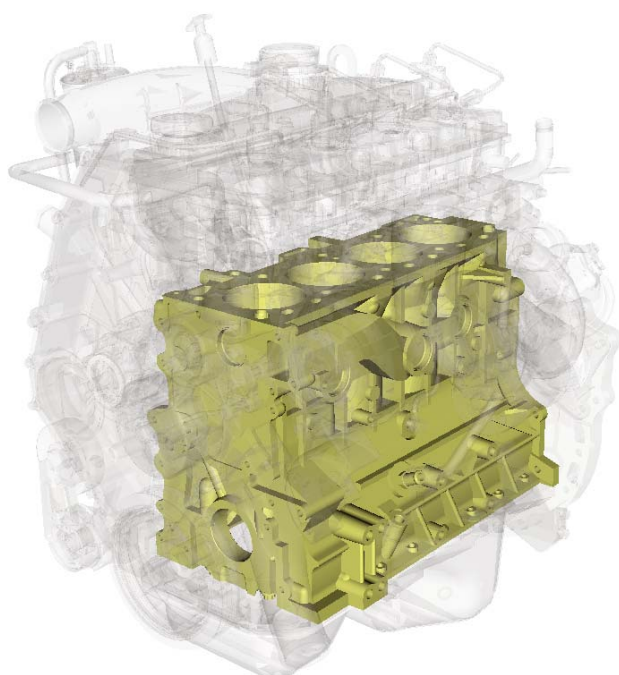




### Valve adjustment

**⚠ Caution:** This engine has a hydraulic lifter system that eliminates valve gap, therefore it is not necessary any type of valve adjustment.





## *Cylinder Block*

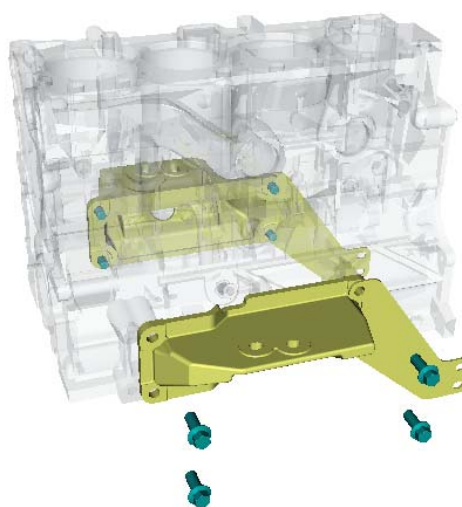
Cylinder block .....	118
Cleaning and inspection of the cylinder block .....	119

## Cylinder block

### Removal

After draining all fluids from cooling and lubrication systems, start the removal as described below:

1. Remove the engine from vehicle.
2. Remove all auxiliary components, [see Accessories](#).
3. Remove all components from intake and exhaust system, [see Intake and Exhaust System](#).
4. Remove the cooling system components, [see Cooling System](#).
5. Remove the fuel system components, [see Fuel System](#).
6. Remove the flywheel from engine, [see Flywheel and Ring Gear](#).
7. Remove the lubrication system components, [see Lubrication System](#).
8. Remove the distribution system components, [see Distribution /Timing](#).
9. Remove the cylinder head, [see Cylinder Head](#).
10. Remove the pistons and connecting rods, [see Pistons and Connecting Rods](#).
11. Remove the crankshaft, [see Crankshaft](#).
12. Using a 15 mm socket wrench, remove the four mounting bolts from engine mount and adapter plate. Perform this procedure for the engine mounts and adapter plates on both sides of the engine.
13. Remove the mounts and the adapter plates.



**Cylinder block cleaning and inspection**

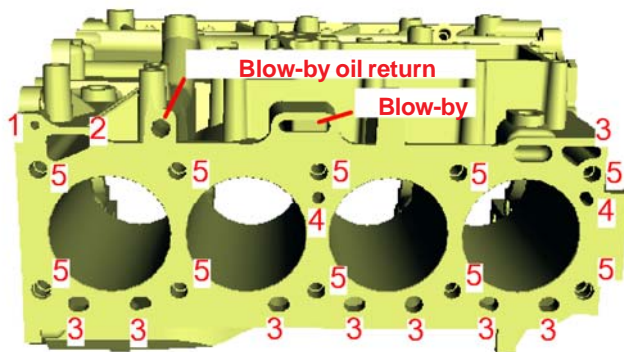
1. Remove the cooling system drain plug, the turbocharger drain plug and the oil gallery plug from cylinder block rear face.
2. Wash the cylinder block with pressurized hot water (80°C) using a degreasing agent. Maintain the cylinder block in an immersion bath for 12 hours, using a solution of water and chemical degreasing agent.

Remove the cylinder block from the bath and dry it with compressed air.

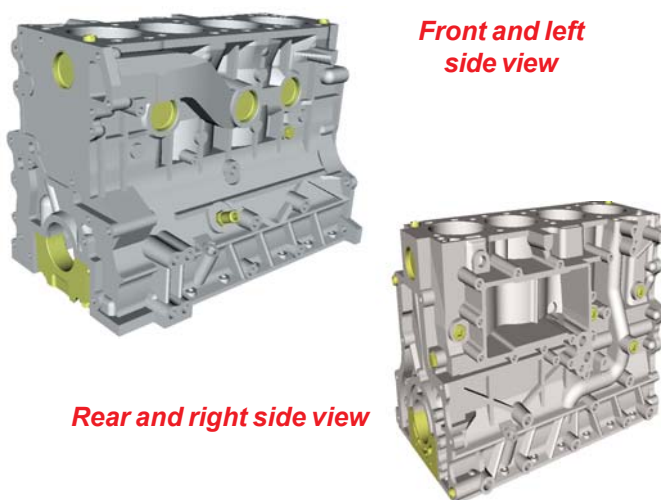
**Caution:** It is recommended to remove the seals before washing the cylinder block. Replace the seals after washing the cylinder block.

3. Clean the cylinder block galleries using pressurized hot water and dry them with compressed air. Check that the coolant and lubricating oil galleries are totally free of obstruction.

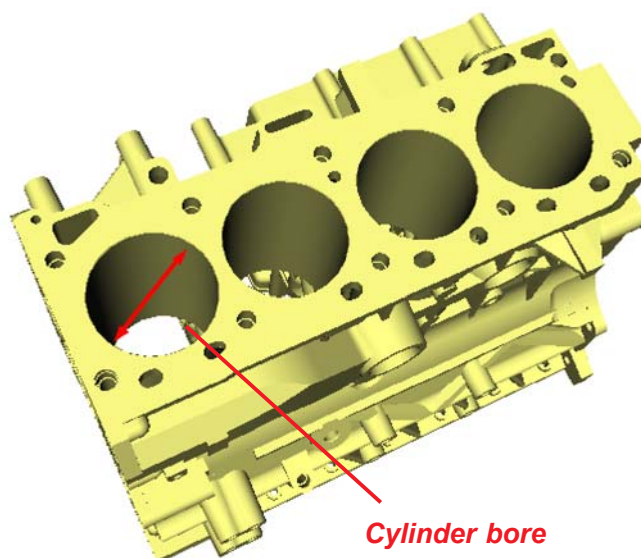
4. Inspect the cylinder block and block seals, checking for any cracks, scratches or other damages.



1. Cylinder head lubricating oil feeding.
2. Cylinder head lubricating oil draining.
3. Water gallery.
4. Water (Cylinder head closed circuit).
5. Cylinder head mounting bolt.



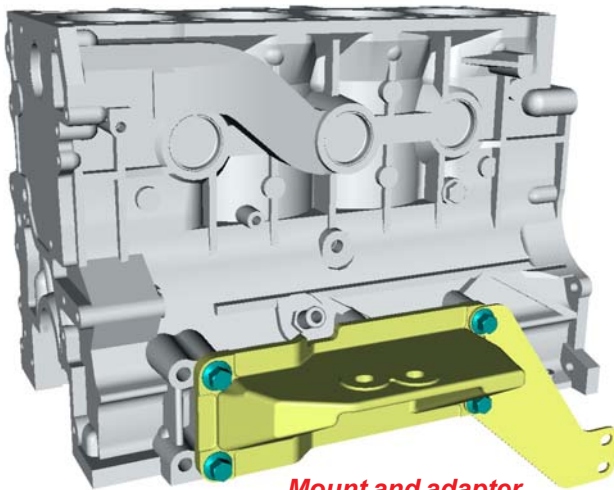
5. Inspect the wearing condition of the cylinders. Measure the internal diameter and compare it with data supplied on chapter "Technical Specifications".



### Assembly

1. Using a 17 mm socket wrench, fasten the cooling system drain plug to the cylinder block applying a torque of 13 - 17 Nm and using a Precote® 80 sealant.
2. Using a 19 mm socket wrench, fasten the turbocharger drain plug to the cylinder block applying a torque of 30 - 35 Nm and use a Loctite® 242 or Threebond® 1386E sealant.
3. Using a 19 mm socket wrench, fasten the oil gallery plug to the cylinder block rear face applying a torque of a 36 - 42 Nm and using Precote® 80 sealant.
4. Install the crankshaft assembly, [see Crankshaft](#).
5. Install the pistons and connecting rods assembly, [see Pistons and Connecting Rods](#).
6. Install the cylinder head assembly, [see Cylinder Head](#).
7. Install the distribution system components assembly, [see Distribution/Timing](#).
8. Install the lubrication system components assembly, [see Lubrication System](#).

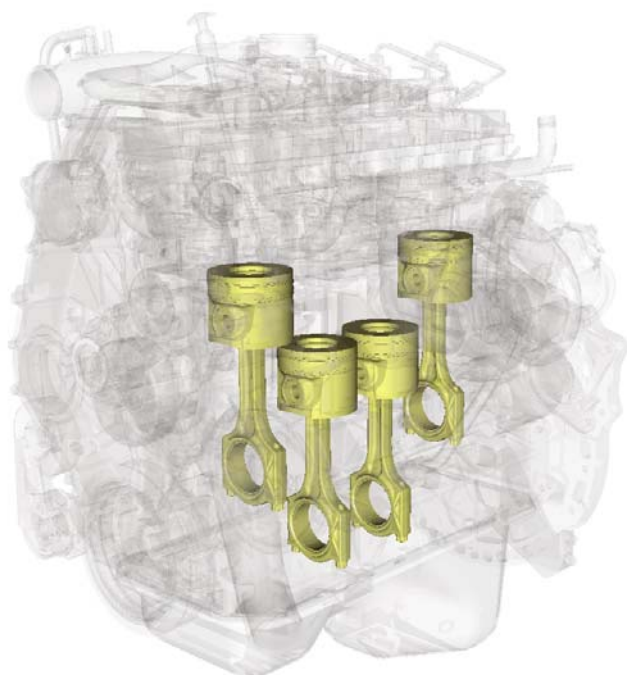




**Mount and adapter  
plate - assembly**

9. Install the engine flywheel assembly, [see Flywheel and Ring Gear](#).
10. Fasten the cylinder block adapter plate using a 13 mm socket wrench and applying a torque of 40 - 50 Nm to the two mounting bolts. Perform this procedure for the adapter plates on both sides of the cylinder block.
11. Fasten the cylinder block holder using a 15 mm socket wrench and apply a torque of 80 - 90 Nm on the four mounting bolts. Perform this procedure for the cylinder block mounts on both sides of the cylinder block.
12. Install the fuel system components assembly, [see Fuel System](#).
13. Install the cooling system components assembly, [see Cooling System](#).
14. Install the intake system components and exhaust system components assembly, [see Intake and Exhaust System](#).
15. Install the auxiliary components assembly, [see Accessories](#).
16. Install the engine on the vehicle.
17. Refill the lubrication system with lubricating oil, [see Lubrication System - Preventive Maintenance](#).
18. Refill the cooling system with engine coolant, [see Cooling System - Preventive Maintenance](#).





## *Pistons and Connecting Rods*

Pistons and connecting rods system removal and assembly .....	124
Cleaning and inspection .....	126

## Pistons and connecting rods system removal and assembly

### Removal

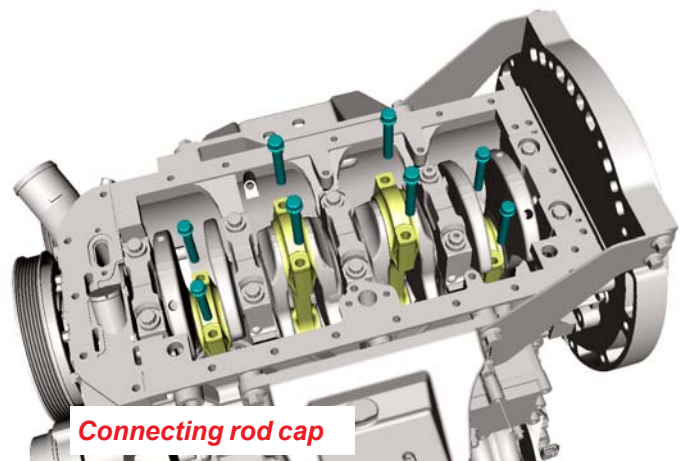
1. Drain the lubrication system, [see Lubrication System - Periodic Maintenance](#).
2. Drain the cooling system, [see Cooling System - Periodic Maintenance](#).
3. Remove the cylinder head, [see Cylinder Head - Removal](#).
4. Remove the oil pan, [see Lubrication System - Oil Pan](#).
5. Remove the suction tube, [see Lubrication System - Suction Tube](#).
6. Remove the breath return pipe, [see Intake and Exhaust - Air Breath Return](#).
7. Place the engine block vertically.

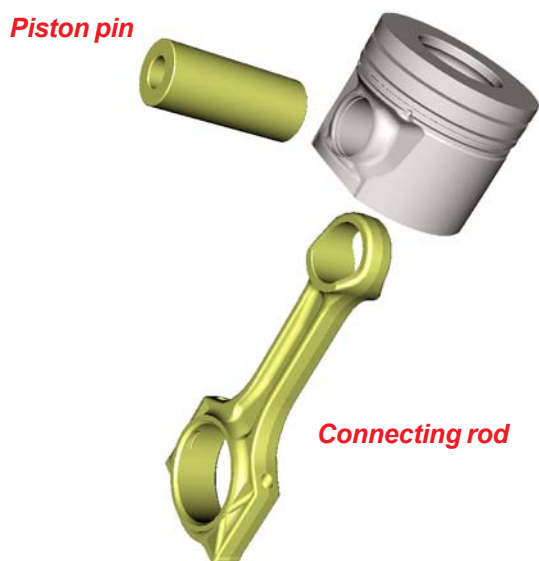
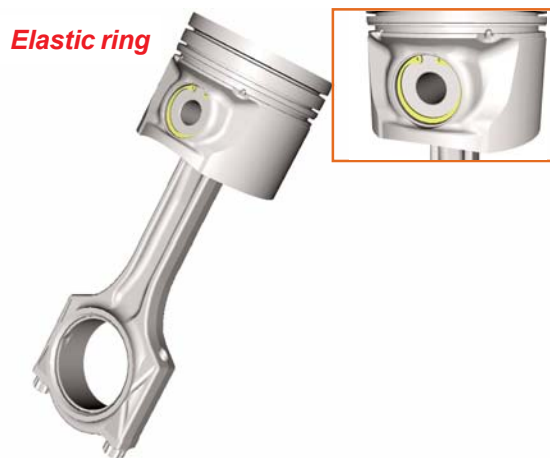
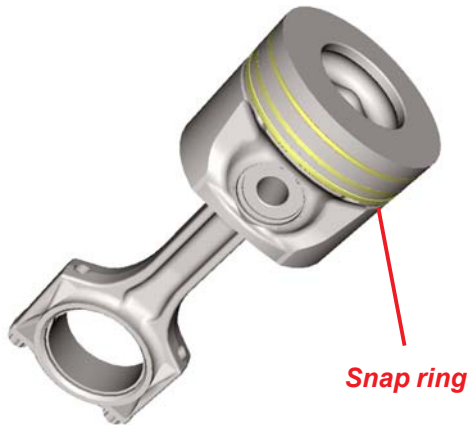
**!** **Caution:** Before removing the piston and connecting rod assembly, remove any carbon deposits built-up on cylinder's top. This operation aims to avoid any possible damages to the cylinders and piston rings during removal.

8. Using a 13 mm wrench, remove the connecting rod caps.

**!** **Caution:** Be very careful to avoid damaging the jet cooler with the connecting rod strut during its removal and assembling.

9. Using a guide tool, MWM-International Motores special tool nr. 8130646, remove the piston and connecting rod assembly.





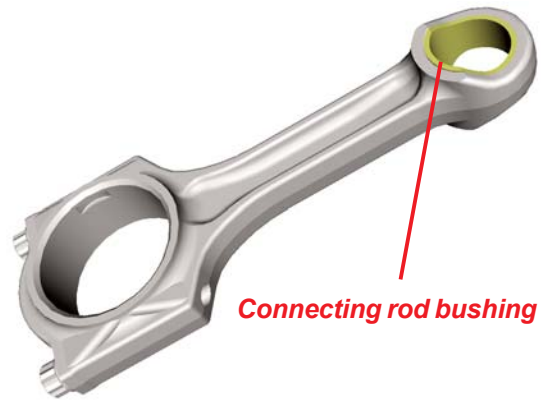
10. Using expansive pliers, MWM-*International* Motores Special tool nr. 813005, remove the piston rings from the piston.

11. Using a needle-nose pliers, remove the piston pin retaining rings.

12. Remove the piston pin and remove the piston from connecting rod.

**Note:** If piston pin removal is difficult, use water or oil to heat the piston up to 80°C.

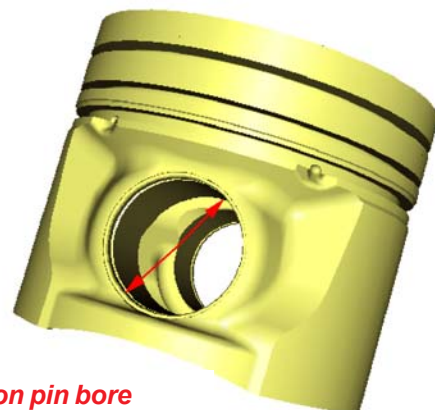
13. Remove the bushing from connecting rod.



### Cleaning and inspection

**!** **Caution:** Consult the chapter “Technical Specifications” to compare the measurements obtained during inspection.

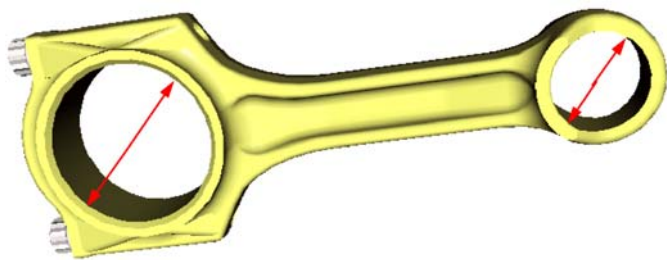
1. Check if the pistons do not have scratches or damages on the side and upper face.
2. Clean the carbon residues from ring guides without damaging them.
3. Using a micrometer with a dial indicator, measure the piston pin bore internal diameter. Using a micrometer with a dial indicator, measure the piston pin bore internal diameter.



**Piston pin bore**

*The measurements should be taken in horizontal, vertical and diagonal directions*

4. Measure the piston pin using a micrometer.

**Crankshaft bearing and connecting rod bushing bores**

The measurements should be taken in horizontal, vertical and diagonal directions

5. Using a micrometer with a dial indicator, measure the crankshaft bearing internal diameter in the connecting rod. The measurements should be taken in horizontal, vertical and diagonal directions.

6. Check the connecting rod for warpage and torsion.

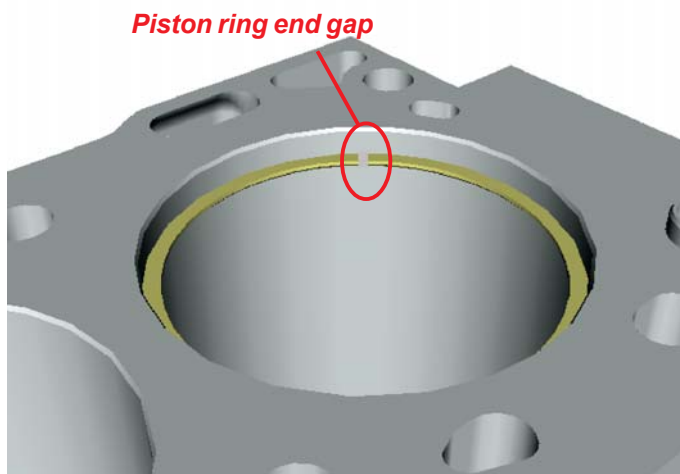
**! Caution:** If an abnormality is found, replace the part and mark the new position number on the connecting rod according to the respective engine block using an etching electric pencil. For example: The connecting rod for the 1st cylinder should be identified with the number 1.

**! Caution:** The connecting rods and the connecting rod caps of NGD 3.0E engine are produced by the fracturing process, which provides the component with better mechanical strength and a lesser weight. Due to this process, the connecting rod and its cap have a serial number on one side. Installation of sets with the same serial number only is mandatory.

**! Caution:** The connecting rod weight control is done by an identification code located on its cap. The last two digits indicate the connecting rod's weight. Ex: 1280g will be identified on the connecting rod by 8.0. In case of replacement, it is mandatory that all connecting rods have the same weight classification; otherwise, a whole set containing four new standard connecting rods should be installed.

- Using a feeler gauge, check the gap between the piston ring ends, installing it into the cylinder bore.

Gap between ends	Millimeters	
	Minimum	Maximum
1st compression ring	0.30	0.55
2nd compression ring	0.20	0.40
3rd oil scraper ring	0.30	0.50

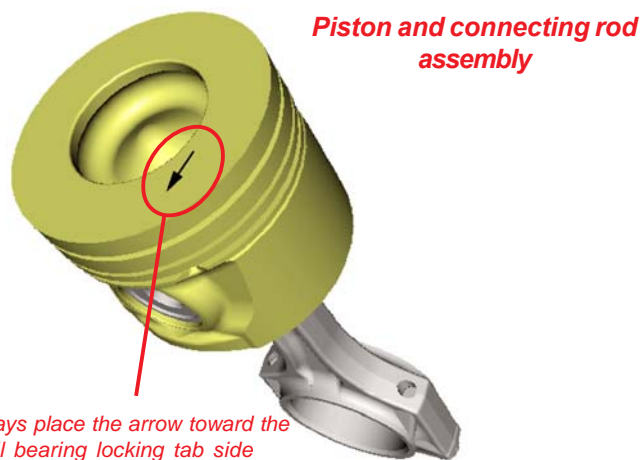
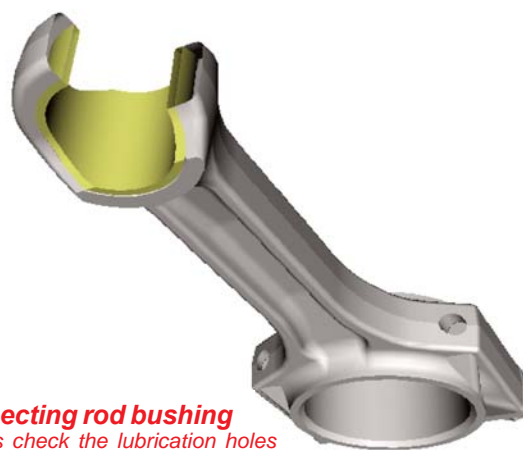


**Assembly**

- Install a new connecting rod bushing, being careful to check the lubrication hole alignment.

**Caution:** Due to deformations that occur to the connecting rod bushing at the time they are pressed, MWM-International Engines supplies the bushings in a semi-finished state, therefore, after they are pressed it is mandatory to finish them internally with a reamer.

- Install piston on the connecting rod with the arrow facing toward the bearing shell locking tab.



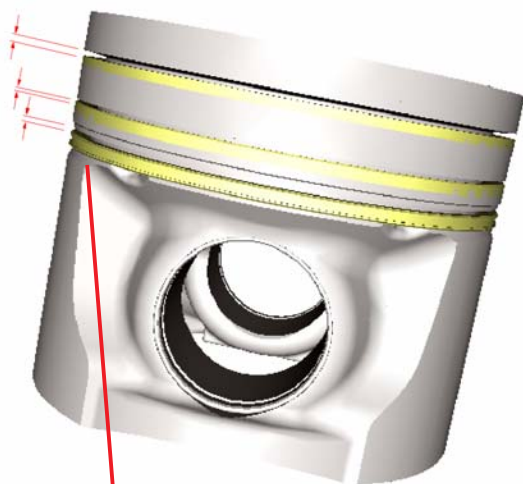


3. Insert the pin in the piston manually.
4. Install the piston pin retaining rings with a needle-nose pliers.
5. Using expansion pliers, MWM-*International* Motores special tools nr. 8130005, install piston rings in the piston, first install the oil scraper ring, and then install the second compression ring and, for last, install the top compression ring on the piston.

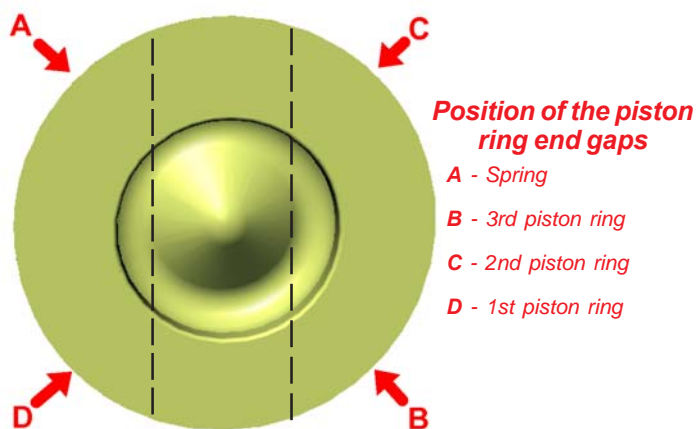
**Caution:** Make sure that the TOP marking is directed toward the upper face of the piston.

6. Using a caliper gauge, check the lateral gap of each piston ring in the groove.

Lateral gap	Milimeters	
	Minimum	Maximum
1st compression ring	0.103	0.182
2nd compression ring	0.050	0.090
3rd oil scraper ring	0.030	0.115



Lateral gap of the piston ring in the groove



7. Place the piston ring ends according to illustration.

**Caution:** The piston rings' end gaps should not be aligned with piston pin direction or the piston skirts.

**!** **Caution:** The weight variation of the four kits containing each one a piston, a connecting rod and piston rings should not exceed 5,5 g.

8. Install new bearing shells (nr. 70 050 215) on the connecting rod struts placing its locking tab correctly.

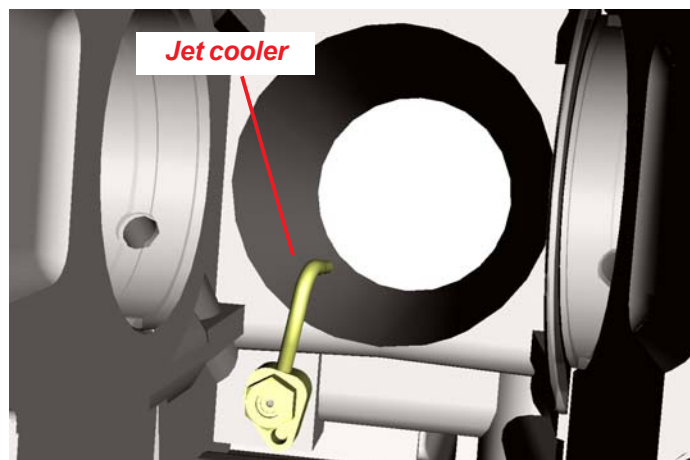
**!** **Caution:** The upper bearing shells differ from the others because they have a specific superficial treatment and should always be installed on the upper part of the connecting rod. There are two identification systems, by means of its identification number (70 050 215) or by its dim gray color.

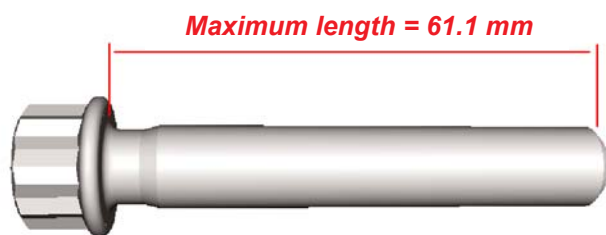
9. Apply engine oil to the piston's grooves area, the interior of the piston liner, the connecting rod shell and the sliding surface of the crankshaft.

**!** **Caution:** During the assembly, make sure that the piston arrow points toward the front of the engine.

10. Using a universal ring compressor and MWM-International Engines special tool nr. 8130646, install the piston and connecting rod assembly into the engine. The correct use of the tools is essential to avoid damages to the engine block.

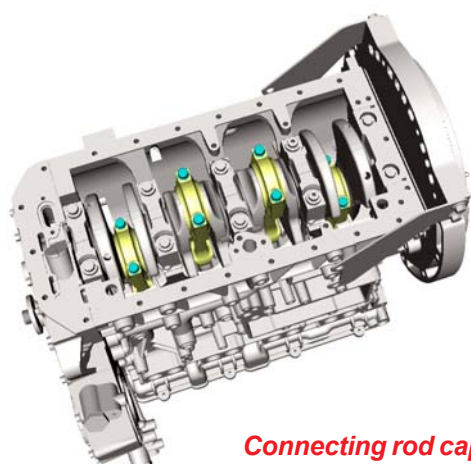
**!** **Caution:** Be very careful during the assembly, so that the connecting rod strut does not damage the jet cooler.





*Install the shell locking tabs aligned*

*Connecting rod cap*



*Connecting rod caps*

11. Install new traditional shell (no. 70 050 174) on the connecting rod cap.

**! Caution:** Check the connecting rod cap mounting bolts for any deformation using a measurement instrument, and also check the nominal length of the bolt.

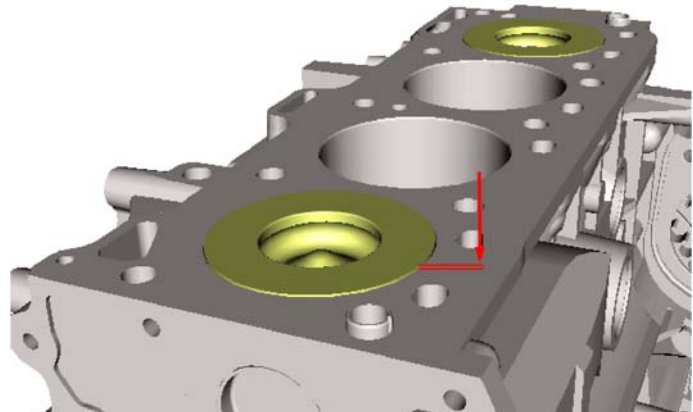
If the nominal length of the bolt exceeds 61.1 mm, discard the bolt and replace it with a new one.

12. Apply new engine oil to the connecting rod cap bearing shell and to crankshaft sliding surface.
13. Install the connecting rod caps corresponding to their respective cylinders.

**! Caution:** During the connecting rod cap assembly for the NGD 3.0E engine, always maintain the correspondence between bearing shell locking tabs from connecting rod and its cap.

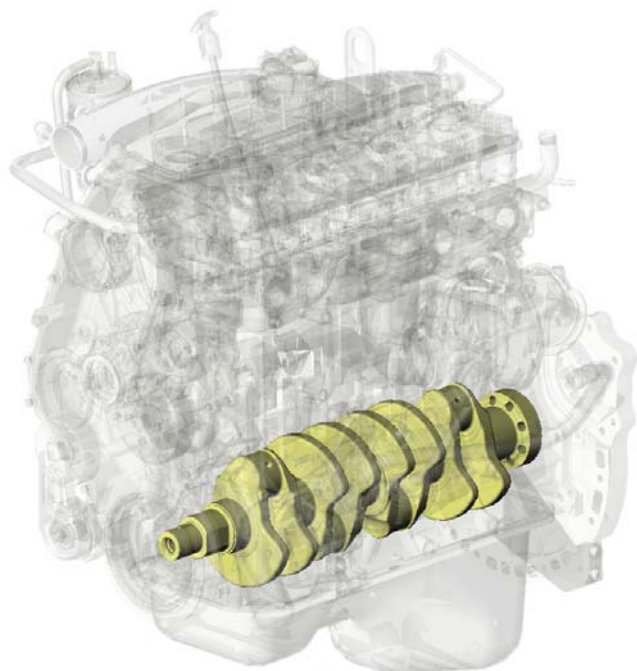
14. Using a 13 mm socket wrench, tighten the connecting rod cap bolts with the specified torque of 17 - 20 Nm + 125 - 130°.

15. Manually rotate the crankshaft while installing each connecting rod. If there is any difficulty in turning it, check all torques applied to the connection rods.
16. Using a dial indicator, check the axial clearance between the installed connecting rod and the crankpin.
17. Place the pistons on TDC and, using a dial indicator, check the protrusion of the piston in relation to the finished face of the block.



*Piston protrusion from block's finished face*

18. Install the cylinder head, [see Cylinder Head - Assembly](#).
  19. Install the distribution housing, [see Distribution / Timing - Distribution housing](#).
  20. Install the suction tube, [see Lubrication System - Suction Tube](#).
- ⚠ Caution:** Always install a new o-ring on the sleeve of the suction tube.
21. Install the return air breath pipe, [see Intake and Exhaust - Return Air Breath](#).
  22. Install the lubricating oil pan, [see Lubrication System - Lubricating Oil Pan](#).
  23. Refill the lubricating system, [see Lubrication System - Periodic Maintenance](#).
  24. Refill the cooling system, [see Cooling System - Periodic Maintenance](#).



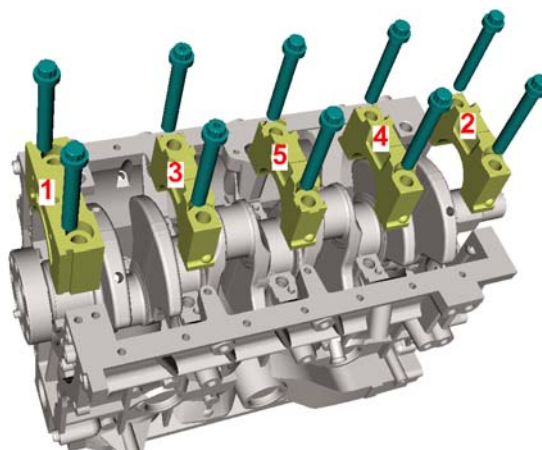
## Crankshaft

Crankshaft .....	134
Crankshaft cleaning and inspection .....	136
Rear seal crankshaft .....	140

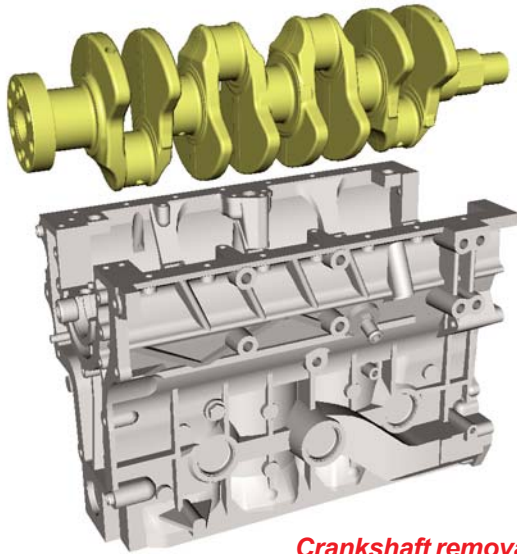
## Crankshaft

### Removal

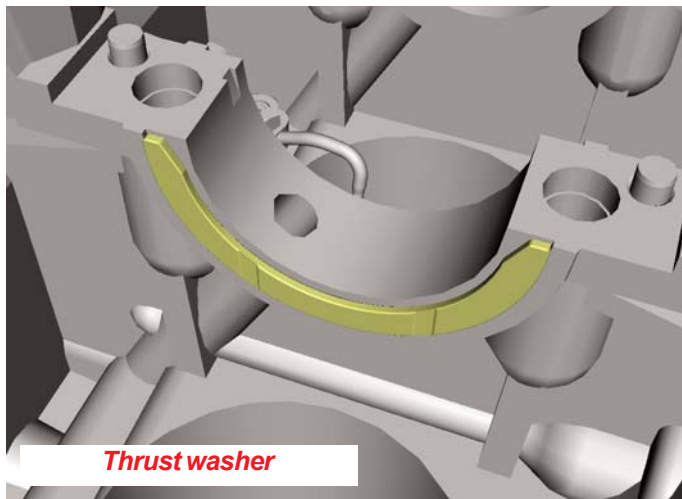
1. Remove the engine from vehicle.
2. Drain the lubrication system - [see Lubrication System - Periodic Maintenance](#).
3. Drain the cooling system - [see Cooling System - Periodic Maintenance](#).
4. Remove the lubricating oil pan, [see Lubrication System - Oil Pan](#).
5. Remove the suction tube, [see Lubrication System - Suction Tube](#).
6. Remove the breath return tube, [see Intake and Exhaust - Breath Return Tube](#).
7. Remove the rotation sensor from engine.
8. Remove the flywheel and the flywheel housing, [see Flywheel and Ring Gear - Removal and Assembly](#).
9. Remove the distribution housing, [see Distribution/Timing - Distribution Housing](#).
10. Remove the pistons and connecting rods, [see Pistons and Connecting Rods - Removal](#).
11. Remove the rear oil seal, [see Crankshaft Rear Oil Seal in this System](#).
12. Using a 14 mm socket wrench and following the illustrated sequence, remove the five crankshaft bearing holders from engine being careful to identify the position of each bearing holder in relation to the cylinder of the engine.



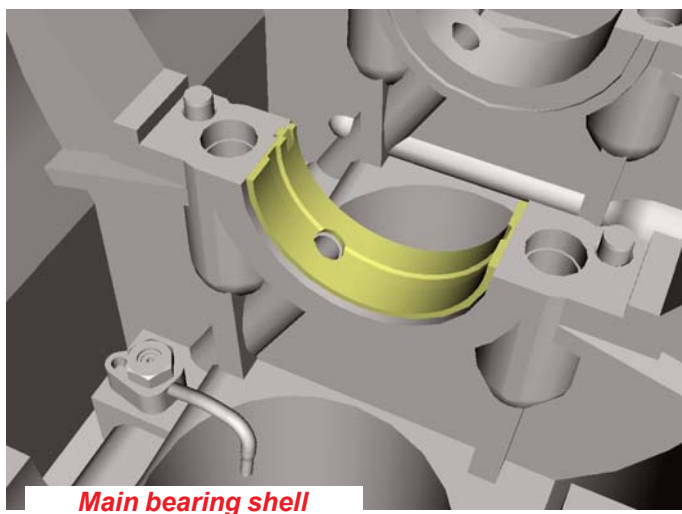
**Crankshaft bearing holders relief sequence**



13. Remove the crankshaft.



14. Remove the thrust washer manually.

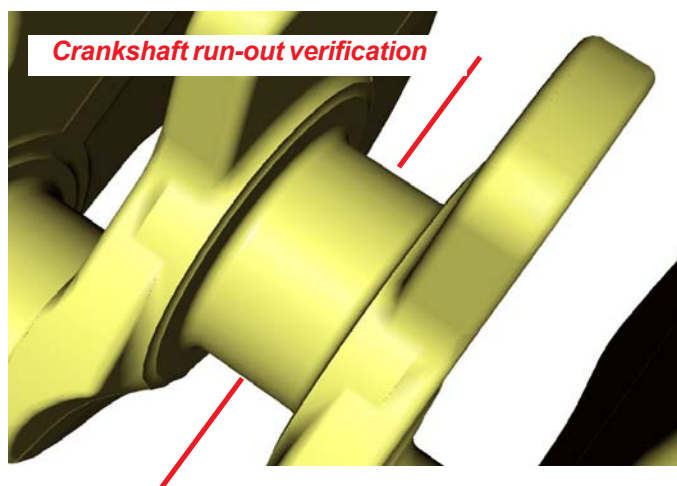


15. Remove the crankshaft shell bearings.

**⚠ Caution:** To avoid warping the crankshaft, store it in a vertical position, fitted in the engine flywheel.

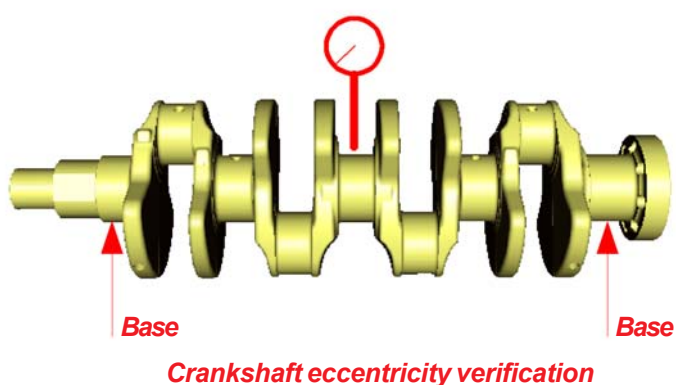
### Crankshaft cleaning and inspection

1. Remove the gasket material residues from engine block housing and from 5th bearing.
2. Clean the main journal and crankpin surfaces, examining them for scratches and damages.
3. Using a micrometer, measure the diameter and out-of-roundness of the main journal and crankpin at least in four distinct points.

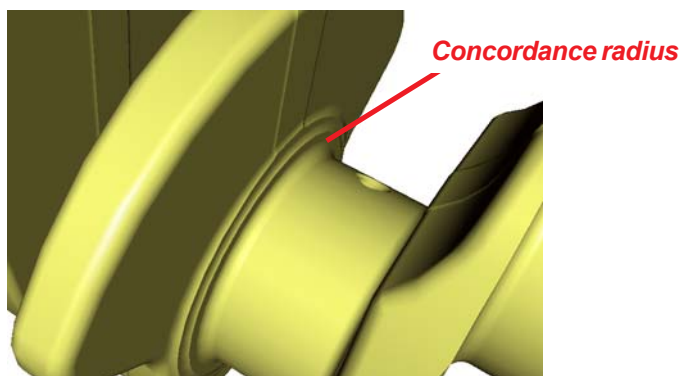


4. Using a dial indicator, check the maximum run-out of the main journals on the crankshaft.

**⚠ Caution:** To check the crankshaft's run-out, always keep the #1 and #5 main journals supported.







5. Using a gauge, check the concordance radius.

6. Check if there are any cracks on the piece using the Magnaflux test. Demagnetize the crankshaft after it.

**⚠ Caution:** If any cracks are found, the crankshaft must be replaced.

### Assembly

1. Clean the bearing shell housings on the block and on the bearing caps.
2. Check if the block lubrication galleries are free of obstruction.
3. Install new upper and lower shells on the block and bearing caps, locating the tabs correctly.

**⚠ Caution:** Whenever removing the crankshaft, install new shells and a new thrust washer.

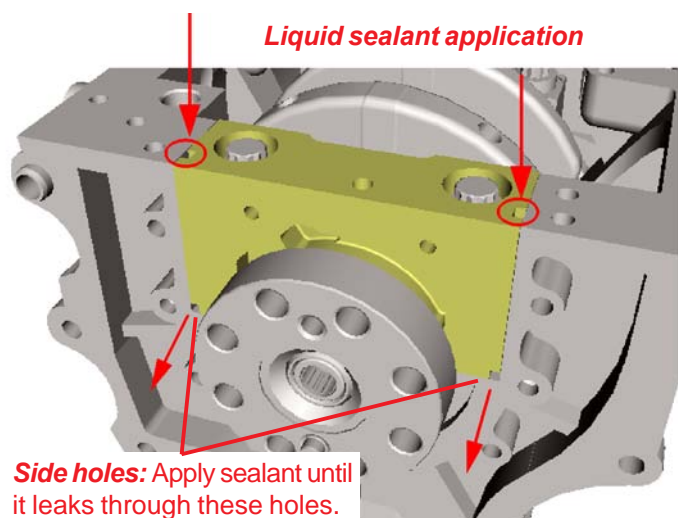
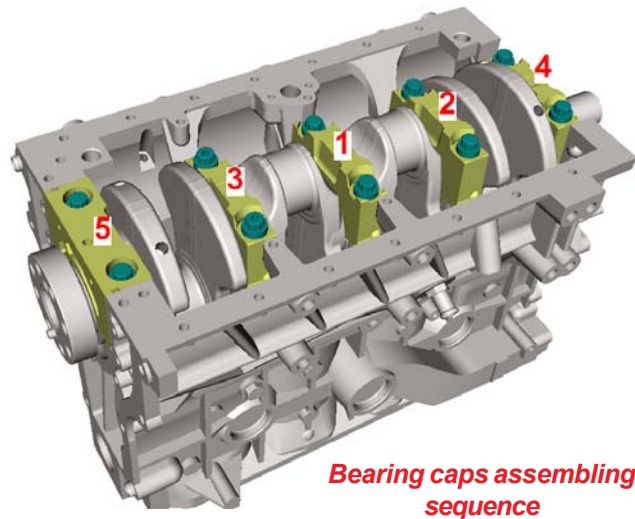
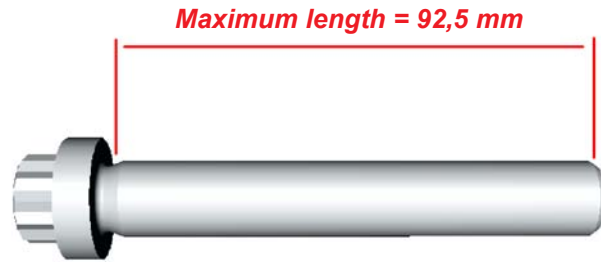
4. Lubricate the upper shells and the crankshaft main journal and crankpin.
5. Lubricate the new thrust washer.
6. Carefully install the crankshaft, and do not to rotate it before fastening the crankshaft bearing caps.
7. Lubricate the lower shells on the crankshaft bearing caps.

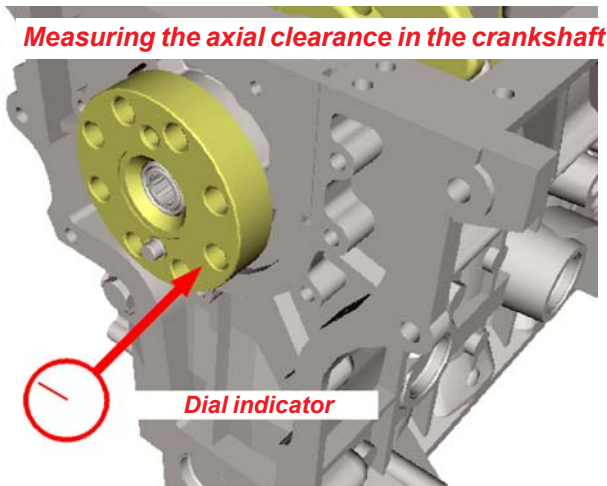
**⚠ Caution:** Before installing the bearing caps bolts, measure the bolts length. In case they exceed the maximum allowable limit, use new bolts. Maximum length limit: 92,5 mm.

**⚠ Caution:** The bolts of the 4th crankshaft-bearing cap have a central hole to attach the suction tube.

8. Install crankshaft-bearing caps positioning them correctly according to the cylinder order.
9. Using a 14 mm socket wrench, tighten the crankshaft-bearing caps applying a specified torque of 54 - 60 Nm +115 - 125° according to the tightening sequence indicated in the illustration.

10. Apply the sealant material Threebond® 1217F in the holes of the 5th crankshaft-bearing cap until it leaks from side holes.
11. Clean the excess sealant material from side holes of the crankshaft-bearing cap.





12. Using a dial indicator, check the crankshaft axial clearance.

**! Caution:** The STD thrust washer should be facing toward the engine's front, and the 0.06 mm thrust washer should face toward the rear of the engine.

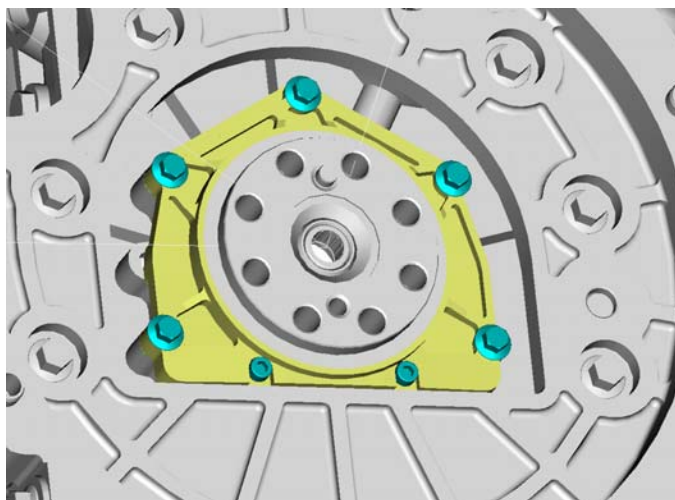
13. Install the pistons and connecting rods, [see \*Pistons and Connecting Rods - Assembly\*](#).
14. Install the rear oil seal retainer, [see \*Crankshaft Rear Oil Seal Retainer in this System\*](#).
15. Install the flywheel and the flywheel housing, [see \*Flywheel and Ring Gear - Removal and System Assembly\*](#).
16. Install the distribution housing, [see \*Distribution/Timing - Distribution Housing\*](#).
17. Install the chain system; [see \*Distribution/Timing - Chain System\*](#).
18. Install the distribution housing cover; [see \*Distribution/Timing - Distribution Housing Cover\*](#).
19. Install the breath return tube; [see \*Intake and Exhaust - Breath return Tube\*](#).
20. Install the suction tube; [see \*Lubrication System - Suction Tube\*](#).
21. Install the oil pan; [see \*Lubrication System - Oil Pan\*](#).

22. Install the engine on in the vehicle.
23. Refill the lubrication system; [see Lubrication System - Preventive Maintenance](#).
24. Refill the cooling system; [see Cooling System - Periodic Maintenance](#).

### Crankshaft rear oil seal retainer

#### Removal

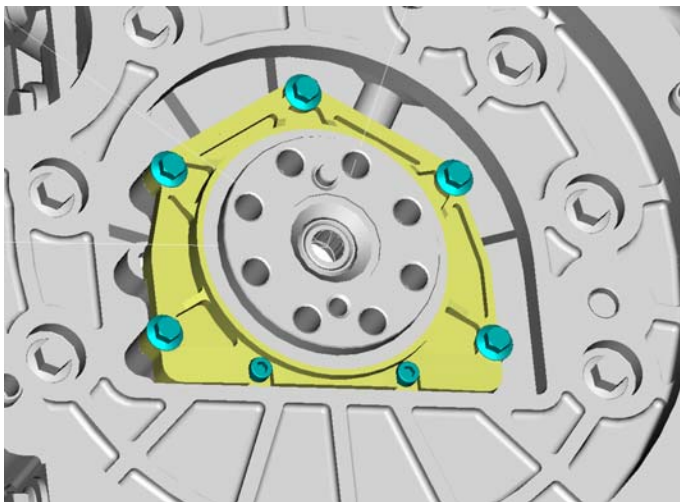
1. Drain the lubrication system; [see Lubrication System - Periodic Maintenance](#).
2. Disconnect the transmission of the vehicle.
3. Remove the flywheel, [see Flywheel and Ring Gear - Engine Flywheel](#).
4. Using a 5 mm Allen wrench, loosen the two bolts at the bottom of the rear oil seal retainer.
5. Using a 10 mm socket wrench, loosen the five bolts of rear oil seal retainer.
6. Using a gasket scraper, remove the rear oil seal retainer.



**Rear oil seal retainer**



*Application of the rear oil seal retainer junction*



*Rear oil seal retainer assembly*

### Assembly

**! Caution:** Every time the crankshaft rear oil seal retainer is removed, it is mandatory to install a new retainer. This procedure is necessary to avoid leakages.

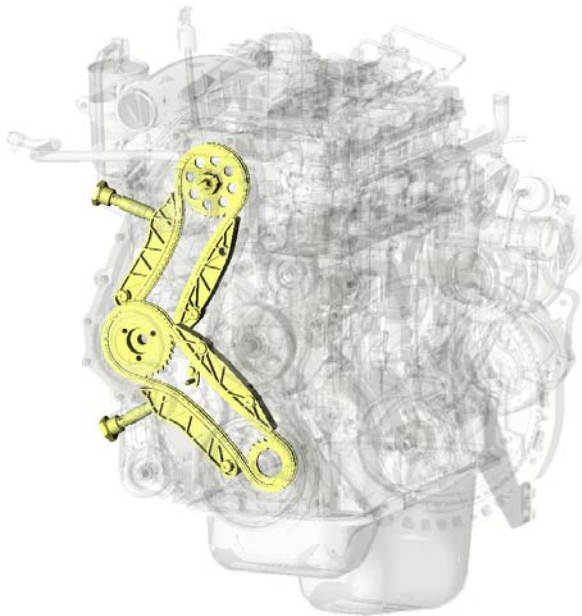
1. Carefully clean the engine block contact surfaces, including the crankshaft flange, and remove all existing residues.
2. Apply a homogeneous fillet of approximately 5 mm of Threebond® 1217F sealant on the whole contour of the new retainer with the oil seal installed, being careful to follow the holes and the guide-holes.

3. Place the new retainer with the rear oil seal on the crankshaft flange, carefully aligning the guide-hole with the block's dowel pin.
4. Press the retainer liberating the disposable plastic protection on the oil seal lip.
5. Install the five hex bolts and the two socket bolts in the housing.

**! Caution:** The two socket bolts should be installed using Threebond® 2471 sealant.

6. Using a 10 mm socket wrench, tighten the five hex bolts with a specified torque of 22 - 28 Nm.
7. Using a 5 mm socket wrench, tighten the two socket bolts with a specified torque of 14 - 17 Nm being careful to use Threebond® 2471 sealant in both bolts to avoid leakage

8. Install the flywheel; [see \*Flywheel and Ring Gear - Engine Flywheel\*](#).
9. Install the vehicle transmission.
10. Refill the lubrication system, [see \*Lubrication System - Preventive Maintenance\*](#).



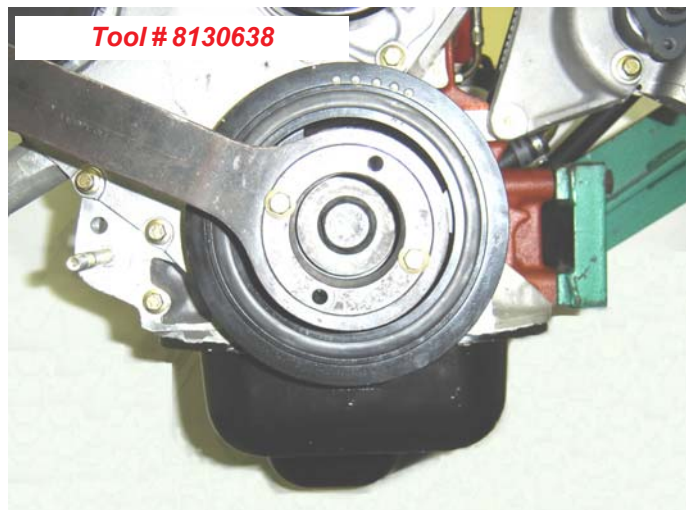
***Distribution / Timing***

Distribution housing cover .....	144
Crankshaft front seal .....	147
Chain system .....	148
Engine timing .....	155
Distribution housing .....	157

## Distribution housing cover

### Removal

1. Drain the lubricating oil from engine, [see Lubrication System - Preventive Maintenance](#).
2. Drain the engine coolant from engine, [see, Cooling System - Preventive Maintenance](#).
3. Remove the breath valve hose, fixed on the clamp of the distribution housing cover.
4. To make this operation easier, remove the air intake hoses.
5. Remove the fan, [see Cooling System - Fan](#).
6. Remove the Poly-V belt tensioner, [see Accessories- Poly-V Belt Tensioner](#).
7. Remove the Poly-V belt, [see Accessories- Poly-V Belt](#).
8. Using a special MWM-International Tool nr. 8130638 along with a 27 mm socket wrench, loosen the crankshaft pulley bolt.

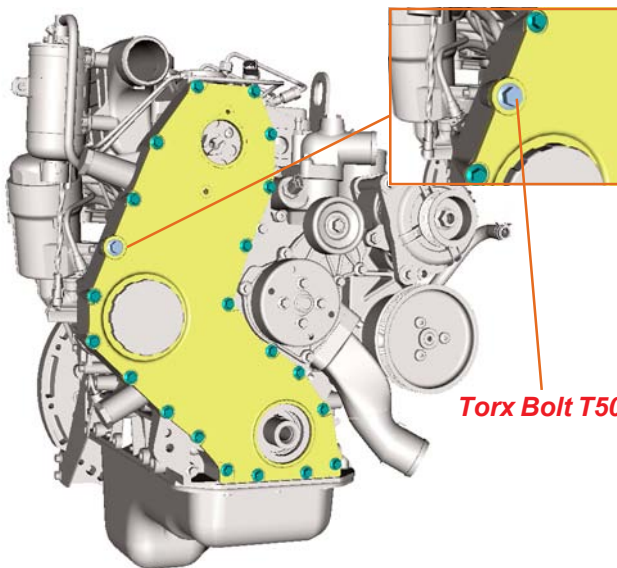


**Crankshaft pulley (locked)**





Tool nr. 8130012

**Removal of distribution housing cover**

Torx Bolt T50

**Removal of the distribution box cover**

9. Using a special MWM-*International* Tool nr. 8130012, remove the crankshaft pulley.

10. Remove the Poly-V belt tensioner, [see Accessories - Poly-V Belt](#).

11. Remove the vacuum pump, [see Accessories - Vacuum Pump](#).

12. Using a T45 and a T50 (for one bolt) Torx socket wrenches, remove the twenty-one bolts from distribution housing front cover.

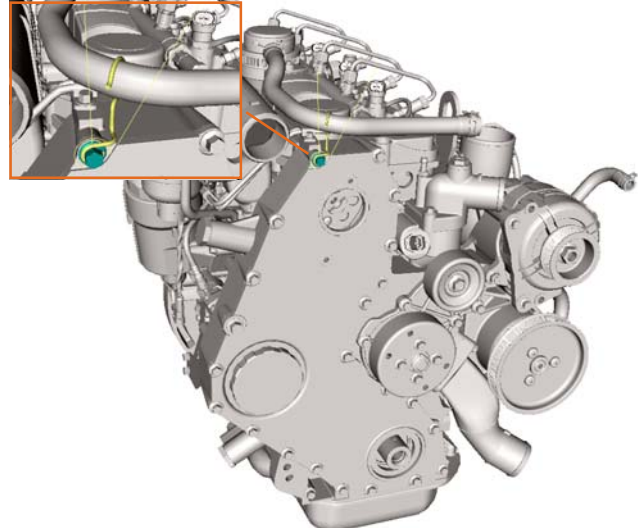
**Note:** On applications without air conditioning, this T50 bolt will be fixing an idler pulley; on applications with air conditioning, this bolt will be installed directly to the distribution housing.

**Assembly**

1. Install the distribution housing front cover, replacing the gasket.
2. Using a T45 and T50 Torx socket wrenches, tighten the twenty-one bolts of distribution housing front cover, applying a torque of 22 - 28 Nm.

**Note:** On applications without air conditioning, this T50 bolt will be fixing an idler pulley; on applications with air conditioning, this bolt will be installed directly to the distribution housing.

**Note:** Do not forget the breath hose holder, which should be fixed along with the upper bolt of distribution housing cover.



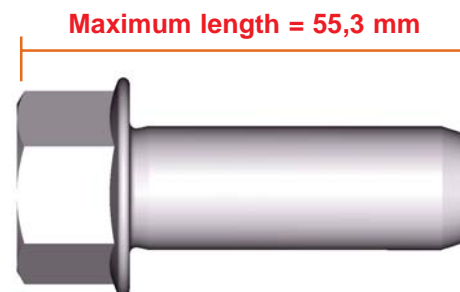
**Breath hose holder**

3. Install vacuum pump, [see Accessories - Vacuum Pump](#).

**Note:** Install a new O-ring at the vacuum pump. Check it for the correct positioning.

4. Install the crankshaft pulley.
5. Using MWM-International Tool nr. 8130638, along with a 27 mm socket wrench, tighten the crankshaft bolt applying a torque of 400 - 680 Nm.

