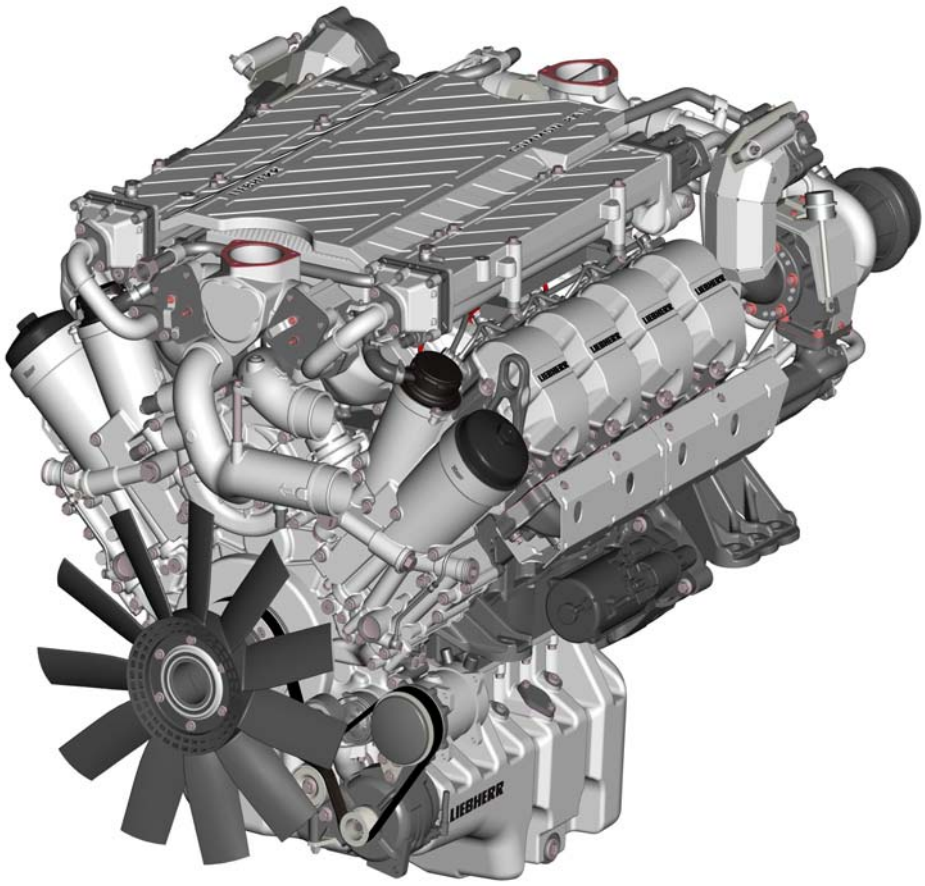
LIEBHERR Diesel engine

D9508

BAL: 10343642-01-en

Operating manual



en

Operating manual

Diesel engine

D9508

Document identification

Order number: 10343642

Version: 01.07.2006

Document version: 01

Author: LMB/Abteilung-BE-MD3

Product identification

Type: D9508

Serial number: 2005140001

Address

Address: LIEBHERR MACHINES BULLE S.A.

45, rue de l'Industrie

CH-1630 BULLE

SWITZERLAND

Manufacturer

Name: LIEBHERR MACHINES BULLE S.A

Machine data:

Complete the following details upon delivery of your diesel engine.
*This details are indicated on the identification plate of the diesel engine. This will also prove beneficial when ordering spare-parts.

*** Diesel engine ident. no.:**

. . . . . .

*** Diesel engine serial no.:**

. . . .

Date of initial start-up:

. . / . . / . .

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Foreword

These operating instructions have been compiled for the **user** and for the **maintenance personnel** of the diesel engine.
The manual includes descriptions regarding:

– Technical data
– Safety requirements
– Operation and servicing
– Maintenance

The operating manual is to be read thoroughly and referred to before initial start-up and at regular periods thereafter by each person contracted to carry out work with/on the diesel engine.
Tasks with, or on, the diesel engine for example include:

– **Operation**, servicing, disposing of fuels and lubricants.
– **Repair**, including maintenance and inspection.

This simplifies training of the operator for his diesel engine and prevents malfunctions resulted from improper use.
Please understand that we do not recognise warranty claims submitted as a result of improper operation, insufficient maintenance, the utilisation of impermissible fuels or negligence of the safety guidelines.
LIEBHERR will revoke any obligations submitted to **LIEBHERR** and/or their dealers, such as guarantees, service orders, etc. without notice, if any parts other than original **LIEBHERR** parts or spare-parts sold by **LIEBHERR** are used for maintenance and repair.
It may be necessary to undertake maintenance tasks more regularly than is prescribed in the inspection plan when working in tougher conditions.
Modifications, conditions and copyright:

– Modifications of technical details, as regards information and illustrations within the documentation currently valid for the machine remain reserved.

  Conditions for warranty and liability of the general terms of trade for the LIEBHERR Company are not extended by the aforementioned details.

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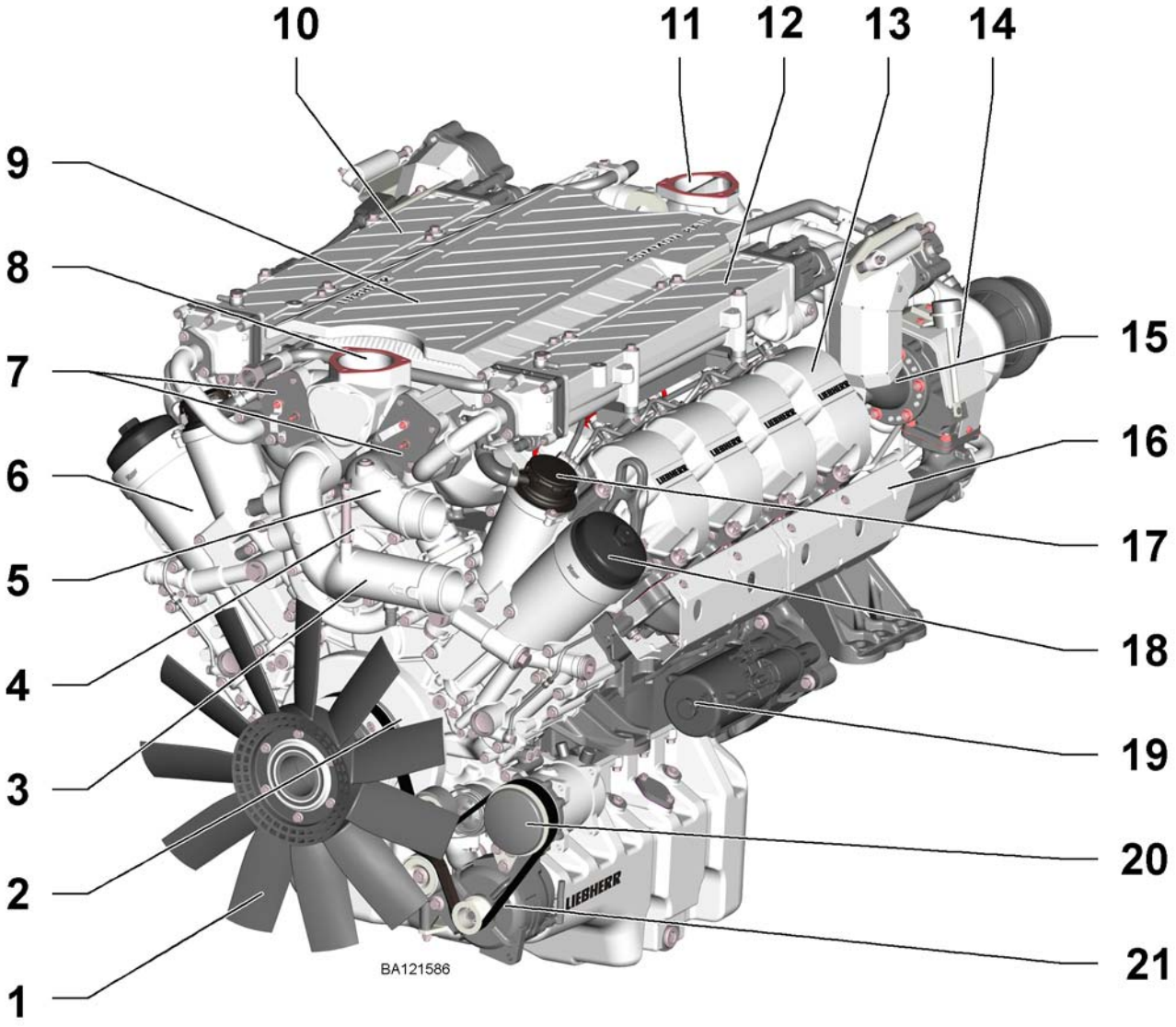
1 Product description

Equipment layout

This section features a summary of the diesel engine including a description of the components represented.