**Caution:** Replace the bolt if it exceeds 55,3 mm.

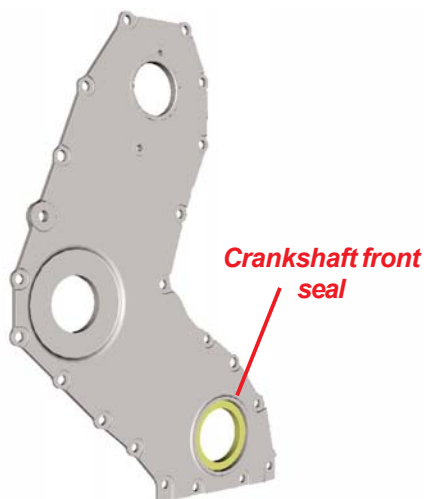


6. Install Poly-V belt tensioner, [see Accessories - Poly-V Belt Tensioner](#).
7. Install Poly-V belt, [see Accessories - Poly-V Belt](#).
8. Install air intake hoses.
9. Fix the breath valve hose on its holder at the distribution housing cover.
10. Install fan, [see Cooling System - Fan](#).
11. Fill the engine with engine coolant, [see - Cooling System - Preventive Maintenance](#).
12. Fill the engine with lubricating oil, [see Lubrication System - Preventive Maintenance](#).

### Crankshaft front oil seal

#### Removal

1. Remove the distribution housing cover, [see Distribution / Timing - Distribution Housing Cover](#).
2. Remove the crankshaft front oil seal, being careful to do not damage the distribution housing cover.



### Assembly

1. Using a device supplied with the MWM-*International* Motores replacement oil seal, install the crankshaft front oil seal assembly on the distribution housing.

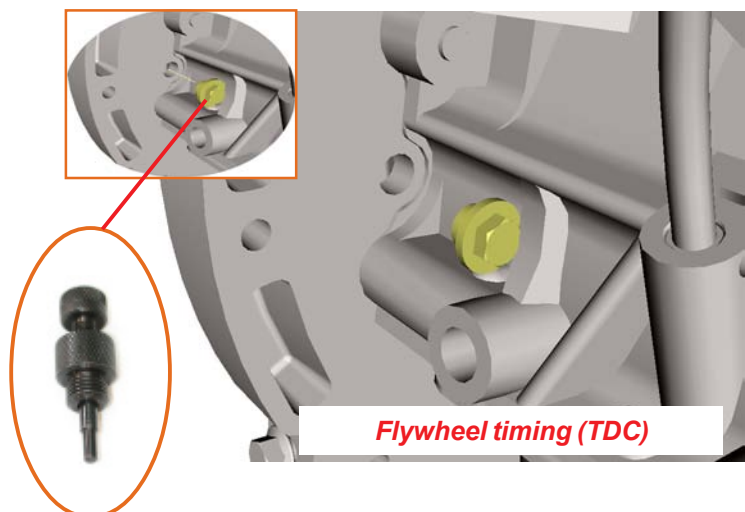
**Note:** The protection cap has the function of assuring the alignment and correct depth of the oil seal inside the distribution housing and it should only be removed after the complete and correct installation of the seal.

2. Install the distribution housing cover, [see \*Distribution/Timing - Distribution Housing Cover\*](#).

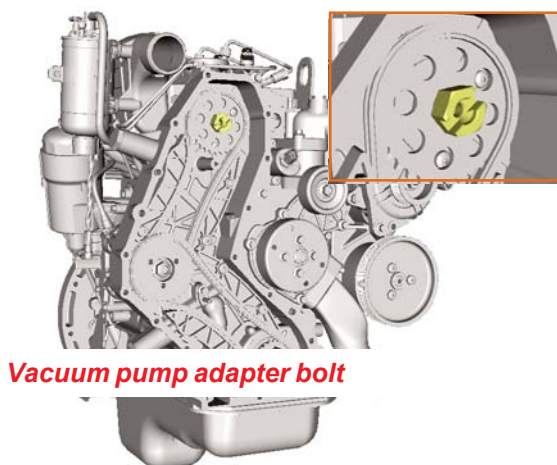
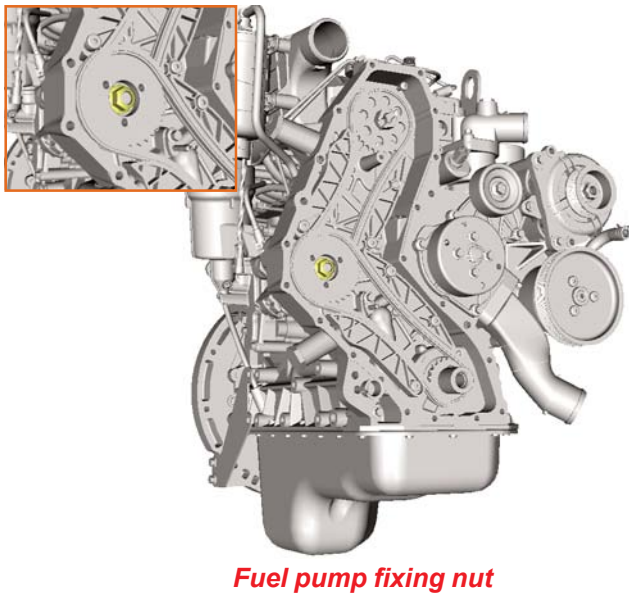
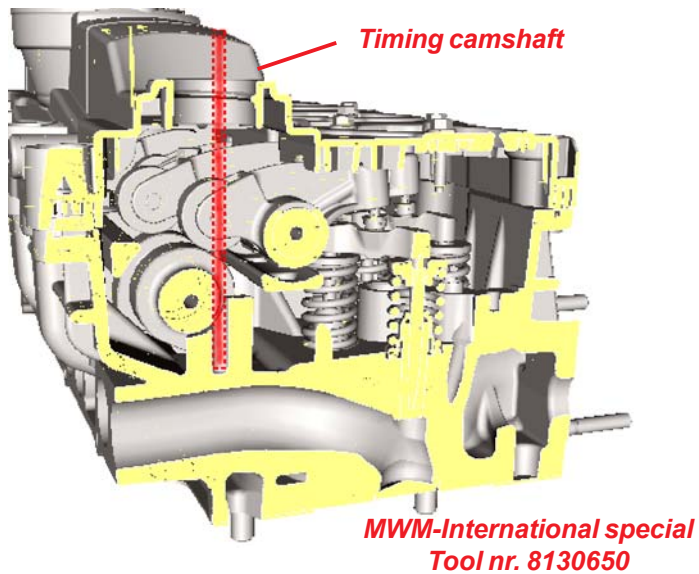
### Chain system

#### Removal

1. Drain the engine lubricating oil, [see \*Lubrication System - Preventive Maintenance\*](#).
2. Drain the engine coolant from engine, [see \*Cooling System - Preventive Maintenance\*](#).
3. Install the MWM-*International* Tool nr. 8130632 on the flywheel housing, making sure its locating pin is completely inserted.
4. Remove the distribution housing cover, [see \*Distribution / Timing - Distribution Housing Cover\*](#).



**MWM-International special Tool nr. 8130632**



5. Install MWM-International special Tool nr. 8130650, or a pin with a 7 mm diameter and minimum length of 200 mm on the camshaft, passing it through the oil refilling neck hole.

**Note:** To assure the installation's accuracy, the locking pin should have a diameter of exactly 7 mm.

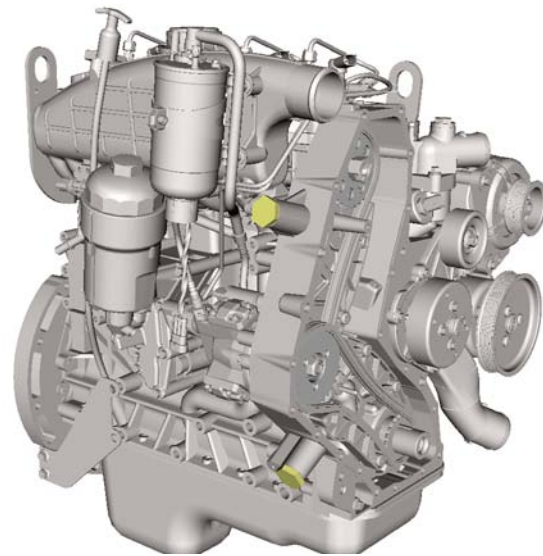
6. Using a 21 mm socket wrench, remove the fuel pump nut.

7. Using a 27 mm socket wrench, remove the vacuum pump adapter bolt.

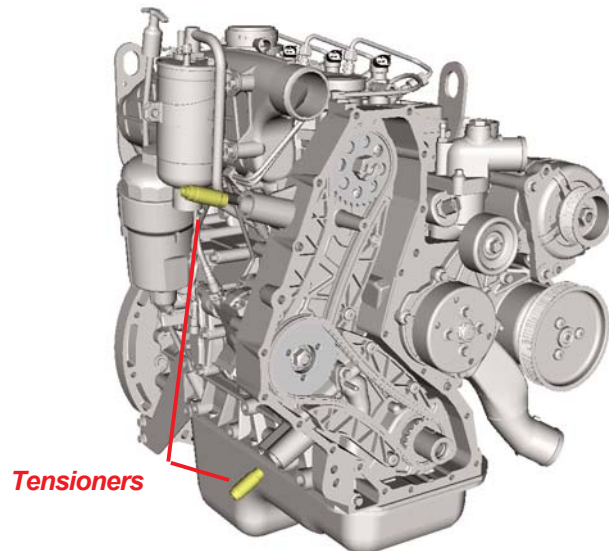
- Using a 32 mm socket wrench, loosen the hydraulic tensioner plugs from chains to relief the tension on them.

**Note:** In this operation it is normal that some lubrication oil leaks through the tensioner.

- Remove the hydraulic tensioners from the distribution housing.



*Distribution chain tensioner plugs*



*Tensioners*

**Caution** The hydraulic tensioners are not interchangeable:

**Upper hydraulic tensioner:** with an oil reservoir.

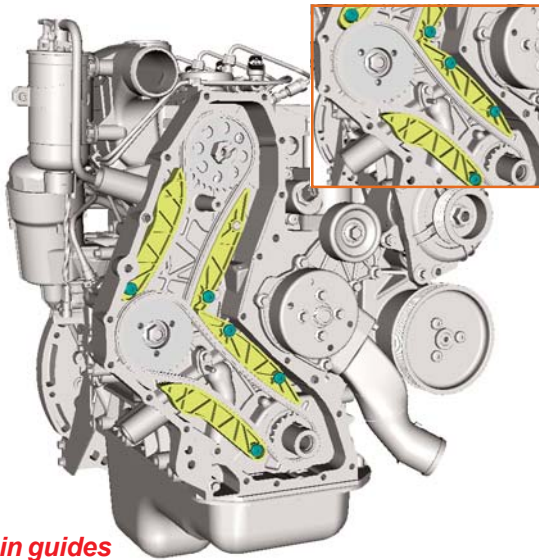
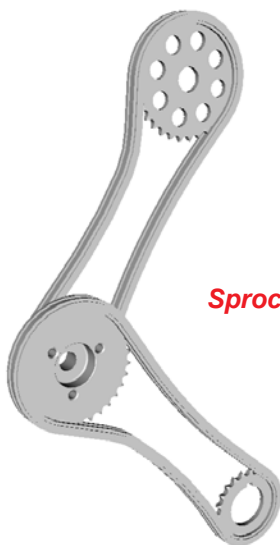
**Lower hydraulic tensioner:** without an oil reservoir.



*Upper tensioner*



*Lower tensioner*

**Chain guides****MWM-International special Tool nr. 8130012****Sprocket s / chains set**

10. Using a T30 Torx socket wrench, remove the bolts from lower chain guides.
11. Using a T30 Torx socket wrench, remove the bolts from upper chain guides.
12. Remove the chain guides.
  
13. Using MWM-International Tool nr. 8130012, loosen the fuel pump sprocket, without removing it.
  
14. Carefully remove the three sprockets and two chain sets.

## Assembly

**!** **Caution:** Check that the engine is at the correct timing point checking the upward position of the crankshaft key, besides the timing locking pins on camshaft and flywheel.

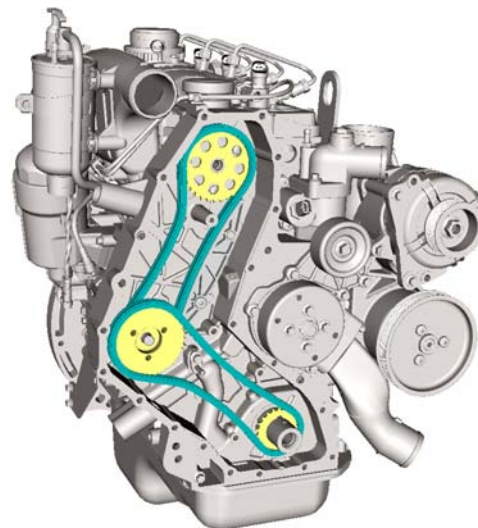
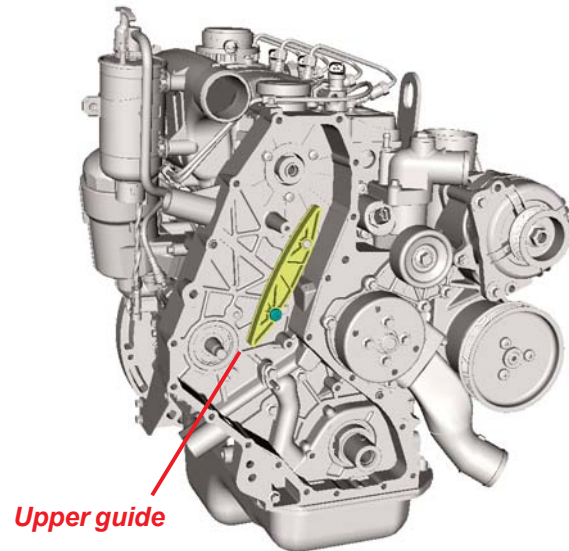
1. Install upper fixing guide of the chain with its oblong hole facing down.

2. Carefully install three sprocket sets and the two distribution chain sets into the distribution housing.

**Note:** To make the installation easier, perform a sub assembly of the sets before placing them into the distribution housing.

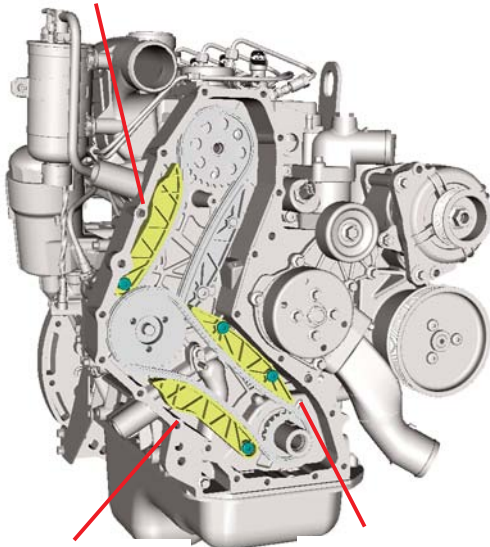
**Note:** The camshaft sprocket is driven by the internal sprocket (smaller diameter) of the double sprocket installed on fuel pump, and the crankshaft sprocket is driven by the outer sprocket (larger diameter).

3. Place temporarily the fuel pump sprocket bolts and the camshaft timing bolts, without tightening them.
4. Using a T30 Torx socket wrench, tighten the upper attached guide bolt applying a torque of 9 - 11 Nm.



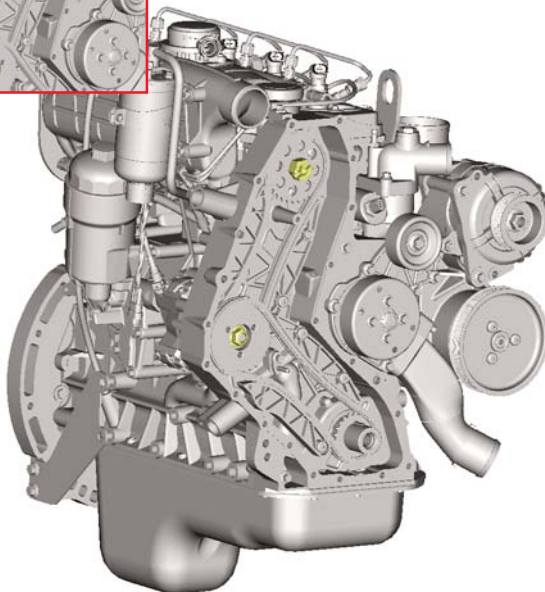


**Upper movable guide**



**Lower movable guide**

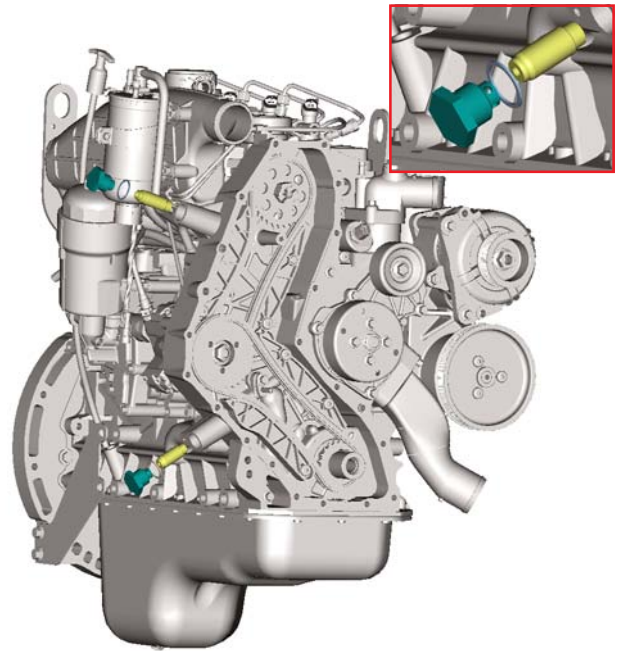
**Lower fixed guide**



**Vacuum pump adapter bolt**

5. Install attached lower guide with its oblong hole facing up.
6. Using a T30 Torx socket wrench, tighten the lower fixed guide bolt applying a torque of 9 - 11 Nm.
7. Install the movable guides observing their correct position.
8. Using a T30 Torx socket wrench, tighten the bolts of the remaining guides applying a torque of 9 - 11 Nm.
9. Using a 21mm socket wrench, tighten the fuel pump sprocket nut applying a torque of 45 - 50 Nm.
10. Using a 27 mm socket wrench, tighten the vacuum pump adapter bolts applying a torque of 84 - 90 Nm.

11. Install the hydraulic tensioners, observing their correct position.
12. Using a 32 mm socket wrench, tighten the hydraulic tensioner chain bolts applying a torque of 50 - 60 Nm.



**Assembly - Tensioners**

**! Caution:** Replace the washer always that the bolts are removed from hydraulic tensioners.

13. Install the distribution housing front cover.  
[See Distribution/ Timing - Distribution Housing Cover.](#)
14. Remove the timing locking pins from camshaft and from engine flywheel.

**! Caution:** After finishing the assembling and timing of the engine, do not forget to remove the timing locking pins.

15. Fill the engine with engine coolant, [see Cooling System - Preventive Maintenance.](#)
16. Fill the engine with lubricating oil, [see Lubrication System - Preventive Maintenance](#)

### Engine timing

For the NGD 3.0E engine timing, it is necessary to use two reference points, which are:

- **Camshaft:** It can be done by using MWM-International Tool nr. 8130650 or simply with any standard 7 mm diameter pin (ex: a drill bit). The locking pin should be placed straightly on the cylinder head, passing it through the oil refilling neck hole. To locate the pin, there is a boss on the cylinder head and a chamfering at the camshaft.
- **Crankshaft:** The engine should be placed on TDC (Top Dead Center). To assure that the engine is really on TDC position, use the MWM-International Tool nr. 8130632, which should be installed into the hole located on the flywheel housing.

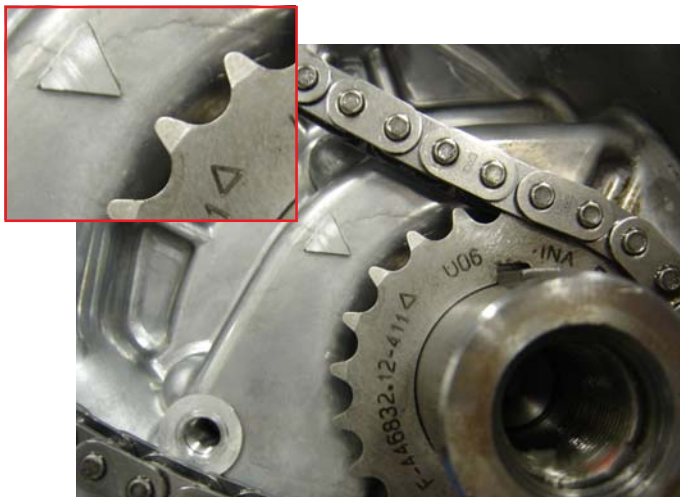
To assure a complete insertion of the pin into the flywheel housing, or as an aid to install it, use two references: the alignment of the two arrows on crankshaft sprocket and distribution housing (figure aside), and the crankshaft key positioned upwards.

**Note:** These two references do not eliminate the importance and necessity of using the timing locking pin MWM-International Tool nr. 8130632.

**Caution:** To assure that the engine is on TDC, the MWM-International Tool nr. 8130632 timing locking pin should be totally inserted (100%) into the flywheel housing. Because the flywheel has an internal toothed wheel for engine rotation monitoring, in certain positions the pin may be inserted 50% deeper, causing an erroneous TDC indication.

**Caution:** After finishing the assembling and engine timing, do not forget to remove the timing locking pins.

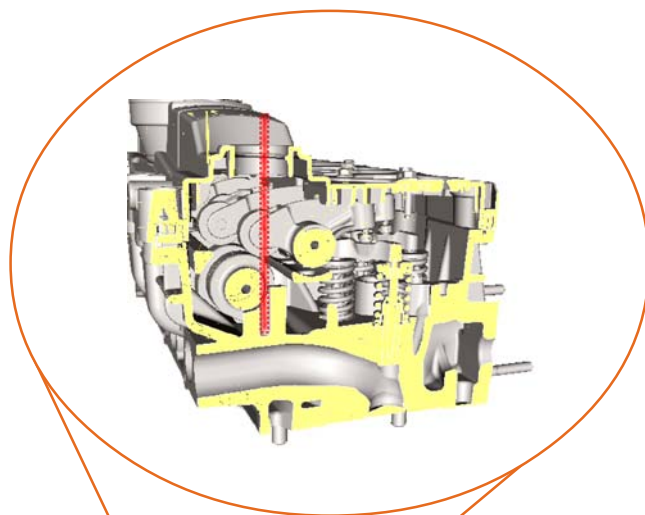
The engine timing should be locked.



*Distribution reference arrows*

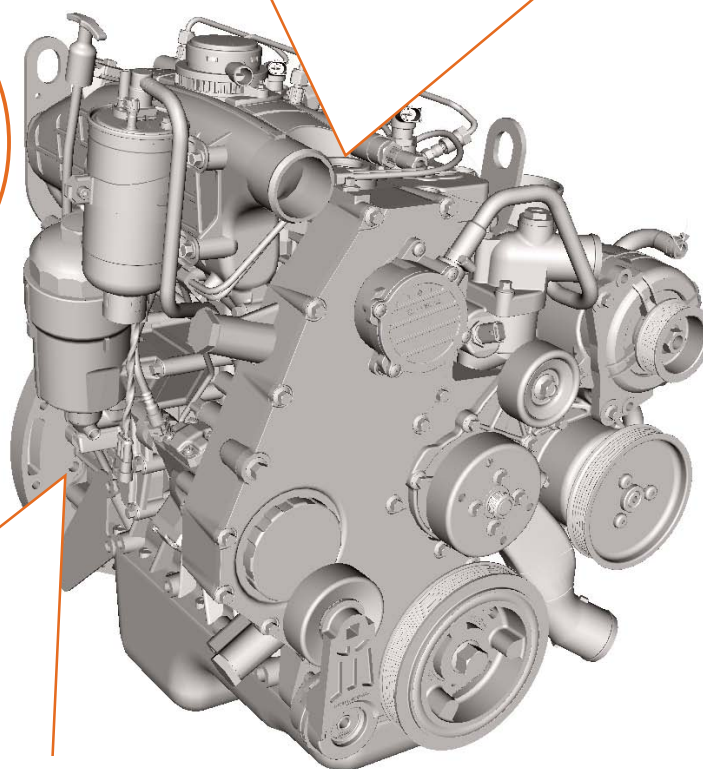
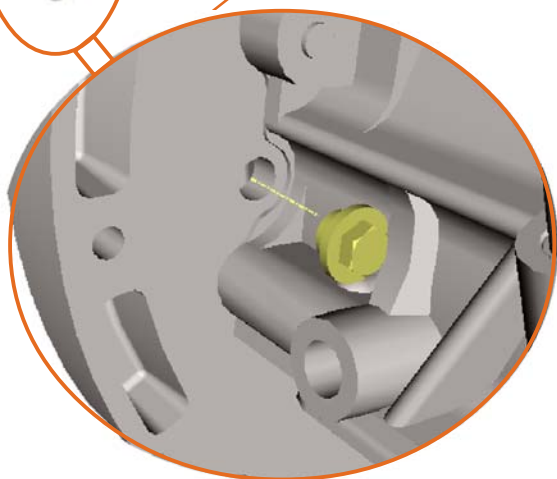
## Camshaft timing

MWM-International Tool nr. 8130650 or a pin with a standard 7 mm diameter and a minimum 200 mm length installed straightly through the oil refilling neck hole and locking the camshaft position (the locking is done by means of the chamfer in the camshaft and the hole at the cylinder head boss).



**Note:** As NGD 3.0E is an electronic engine, its fuel pump does not need be synchronized, because the engine adapts its injection timing according to engine's request and its sensor signals.

**MWM-International Tool nr. 8130632**

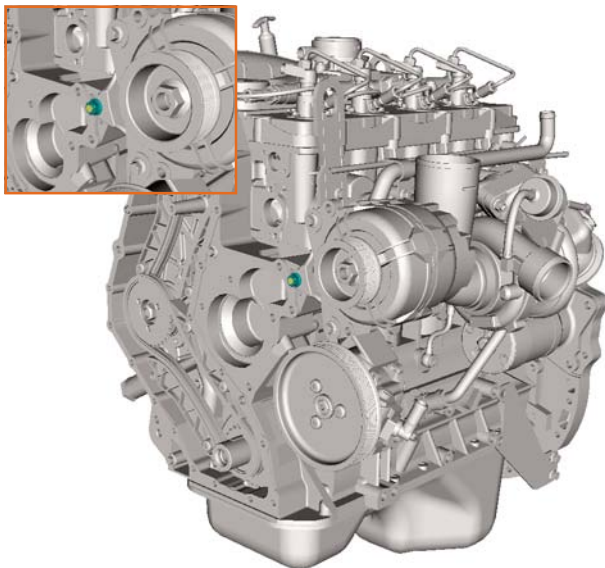


## Crankshaft timing

MWM-International Tool nr. 8130632 locking the engine on top dead center (TDC). It replaces the plug located on the flywheel housing.

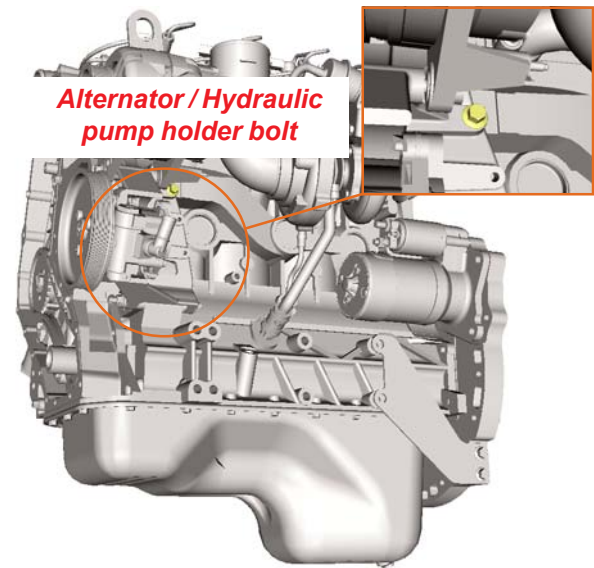
**Distribution housing****Removal**

1. Drain the lubricating oil from engine, [see Lubrication System - Preventive Maintenance](#).
2. Drain the engine coolant from engine - [see Cooling System - Preventive Maintenance](#).
3. Remove the distribution housing cover, [see Distribution / Timing - Distribution Housing Cover](#).
4. Remove the water pump, [see Cooling System - Water Pump](#).
5. Remove the water inlet pipe, [see Cooling System - Water Inlet Pipe](#).
6. Remove the thermostatic valve housing, [see Cooling System - Thermostatic Valve Housing](#).
7. Using a 13 mm socket wrench and a 10 mm wrench, remove the nut and bolt from alternator holder / hydraulic pump on the distribution housing.

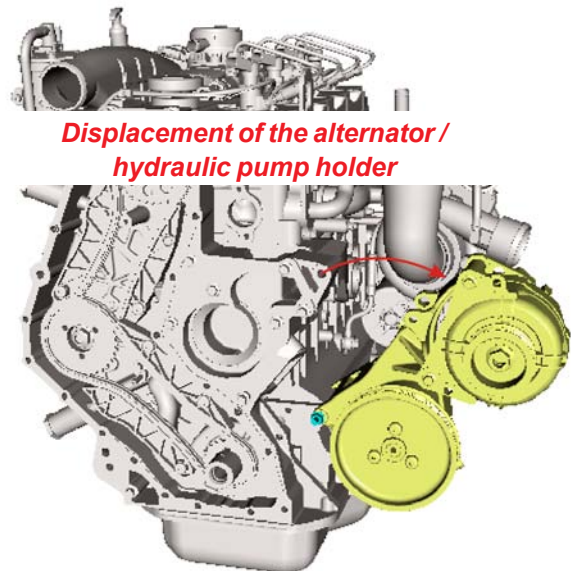


**Alternator / Hydraulic pump holder  
nut and bolt**

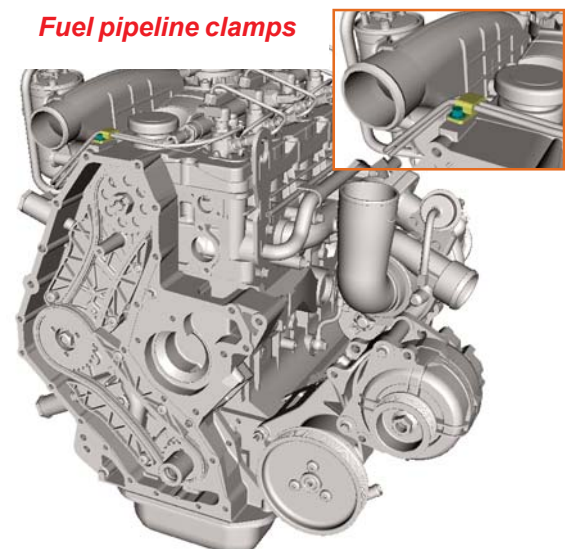
- Using a 10 mm socket wrench, loosen the alternator holder bolts/ hydraulic pump from the engine block.

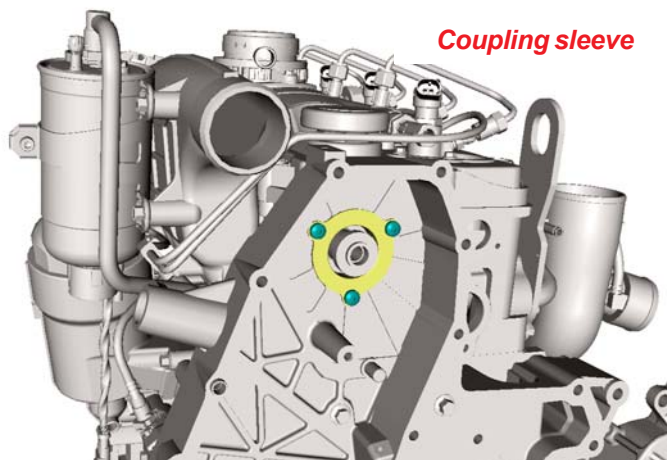


- Manually displace the alternator and holder assembly to facilitate the removal of distribution housing.



- Using an 8 mm socket wrench, remove the fuel pipeline clamps.





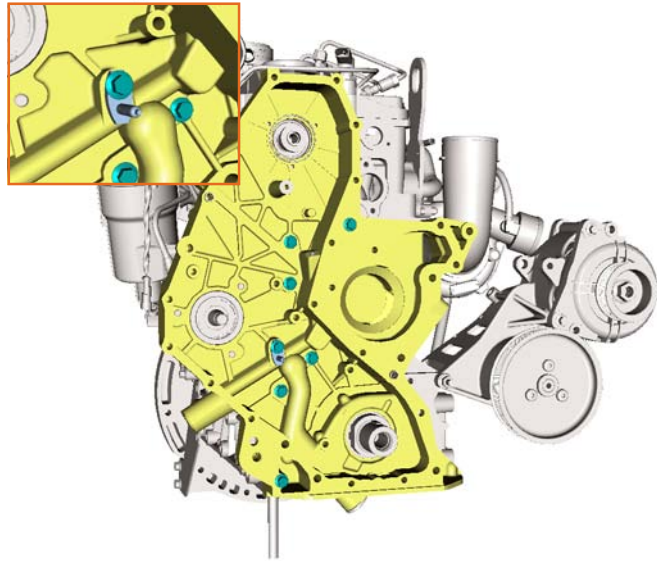
11. Using a 10 mm socket wrench, remove the two bolts from fuel pump holder, which are fixed on the fuel pump.
12. Remove the distribution chain system, [see Distribution / Timing - Chain System](#).
13. Remove the oil pan, [see Lubrication System - Oil Pan](#).
14. Remove the suction pipe, [see Lubrication System - Suction Pipe](#).
15. Using a T30 Torx socket wrench, remove the bolts from coupling sleeve.
16. Remove the coupling sleeve.

17. Disconnect the electrical connectors from VCV and PCV valves from fuel pump.
18. Loosen the fuel return hose from fuel pump, pressing manually the locking tab.
19. Remove the feeding hose from fuel pump, pressing manually the locking tab (red).

**Note:** If necessary, press the other end of the clamp with a small screwdriver.

20. Using a 10 mm socket wrench, remove the seven bolts from distribution housing.

**Note:** One of the bolts also has an oil sprayer. Remove the sprayer along with the bolt.



*Distribution oil sprayer*

21 Remove the distribution housing with the fuel pump connected to it.

22. Using a 10 mm socket wrench, remove the three bolts from fuel pump.

**Caution:** The oil pump and relief valve are coupled to the distribution housing. In case it is necessary to repair them, [see Lubrication System - Oil Pump](#).

23. In case it is necessary to replace the distribution housing, remove the tensioner stud bolt from Poly-V belt.

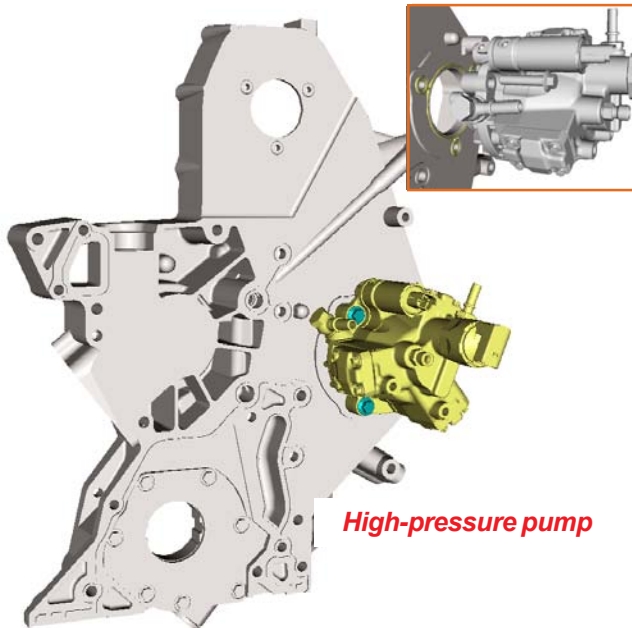


## Assembly

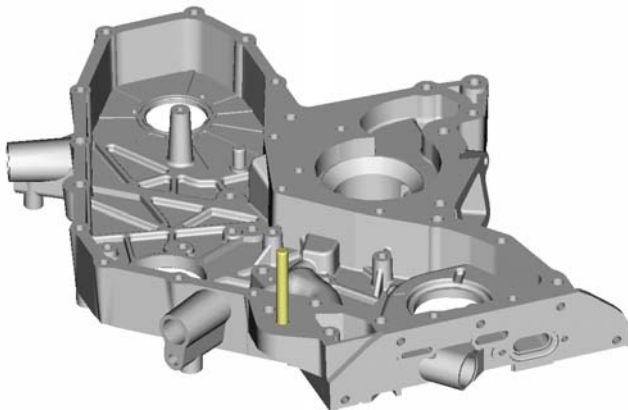
**⚠ Caution:** Check that the engine is at the right timing point by checking the upward position of the crankshaft key, besides the timing locking pins at the camshaft and at the flywheel housing.

1. Using a new sealing gasket (O-ring), install the fuel pump on the distribution housing.
2. Using a 10 mm socket wrench, tighten the three fuel pump bolts, using Loctite® 242 or Threebond® 1345T and applying a torque of 22-28 Nm.
3. In case of distribution housing replacement, install the Poly-V belt tensioner stud bolt on the distribution housing.

*Fuel pump gasket*

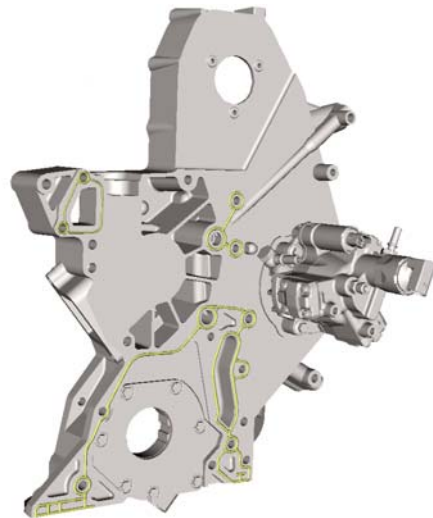


*High-pressure pump*



*Tensioner stud bolt*

- Using new sealing gaskets (O-rings), install the distribution housing on engine block.

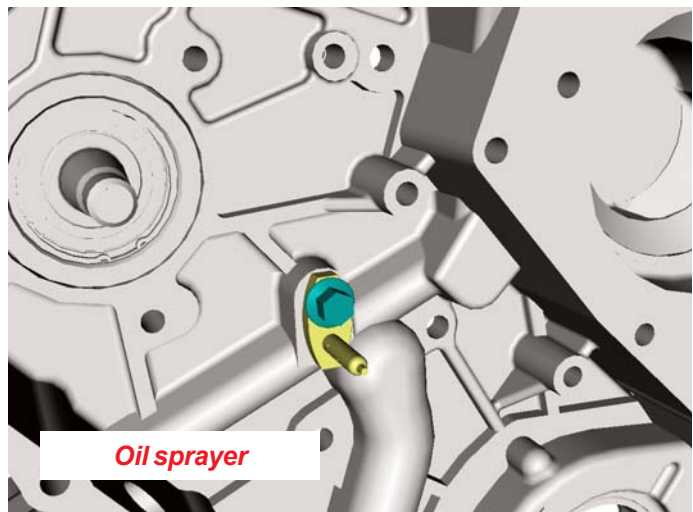


**Distribution housing gasket**

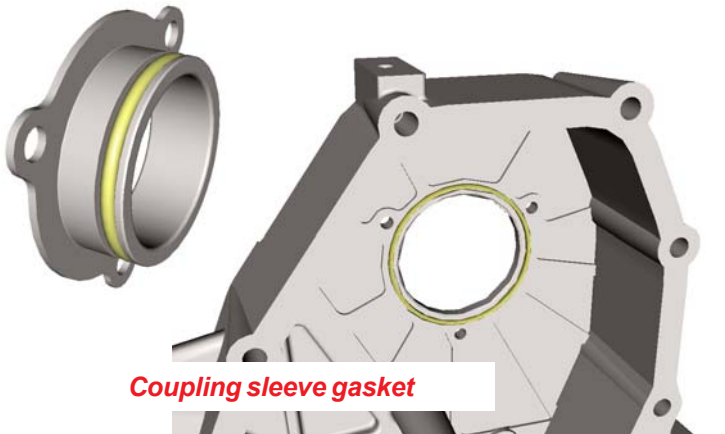
**⚠ Caution:** Do not forget to install the oil sprayer using the distribution housing central bolt to fix it.

**⚠ Caution:** Use only *MWM-International Motores* genuine parts.

- Using a 10 mm socket wrench, tighten the distribution housing seven bolts applying a torque of 22-28 Nm.
- Install fuel pump holder.
- Using a 10 mm socket wrench, tighten the two bolts of the fuel pump holder on the pump, and apply a torque of 22-28 Nm.



**Oil sprayer**



8. Install the coupling sleeve with new gaskets on the sleeve and on the distribution housing.

**⚠ Caution:** Use only MWM-*International* Motores genuine parts.

9. Using a T30 Torx socket wrench, tighten the coupling sleeve bolts, using Threebond® 2471 and applying a torque of 4 - 6 Nm.
10. Install the chain system, [see Distribution/ Timing - Chain System](#).
11. Install the distribution housing front cover, [see Distribution / Timing - Distribution Housing Front Cover](#).
12. Install the water pump, [see Cooling System - Water Pump](#).


**Note:** Using a new O-ring on the water pump, check it for the correct positioning.

**⚠ Caution:** Use only MWM-*International* Motores genuine parts.




13. Install the Poly-V belt tensioner pulley on the water pump housing, [see Accessories - Tensioner Pulley](#).
14. Install thermostatic valve housing, [see Cooling System - Thermostatic Valve Housing](#).

**Note:** Install a new O-ring on the thermostatic valve housing. Check it for correct positioning.

 **Caution:** Use only MWM-International Motores genuine parts.

15. Install the water inlet pipe, [see Cooling System - Water Inlet Pipe](#).

**Note:** Use a new O-ring gasket on the water inlet pipe. Check it for correct positioning.

 **Caution:** Use only MWM-International Motores genuine parts.

16. Install cooling expansion tank hose to the thermostatic valve connection cover using a screwdriver to tighten the bracket screw.

17. Manually place the alternator and holder assembly for attachment.

18. Using a 10 mm socket wrench, tighten the alternator holder bolts applying a torque of 22 - 28 Nm.

19. Using a 10 mm and a 13 mm socket wrenches, fix the alternator holder applying a torque of 22 - 28 Nm on its nuts and bolts.

20. Install the Poly-V belt, [see Accessories - Poly-V Belt](#).

21. Install the air intake hoses to intake system, [see Intake and Exhaust - Hoses and Intake Duct](#).

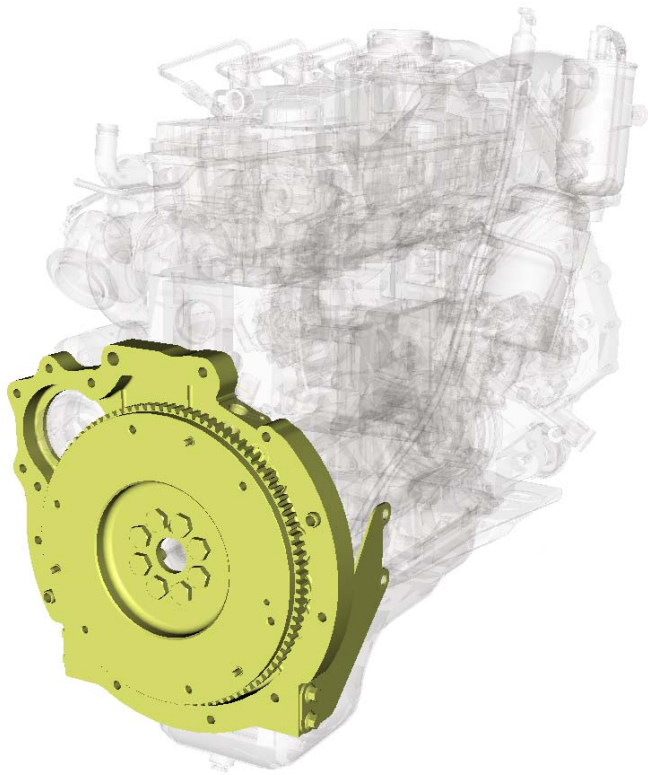
22. Install the suction pipe, [see Lubrication System - Suction Pipe](#).

23. Install the oil pan, [see Lubrication System - Oil Pan](#).

24. Install the fan, [see Cooling System - Fan](#).

25. Fill the engine with engine coolant, [see Cooling System - Preventive Maintenance](#).

26. Fill the engine with lubricating oil, [see Lubrication System - Preventive Maintenance](#).



## *Flywheel and Ring Gear*

Engine flywheel .....	166
Cleaning and inspection of the engine flywheel .....	168
Ring gear .....	171

**⚠ Caution:** All described procedures are based on work done with the engine out of the vehicle.

**⚠ Caution:** Some of the described operations in the following procedures will be done with high temperatures, and may cause burnings.

## Removal and system assembling

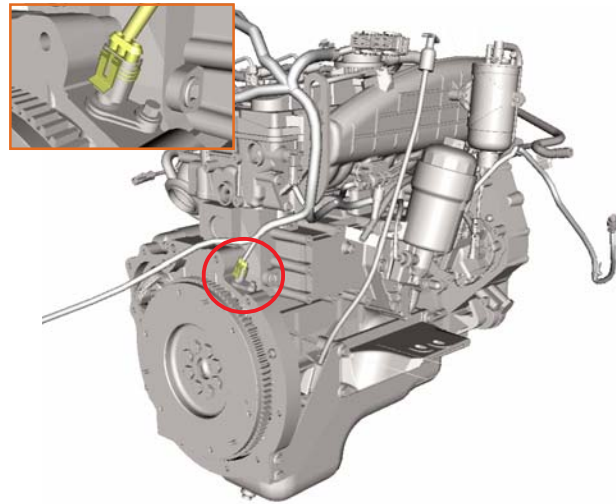
### Engine flywheel

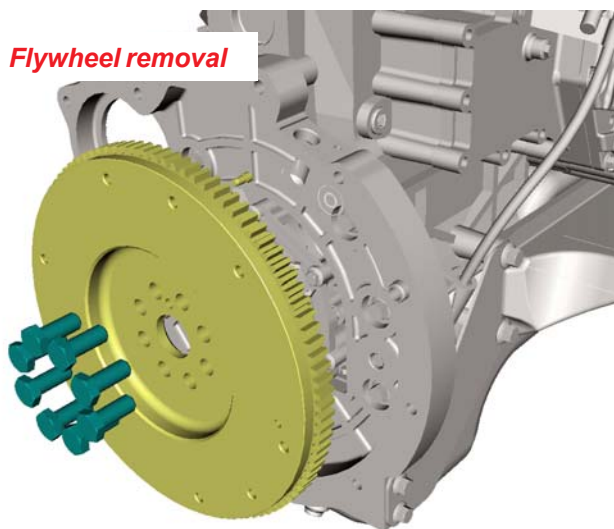
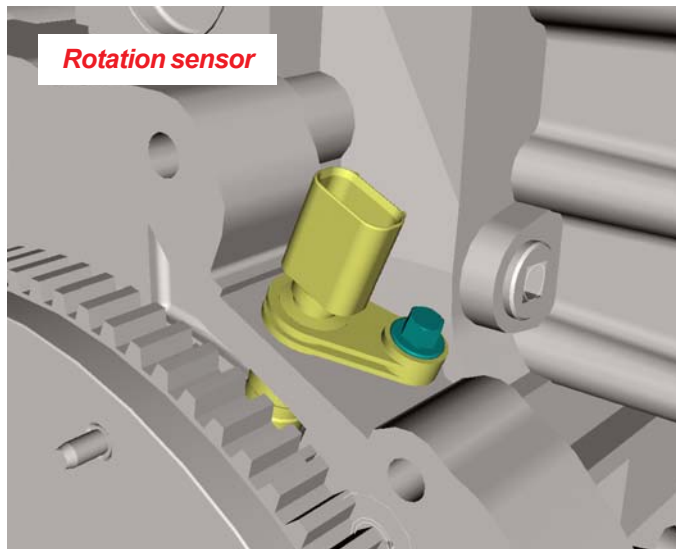
#### Removal


1. Remove the electrical wiring connector from the engine rotation sensor attached to flywheel housing.

2. Remove the vehicle transmission assembly.
3. Using an 8 mm socket wrench, remove the bolt that holds the engine rotation sensor.

**Rotation sensor electrical connector**





4. Remove the engine rotation sensor.
  
  
  
  
  
  
  
  
  
  
  5. Remove the starter; [see Accessories-Starter](#).
  6. Using a 22 mm socket wrench, remove the eight flywheel bolts.
-  **Caution:** It is necessary to lock the flywheel for this procedure.
7. Remove the flywheel.

- Using a 13 mm socket wrench, remove the two bolts that hold the adapter plate to engine block and to flywheel housing. Do this procedure for the adapter plate on each side of the engine.

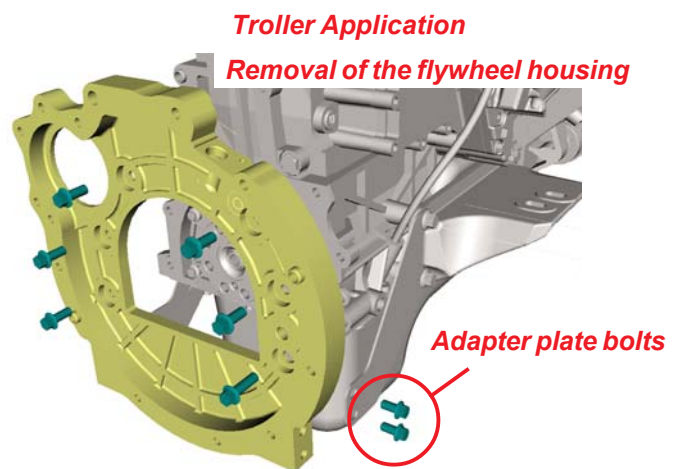
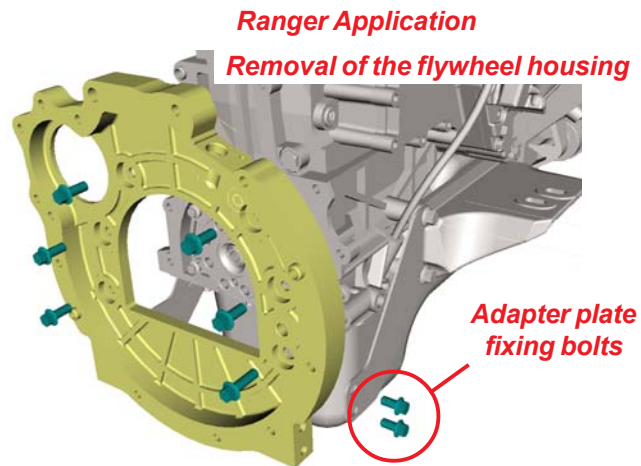
**Note:** Only for Ranger application.

- Remove the bolts and leave the adapter plate loosened at the housing.

- Using a 13 mm socket wrench, remove the six bolts that hold the flywheel housing.

**Note:** On Troller application, there are eight bolts fixing the housing.

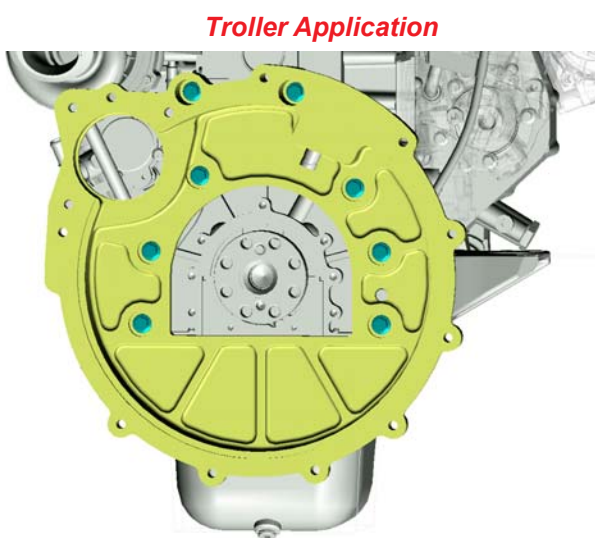
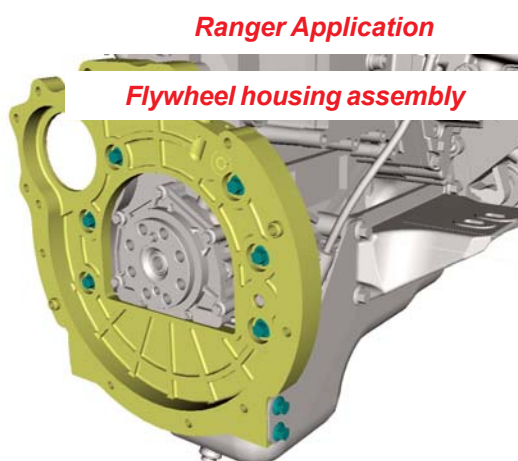
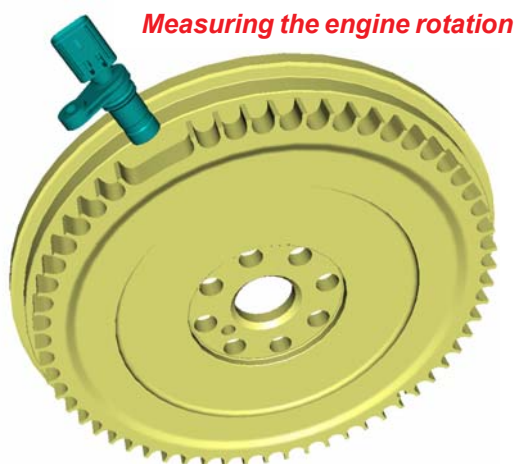
- Remove the flywheel housing.



## Cleaning and inspection of the engine flywheel

- Wash the flywheel and the flywheel housing with a solution of water and a chemical degreaser.
- Remove any sealant residues and gasket material from flywheel bolts, crankshaft openings and contact surfaces of flywheel and crankshaft.
- Inspect the flywheel external ring gear teeth. Check if there is any wearing or damages. In case of replacement is necessary; [see Ring Gear in this chapter](#).
- Inspect the flywheel internal toothed wheel teeth. In case of any abnormality, replace the flywheel.





**Caution:** The internal flywheel toothed wheel has the exclusive purpose of supplying information to the engine rotation sensor. The information collected by the sensor, concerning rotation and position of the flywheel, is extremely important for the electronic control. The information is collected by means of a double pitch gap located on the internal toothed wheel. In this way, when the larger gap passes by the sensor, the electronic module identifies the flywheel position.

### Assembly

- Using a 13 mm socket wrench, tighten the flywheel housing six bolts using Loctite® 242 sealant and applying a specified torque of 40 - 50 Nm.

**Note:** Install the longer length bolt at the flywheel housing hole with the dowel pin.

**Note:** On Troller application, there are eight bolts fixing the flywheel housing, the longer bolts should be installed on the holes with the dowel pins.

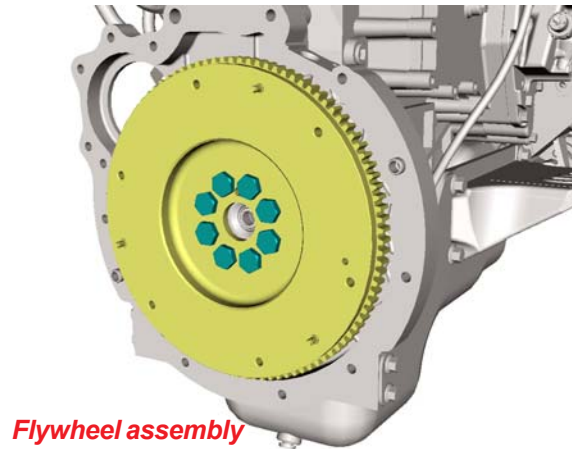
**Note:** On Troller application, apply liquid sealant Threebond® 1217F between block and flywheel housing faces.

- Using a 13 mm socket wrench, tighten the adapter plate two bolts on block and flywheel housing applying a specified torque of 40 - 50 Nm. Do this procedure for the adapter plate on each side of the engine.

**Note:** Item used only on Ford Ranger application.

**Note:** On Troller application there are no external dowel pins for the transmission housing.

- Using a 22 mm socket wrench and Loctite® 242 sealant, tighten the eight flywheel bolts applying a specified torque of 54 - 60 Nm + 60° - 66°.



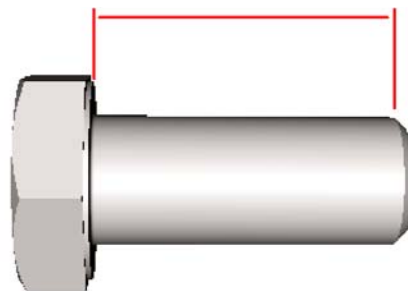
**! Caution:** Always check the flywheel bolts length before reusing them. In case the length exceeds the specified maximum of 34.6 mm, it is mandatory to use a new set of bolts..

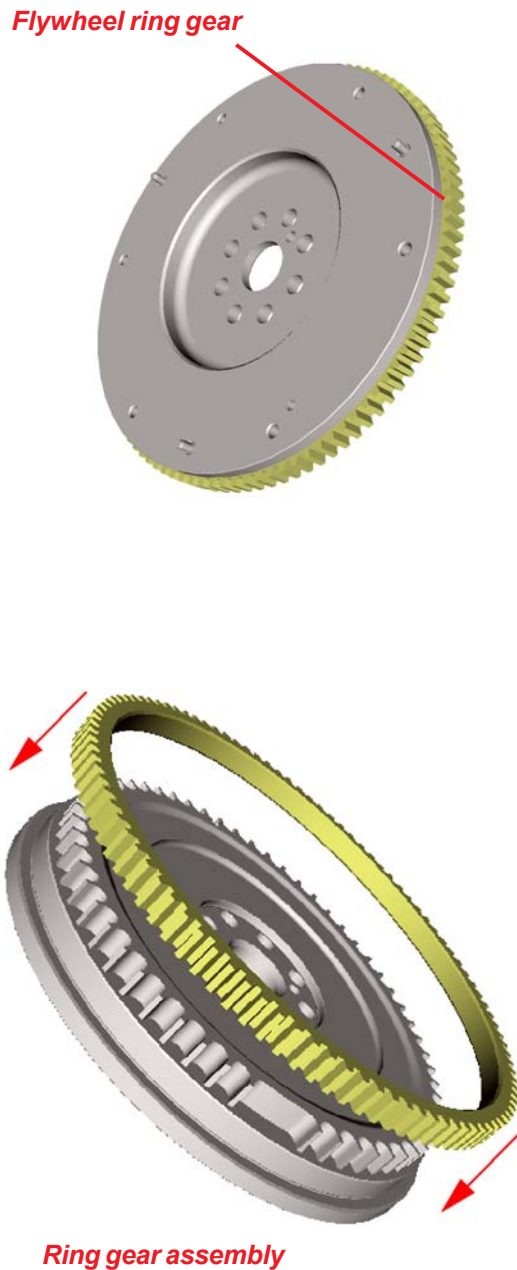
**! Caution:** To reuse the bolts it is necessary to assure the cleaning and removal of all existing residues of Dry-loc®. For the new assembling, apply Loctite® sealant.

**! Caution:** It is necessary to lock the flywheel gear ring for this procedure.

- Using an 8 mm socket wrench, tighten the engine rotation sensor bolt applying a specified torque of 8 -11 Nm.
- Install the starter assembly; [see Accessories - Starter](#).
- Install the transmission assembly.
- Connect the electrical wiring connector to the engine rotation sensor.

**Maximum length = 34.6 mm**





### Ring gear

**⚠ Caution:** Be careful. The following operations are made at high temperatures, which may cause burnings.

### Removal

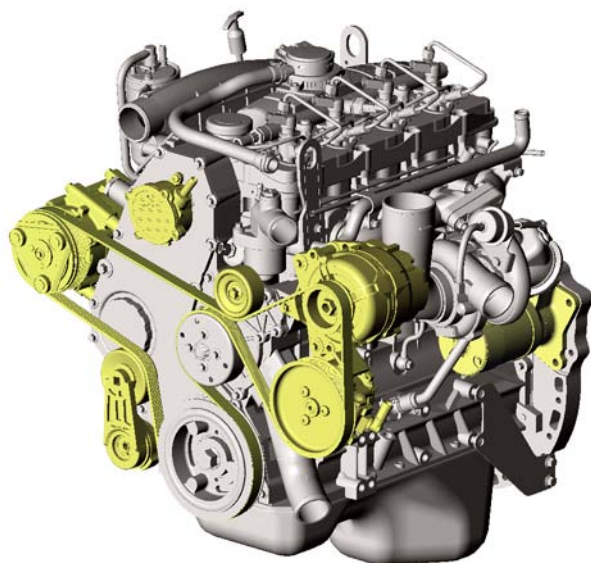
To remove the flywheel ring gear, use the procedures described as follows.

1. Place the flywheel in an adequate container with clean water, supporting the ring gear on four metal blocks immersed in water. Locate the ring gear approximately 6.5 mm above the level of the water.
2. Heat the whole extension of the ring gear until it comes loosen from flywheel.

### Assembly

1. For assembling the ring gear to flywheel, heat the ring gear in an oven until an approximate temperature of 246°C and insert the ring gear with the starter entrance angle facing toward its internal side.





## Accessories

Poly-V Belt .....	174
Air conditioning compressor / pulley .....	176
Tensioner pulley .....	177
Poly-V belt tensioner .....	178
Vacuum pump .....	179
Idler pulley .....	180
Hydraulic pump / pulley .....	181
Alternator / pulley .....	182
Alternator holder / hydraulic pump .....	183
Starter .....	184

## Poly-V Belt

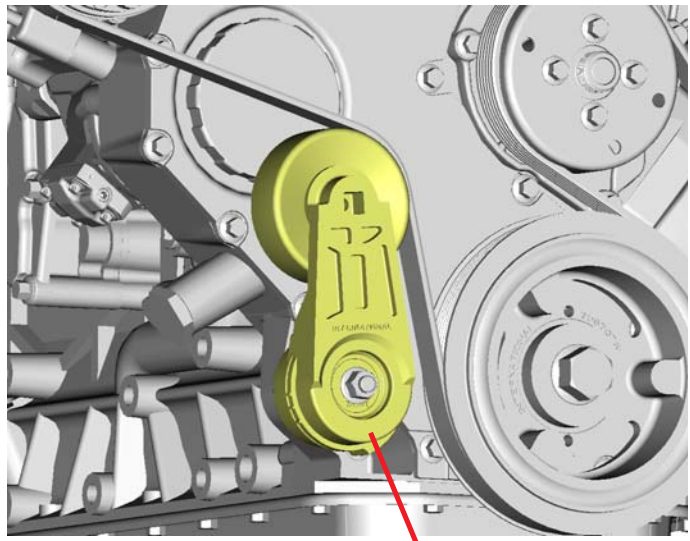
There are two assembling layouts for the Poly-V belt assembling on the distribution housing cover pulley.

In vehicles equipped with air conditioning, the Poly-V belt should be installed on the pulley of the air conditioning compressor. In vehicles without air conditioning, the belt should be installed on the idler pulley, located on the left side of the distribution housing cover.

The two assembling layouts for the Poly-V belt removal and installation are described as follows.

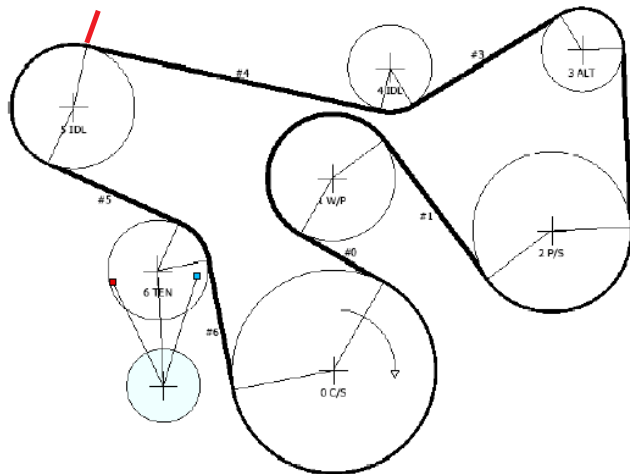
### Removal

1. Remove the fan, [see Cooling System - Fan](#).
2. Mark the direction of the Poly-V belt rotation with an arrow on it.
3. Apply a square head handle (adapter for fixing socket wrenches) on the belt tensioner pulley, and relief the belt tension moving the tensioner unit pulley counterclockwise.
4. Remove the belt from tensioner pulley.
5. Remove the belt from all pulleys at distribution housing.



**Removal of the Poly-V belt showing the tensioner unit working**

**W / Air: Air conditioning compressor pulley**  
**W / O Air: Idler pulley installed to distribution housing**



**Project of the belt assembly**

### Inspection

Inspect the belt and check it for any wearing. If is worn out, replace it.

Replace the Poly-V belt pulley as described on section Preventive Maintenance. Use only original MWM-*International* Motores parts.

### Assembly

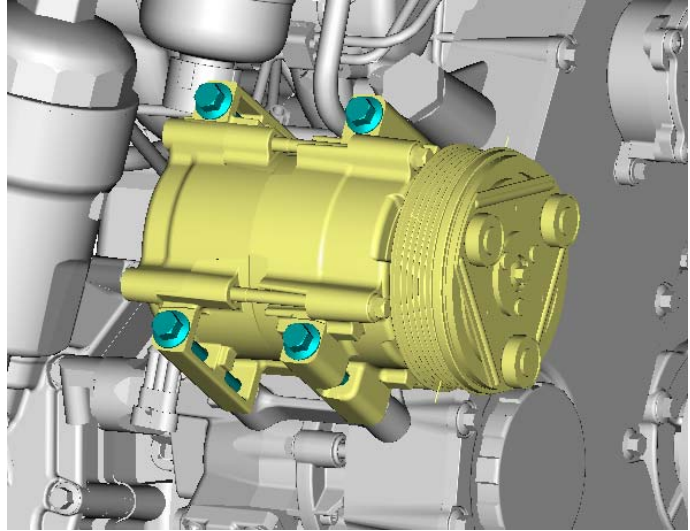
1. Reinstall the belt on all pulleys from distribution housing cover, as illustrated on the diagram according to the engine (with or without air conditioning).

**Note:** If the installed belt will be reused, install the belt at the same rotation direction as noted during the removal.

2. Applying a square head handle (adapter for fixing socket wrenches) on the tensioner belt pulley, move it counter-clockwise so that the belt fits on the tensioner unit pulley.
3. Install the fan assembly, [see Cooling System - Fan.](#)

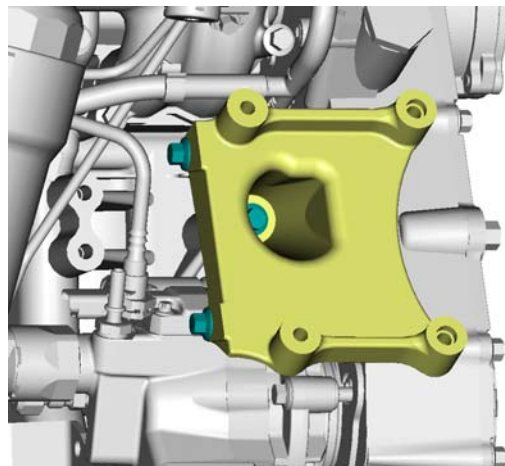
**Air conditioning compressor / pulley****Removal**

1. Remove the electrical wiring connector from the air conditioning compressor.
2. Using a 10 mm socket wrench, remove the four mounting bolts from air conditioning compressor.
3. Remove the air conditioning compressor.



*Compressor removal*

4. Using a 10 mm socket wrench, remove the three mounting bolts from air conditioning compressor holder. Two of these bolts are placed laterally and one on the central part of the holder.



*Removal of compressor holder*



5. Remove the holder from air conditioning compressor.

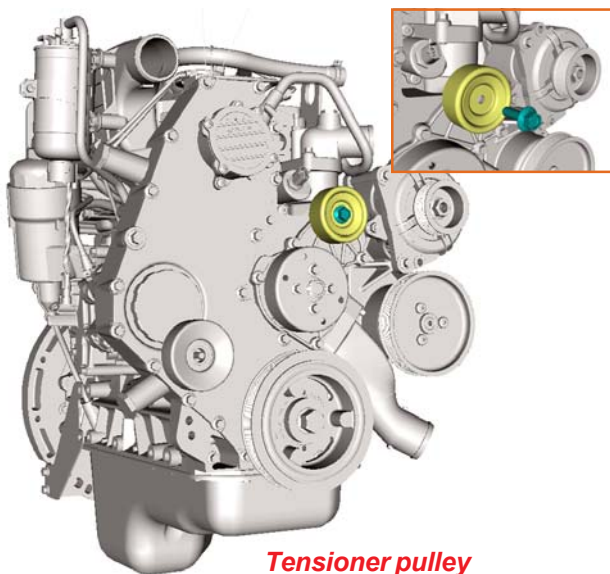
### Assembly

1. Using a 10 mm socket wrench, install the air conditioning holder applying a specified torque of a 22 - 28 Nm on the three mounting bolts.
2. Using a 10 mm socket wrench, install the air conditioning compressor applying a specified torque of 40 - 50 Nm on the four mounting bolts.
3. Connect the electrical wiring connector on air conditioning compressor.

### Tensioner pulley

#### Removal

1. Remove the fan, [see Cooling System - Fan](#).
2. Remove the Poly-V belt pulley, [see Accessories - Poly-V belt](#).
3. Using a 15 mm socket wrench, remove the mounting bolts from tensioner pulley.
4. Remove the tensioner pulley.



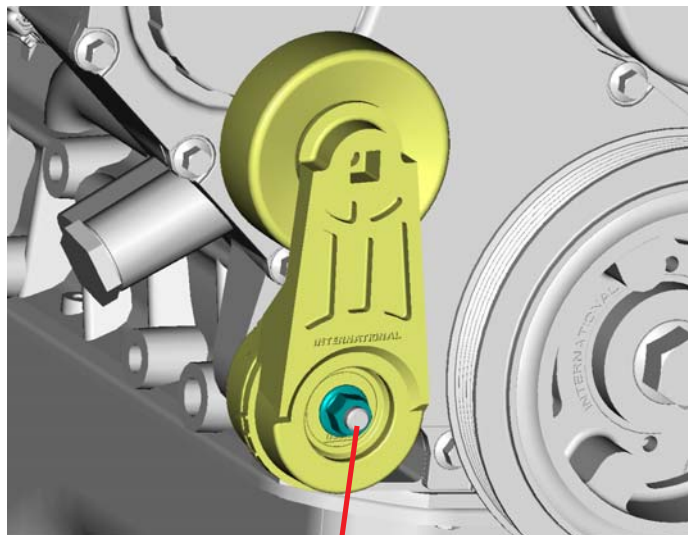
### Assembly

1. Using a 15 mm socket wrench, install the tensioner pulley applying a torque of 40 - 50 Nm on the mounting bolt.
2. Install the Poly-V belt assembly, [see Accessories - Poly-V Belt](#).
3. Install the fan assembly, [see Cooling System - Fan](#).

### Poly-V belt tensioner pulley

#### Removal

1. Remove the fan, [see Cooling System - Fan](#).
2. Remove the Poly-V belt pulley, [see Accessories - Poly-V Belt](#).
3. Using a 15 mm socket wrench, remove the mounting nut from the Poly-V belt tensioner.
4. Remove the Poly-V belt tensioner.



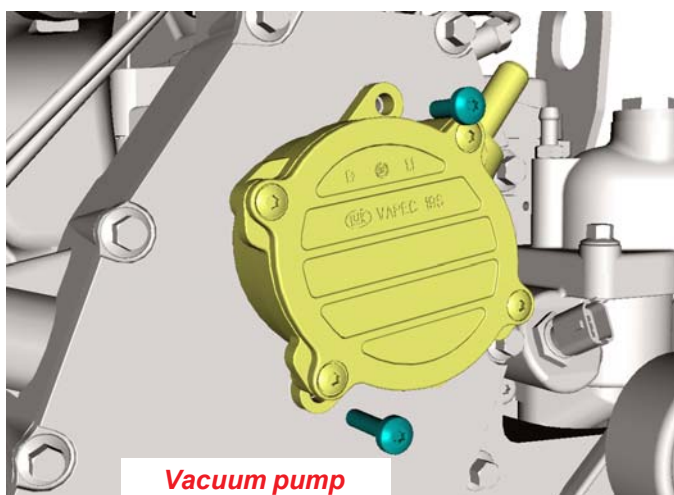
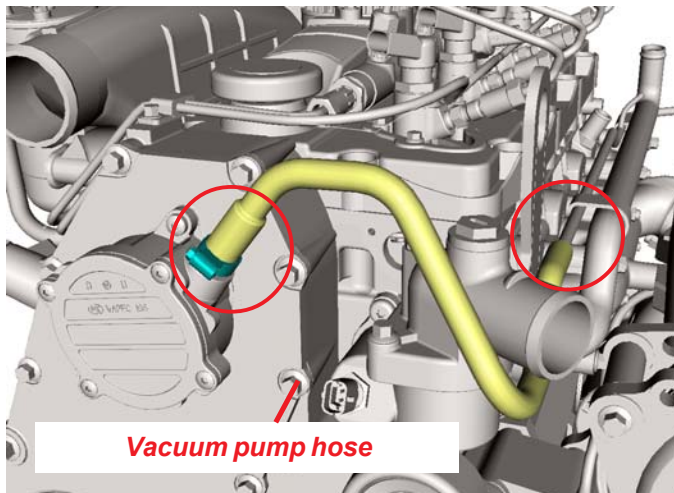
**Tensioner**

**Assembly**

1. Using a 15 mm socket, install the Poly-V belt tensioner applying a torque of 40 - 50 Nm on the mounting nut.
2. Install the Poly-V belt assembly, [see Accessories - Poly-V Belt](#).
3. Install the fan assembly, [see Cooling System - Fan](#).

**Vacuum pump****Removal**

1. Using pliers, loosen the clamp that fastens the vacuum system hose near to the vehicle heating system tube.
2. Disconnect the hose from the tube.
3. Using a screwdriver, loosen the vacuum system hose-fastening clamp near to the vacuum pump.
4. Disconnect the hose from vacuum pump, and remove it.
5. Using an 8 mm socket wrench, remove the two mounting bolts from vacuum pump.
6. Remove the vacuum pump.



**Assembly**

1. Using an 8 mm socket wrench, install the vacuum pump applying a torque of 8 - 11 Nm on the two mounting bolts.
2. Connect the vacuum system hose to the vacuum pump and, using a screwdriver, fasten its clamp.
3. Connect the vacuum system hose to the vehicle heating system tube and, using pliers, fasten its clamp.

**Idler pulley**

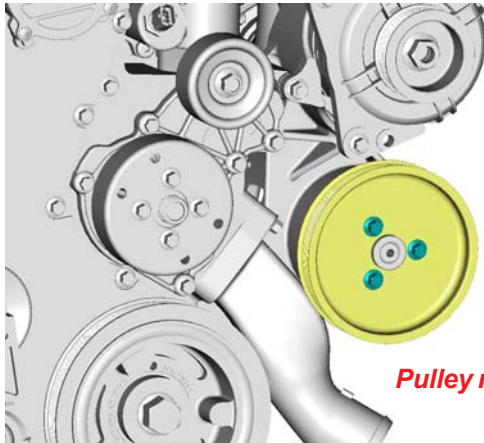
The engine distribution housing cover is fastened with twenty-one bolts. One of them is used to install the idler pulley on vehicles without air conditioning. This bolt is placed on the left side of the distribution housing cover.

**Removal**

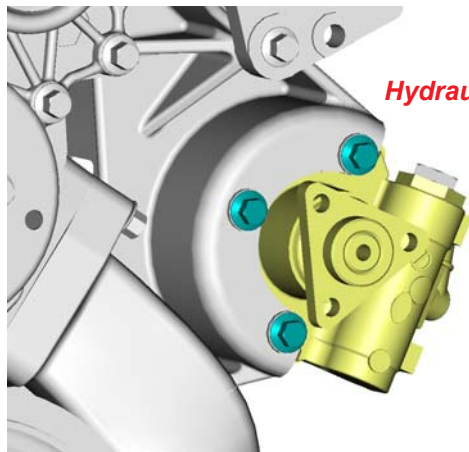
1. Remove the fan, [see Cooling system - Fan](#).
2. Remove the Poly-V belt, [see Accessories - Poly-V Belt](#).
3. Using a 13 mm socket wrench, remove the mounting bolt from idler pulley assembly.
4. Remove the idler pulley.

**Assembly**

1. Using a 13 mm socket wrench, install the idler pulley applying a torque of 22 - 28 Nm on the mounting bolt.
2. Install the Poly-V belt assembly, [see Accessories - Poly-V Belt](#).
3. Install the fan assembly, [see Cooling System - Fan](#).



Pulley removal



Hydraulic pump

## Hydraulic pump / pulley

### Removal

1. Remove the fan, [see Cooling System - Fan](#).
2. Remove the Poly-V belt, [see Accessories - Poly-V Belt](#).
3. Using a 14 mm hex-wrench to lock the hydraulic pump shaft and a 10 mm socket wrench, remove the three mounting bolts from hydraulic pump pulley.
4. Remove the hydraulic pump pulley.
5. Remove the hydraulic system hose.
6. Using a 10 mm socket wrench, remove the three mounting bolts from hydraulic pump.
7. Remove the hydraulic pump.

**Note:** The hydraulic pump is a “Black box” item. If it is necessary to repair it, send the pump to a manufacturer's authorized center.

**Note:** The hydraulic pump applied on Troller vehicles is different from that of Ford Ranger.

### Assembly

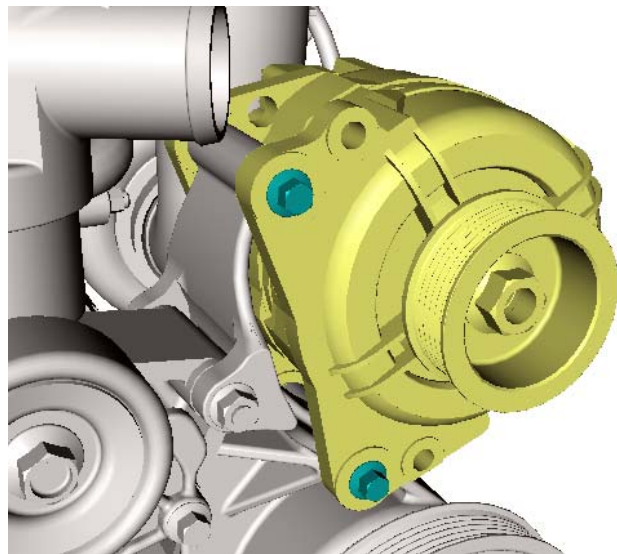
1. Using a 10 mm socket wrench, install the hydraulic pump applying a torque of 22 - 28 Nm on the three mounting bolts.
2. Using a 14 mm hex-wrench to lock the hydraulic pump shaft and a 10 mm socket wrench, install the hydraulic pump pulley applying a torque of 22 - 28 Nm on the three mounting bolts.
3. Install the Poly-V belt assembly, [see Accessories - Poly-V Belt](#).
4. Install the fan assembly, [see Cooling System - Fan](#).

### Alternator / pulley

#### Removal

1. Remove the fan, [see Cooling System - Remove the fan, see Cooling System - Fan](#).
2. Remove the Poly-V belt, [see Accessories - Poly-V Belt](#).
3. Disconnect the alternator electrical wiring connectors.
4. Using a 10 mm socket wrench, remove the two mounting bolts from alternator.
5. Remove the alternator.

**Note:** The alternator for Troller version is different from that of Ford Ranger version. They are not interchangeable.



**Alternator**

**Assembly**

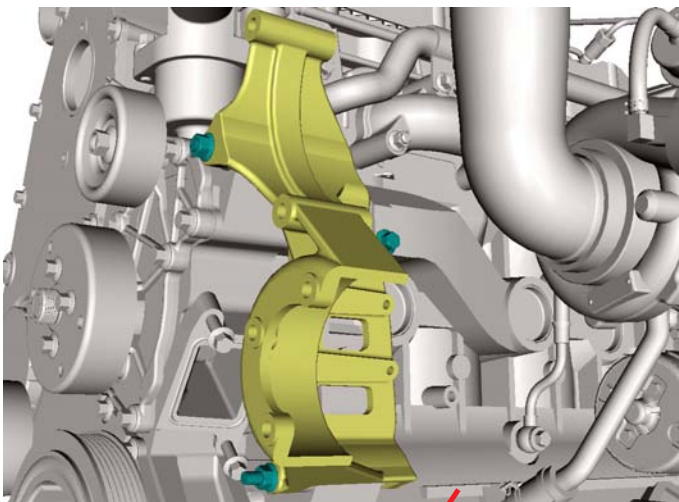
1. Using a 10 mm socket wrench, install the alternator applying a torque of 22 - 28 Nm on the two mounting bolts.
2. Connect the alternator electrical wiring connectors.
3. Install the Poly-V belt assembly, [see Accessories - Poly-V Belt](#).
4. Install the fan assembly, [see Cooling System - Fan](#).

**Alternator holder / hydraulic pump****Removal**

1. Remove the Poly-V belt, [see Accessories - Poly-V Belt](#).
2. Remove the Poly-V belt, [see Accessories - Poly-V Belt](#).
3. Remove the hydraulic pump, [see Accessories - Hydraulic Pump](#).
4. Remove the alternator, [see Accessories - Alternator](#).
5. Using a 10 mm socket wrench and a 13 mm socket wrench, remove the three bolts and the mounting nut from alternator/ hydraulic pump holder.

**Note:** The alternator holder upper bolt is passed through the front part of distribution housing and a 13 mm nut fastens it.

6. Remove the holder.



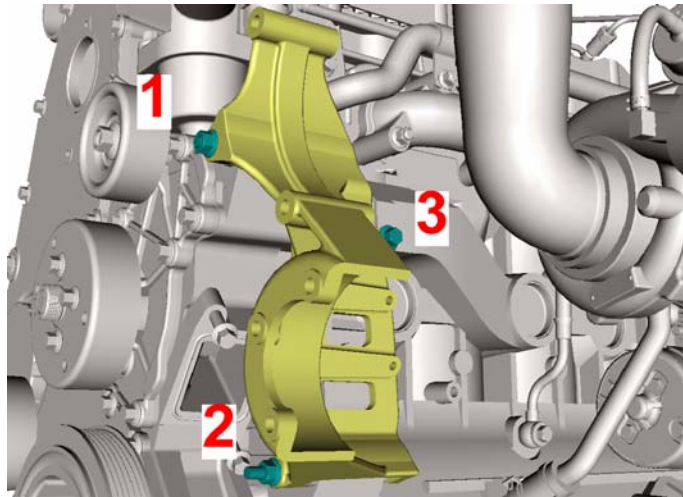
**Alternator holder / hydraulic pump**

### Assembly

1. Using a 10 mm and a 13 mm socket wrenches, install alternator / hydraulic pump holder, placing the mounting bolts and washers (without tighten them). After this step, apply a torque of 22 - 28 Nm on the three mounting bolts and washers, as shown on the illustration.

**⚠ Caution:** Before installing the remaining components, check the mounts alignment in relation to the distribution housing. A misaligned system will damage the Poly-V belt.

2. Install the alternator assembly, [see Accessories - Alternator](#).
3. Install the hydraulic pump assembly, [see Accessories - Hydraulic Pump](#).
4. Install the Poly-V belt assembly, [see Accessories - Poly-V Belt](#).
5. Install the fan assembly, [see Cooling System - Fan](#).



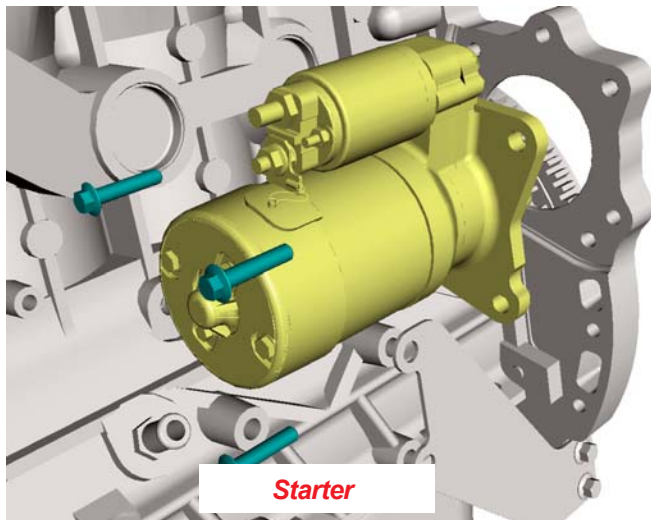
**Assembly sequence**

### Starter

#### Removal

1. Disconnect electrical wiring from starter.





2. Using a 13 mm socket wrench, remove the starter mounting bolts.

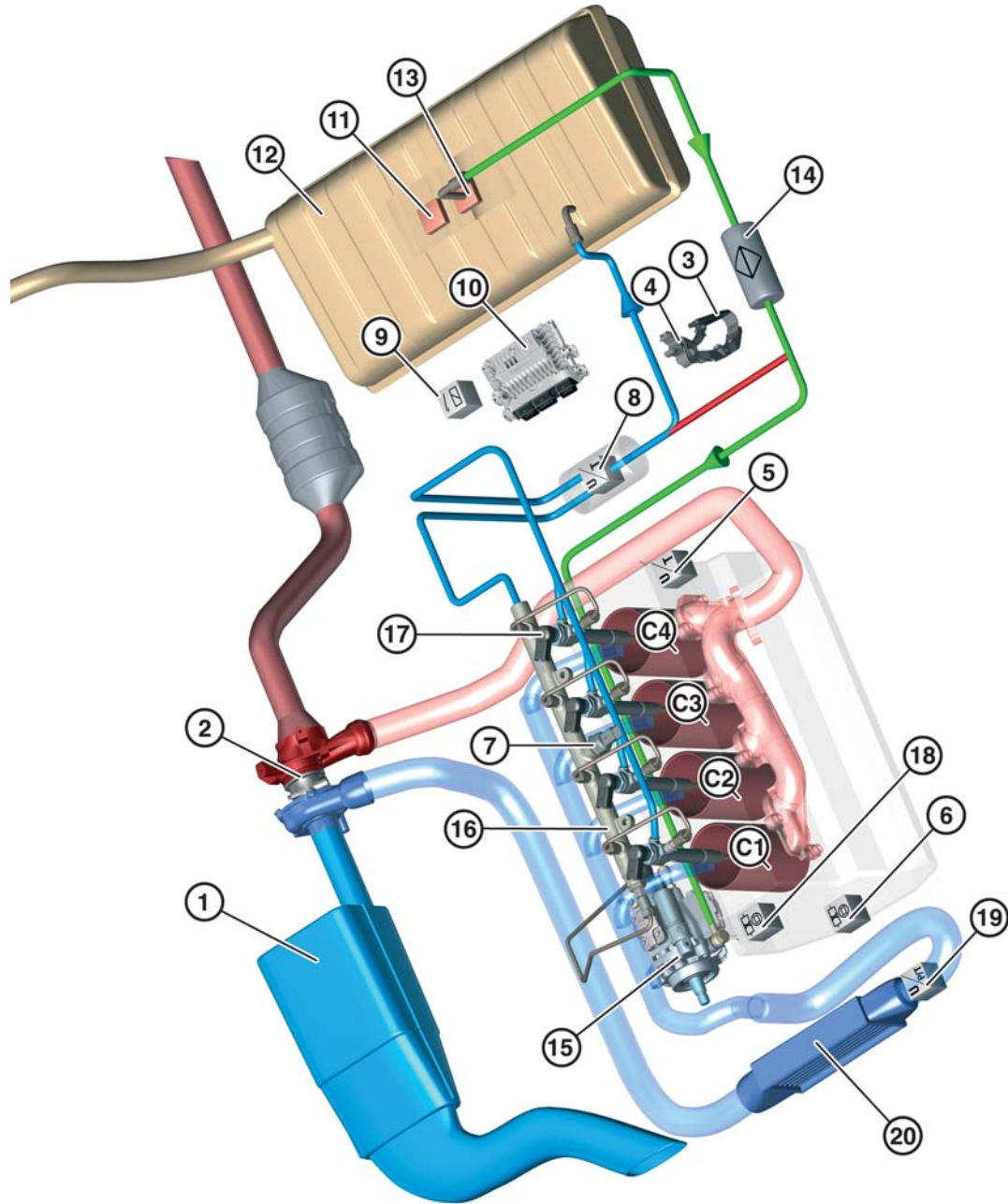
3. Remove the starter.

#### Assembly

1. Using a 13 mm socket wrench, install the starter mounting bolts applying a torque of 40 - 50 Nm.
2. Connect the starter electrical wiring connectors.



# ***Electronic Control***



## Electronic control

The MWM-*International* Motores engine NGD 3.0E is equipped with a Siemens PCR electronic fuel injection system.

The Siemens Piezo Common Rail (PCR) system is a 2nd generation injection system that uses fuel injectors with piezoelectric actuators.

The system is compound of a high-pressure pump, (DCP), common rail (feeding duct), high-pressure tubes, piezoelectric fuel injectors, sensors and actuators.

1. Air filter
2. Turbocharger
3. Accelerator pedal
4. Accelerator pedal sensor
5. Engine coolant temperature sensor
6. Crankshaft sensor (rotation sensor)
7. Fuel high-pressure sensor
8. Fuel temperature sensor (optional)
9. Glow plug relay (optional)
10. Electronic Control Unit (ECU)
11. Tank meter gauge for fuel level
12. Fuel tank
13. Electric fuel transfer pump (vehicle)
14. Fuel filter (MWM-*International* fuel system)
15. Fuel pump (DPC)
  - 15.1 Pressure control valve (PCV)
  - 15.2 High-pressure pump (HPP)
  - 15.3 Volume control valve (VCV)
  - 15.4 Internal transfer pump (ITP)
16. Common rail
17. Fuel injector
18. Camshaft position / phase sensor
19. Intake air pressure and temperature sensor - T-MAP
20. Intercooler (vehicle)
  - C1) Cylinder #1
  - C2) Cylinder # 2
  - C3) Cylinder # 3
  - C4) Cylinder # 4

### Temperature sensor (engine coolant and fuel)

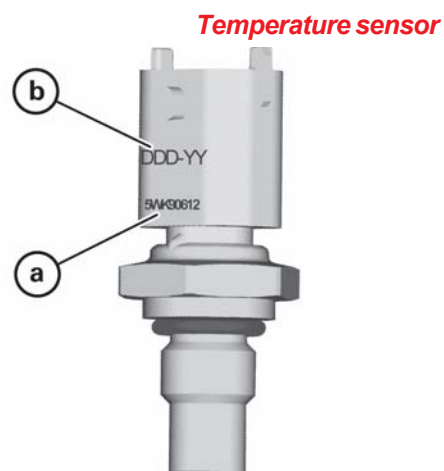
The system is equipped with two identical temperature sensors, one for fuel temperature and the other for the engine coolant temperature.

The engine coolant temperature sensor is located inside the thermostatic valve housing, [see Cooling System - Temperature Sensor on Thermostatic Valve Housing](#), while the fuel temperature sensor is located on the fuel return line to the tank, [see Fuel System - Fuel Temperature Sensor Housing](#).

### Temperature sensor identification

**⚠ Caution:** To accomplish the procedures in accordance with the warranty, it is mandatory to fill-out the forms with the correct sensor identification.

- a. Siemens VDO number.
- b. Date code:
  - 1st through 3rd digits: Manufacturing date.
  - 4th and 5th digits: Manufacturing year.

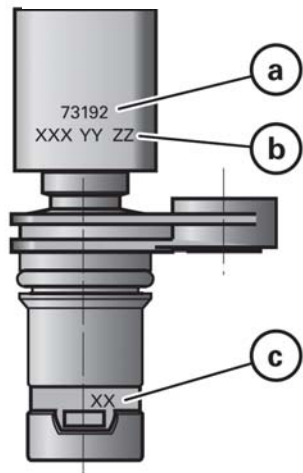


### Rotation sensor

The rotation sensor reads the position by means of a toothed wheel installed on the engine flywheel.

The rotation sensor is installed on the flywheel housing, [see Flywheel and Gear Ring - Flywheel](#).

Rotation Sensor



Rotation sensor identification

**! Caution:** To accomplish the procedures in accordance with the warranty, it is mandatory to fill-out the forms with the correct sensor identification.

- a. International Number.
- b. Date code:  
1st through 3rd digits: Manufacturing date.  
4th and 5th digits: Manufacturing year.  
6th and 7th digits: Identification.
- c. Housing number.

Common rail pressure sensor / fuel pressure

The common rail pressure sensor measures the pressure of the high-pressure fuel line.

This sensor is located directly on the common rail, sealed by a pliable steel washer.

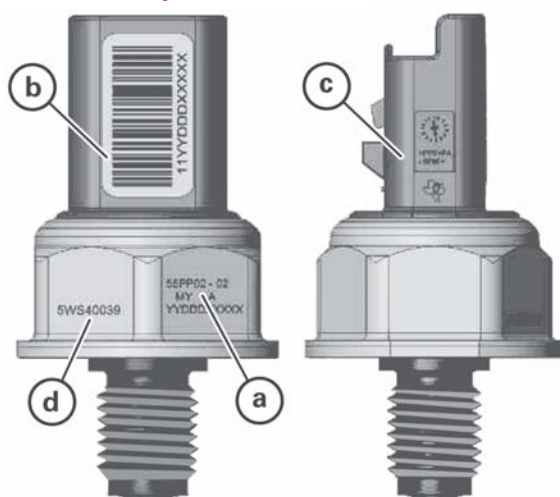
**! Caution:** For safety reasons, this sensor should never be removed from common rail and in case of any repair is required, the complete common rail should be replaced.

Common rail pressure sensor identification

**! Caution:** To accomplish the procedures in accordance with the warranty, it is mandatory to fill-out the forms with the correct sensor identification.

- a. Product Type (55P02-01).
- b. Code and serial number:  
1st and 2nd digits: 11 = SICMA 2 connector.  
3rd and 4th digits: Year (example: 03).  
5th through 7th digits: Manufacturing date.  
8th up to 12th digits: Serial number.
- c. Manufacturer's Logotype.
- d. Siemens VDO number.

Common rail pressure sensor



### Camshaft position sensor / phase

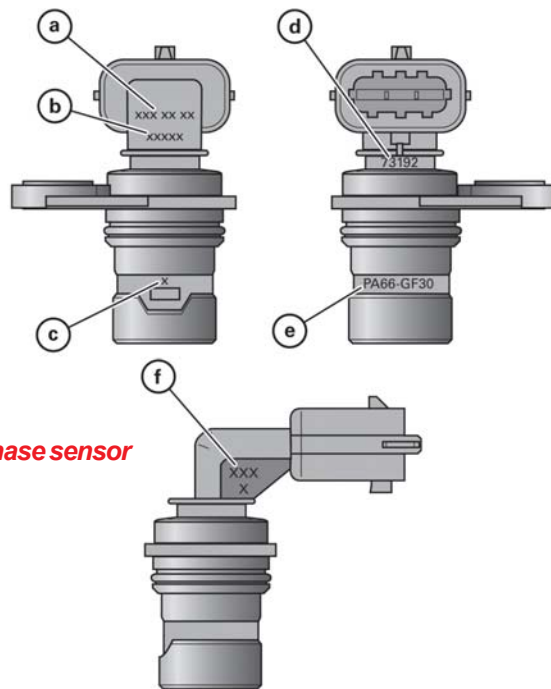
The camshaft position sensor reads the position by means of a toothed wheel installed on the camshaft.

The camshaft position sensor is installed directly on the engine's cylinder head.

### Camshaft position sensor identification

**!** **Caution:** To accomplish the procedures in accordance with the warranty, it is mandatory to fill-out the forms with the correct sensor identification.

- a. Date code:  
1st through 3rd digits: manufacturing date.  
4th and 5th digits: manufacturing year.  
6th and 7th digits: Identification.
- b. Serial number.
- c. Housing number.
- d. International number.
- e. Housing material identification.
- f. Specified corresponding connector code.

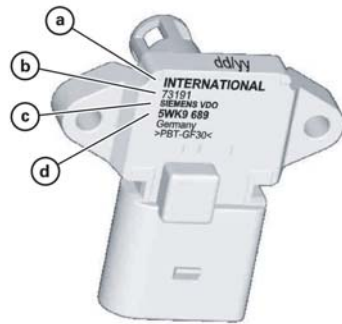


### T-MAP sensor (Intake air temperature and pressure)

With a temperature sensor together with a pressure sensor, it measures the pressure and temperature of the intake air to the engine in relation to the atmospheric pressure.

The T-MAP sensor is located on the intake manifold.



**T-MAP sensor****T-MAP sensor identification**

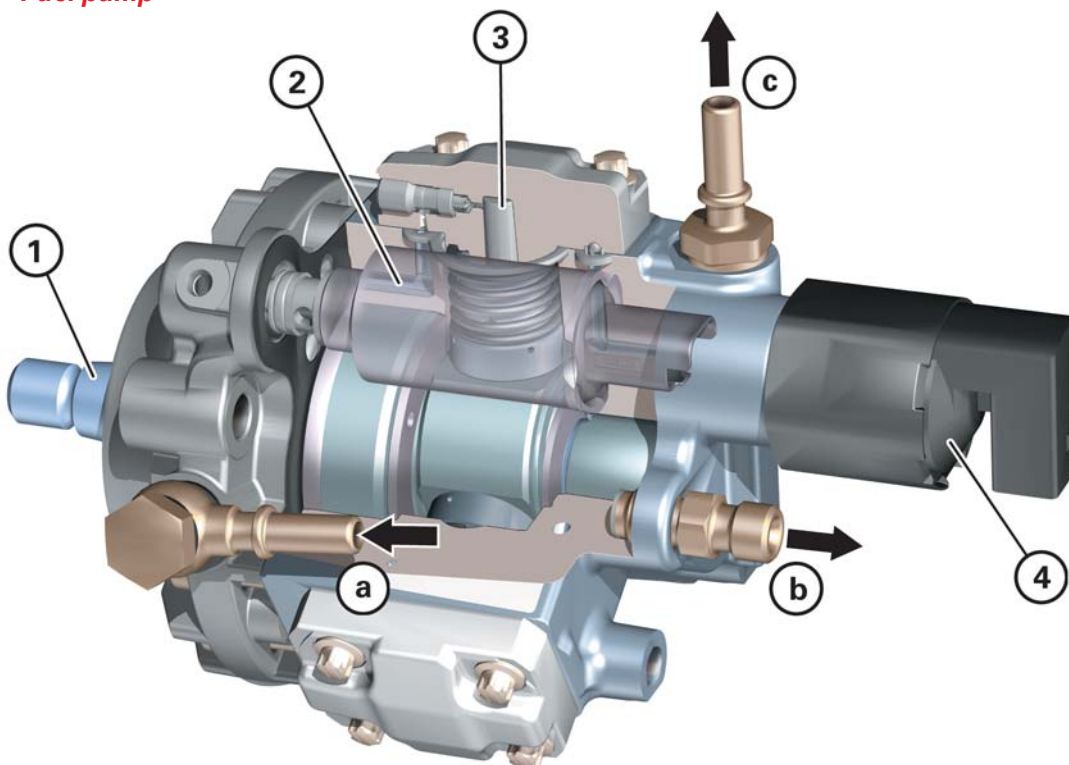
**! Caution:** To accomplish the procedures in accordance with the warranty, it is mandatory to fill-out the forms with the correct sensor identification.

- a. International Logotype.
- b. International Number.
- c. Siemens VDO Logotype.
- d. Siemens VDO Number.
- e. Date code:
  - 1st and 2nd digits: 17 = Type.
  - 3rd and 4th digits: Identification.
  - 5th digit: Manufacturing year.
  - 6th and 7th digits: Manufacturing week.
  - 8th digit: Manufacturing date.
- f. Serial number.

**Fuel pump (DPC)**

The fuel pump (DCP) is responsible for the fuel flow and volume supplied and for transferring this flow and volume under high-pressure to the common rail, by this way feeding the fuel injectors with the necessary amount of fuel for the engine's entire range of operating conditions, [see Fuel System - High-pressure Pump](#).

*Fuel pump*



- 1. Internal transfer pump (ITP)
- 2. Volume control valve (VCV)
- 3. High-pressure pump (HPP)
- 4. Pressure control valve (PCV)
  - a. Fuel feeding
  - b. High-pressure connection
  - c. Fuel return

**Volume control valve (VCV)**

The volume control valve (VCV) regulates the fuel transferring in the internal transfer pump, which is integrated into the fuel pump (DCP), for the elements of the high-pressure pump. This way, the amount of high-pressure fuel can be adjusted for the different needs of the engine.

The volume control valve (VCV) is fastened directly to the fuel pump (DCP).

**Important:** The volume control valve (VCV) cannot be separated from fuel pump (DCP).

The pressure control valve (PCV) controls the fuel pressure on the high-pressure fuel pump (DCP) outlet, and therefore it is also located inside the pump. Besides, the pressure control valve softens the pressure fluctuations that can occur during the fuel supplying by means of the fuel pump and the fuel injection process.

**Important:** If there is a need for repairs, the pressure control valve (PCV) cannot be separated from fuel pump (DCP).

**Fuel pump identification**

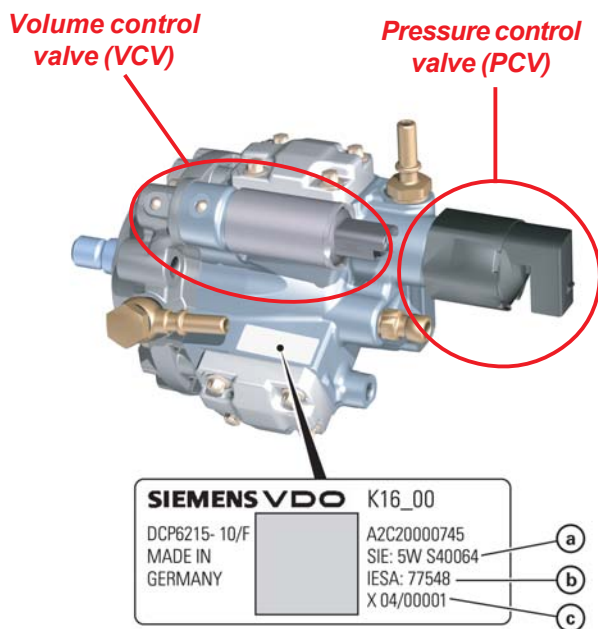
**Caution:** To accomplish the procedures in accordance with the warranty, it is mandatory to fill-out the forms with the correct valve identification.

- a. Manufacturer's number.
- b. International serial number.
- c. Manufacturing year:  
 X = 2004  
 Y = 2005  
 Z = 2006

Example: X04/00001

X04 = Week 4 of year 2004

00001 = Pump #1 assembled on 4<sup>th</sup> week of 2004



## Common rail

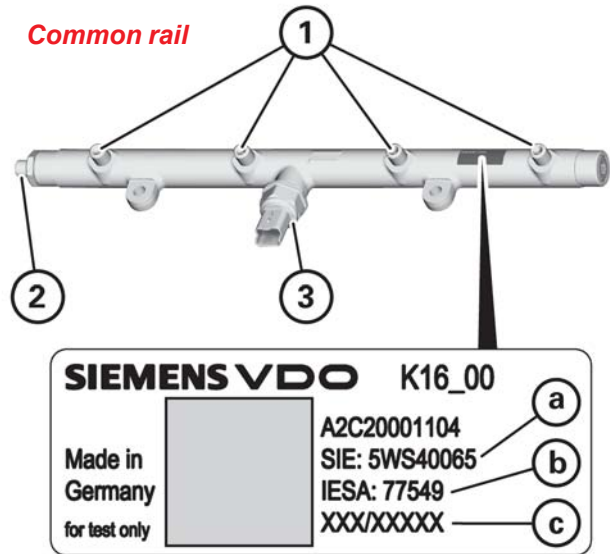
The common rail operates as a high-pressure repository for the fuel transferred through the fuel pump (DCP) to feed the fuel injectors with the necessary amount of fuel and fuel pressure for any operating condition.

**Important:** The high-pressure sensor should not be removed from common rail.

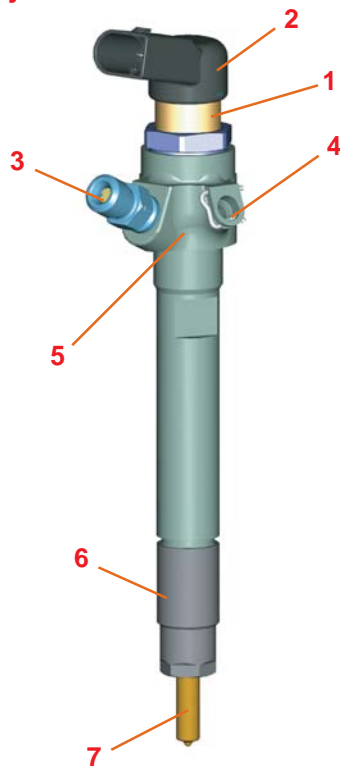
## Common rail identification

**Caution:** To accomplish the procedures in accordance with the warranty, it is mandatory to fill-out the forms with the correct sensor identification.

1. High-pressure tube connections for the fuel injectors.
2. High-pressure tube connection for fuel pump feeding.
3. High-pressure sensor:
  - a. Siemens VDO serial number.
  - b. International serial number.
  - c. Manufacturing period.



Fuel injector



### Fuel injector

The piezoelectric fuel injectors, connected to the common rail, inject the necessary amount of fuel into the combustion chamber, for all operating conditions of the engine.

#### Important:

The electrical wiring connectors between the fuel injector and the ECU must not be disconnected while the engine is running under risk of damaging the components.

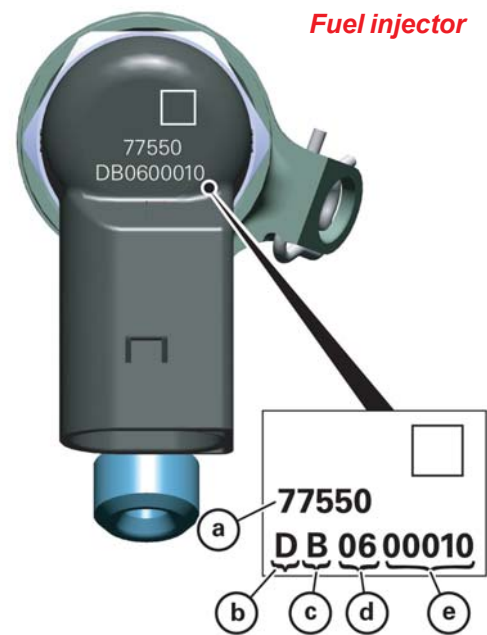
In case of any repair is required, the fuel injectors must not be removed. No parts can be loosened or unscrewed; any attempt to remove them compromises the engine's perfect operation and causes the automatic warranty loss.

1. Piezoelectric actuator.
2. Connector.
3. High-pressure connection.
4. Fuel return.
5. Fuel injector head.
6. Fuel injector holder.
7. Fuel injector nozzle.

**Fuel injector identification**

**!** **Caution:** To accomplish the procedures in accordance with the warranty, it is mandatory to fill-out the forms with the correct fuel injector identification.

- a. IESA number.
- b. Manufacturing year:  
C = 2003  
D = 2004  
E = 2005
- c. Manufacturing month:  
A = January  
B = February  
C = ----  
L = December
- d. Day:  
1 - 31
- e. Serial number:  
00001 - 99999



## Electronic control unit (ECU)

The engine control module, or engine control unit, tests all of the necessary processes to control the entire engine system. In function of the user's needs and the data received from engine and vehicle, (as engine rotation, vehicle speed, engine coolant temperature, air mass flow, etc.), this module also calculates the necessary output information, (such as the amount of fuel injected, fuel pressure, etc.). Besides these, some functions of the vehicle are also verified, such as the immobilization system.

The engine control unit communicates with other controls and control units, (for example, ABS, air conditioning, etc.), via CAN communication.

### Warning - high voltage

When services are to be executed on the ECU, all usual working safety measures for working where high voltage is present should be observed.

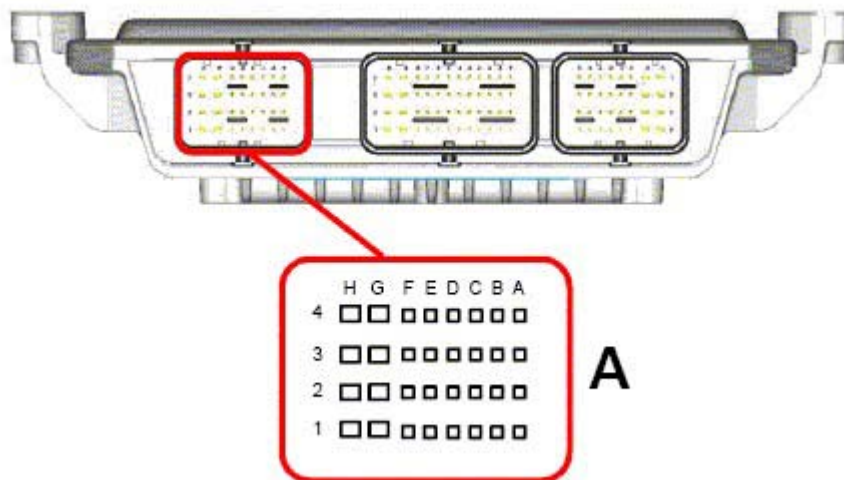
**Note:** The electrical connectors for the ECU should not be disconnected while the engine is operating, under risk of causing serious damages to the engine.

### Engine ECU identification

- a. Date.
- b. Siemens Number.
- c. Ford bar code identification.

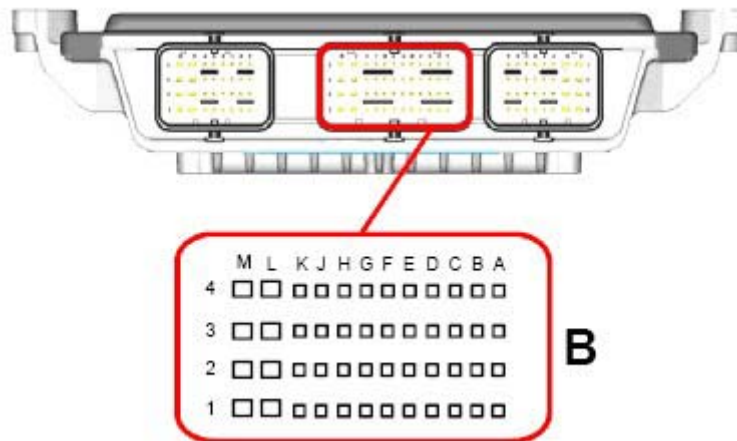


**Electronic Control Unit (ECU) pins identification**

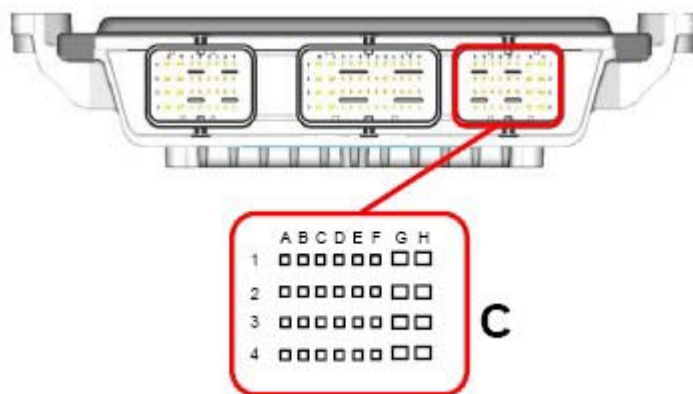


A1	RX-PATS	E1	Not used
A2	Reserved	E2	Not used
A3	Low level CAN	E3	Clutch pedal sensor
A4	High level CAN	E4	Brake pedal sensor (redundant)
B1	Not used	F1	Not used
B2	Not used	F2	Accelerator pedal position sensor (feed signal 1)
B3	Air conditioning	F3	Not used
B4	Not used	F4	Accelerator pedal sensor (ground)
C1	Not used	G1	Not used
C2	Accelerator pedal position sensor (signal 2)	G2	Accelerator pedal position sensor (feed signal 2)
C3	Battery positive for the ignition key	G3	Accelerator pedal position sensor (signal 1)
C4	Reserved	G4	Ground
D1	Reserved	H1	Not used
D2	TX-PATS	H2	Not used
D3	Reserved	H3	Accelerator pedal sensor (ground)
D4	Not used	H4	Ground

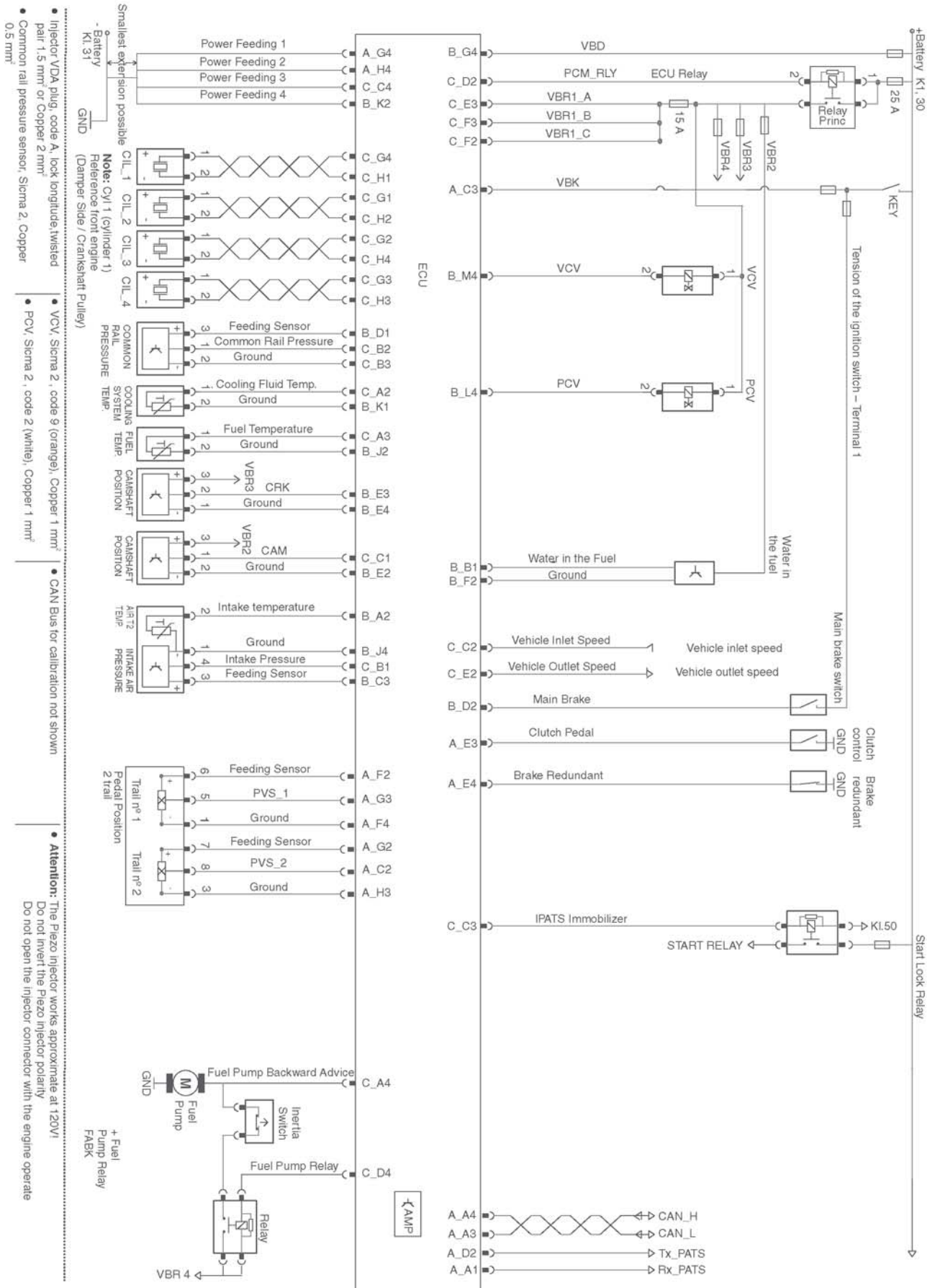




A1	Air conditioning (signal on / off)	G1	Not used
A2	T-MAP sensor (signal)	G2	Reserved
A3	Reserved	G3	Not used
A4	Reserved	G4	Battery positive
B1	Water-in-fuel presence sensor	H1	Not used
B2	Reserved	H2	Reserved
B3	Reserved	H3	Not used
B4	Reserved	H4	Reserved
C1	Reserved	J1	Not used
C2	Reserved	J2	Fuel temperature sensor (ground)
C3	T-MAP sensor (feed)	J3	Not used
C4	Reserved	J4	T-MAP sensor (ground)
D1	High-pressure sensor (feed) (ground)	K1	Cooling system temperature sensor (ground)
D2	Brake light switch	K2	Ground
D3	Reserved	K3	Not used
D4	Reserved	K4	Not used
E1	Not used	L1	Not used
E2	Camshaft sensor - Position (ground)	L2	Not used
E3	Crankshaft rotation sensor - Rotation (signal)	L3	Not used
E4	Crankshaft rotation sensor - Rotation (ground)	L4	Pressure control valve (PCV)
F1	Not used	M1	Not used
F2	Water-in-fuel presence sensor (ground)	M2	Reserved
F3	Reserved	M3	Reserved
F4	Reserved	M4	Volume control valve (VCV)



A1	Reserved	E1	Reserved
A2	Cooling system temperature sensor (signal)	E2	Vehicle speed sensor (output)
A3	Fuel temperature sensor (signal)	E3	Positive voltage switched from power relay
A4	Fuel pump (feeding signal)	E4	Reserved
B1	T-MAP sensor (ground)	F1	Reserved
B2	High-pressure sensor (signal)	F2	Positive voltage switched from power relay
B3	High-pressure sensor (ground)	F3	Positive voltage switched from power relay
B4	Reserved	F4	Air conditioning clutch relay
C1	Camshaft sensor - Place (signal)	G1	Fuel injector cylinder #2 (+)
C2	Vehicle speed sensor (signal)	G2	Fuel injector cylinder #3 (+)
C3	Immobilizer (signal)	G3	Fuel injector cylinder #4 (+)
C4	Ground	G4	Fuel injector cylinder #1 (+)
D1	Reserved	H1	Fuel injector cylinder #1 (-)
D2	PCM relay (signal)	H2	Fuel injector cylinder #2 (-)
D3	Reserved	H3	Fuel injector cylinder #4 (-)
D4	Fuel pump (signal)	H4	Fuel injector cylinder #3 (-)





## Diagnosis of Faults

### 1. Nominal system values and operating conditions

#### 1.1 Typical values for various operating conditions

##### 1.1.1 Conditions:

- Vehicle is stopped;
- Tank: at least half full;
- Battery voltage: 12-14.7 V;
- Ambient temperature: approx. 20 °C;
- Engine operating temperature: 80-90 °C.

##### Note:

All the electrical and mechanical consumers must be switched off.