Components of the diesel engine featuring eAGR-module / as viewed from the left

1 Fan
2 Crankshaft and vibration damper
3 Coolant manifold
4 Coolant pump
5 Thermostat housing
6 Oil module
7 Heater flange
8 Air intake
9 Kick plate
10 eAGR-module right
11 Charge air connection
12 eAGR-module left
13 Cylinder head
14 Exhaust turbocharger
15 Exhaust manifold
16 Exhaust pipe and thermal protection plate
17 Crankcase aeration
18 Oil filter element
19 Starter
20 Air-conditioning compressor
21 Alternator

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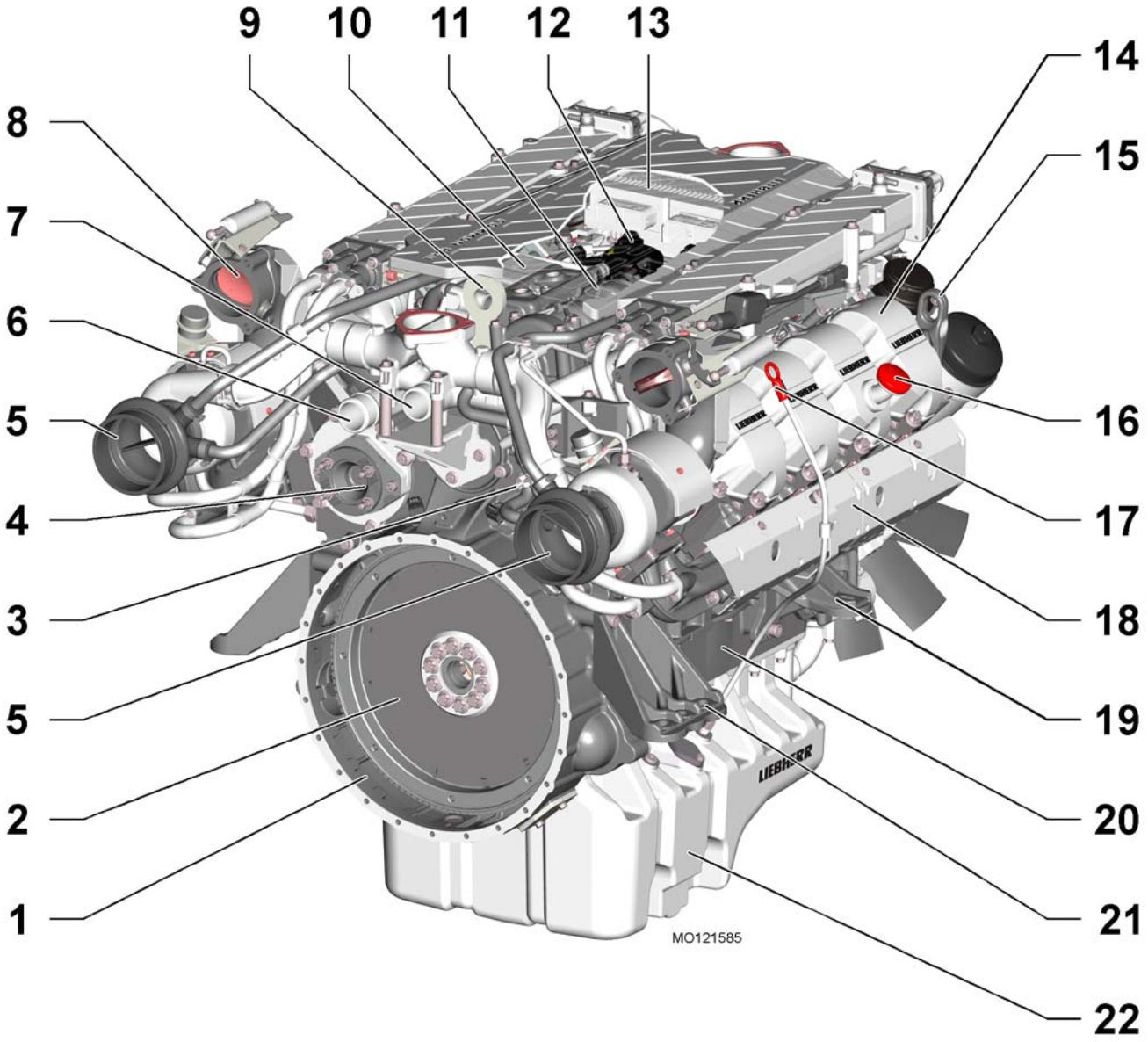

Components of the diesel engine featuring eAGR-module / as viewed from the right

1 Flywheel housing
2 Flywheel
3 Power take-off right NA2
4 Power take-off left NA1
5 Air intake scoop
6 Coolant from retarder
7 Coolant to retarder
8 Exhaust stack 180° with engine brake
9 Lifting eye
10 Air compressor
11 High-pressure pump
12 Fuel fine filter (KSC-module)
13 Control unit
14 Cylinder head
15 Lifting eye
16 Oil intake
17 Oil dipstick
18 Exhaust pipe and thermal protection plate
19 Motor feet, front
20 Crankcase with bed plate
21 Engine bracket
22 Oil sump

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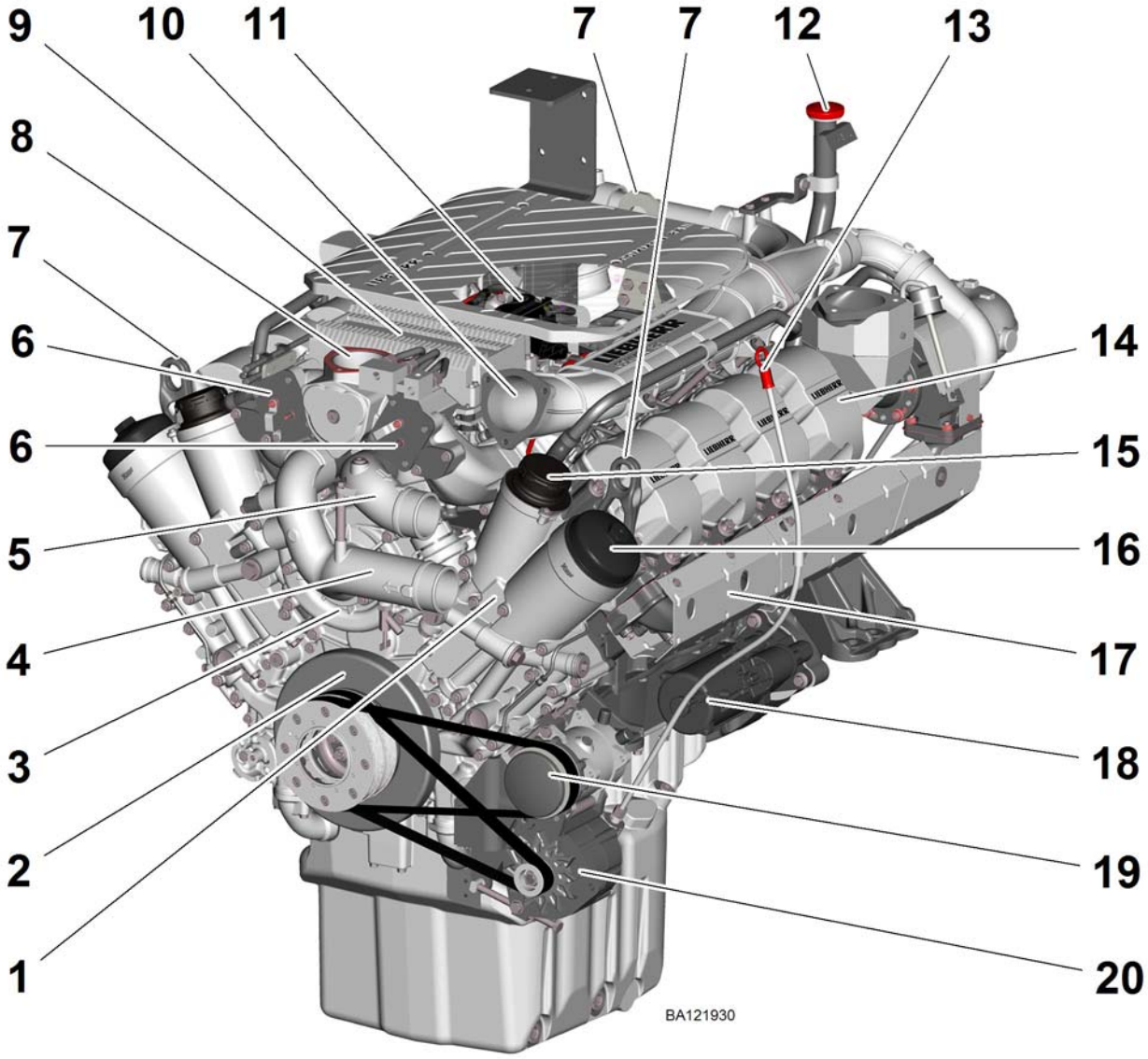