## Typical values for condition of ignition on

		Min.	Max.
Engine speed	rpm	0	0
Coolant temperature	°C	15	25
Air intake temperature	°C	15	25
Accelerator pedal sensor value	%	0	0
Battery voltage	V	8	13
Injection quantity complete injection	mg/stroke	32	36
Injection quantity pre-injection	mg/stroke	0	0
Injection quantity main injection	mg/stroke	0	0
Activation duration of main injection	ms	0	0
Activation duration of pre-injection	ms	0	0
Start of main injection	°after TDC	0	0
Start of pre-injection	°after TDC	0	0
Rail pressure - nominal value	MPa	0	0
Rail pressure - actual value	MPa	0	0.5
PCV PWM	%	0	0
Current VCV	A	0	0.3
VCV PWM	%	0	0
Current VCV	A	0	0.33
Fuel temperature	°C	15	25
Smoke limitation	mg/stroke	240	270
Intake air mass actual value	mg/stroke	0	0
Absolute pressure prior to the fuel filter (static)	bar	0.9	1.1
Absolute pressure in the pump return flow (static)	bar	0.9	1.1
Absolute pressure in the injector return flow (static)	bar	0.9	1.1
Absolute pressure in the complete return flow (static)	bar	0.9	1.1

## Typical values for condition of idle cold

		Min.	Max.
Engine speed	rpm	790	1000
Coolant temperature	°C	18	25
Air intake temperature	°C	15	25
Accelerator pedal sensor value	%	0	0
Battery voltage	V	12	15
Injection quantity complete injection	mg/stroke	12	17.5
Injection quantity pre-injection	mg/stroke	2,5	3
Injection quantity main injection	mg/stroke	9	14.5
Activation duration of main injection	ms	0,7	1.1
Activation duration of pre-injection	ms	0,4	0.6
Start of main injection	°after TDC	-10.5	-6.6
Start of pre-injection	°after TDC	-25	-20
Rail pressure - nominal value	MPa	21.5	23
Rail pressure - actual value	MPa	19.5	25
PCV PWM	%	11	14
Current VCV	A	0.26	0.37
VCV PWM	%	20	24
Current VCV	A	0.7	0.85
Fuel temperature	°C	20	25
Smoke limitation	mg/stroke	35	39
Intake air mass actual value	mg/stroke	700	750
Absolute pressure prior to the fuel filter (static)	bar	1.3	1.7
Absolute pressure in the pump return flow (static)	bar	1.3	1.7
Absolute pressure in the injector return flow (static)	bar	1.8	2.4
Absolute pressure in the complete return flow (static)	bar	1.3	1.7

## Typical values for condition of idle warm

		<b>Min.</b>	<b>Max.</b>
Engine speed	rpm	775	850
Coolant temperature	°C	82	95
Air intake temperature	°C	15	40
Accelerator pedal sensor value	%	0	0
Battery voltage	V	12	15
Injection quantity complete injection	mg/stroke	4.5	7
Injection quantity pre-injection	mg/stroke	1.5	2.5
Injection quantity main injection	mg/stroke	3	4.5
Activation duration of main injection	ms	0.4	0.6
Activation duration of pre-injection	ms	0.3	0.45
Start of main injection	°after TDC	-5	-3.5
Start of pre-injection	°after TDC	-17	-15.5
Rail pressure - nominal value	MPa	21	23
Rail pressure - actual value	MPa	20	24
PCV PWM	%	12	13.5
Current VCV	A	0.3	0.4
VCV PWM	%	18	21
Current VCV	A	0.5	0.7
Fuel temperature	°C	38	50
Smoke limitation	mg/stroke	34	40
Intake air mass actual value	mg/stroke	675	710
Absolute pressure prior to the fuel filter (static)	bar	1.3	1.7
Absolute pressure in the pump return flow (static)	bar	1.3	1.7
Absolute pressure in the injector return flow (static)	bar	1.8	2.4
Absolute pressure in the complete return flow (static)	bar	1.3	1.7



**Typical values for condition of 2000 rpm, without load**

		<b>Min.</b>	<b>Max.</b>
Engine speed	rpm	1900	2100
Coolant temperature	°C	89	92
Air intake temperature	°C	15	45
Accelerator pedal sensor value	%	9	14
Battery voltage	V	12	15
Injection quantity complete injection	mg/stroke	4.2	8.5
Injection quantity pre-injection	mg/stroke	1.5	1.9
Injection quantity main injection	mg/stroke	2.7	6.7
Activation duration of main injection	ms	0.4	0.6
Activation duration of pre-injection	ms	0.25	0.34
Start of main injection	°after TDC	-13.3	-11.7
Start of pre-injection	°after TDC	-34	-29.5
Rail pressure - nominal value	MPa	21.5	27.1
Rail pressure - actual value	MPa	21.5	27.1
PCV PWM	%	12	14
Current VCV	A	0.3	0.5
VCV PWM	%	20	22
Current VCV	A	0.6	0.75
Fuel temperature	°C	40	50
Smoke limitation	mg/stroke	40	43
Intake air mass actual value	mg/stroke	700	750
Absolute pressure prior to the fuel filter (static)	bar	1.3	1.7
Absolute pressure in the pump return flow (static)	bar	1.3	1.7
Absolute pressure in the injector return flow (static)	bar	1.8	2.4
Absolute pressure in the complete return flow (static)	bar	1.3	1.7

## Typical values for condition of 4000 rpm, without load

		<b>Min.</b>	<b>Máx.</b>
Engine speed	rpm	3900	4100
Coolant temperature	°C	85	100
Air intake temperature	°C	15	50
Accelerator pedal sensor value	%	11	15.5
Battery voltage	V	12	15
Injection quantity complete injection	mg/stroke	10.5	15
Injection quantity pre-injection	mg/stroke	0	0
Injection quantity main injection	mg/stroke	10.5	15
Activation duration of main injection	ms	0.5	0.7
Activation duration of pre-injection	ms	0	0
Start of main injection	°after TDC	-21	-22
Start of pre-injection	°after TDC	-21	-21.5
Rail pressure - nominal value	MPa	21.5	27.1
Rail pressure - actual value	MPa	21.5	27.1
PCV PWM	%	12	14
Current VCV	A	0.3	0.5
VCV PWM	%	20	22
Current VCV	A	0.6	0.75
Fuel temperature	°C	40	50
Smoke limitation	mg/stroke	40	43
Intake air mass actual value	mg/stroke	700	750
Absolute pressure prior to the fuel filter (static)	bar	1.3	1.7
Absolute pressure in the pump return flow (static)	bar	1.3	1.7
Absolute pressure in the injector return flow (static)	bar	1.8	2.4
Absolute pressure in the complete return flow (static)	bar	1.3	1.7

## Typical values for condition of 1000 rpm, 1st Gear

		Min.	Máx.
Engine speed	rpm	900	1100
Coolant temperature	°C	85	95
Air intake temperature	°C	45	46
Accelerator pedal sensor value	%	2.6	4,8
Battery voltage	V	12	15
Injection quantity complete injection	mg/stroke	2.5	6.5
Injection quantity pre-injection	mg/stroke	0	1.8
Injection quantity main injection	mg/stroke	2	5
Activation duration of main injection	ms	0.25	0.65
Activation duration of pre-injection	ms	0	0.4
Start of main injection	°after TDC	-12	-9
Start of pre-injection	°after TDC	-26	-9
Rail pressure - nominal value	MPa	21	23
Rail pressure - actual value	MPa	21	23
PCV PWM	%	12	16
Current VCV	A	0.3	0.5
VCV PWM	%	19	22
Current VCV	A	0.5	0.7
Fuel temperature	°C	40	60
Smoke limitation	mg/stroke	38	41
Intake air mass actual value	mg/stroke	660	710
Absolute pressure prior to the fuel filter (static)	bar	1.3	1.7
Absolute pressure in the pump return flow (static)	bar	1.3	1.7
Absolute pressure in the injector return flow (static)	bar	1.8	2.4
Absolute pressure in the complete return flow (static)	bar	1.3	1.7

Typical values for condition of 2000 rpm, 1st Gear:

		<b>Min.</b>	<b>Máx.</b>
Engine speed	rpm	1900	2100
Coolant temperature	°C	80	95
Air intake temperature	°C	15	45
Accelerator pedal sensor value	%	10	17
Battery voltage	V	12	15
Injection quantity complete injection	mg/stroke	5	10.5
Injection quantity pre-injection	mg/stroke	1.5	2
Injection quantity main injection	mg/stroke	3.5	9
Activation duration of main injection	ms	0.4	0.65
Activation duration of pre-injection	ms	0.25	0.4
Start of main injection	°after TDC	-13	-11
Start of pre-injection	°after TDC	-34	-29
Rail pressure - nominal value	MPa	21	31
Rail pressure - actual value	MPa	21	31
PCV PWM	%	12	15
Current VCV	A	0.3	0.5
VCV PWM	%	21	23
Current VCV	A	0.6	0.8
Fuel temperature	°C	40	60
Smoke limitation	mg/stroke	40	43
Intake air mass actual value	mg/stroke	700	740
Absolute pressure prior to the fuel filter (static)	bar	1.3	1.7
Absolute pressure in the pump return flow (static)	bar	1.3	1.7
Absolute pressure in the injector return flow (static)	bar	1.8	2.4
Absolute pressure in the complete return flow (static)	bar	1.3	1.7

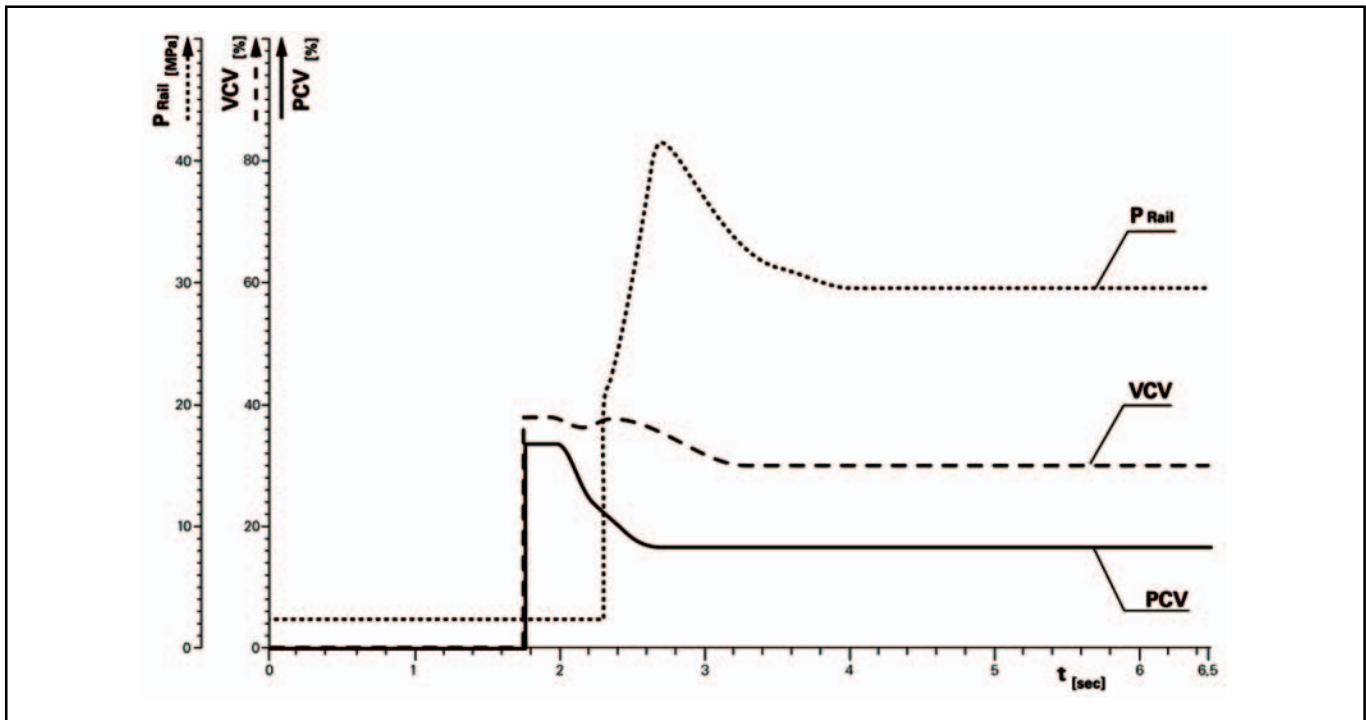
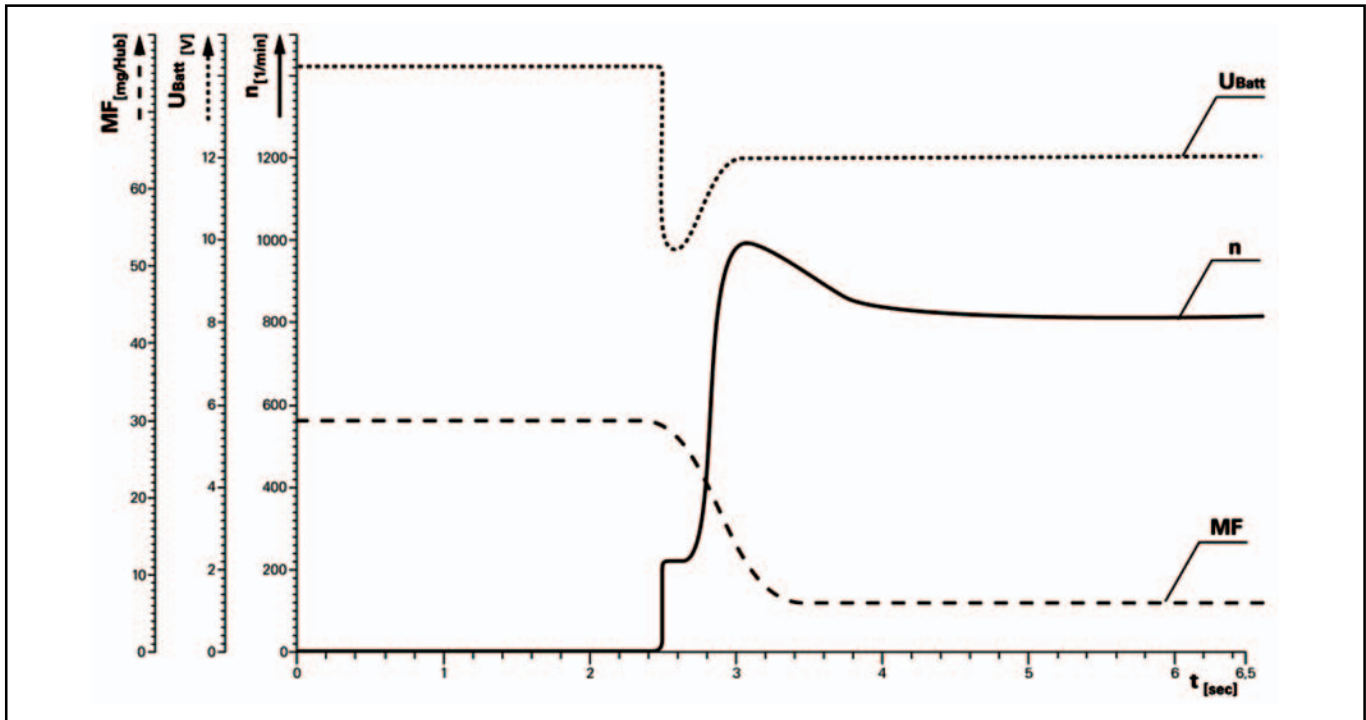
## 1.2 Typical start performance

### 1.2.1 Tolerance bands

Speed	<b>n</b>	Start: 150 - 250 rpm (cold start) 200 - 300 rpm (warm start)  Idle $\pm$ 30 rpm
Battery voltage	<b>U<sub>Bat</sub></b>	$\pm$ 10% (max. 14.7) V
Injection quantity	<b>MF</b>	$\pm$ 10%
Rail pressure	<b>P<sub>Rail</sub></b>	$\pm$ 20%
Pressure control valve Pulse duty factor	<b>PCV</b>	$\pm$ 10%
Volume flow control valve Pulse duty factor	<b>VCV</b>	+ 20%

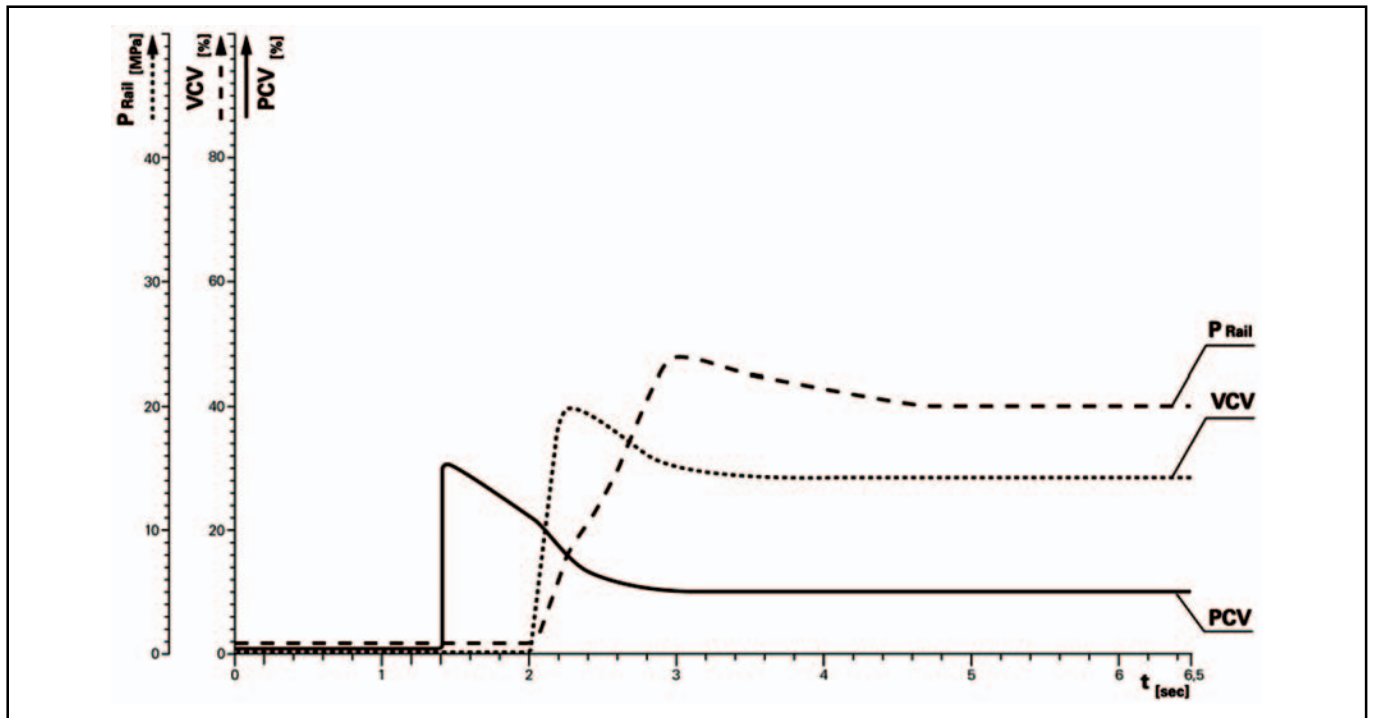
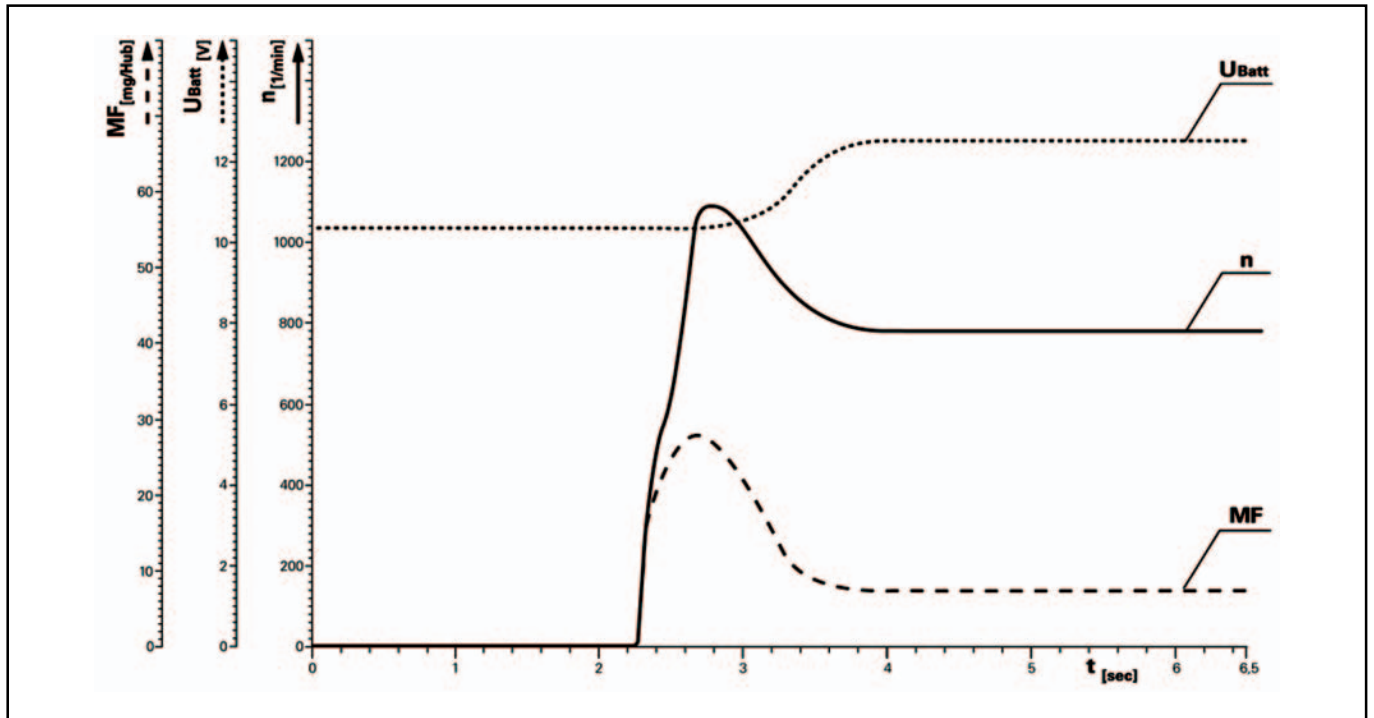
## Cold start

Coolant temperature: 20 °C



Warm start

Coolant temperature: 80 °C



## 2 Troubleshooting

### Notes:

System faults may cause sequential faults which are to be handled secondarily during fault elimination. At the beginning of troubleshooting, all sensors and actuators are to be checked and faults corrected.

Defective and unconnected sensors can impair troubleshooting.

### Important:

When the service tool is in usage (i.e. idle speed) you must not interrupt the session by disconnecting the service tool.

If no fault codes are shown or no possibility to read them out is available, all suitable tests must be carried out:

(S) Siemens test instructions;

(C) Customer test instructions.

### Process for fault elimination:

A fault code may be caused by a number of factors. You can find the possible causes in this chapter. To do this, use the Search feature in Acrobat Reader. For a detailed description of the individual faults, see chapter "Fault code list".

### Symptoms analysis

[2.1 MIL control lamp does not light up with the ignition switched on](#)

[2.2 MIL control lamp lights up when the engine is running](#)

[2.3 Engine does not start](#)

[2.4 Engine starts poorly](#)

[2.5 Poor cold start performance \(occurs primarily at cold temperatures\)](#)

[2.6 Engine cannot be turned off](#)

[2.7 Engine stalls](#)

[2.8 Engine idle speed too high](#)

[2.9 Engine idle speed too slow / rough](#)

[2.10 No / low vehicle acceleration, engine speed does not increase / too low](#)

[2.11 Vehicle jerks at constant speed](#)

[2.12 Vehicle accelerates without actuation of the accelerator pedal](#)

[2.13 Vehicle does not decelerate \(no overrun condition\)](#)

[2.14 Vehicle jerks while coasting with gear engaged](#)

[2.15 Power too low](#)

[2.16 Power too high](#)

[2.17 Load kick when accelerating or decelerating](#)

[2.18 Vehicle accelerates fast while coasting after releasing the brake](#)

[2.19 Engine smoking at start](#)

[2.20 Engine smokes / blue smoke](#)

[2.21 Engine smokes while climbing passes](#)

[2.22 Engine develops white smoke \(particularly after start\)](#)

[2.23 High fuel consumption](#)

[2.24 Engine knocks](#)

[2.25 Engine gets too hot](#)



**2.1 MIL control lamp does not light up with the ignition switched on**

<b>Cause of Fault</b>	<b>Location of Fault</b>	<b>Code</b>	<b>Fault Elimination</b>
Control lamp defective	Control lamp	No entry	Check vehicle electric system (C)
No voltage supply	Fault in vehicle electric system	No entry(s)	

**2.2 MIL control lamp lights up when the engine is running**

<b>Cause of Fault</b>	<b>Location of Fault</b>	<b>Code</b>	<b>Fault Elimination</b>
Entry of a fault diagnosis	Read out fault diagnosis	No entry	Correct relevant faults

## 2.3 Engine does not start

Cause of Fault	Location of Fault	Code	Fault Elimination
Engine start speed too low	Battery capacity too low	P0562; P0563	Check battery capacity (C)
	Faulty starter or relay	P0615	Check starter and relay (C)
Engine control unit does not work	No voltage supply to the engine control unit	No entry	Supply via the ignition switch / check the continual voltage supply to the engine control unit (C)
Engine control unit has no function	Hardware or software in the engine control unit	P0200; P0602; P0606; P0608; P1612; P1613; P1639	Check engine control unit and replace it, if necessary ( <a href="#">see chapter 4.5</a> )
	ECU ground connection defective	No entry	Check ECU ground connection (C)
No main voltage supply to engine control unit and actuators	Main relay defective	P0685; P0687	Check main relay and ignition switch (C) Check pins 15 / 30 on the engine control unit (ECU) (C)
	Wiring harness or plug-in connections defective	No entry	Check electrical connections (C)
No voltage supply to the sensors (5 V)	Faulty engine control unit	P0642; P0643; P0652; P0653	Check the wire connection and power supply (+) on the sensors (C) Replace engine control unit if necessary
	Defective wiring harness or plug-in connections	P0642; P0643; P0652; P0653	
Incorrect or no sensor signal	Faulty sensors	No entry	Replace sensors (C)
Limp home activated		No entry	
No engine speed detected in engine control unit	Incorrect or no camshaft signal	P0340; P0341	Check camshaft sensor and electrical connections (C)
	Incorrect or no crankshaft signal	P0335; P0336	Check crankshaft sensor and electrical connections (C)
Too little or no fuel intake	Internal transfer pump faulty; fuel filter blocked	P0001; P0089; P0090; P0091; P0092; P0190; P0191; P0192; P0193; P0194	Check low-pressure system (S) ( <a href="#">see chapter 4.2</a> )
	Air in low-pressure line; leaky low-pressure line		
	Fuel filter blocked		
	Empty tank	P1933	Top up fuel (C)

2.3 Engine does not start (Cont.)

Cause of Fault	Location of Fault	Code	Fault Elimination
Too little or no pressure at the rail	Too little or no fuel intake	P0001; P0089; P0090; P0091; P0092; P0190; P0191; P0192; P0193; P0194	Check low-pressure system (S) ( <a href="#">see chapter 4.2</a> )
	High-pressure pump defective	P0002; P0089; P0090; P0091; P0092	Check high-pressure system (S) ( <a href="#">see chapter 4.3</a> )
	PCV / VCV defective	P0001; P0002; P0003; P0004; P0089; P0090; P0091; P0092	
	Leaky high-pressure lines / rail	P0001; P0089; P0090; P0091; P0092; P0190; P0191; P0192; P0193; P0194	
	High-pressure signal missing or incorrect	P0190; P0191; P0192; P0193; P0194	Check high-pressure sensor (C) Check high-pressure system (C)
	Faulty engine control unit	P0200; P0602; P0606; P0608; P1612; P1613	Check engine control unit (S), replace it, if necessary ( <a href="#">see chapter 4.5</a> )
	High injector leakage	P0090; P0091; P0092; P0089; P0001	Check injectors (S) ( <a href="#">see chapter 4.4</a> )
Free water or gasoline in the tank	Fuel tank soiled or incorrectly filled	P1140	Empty tank and clean it, if necessary (C)
Some or all cylinders are not working	Injectors defective	P0201; P0202; P0203; P0204; P0200; P1201; P1202; P1203; P1204	Check injectors (S) ( <a href="#">see chapter 4.4</a> ) Check wire connection (C)
	Defective wiring harness or plug-in connections	P0200; P0201; P0202; P0203; P0204; P1201; P1202; P1203; P1204; P0606	Check electrical connections (C)
	Faulty engine control unit	P0200; P0602; P0606; P0608; P1612; P1613	Replace engine control unit if necessary (S) ( <a href="#">see chapter 4.5</a> )
	Compression too low	No entry	Check compression (C)
Too little air intake	Air filter is blocked or intake line is bent.	P0105; P 0107; P0108; P0109; P0110; P0112; P0113; P0114	Check air intake system (C)

## 2.4 Engine starts poorly

Cause of Fault	Location of Fault	Code	Fault Elimination
Faulty engine control unit	Various effects possible	P0200; P0602; P0606; P0608; P1612; P1613	Replace engine control unit if necessary (S) ( <a href="#">see chapter 4.5</a> )
Sporadic loss of sensor or actuator signals	Defective wiring harness or plug-in connections	No entry	Check electrical connections (C)
Engine start speed too low	Battery capacity too low	P0562; P0563	Check battery capacity (C)
	Faulty starter or relay	P0615	Check starter and relay (C)
Voltage drop at the engine control unit during start	Poor ground connections	P0562	Check ground connections (C)
	Faulty voltage supply		Check voltage supply system (C)
Too little or no fuel intake	Faulty internal transfer pump	P0001; P0089; P0090; P0091; P0092; P0190; P0191; P0192; P0193; P0194	Check low-pressure system (S) ( <a href="#">see chapter 4.2</a> )
	Air in the low-pressure line		
	Leaky low-pressure line		
	Fuel filter blocked		Top up fuel (C)
Rail pressure too low	Empty tank		
	Too little or no fuel intake	P0001; P0089; P0090; P0091; P0092; P0190; P0191; P0194; P0192; P0193	Check low-pressure system (S) ( <a href="#">see chapter 4.2</a> )
	High-pressure pump defective	P0089; P0090; P0091; P0092; P0001	Check high-pressure system (S) ( <a href="#">see chapter 4.3</a> )
	PCV / VCV defective	P0002; P0003; P0004; P0089; P0090; P0091; P0092; P0001	
	Faulty engine control unit	P0200; P0602; P0606; P0608; P1612; P1613	Replace engine control unit, if none of the previous tests have achieved any improvement (S) ( <a href="#">see chapter 4.5</a> )
	Leaky high-pressure lines / rail	P0001; P0089; P0090; P0091; P0092; P0190; P0191; P0192; P0193; P0194	Check high-pressure system (S) ( <a href="#">see chapter 4.3</a> )
	High-pressure signal missing or incorrect	P0190; P0191; P0192; P0193; P0194	Check high-pressure system (S) ( <a href="#">see chapter 4.3</a> )
High injector leakage	P0089; P0090; P0091; P0092; P0001	Check injectors (S) ( <a href="#">see chapter 4.4</a> )	
Free water or gasoline in the tank	Fuel tank soiled or incorrectly filled	P1140	Empty tank and clean it, if necessary (C)

## 2.4 Engine starts poorly (Cont.)

Cause of Fault	Location of Fault	Code	Corrective Action
One or more cylinders are not working	Injectors defective	P1201; P1202; P1203; P1204; P0201; P0202; P0203; P0204; P0200	Check injectors (S) ( <a href="#">see chapter 4.4</a> )
	Defective wiring harness or plug-in connections	P0200; P1201; P1202; P1203; P1204; P0200; P0601; P0606	Check electrical connections (C)
	Faulty engine control unit	P0200; P0602; P0606; P0608; P1612; P1613	If other measures have no effect, check the engine control unit and replace it if necessary (S) ( <a href="#">see chapter 4.5</a> )
	Compression too low	No entry	Check compression (C)
Too little air intake	Air filter is blocked or intake line is bent	P0103	Check air intake system (C)

**2.5 Poor cold start performance (occurs primarily at cold temperatures)**

Cause of Fault	Location of Fault	Code	Fault Elimination
Engine start speed too low	Battery capacity too low	P0562; P0563	Check battery capacity (C)
	Incorrect engine oil viscosity	No entry	Carry out oil change (C)
	Faulty starter	No entry	Check starter (C)
Too little rail pressure as well as too little injection quantity during the start process	Air intake temperature signal too high	No entry	Check air intake temperature sensor (C)
	Coolant temperature signal too high	P0115; P0116; P0117; P0118	Check coolant temperature sensor (C)
	Fuel temperature signal too high	P0180; P0184; P0183	Check fuel temperature sensor (C)
Faulty glow plug system (optional)*	One or more glow plugs defective	No entry	Check glow plug system (C)
	Glow plug relay defective	No entry	
	Glow plug control lamp defective	No entry	
Too little or no fuel intake	Fuel filter soiled	No entry	Replace fuel filter (C)
	Fuel filter iced up by free water	No entry	Replace the fuel filter and clean the tank if necessary (C)
	Fuel filter blocked by wax deposits from the fuel	No entry	Replace the fuel filter and change the fuel (C)
	Air in low-pressure line	No entry	Check low-pressure system (C)
Low compression	Heavy wear on the piston rings or leakage at the valves	No entry	Check compression (C)

**Note:**

\*\* The glow plug system is an optional component of the system provided by Siemens VDO.

**2.6 Engine cannot be turned off**

Cause of Fault	Location of Fault	Code	Fault Elimination
Engine control unit does not react	Ignition switch defective	No entry	Check pin 15 on the control unit (C)
	Faulty engine control unit	P0200; P0602; P0606; P0608; P1612; P1613	Check engine control unit (C)
	Defective wiring harness	No entry	Check electrical connections (C)

2.7 Engine stalls

Cause of Fault	Location of Fault	Code	Fault Elimination
Faulty engine control unit	Various effects possible	P0200; P0602; P0606; P0608; P1612; P1613	If other measures have no effect, check the engine control unit and replace it if necessary (S) <a href="#">(see chapter 4.5)</a>
Too little or no pressure at the rail	Too little or no fuel intake	P0089; P0090; P0091; P0092; P0190; P0191; P0192; P0193; P0194	Check low-pressure system (S) <a href="#">(see chapter 4.2)</a>
	High-pressure pump defective	P0089; P0090; P0091; P0092; P0001	Check high-pressure system (S) <a href="#">(see chapter 4.3)</a>
	PCV / VCV defective	P0002; P0003; P0004; P0089; P0090; P0091; P0092; P0263; P0266; P0269; P0272; P0001	Check high-pressure system (S) <a href="#">(see chapter 4.3)</a>
	Leaky high-pressure lines / rail	P0001; P0089; P0090; P0091; P0092; P0190; P0191; P0192; P0193; P0194	
	High-pressure signal missing or incorrect	P0190; P0191; P0192; P0193; P0194	Check high-pressure system (S) <a href="#">(see chapter 4.3)</a>
	High injector leakage	P0263; P0266; P0269; P0272; P0089; P0090; P0091; P0092; P0001	Check injectors (S) <a href="#">(see chapter 4.4)</a>
	Faulty engine control unit	P0200; P0602; P0606; P0608; P1612; P1613	Check engine control unit (C)
Sporadic voltage drop at the engine control unit	Poor ground connections:	No entry	Check ground connections (C)
	Faulty voltage supply		Check voltage supply system (C)
Sporadic loss of sensor or actuator signals	Defective wiring harness	No entry	Check electrical connections (C)
Too little or no fuel intake	Faulty internal transfer pump	P0089; P0090; P0091; P0092; P0190; P0191; P0192; P0193; P0194	Check low-pressure system (S) <a href="#">(see chapter 4.2)</a>
	Air in low-pressure line		
	Leaky low-pressure line		
	Fuel filter heavily soiled		
	Empty tank		

**2.7 Engine stalls (Cont.)**

Cause of Fault	Location of Fault	Code	Fault Elimination
Too little air intake	Air filter is blocked or intake lines are bent	P0103	Check air intake system (C)
	Leakage in the intake line downstream of the turbocharger		
False or no recognition of the gear by the engine control unit (-> no anti-jerk control)	Clutch pedal slightly activated	No entry	
	Clutch switch incorrectly adjusted or faulty	No entry	
	Vehicle speed signal missing or incorrect	P0608	

**2.8 Engine idle speed too high**

Cause of Fault	Location of Fault	Code	Fault Elimination
Faulty engine control unit	Various effects possible	P0200; P0602; P0606; P0608; P1612; P1613	If other measures have no effect, check the engine control unit and replace it if necessary (S) <a href="#">(see chapter 4.5)</a>
On-board voltage too low	On-board voltage controller defective	No entry	Check vehicle electric system (C)
	Too many consumers turned on	No entry	
Coolant temperature signal too low	Faulty coolant temperature sensor	P0116; P0117; P0118	Check coolant temperature sensor and electrical connections (C)
Faulty accelerator pedal signal	Faulty accelerator pedal position	No entry	Check accelerator pedal (C)
	Defective wiring harness or plug-in connections	P0122; P0123; P0222; P0223; P2135; P1577	Check accelerator pedal sensor and electrical connections (C)
	Faulty accelerator pedal sensor		
Limp home activated	Read out fault memory	No entry	Correct relevant faults (C)



2.9 Engine idle speed too slow / rough

Cause of Fault	Location of Fault	Code	Fault Elimination
Faulty engine control unit	Various effects possible	P0200; P0602; P0606; P0608; P1612; P1613	If other measures have no effect, check the engine control unit and replace it if necessary (S) <a href="#">(see chapter 4.5)</a>
Too little air intake	Air filter is blocked or intake lines are bent	P0263; P0266; P0269; P0272	Check air intake system (C)
	Leakage in the intake line downstream of the turbocharger		
Too little or no fuel intake	Faulty internal transfer pump	P0089; P0090; P0091; P0092; P0263; P0266; P0269; P0272; P0190; P0191; P0192; P0193; P0194	Check low-pressure system (S) <a href="#">(see chapter 4.2)</a>
	Air in low-pressure line		
	Leaky low-pressure line		
	Fuel filter blocked	No entry	Top up fuel (C)
Rail pressure fluctuations	PCV / VCV defective	P0002; P0003; P0004; P0089; P0090; P0091; P0092; P0263; P0266; P0269; P0272; P0001	Verificar circuito de alta pressão <a href="#">(ver cap. 4.3)</a>
	High-pressure pump defective	P0089; P0090; P0091; P0092; P0001; P0263; P0266; P0269; P0272	
	Leaky high-pressure line / rail	P0089; P0090; P0091; P0092; P0001; P0263; P0266; P0269; P0272; P0190; P0191; P0192; P0193; P0194	
	High-pressure signal missing or incorrect	P0190; P0191; P0192; P0193; P0194	Check high-pressure system (S) <a href="#">(see chapter 4.3)</a>
	Leaky low-pressure line	No entry	Check low-pressure system (S) <a href="#">(see chapter 4.2)</a>
	Injectors defective	P0263; P0266; P0269; P0272	Check injectors (S) <a href="#">(see chapter 4.4)</a>
	Defective wiring harness or plug-in connections	No entry	Check wire connections (C)
	Faulty engine control unit	P0200; P0602; P0606; P0608; P1612; P1613	If other measures have no effect, check the engine control unit and replace it if necessary (S) <a href="#">(see chapter 4.5)</a>
ECU is not responding to additional load on the air conditioning system compressor	Air conditioning system pressure sensor defective	No entry	Check air conditioning system pressure sensor (C)

## 2.10 No / low vehicle acceleration, engine speed does not increase / too low

Cause of Fault	Location of Fault	Code	Fault Elimination
Faulty engine control unit	Various effects	P0200; P0602; P0606; P0608; P1612; P1613	If other measures have no effect, check the engine control unit and replace it if necessary (S) <a href="#">(see chapter 4.5)</a>
Too little air intake	Air filter is blocked or intake lines are bent	P0263; P0266; P0269; P0272	Check air intake system (C)
	Leakage in the intake line downstream of the turbocharger		Check boost pressure (C)
	Turbocharger defective		
Too little or no fuel intake	Faulty internal transfer pump	P0089; P0090; P0091; P0092; P0001; P0263; P0266; P0269; P0272; P0190; P0191; P0192; P0193; P0194	Check low-pressure system (S) <a href="#">(see chapter 4.2)</a>
	Air in low-pressure line		
	Fuel filter blocked		
	Leaky low-pressure line		
	Empty tank		Top up fuel (C)
Accelerator pedal signal incorrect or missing	Faulty accelerator pedal position	No entry	Check accelerator pedal sensor and electrical connections (C)
	Defective wiring harness or plug-in connections	P0122; P0123; P0222; P0223; P2135; P1577	
	Faulty accelerator pedal sensor		
(if a brake light signal and a constant accelerator pedal signal appear at the same time, the accelerator pedal signal will be reduced for reasons of safety)	Faulty brake switch	P0571	Check ABS (C)
	Defective wiring harness or plug-in connections		
Too little injection quantity or incorrect injection timing	Faulty injectors, wiring harness or plug-in connection	P0263; P0266; P0269; P0272	Check injectors (S) <a href="#">(see chapter 4.4)</a>
Too little injection quantity or incorrect injection timing	Air-mass flow sensor signal too low (->reduction in injection quantity to prevent black smoke from developing)	P0263; P0266; P0269; P0272	Check air-mass flow sensor (C) Check exhaust gas recirculation system (C) Check air intake system (C)

2.10 No / low vehicle acceleration, engine speed does not increase / too low (Cont.)

Cause of Fault	Location of Fault	Code	Fault Elimination
Too little injection quantity or incorrect injection timing	Leakage in the intake line upstream of the turbocharger ( ->reduction in injection quantity to prevent black smoke from developing)	P0263; P0266; P0269; P0272	Check air-mass flow sensor (C) Check exhaust gas recirculation system (C) Check air intake system (C)
	Faulty engine control unit	P0200; P0602; P0606; P0608; P1612; P1613	If other measures have no effect, check the engine control unit and replace it if necessary (S) <a href="#">(see chapter 4.5)</a>
Rail pressure too low	Too little or no fuel intake	P0089; P0090; P0091; P0092; P0001; P0263; P0266; P0269; P0272; P0190; P0191; P0192; P0193; P0194	Check low-pressure system (S) <a href="#">(see chapter 4.2)</a>
	High-pressure pump defective	P0089; P0090; P0091; P0092; P0002	Check high-pressure system (S) <a href="#">(see chapter 4.3)</a>
	PCV / VCV defective	P0002; P0003; P0004; P0089; P0090; P0091; P0092; P0001	Check high-pressure system (S) <a href="#">(see chapter 4.3)</a>
	Leaky high-pressure lines / rail	P0001; P0089; P0090; P0091; P0092; P0190; P0191; P0192; P0193; P0194	
	High injector leakage	P0089; P0090; P0091; P0092; P0002	Check injectors (S) <a href="#">(see chapter 4.4)</a>
	High-pressure signal missing or incorrect	P0263; P0266; P0269; P0272; P0190; P0191; P0192; P0193; P0194	Check high-pressure system (S) <a href="#">(see chapter 4.3)</a>
	Faulty engine control unit	P0200; P0602; P0606; P0608; P1612; P1613	If other measures have no effect, check the engine control unit and replace it if necessary (S) <a href="#">(see chapter 4.5)</a>

**2.11 Vehicle jerks at constant speed**

Cause of Fault	Location of Fault	Code	Fault Elimination
Faulty engine control unit	Various effects possible	P0200; P0602; P0606; P0608; P1612; P1613	If other measures have no effect, check the engine control unit and replace it if necessary (S) <a href="#">(see chapter 4.5)</a>
False or no recognition of the gear by the engine control unit (-> no anti-jerk control)	Clutch pedal slightly activated	No entry	Check clutch switch (C)
	Clutch switch incorrectly adjusted or faulty		
	Faulty engine control unit	P0200; P0602; P0606; P0608; P1612; P1613	If other measures have no effect, check the engine control unit and replace it if necessary (S) <a href="#">(see chapter 4.5)</a>
	Speed signal missing or incorrect	P0501	Check speed signal (C)
Faulty injection	Faulty injectors	No entry	Check injectors (S) <a href="#">(see chapter 4.4)</a>
Faulty accelerator pedal signal	Faulty accelerator pedal position	No entry	Check accelerator pedal (C)
	Defective wiring harness or plug-in connections	P0122; P0123; P0222; P0223; P2135; P1577	Check accelerator pedal sensor and electrical connections (C)
	Faulty accelerator pedal sensor		
Signal fluctuations from the T-MAP sensor	Water in the air intake system	P0263; cyl. 1 P0266; cyl. 2 P0269; cyl. 3 P0272; cyl. 4	Check air intake system (S)
	T-MAP sensor or electrical connections defective	P0238; P0239	Check T-MAP sensor (C) Check electrical connections (C)
Sporadic loss of sensor or actuator signals	Defective wiring harness or plug-in connections	No entry	Check wire connections (C)

2.11 Vehicle jerks at constant speed (Cont.)

Cause of Fault	Location of Fault	Code	Fault Elimination
Rail pressure fluctuations	PCV / VCV defective	P0002; P0003; P0004; P0089; P0090; P0091; P0092; P0263; P0266; P0269; P0272; P0001	Check high-pressure system (S) <a href="#">(see chapter 4.3)</a>
	Leaky high-pressure lines / rail	P0002; P0003; P0004; P0089; P0090; P0091; P0092; P0263; P0266; P0269; P0272; P0001	
	High-pressure signal missing or incorrect	P0263; P0266; P0269; P0272; P0190; P0191; P0192; P0193; P0194	Check high-pressure system (S) <a href="#">(see chapter 4.3)</a>
	Leaky low-pressure line	P0263; P0266; P0269; P0272; P0191; P0192; P0193	Check high-pressure system <a href="#">(see chapter 4.3)</a>
	Faulty injectors	P0263; P0266; P0269; P0272	Check injectors (S) <a href="#">(see chapter 4.4)</a>
	Defective wiring harness	No entry	Check wire connections (C)
	Faulty engine control unit	P0200; P0602; P0606; P0608; P1612; P1613	If other measures have no effect, check the engine control unit and replace it if necessary (S) <a href="#">(see chapter 4.5)</a>

**2.12 Vehicle accelerates without actuation of the accelerator pedal**

Cause of Fault	Location of Fault	Code	Fault Elimination
Faulty engine control unit	Various effects possible	P0200; P0602; P0606; P0608; P1612; P1613	If other measures have no effect, check the engine control unit and replace it if necessary (S) <a href="#">(see chapter 4.5)</a>
Too high or uncontrolled injection quantity	Injector jammed open	P0263; P0266; P0269; P0272	Check injectors (S) <a href="#">(see chapter 4.4)</a>
Faulty accelerator pedal signal	Faulty accelerator pedal position	No entry	Check accelerator pedal (C)
	Defective wiring harness or plug-in connections	P0122; P0123; P0222; P0223; P2135; P1577	Check accelerator pedal sensor and electrical connections (C)
	Faulty accelerator pedal sensor		
Sudden increase in rail pressure	PCV / VCV defective	P0002; P0003; P0004; P0089; P0090; P0091; P0092; P0263; P0266; P0269; P0272; P0001	Check high-pressure system (S) <a href="#">(see chapter 4.3)</a>
	High-pressure pump defective	P0089; P0090; P0091; P0092; P0001	
	Faulty high-pressure signal	P0263; P0266; P0269; P0272; P0190; P0191; P0192; P0193; P0194	Check high-pressure system (S) <a href="#">(see chapter 4.3)</a>
False or no recognition of the gear by the engine control unit (-> faulty torque control)	Clutch pedal slightly activated	No entry	Check clutch switch (C)
	Clutch switch incorrectly adjusted or faulty		
	Vehicle speed signal missing or incorrect	P0608	Check speed signal (C)

**2.13 Vehicle does not decelerate (no overrun condition)**

Cause of Fault	Location of Fault	Code	Fault Elimination
Faulty engine control unit	Various effects possible	P0200; P0602; P0606; P0608; P1612; P1613	If other measures have no effect, check the engine control unit and replace it if necessary (S) ( <a href="#">see chapter 4.5</a> )
Faulty accelerator pedal signal	Faulty accelerator pedal position	No entry	Check accelerator pedal (C)
	Faulty accelerator pedal sensor	P0122; P0123; P0222; P0223; P2135; P1577	Check accelerator pedal sensor and electrical connections (C)
	Defective wiring harness or plug-in connections		
Too high or uncontrolled injection quantity	Injector jammed open	P0263; P0266; P0269; P0272	Check injectors (S) ( <a href="#">see chapter 4.4</a> )

**2.14 Vehicle jerks while coasting with gear engaged**

Cause of Fault	Location of Fault	Code	Fault Elimination
False or no recognition of the gear by the engine control unit (-> no anti-jerk control)	Clutch switch incorrectly adjusted or faulty	No entry	Check clutch switch (C)
	Clutch pedal slightly activated		
	Faulty engine control unit	No entry	If other measures have no effect, check the engine control unit and replace it if necessary (S) ( <a href="#">see chapter 4.5</a> )
	Speed signal missing or incorrect	P0501	Check speed signal (C)
Gear engaged is too high		No entry	Shift down

## 2.15 Power too low

Cause of Fault	Location of Fault	Code	Fault Elimination
Faulty engine control unit	Various effects possible	P0200; P0602; P0606; P0608; P1612; P1613	If other measures have no effect, check the engine control unit and replace it if necessary (S) <a href="#">(see chapter 4.5)</a>
Coolant temperature signal too high (-> max. rail pressure and injection quantity reduction)	Faulty cooling system	No entry	Check the cooling system (C)
	Faulty coolant temperature sensor or connector	P0115; P0116; P0117; P0118; P0119	Check coolant temperature sensor and electrical connections (C)
Coolant temperature signal too high (-> max. rail pressure and injection quantity reduction to protect plastic lines)	Not enough fuel in the tank with heavy engine load and high temperature	No entry	Check fuel temperature sensor (C)
	Faulty fuel temperature sensor	P0180; P0182; P0183; P0184	
False or no recognition of the gear by the engine control unit (-> faulty torque control)	Clutch pedal slightly activated	No entry	Check clutch switch (C)
	Clutch switch incorrectly adjusted or faulty		
	Speed signal missing or incorrect	No entry	Check speed signal (C)
Limp home	Read out fault diagnosis	No entry	
Too little air intake	Air filter is blocked or intake lines are bent	P0490; P1461; P2141; P2145	Check air intake system (C)
	Leakage in the intake line downstream of the turbocharger	No entry	
	Air intake system blocked	No entry	Clean intake system (C)
	Faulty turbocharger or vacuum control	No entry	Check boost pressure (C)
Faulty accelerator pedal signal	Faulty accelerator pedal position	No entry	Check accelerator pedal (C)
	Faulty accelerator pedal sensor	P0122; P0123; P0222; P0223; P2135; P1577	Check accelerator pedal sensor and electrical connections (C)
	Defective wiring harness or plug-in connections		



2.15 Power too low (Cont.)

Cause of Fault	Location of Fault	Code	Fault Elimination
Injection quantity too small	Faulty or heavily soiled injectors	P0263; P0266; P0269; P0272	Check injectors (S) ( <a href="#">see chapter 4.4</a> )
	Air-mass flow sensor signal missing or too low (-> reduction in injection quantity to prevent black smoke from developing)	P0263; P0266; P0269; P0272	Check air-mass flow sensor (C) Check exhaust gas recirculation system (C)
	Leakage in the intake line upstream of the turbocharger (-> reduction in injection quantity to prevent black smoke from developing)		Check air-mass flow sensor (C) Check air intake system (C) Check exhaust gas recirculation system (C)
	Faulty high-pressure signal	P0263; P0266; P0269; P0272; P0190; P0191; P0192; P0193; P0194	Check high-pressure system (S) ( <a href="#">see chapter 4.3</a> )
Rail pressure too low	Too little fuel intake	P0263; P0266; P0269; P0272; P0089; P0090; P0091; P0092; P0001	Check low-pressure system ( <a href="#">see chapter 4.2</a> )
	High-pressure pump defective	P0089; P0090; P0002	Check high-pressure system ( <a href="#">see chapter 4.3</a> )
	PCV / VCV defective	P0002; P0003; P0004; P0089; P0090; P0091; P0092; P0001	Check high-pressure system (S) ( <a href="#">see chapter 4.3</a> )
	Leaky high-pressure lines / rail	P0002; P0003; P0004; P0089; P0090; P0091; P0092; P0263; P0266; P0269; P0272; P0001	
	Faulty high-pressure signal	P0190; P0191; P0192; P0193; P0194; P0263; P0266; P0269; P0272	
Incorrect air intake	Intercooler clogged	No entry	Clean and if necessary replace it Check air intake system (C)

## 2.16 Power too high

Cause of Fault	Location of Fault	Code	Fault Elimination
Faulty or modified engine control unit (chip tuning)		P0200; P0602; P0606; P0608; P1612; P1613	If other measures have no effect, check the engine control unit and replace it if necessary (S) <a href="#">(see chapter 4.5)</a>
Injection quantity too high	Faulty injectors	P0263; P0266; P0269; P0272	Check injectors (S) <a href="#">(see chapter 4.4)</a>
	Coolant temperature signal incorrect	P0115; P0116; P0117; P0118; P0119	Check coolant temperature sensor (C)
Rail pressure too high	PCV / VCV defective	P0002; P0003; P0004; P0089; P0090; P0091; P0092; P0001	Check high-pressure system (S) <a href="#">(see chapter 4.3)</a>
	High-pressure pump defective	P0089; P0090; P0091; P0092; P0001	
	Faulty high-pressure signal	P0190; P0191; P0192; P0193; P0194	Check high-pressure system (S) <a href="#">(see chapter 4.3)</a>
False or no recognition of the gear by the engine control unit (-> faulty torque control)	Clutch pedal slightly activated	No entry	Check clutch switch (C)
	Clutch switch incorrectly adjusted or faulty		
	Speed signal missing or incorrect	No entry	Check speed signal (C)
Boost pressure too high	Faulty boost pressure control	No entry	Check boost pressure (C)

## 2.17 Load kick when accelerating or decelerating

Cause of Fault	Location of Fault	Code	Fault Elimination
False or no recognition of the gear by the engine control unit (-> no damping of the load kick)	Clutch pedal slightly activated	No entry	Check clutch switch (C)
	Clutch switch incorrectly adjusted or faulty		If other measures have no effect, check the engine control unit and replace it if necessary (S) <a href="#">(see chapter 4.5)</a>
	Faulty engine control unit	P0200; P0602; P0606; P0608; P1612; P1613	Check CAN connection (P)
	Speed signal missing or incorrect	No entry	Check speed signal (C)

2.18 Vehicle accelerates fast while coasting after releasing the brake

Cause of Fault	Location of Fault	Code	Fault Elimination
No brake detection in the engine control unit (-> faulty idle controller)	Faulty brake switch in the ABS system	No entry	Check ABS (C)
	Faulty engine control unit	P0200; P0602; P0606; P0608; P1612; P1613;	If other measures have no effect, check the engine control unit and replace it if necessary (S) ( <a href="#">see chapter 4.5</a> )

2.19 Engine smoking at start

Cause of Fault	Location of Fault	Code	Fault Elimination
Too high rail pressure and too high injection quantity during the start process	Coolant temperature signal too low	P0115; P0116; P0117; P0118; P0119	Check coolant temperature sensor (C) Check high-pressure system (S) ( <a href="#">see chapter 4.3</a> )
	Fuel temperature signal too low	P0180; P0182; P0183; P0184	Check fuel temperature sensor (C) Check high-pressure system (S) ( <a href="#">see chapter 4.3</a> )

## 2.20 Engine smokes / blue smoke

Cause of Fault	Location of Fault	Code	Fault Elimination
Engine oil level too high		No entry	Draw off excess oil quantity (C)
High oil consumption	Engine wear	No entry	
Dripping injectors	Faulty injectors	No entry	Check injectors (S) ( <a href="#">see chapter 4.4</a> )
	Coolant temperature signal incorrect	P0115; P0116; P0117; P0118; P0119	Check coolant temperature sensor (C)
Injection quantity too high	Faulty engine control unit	P0200; P0602; P0606; P0608; P1612; P1613	If other measures have no effect, check the engine control unit and replace it if necessary (S) ( <a href="#">see chapter 4.5</a> )
	Faulty injectors	P0263; P0266; P0269; P0272	Check injectors (S) ( <a href="#">see chapter 4.4</a> )
Poor mixture preparation	Injectors heavily soiled	P0263; P0266; P0269; P0272	Check injectors (S) ( <a href="#">see chapter 4.4</a> )
Unsuitable fuel		No entry	Exchange fuel (C)
Too little air intake	Air filter is blocked or intake lines are bent	P0263; P0266; P0269; P0272	Check air intake system (C)
	Leakage in the intake line downstream of the turbocharger		
	Faulty turbocharger or vacuum control		Check boost pressure (C)
	Air intake system heavily soiled	No entry	Clean intake system (C)
Rail pressure too high (-> resulting in a too high exhaust gas recirculation rate)	High-pressure pump defective	P0089; P0090; P0091; P0092; P0001	Check high-pressure system (S) ( <a href="#">see chapter 4.3</a> )
	PCV / VCV defective	P0002; P0003; P0004; P0089; P0090; P0091; P0092; P0001	
	Faulty high-pressure signal	P0190; P0191; P0192; P0193; P0194	Check high-pressure sensor and electrical connections (C) Check high-pressure system (S) ( <a href="#">see chapter 4.3</a> )
	Faulty engine control unit	P0200; P0602; P0606; P0608; P1612; P1613	If other measures have no effect, check the engine control unit and replace it if necessary (S) ( <a href="#">see chapter 4.5</a> )

**2.21 Engine smokes while climbing passes**

Cause of Fault	Location of Fault	Code	Fault Elimination
Air pressure signal too high	Faulty air pressure sensor	No entry	Check air pressure sensor. If necessary replace engine control unit (S) ( <a href="#">see chapter 4.5</a> )
Air temperature sensor signal too low	T-MAP sensor faulty	P0110; P0112; P0113; P0114	Check T-MAP sensor (C)

**2.22 Engine develops white smoke (particularly after start)**

Cause of Fault	Location of Fault	Code	Fault Elimination
Faulty glow plug system (optional)*	One or more glow plugs defective	P0263; P0266; P0269; P0272	Check glow plug system (C)
	Glow plug relay or wiring harness defective	P0263; P0266; P0269; P0272	
Frequent cold starts without warm-up period	Unburned fuel in exhaust gas system	No entry	Run engine until hot (observe oil level) (C)
Faulty injection	Injector jammed open	P0263; P0266; P0269; P0272	Check injectors (S) ( <a href="#">see chapter 4.4</a> )

**Note:**

\*The glow plug system is an optional component of the system provided by Siemens VDO.

## 2.23 High fuel consumption

Cause of Fault	Location of Fault	Code	Fault Elimination
Faulty engine control unit	Various effects possible	P0200; P0602; P0606; P0608; P1612; P1613	If other measures have no effect, check the engine control unit and replace it if necessary (S) <a href="#">(see chapter 4.5)</a>
Too little air intake	Air filter is blocked or intake lines are bent	P0263; P0266; P0269; P0272	Check air intake system (C)
	Faulty turbocharger or vacuum control		Check boost pressure (C)
	Air intake system heavily soiled		Clean intake system (C)
Fuel - leakage	Leakage in high-pressure / low-pressure system	P0089; P0090; P0091; P0092; P0001	Check high-pressure system (S) <a href="#">(see chapter 4.3)</a> Check low-pressure system (S) <a href="#">(see chapter 4.2)</a>
Rail pressure too high	PCV / VCV defective	P0002; P0003; P0004; P0089; P0090; P0091; P0092; P0001	Check high-pressure system (S) <a href="#">(see chapter 4.3)</a>
	High-pressure pump defective	P0089; P0090; P0091; P0092; P0001	
	Faulty high-pressure signal	P0190; P0191; P0192; P0193; P0194	Check high-pressure system (S) <a href="#">(see chapter 4.3)</a>
Injection quantity too high	Coolant temperature signal incorrect	P0115; P0116; P0117; P0118; P0119	Check coolant temperature sensor (C)
	Faulty engine control unit	P0200; P0602; P0606; P0608; P1612; P1613	If other measures have no effect, check the engine control unit and replace it if necessary (S) <a href="#">(see chapter 4.5)</a>
Faulty accelerator pedal signal	Faulty accelerator pedal position	No entry	Check accelerator pedal sensor (C)
	Faulty accelerator pedal sensor	P0122; P0123; P0222; P0223; P2135; P1577	
	Defective wiring harness		
Poor mixture preparation	Faulty or heavily soiled injectors	P0263; P0266; P0269; P0272	Check injectors (S) <a href="#">(see chapter 4.4)</a>
Poor or no cooling	Faulty radiator fan or radiator	No entry	Check cooling system (C)
	Coolant temperature signal incorrect	P0115; P0116; P0117; P0118; P0119	Check coolant temperature sensor (C)
	Thermostat defective	No entry	
	Coolant level too low / leakage in the system	No entry	Check Thermostat (C)

2.24 Engine knocks

Cause of Fault	Location of Fault	Code	Fault Elimination
Rail pressure too high	PCV / VCV defective	P0002; P0003; P0004; P0089; P0090; P0091; P0092; P0001	Check high-pressure system (S) <a href="#">(see chapter 4.3)</a>
	High-pressure pump defective	P0089; P0090; P0091; P0092; P0001	
	Faulty high-pressure signal	P0190; P0191; P0192; P0193; P0194	Check electrical connections (C) Check high-pressure system (S) <a href="#">(see chapter 4.3)</a>
	Faulty engine control unit	P0200; P0602; P0606; P0608; P1612; P1613	If other measures have no effect, check the engine control unit and replace it if necessary (S) <a href="#">(see chapter 4.5)</a>
Poor mixture preparation	Faulty injectors / jets	P0263; P0266; P0269; P0272	Check injectors (S) <a href="#">(see chapter 4.4)</a>
Bad fuel		No entry	

2.25 Engine gets too hot

Cause of Fault	Location of Fault	Code	Fault Elimination
Faulty engine control unit	Various effects possible	P0200; P0602; P0606; P0608; P1612; P1613	If other measures have no effect, check the engine control unit and replace it if necessary (S) <a href="#">(see chapter 4.5)</a>
Poor or no cooling	Faulty radiator fan or radiator	No entry	Check cooling system (C)
	Coolant temperature signal incorrect	P0115; P0116; P0117; P0118; P0119	Check coolant temperature sensor (C)
	Coolant level too low / leakage in the system	No entry	
	Defective wiring harness	No entry	Check wire connections (C)
	Defective degasification valve	No entry	Check degasification valve (C)
	Thermostat defective	No entry	Check Thermostat (C)
Incorrect air intake	Intercooler clogged	No entry	Clean and if necessary replace it Check air intake system (C)

### 3. Fault code list

**Note:**

When the service tool is in usage (i.e. idle speed) you must not interrupt the session by disconnecting the service tool.

Specific DTC	Type of fault	Limp home strategy Substitute value	Reset conditions for limp home
P0002	Rail pressure function: <ul style="list-style-type: none"> <li>VCV adaptation exceeds a specified threshold.</li> <li>Leakage amount of injectors too high.</li> <li>Check injectors and high-pressure system.</li> </ul>	Engine stalls. Not possible to restart: <ul style="list-style-type: none"> <li>FUP limitation.</li> <li>Torque limitation.</li> </ul> Engine runs: <ul style="list-style-type: none"> <li>FUP limitation.</li> <li>Torque limitation.</li> <li>Engine speed limitation.</li> </ul>	As far as the factors are in the tolerances.
	Wire connection to the VCV: <ul style="list-style-type: none"> <li>Short circuit to ground (VCV closed).</li> <li>VCV electric power consumption excessive.</li> <li>Short circuit to ground or wire interruption in the current measurement feedback.</li> </ul>		As far as the factors are in the tolerances.
P0003	Wire connection to the VCV: <ul style="list-style-type: none"> <li>Wire interruption (VCV open).</li> </ul>		As far as the factors are in the tolerances.
P0004	Wire connection to the VCV: (VCV closed). <ul style="list-style-type: none"> <li>Short circuit to + or in the winding.</li> <li>Short circuit to + in the current measurement feedback.</li> </ul>	Engine stalls. Not possible to restart: <ul style="list-style-type: none"> <li>FUP limitation.</li> <li>Torque limitation.</li> </ul> Engine runs: <ul style="list-style-type: none"> <li>FUP limitation.</li> <li>Torque limitation.</li> <li>Engine speed limitation.</li> </ul>	As far as the factors are in the tolerances.
P0089	Rail pressure control: <ul style="list-style-type: none"> <li>Fault in rail pressure control.</li> </ul>	<ul style="list-style-type: none"> <li>Torque limitation.</li> <li>Engine speed limitation.</li> </ul>	As far as the controllers are in the tolerances.
B0090	Wire connection to the PCV (PCV open): <ul style="list-style-type: none"> <li>Short circuit to + or in the winding.</li> <li>Short circuit to + in the current measurement feedback.</li> <li>Short circuit to ground.</li> <li>Wire interruption.</li> </ul>		As far as the factors are in the tolerances.



3. Fault code list (cont.)

Specific DTC	Type of fault	Limp home strategy Substitute value	Reset conditions for limp home
P0091	Rail pressure control: <ul style="list-style-type: none"> <li>Nominal rail pressure was not reached.</li> <li>Rail pressure controller (PI) is at the lower stop / end position (MIN).</li> </ul>	Engine stalls. Not possible to restart: <ul style="list-style-type: none"> <li>FUP limitation.</li> <li>Torque limitation.</li> <li>Engine speed limitation.</li> </ul>	As far as the factors are in the tolerances.
P0092	Rail pressure control: <ul style="list-style-type: none"> <li>Nominal rail pressure was not reached.</li> <li>Rail pressure controller (PI) is at the upper stop / end position (MAX).</li> </ul>	Engine stalls. Not possible to restart: <ul style="list-style-type: none"> <li>FUP and Torque limitation.</li> <li>Engine speed limitation.</li> <li>Torque reduction / Limitation of PCV.</li> </ul>	As far as the factors are in the tolerances.
P0096	Charge air temperature sensor: <ul style="list-style-type: none"> <li>Gradient (increase) too high.</li> </ul>	Substitute value: 100 °C.	As far as no error is detected.
P0097	Charge air temperature sensor: <ul style="list-style-type: none"> <li>Charge air temperature is too low compared to intake air temperature (MIN).</li> </ul>	Substitute value: 100 °C.	As far as no error is detected.
P0098	Charge air temperature sensor: <ul style="list-style-type: none"> <li>Charge air temperature is too high compared to intake air temperature (MAX).</li> </ul>	Substitute value: 100 °C.	As far as no error is detected.
P0107	Ambient pressure sensor: Ambient pressure falls below a specified threshold: (MIN). <ul style="list-style-type: none"> <li>Short circuit to +.</li> <li>Ambient pressure too low.</li> <li>Ambient pressure in idle/at start is too low compared to suction tube pressure.</li> </ul>	Substitute value: 1000 mbar.	As far as the factors are in the tolerances.

### 3. Fault code list (cont.)

Specific DTC	Type of fault	Limp home strategy Substitute value	Reset conditions for limp home
P0108	Ambient pressure sensor: Ambient pressure exceeds a specified threshold: (MAX). <ul style="list-style-type: none"> <li>• Short circuit to ground.</li> <li>• Wire interruption.</li> <li>• Ambient pressure too high.</li> <li>• Ambient pressure in idle/at start is too low compared to suction tube pressure.</li> </ul>	Substitute value: 1000 mbar.	As far as the factors are in the tolerances.
P0109	Ambient pressure sensor: <ul style="list-style-type: none"> <li>• Ambient pressure gradient (increase) too high.</li> </ul>	Substitute value: 1000 mbar.	As far as the factors are in the tolerances.
P0113	Intake air temperature sensor: <ul style="list-style-type: none"> <li>• Intake air temperature implausible.</li> </ul>	Substitute value: 100°C.	As far as no error is detected.
P0116	Coolant temperature sensor: <ul style="list-style-type: none"> <li>• Coolant temperature implausible.</li> </ul>	Substitute value: 10°C.	As far as the factors are in the tolerances.
P0117	Coolant temperature sensor: Coolant temperature drops below a specified threshold: (MIN). <ul style="list-style-type: none"> <li>• Short circuit to ground.</li> </ul>	Substitute value: 10°C.	As far as the factors are in the tolerances.
P0118	Coolant temperature sensor: Coolant temperature exceeds a specified threshold: (MAX). <ul style="list-style-type: none"> <li>• Short circuit to +.</li> <li>• Wire interruption.</li> </ul>	Substitute value: 10°C.	As far as the factors are in the tolerances.
P0119	Coolant temperature sensor: <ul style="list-style-type: none"> <li>• Gradient (increase) too high.</li> </ul>	Substitute value: 10°C.	As far as the factors are in the tolerances.
P0122	Pedal value sensor: Accelerator pedal signal from channel 1 is below a specified threshold (MIN). <ul style="list-style-type: none"> <li>• Short circuit to ground.</li> <li>• Wire interruption.</li> </ul>	<ul style="list-style-type: none"> <li>• Torque limitation.</li> <li>• Engine speed limitation.</li> </ul>	Return in the tolerances and after key off / key on.
P0123	Pedal value sensor: Accelerator pedal signal from channel 1 exceeds a specified threshold (MAX). <ul style="list-style-type: none"> <li>• Short circuit to +.</li> </ul>	<ul style="list-style-type: none"> <li>• Torque limitation.</li> <li>• Engine speed limitation.</li> </ul>	Return in the tolerances and after key off / key on.

3. Fault code list (cont.)

Specific DTC	Type of fault	Limp home strategy Substitute value	Reset conditions for limp home
P0180	Fuel temperature sensor: <ul style="list-style-type: none"> <li>Fault in control loop.</li> </ul>	Substitute value: 80°C.	As far as the factors are in the tolerances.
P0182	Fuel temperature sensor: Fuel temperature falls below a specified threshold: (MIN). <ul style="list-style-type: none"> <li>Short circuit to +.</li> <li>Wire interruption.</li> </ul>	Substitute value: 80°C.	As far as the factors are in the tolerances.
P0183	Fuel temperature sensor: Fuel temperature exceeds a specified threshold: (MAX). <ul style="list-style-type: none"> <li>Short circuit to ground.</li> </ul>	Substitute value: 80°C.	As far as the factors are in the tolerances.
P0184	Fuel temperature sensor: <ul style="list-style-type: none"> <li>Fuel air temperature gradient (increase) too high.</li> </ul>	Substitute value: 80°C.	As far as the factors are in the tolerances.
P0191	Rail pressure sensor: <ul style="list-style-type: none"> <li>Rail pressure offset.</li> <li>Rail pressure &gt; threshold value.</li> <li>Rail pressure between current value and open loop is implausible.</li> </ul>	<ul style="list-style-type: none"> <li>FUP limitation.</li> <li>Torque limitation.</li> <li>Fuel pressure limitation.</li> </ul>	As far as the factors are in the tolerances.
P0192	Rail pressure sensor: Voltage of the rail pressure sensor drops below a specified threshold: (MIN). <ul style="list-style-type: none"> <li>Short circuit to ground.</li> </ul>	<ul style="list-style-type: none"> <li>FUP limitation.</li> <li>Torque limitation.</li> <li>Fuel pressure limitation.</li> </ul>	As far as the factors are in the tolerances.
P0193	Rail pressure sensor: Voltage of the rail pressure sensor exceeds a specified threshold: (MAX). <ul style="list-style-type: none"> <li>Short circuit to +.</li> <li>Wire interruption.</li> </ul>	<ul style="list-style-type: none"> <li>FUP limitation.</li> <li>Torque limitation.</li> <li>Fuel pressure limitation.</li> </ul>	As far as the factors are in the tolerances.
P0194	Rail pressure sensor: <ul style="list-style-type: none"> <li>Rail pressure offset.</li> <li>Rail pressure &gt; threshold value.</li> <li>Differential pressure test: (between current pressure – old pressure) &lt; threshold value.</li> <li>Gradient (increase) too high.</li> </ul>	<ul style="list-style-type: none"> <li>FUP limitation.</li> <li>Torque limitation.</li> <li>Fuel pressure limitation.</li> </ul>	As far as the factors are in the tolerances.

### 3. Fault code list (cont.)

Specific DTC	Type of fault	Limp home strategy Substitute value	Reset conditions for limp home
P0200	Piezo power stage: <ul style="list-style-type: none"> <li>• Initialisation of power stage faulty</li> <li>• Fault, driver ATIC20</li> </ul> Voltage check: <ul style="list-style-type: none"> <li>• Injector or wiring harness fault</li> </ul>	Engine stalls and no start possible.	After key off / key on if failure is not present anymore.
P0201	Piezo power stage: <ul style="list-style-type: none"> <li>• Faulty injector cylinder 1</li> <li>• Faulty boost or discharge operation</li> </ul>	<ul style="list-style-type: none"> <li>• Torque limitation.</li> <li>• Engine speed limitation.</li> </ul> Engine runs on 2 cylinders min. Impacted injectors are shut off. Cylinder-balancing and anti-jerk are shut off.	After key off / key on if failure is not present anymore.
P0202	Piezo power stage: <ul style="list-style-type: none"> <li>• Faulty injector cylinder 2</li> <li>• Faulty boost or discharge operation</li> </ul>	<ul style="list-style-type: none"> <li>• Torque limitation</li> <li>• Engine speed limitation.</li> </ul> Engine runs on 2 cylinders min. Impacted injectors are shut off. Cylinder-balancing and anti-jerk are shut off.	After key off / key on if failure is not present anymore.
P0203	Piezo power stage: <ul style="list-style-type: none"> <li>• Faulty injector cylinder 3</li> <li>• Faulty boost or discharge operation</li> </ul>	<ul style="list-style-type: none"> <li>• Torque limitation</li> <li>• Engine speed limitation</li> </ul> Engine runs on 2 cylinders min. Impacted injectors are shut off. Cylinder-balancing and anti-jerk are shut off.	After key off / key on if failure is not present anymore.

3. Fault code list (cont.)

Specific DTC	Type of fault	Limp home strategy Substitute value	Reset conditions for limp home
P0204	Piezo power stage: <ul style="list-style-type: none"> <li>Faulty injector cylinder 4.</li> <li>Faulty boost or discharge operation.</li> </ul>	<ul style="list-style-type: none"> <li>Torque limitation.</li> <li>Engine speed limitation.</li> </ul> Engine runs on 2 cylinders min. Impacted injectors are shut off. Cylinder-balancing and anti-jerk are shut off.	After key off / key on if failure is not present anymore.
P0222	Pedal value sensor: Accelerator pedal signal from channel 2 is below a specified threshold (MIN). <ul style="list-style-type: none"> <li>Short circuit to ground.</li> </ul>	<ul style="list-style-type: none"> <li>TQ limitation.</li> <li>Engine speed limitation.</li> </ul>	Return in the tolerances and after key off / key on.
P0223	Pedal value sensor: Accelerator pedal signal from channel 2 exceeds a specified threshold (MAX). <ul style="list-style-type: none"> <li>Short circuit to +.</li> <li>Wire interruption.</li> </ul>	<ul style="list-style-type: none"> <li>TQ limitation.</li> <li>Engine speed limitation.</li> </ul>	Return in the tolerances and after key off / key on.
P0236	Boost pressure sensor: <ul style="list-style-type: none"> <li>Boost pressure offset.</li> <li>Boost pressure &gt;threshold value.</li> <li>Differential pressure test: (between current pressure – old pressure) &lt; threshold value.</li> <li>Gradient (increase) too high.</li> </ul>	Substitute value: 1500 mbar.	As far as the factors are in the tolerances.
P0237	Boost pressure sensor: Boost pressure falls below a specified threshold: (MIN). <ul style="list-style-type: none"> <li>Short circuit to +.</li> <li>Suction tube pressure too low.</li> <li>Suction tube pressure in idle/at start is too low compared to ambient pressure.</li> </ul>	Substitute value: 1500 mbar.	As far as the factors are in the tolerances.

**3. Fault code list (cont.)**

Specific DTC	Type of fault	Limp home strategy Substitute value	Reset conditions for limp home
P0238	Boost pressure sensor (EURO 4-specific): Boost pressure exceeds a specified threshold: (MAX). <ul style="list-style-type: none"> <li>• Short circuit to ground.</li> <li>• Wire interruption.</li> <li>• Suction tube pressure too high.</li> <li>• Suction tube pressure in idle/at start is too low compared to ambient pressure.</li> </ul>	Substitute value: 1500 mbar.	As far as the factors are in the tolerances.
P0263	Cylinder balancing control: <ul style="list-style-type: none"> <li>• Cylinder balancing factor of cylinder 1 is exceeding or falling below a specified threshold.</li> <li>• Excessive dispersion of the injection quantity from the injectors among each other.</li> </ul> Check injectors.		As far as the factors are in the tolerances.
P0266	Cylinder balancing control: <ul style="list-style-type: none"> <li>• Cylinder balancing factor of cylinder 2 is exceeding or falling below a specified threshold.</li> <li>• Excessive dispersion of the injection quantity from the injectors among each other.</li> </ul> Check injectors.		As far as the factors are in the tolerances.
P0269	Cylinder balancing control: <ul style="list-style-type: none"> <li>• Cylinder balancing factor of cylinder 3 is exceeding or falling below a specified threshold.</li> <li>• Excessive dispersion of the injection quantity from the injectors among each other.</li> </ul> Check injectors.		As far as the factors are in the tolerances.

3. Fault code list (cont.)

Specific DTC	Type of fault	Limp home strategy Substitute value	Reset conditions for limp home
P0272	Cylinder balancing control: <ul style="list-style-type: none"> <li>• Cylinder balancing factor of cylinder 4 is exceeding or falling below a specified threshold.</li> <li>• Excessive dispersion of the injection quantity from the injectors among each other.</li> </ul> Check injectors.		As far as the factors are in the tolerances.
P0335	Crankshaft sensor: <ul style="list-style-type: none"> <li>• Crankshaft signal outside range of tolerance.</li> </ul>	System reaction: Engine stalls.	After reconnection.
P0336	Crankshaft sensor: <ul style="list-style-type: none"> <li>• Line to crankshaft sensor interrupted.</li> <li>• No crankshaft signal present.</li> </ul>	System reaction: Engine stalls.	After reconnection.
P0340	Camshaft sensor: <ul style="list-style-type: none"> <li>• Camshaft signal outside range of tolerance.</li> </ul>	During engine running no reaction, but no restart possible.	After reconnection.
P0341	Camshaft sensor: <ul style="list-style-type: none"> <li>• No camshaft signal present.</li> </ul>	During engine running no reaction, but no restart possible.	After reconnection.
P0501	Speed sensor: <ul style="list-style-type: none"> <li>• Speed signal exceeds a specified threshold (MAX).</li> <li>• Speed signal implausible during cold start (plausibility test with <math>V = 0</math>).</li> </ul>		As far as no error is detected.
P0562	Battery voltage too low.		As far as the factors are in the tolerances.
P0563	Battery voltage too low.		As far as the factors are in the tolerances.

**3. Fault code list (cont.)**

Specific DTC	Type of fault	Limp home strategy Substitute value	Reset conditions for limp home
P0571	Brake test switch sensor: • Brake light signal via CAN faulty.		As far as no error is active.
	Brake test switch sensor: • Brake light signal implausible during brake test.		
	Brake test switch sensor: • Brake light signal with brake test signal implausible.		
P0601	Internal self-test 1 in engine control unit: • CRC boot software error. • CRC ECU software error. • CRC calibration data error.		Irreversible.
P0606	Piezo power stage: • Initialisation of power stage faulty. • Fault, driver ATIC20. • SPI / PR /ID / T55 fault.	Engine stalls and no start possible	As far as the factors are in the tolerances.
P0606	Internal monitoring fault in the engine control unit: • Microunit. • Injection (fuel) cut off implausible. • Control of maximum engine speed limiting implausible. • Accelerator pedal monitoring implausible. • Comparison of signal and value calculated from torque. • Engine speed implausible. • Service tool monitoring. • A/D converter (conversion) implausible. • Tempomat monitoring.	Engine stalls. No restart possible. • Reset. Engine stalls. • Engine speed limitation.	Irreversible.



3. Fault code list (cont.)

Specific DTC	Type of fault	Limp home strategy Substitute value	Reset conditions for limp home
P0608	Speed signal output (hardware) <ul style="list-style-type: none"> <li>• Short circuit to +.</li> <li>• Short circuit to ground.</li> </ul>		As far as no error is detected.
P0642	5V voltage supply (VCC_1) for rail pressure sensor falls below a specified threshold (MIN).	<ul style="list-style-type: none"> <li>• TQ limitation</li> <li>• FUP limitation</li> <li>• Engine speed limitation.</li> </ul> If VCC_1 and VCC_2 also engine speed in IS t0 1200 rpm and no pedal reaction.	Return in the tolerances and after key off / key on.
P0643	5V voltage supply (VCC_1) for rail pressure sensor falls below a specified threshold (MAX).	<ul style="list-style-type: none"> <li>• TQ limitation</li> <li>• FUP limitation</li> <li>• Engine speed limitation.</li> </ul> If VCC_1 and VCC_2 also engine speed in IS t0 1200 rpm and no pedal reaction.	Return in the tolerances and after key off / key on.
P0652	5V voltage supply (VCC_2) for accelerator pedal sensor falls below a specified threshold (MIN).	<ul style="list-style-type: none"> <li>• Engine speed limitation</li> </ul> If VCC_1 and VCC_2 also engine speed in IS t0 1200 rpm and no pedal reaction	Return in the tolerances and after key off / key on.
P0653	5V voltage supply (VCC_2) for accelerator pedal sensor exceeds a specified threshold (MAX).	<ul style="list-style-type: none"> <li>• Engine speed limitation</li> </ul> If VCC_1 and VCC_2 also engine speed in IS t0 1200 rpm and no pedal reaction.	Return in the tolerances and after key off / key on.
P0654	Signal "Engine running": <ul style="list-style-type: none"> <li>• Short circuit to +.</li> </ul>		Return in the tolerances and after key off / key on.

### 3. Fault code list (cont.)

Specific DTC	Type of fault	Limp home strategy Substitute value	Reset conditions for limp home
P0685	Wire connection to main relay: <ul style="list-style-type: none"> <li>• Short circuit to ground.</li> <li>• Wire interruption.</li> </ul>	Engine stalls. No restart possible	As far as the factors are in the tolerances.
P0687	Wire connection to main relay: <ul style="list-style-type: none"> <li>• Short circuit to +.</li> </ul>	Engine stalls. No restart possible	As far as the factors are in the tolerances.
P0704	Clutch switch: <ul style="list-style-type: none"> <li>• Value of clutch switch between channel 1 and 2 implausible.</li> </ul>		
P1140	Fuel warning: <ul style="list-style-type: none"> <li>• Water in tank.</li> </ul>		
P1201	Piezo power stage: <ul style="list-style-type: none"> <li>• Faulty injector cylinder 1.</li> <li>• Faulty injector voltage.</li> </ul>	<ul style="list-style-type: none"> <li>• Torque limitation</li> <li>• Engine speed limitation.</li> </ul> Engine runs on 2 cylinders min. Impacted injectors are shut off. Cylinder-balancing and anti-jerk are shut off.	After key off / key on if failure is not present anymore.
P1202	Piezo power stage: <ul style="list-style-type: none"> <li>• Faulty injector cylinder 2.</li> <li>• Faulty injector voltage.</li> </ul>	<ul style="list-style-type: none"> <li>• Torque limitation</li> <li>• Engine speed limitation</li> </ul> Engine runs on 2 cylinders min. Impacted injectors are shut off. Cylinder-balancing and anti-jerk are shut off.	After key off / key on if failure is not present anymore.

3. Fault code list (cont.)

Specific DTC	Type of fault	Limp home strategy Substitute value	Reset conditions for limp home
P1203	Piezo power stage: <ul style="list-style-type: none"> <li>Faulty injector cylinder 3.</li> <li>Faulty injector voltage.</li> </ul>	<ul style="list-style-type: none"> <li>Torque limitation.</li> <li>Engine speed limitation.</li> </ul> Engine runs on 2 cylinders min. Impacted injectors are shut off. Cylinder-balancing and anti-jerk are shut off.	After key off / key on if failure is not present anymore.
P1204	Piezo power stage: <ul style="list-style-type: none"> <li>Faulty injector cylinder 4.</li> <li>Faulty injector voltage.</li> </ul>	<ul style="list-style-type: none"> <li>Torque limitation</li> <li>Engine speed limitation.</li> </ul> Engine runs on 2 cylinders min. Impacted injectors are shut off. Cylinder-balancing and anti-jerk are shut off.	After key off / key on if failure is not present anymore.
P1563	Engine switch-off: <ul style="list-style-type: none"> <li>Engine switch-off via injectors (electrical) faulty.</li> <li>Engine switch-off via pump faulty.</li> </ul>	<ul style="list-style-type: none"> <li>Engine stops via injektion off.</li> <li>Engine stops via hydraulic path.</li> </ul>	As far as no error is detected.
P1577	Pedal value sensor: <ul style="list-style-type: none"> <li>Value of accelerator pedal sensor implausible.</li> <li>Trigger signal from brake switch retained.</li> <li>Gradient of accelerator pedal sensor between channel 1 and channel 2 implausible.</li> </ul>		Return in the tolerances and after key off key on.
P1612	Piezo power stage: <ul style="list-style-type: none"> <li>Voltage of the power stage for the injectors in the engine control unit too low (MIN).</li> </ul>		As far as the factors are in the tolerances.

**3. Fault code list (cont.)**

Specific DTC	Type of fault	Limp home strategy Substitute value	Reset conditions for limp home
P1613	Piezo power stage: <ul style="list-style-type: none"> <li>Voltage of the power stage for the injectors in the engine control unit too high (MAX).</li> </ul>		As far as the factors are in the tolerances.
P1639	Variant coding: <ul style="list-style-type: none"> <li>Coding faulty.</li> <li>Coding not completed.</li> </ul>	Engine stalls. No restart possible.	As far as the factors are in the tolerances.
P1639	Variant coding: <ul style="list-style-type: none"> <li>Coding faulty.</li> <li>Coding not completed.</li> </ul>	<ul style="list-style-type: none"> <li>No start possible.</li> </ul>	Irreversible.
P1933	Fuel: <ul style="list-style-type: none"> <li>Fuel reserve signal implausible.</li> </ul>		As far as no error is detected.
	<ul style="list-style-type: none"> <li>Fuel level too low.</li> </ul>		
P2135	Pedal value sensor: <ul style="list-style-type: none"> <li>Value of accelerator pedal sensor between channel 1 and channel 2 implausible.</li> </ul>	<ul style="list-style-type: none"> <li>TQ limitation.</li> <li>Engine speed limitation.</li> </ul>	Return in the tolerances and after key off key on.
P2299	Pedal value sensor: <ul style="list-style-type: none"> <li>Signal from Brake implausible.</li> <li>Gradient of accelerator pedal sensor between channel 1 and channel 2 implausible.</li> </ul>	<ul style="list-style-type: none"> <li>TQ limitation.</li> <li>Engine speed limitation.</li> </ul>	Return in the tolerances and after key off key on.

## 4. Test instructions

### 4.1 Prerequisites of working on the diesel fuel system

#### 4.1.1 Recommendations

**Important:** The use of agents containing additives such as fuel line cleaners / metal coatings is prohibited.

#### 4.1.2 Work safety instructions

##### Introduction

Any work on the injection system is subject to the relevant regulations and provisions:

- Of accident prevention;
- Of environmental protection;
- Of the competent health authorities.

Any work must be carried out by skilled personnel that is familiar with the safety instructions and the special safety precautions.

##### Safety instructions

Owing to the extremely high pressures (1600 bar) that may occur in the fuel system, the following instructions must be heeded:

- Do not work in the proximity of flames or sparks
- Do not carry out any work on the high-pressure fuel system with the engine running
- Wait for 30 seconds after turning off the engine before carrying out any work
- It is absolutely prohibited to smoke in the immediate proximity of the high-pressure system while work is being carried out.

**Note:** This waiting time is required to allow ambient pressure to be restored in the high-pressure fuel system.

##### When the engine is running

- Do not let your hands come near a leak in the highpressure fuel system
- Always remain out of reach of a possible jet of fuel, which could result in serious injury
- Do not pull the plugs from the injectors and the engine control unit (ECU), this could result in damage to the engine.

## Danger

When performing work at the engine control unit (ECU) and the injectors, the accident prevention regulations for high-voltage equipment must be observed.

## Working area

The working area must be clean (floor, etc.) and without any obstacles; parts that are being repaired must be stored dustproof.

## Preparatory work

Prior to working on the system, it may be necessary to clean the components of this sensitive system (see relevant instructions).

Components of the sensitive system:

- Injectors;
- High-pressure fuel pump;
- Injection distributing tube (rail);
- High-pressure fuel lines.

**Important:** When removing or mounting the diesel common rail pump, do not carry the pump at the connectors, line connections or casings of the volume flow control valve and pressure control valve. When mounting or removing the rail, do not carry it or pull it out at the high-pressure sensor. Otherwise there is a risk of damage!

**Note:** The engine control unit may become very hot in operation. A high temperature at the housing does not indicate that the engine control unit is damaged. The engine control unit is checked by following the test instructions (chapter B, section 4.5).

**Important:** Cleanliness regulations:

- All staff must wear clean clothing.
- Directly after being disassembled, all connections of the high-pressure system must be sealed with plugs to prevent pollutants from entering the high-pressure system.

Safety torques:

- The tightening torques for the high-pressure system (lines, injector flanges, rail) must always be observed.
- Use regularly checked torque wrenches.

**Importante:** When the service tool is in usage (i.e. idle speed) you must not interrupt the session by disconnecting the service tool.

## 4.1.3 Information regarding the exchange of parts and the procedures

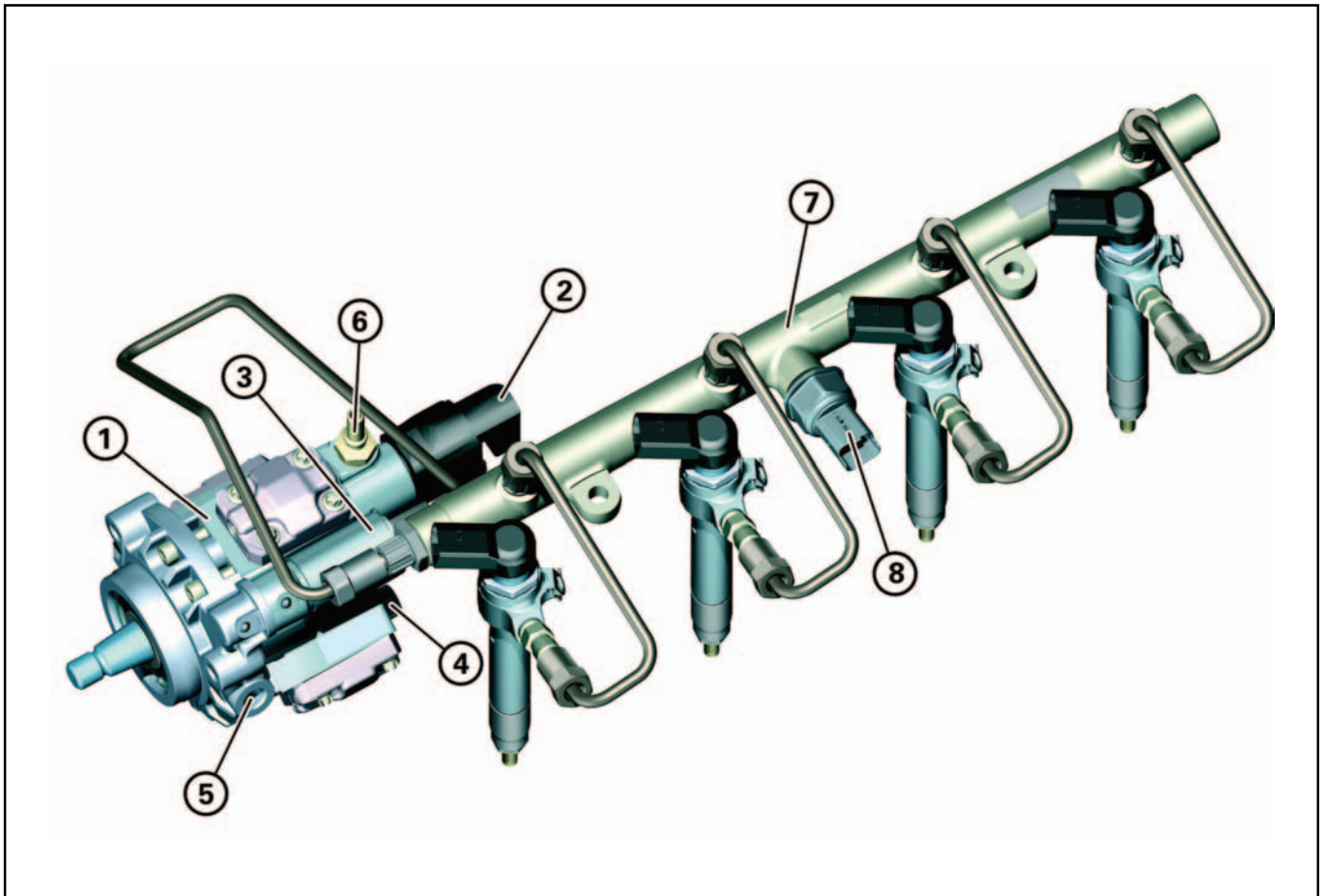


Abb. B - 1 Overview of the main components

Do not disconnect the following parts from the high-pressure pump (1):

- High-pressure control valve (PCV) (2).
- Volume flow control valve (VCV) (3).
- High-pressure outlet port (4).
- Ring nipple banjo bolt of the pump supply (5)
- Ring nipple banjo bolt of the pump return (6).

**Important:** Should one of these parts become damaged, the pump must always be sent to Siemens VDO for analysis.

Do not disconnect the high-pressure sensor (8) from the rail (7).

**Important:** In case of damage, the rail, the high-pressure lines or the high-pressure sensor must always be sent back to Siemens VDO for analysis.

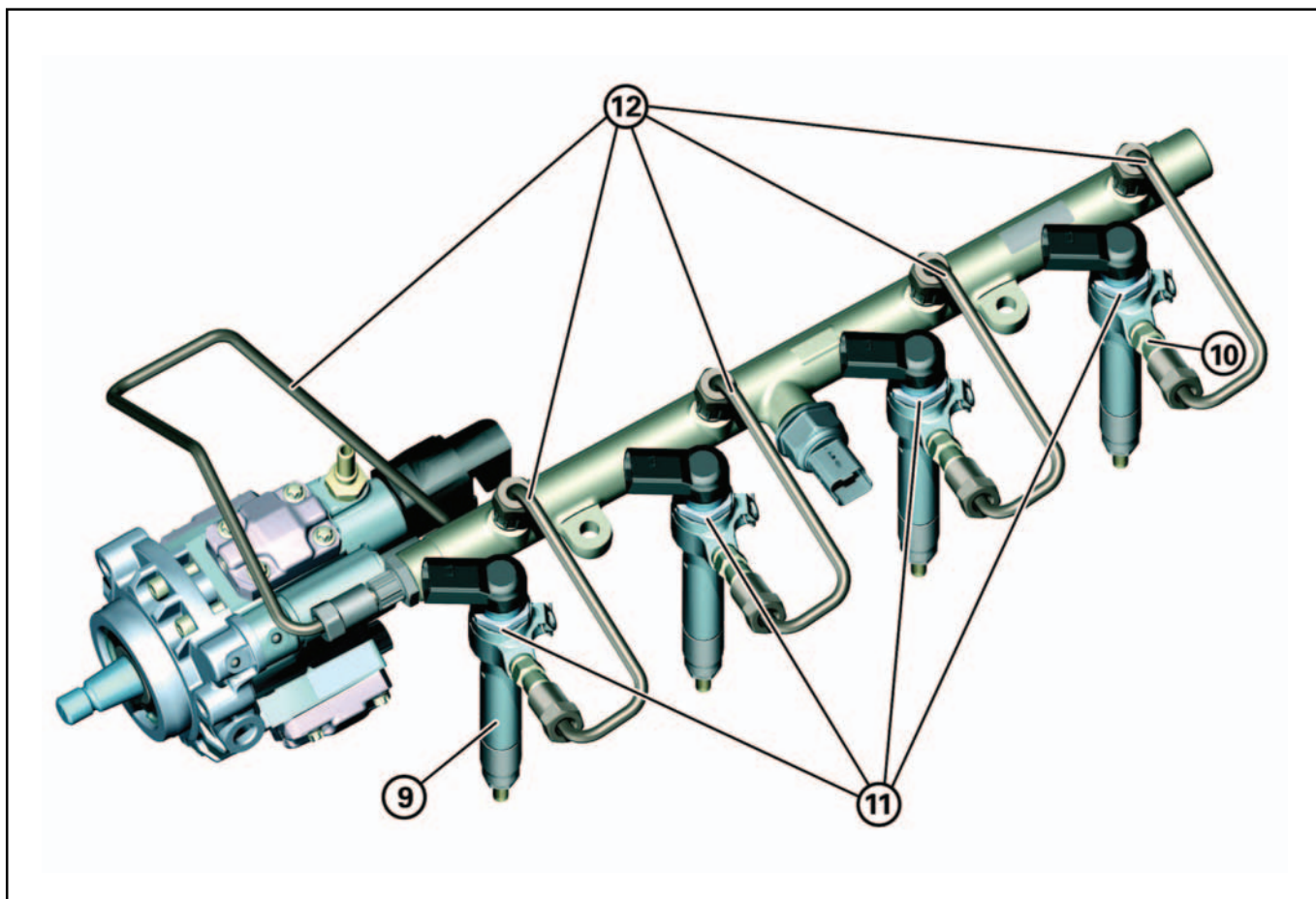


Abb. B - 2 Overview of the main components

Do not disassemble the injector (9).

- Do not disconnect the high-pressure connection (10).
- Do not unscrew the nut (11).

**Observação:**

When reusing an injector, the nozzle shaft must be cleaned using a soft cloth (if required, by means of a brake cleaner) to remove all loose impurities. To prevent impurities from entering the nozzle holes, the nozzle cap must not be cleaned mechanically (e.g. wiping off with a cloth, using a steel wire brush).

**Important:**

In case of damage, the injector must be sent back to Siemens VDO for analysis. It is prohibited to clean the injection nozzle of the injector by ultrasound!  
Any work carried out at the high-pressure lines (12) always requires their replacement. The high-pressure lines are not part of the system delivered by Siemens VDO.



Do not open the engine control unit (13).

**Important:** In case of damage, the engine control unit (ECU) must always be sent back to Siemens VDO for analysis.  
**The engine control unit (ECU) must not be opened!**

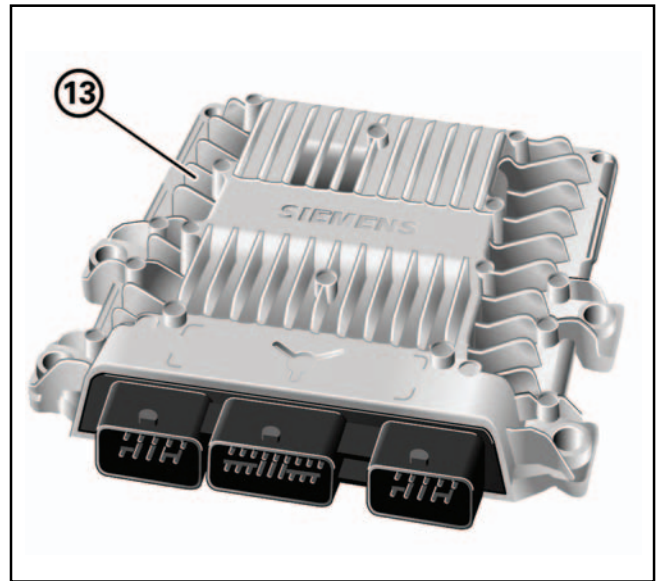


Abb. B - 3 Engine control unit

## 4.2 Checking the low-pressure system

### 4.2.1 Checking the internal fuel transfer system

#### Symptom

Air bubbles in the supply line to the DCP. Engine does not start.

#### Prerequisite

- Read the fault codes and carry out the appropriate checks.

#### Check steps:

- Bleed the internal fuel transfer system according to the manufacturer's specifications.
- Check the electrical internal transfer pump and check for sufficient pumping output.

If no or too little fuel is being delivered, then check the following components:

- Check fuel filter for dirt accumulation.
- Check contents of the tank (gasoline instead of diesel, soiled fuel).
- Check supply and return lines for leakage, damage, as well as for a proper installation of the lines.
- Dismantle surge chamber and check for leaks (acc. to the manufacturer's specifications).  
Check strainer in surge chamber for blockage.

**Important:** The fuel line between the fuel filter and the diesel common rail pump (DCP) must not be opened in the field.

It is recommended that the fuel lines to the fuel filter not be opened, since otherwise the system must be evacuated of air (bled).

**Important:** When the service tool is in usage (i.e. idle speed) you must not interrupt the session by disconnecting the service tool.

In the event of the following fault code entries, the engine control unit must be reprogrammed or replaced:

Possible fault code entries	Possible sequential faults

### 4.2.2 Checking the internal transfer pump (ITP)

#### Symptom

Fuel is present in the supply line to the DCP, however the fuel column does not move during the start.

#### Prerequisite:

- Read the fault codes and carry out the appropriate checks.
- Internal fuel transfer system is found to be in a proper condition. See section “4.2.1 Checking the internal fuel transfer system” for information concerning this process.

**Note:** The fuel is pumped to the DCP by the electrical fuel pump (EFP) in the tank. Then the IPT leads the fuel to the high-pressure pump (HPP) via the VCV. For the lubrication of the pump elements, the fuel is also fed to the inside of the pump via the scavenger valve from where it is passed to the fuel return. During the start phase, the EFP pumps more fuel than can be taken in by the ITP. Because of this, the EFP must be disconnected from the DCP!

#### Check steps

- Switch the ignition off.
- Pull the connector off the VCV (colour: orange).
- Disconnect the fuel supply line prior to the fuel filter.
- Put the tank-side end of the fuel supply line in a suitable container.
- Use an additional line to connect the container to the fuel filter.
- Disconnect the bypass fuel line and close both ends of the bypass line (see Page A-2, bypass is the red line in the picture).

**Important:** The opening of the additional line must be immersed in the fuel. The additional line must be filled with bubble-free fuel.

- Open the fuel return line of the DCP
- Start the engine for at least 15 s at an engine start speed of 250 rpm
- Measure the amount of fuel delivered ( $V_{ITP}$ ) on the return flow connection of the DCP
- Compare the amount of fuel delivered ( $V_{ITP}$ ) with the minimum amount of fuel delivered ( $V_{ITP,min}$ ).

Minimum amount of fuel delivered  $V_{ITP,min} = 130 \text{ ml/min}$  (engine start speed of 250 rpm).

If  $V_{ITP} < V_{ITP,min}$ , then exchange the DCP.

Possíveis entradas de códigos de falhas	Possível falha seqüencial

## 4.3 Checking the high-pressure system

### 4.3.1 Checking the PCV

#### Symptom

Rail pressure approx. 50 bar during the start phase (holding pressure PCV).

#### Prerequisite

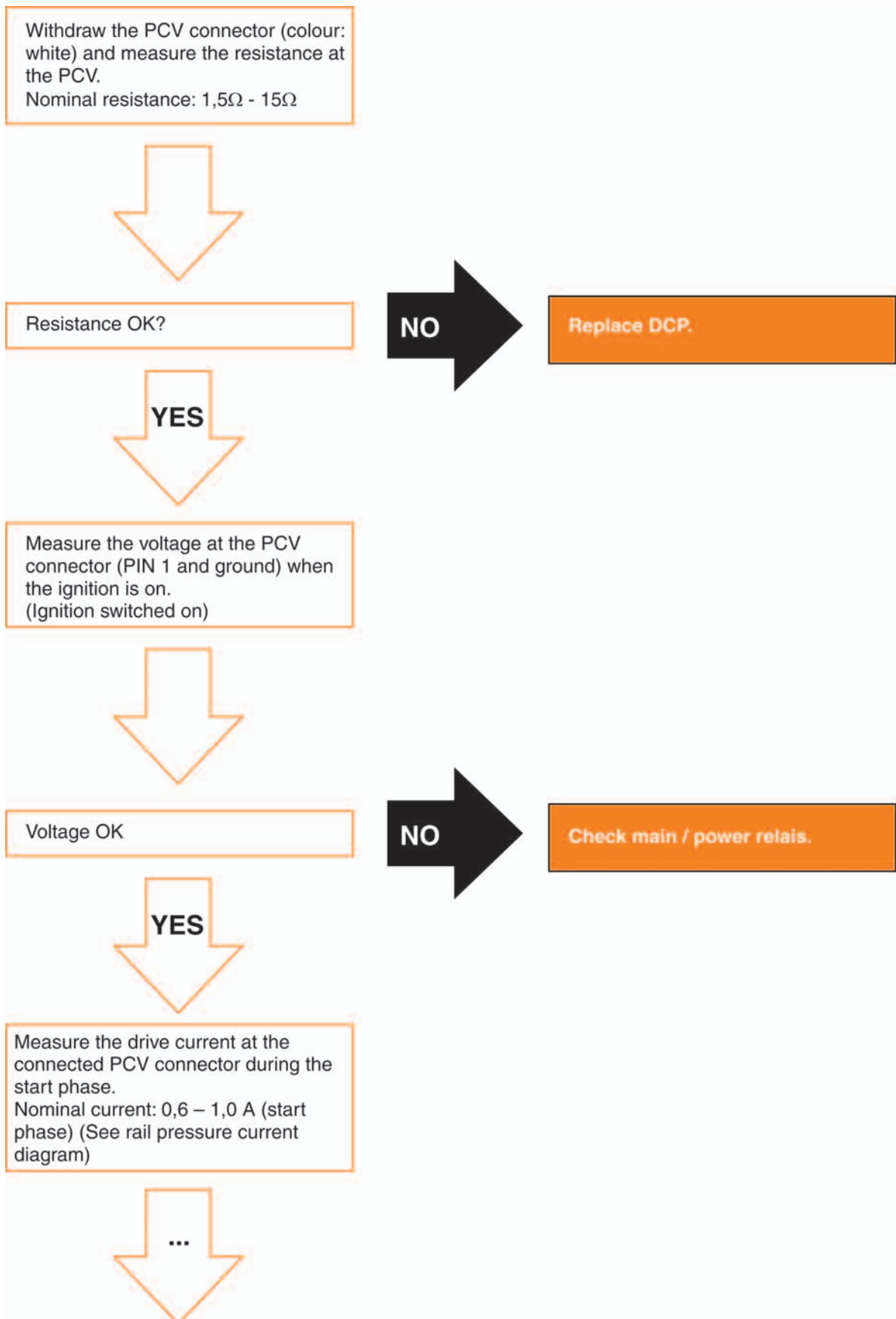
- Read the fault codes and carry out the appropriate checks.
- The entire low-pressure system is found to be in a proper condition. See section “4.2 Checking the low-pressure system” for information concerning this process.
- High-pressure lines and high-pressure connections have been checked for leaks.

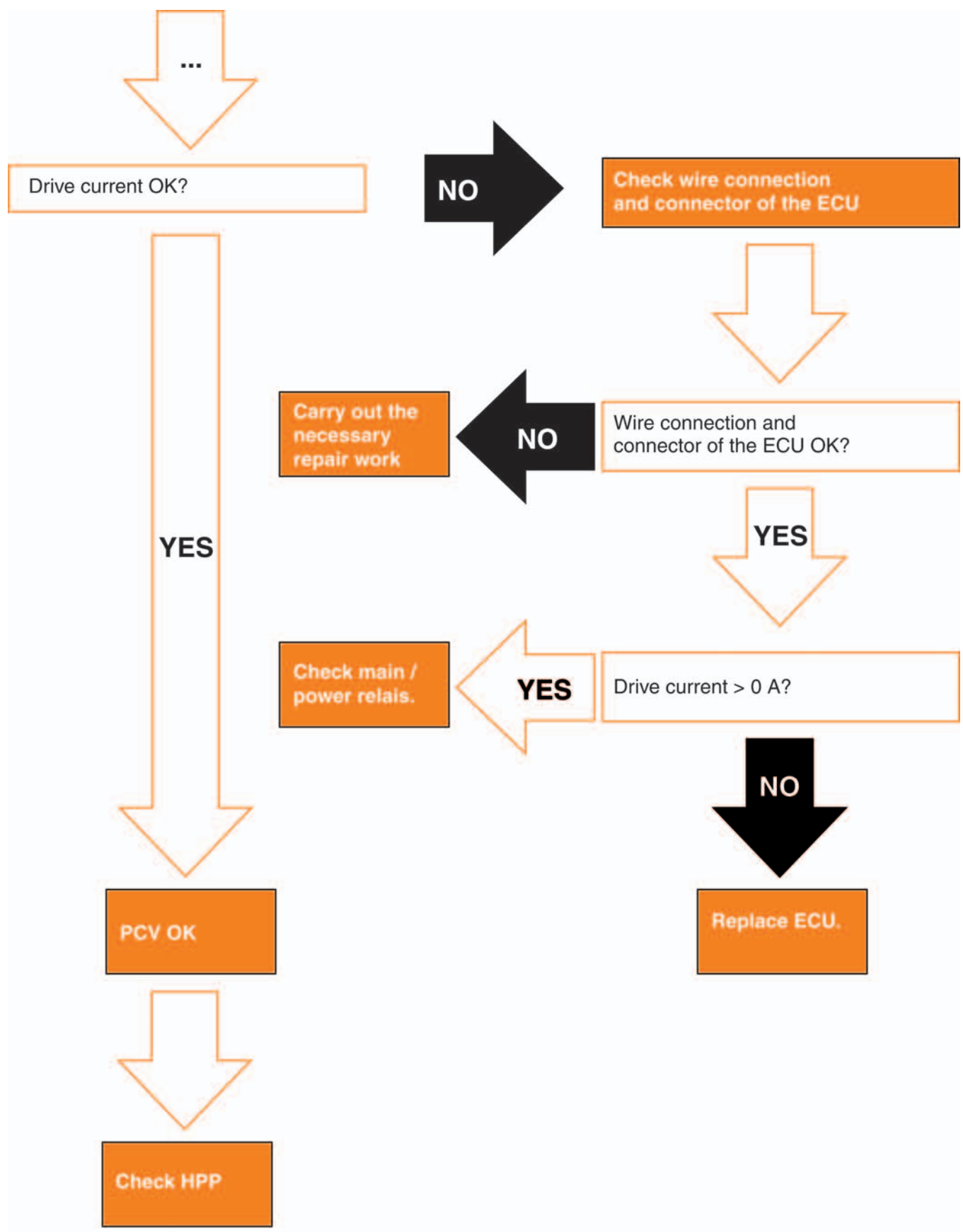
**Note:** In the case of a faulty PCV (e.g. without power), a rail pressure of only 50 bar will be reached during the start phase. This holding pressure develops by the closing pressure of a spring in the PCV.

Possible fault code entries	Possible sequential faults
P0002 P0004 P0090 P0092	P0001

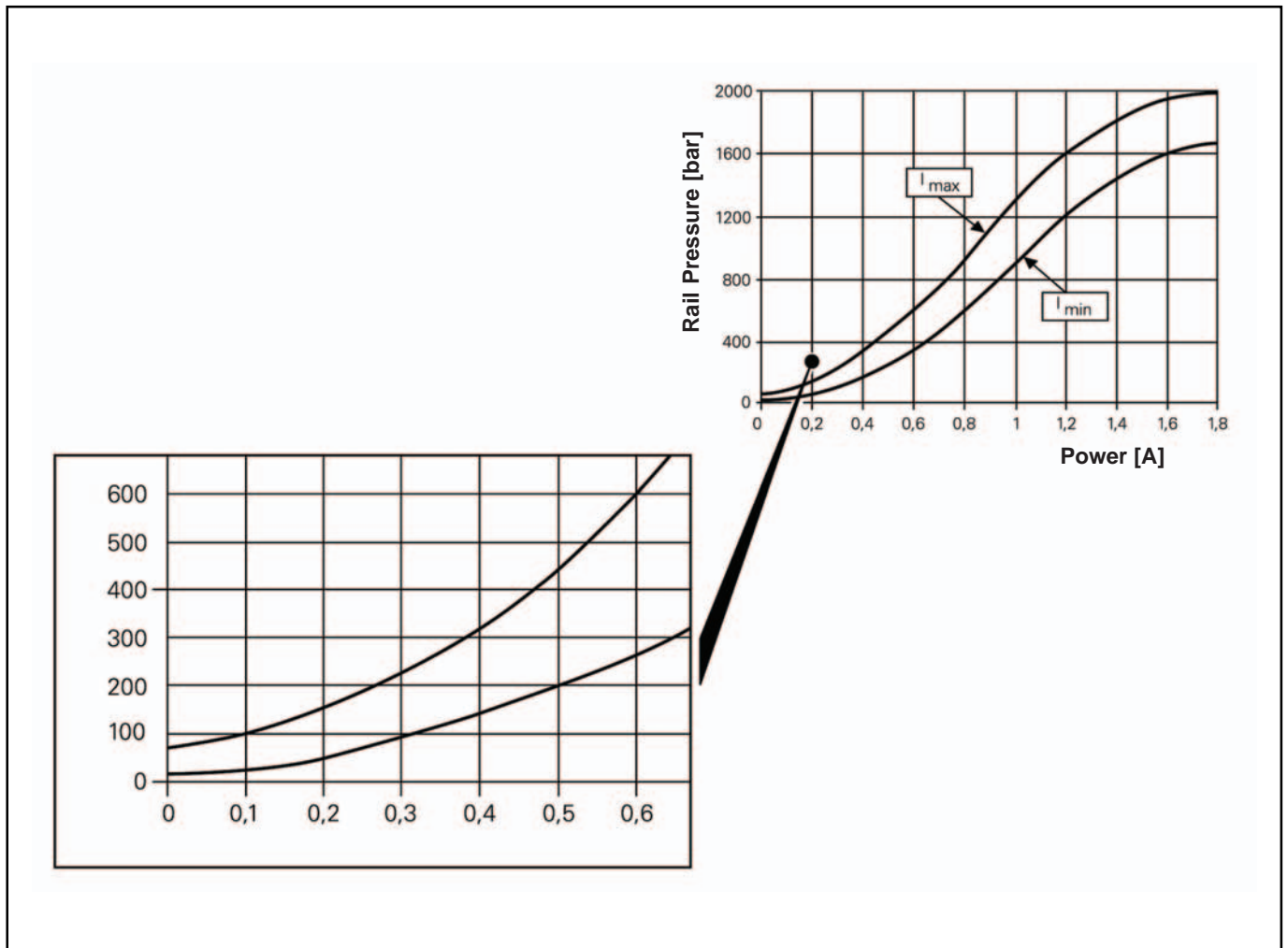
**Important:** Measure the current at the pressure control valve using a diagnostic tool or a multimeter.

Check steps





Rail pressure current diagram



**4.3.2 Checking the high-pressure pump (HPP) and VCV**

**Symptom**

Too little or no rail pressure during the start phase.

**Prerequisite**

- Read the fault codes and carry out the appropriate checks.
- High-pressure lines and high-pressure connections have been checked for leaks.
- PCV was checked. See also section “4.3.1 Checking the PCV” for information concerning this process.
- The entire low-pressure system is found to be in a proper condition. See section “4.2 Checking the low-pressure system” for information concerning this process..

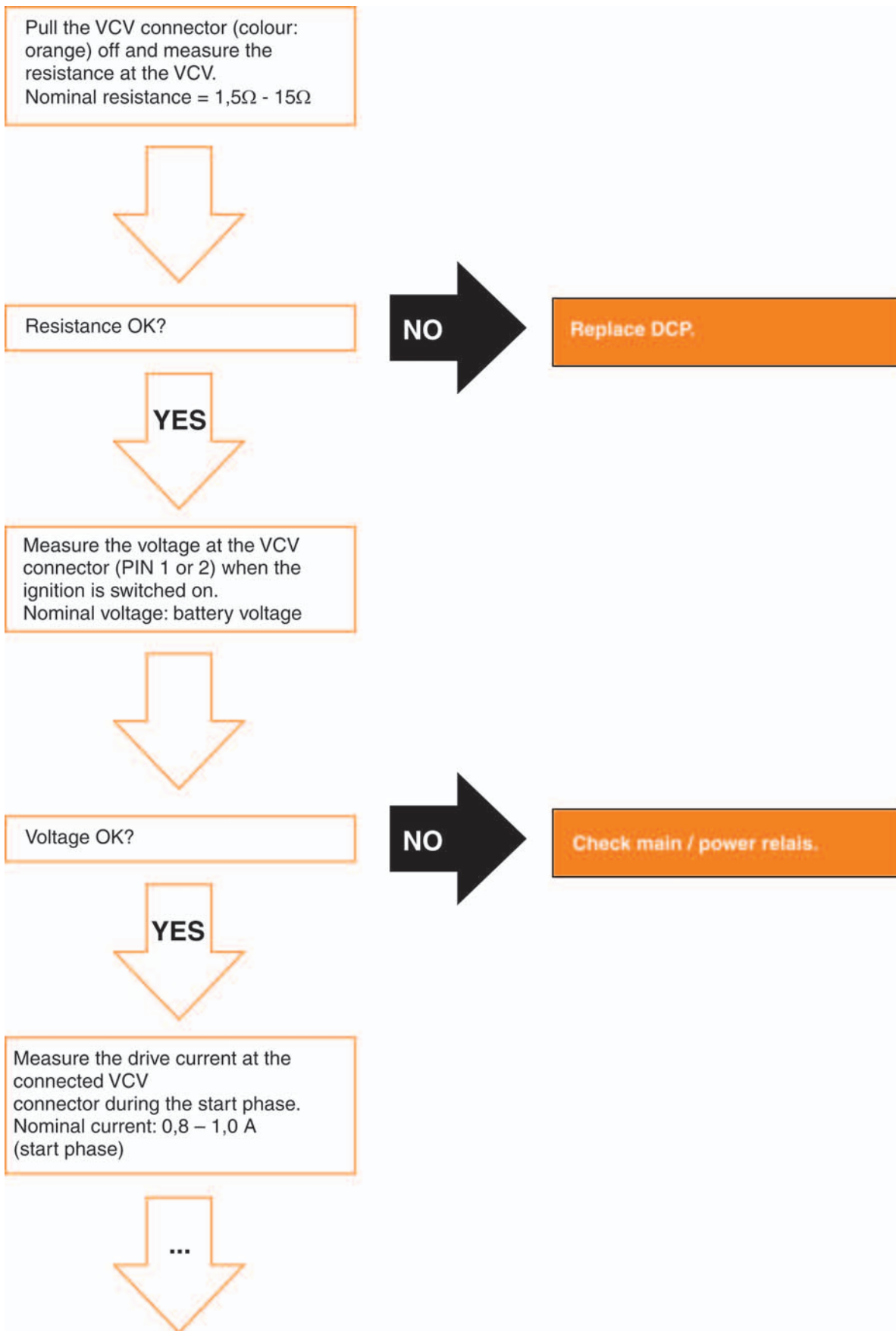
**Note:** Nominal rail pressure during the start phase: min. 150 bar.  
 During the test, the EFP (electrical fuel transfer pump) must be disconnected. See section “4.2.2 Checking the internal transfer pump (ITP)” for information concerning this process.