Components of the diesel engine featuring iAGR / as viewed from the left

1 Oil module
2 Crankshaft and vibration damper
3 Coolant pump
4 Coolant manifold
5 Thermostat housing
6 Heater flange
7 Lifting eye
8 Air intake
9 Control unit
10 Charge air connection
11 Fuel fine filter (KSC-module)
12 Oil intake
13 Oil dipstick
14 Cylinder head
15 Crankcase aeration
16 Oil filter element
17 Exhaust pipe and thermal protection plate
18 Starter
19 Air-conditioning compressor
20 Alternator

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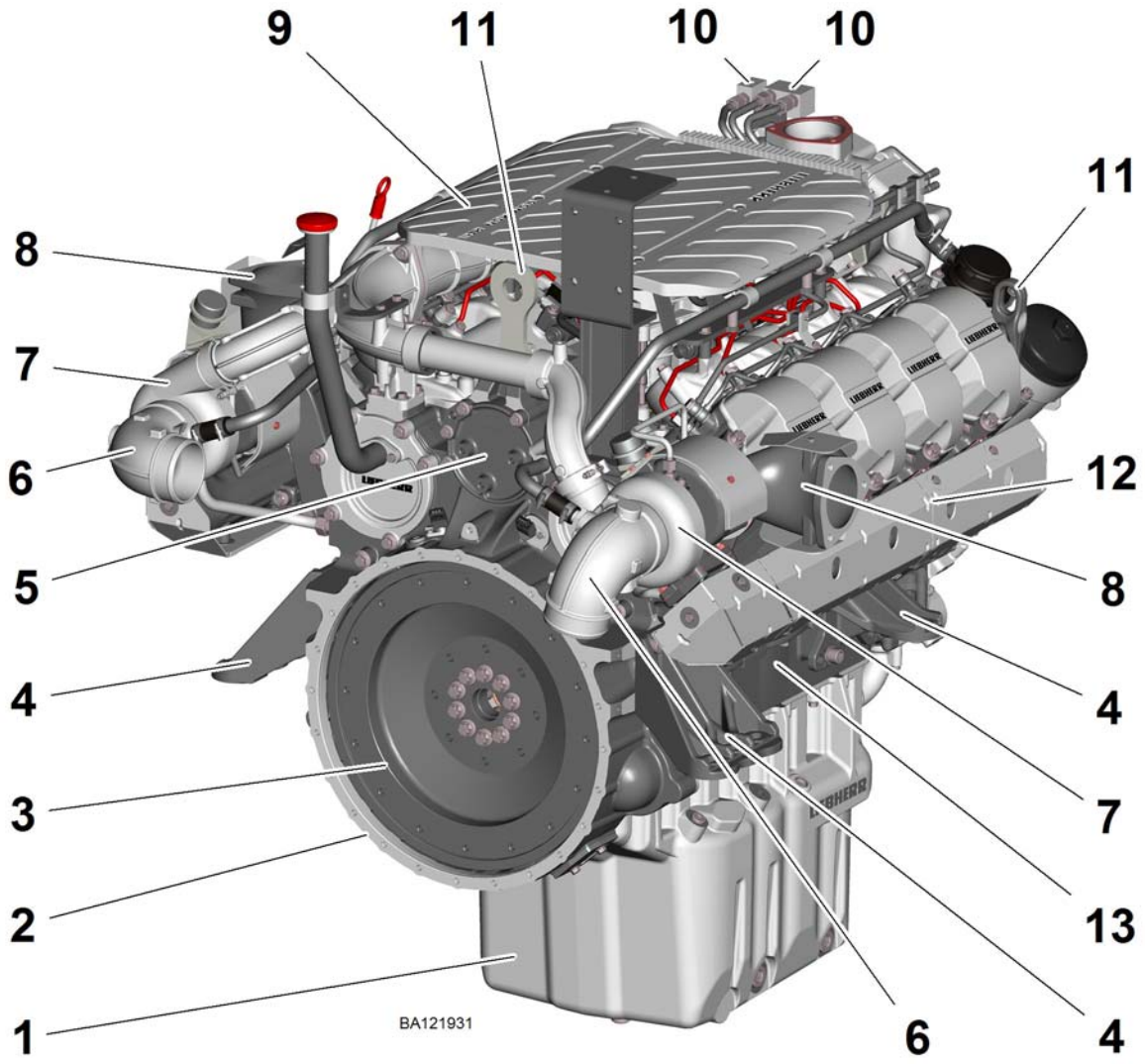

Components of the diesel engine featuring iAGR / as viewed from the right

1 Oil sump
2 Flywheel housing
3 Flywheel
4 Engine bracket
5 High-pressure pump drive mechanism
6 Air intake scoop
7 Exhaust turbocharger
8 Exhaust stack
9 Kick plate
10 Fuel connection
11 Lifting eye
12 Exhaust pipe and thermal protection plate
13 Crankcase with bed plate

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1.1 Technical data

1.1.1 Diesel engine

Name	Value	Units
Design	V-diesel engine	
Number of cylinders	8	
Firing sequence	1–5–7–2–6–3–4–8	
Bore	128	mm
Stroke	157	mm
Displacement	16.16	Litres
Compression ratio	21:1 / 17:1	
Diesel engine's direction of rotation (looking at the flywheel)	left	
Performance group	LG1 to LG5	
Power rating in accordance with	see identification plate	
Nominal output	see identification plate	kW
Speed rating	see identification plate	min^{-1}
Emission standards	see identification plate	
Dry weight of diesel engine	approx. 1450	kg

1.1.2 Cylinder head, standard

Name	Value	Units
Valve clearance intake cold	see identification plate	mm
Valve clearance exhaust cold	see identification plate	mm

1.1.3 Cylinder head with engine auxiliary brake system (ZBS)

Name	Value	Units
Valve clearance intake cold	see identification plate	mm

Name	Value	Units
Valve clearance exhaust valve fitting/rocker arm cold	see identification plate	mm
Valve clearance exhaust valve fitting/retainer cold	0.4	mm

1.1.4 Coolant pump for diesel engine with iAGR

Name	Value	Units
Flow rate (with nominal speed of 1800 min^{-1} and counterpressure 0.6 bar)	approx. 725	l/min

1.1.5 Coolant pump for diesel engine with eAGR

Name	Value	Units
Flow rate (with nominal speed of 1900 min^{-1} and counterpressure 0.6 bar)	approx. 930	l/min

1.1.6 Coolant thermostat

Name	Value	Units
Beginning of opening	82	°C
Fully opened	92	°C

1.1.7 Alternator

Name	Value	Units
Voltage	28	V
Amperage	100 / 110	A

1.1.8 Starter

Name	Value	Units
Voltage	24	V
Output	7.8	kW

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1.1.9 Flywheel housing

Name	Value	Units
Connection	SAE1	

1.1.10 Air compressor

Name	Value	Units
Flow rate at nominal speed 1900 min^{-1} and 6 bar	1050	l/min
Gear transmission ratio	1:1.229	
Water-cooled	Yes	