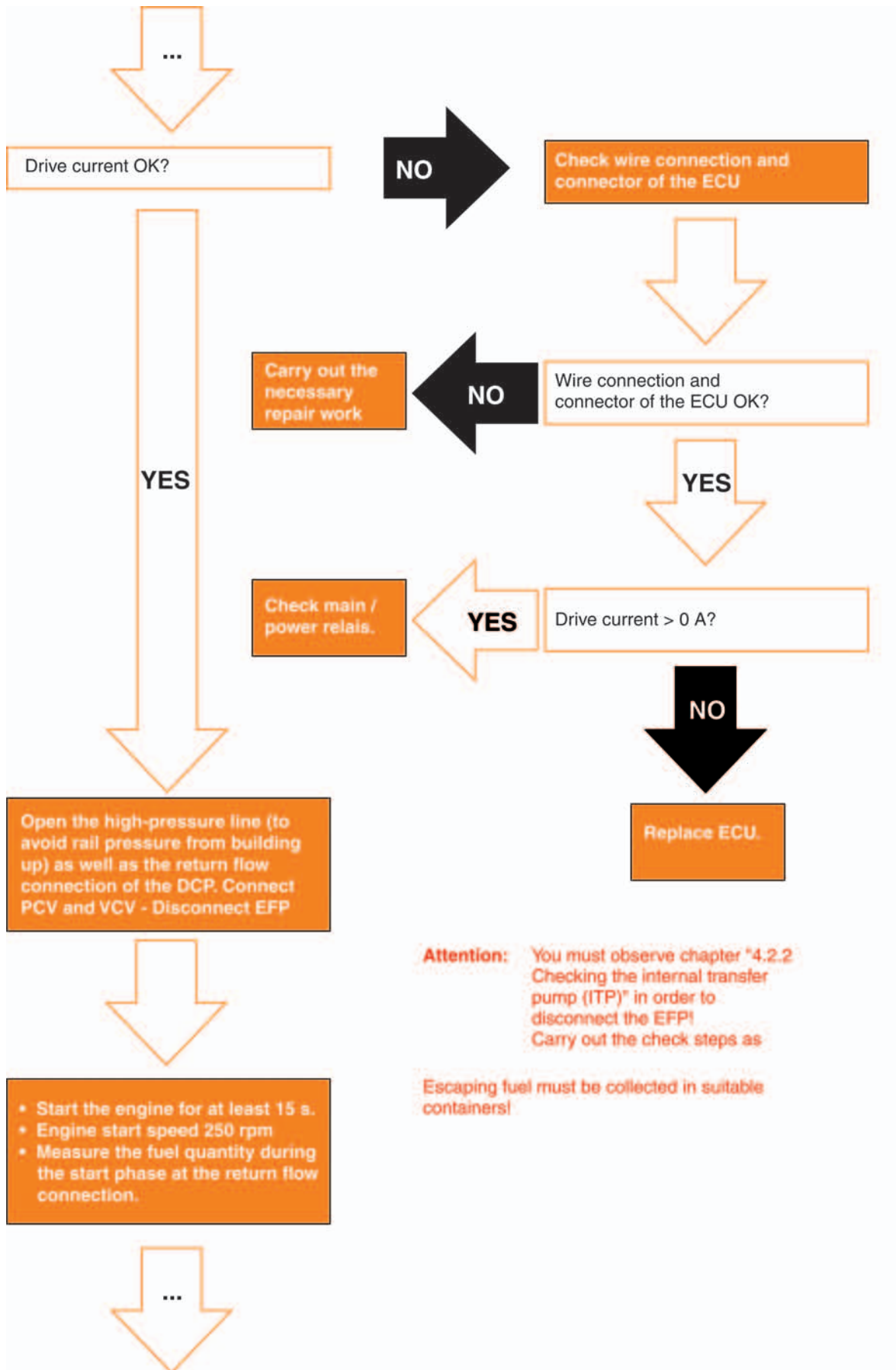
Possible fault code entries	Possible sequential faults
P0002 P0004 P0090 P0092	P0001 P0191

**Important:** Measure the current at the volume flow control valve using a diagnostic tool or a multimeter.



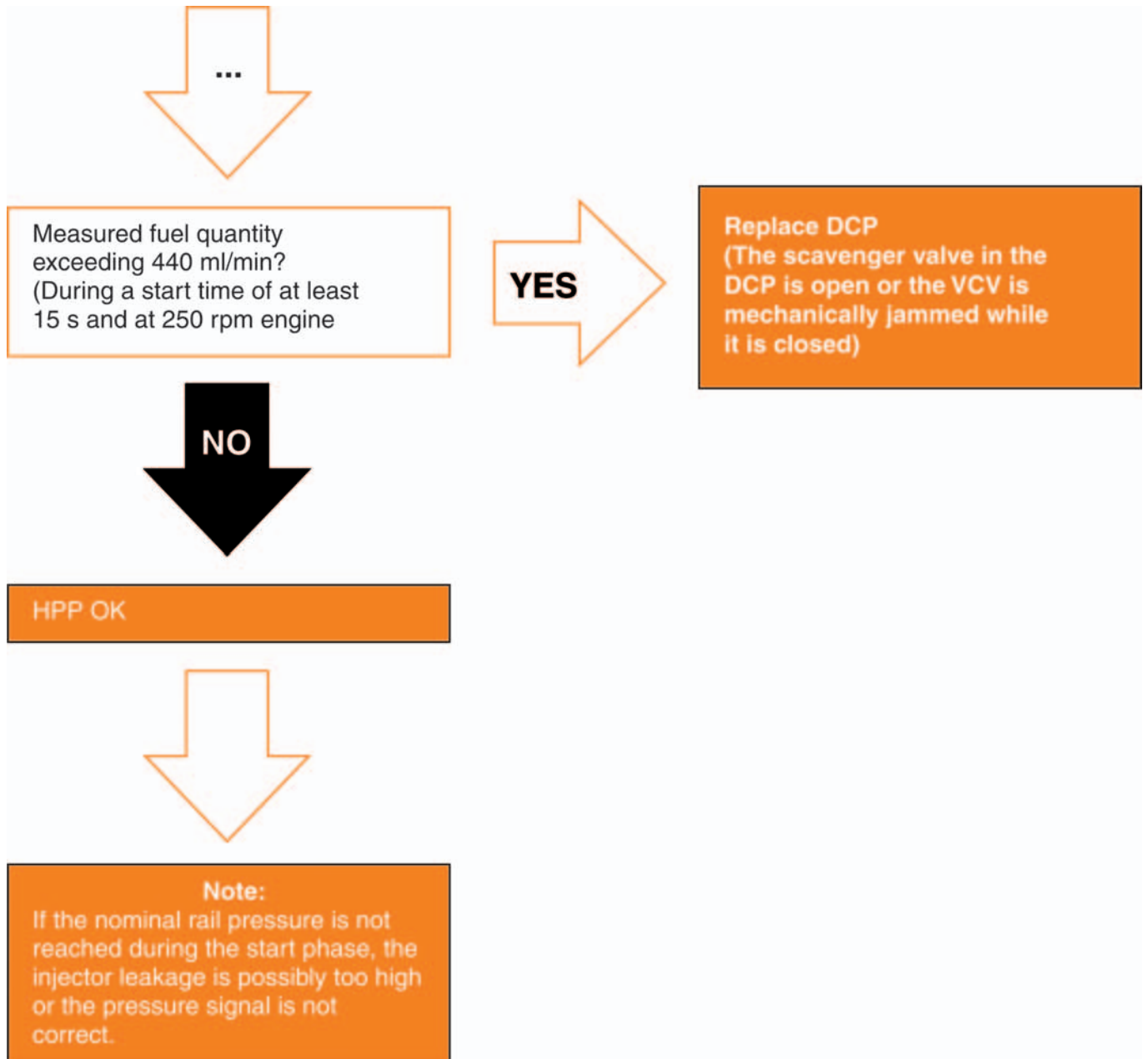
Check steps



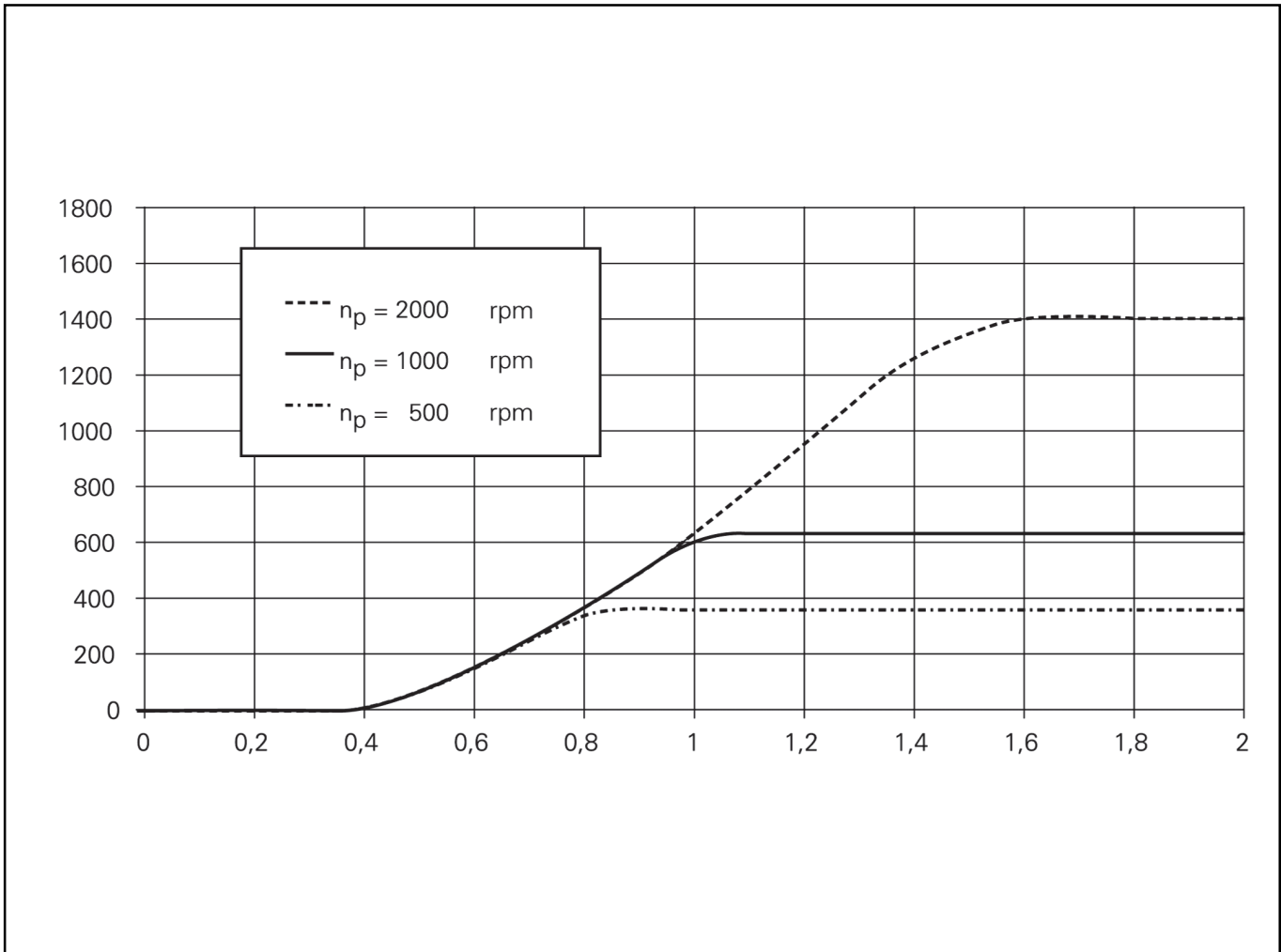


**Attention:** You must observe chapter "4.2.2 Checking the internal transfer pump (ITP)" in order to disconnect the EFP! Carry out the check steps as

Escaping fuel must be collected in suitable containers!



Characteristic flow rate graph of the VCV depending on the pump speed ( $n_p$ )



**4.3.3 Checking the rail pressure control loop**

**Symptom**

- Unstable idling
- Rail pressure fluctuations
- Nominal rail pressure was not reached
- Loud or untypical combustion noises possible.

**Prerequisite**

- Read the fault codes and carry out the appropriate checks.
- Air-conditioning is switched off.
- The tank is at least half full.
- Coolant temperature 80 - 90°C.
- All electrical consumers must be switched off.
- Hydraulic lines have been checked and there are no leaks.
- Connectors and wire connections have been checked.

**Note:**

The appropriate rail pressure will be set for every engine operating condition. The engine control unit monitors continually the momentary rail pressure via the high-pressure sensor, adjusts this to the nominal value stored in the characteristics and regulates the pressure control valve PCV and the volume flow control valve VCV.

This results in a closed rail pressure control loop. The VCV serves the purpose of customising the delivered amount of fuel from the high-pressure pump according to the needs of the engine. This will reduce the power requirement of the high-pressure pump.

**Important:** If the DCP is blocked, i.e. if the pump shaft cannot be turned by hand even with the impeller mounted, or if heavy soiling (filings) in the transparent fuel return line can be discerned, then the complete injection system (injectors, DCP, rail, high-pressure lines and all fuel return lines) has to be replaced.

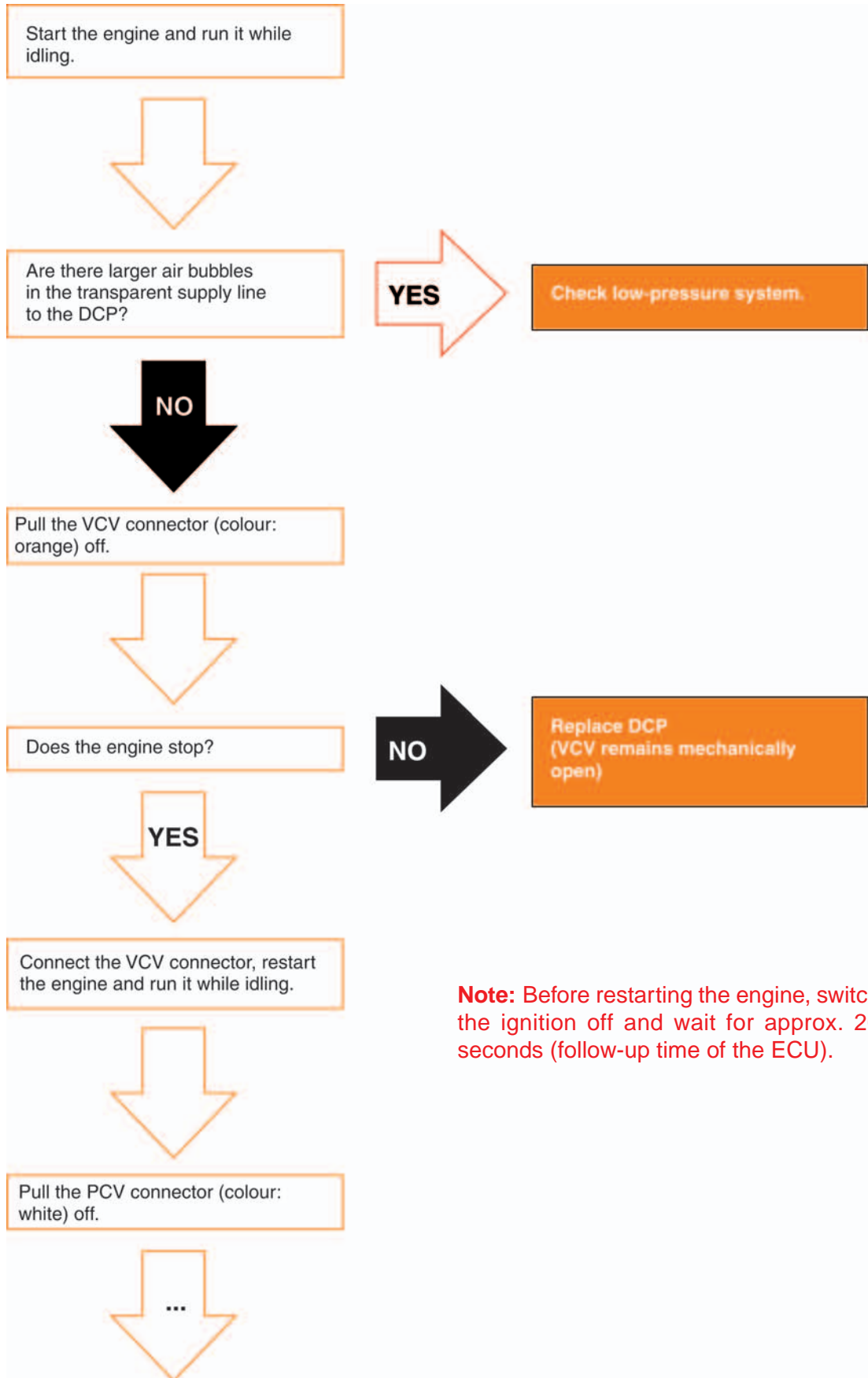
Possible fault code entries	Possible sequential faults
P0002 P0004 P0089 P0090 P0092 P0192 P0193	P0001 P0263 P0266 P0269 P0272

If more than one cylinder balancing DTC is shown, you must proceed as follows:

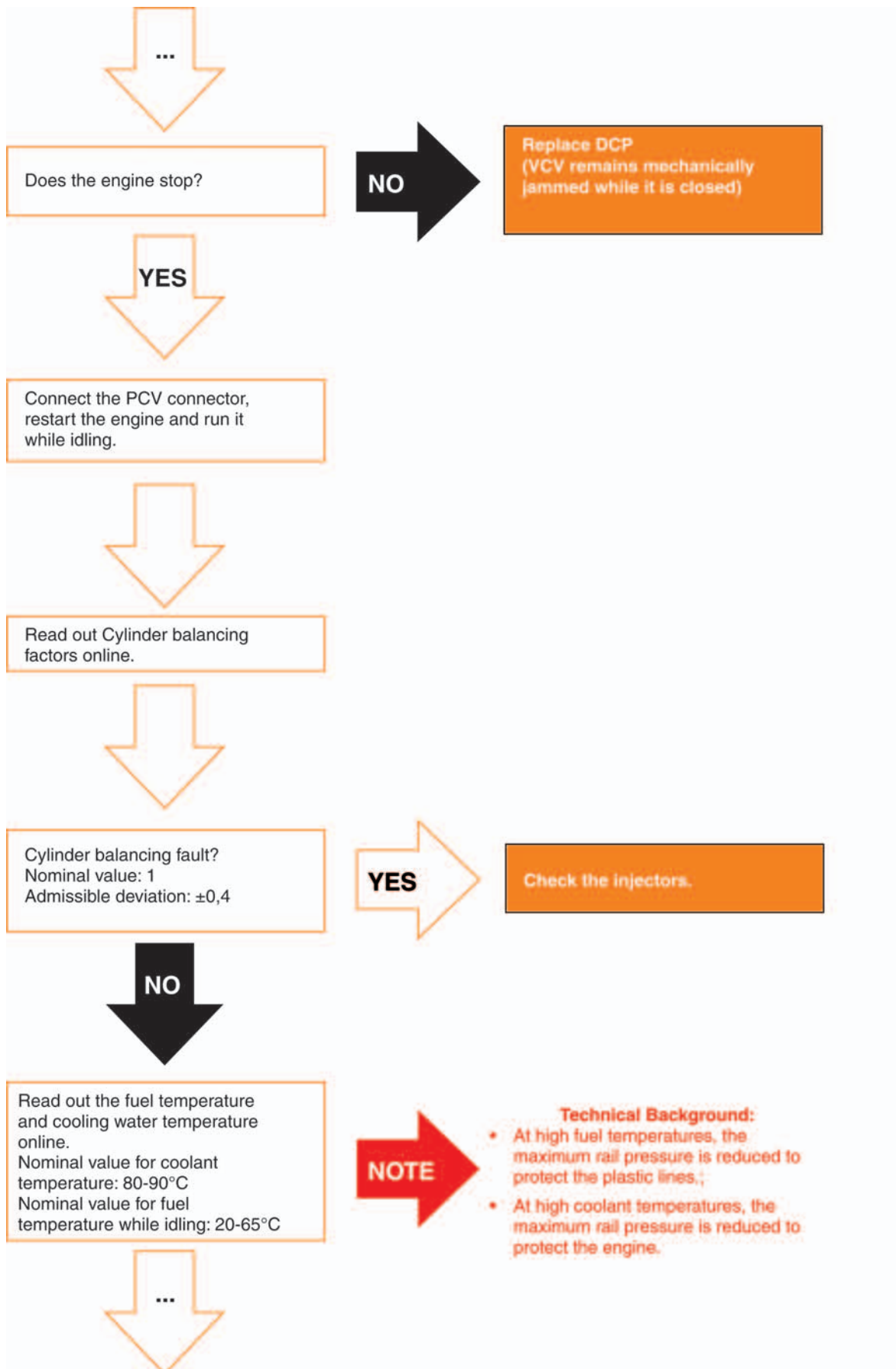
- Warm up the engine up to min. 60°C.
- Delete all DTCs in the fault memory.
- Start the engine and wait until the follow-up time has expired.
- Run the engine at idle speed, do not move the vehicle.
- Wait until the first cylinder balancing DTC is shown.
- Then replace the injector shown (see also chapter C - "Mounting/Dismounting the injectors").

For the final test, you must erase the fault memory again and restart the engine (observe again the follow-up time of the control unit).

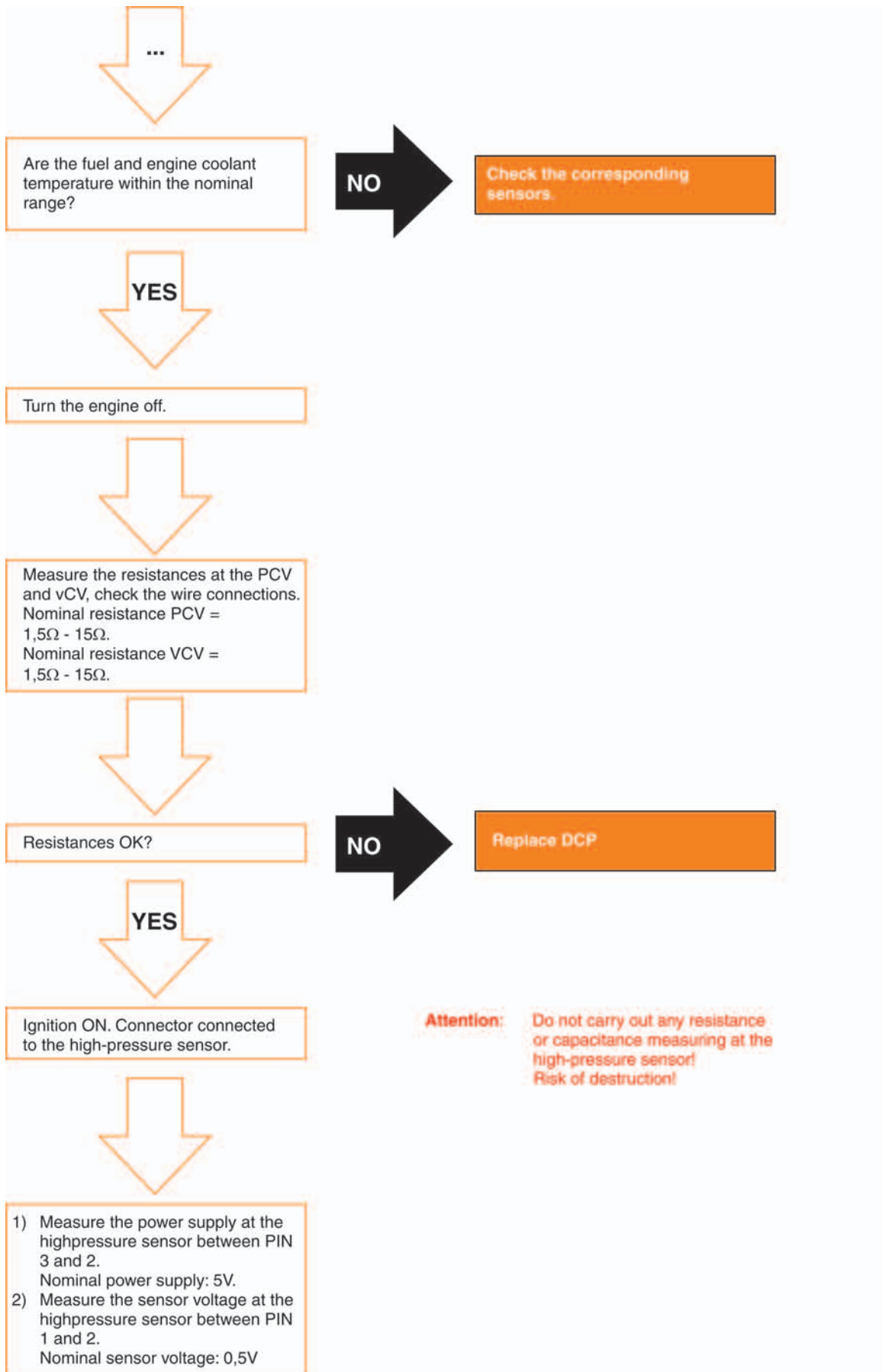
Check steps

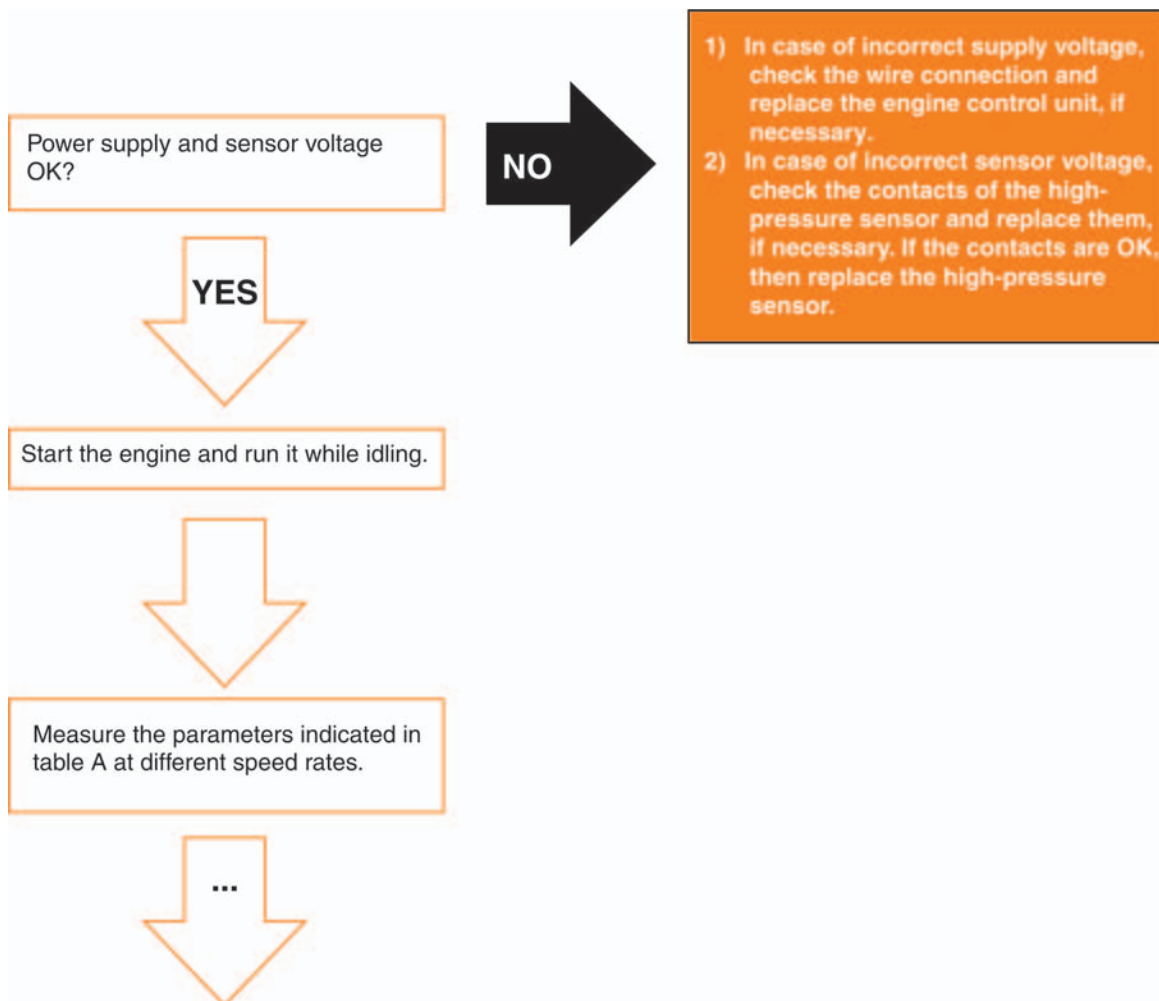
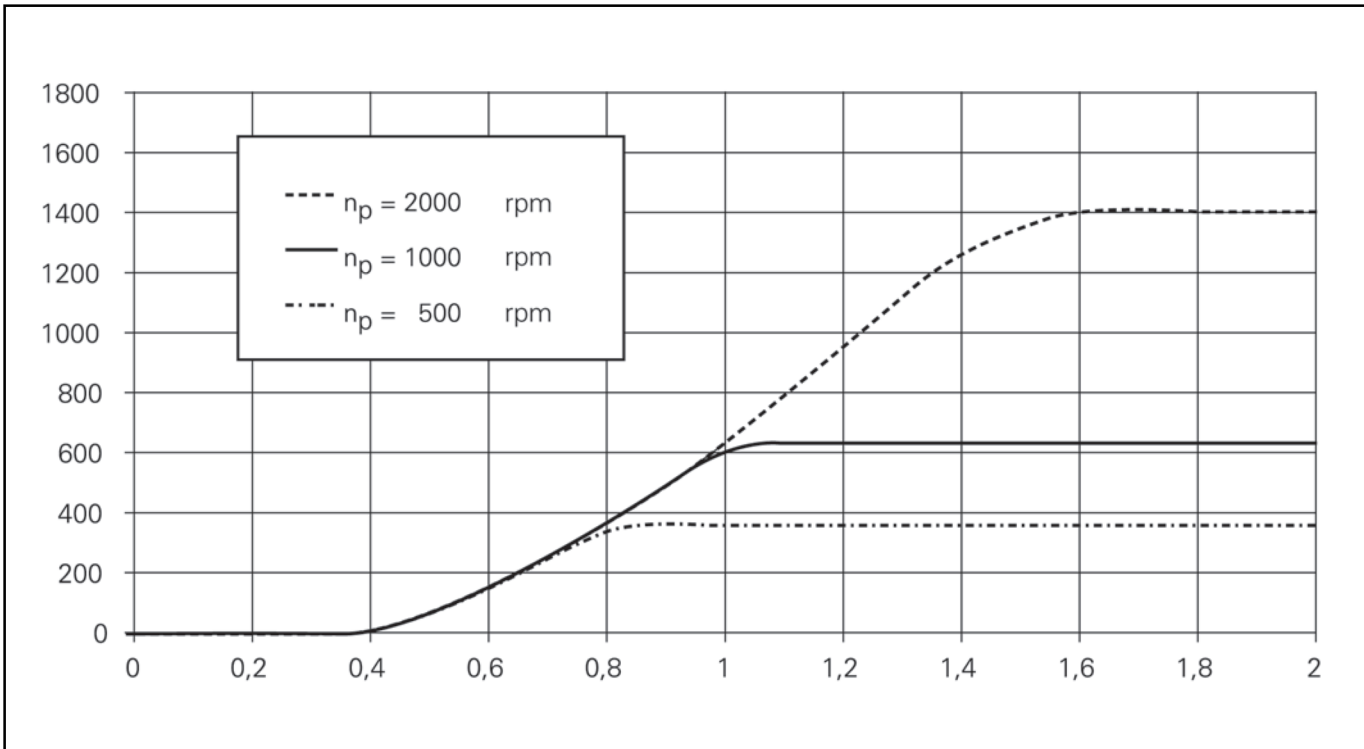


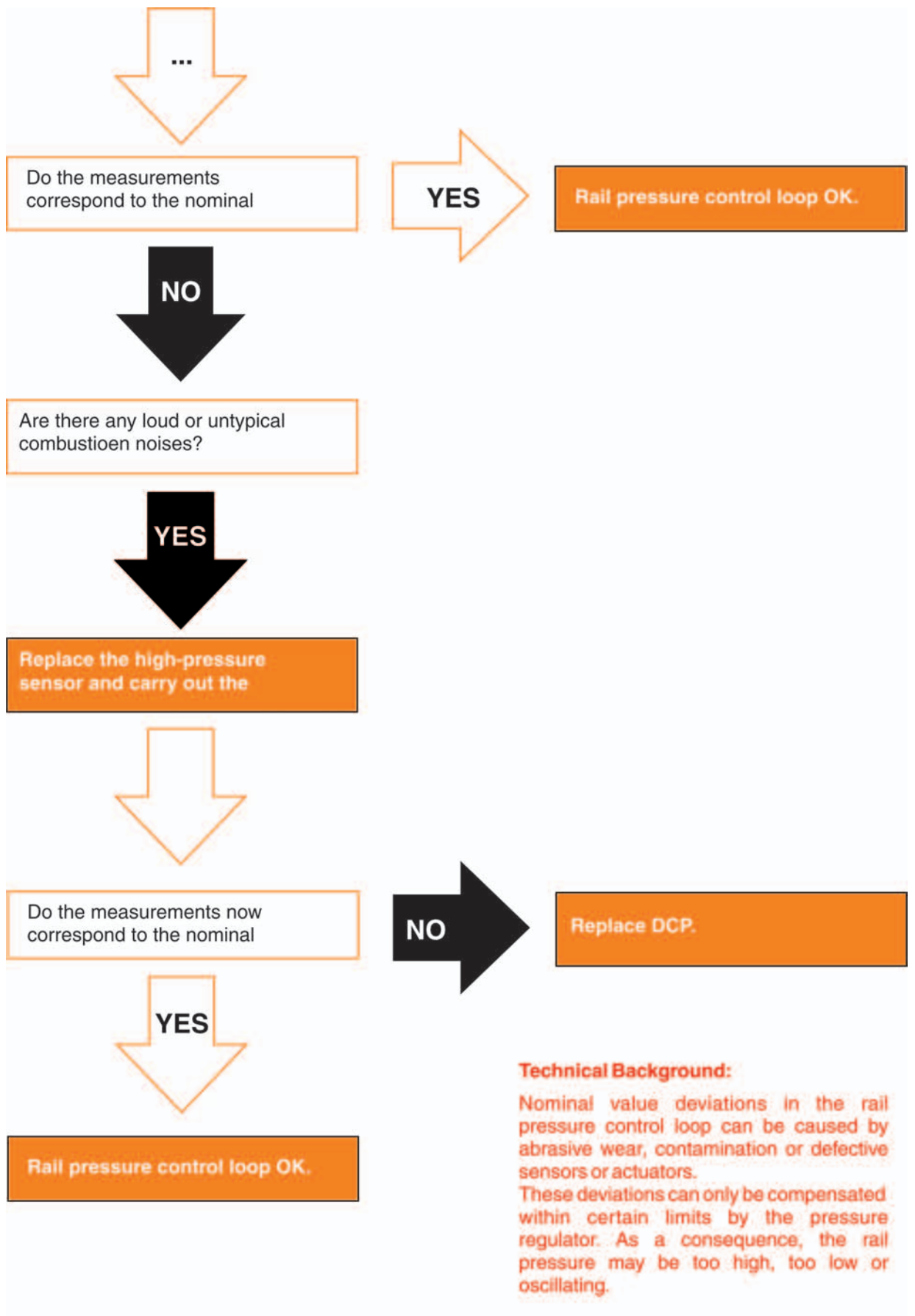
**Note:** Before restarting the engine, switch the ignition off and wait for approx. 20 seconds (follow-up time of the ECU).











**Technical Background:**

Nominal value deviations in the rail pressure control loop can be caused by abrasive wear, contamination or defective sensors or actuators.

These deviations can only be compensated within certain limits by the pressure regulator. As a consequence, the rail pressure may be too high, too low or oscillating.

**Table A**

<b>Speed (no load) [rpm]</b>	<b>Rail pressure [MPa]</b>	<b>Voltage at high-pres- sure sensor between PIN 1 and PIN 2 [V]</b>	<b>PWM signal at PCV (%)</b>	<b>Current at PCV (A)</b>
1000	210 - 230	0.8 - 1.1	12 - 14	0.3 - 0.4
2000	210 - 280	0.8 - 1.2	12 - 14	0.3 - 0.5
3000	240 - 350	0.9 - 1.4	12 - 15	0.3 - 0.5
4000	290 - 390	1.1 - 1.5	14 - 16	0.3 - 0.5

4.4 Checking the injectors

4.4.1 High injector leakage / injectors staying open

Symptom

Too low or no rail pressure during the start phase.  
Engine does not start.

Prerequisite

- Read the fault codes and carry out the appropriate checks.
- High-pressure lines and high-pressure connections have been checked for leaks.
- PCV was checked. See also section “4.3.1 Checking the PCV” for information concerning this process.
- Pressure sensor has been checked. See also section “4.3.3 Checking the rail pressure control loop” for information concerning this process.
- The entire low-pressure system is found to be in a proper condition. See section “4.2 Checking the low-pressure system” for information concerning this process.
- The high-pressure pump (HPP) and VCV were checked. See section “4.3.2 Checking the high-pressure pump (HPP) and VCV” for information concerning this process.


**Note:** Abrasive wear or dirt particles in the injector may cause the amount of return flow in the injectors to rise above permissible levels or may cause the injector to be open to the cylinder.  
This has the result that the amount of fuel delivered by the high-pressure pump (HPP) is no longer sufficient to build up an adequate pressure in the rail.  
The injectors will not be triggered at a rail pressure.

Important:

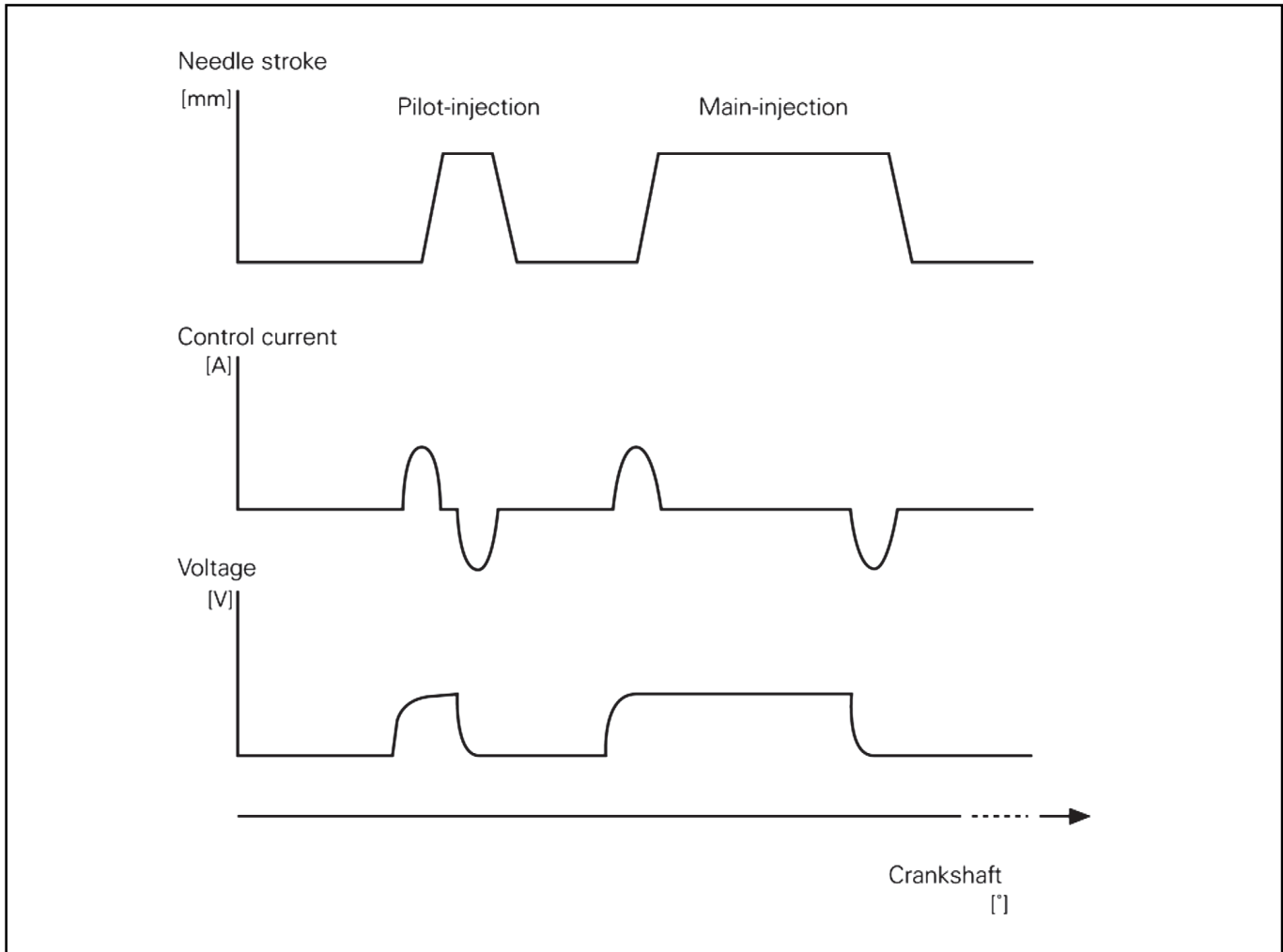
When the service tool is in usage (i.e. idle speed) you must not interrupt the session by disconnecting the service tool.

4.4.2 Erro na quantidade de combustível injetado

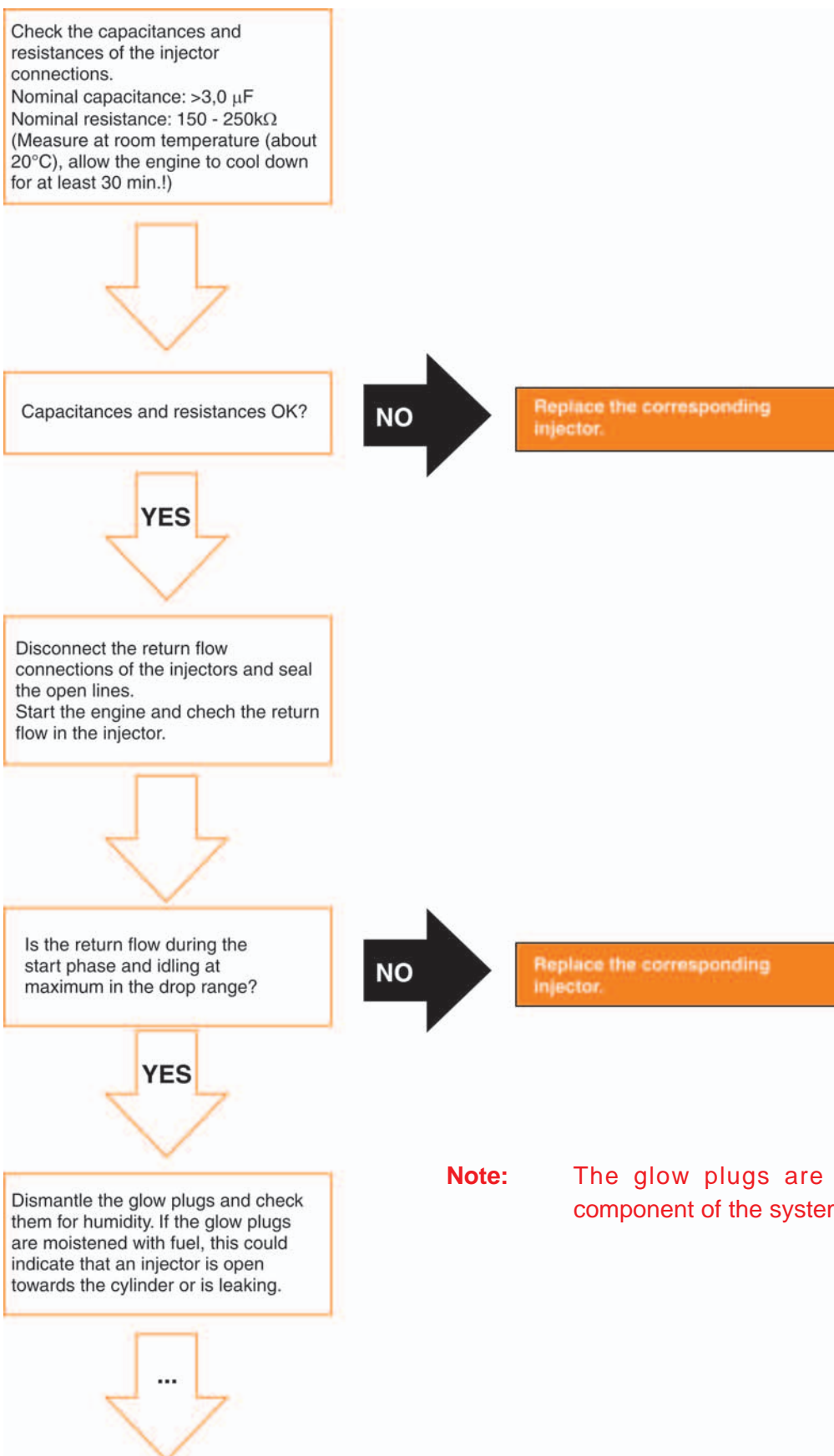
Possible fault code entries	Possible sequential faults
P0263 P0266 P0269 P0272  P1201 P1202 P1203 P1204	

 **Danger:** When performing work at the engine control unit (ECU) and the injectors, the accident prevention regulations for high-voltage equipment must be observed.

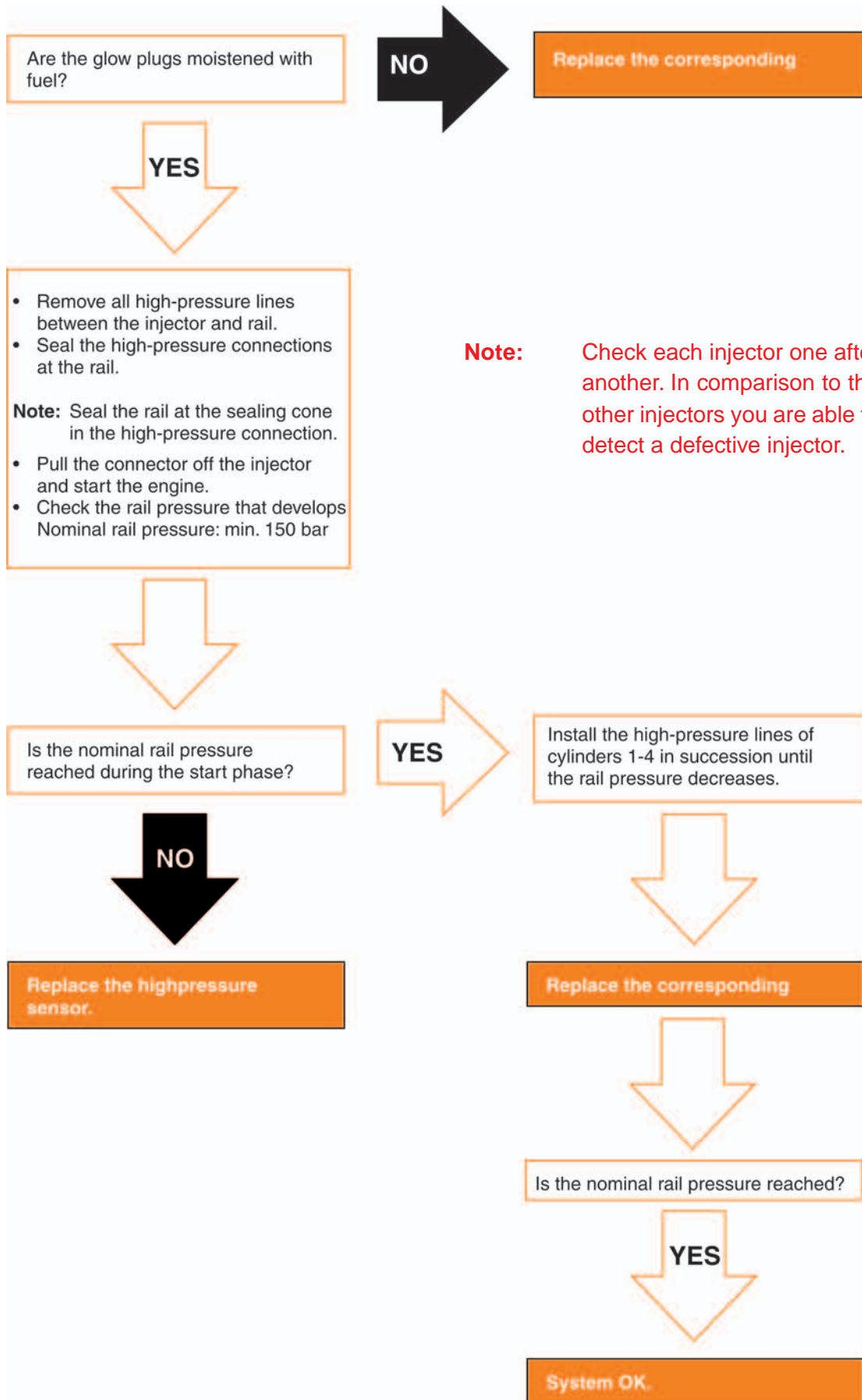
**Characteristic curve of the injector activation**



Check steps:



**Note:** The glow plugs are an optional component of the system.



**Note:** Check each injector one after another. In comparison to the other injectors you are able to detect a defective injector.



**4.4.2 Incorrect injection quantities**

**Symptom**

Engine idle runs rough, possibly produces white smoke.

**Prerequisite**

- Read the fault codes and carry out the appropriate checks.
- Air-conditioning is switched off.
- Engine temperature minimum 80°C.
- All electrical consumers must be switched off.
- High-pressure lines and high-pressure connections have been checked for leaks.
- PCV was checked. See also section “4.3.1 Checking the PCV” for information concerning this process.
- The entire low-pressure system is found to be in a proper condition. See section “4.2 Checking the low-pressure system” for information concerning this process.
- The high-pressure pump (HPP) and VCV were checked. See section “4.3.2 Checking the high-pressure pump (HPP) and VCV” for information concerning this process.

**! Attention:** Abrasive wear or dirt particles in the injectors may lead to the injection quantities passed through the injectors deviating from one another, or may cause the sealing of the injectors to the cylinder to no longer be guaranteed.  
 Different injection quantities between the individual cylinders lead to power variations, which causes the crankshaft to be accelerated with differing forces.  
 The allocation of injection quantities to the individual cylinders can be compensated by the cylinder balancing factors. This results in an engine that runs smoothly.

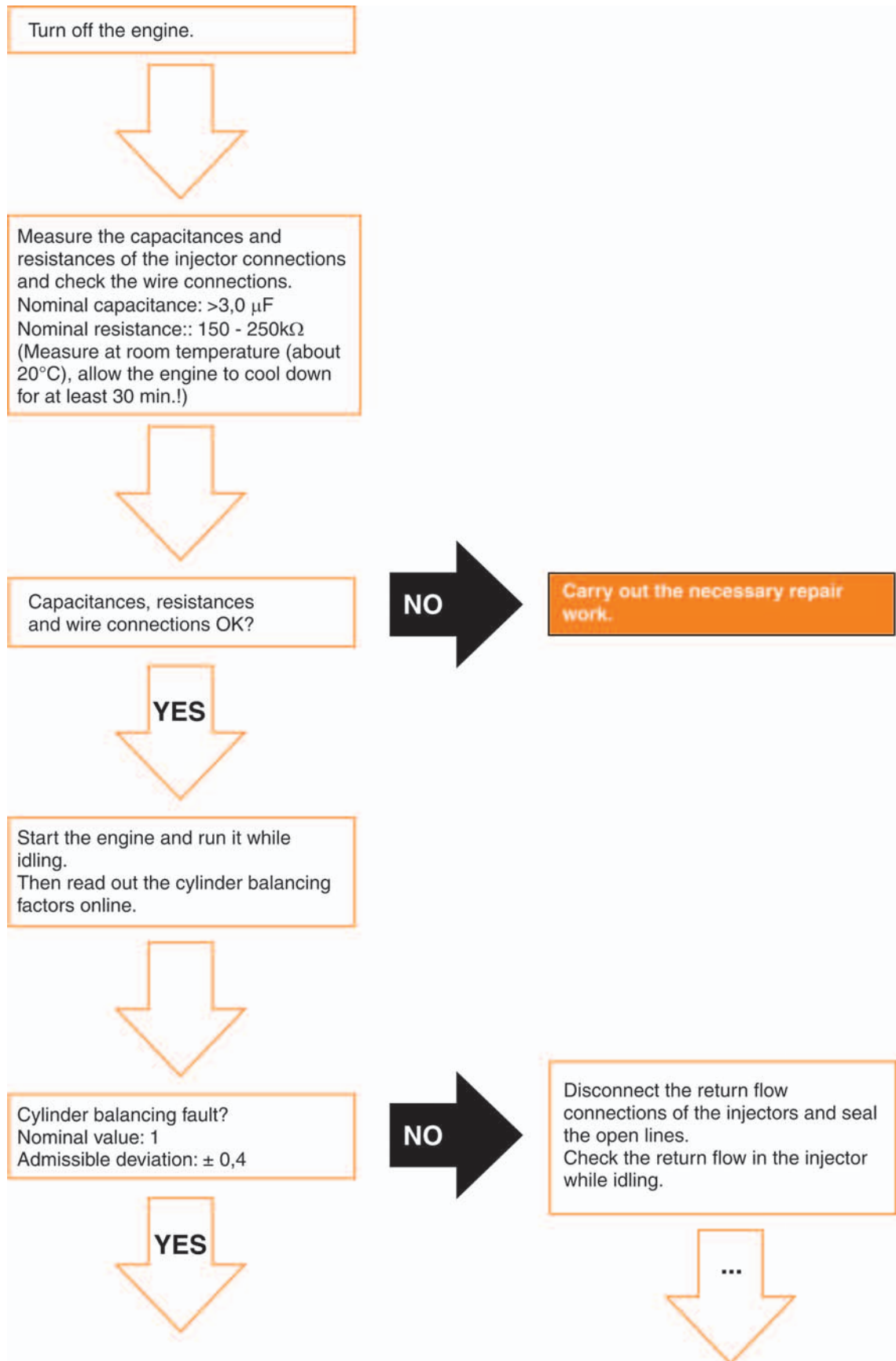
Possible fault code entries	Possible sequential faults
P0263 P0266 P0269 P0272  P1201 P1202 P1203 P1204	

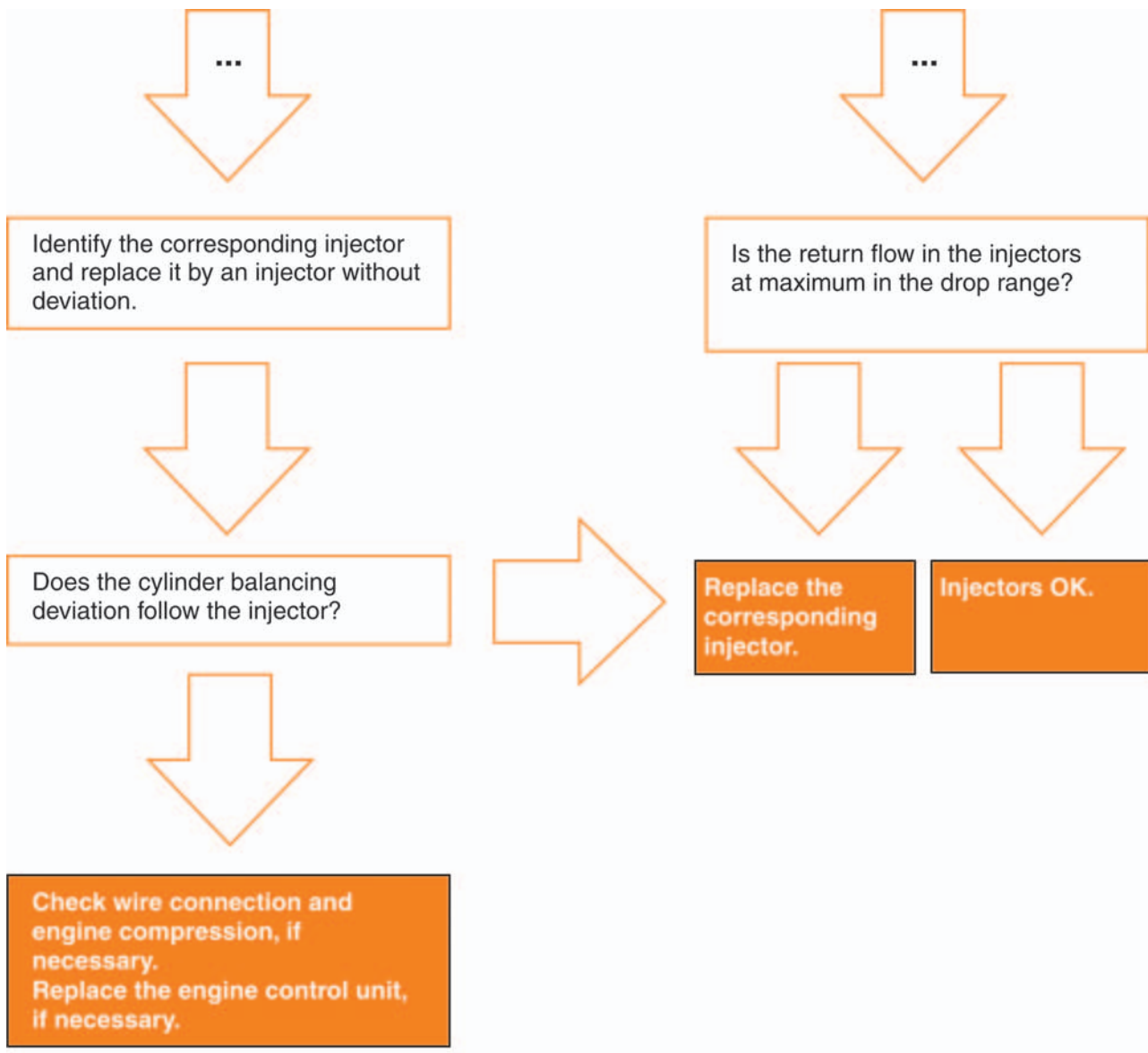
If more than one cylinder balancing DTC is shown, you must proceed as follows:

- Warm up the engine up to min. 60°C.
- Delete all DTCs in the fault memory.
- Start the engine and wait until the follow-up time has expired.
- Run the engine at idle speed, do not move the vehicle.
- Wait until the first cylinder balancing DTC is shown.
- Then replace the injector shown (see also chapter C - "Mounting/Dismounting the injectors").

For the final test, you must erase the fault memory again and restart the engine (observe again the follow-up time of the control unit).

Check steps





#### 4.5 Checking the engine control unit (ECU)

##### Danger

In case work has to be carried out on the engine control unit, the rules and regulations for accident prevention when using high-voltage equipment must be observed.

##### Important

When the service tool is in usage (i.e. idle speed) you must not interrupt the session by disconnecting the service tool.

##### Note

System errors may cause sequential faults which are to be handled secondarily during fault elimination. At the beginning of troubleshooting, all sensors and actuators as well as the wiring harness and the hydraulic system are to be checked and faults corrected.

Prior to the replacement of the engine control unit (ECU), all other possible fault sources should be excluded.