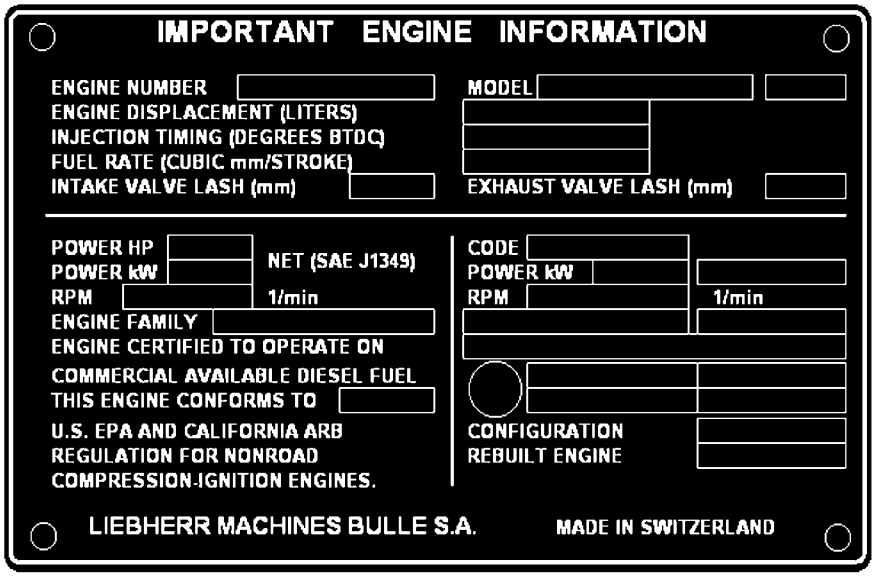
1.1.11 Explanation of type description

Type description

			Description
D	**95**	**08**	**Type description**
D			Diesel engine
	95		Bore 128 mm, Stroke 157 mm
		8	Number of cylinders (8 cylinder)

Diesel engine type identification plate

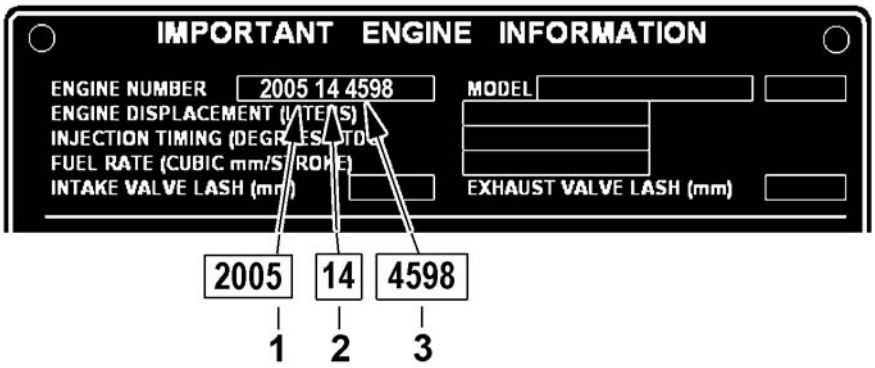
The diesel engine type identification plate is mounted on the left-hand side of the crankcase looking at the flywheel. A second identification plate is affixed in a visible position depending on the circumference of the diesel engine.



Identification plate

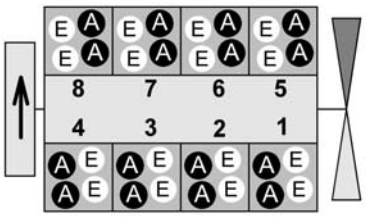
Diesel engine number

The diesel engine number is stamped onto the diesel engine identification plate and in the crankcase. The diesel engine number is located on the crankcase opposite the flywheel at the end of cylinder 5.



1 Year (4–digit)
2 Number of cylinders (14=8 cylinders)
3 Serial number

Cylinder description, rotational direction



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Cylinder description — Rotational direction

A = Exhaust valve E = Intake valve

Cylinder 1 is located on the opposite side of the flywheel on the right.
The rotational direction is to the left, as viewed when looking at the flywheel.

1.1.12 Design features

Design Water-cooled 8-cylinder V-diesel engine with CR (Common Rail) direct injection, exhaust turbocharging and air to air intercooling.

Features A rugged basic design and largely-dimensioned size form the basis for optimum operating safety and long life-expectancy. Reduced fuel-consumption, as well as low noise and exhaust emissions due to a combustion process which is specially adapted to suit the requirements. Reduced maintenance to easily accessible components and a multitude of mounting options for special equipment contribute to optimum overall efficiency of the diesel engines.

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Engine
The 8-cylinder V-diesel engines feature a steel crankshaft with 5 bearing points, with inductive hardened running surfaces and 6 bolted-on counterweights.
A torsion damper is mounted on the crankshaft on the same side as the fan. Precisely forged, 'cracked' connecting rods, transmission bearing in lead-bronze, triplex-friction bearings or sputter bearing. Steel Monotherm pistons featuring strut support and cooling duct. Replaceable, wet cylinder liners

Housing
Rigid crankcase upper section in deep-skirt design, acoustic-optimised configuration and made of vermicular cast iron with a bed plate made of ductile cast iron for the crankcase lower section. 4–valve individual cylinder heads featuring a charging port and swirl duct, as well as replaceable valve seat rings and valve guides.
Flywheel housing, front-mounted aggregate carrier and oil sump mounted on the underside encase the diesel engine.

Drive control
Two intake valves and exhaust valves respectively per cylinder suspended in the cylinder head. Actuated by steel camshaft by 5 bearings via roller tappet, push rod and rocker arm. Drive comprising cam shaft, high-pressure pump, fuel delivery pump, air compressor and auxiliary hydraulic pumps from the crankshaft via case-hardened gear wheels on the flywheel side; coolant pump and two lube oil pumps on the aggregate carrier side.

Lubrication
Forced-fed lubrication with lube oil pump s for crankshaft bearing, connecting rod bearing and camshaft bearing, as well as small end bush, roller tappet and rocker arm.
Oil filtering via two filter modules featuring integrated oil cooler and crankcase breather in the main flow. Accessories, including high-pressure pump, coolant pump drive, turbocharger, power take-offs and air compressor are connected to the diesel engine lube oil circuit.

Cooling
Thermostatic-regulated liquid cooling with cooling pump. Individual supply of each cylinder unit via cast distributor ducts in the crankcase.
Piston cooling via cooling duct from the lube oil circuit of the diesel engine.

Injection system
High-pressure pump with flow control, supplied from a flange-mounted fuel transfer pump. Fuel filter; Rail; CR-injectors with 6 or 7-jet blind hole nozzles.

Electrical equipment
Starter and alternator: 24 Volt.

Electronic diesel engine regulation
The electronic diesel engine governor (EDC) serves to regulate the speed, injection begin and torque of LIEBHERR diesel engines.
The EDC is comprised essentially of sensors and the control unit. Devices located on the same side as the diesel engine and on the same side as the vehicle are connected to the EDC-control unit via cable harnesses.

Electronic sensors on the engine side
Boost pressure sensor, fuel pressure sensor, Rail pressure sensors, oil pressure sensor, temperature sensor for coolant, charge air and speed sensors are interfaces for external monitoring and control functions. The individual functions and error reports are described in the respective user documentation.

Exhaust gas recirculation (AGR)
With the internal AGR, part of the exhaust gas is pushed into the intake stroke during the exhaust stroke and then sucked in again upon the next intake stroke. This ensures lower NOx emissions.
With external AGR, part of the combusted hot exhaust is supplied again to the cylinder charge via a heat exchanger integrated in the engine cooling system. This ensures reduced combustion temperatures and lower NOx emissions.

Mounting options for pumps
The mounting of hydraulic pumps is possible on up to 4 power take-offs of the diesel engine.

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1.1.13 Special equipment for the diesel engine

Diesel engine brake and auxiliary brake system

The diesel engine exhaust gas brake flap is installed in the left-hand and right-hand exhaust gas pipe which runs from the exhaust turbocharger to the muffler. The diesel engine exhaust gas brake flap is actuated via a cylinder pressurised with compressed air, whereby the diesel engine braking action is generated via closing of the diesel engine exhaust gas brake flap.

A diesel engine auxiliary brake system (ZBS), in addition to the diesel engine exhaust gas brake flap, has been installed to increase diesel engine braking action. Thus, during the engine braking procedure, the ZBS allows a gap in the exhaust valves to remain open, increasing diesel engine braking action.