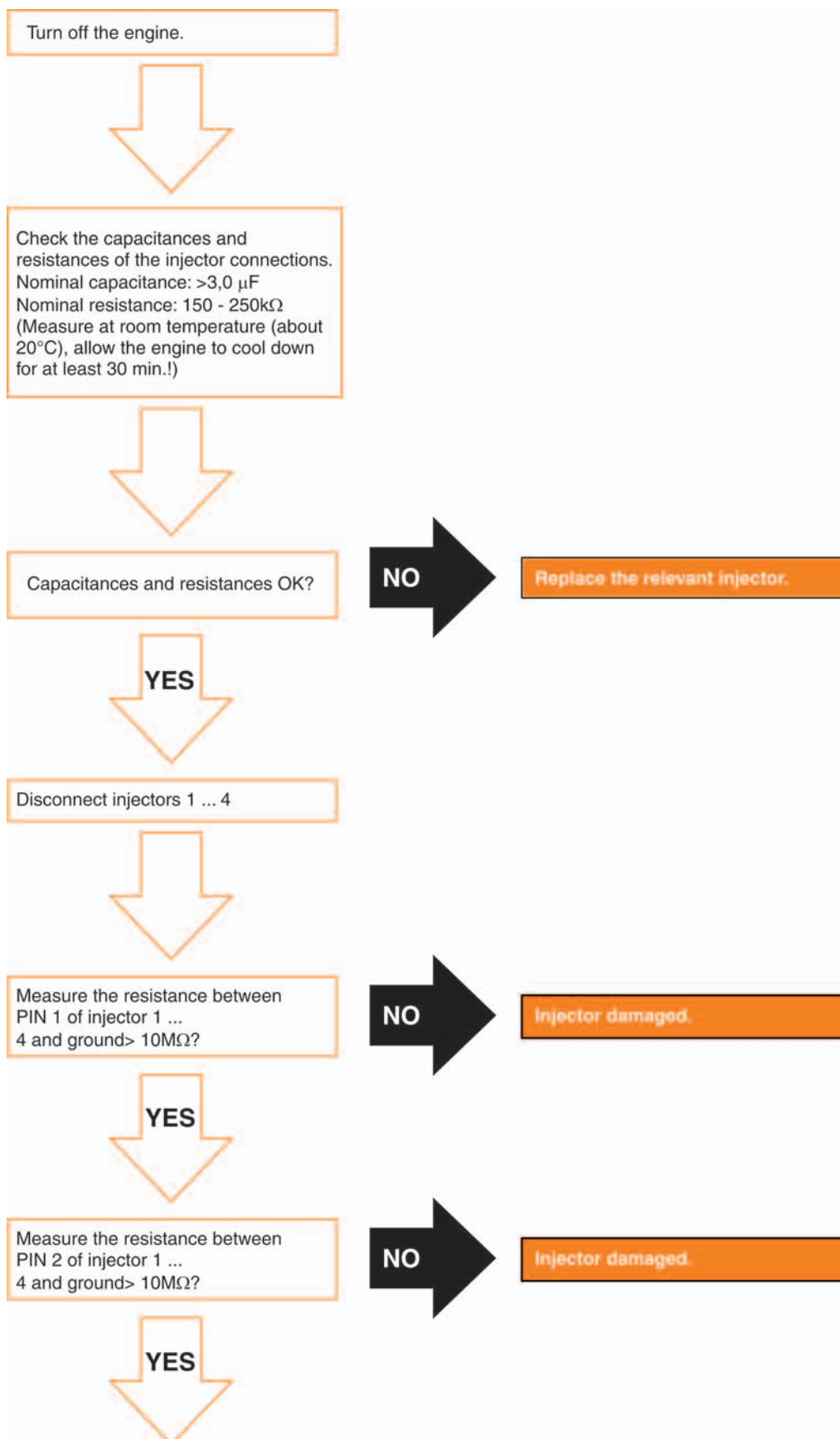
The engine control unit may become very hot in operation. A high temperature at the housing does not indicate that the engine control unit is damaged.

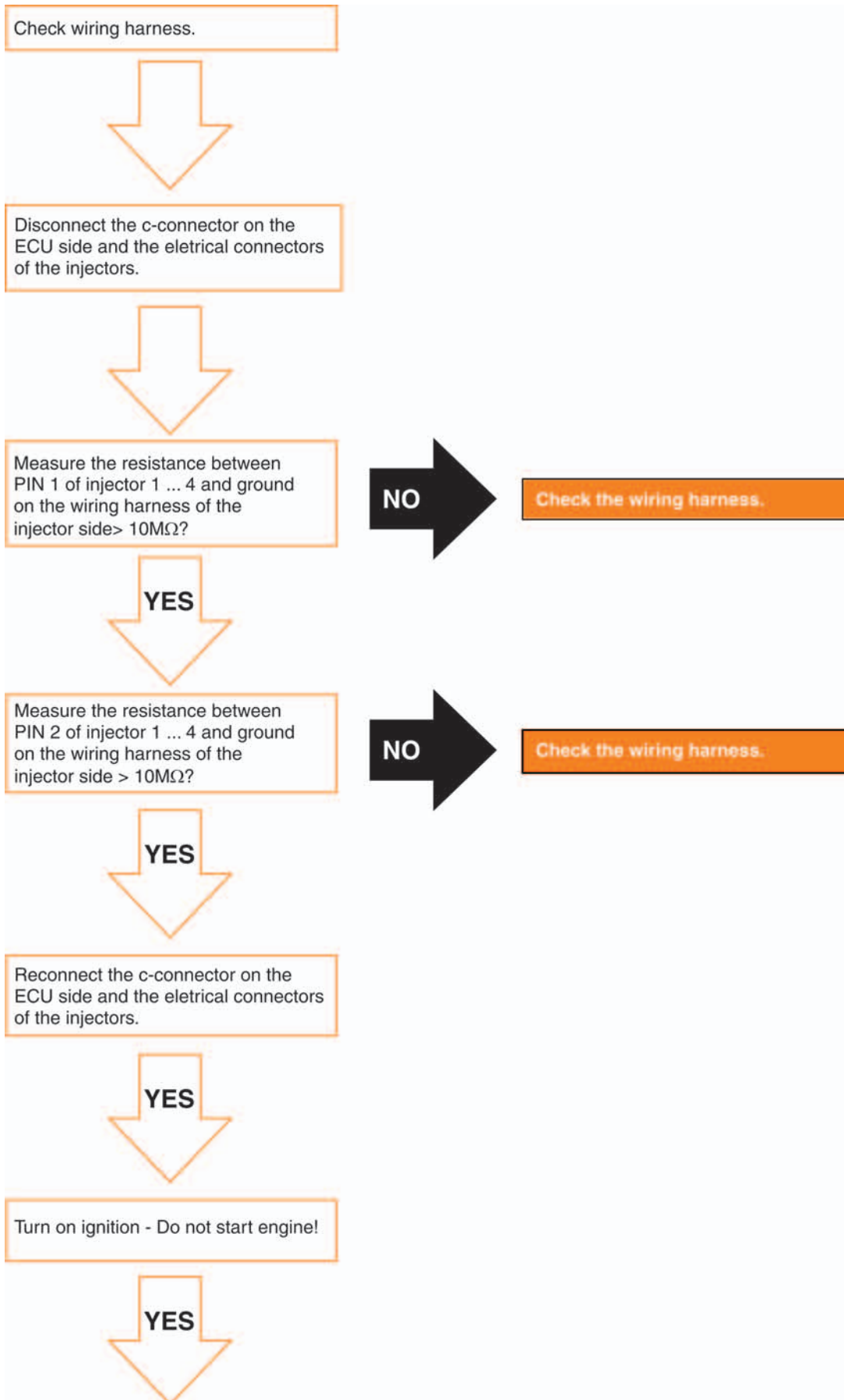
**In the event of the following fault code entries, the engine control unit has to be replaced:**

Fault code	Cause
P0200	Injector power stage fault in the engine control unit. <b>Note:</b> The fault may also be entered in the case of a faulty wire connection. - If so, check the wire connections (see below)! - Otherwise, if the wire connections are checked and OK, replace the ECU.
PE051	Internal software error.
P0606	Monitoring fault Injector power stage fault in the engine control unit.
P0642	5V voltage supply 1 too low. <b>Note:</b> The fault may also be entered in the case of a faulty wire connection.
P0643	5V voltage supply 1 too high. <b>Note:</b> The fault may also be entered in the case of a faulty wire connection.
P0652	5V voltage supply 2 too low. <b>Note:</b> Note: The fault may also be entered in the case of a faulty wire connection.
P0653	5V voltage supply 2 too high. <b>Note:</b> The fault may also be entered in the case of a faulty wire connection.
P1612	Voltage of the power stage too low.
P1613	Voltage of the power stage too high.

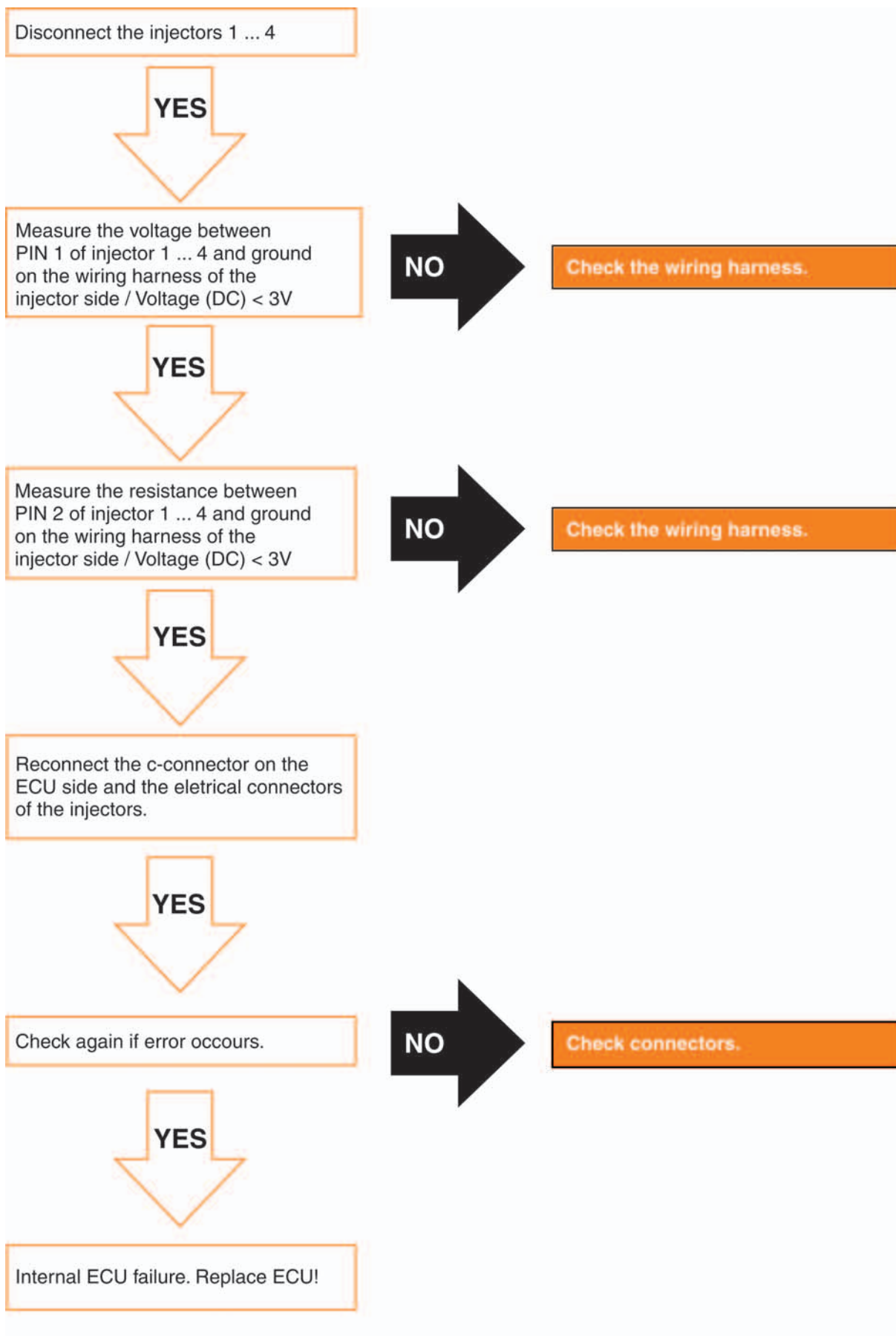
<b>Fault code</b>	<b>Cause</b>
P1639	Faulty or incorrect variant coding.
P0107	Defective atmospheric pressure sensor: Short circuit to -
P0108	Defective atmospheric pressure sensor: Short circuit to -
P0109	Defective atmospheric pressure sensor: Gradient fault

Check steps to the event of the code P0200:











## ***Technical Specifications***

<b>Cylinder block</b>	<b>Millimeters</b>	
Total height, between finished surfaces	348.382	348.562
Cylinder bore, after burnishing	96.00	96.013
Roughness, after burnishing (CLA)	0.45µm	0.7µm
Burnishing angle	38°	40°
Main bearing journals diameter	67.704	67.721
<b>Main bearing journals</b>	<b>Millimeters</b>	
Outer diameter	67.704	67.721
Inner diameter, after assembly	63.535	63.536
Main bearings journals width # 1, 2, 3, and 4	24.25	24.5
Main bearing journal width # 5 (rear)	34.81	35.06
Bearing shell thickness	2.083	2.093
Clearance between shell and main journal (diametrical)	0.030	0.080
<b>Camshaft sprocket</b>	<b>Specifications</b>	
Number of teeth	z = 22	
Sprocket housing diameter	38.036	38.076
<b>Camshaft pulley</b>	<b>Millimeters</b>	
Oil seal diameter	60.34	60.46

<b>Crankshaft</b>	<b>Millimeters</b>	
Main journals diameter - standard	63.471	63.491
Main journal length # 1	31.09	31.85
Main journal length # 2	34.393	34.645
Main journal length # 3	33.275	33.325
Main journal length # 4	34.393	34.645
Main journal length # 5	44.704	44.958
Crankpins diameter - Standard	58.725	58.745
Crankpins width - Standard	33.249	33.401
Main journals / crankpins fillets	3.300	3.700
Main journals / crankpins maximum out-of-roundness	0.007	
Main journals / crankpins roughness (CLA)	0.25 µm	
Fillets roughness (CLA)*	0.8 µm*	
Rear flange diameter	99.495	99.517
Rear flange width	21.122	22.176
Maximum run-out - Main journals # 1 and # 5 supported	0.025	
Axial clearance	0.050	0.150
* = up to 45°; in the remaining direction of the radius in direction to the face, roughness must be 1.6 µm.		
<b>Connecting rod</b>	<b>Millimeters</b>	
Shell housing diameter	62.433	62.446
Bushing housing diameter	36.650	36.675
Distance between centers (shell housing / connecting rod bushing housing)	175.388	175.438
Maximum radial clearance	0.029	
Crankshaft axial clearance	0.150	0.350
<b>Connecting rod shells</b>	<b>Millimeters</b>	
Outer diameter (assembled)	62.433	62.446
Inner diameter, after assembly	60.600	60.619
Thickness	1.827	1.833
Shells width	24.750	25.000
Clearance between shell and main journal (diametrical)	0.025	0.076

<b>Connecting rod bushing</b>		<b>Millimeters</b>	
Outer diameter	36.650	36.675	
Inner diameter after finished	32.020	32.035	
Clearance between pin and bushing	0.020	0.041	
<b>Piston</b>		<b>Millimeters</b>	
Height, in relation to engine block surface	0.580	0.990	
<b>Piston pin</b>		<b>Millimeters</b>	
Diameter	31.994	32.000	
<b>Piston ring</b>		<b>Millimeters</b>	
Side clearance in the 1st groove - Compression	0.103	0.182	
Side clearance in the 2nd groove - Compression	0.050	0.090	
Side clearance in the 3rd groove - Oil Ring	0.030	0.115	
Clearance between piston ring end gap of the 1st ring - Compression	0.300	0.550	
Clearance between piston ring end gap of the 2nd ring - Compression	0.200	0.400	
Clearance between piston ring end gap of the 3rd ring - Oil ring	0.300	0.550	
<b>Camshaft sprocket</b>		<b>Specifications</b>	
Number of teeth	z = 32		
Sprocket hole bore	20.020	20.060	
<b>Camshaft</b>		<b>Millimeters</b>	
Axial clearance	0.085	0.139	
Camshaft bearing diameter	27.939	27.960	
<b>Cylinder head</b>		<b>Millimeters</b>	
Height	125.900	126.100	
Camshaft housing bore diameter	28.000	28.021	
Valve guides hole diameter	12.000	12.018	
Sleeve housing diameter of intake valve seat	33.950	33.975	
Intake valve seat housing depth	7.400	7.500	
Sleeve housing diameter of exhaust valve seat	30.950	30.975	
Exhaust valve seat housing depth	7.400	7.500	

<b>Nozzle washer</b>	<b>Millimeters</b>	
Standard thickness	1.850	2.100
Service washer thickness (for machined cylinder head)	2.100	2.350
<b>Intake valve seat</b>	<b>Millimeters</b>	
Outer diameter	34.043	34.059
<b>Exhaust valve seat</b>	<b>Millimeters</b>	
Outer diameter	31.043	31.059
<b>Intake valve guide</b>	<b>Millimeters</b>	
Inner diameter after assembly	5.975	6.000
Outer diameter	12.050	12.060
<b>Exhaust valve guide</b>	<b>Millimeters</b>	
Inner diameter after assembly	5.975	6.000
Outer diameter	12.050	12.060
<b>Intake valve</b>	<b>Millimeters</b>	
Valve stem diameter	5.936	5.950
Valve-to-guide clearance	0.025	0.064
Valve head diameter	31.900	32.100
Seat surface angle	45° 10' - 45° 26'	
Valve depth, under cylinder head surface: Standard	0.555	0.855
Total length	113.990	114.390
<b>Exhaust valve</b>	<b>Millimeters</b>	
Valve stem diameter	5.923	5.937
Valve-to-guide clearance	0.038	0.077
Valve head diameter	28.900	29.100
Seat surface angle	45° 10' - 45° 26'	
Valve depth, under cylinder head surface: Standard	0.550	0.850
Total length	114.000	114.400

<b>Valve spring</b>		<b>Millimeters</b>	
Spring inner diameter	17.300	17.500	
Free length	50.000		
Minimum length, under load of : - 312 N - 588.5 N	37.600		
	28.600		
<b>Rocker arm</b>		<b>Millimeters</b>	
Housing diameter	20.020	20.350	
Clearance of the shaft in the bushing	0.040	0.076	
<b>Rocker arm shaft</b>		<b>Millimeters</b>	
Diameter	19.959	19.980	
Total length	442.800	443.200	
<b>Distribution housing cover</b>		<b>Millimeters</b>	
Oil seal housing diameter	79.320	79.400	
Oil seal housing diameter	14.800	15.200	
Depth of oil seal from housing cover surface	4.750	5.000	
<b>Lubricating oil filter</b>		<b>Specifications</b>	
Valve opening pressure	2.500 bar	3.000 bar	
<b>Thermostatic valve</b>		<b>Specifications</b>	
Type	Wax capsule		
Opening temperature	86 - 90°C		
Valve minimum lift at maximum opening temperature	9 mm		
Maximum opening temperature	102°C		

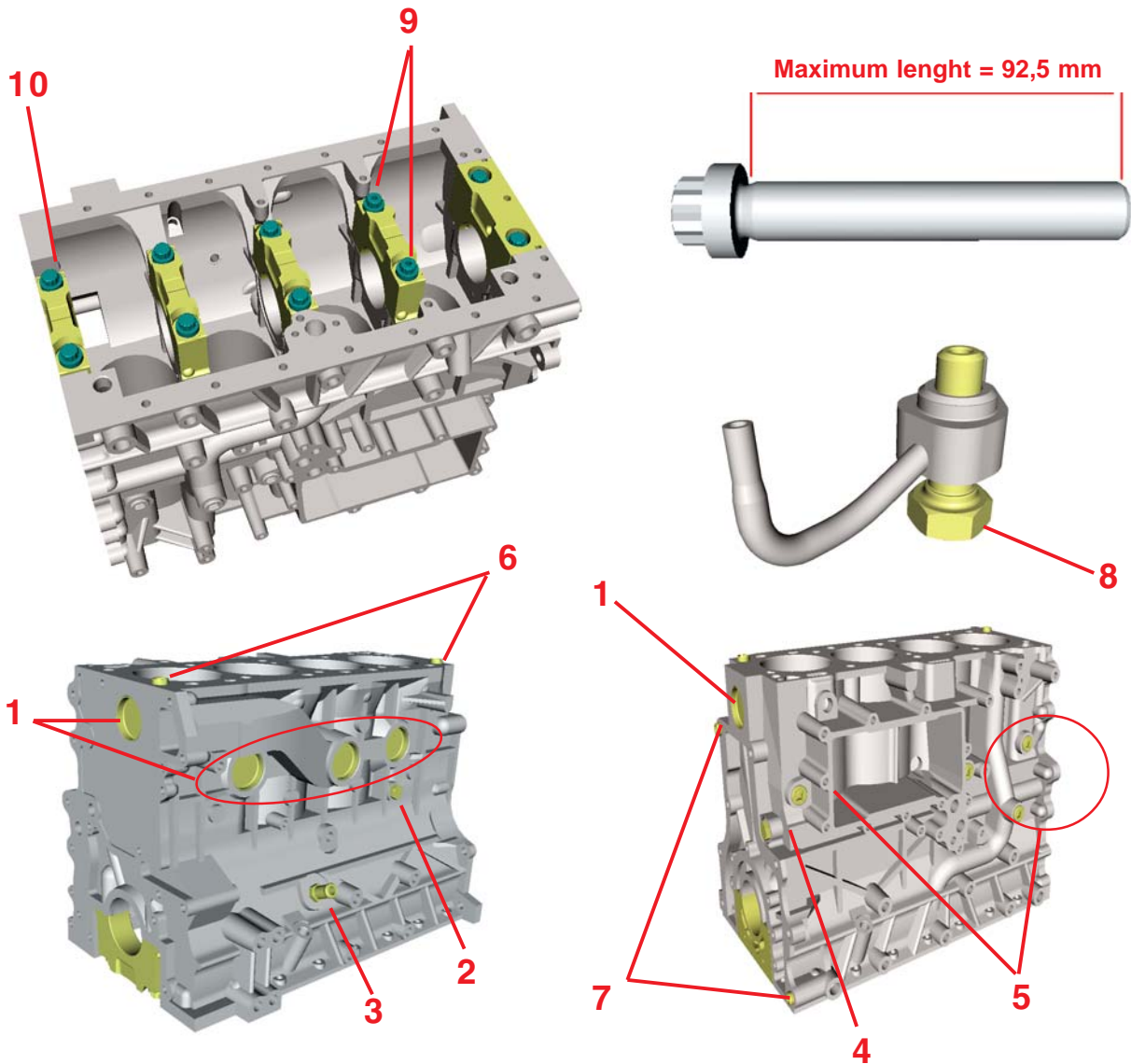


<b>Injection system</b>		<b>Specifications</b>	
Brand		Siemens	
Type		Electronic - Piezo Common Rail	
International fuel pump number		77548	
International fuel injector number		77550	
International common rail number		77549	
International T-MAP sensor number		73191	
International timing sensor number		73192	
International rotation sensor number		73193	
International fuel return temperature sensor number		73190	
International coolant temperature sensor number		73190	
<b>Fuel pump sprocket</b>		<b>Specifications</b>	
Number of inner sprocket teeth (camshaft)		z = 24	
Number of outer sprocket teeth (crankshaft)		z = 33	
<b>Vacuum pump</b>		<b>Specifications</b>	
Brand		Luk	
Type		Vaptec 195	
<b>Hydraulic pump</b>		<b>Specifications</b>	
Brand		Luk	
Type		LF30	
Pressure (Ford Ranger)		80 bar	100 bar
Pressure (Troller)		80 bar	
Outflow		9 cm <sup>3</sup> /revolution	
<b>Turbocharger</b>		<b>Specifications</b>	
Brand		Garrett	
Type		Waste Gate	
Working pressure		1.3 bar	1.5 bar
Waste-Gate valve type		Diaphragm	

<b>Alternator</b>	<b>Specifications</b>
Brand	Bosch®
Output (Ford Ranger)	90 A
Output (Troller)	110 A
Pulley diameter	73 mm
<b>Starter</b>	<b>Specifications</b>
Brand	Prestolite®
Voltage	12 V
Output	2.2 kW
Number of pinion's teeth	Z = 9

## ***Torque Specifications***

Engine block



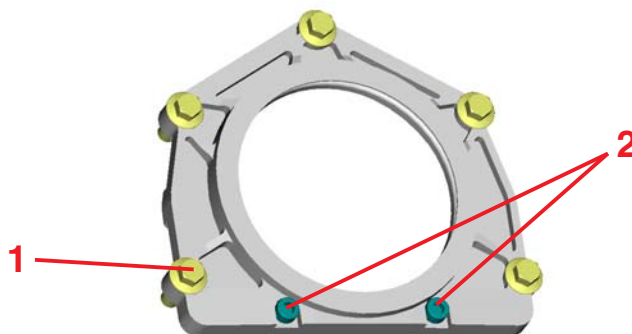
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	5	SEALANT	-----	-----	LOCTITE® 242 or TB1386E
2	1	PLUG	M14 x 2	13 - 17	PRECOTE® 80
3	1	CONNECTION	M16 x 1.5	30 - 35	LOCTITE® 242 or TB1386E
4	1	PLUG	3/8" x 1/2"	36 - 42	PRECOTE® 80
5	4	PLUG	1/2"	36 - 42	-----
6	2	SPRING PIN	-----	-----	-----
7	2	DOWEL PIN	-----	-----	-----
8	4	PISTON COOLER JET SET	M8 x 1.25	14 - 20	-----
9	2	TWELVE SIDED FLANGE BOLT	M14 x 1.5 x 90	60 - 6 + 120° ± 5	-----
10	8	TWELVE SIDED FLANGE BOLT	M14 x 1.5 x 90	60 - 6 + 120° ± 5	-----

Connecting rods



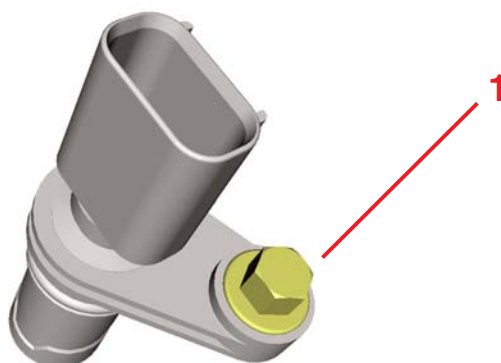
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	2	TWELVE SIDED FLANGE BOLT	M10 x 1.5 x 60	20 - 3 + 130° - 5	Threebond® 2471

Rear crankshaft oil seal retainer



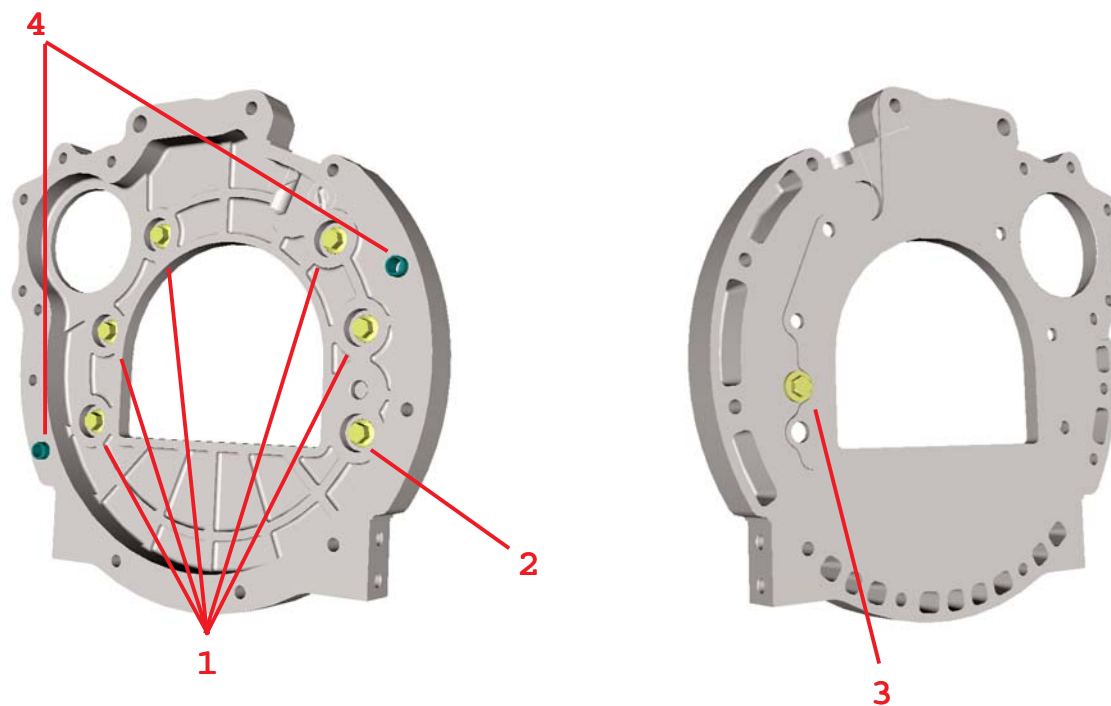
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	5	FLANGE BOLT	M8 X 25	22 - 28	-----
2	2	SOCKET BOLT WITH DRY-LOC 215	M6 X 1.0	14 - 17	

Rotation sensor



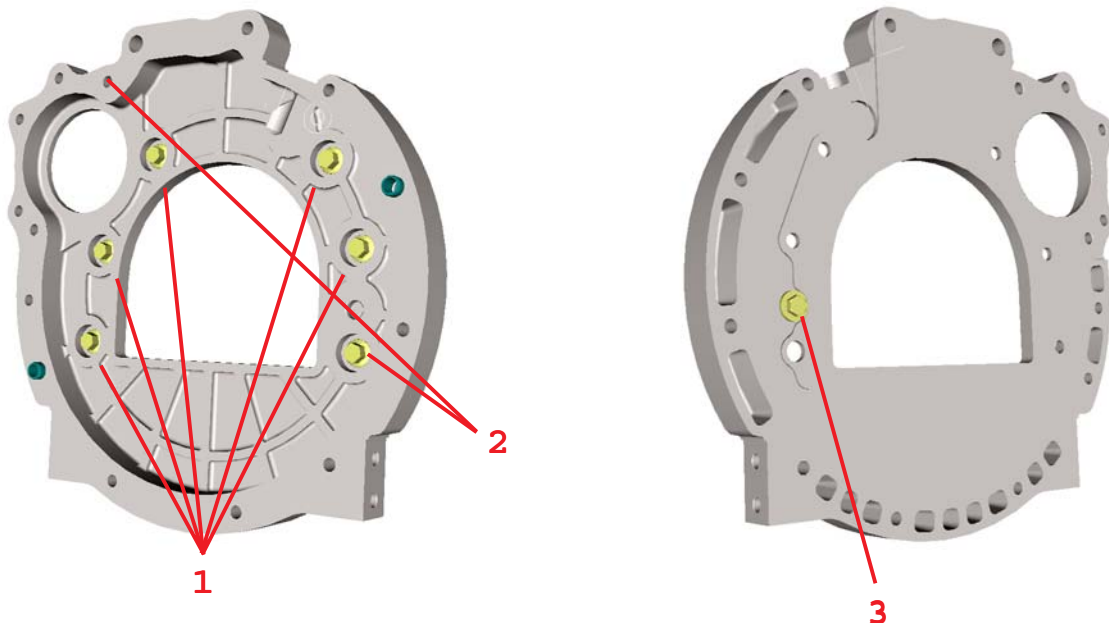
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	1	HEXAGONAL BOLT	M6 x 16	8 -11	-----

Ford ranger flywheel housing



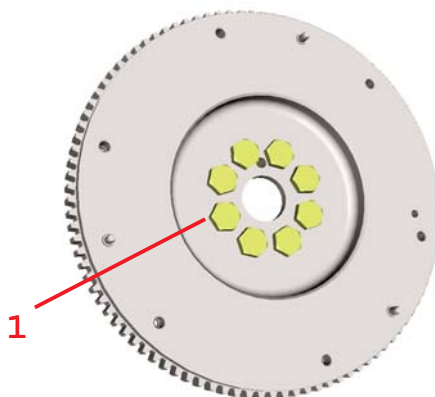
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	5	HEXAGONAL BOLT	M10 x 25	40 - 50	-----
2	1	HEXAGONAL BOLT	M10 x 35	40 - 50	-----
3	1	PLUG	M14	22 - 28	-----
4	2	DOWEL PIN	-----	-----	-----

Troller flywheel housing



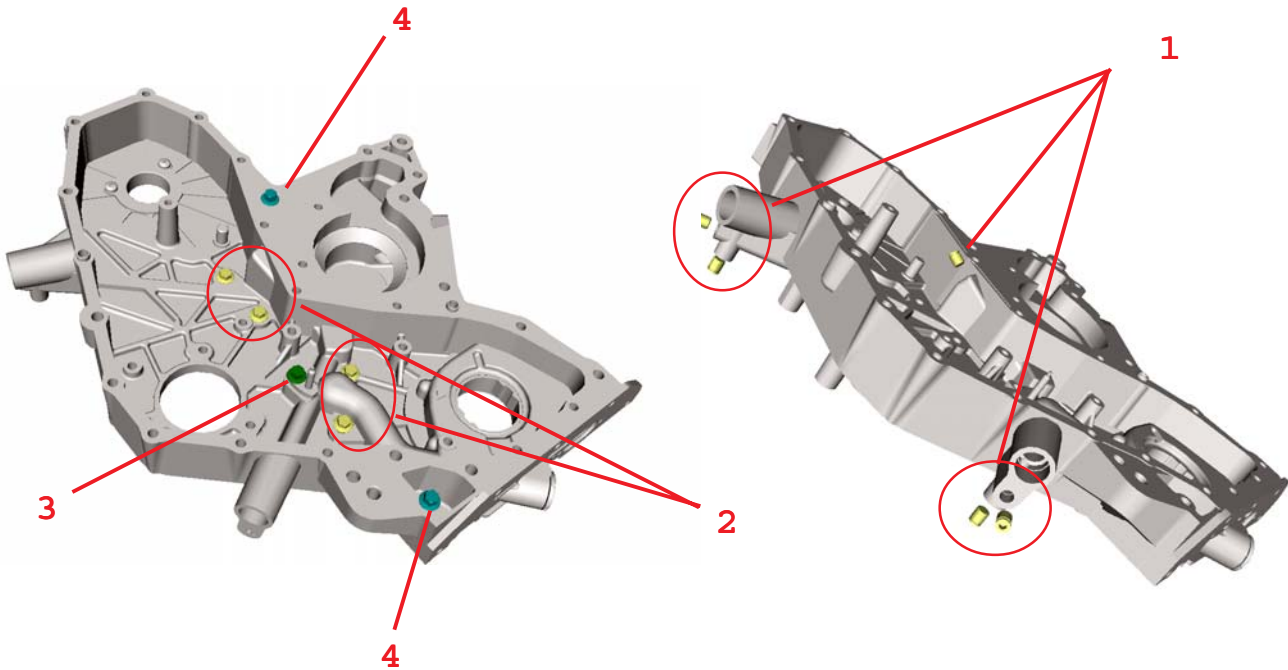
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	5	HEXAGONAL BOLT	M10 x 25	40 - 50	-----
2	1	HEXAGONAL BOLT	M10 x 35	40 - 50	-----
3	1	PLUG	M14	22 - 28	-----

Flywheel



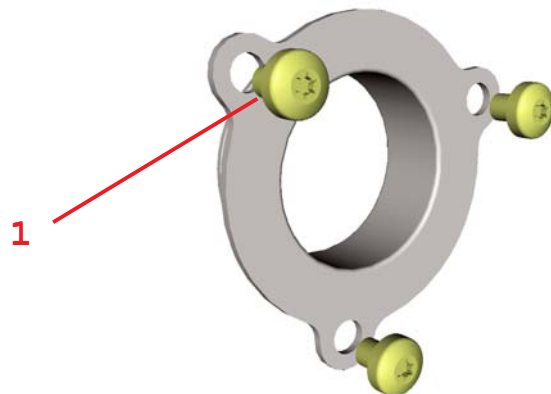
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	8	HEXAGONAL BOLT	M14 x 1.5 x 34	54 - 60 + 60° - 66°	Loctite® 242

Distribution housing



	Qty.	Description	Specification	Torque (Nm)	Sealant
1	5	PLUG	M10 x 1.25	8 -11	LOCTITE® 242 or TB1345T
2	4	HEXAGONAL BOLT	M8 x 25	22 - 28	-----
3	1	HEXAGONAL BOLT	M8 x 45	22 - 28	-----
4	2	HEXAGONAL BOLT	M8 x 75	22 - 28	-----

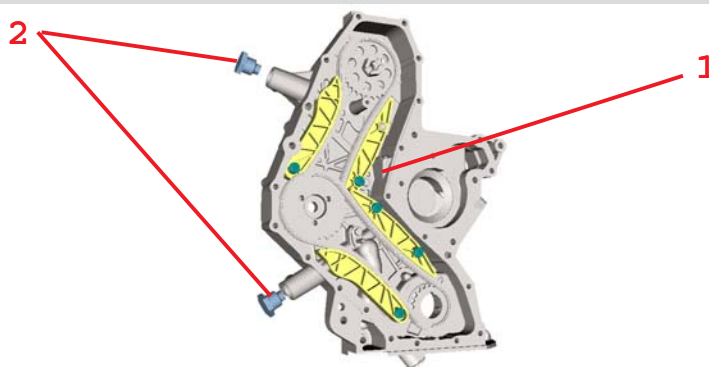
Coupling sleeve



	Qty.	Description	Specification	Torque (Nm)	Sealant
1	3	TORX SCREW WITH DRY-LOC	M6 x 8	5 ±1	Threebond® 2471

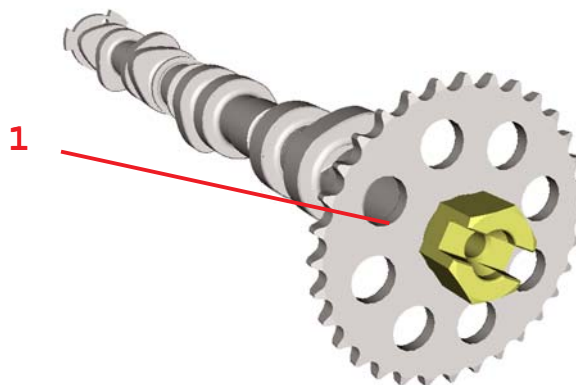


Chain system



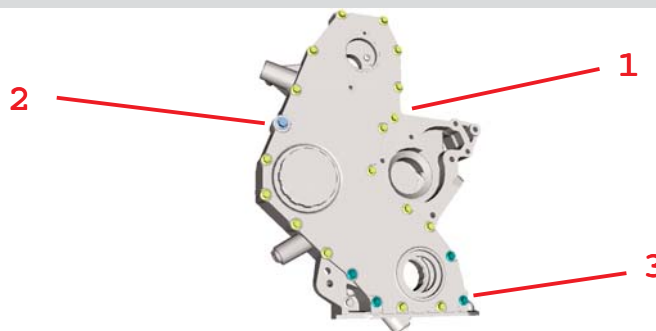
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	5	TORX BOLT	M8 x 1.25	9 – 11	-----
2	2	TENSIONER PLUG	M24 x 1.5	50 - 60	-----

Vacuum pump adapter



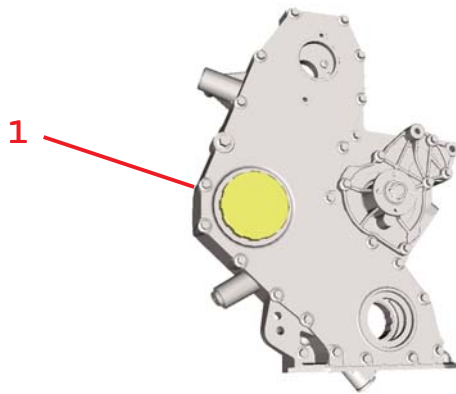
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	1	HEXAGONAL BOLT	M14 x 2 x 22.5	84 - 90	-----

Distribution housing cover



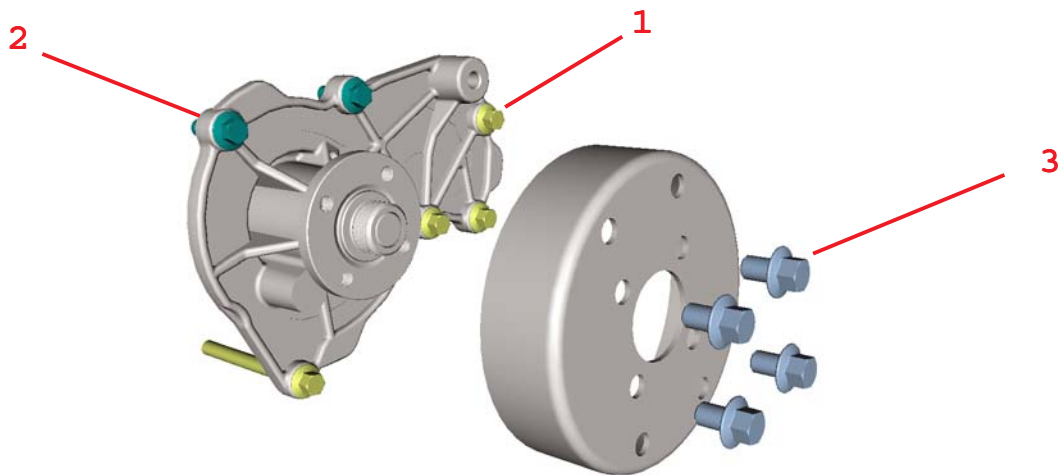
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	16	TORX BOLT	M8 x 20	22 - 28	-----
2	1	TORX BOLT	M10 x 25	22 - 28	-----
3	4	TORX BOLT	M8 x 80	22 - 28	-----

Inspection cap



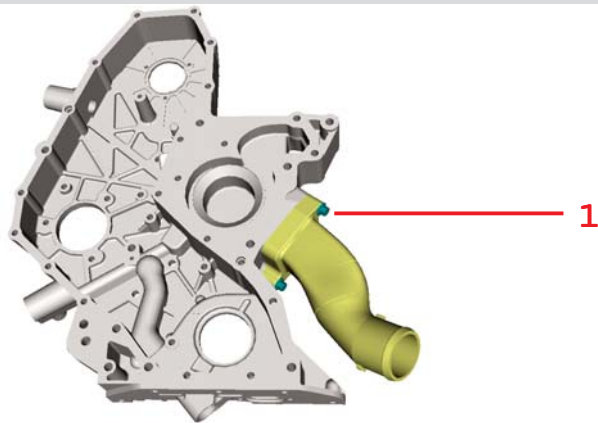
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	1	INSPECTION COVER	-----	LEAN + ¼ TURN	APPLY ENGINE OIL BEFORE ASSEMBLING

Water pump



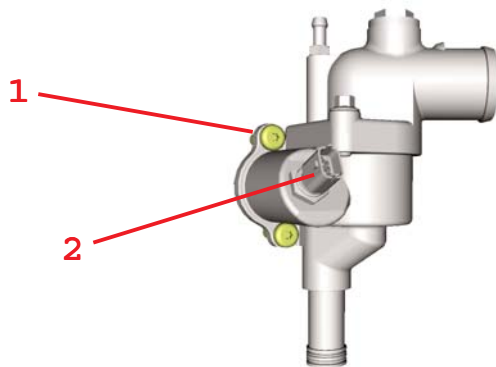
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	4	HEXAGONAL BOLT	M8 x 85	22 - 28	-----
2	2	HEXAGONAL BOLT	M8 x 25	22 - 28	-----
3	4	HEXAGONAL BOLT	M8 x 12	22 - 28	-----

Water inlet tube



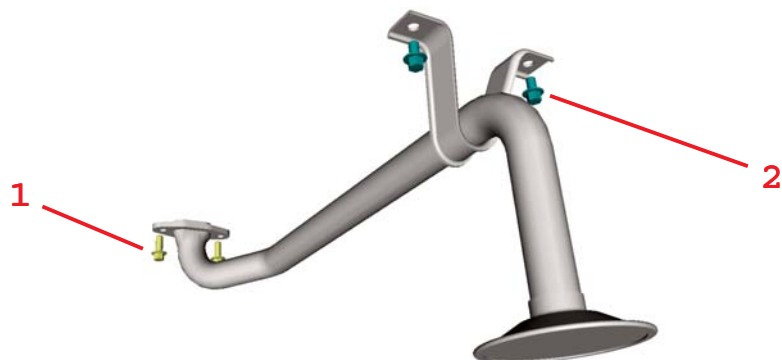
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	2	HEXAGONAL BOLT	M8 x 35	22 - 28	-----

Thermostatic valve housing



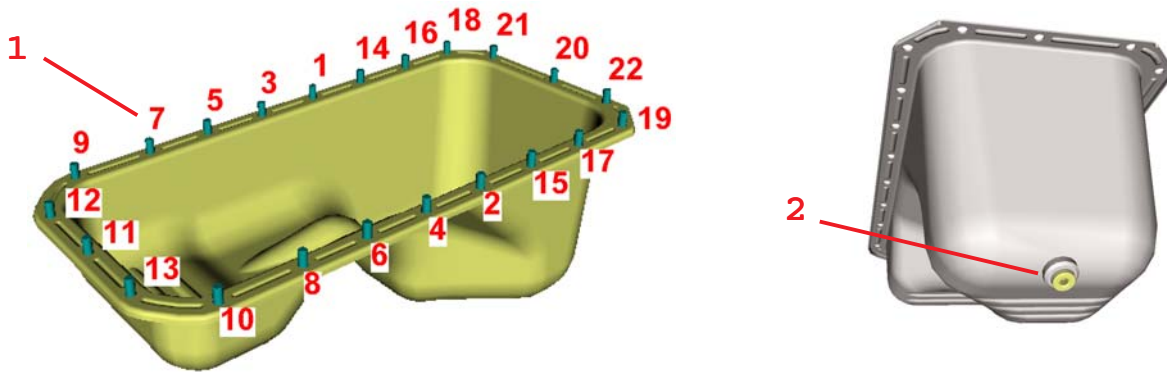
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	2	HEXAGONAL BOLT	M8 x 25	22 - 28	-----
2	1	COOLANT TEMPERATURE SENSOR	M12 x 1.5	16 - 20	-----

Oil suction pipe



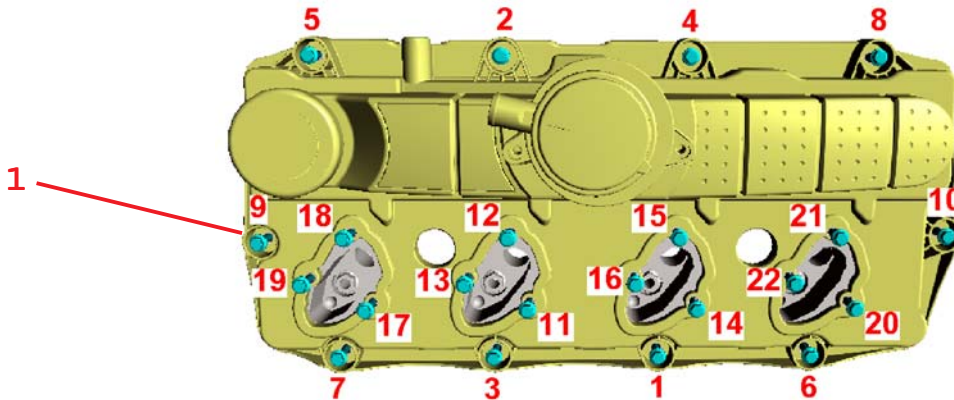
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	2	HEXAGONAL BOLT	M6 x 16	8 - 11	-----
2	2	HEXAGONAL BOLT	M6 x 10	8 - 11	LOCTITE® 242 or TB1345T

Oil pan



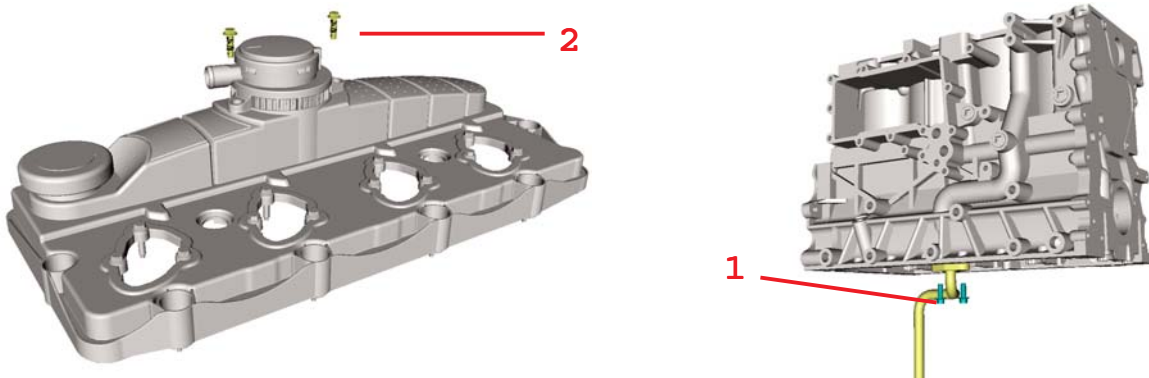
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	22	HEXAGONAL BOLT	M8 x 16	22 - 28	-----
2	1	PLUG	M14 x 1.25	30 - 40	-----

Valve cover



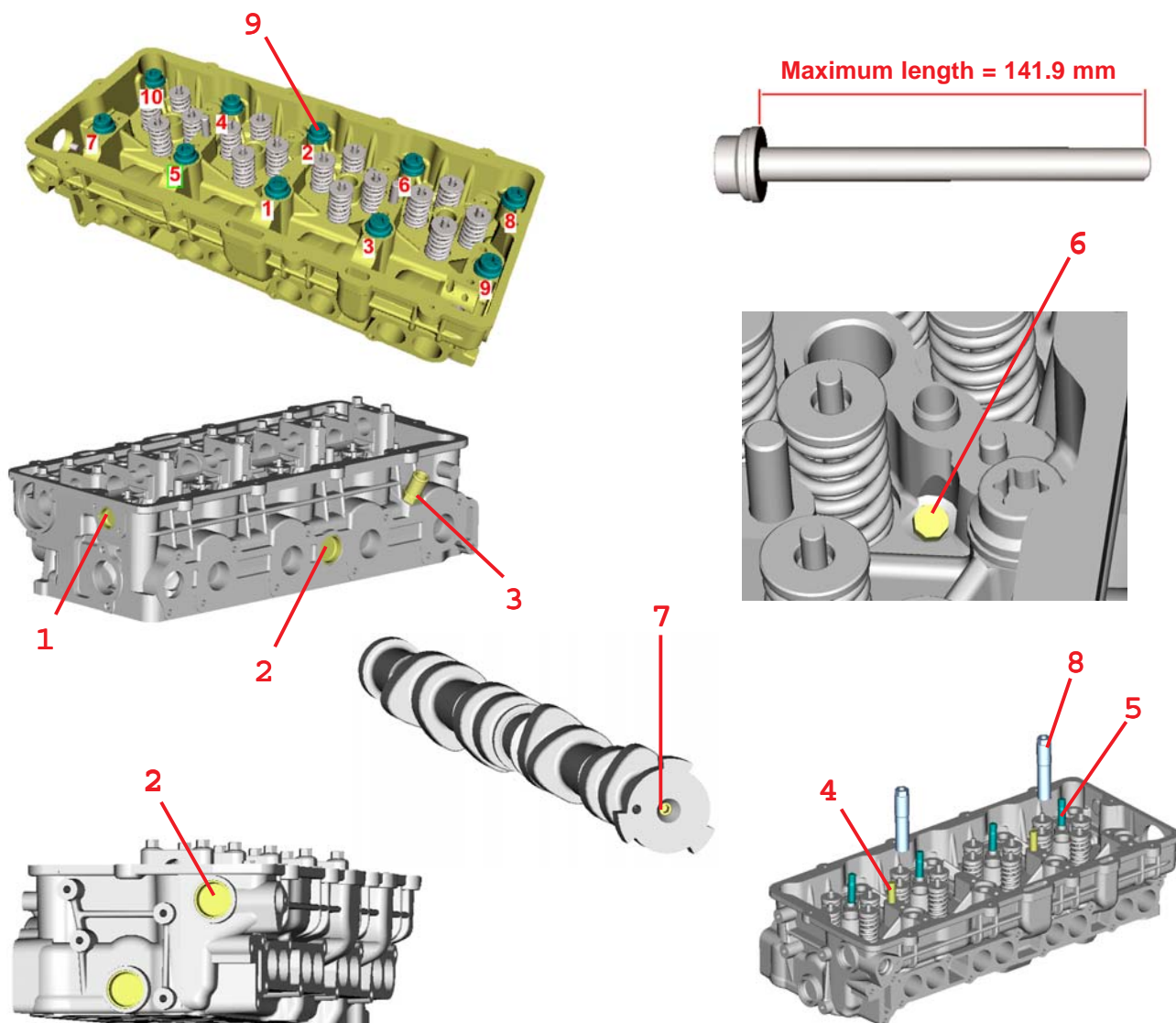
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	22	SPECIAL BOLT	M5	5 - 6	-----

Engine breath



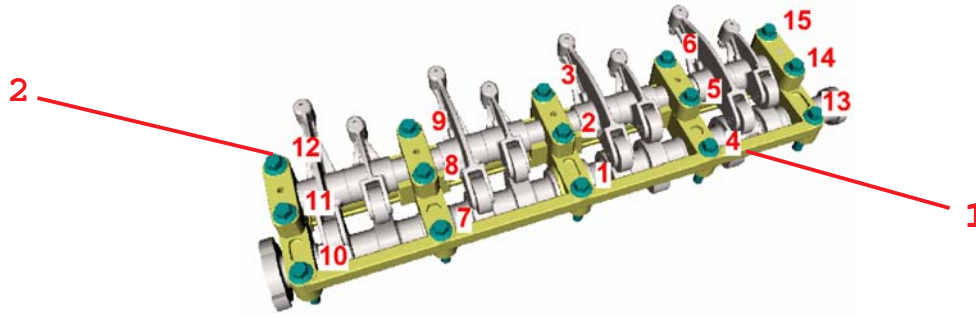
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	2	HEXAGONAL BOLT	M8 x 20	22 - 28	-----
2	2	SPECIAL BOLT	M5	5 - 6	-----

Cylinder head



	Qty.	Description	Specification	Torque (Nm)	Sealant
1	1	WATER OUTLET CONNECTION	3/ago	36 – 42	LOCTITE® 242 or TB1345T
2	3	SEAL	Ø 32 mm	-----	LOCTITE® 242 or TB1386E
3	1	SEAL	Ø 24 mm	-----	LOCTITE® 242 or TB1386E
4	2	STUD BOLT	M10	8 – 11	-----
5	4	STUD BOLT	M8	8 – 11	-----
6	4	GLOW PLUG ADAPTER	-----	8 – 12	-----
7	1	PARALLEL PLUG	M8 x 1.25	FLUSH	LOCTITE® 242 or TB1345T
8	2	COMMON RAIL HOLDER	-----	35 - 40	-----
9	10	TORX BOLT	M12 x 1.5 x 140	SEE PROCEDURE IN CYLINDER HEAD CHAPTER	

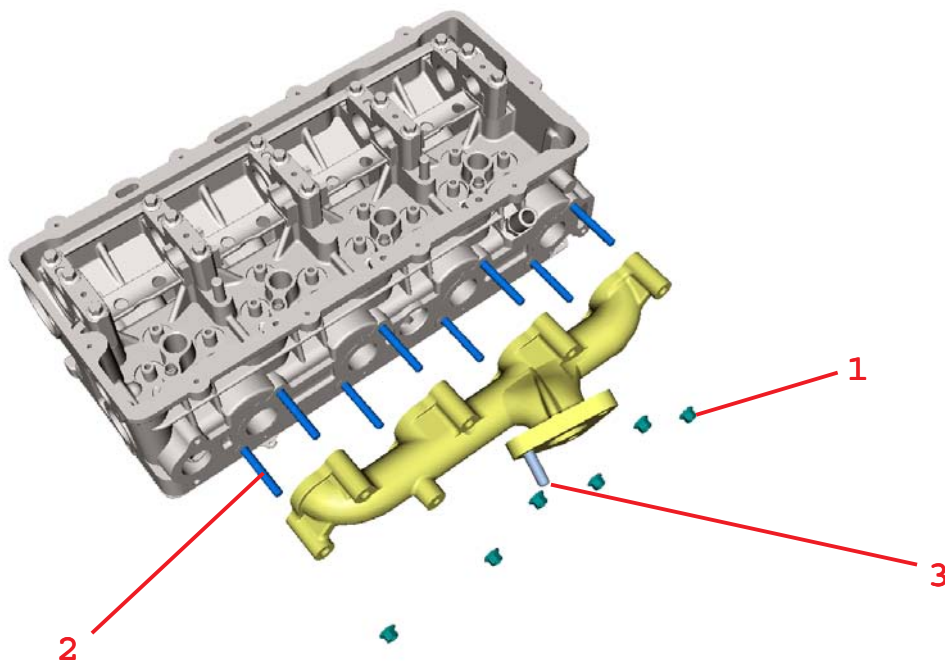
Frame attachment



**CAUTION:** FRAME ASSEMBLING SHOULD BE DONE IN TWO STEPS

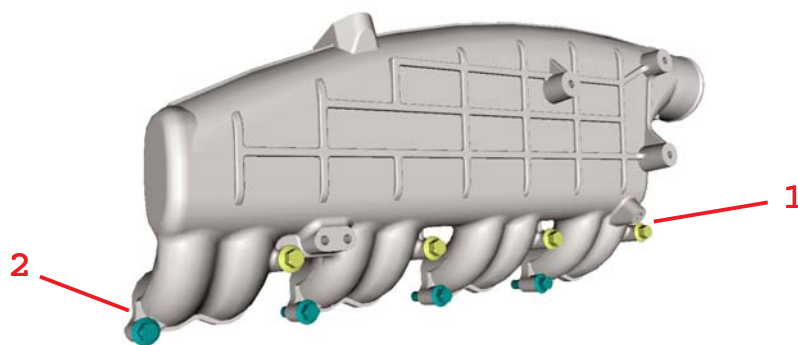
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	5	HEXAGONAL BOLT	M8x1.25 x 45	18 - 22	-----
2	10	HEXAGONAL BOLT	M8x1.25 x 60	18 - 22	-----

Exhaust manifold



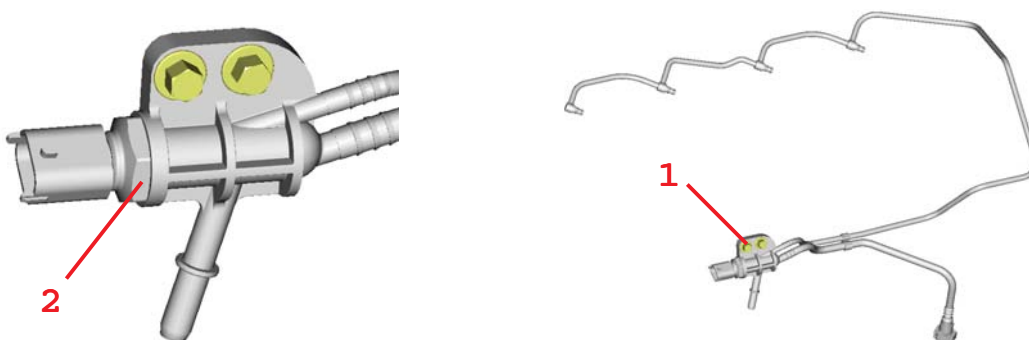
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	6	NUT	M8 x 1.25	22 – 28	-----
2	8	STUD BOLT	M8 x 1.25	08 – 11	-----
3	1	STAINLESS STEEL STUD BOLT	M10 x 1.25	08 – 11	-----

Intake manifold



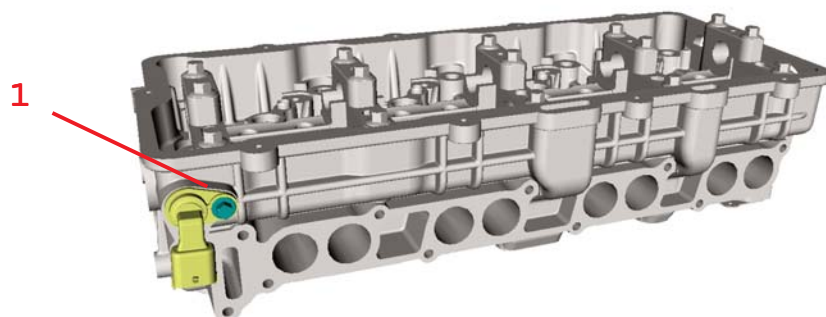
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	4	HEXAGONAL BOLT	M8 x 85	22 - 28	-----
2	4	HEXAGONAL BOLT	M8 x 35	22 - 28	-----