Air compressor

The air compressor is flange-mounted directly onto the diesel engine. Cooling or lubrication of the air compressor is connected to the respective circuits of the diesel engine.

Air-conditioning compressor

The air-conditioning compressor can be mounted directly onto the diesel engine and powered via a magnetic clutch featuring a ribbed V-belt. When the air-conditioning is switched on, the magnetic clutch is active and the compressor is working.

Cold start package

The interfaces for the retrofitting of pre-heating devices, e.g. for coolant, fuel and diesel engine oil, are already integrated.

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2 Safety regulations

Working on the diesel engine is extremely hazardous to user, machine operator or maintenance technician. Dangers and accidents can be avoided if the various notes on safety are frequently read and adhered to.

This applies in particular for personnel carrying out maintenance tasks opportunely on the diesel engine.

Conscientious adherence of the safety guidelines specified as follows, will guarantee the safety of yourself and others, as well as safeguarding against damage to the diesel engine.

All necessary safety precautions relevant to the description of tasks which could cause injury to personnel or damage to the diesel engine, are described in this book.

They are indicated with the references **Danger**, **Warning** or **Caution**.

2.1 Introduction

1. The terms represent the following meaning throughout this book:

Danger

warns against certain operational procedures which could lead to fatalities should the respective precautionary measures not be observed.

Warning

warns against certain operational procedures which could lead to serious physical injury should the respective precautionary measures not be observed.

“Caution“ warns against certain operational procedures which could lead to minor physical injury or damage to the diesel engine, should the respective precautionary measures not be observed.

“Note”

Provides additional information to certain operational procedures.

2. **Observation of these points does not exempt you from the adherence of additional rules and regulations!**

   All safety regulations valid for the application site are also to be adhered to.

2.2 General safety guidelines

1. Familiarise yourself with the operating and maintenance instructions before starting up the machine.

   Make sure that you possess, have read, and have understood any additional instructions relevant to your machine's optional features.
2. Only expressly authorised personnel may operate, maintain or repair the diesel engine.

   Observe the legal, permissible minimum age!
3. Employ only trained or instructed personnel and allocate definitive responsibility for personnel regarding operation, setting up, maintenance and repair.

4. Personnel who are still undergoing training, or are involved with a general apprenticeship, should only be allowed to work on the diesel engine while under constant supervision of an experienced person.
5. Ensure regularly that personnel are conscientious of safety and dangers while working, and are observing the operating instructions.
6. Always wear safety clothing when working on the diesel engine.
   Avoid the wearing of rings, wrist watches, ties, scarves, open jackets, baggy clothing etc. There is a risk of injury as a result of getting caught up or being drawn in.

2.3 Use as directed

1. This diesel engine has been designed exclusively for the intended use defined by the manufacturer and stipulated in the scope of delivery (use as directed): Any other form of use is not considered use as directed. The manufacturer can not be held responsible for any damage which occurs as a result. The user bears full responsibility.
2. Use as directed also includes the adherence of operating, maintenance and repair requirements prescribed by the manufacturer. The diesel engine may only be operated maintained and repaired by persons who are familiar with these tasks and are fully aware of the dangers.
3. The manufacturer does not bear responsibility for any material damage or injury to persons which occurs as a result of unauthorised modifications to the diesel engine.
   Likewise, manipulation of the injection system and servo system could influence output and exhaust characteristics of the diesel engine, whereby compliance of the legal environmental regulations can no longer be guaranteed.

2.4 Notes on the prevention of crushing and burns

1. Do not use any lifting materials, such as ropes or chains, which are damaged or do not feature sufficient lift capacity.
   Always wear industrial gloves when handling wire cables.
2. Ensure that no objects come into contact with the fan while the diesel engine is running.
   Objects which fall into, or protrude into, the fan will be flung back out or destroyed, and could cause damage to the fan.
3. When verging on operating temperature, the diesel engine's cooling system is hot and under pressure.
   Avoid any contact with parts carrying cooling water.
   Risk of burns!
4. Only check the cooling water level if the sealing cap of the expansion tank is cool enough to touch.
   Open the cap carefully to relieve any excess pressure.
5. Verging on operating temperature, the diesel engine oil is hot.
   Avoid skin contact with hot oil or parts carrying oil.
6. Always wear protective glasses and industrial gloves when working on the battery.

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Avoid sparks and naked flames.

2.5 Notes on the prevention of fire and explosions

1. The diesel engine must be switched off when refuelling.
2. Do not smoke and avoid naked flames in the area where batteries are being recharged and when refuelling.
3. Always start the diesel engine in accordance with the operating and maintenance instructions guidelines.
4. Check the electrical system.
   Remedy all faults, such as loose connections and worn cables, immediately.
5. Check all lines, hoses and threaded unions regularly for leaks and damage.
6. Remedy leaks and replace damaged components immediately.
   Oil spraying out of points which are not properly sealed is highly flammable.

2.6 Observe safety precautions when starting

1. Unless otherwise specified, always start the diesel engine in compliance with the guidelines in the **"Operating and Maintenance Instructions"**.
2. Start the diesel engine and then check all display equipment and control devices.
3. Only allow the diesel engine to run in enclosed areas if sufficient ventilation has been provided.
   If necessary, open doors and windows to ensure that a sufficient supply of fresh air can be guaranteed.

2.7 Measures for safe maintenance

1. Do not carry out any maintenance or repair tasks with which you are not familiar.
2. Adhere to any intervals for recurring checks or inspections which have been prescribed or are specified in the operating instructions.
   To carry out servicing measures, it is absolutely imperative that factory equipment appropriate for the respective task be used.
3. The tasks to be carried out, as well as the personnel by which these tasks must, or may be performed, are clearly defined in the listing at the end of these **"Operating and Maintenance Instructions"**.
   The tasks listed under **"daily/weekly"** in the maintenance chart can be carried out by the machine operator or the maintenance personnel.
   All other tasks may only be carried out by authorised personnel who have undergone the appropriate training.

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4. Spare parts must comply with the technical requirements specified by the manufacturer. This can always be guaranteed with original spare parts.
5. Always wear protective clothing when carrying out maintenance tasks.
6. Unless otherwise specified in these **"Operating and Maintenance Instructions"**, all maintenance tasks to the diesel engine must be carried out on firm, even ground and with the diesel engine switched off.
7. For maintenance and repair tasks, all loosened screw connections must be tightened with the tightening torque prescribed.
8. Clean the diesel engine of oil, fuel or detergents, in particular connections and threaded unions, before commencing maintenance/repair tasks. Do not use any aggressive cleaning agents. Use fibre-free cleaning cloths.
   Do not use any flammable liquids for cleaning the diesel engine.
9. Before cleaning the machine with water, steam jet (high-pressure cleaner) or other cleaning agents, seal or cover all openings into which water/steam/cleaning agents should not be allowed to penetrate due to reasons of safety or functionality.
   The crankcase air vent, electronics box, starter and generator are at particular risk.
   Additional tasks:
   – After cleaning, remove the covers/bondings completely.
   – Inspect all fuel lines, diesel engine oil lines and hydraulic oil lines for leaks, loose connections, points of wear and damage upon completion of cleaning.
   – Remedy any determined faults immediately.
10. Observe the safety guidelines valid for the product when handling oils, greases and other chemical substances.
11. Ensure a safe and environmentally-sound disposal of fuels and consumables, as well as replacement parts.
12. Observe caution when handling hot fuels and consumables (danger of burning and scalding).
13. Always wear gloves when searching for leaks. A fine jet of liquid, when pressurised, could penetrate the skin.
14. Shut down the diesel engine before loosening oil lines.
15. Combustion engines may only be operated in sufficiently ventilated areas. Ensure sufficient ventilation before initiating operation in enclosed areas. Observe the valid guidelines for the respective jobsite.
16. Do not try to lift heavy parts. Suitable lifting gear featuring sufficient lift capacity must be used for these tasks.
    Procedure:
    – Tighten and secure individual parts and larger assemblies carefully to the hoist when replacing heavy parts, in order that no danger is resulted.
    – Only use suitable and technically-sound hoists, as well as load carrying equipment featuring sufficient lift capacity.

    It is prohibited to remain or work beneath suspended loads.
17. Do not use ropes which are damaged, or do not feature sufficient lift capacity. Always wear industrial gloves when handling wire cables.
18. Tasks to electrical equipment on the machine may only be carried out by an electrical specialist or by trained personnel under the supervision and instruction of an electrical specialist in compliance with the electrotechnical regulations.
19. Disconnect the battery when working on the electrical system and also remove the plug from the control unit if electric welding is to be carried out on the machine.
    Always disconnect the negative terminal first and reconnect last.

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2.8 Observe the safety precautions for diesel engines featuring electronic control units

1. Only start up the diesel engine with the batteries securely connected.
2. Do not disconnect batteries while the diesel engine is running.
3. The diesel engine may only ever be started with the control unit connected.
4. Do not use a fast charger to start the diesel engines. Only use jump leads with separate batteries.
5. The battery terminals must be removed for fast charging of the batteries. Observe the operating instructions of the fast charger.
6. When carrying out electrical welding tasks, the batteries must be disconnected and both cables (+ and —) must be securely connected with each other. Connection to the engine electronics is to be cut via both interface plugs.
7. Connections of the control units may only be connected or disconnected with the electrical system switched off. Tighten the fastening screws of the interface plugs with the prescribed tightening torque.
8. Incorrect polarity of the control unit's voltage or the supply voltage (e.g. due to incorrect polarity of the batteries) can lead to ruination of the control units.
9. Tighten the connections on the injection system with the prescribed tightening torque.
10. If temperatures exceeding 80 °C (e.g. drying kiln) are expected, the control units must be removed.
11. Only use suitable test leads for measurements at the plug connections.
12. Neither sensors nor actuators may be connected individually to, or between, external voltage sources for inspection or test purposes, but rather always with the electronic control unit, otherwise there is a risk of the diesel engine malfunctioning or even becoming ruined.
13. The electronic control unit is only sufficiently protected against dust and water if the mating connector is mounted and attached. If no mating connectors have been attached, the control unit must be sufficiently protected against dust and water.
14. Telephones and radio equipment which are not connected to an exterior aerial could lead to functional failure of the vehicle's electronics, and thus jeopardise operational safety of the diesel engine.

2.9 Safety and emergency run program for diesel engines featuring electronic control units

1. The diesel engine features an electronic regulating system, which monitors the diesel engine as well as the electronic regulating system itself (self-diagnosis).

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As soon as a fault is recognised, one of the following measures is automatically initiated following evaluation of the fault:

– Issue of an error report featuring error code.
– The error code is issued directly via a display in conjunction with the vehicle diagnosis system.
– Changeover to suitable back-up function for further, however limited, operation of the diesel engine (e.g. constant emergency-run speed).

Have all faults remedied immediately by the respective LIEBHERR after-sales service department.

2.10 Special notes regarding tasks on the Common Rail System

1. The lines are under a constant fuel pressure of up to 1.600 bar while the diesel engine is running.
   – Never loosen the screw connections on the fuel high-pressure side of the Common Rail System (injection from the high-pressure pump to the Rail, at the rail and on the cylinder head to the injector) while the diesel engine is running.
2. Any fuel which escapes while under pressure can penetrate human skin, and thus cause serious injury. There is a risk of conflagrations due to misting of the fuel.
   – After the diesel engine has been shut down, wait for at least another minute to give pressure in the Rail system time to dissipate.
   – Do not remain in direct proximity of the diesel engine while the diesel engine is running.
   – Persons with pacemakers should not approach within 20 cm of the running diesel engine.
   – Do not touch voltage-carrying parts on the electrical connection of the injectors while the diesel engine is running.
3. State-of-the-art components for the diesel injection are nowadays made of high-precision parts which are subjected to extreme stresses. Due to this high-precision technology, **utmost cleanliness** must be guaranteed whenever tasks on the fuel system are undertaken.
   Dirt particles exceeding **0.2 mm** in size are enough to cause the failure of components.
4. It is absolutely **imperative**, therefore, that the following prescribed measures are adhered to before commencing any tasks:

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– Before commencing any tasks on the pure side of the fuel system, the diesel engine and the diesel engine compartment must be cleaned (steam-jet cleaning), ensure that the fuel system is closed.
– Perform a visual inspection of the fuel system for leaks or damages.
– Do not spray directly onto electrical components with the steam jet cleaner, mount covers wherever necessary.
– Place the diesel engine in a clean area within the workshop where no work is being carried out which may cause dust to rise (grinding and welding work, repairs to brakes, inspecting brakes and lines etc.).
– Avoid disturbing the air (possible raising of dust by starting the diesel engine, aeration or heating of the workshop or as a result of draughts etc.).
– The area around the still closed fuel system is to be cleaned and dried with compressed air.
– Remove loose dirt particles such as flakes of paint and insulating paper using suitable suction equipment (industrial vacuum cleaner).
– Hang a new, and clean cover sheet over areas of the diesel engine compartment which may be prone to releasing dirt particles.
– Before commencing the disassembly work, wash your hands and put on clean overalls.

5. It is **imperative** that the following prescribed measures are adhered to when carrying out work:
   – The utilisation of compressed air for cleaning is not permissible after opening the fuel system on the clean side.
   – Loose dirt is to be removed during the assembly procedure using suitable suction equipment (industrial vacuum cleaner).
   – Only lint-free cleaning cloths may be used on the fuel system.
   – Tools and working appliances are to be cleaned before commencing work.
   – Only tools which do not indicate any damage (cracks in the chrome coating may be used.
   – When removing and installing components, do not use materials such as towels, cardboard or wood, as these materials could release particles and fibres.
   – Should flakes of paint become released when loosening connections (possibly caused by excessive painting), these flakes of paint must be carefully removed before definitively disconnecting the fitting.
   – The open connection ports from all removed parts from the clean side of the fuel system are to be sealed **immediately** using appropriate sealing caps.

   – This sealing material must remain in its dustproof packaging up to the point of utilisation and is to be disposed of immediately following initial use.
   – The components are then to be stored carefully in a clean, sealed container.
   – **Never** apply used cleaning agents or test fluids to the components.
   – New parts may only be removed from their original packaging immediately before use.
   – Work on removed components may only be carried out in a workplace specifically provided for this purpose.
   – Should removed parts require posting, always use the original packaging from the new parts.

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2.11 Disposing of fuels and lubricants

1. Ensure when handling fuels and lubricants, that no substances are spilled or poured onto the earth, into drainage systems or into bodies of water.
2. Different fuels and lubricants are to be collected and disposed of in separate containers.
3. Use sealed containers for draining fuels and lubricants. Under no circumstances should containers for food or drinks be used as the liquids could be drunk inadvertently.
4. Before recycling or disposing of waste products, enquire about the correct method at the environmental or recycling centre responsible. Incorrect disposal of waste products can harm the environment and the ecology.

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3 Operation, Handling

3.1 Control elements and operating elements

The control elements and operating elements are integral parts of the equipment and are described in the documentation of the manufacturer.
Data regarding oil pressure, coolant temperature, speed, operating hours and service code, for example, are transferred to the equipment via the electronic interface on the diesel engine for operation and regulation of the diesel engine.

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3.2 Operation

3.2.1 Preparing for initial start-up

Brand new diesel engines are delivered from the factory already filled with the oil required for initial start-up. As a rule, replacement engines and engines which have undergone a general overhaul are delivered without fuel.

The high-grade oils used for initial start-up are ideally suited for the break-in process and allow the first oil-change to be carried out at the normal oil-change interval.

For filling amounts and quality, see the chapter, Fuels and Lubricants—Specifications.

Filling in fuels

The following fuels are to be filled in before initial start-up:

– **Diesel engine oil**
  With replacement engines or engines which have undergone a general overhaul, use authorised diesel engine oils only, see the chapter, Fuels and Lubricants-Specifications.
– **Coolant**
  For coolant composition, see the chapter, Fuels and Lubricants-Specifications.
– **Fuel**
  Use summer fuel or winter fuel in accordance with the season. Diesel fuels must comply with the permissible fuel specifications, see the chapter, Fuel and Lubricants Specifications.
– Ensure utmost cleanliness, use a funnel with sieve. When refuelling from drums or canisters, observe the safety guidelines, see the chapter, Safety Guidelines. It is imperative that the penetration of water is avoided.