Fuel temperature sensor housing



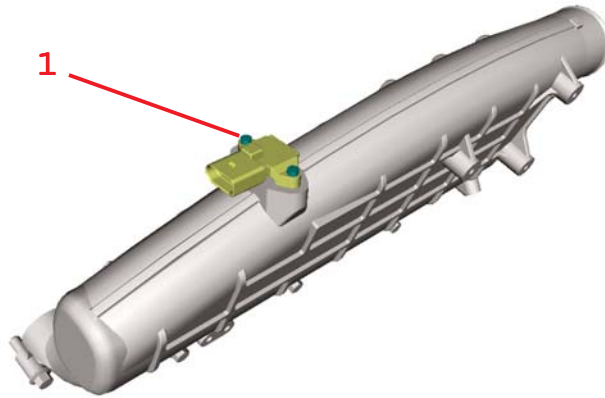
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	2	HEXAGONAL BOLT	M6 x 16	8 - 11	-----
2	1	TEMPERATURE SENSOR	-----	5 - 8	-----

Camshaft timing sensor



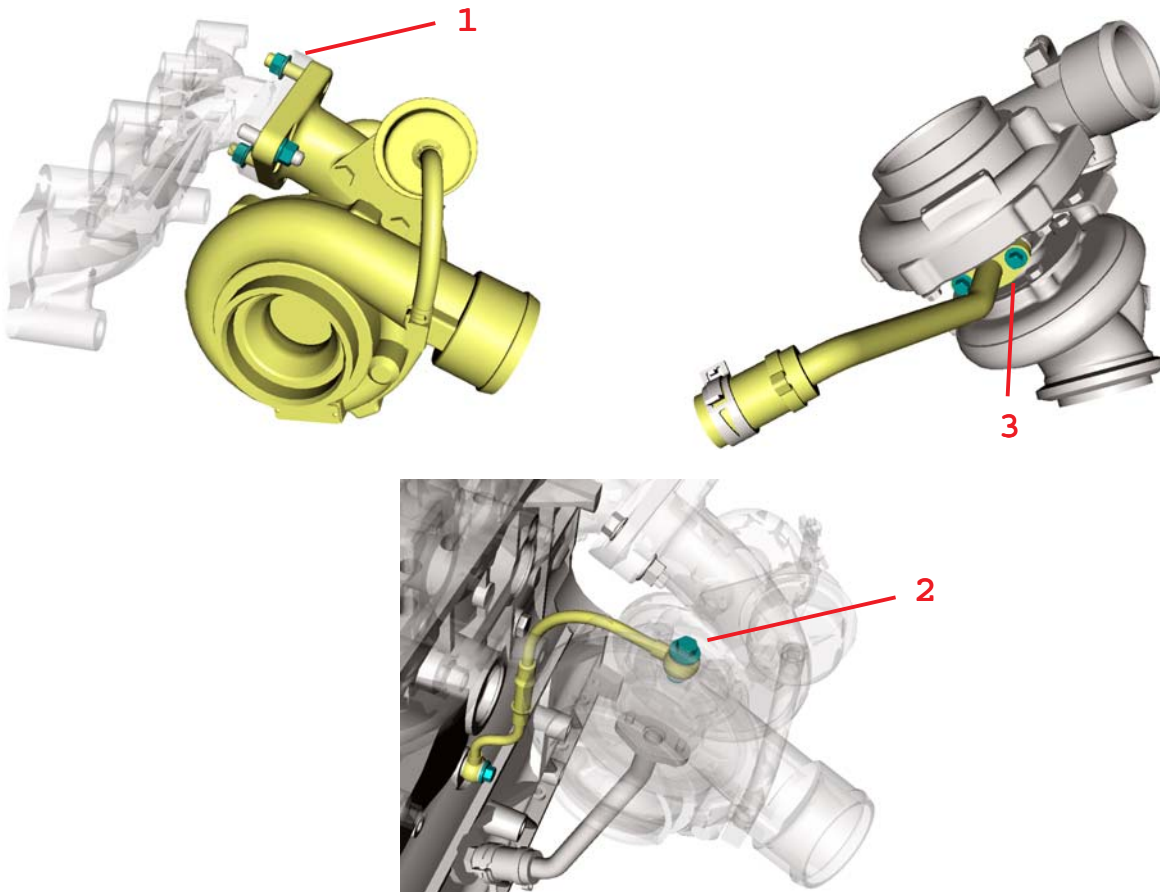
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	1	HEXAGONAL BOLT	M5	8 - 9	-----

T-MAP Sensor



	Qty.	Description	Specification	Torque (Nm)	Sealant
<b>1</b>	2	HEXAGONAL BOLT	M4 x 16	3 - 4	-----

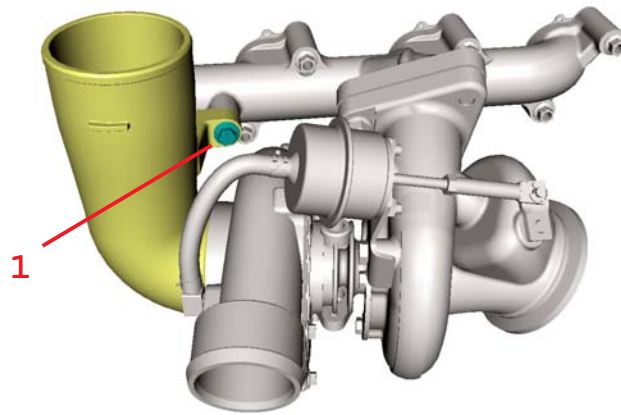
Turbocharger



	Qty.	Description	Specification	Torque (Nm)	Sealant
<b>1</b>	3	SELF-LOCKING	M10 x 1.5	45 – 55	-----
<b>2</b>	2	BANJO BOLT	M12 x 1.5 x 22	22 - 28	-----
<b>3</b>	2	HEXAGONAL BOLT	M6 x 16	8 - 11	-----

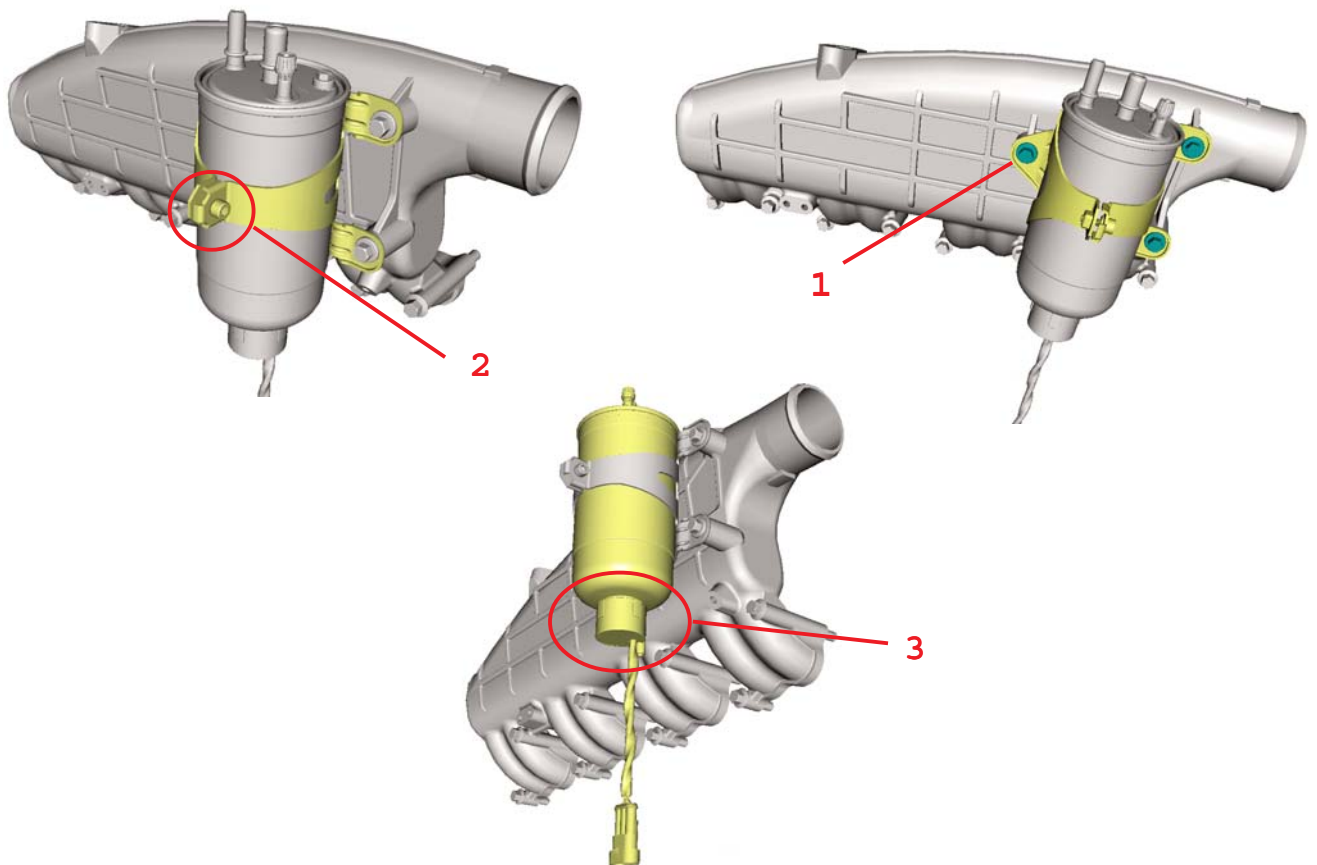


**Air intake duct**



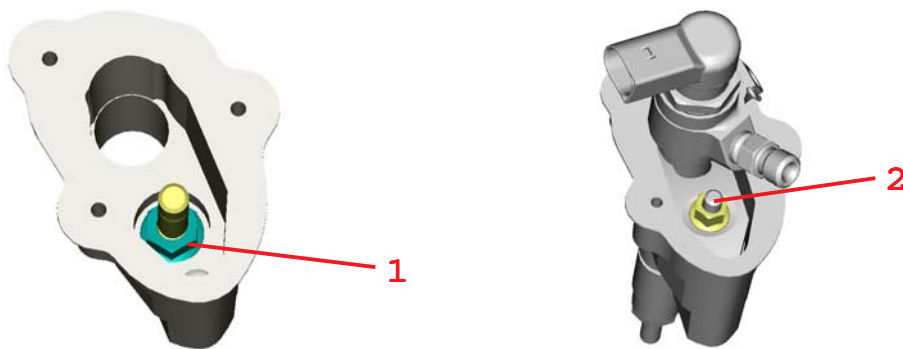
	Qty.	Description	Specification	Torque (Nm)	Sealant
<b>1</b>	1	HEXAGONAL BOLT	M8 x 30	22 - 28	-----

**Fuel filter**



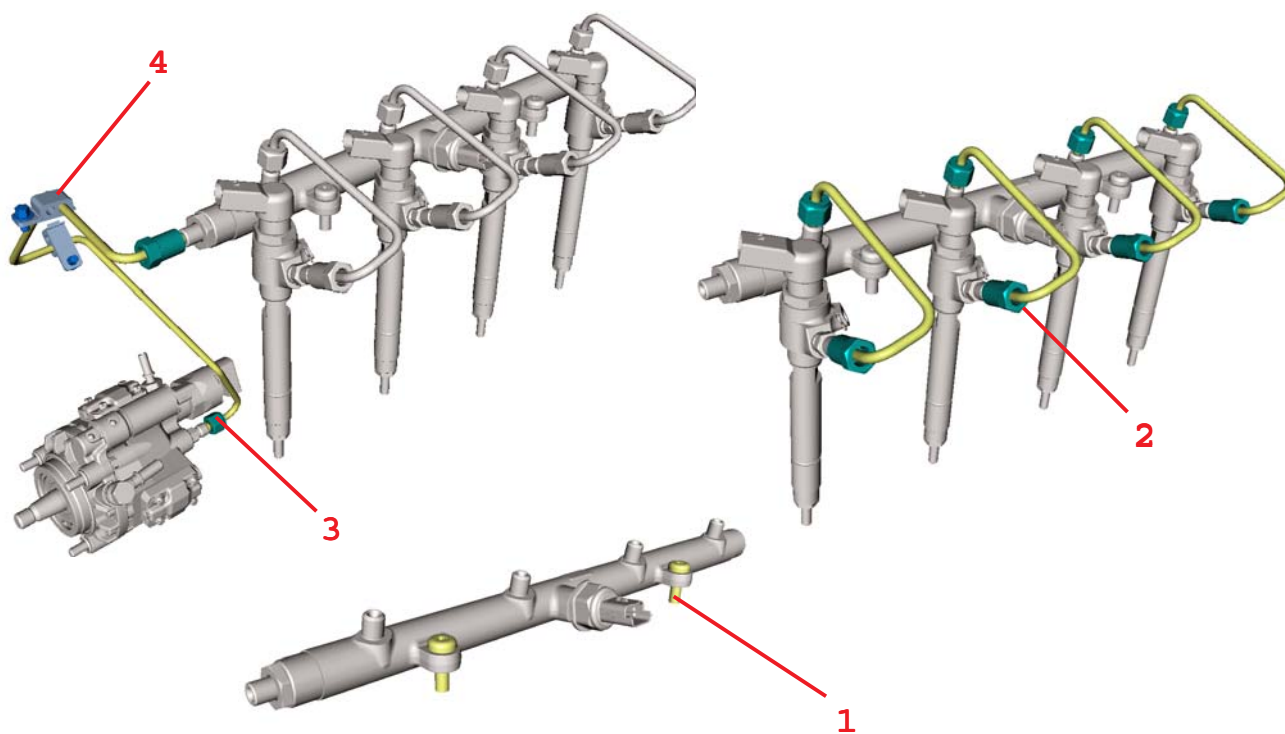
	Qty.	Description	Specification	Torque (Nm)	Sealant
<b>1</b>	3	HEXAGONAL BOLT	M6 x 10	8 - 11	-----
<b>2</b>	1	HEXAGONAL BOLT WITH NUT		4 - 6	
<b>3</b>	1	WATER-IN-FUEL PRESENCE SENSOR		1/4 - 1/2 turn	

Fuel injectors



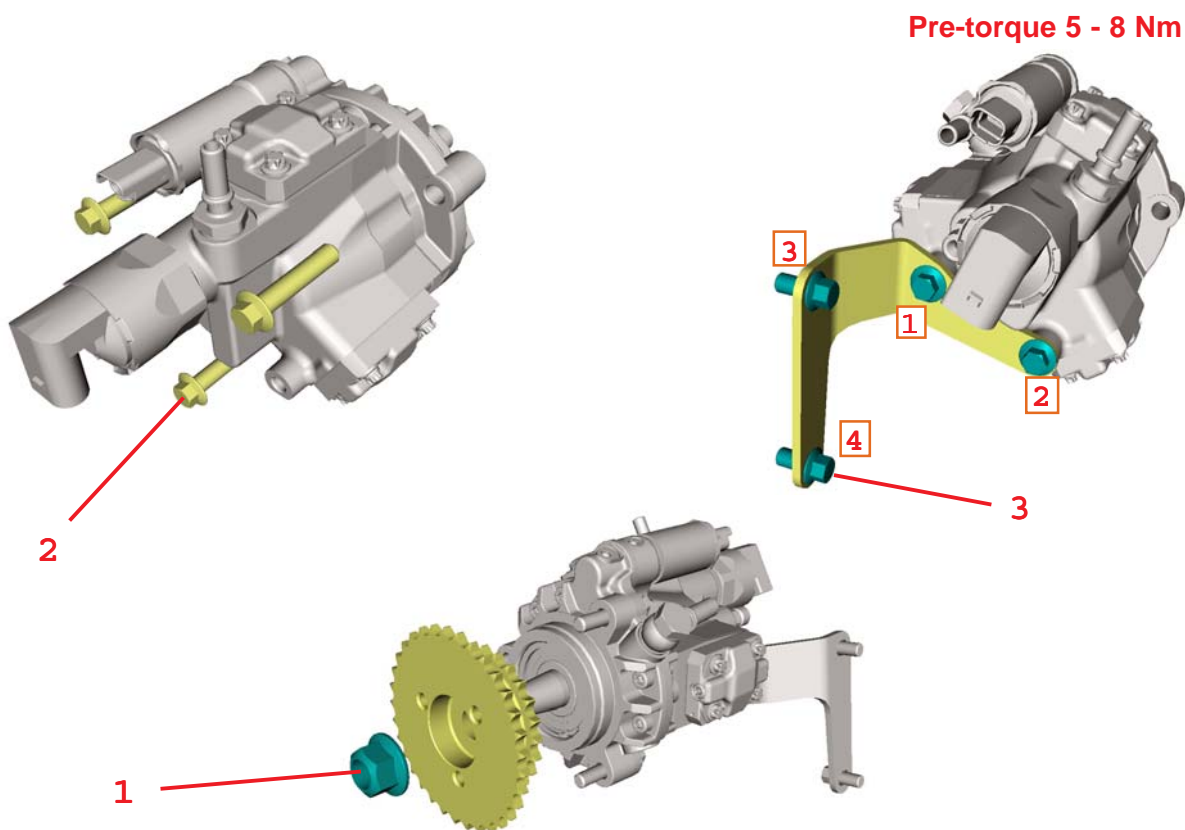
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	4	NUT	M8	22 – 25	-----
2	4	SPECIAL NUT	M8 x 1.25	24 – 26	-----

Fuel tubing



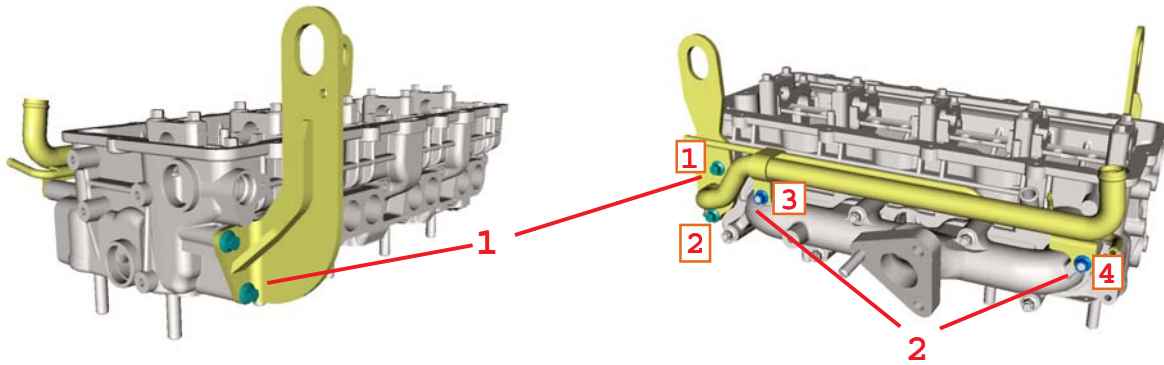
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	2	TORX BOLT	M8 x 25	24 – 26	-----
2	4	HIGH-PRESSURE PIPE	-----	25 – 28	-----
3	1	HIGH-PRESSURE PIPE	-----	25 – 28	-----
4	2	HEXAGONAL BOLT	M6 x 10	8 – 11	-----

High-pressure pump



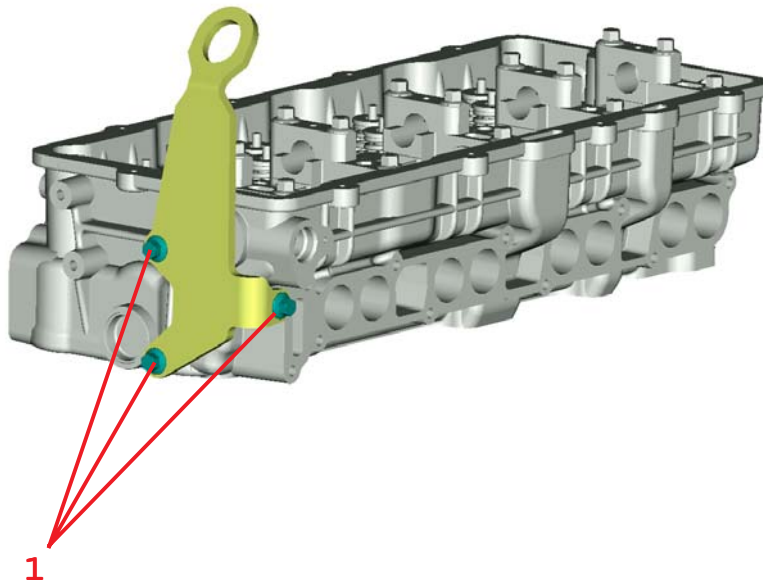
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	1	NUT	M14 x 1.5	45 - 50	-----
2	3	HEXAGONAL BOLT	M8 x 40	22 - 28	LOCTITE® 242 or TB1345T
3	4	HEXAGONAL BOLT	M8 x 16	22 - 28	-----

Lifting eye (Ford Ranger Application)



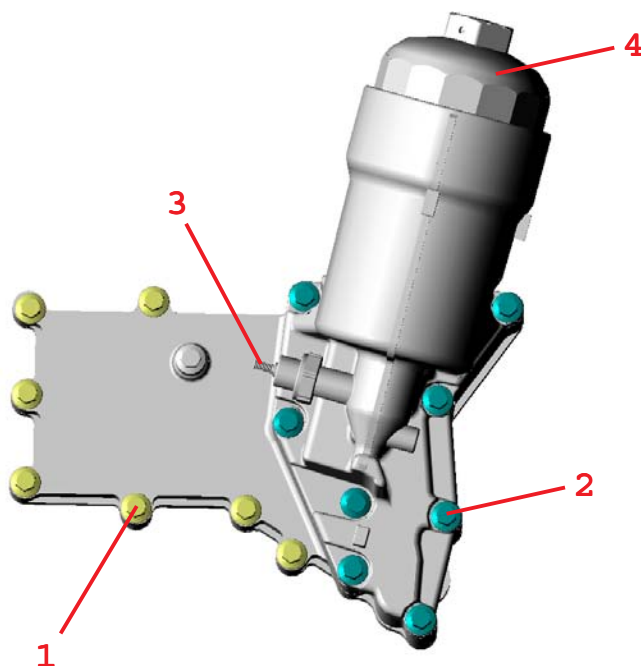
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	4	HEXAGONAL BOLT	M8 x 20	22 - 28	-----
2	2	NUT	M8 x 1.25	22 - 28	-----

Lifting eye (Troller Application)



	Qty.	Description	Specification	Torque (Nm)	Sealant
1	3	HEXAGONAL BOLT	M8 x 20	20 - 28	-----

Oil module / oil filter



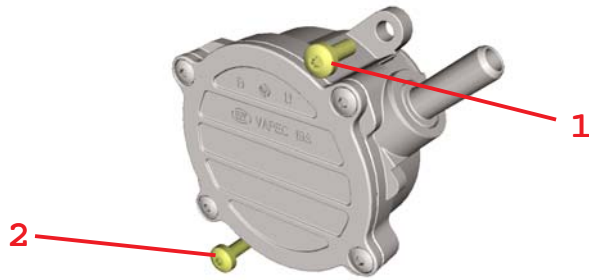
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	7	HEXAGONAL BOLT	M8 x 40	22 – 28	-----
2	7	HEXAGONAL BOLT	M8 x 75	22 –28	-----
3	1	SENSOR	-----	9 – 13	TB1134B or LOCTITE® 567 a 570
4	1	OIL FILTER CAP	-----	22.5 – 27.5	-----

Crankshaft pulley



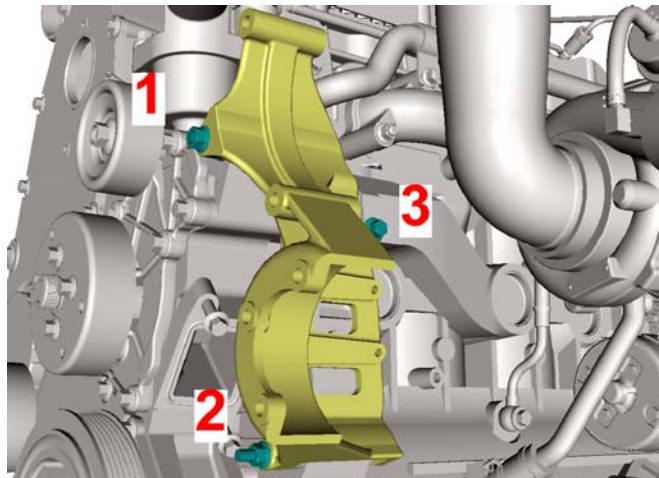
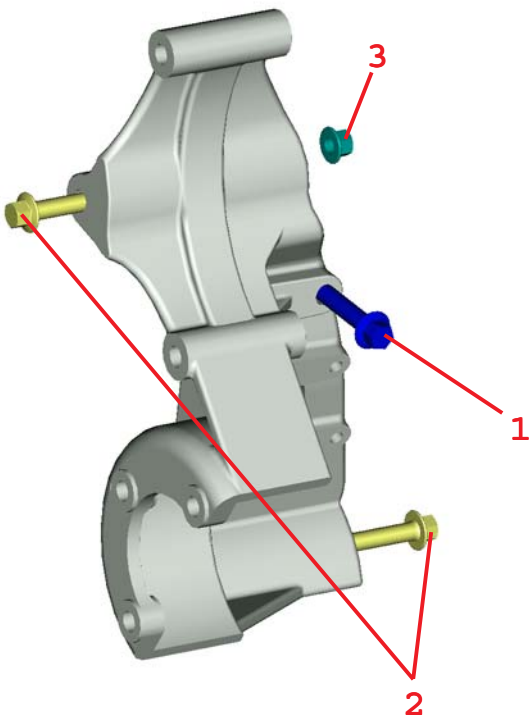
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	1	HEXAGONAL FLANGE BOLT	M20 x 1.5 x 54	400 - 680	-----

Vacuum pump



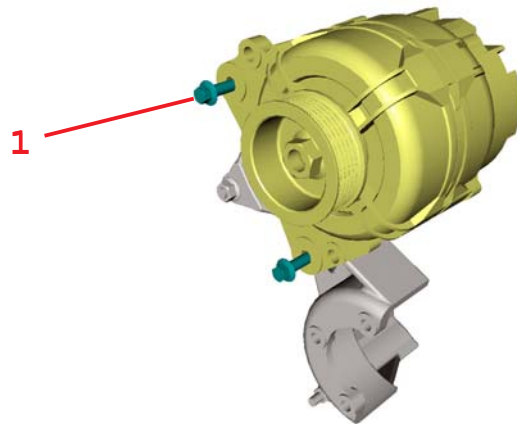
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	1	HEXAGONAL BOLT	M6 x 16	8 - 11	-----
2	1	HEXAGONAL BOLT	M6 x 25	8 - 11	-----

Alternator and hydraulic pump holder



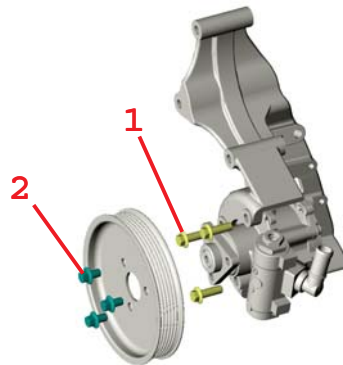
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	1	HEXAGONAL BOLT	M8 x 45	22 - 28	-----
2	2	HEXAGONAL BOLT	M8 x 100	22 - 28	-----
3	1	NUT	M8	22 - 28	-----

**Alternator**



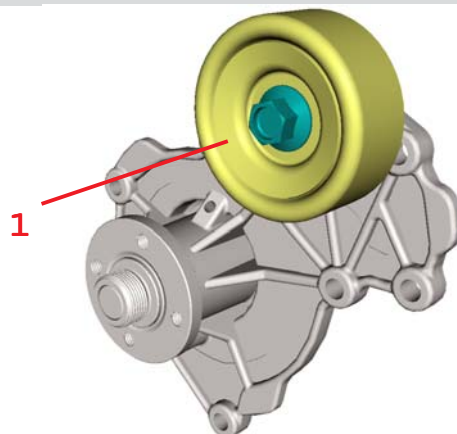
	Qty.	Description	Specification	Torque (Nm)	Sealant
<b>1</b>	2	HEXAGONAL BOLT	M8 x 85	22 - 28	-----

**Hydraulic pump**



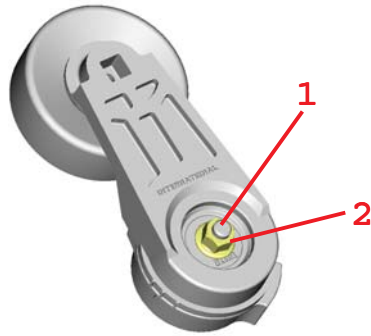
	Qty.	Description	Specification	Torque (Nm)	Sealant
<b>1</b>	3	HEXAGONAL BOLT	M8 x 25	22 - 28	-----
<b>2</b>	3	HEXAGONAL BOLT	M8 x 12	22 - 28	-----

**Idler pulley**



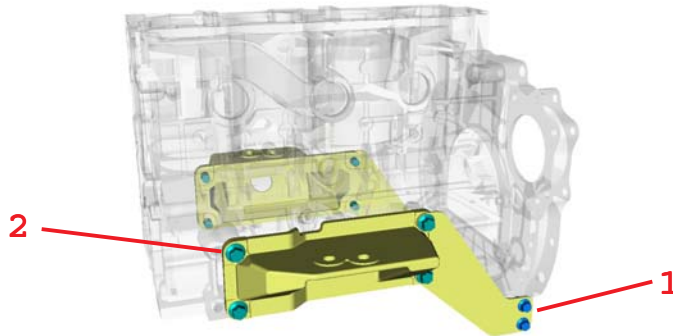
	Qty.	Description	Specification	Torque (Nm)	Sealant
<b>1</b>	1	IDLER PULLEY	-----	40 - 50	-----

**Tensioner**



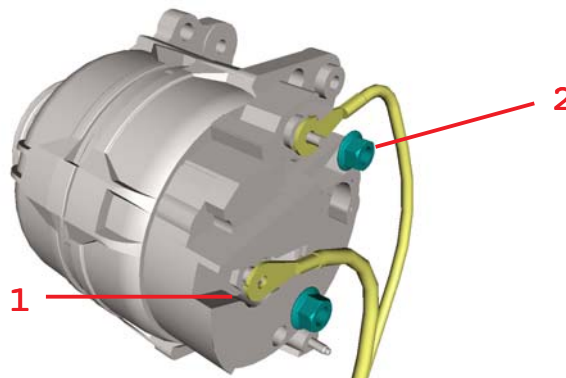
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	1	STUD BOLT	M10 x 75	16 - 20	-----
2	1	NUT	M10	40 - 50	-----

**Mounts**



	Qty.	Description	Specification	Torque (Nm)	Sealant
1	8	HEXAGONAL BOLT	M12 X 30	80 - 90	-----
2	4	HEXAGONAL BOLT	M10 x 20	40 - 50	-----

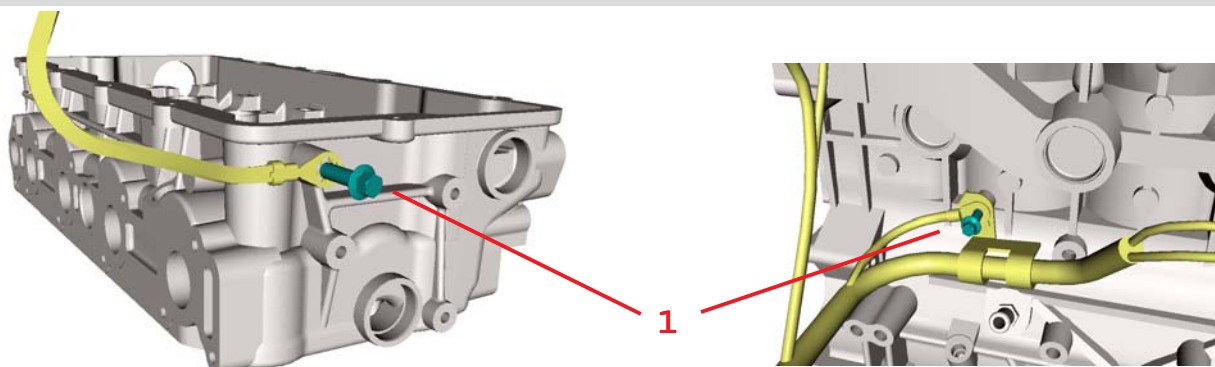
**Alternator wiring harness**



	Qty.	Description	Specification	Torque (Nm)	Sealant
1	1	NUT	M8	13 - 15	-----
2	2	NUT	M5	4 - 5	-----

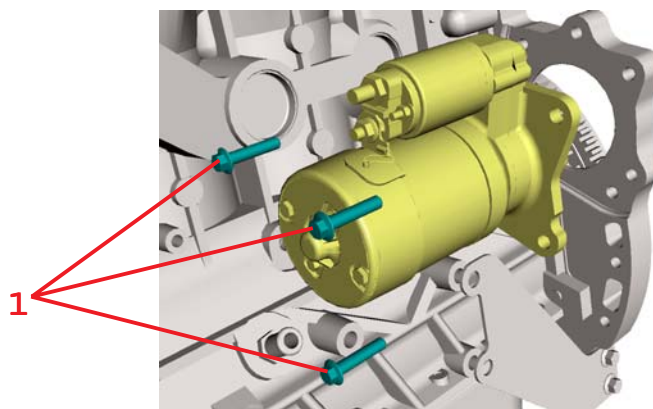


Wiring harness holder to the engine block



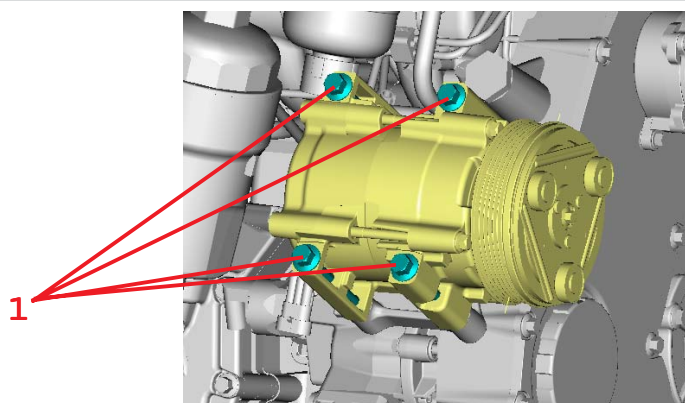
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	2	HEXAGONAL BOLT	M8 x 16	22 - 28	-----

Starter



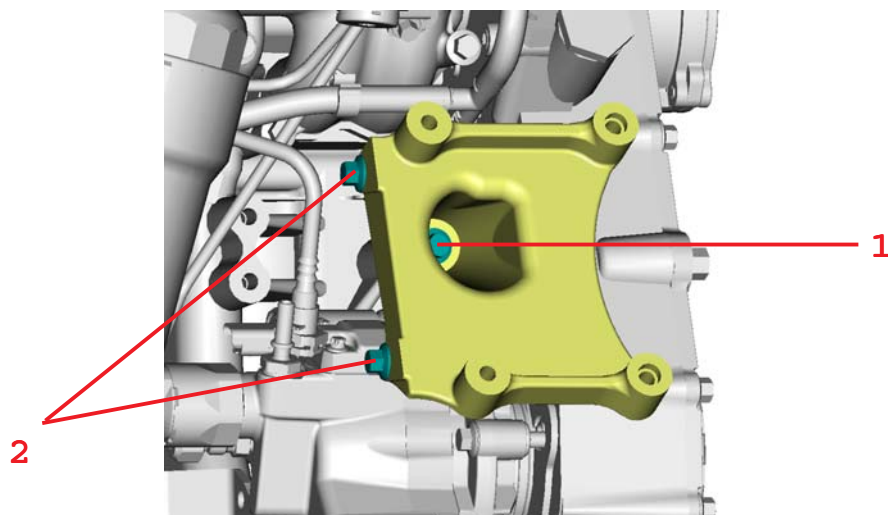
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	3	HEXAGONAL BOLT	M10 x 30	40 - 50	-----

Air conditioning compressor



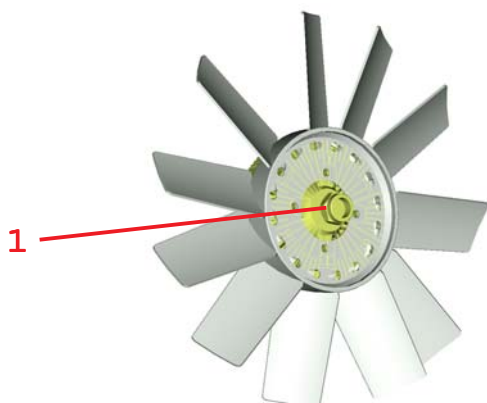
	Qty.	Description	Specification	Torque (Nm)	Sealant
1	4	HEXAGONAL BOLT	M8 x 100	22 - 28	-----

Air conditioning compressor holder




	Qty.	Description	Specification	Torque (Nm)	Sealant
<b>1</b>	1	HEXAGONAL BOLT	M8 x 70	22 - 28	-----
<b>2</b>	2	HEXAGONAL BOLT	M8 x 55	22 - 28	-----

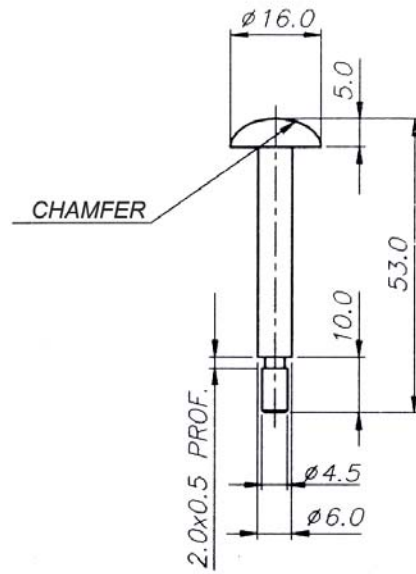
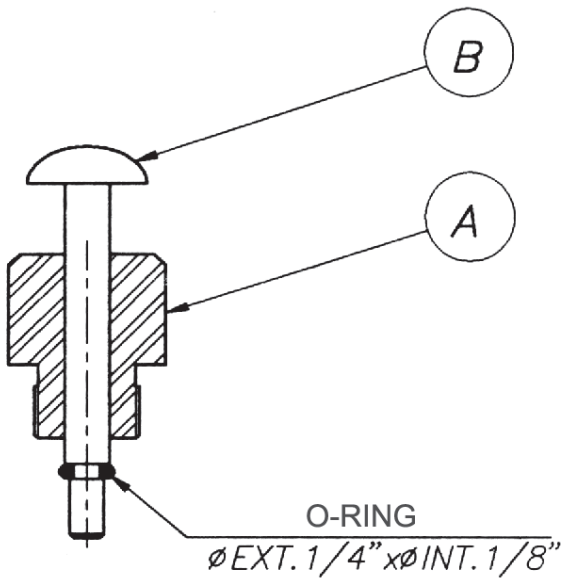
Fan assembly



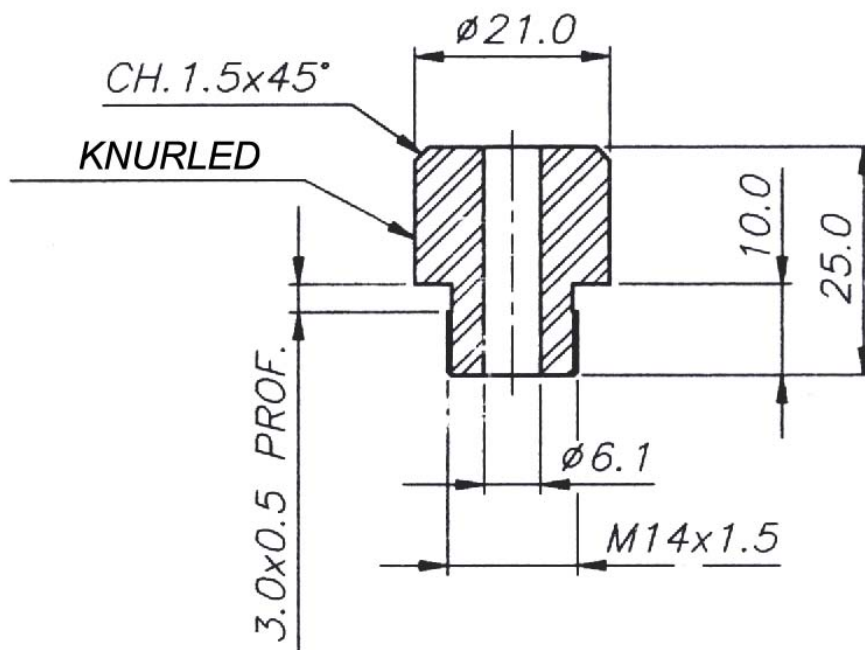
	Qty.	Description	Specification	Torque (Nm)	Sealant
<b>1</b>	1	FAN ASSEMBLY	-----	40 - 50	-----


## *Special Tools*

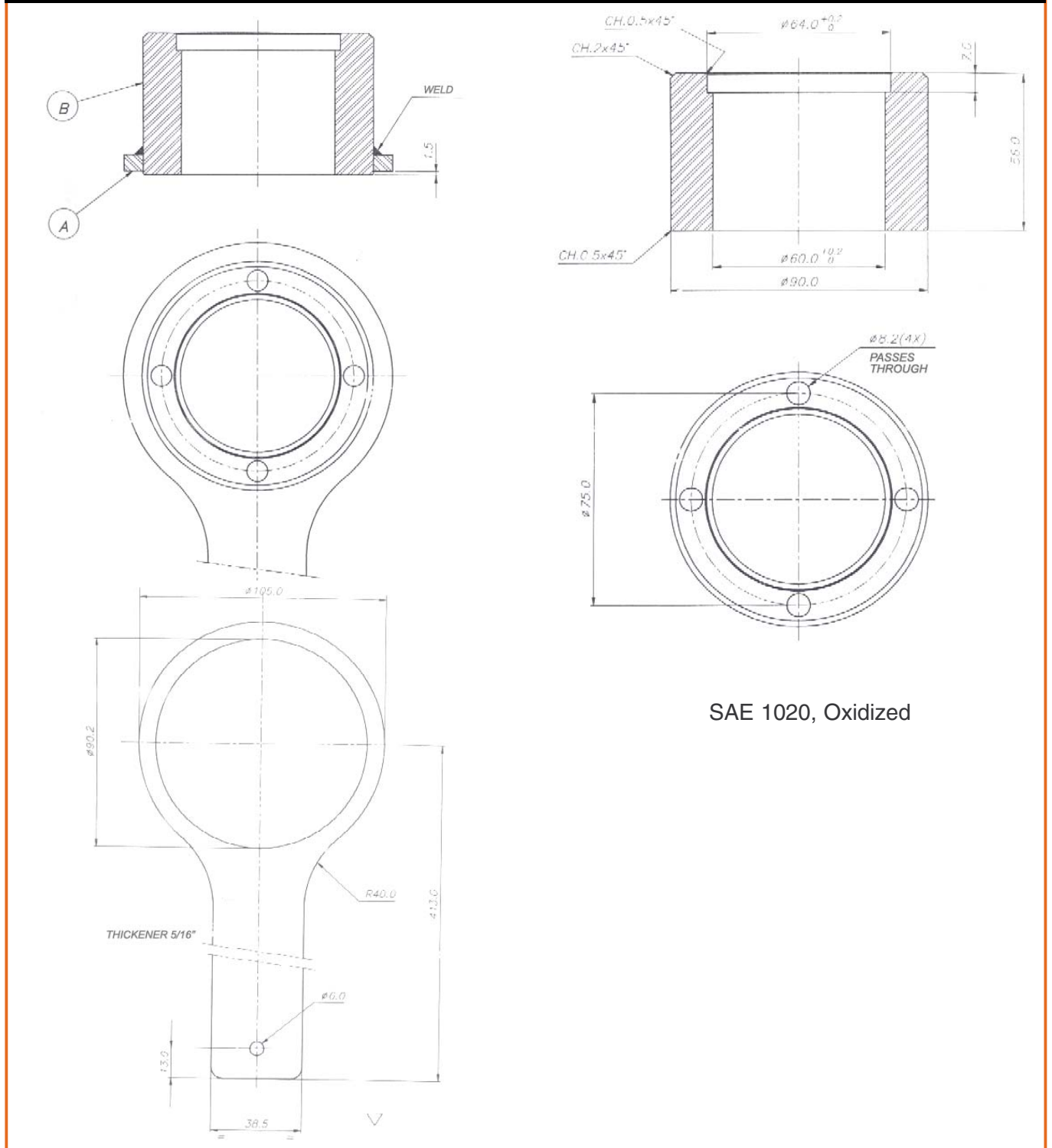
Tool	Description	International Nr.
	Crankshaft timing locking tool	8130632




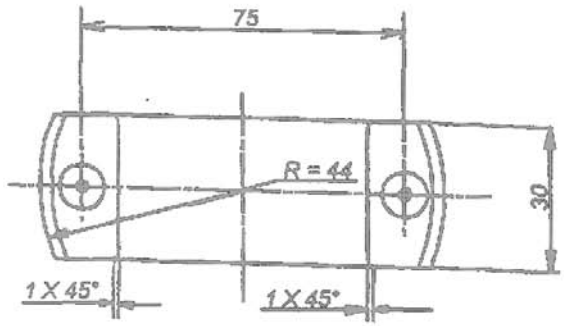
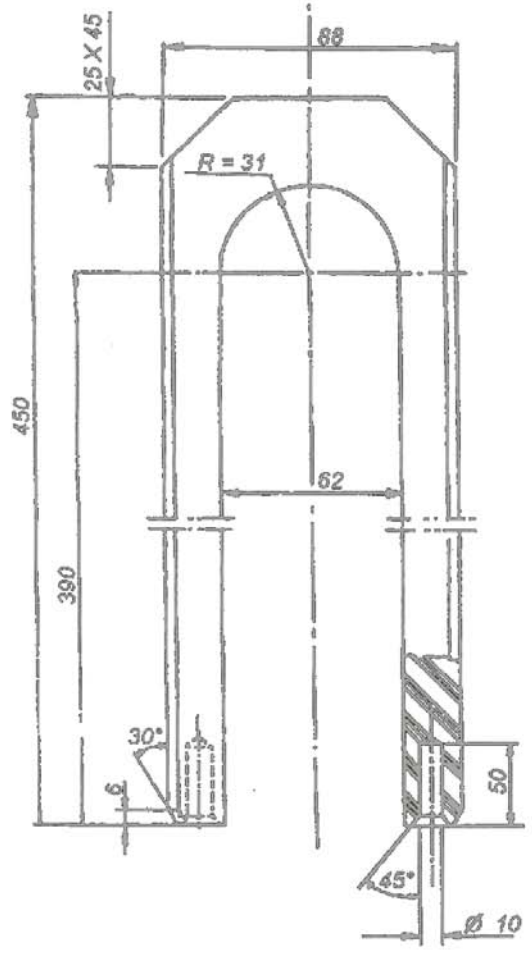
SAE 1020  
Black Oxidized



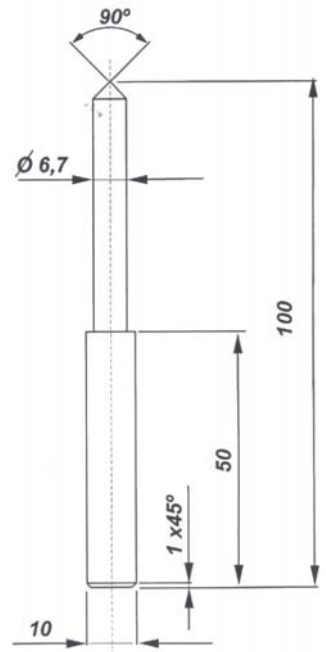
Tool	Description	International Nr.
	Crankshaft pulley attaching tool (for crankshaft pulley removal and installation)	8130638




Tool	Description	International Nr.
	Connecting rods assembling guide	8130646

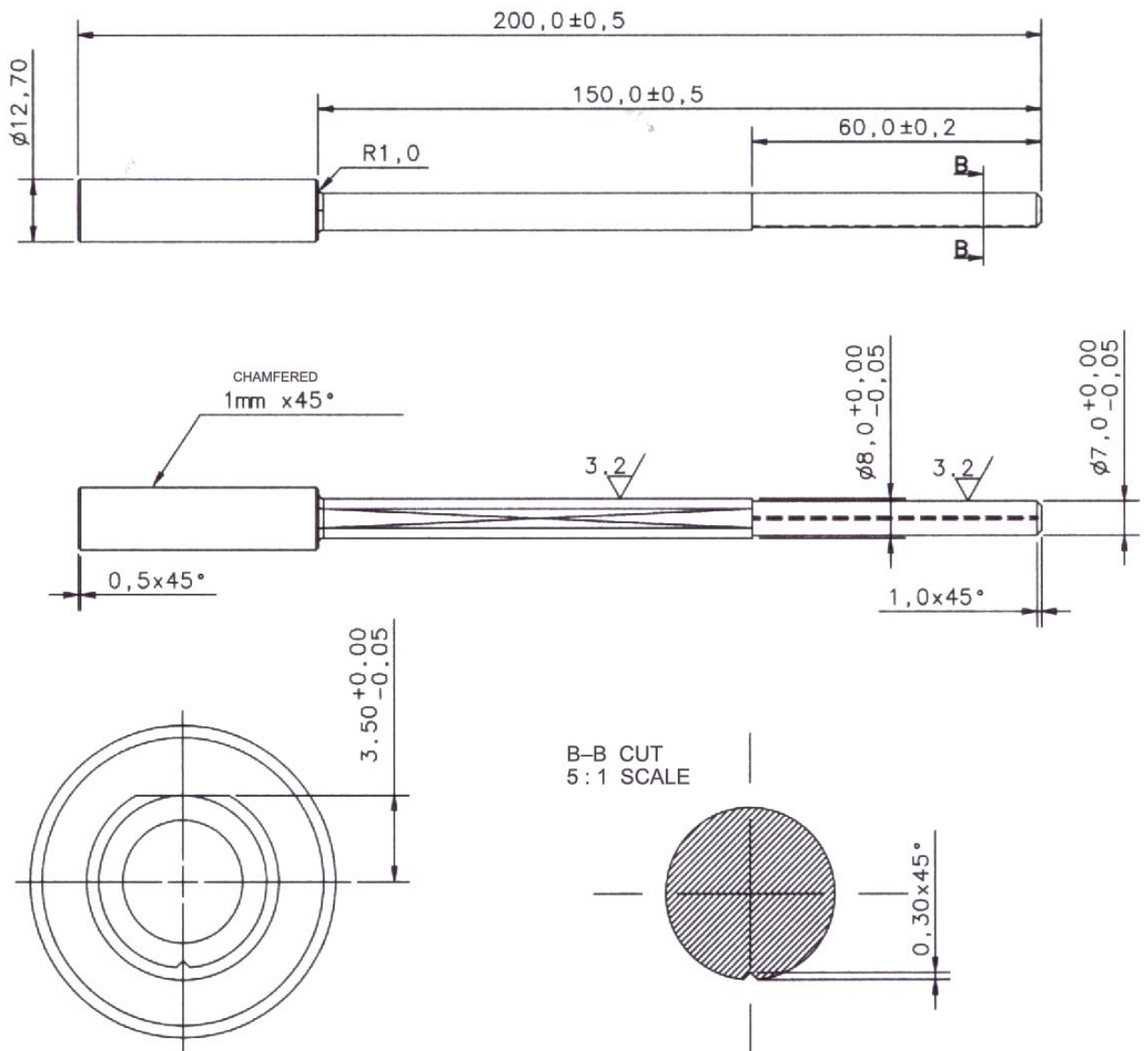


Nylon



SAE 1020

Tool	Description	International Nr.
	Camshaft timing locking tool	8130650



AISI D2 Hardened Steel  $54 \pm 2$  HRc





## Standard tools

Tool	Description	International Nr.
	Valves assembling / removal device for disassembled cylinder head	8130001
	Valves assembler / extractor with assembled cylinder head (Standard)	8130002
	Base for height and depth checking with dial indicator gauge (Standard)	8130004
	Expander pliers for piston rings (Standard)	8130005
	Standard extractor	8130012
	Angle gauge (Torque/angle device) (Standard)	8130625
	Band tool for pistons assembling into cylinders (Standard)	8130647



## Remissive Index

	<b>Page</b>
1. DTC code list.....	Failure Diagnosis ..... 240
2. Failure diagnosis.....	Failure Diagnosis ..... 216
3. Nominal values and operating conditions .....	Failure Diagnosis ..... 205
4. Test instructions .....	Failure Diagnosis ..... 253
 <b>A</b>	
Air conditioning compressor / pulley .....	Accessories ..... 176
Alternator / Pulley .....	Accessories ..... 182
Alternator holder / hydraulic pump .....	Accessories ..... 183
 <b>B</b>	
Before starting the engine .....	Operation and Maintenance ..... 21
Bleeding the system .....	Fuel System ..... 49
Breath return .....	Intake and Exhaust ..... 92
 <b>C</b>	
Camshaft position sensor / phase .....	Electronic Control ..... 192
Camshaft.....	Cylinder Head ..... 112
Housing cover and thermostatic cover .....	Cooling System ..... 37
Chain system .....	Distribution / Timing ..... 148
Changing fuel filter .....	Fuel System ..... 47
Changing lubricating oil and filter element .....	Lubrication System ..... 67
Cleaning and inspection .....	Piston and Connecting Rod ..... 119
Cleaning and inspection of engine flywheel.....	Flywheel and Ring Gear ..... 168
Common rail .....	Fuel System ..... 53
Common rail .....	Electronic Control ..... 196
Common rail pressure sensor / fuel pressure .....	Electronic Control ..... 191
Coolant level checking .....	Cooling System ..... 28
Cooling system draining .....	Cooling System ..... 29
Crankshaft cleaning and inspection .....	Crankshaft ..... 136
Crankshaft front seal.....	Distribution / Timing ..... 147
Crankshaft rear oil seal retainer .....	Crankshaft ..... 140
Crankshaft .....	Crankshaft ..... 134
Cylinder block cleaning and inspection .....	Cylinder Block ..... 119
Cylinder block .....	Cylinder Block ..... 118
Cylinder head mounting bolts .....	Cylinder Head ..... 114

## Remissive Index (Cont.)

	<b>Page</b>
<b>C</b>	
Cylinder head gasket .....	Cylinder Head ..... 109
Cylinder head .....	Cylinder Head ..... 98
<b>D</b>	
Dipstick tube .....	Lubrication System ..... 69
Directions how to work with the fuel system .....	Fuel System ..... 44
Disposal of used components of the engine .....	Environmental ..... 15
Distribution housing .....	Distribution / Timing ..... 157
Distribution housing cover .....	Distribution / Timing ..... 144
Draining system .....	Fuel System ..... 49
During life span of the engine .....	Operation and Maintenance ..... 22
<b>E</b>	
Electronic Control .....	Electronic Control ..... 189
Electronic Control Unit (ECU) .....	Electronic Control ..... 199
Electronic Control Unit (ECU) pins identification .....	Electronic Control ..... 200
Engine breath .....	Intake and Exhaust ..... 88
Engine flywheel .....	Flywheel and Ring Gear ..... 166
Engine side (right and left), rear and front views .....	Technical Specifications ..... 20
Engine timing .....	Distribution / Timing ..... 155
Environmental Policy .....	Environmental ..... 14
Environmental pollution control .....	Environmental ..... 15
Environmental .....	Environmental ..... 14
Exhaust manifold .....	Intake and Exhaust ..... 95
<b>F</b>	
Fan .....	Cooling System ..... 34
Filling up the cooling system .....	Cooling System ..... 30
Fuel filter .....	Fuel System ..... 47/50
Fuel filter holder .....	Fuel System ..... 60
Fuel Pump .....	Fuel System ..... 55
Fuel pump (DPC) .....	Electronic Control ..... 194
Fuel temperature sensor housing .....	Fuel System ..... 61
Fuel injector .....	Fuel System ..... 50
Fuel injector .....	Electronic Control ..... 197

## Remissive Index (Cont.)

	Page
<b>G</b>	
Guidelines ..... Environmental .....	14
<b>H</b>	
High-pressure tubes ..... Fuel System .....	50
Hydraulic pump / pulley ..... Accessories .....	181
<b>I</b>	
Idler pulley ..... Accessories .....	180
Information concerning replacement of components and their steps ..... Fuel System .....	46
Intake and exhaust valve, bridges, valve stem seals and valve springs ..... Cylinder Head .....	105
Intake hoses and ducts ..... Intake and Exhaust .....	86
Intake manifold ..... Intake and Exhaust .....	92
<b>J</b>	
Jet cooler ..... Lubrication System .....	77
<b>L</b>	
Lifting eyes ..... Operation and Maintenance .....	22
Location and Engine Serial Number Identification ..... Technical Specifications .....	19
Lubricating oil filter head ..... Lubrication System .....	72
Lubricating oil level ..... Lubrication System .....	66
Lubricating oils ..... Environmental .....	15
Lubricating turbocharger pipe ..... Intake and Exhaust .....	84
Lubrication system preventive maintenance ..... Lubrication System .....	66
<b>O</b>	
Oil module ..... Lubrication System .....	71
Oil pan ..... Lubrication System .....	73
Oil pan capacity ..... Lubrication System .....	69
Oil pressure sensor ..... Lubrication System .....	70
Oil pump ..... Lubrication System .....	76
Oil check valve on distribution housing ..... Lubrication System .....	80
Oil sprayer on distribution housing ..... Lubrication System .....	78
Oil suction pipe ..... Lubrication System .....	74
Operation and maintenance ..... Operation and Maintenance .....	21

## Remissive Index (Cont.)

Page

### P

Periodic / Preventive Maintenance (Ford Ranger Application) .....	Operation and Maintenance .....	24
Periodic / Preventive Maintenance (Troller T4/Pantanal Application) .....	Operation and Maintenance .....	25
Piston cooling oil jet .....	Lubrication System .....	77
Plastic and metallic components / packing .....	Environmental .....	15
Poly-V belt .....	Accessories .....	174
Poly-V belt tensioner pulley .....	Accessories .....	178
Preventive maintenance .....	Cooling System .....	28
Preventive maintenance of the fuel system .....	Fuel System .....	47

### R

Recommended cooling systems additives .....	Cooling System .....	33
Removal and assembly of the oil filter system .....	Lubrication System .....	69
Removal and assembly of the pistons and connecting rods system .....	Pistons and Connecting Rods .....	124
Removal and handling the engine from vehicle .....	Operation and Maintenance .....	22
Revision programs .....	Operation and Maintenance .....	23
Ring gear .....	Flywheel and Ring Gear .....	171
Rocker arm shaft .....	Cylinder Head .....	110
Rotation sensor .....	Electronic Control .....	190
Running-in .....	Operation and Maintenance .....	21

### S

Safety precautions .....	Safety Precautions .....	8
Special Tools .....	Special Tools .....	323
Start and Stop .....	Operation and Maintenance .....	21
Starter .....	Accessories .....	184
Starting .....	Operation and Maintenance .....	21

## Remissive Index (Cont.)

	<b>Page</b>
<b>T</b>	
Technical Characteristics .....	16
Technical Characteristics (Ford Ranger Application) .....	16
Technical Characteristics (Troller-T4/Pantanal Application) .....	17
Temperature sensor (cooling and fuel) .....	190
Temperature sensor in the thermostatic housing cover .....	39
Tensioner pulley .....	177
Thermostatic valve housing .....	38
T-MAP sensor (Intake air temperature and pressure) .....	192
Torque specifications .....	299
Turbocharger .....	87
Turbocharger oil return pipe .....	85
Turbocharger precautions .....	83
<b>V</b>	
Vacuum pump .....	179
Valve adjustment .....	115
Valve cover and breath valve .....	89
Valve springs and valve stem seals .....	107
Vehicle heating system tube .....	40
Volume control valve (VCV) .....	195
<b>W</b>	
Water pump inlet pipe .....	40
Water pump .....	35







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