The following preparations must be carried out following the filling of fuels:

- Lubricate the starter ring gear with grease wherever necessary.
- Check the batteries. Only use fully charged batteries which have undergone regular maintenance.
- Bleed the fuel system (see the chapter, Maintenance)
- If a fuel shut-off valve is available:
  Open the fuel shut-off valve.
- Start the diesel engine.
- Check the oil pressure gauge immediately after starting the diesel engine.

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Troubleshooting

No oil pressure has been attained within 5 seconds?

- Switch off diesel engine immediately.
- Determine and remedy the cause.

- Carry out a test-run after completing the prescribed preparations.
- Allow the diesel engine speed to increase gradually to 3/4 of the permissible maximum speed, until operating temperature has been reached.

Tasks during and following the test-run

Bleeding the cooling system:

- Allow the diesel engine to run for approx. 5–10 minutes at medium speed.
- Switch off the diesel engine and check the coolant level again, top up coolant as required.
- If a heating system is connected to the cooling system, all heating valves must be opened when refilling. The heating valves may only be closed again after the diesel has been allowed to run for a short time and, if necessary, has been refilled.

Checking the diesel engine oil level:

- Check the diesel engine oil level approx. 2–3 minutes after switching off the diesel engine, if necessary refill oil up to the maximum marking on the oil dipstick.

Checking the diesel engine

- Check the diesel engine for leaks.
- Check hose clamps and pipe connections around the entire system for leaks and correct tightening, tighten as necessary.

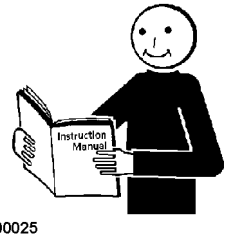
3.2.2 Maintenance tasks before daily start-up

Before daily start-up, the maintenance tasks (daily) must be carried out every 10 operating hours (see the chapter, Maintenance).

3.2.3 Starting the diesel engine

Start procedure

Starting of the diesel engine is only permissible if you have read and thoroughly understood the operating instructions.



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Operating instructions

- If a fuel shut-off valve is available:
  Open the fuel shut-off valve.
- Start the diesel engine in the idle position using the using the ignition key or starter button.

Troubleshooting
The engine has still not started after approx. 20 seconds?

- Wait for 1 minute.
- If this measure has been repeated three times:
  Determine and remedy the cause.

- Check the oil pressure gauge immediately after starting the diesel engine.

– The oil pressure is not displayed within 5 seconds.
– Switch off diesel engine immediately.

- Do not subject the engine to full load immediately after starting. After a brief (10–15 sec.) spell at idle speed, allow the diesel engine to run warm at medium speed and medium load.

Operation

- Checking the diesel engine in operation.

– Oil pressure is constant.
– Output and speed are constant.
– Exhaust gas is colourless.
– Cooling water temperature is stable.
– The sounds of the diesel engine appear normal.

Troubleshooting
Faults have been determined?

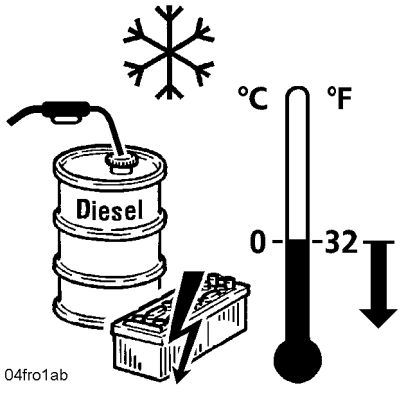
- Switch off diesel engine immediately.

3.2.4 Precautions for starting up in icy temperatures

Low temperatures

The starting behaviour can thus be improved considerably in low temperatures:

Warning
Danger of the diesel engine exploding!
There is a serious risk of the engine exploding if ether-based starting aids are used for starting the diesel engine with preheating system!
! Ether-based start aids are prohibited.



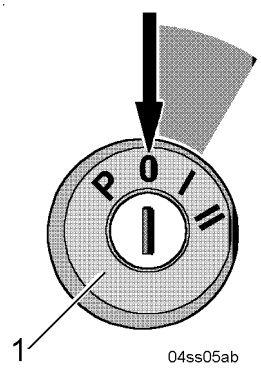
Winter operation

- Check the charge of the battery.
- If the battery is not sufficiently charged:
  Recharge the battery.
- Use winter fuel (see the chapter, “Fuels and Lubricants“ under winter operation).
- Diesel engine induction air prewarning via heater flange, see documentation of the machine manufacturer.

3.2.5 Shutting down

Switching off the diesel engine.

Caution
Risk of the diesel engine becoming damaged!
When switching off the diesel engine, the turbocharger continues to run briefly with no supply of oil.
! Never switch off the diesel engine directly from running at full load.



Start switch – 0-position

- Reduce the diesel engine speed to idle.
- Allow the diesel engine to continue to run briefly, approx. 10 to 15 seconds, without load in idle.
- Turn the ignition key to the -**0**- position and remove.

The diesel engine has been shut down.

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4 Malfunctions

Troubleshooting can prove to be difficult for diesel engines. For possible diesel engine faults with suspected causes and remedial measures, see the Troubleshooting Chart.

Note
Faults in the diesel engine are indicated via error code on the machine display for diagnosis.

! An explanation and a remedy are described in the respective machine documentation.

Fundamental logical steps for diagnosis are included in the following list:

– Knowing the diesel engine and all associated systems
– Scrutinise the problem thoroughly.
– Relate the problem and knowledge of the diesel engine and its systems.
– Diagnose the problem, whereby the simplest assumptions are worked upon.
– Double check before beginning disassembly.
– Establish the causes and perform repair work thoroughly.
– Following repair, allow the diesel engine to run under normal operating conditions and check whether the problem and the cause have been remedied.

4.1 Error code tables

Fault	Possible cause	Remedy
Starter will not crank	Main fuse is burned out	Replace fuse
	Battery connections loose or corroded	Clean loose connections and tighten
	Battery voltage too low	Recharge or replace battery
	Starter electric circuit broken or contacts corroded	Consult LIEBHERR AFTER-SALES-SERVICE
	Starter faulty	Consult LIEBHERR AFTER-SALES-SERVICE
Starter will crank only slowly	Battery voltage too low	Recharge or replace battery
	Battery connections loose or corroded	Clean loose connections and tighten
	Ambient temperature too low	Observe the measures for winter operation
Diesel engine will not start or cuts out again shortly after starting	Fuel tank is empty	Refuel, bleed the fuel system
	Fuel filter is clogged	Replace fuel filter
	Fuel line, pre-cleaner or sieve in fuel tank is clogged	Clean and bleed the fuel system
	Fuel system or filter leaking	Seal and bleed
	Air in the fuel system	Bleed the fuel system
	Fuel not frost-resistant	Clean pre-filter, replace fuel filter; Use winter fuel
	Ambient temperature too low	Observe the measures for winter operation

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Fault	Possible cause	Remedy
	Heater flange faulty (with cold temperatures)	Check heater flange and replace as necessary
Diesel engine has difficulty starting	Leakages or insufficient pressure in the fuel low-pressure circuit	Inspection for leaks (visual inspection); to be carried out by LIEBHERR AFTER-SALES-SERVICE
	Diesel engine - insufficient compression	Check compression, if not OK; Consult LIEBHERR AFTER-SALES-SERVICE
	Heater flange faulty (with cold temperatures)	Check heater flange and replace as necessary
	Fault in the electronics	Read out error memory from engine control unit, consult LIEBHERR AFTER-SALES-SERVICE
Diesel engine shuts down without warning	Voltage supply cuts out	Consult LIEBHERR AFTER-SALES-SERVICE
	Leakages or insufficient pressure in the fuel low-pressure circuit	Inspection for leaks (visual inspection); to be carried out by LIEBHERR AFTER-SALES-SERVICE
	Fault in the electronics	Read out error memory from engine control unit, consult LIEBHERR AFTER-SALES-SERVICE
Poor diesel engine output (output deficiency)	Fuel system faulty (clogged, leaking)	Visual inspection for leaks, replace filter, consult LIEBHERR AFTER-SALES-SERVICE
	Boost pressure too low	Loose clamps, faulty seals and hoses, air filter contaminated, turbocharger has no output
	Charge air temperature too high (automatic reduction in output by engine control unit)	Intercooler contaminated, poor fan output, ambient temperature too high, consult LIEBHERR AFTER-SALES-SERVICE
	Coolant temperature too high (automatic reduction in output by engine control unit)	Check radiator for contamination, check fan and thermostat, check coolant level, consult LIEBHERR AFTER-SALES-SERVICE
	Fuel temperature too high (automatic reduction in output by engine control unit)	Consult LIEBHERR AFTER-SALES-SERVICE
	Application area more than 1800 meters above sea level	No remedy, diesel engine output was reduced automatically
	Diesel engine brake flap faulty (if available)	Functional or visual inspection; Consult LIEBHERR AFTER-SALES-SERVICE
	Injection nozzles getting stuck or not spraying	Consult LIEBHERR AFTER-SALES-SERVICE
	Diesel engine - insufficient compression	Consult LIEBHERR AFTER-SALES-SERVICE
	Fault in the electronics	Read out error memory from engine control unit, consult LIEBHERR AFTER-SALES-SERVICE
Poor diesel engine braking action	Diesel engine brake flap not functioning	Functional or visual inspection; Consult LIEBHERR AFTER-SALES-SERVICE
	Fault in the electronics	Consult LIEBHERR AFTER-SALES-SERVICE
Diesel engine is becoming too hot (indicated on the coolant temperature display)	Insufficient coolant,	Refill

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Fault	Possible cause	Remedy
	Cooler interior contaminated or calcified, cooler exterior heavily contaminated	Clean or decalcify
	Thermostat faulty	Check and replace as necessary, consult LIEBHERR AFTER-SALES-SERVICE
	Coolant temperature sensor faulty	Check and replace as necessary, consult LIEBHERR AFTER-SALES-SERVICE
	Speed of fan too low (hydrostatic fan drive only)	Check fan drive and replace wherever necessary, consult LIEBHERR AFTER-SALES-SERVICE
Charging current indicator lamp lights up when the diesel engine is running	Inadequate tension of ribbed V-belt	Check belt tension, if necessary replace tension pulley
	Ribbed V-belt torn	Replace ribbed V-belt
	Cable connections loose or disconnected	Secure or replace cable
	Alternator, rectifier or governor faulty	Consult LIEBHERR AFTER-SALES-SERVICE
Diesel engine emitting black smoke	Injection nozzles getting stuck or not spraying	Consult LIEBHERR AFTER-SALES-SERVICE
	Diesel engine brake flap faulty	Functional or visual inspection; Consult LIEBHERR AFTER-SALES-SERVICE
	Turbocharger faulty (boost pressure too low)	Consult LIEBHERR AFTER-SALES-SERVICE
Exhaust gases are blue in colour	Oil level in diesel engine too high	Ensure correct oil level
	Lube oil is entering the combustion chamber and is being burned.	Consult LIEBHERR AFTER-SALES-SERVICE
	Seals on the compressor side on the exhaust turbocharger faulty	Check exhaust turbocharger, replace as necessary; Consult LIEBHERR AFTER-SALES-SERVICE
	Crankcase breather faulty	Check and replace as necessary
Exhaust gases are white in colour	Injection begin too late	Consult LIEBHERR AFTER-SALES-SERVICE
	Heater flange faulty (with cold temperatures)	Check heater flange and replace as necessary
Diesel engine knocking	Combustion disorder	Consult LIEBHERR AFTER-SALES-SERVICE
Diesel engine rattling	Valve clearance too big	Adjust valve clearance
	Injection nozzles faulty or carbonised	Consult LIEBHERR AFTER-SALES-SERVICE
	Damaged bearings	Consult LIEBHERR AFTER-SALES-SERVICE
	Piston rings worn or broken, pistons eroded	Consult LIEBHERR AFTER-SALES-SERVICE
Irregular noises	Leakages at the induction pipe and exhaust gas pipe cause whistling noises	Remedy leakages, if necessary replace seal
	Rubbing of turbine wheel or compressor impeller on the housing; Foreign bodies in compressor or turbine; Seized bearing of rotating parts	Consult LIEBHERR AFTER-SALES-SERVICE
Insufficient lube oil pressure	Oil level in the oil sump too low	Fill in oil to prescribed level
	Viscosity of lube oil too low (thinning of oil by diesel fuel)	Drain oil, fill in prescribed oil

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Fault	Possible cause	Remedy
	Oil pressure gauge or pressure sensor faulty	Check oil pressure and replace faulty oil sensor or pressure gauge; Consult LIEBHERR AFTER-SALES-SERVICE
	Bearing clearance too great due to wear or bearing damaged	Consult LIEBHERR AFTER-SALES-SERVICE
Lube oil in the cooling system	Oil cooler or oil cooler grill leaking	Consult LIEBHERR AFTER-SALES-SERVICE
Cooling water in the lube oil	O-rings on the cylinder liners not tight	Consult LIEBHERR AFTER-SALES-SERVICE
	Oil cooler or oil cooler grill leaking	Consult LIEBHERR AFTER-SALES-SERVICE

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5 Maintenance

5.1 Maintenance and inspection schedule

Abbreviations used in this section:
h = Operating hours
BA = Operating instructions
WH = Workshop handbook
AFP = Authorised, trained personnel
WP = Maintenance personnel

Different symbols(circle, box – filled or circle, box – blank) divide the maintenance tasks into two groups.
Meaning of symbols:

– Circle, box – filled out means that the machine operator or his maintenance personnel must carry out the maintenance tasks independently.
  The maintenance intervals correspond to every 10 and 50 operating hours (h)
– Circle, box – blank means that the specialist personnel authorised by the LIEBHERR company, or their appointed dealers, must carry out or supervise the maintenance and inspection tasks.
  The maintenance intervals apply upon commissioning and every 500, 1000, 2000 operating hours (h)

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Customer: ..... Machine type: ..... Serial No.: ..... Oper. hours: ..... Date .....

Maintenance/inspection according to operating hours							TASKS TO BE PERFORMED
On delivery	Every 10	Every 50	Every 500	Every 1000	Every 2000	Special intervals	**By maintenance personnel** ■ One-off activity ● Repetition interval ✦ If necessary ❄ Annually at the start of the cold season **By authorised qualified personnel** □ One-off activity ❍ Repetition interval ✧ If necessary
							Diesel engine
	●	●	❍	❍	❍		Check the oil level
	●	●	❍	❍	❍		Visual inspection (leaks, contamination, damages)
			❍	❍	❍		Check the flap of the diesel engine brake
			❍	❍	❍		Check the exhaust return shut-off flap
			❍	❍	❍		Change the diesel engine oil (however at least once a year): CAUTION! Only engine oils E4, E5, E6, E7 may be used. Other oil qualities and difficulty factors: see Fuel and Lubricants
			❍	❍	❍		Replace the oil filter element (however at least once a year)
			❍	❍	❍		Check batteries and cable connections
			❍	❍	❍		Check condition of belt drive, replace as necessary / check tension of ribbed V-belt and adjust as necessary
			□	❍	❍		Check induction and exhaust systems for sound condition, secure fastening and leaks
				❍	❍		Lubricate ring gear on the flywheel
				❍	❍		Check oil sump, engine mounting and diesel engine bracket for secure fastening
						❄	Check heater flange
							Cylinder head - valves
			❍	❍	❍		Check / adjust valve clearance
							Cooling system
	●	●	❍	❍	❍		Check the coolant level
			❍	❍	❍		Check the cooling and heating systems for sound condition and for leaks
			❍	❍	❍	❄	Check anticorrosive and antifreeze concentrations in the coolant
						3000h	Replace coolant (at least every 2 years)
							Fuel system
	●	●	❍	❍	❍		Check water separator on the fuel pre-filter and drain water as required
		●	❍	❍	❍		Drain water and sediment in the fuel tank
			❍	❍	❍		Check lubrication system and fuel system for leaks and for sound condition
			❍	❍	❍		Replace the fuel prefilter (or with output deficiency)
			❍	❍	❍		Replacing the fuel fine filter
						✧	Bleed the fuel system (injection lines may not be loosened)
							Air filter
	●	●	❍	❍	❍		Check low-pressure display of the air filter
		●	❍	❍	❍		Clean the dust discharge valve of the air filter

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Customer: ..... Machine type: ..... Serial No.: ..... Oper. hours: ..... Date .....

Maintenance/inspection according to operating hours							TASKS TO BE PERFORMED
On delivery	Every 10	Every 50	Every 500	Every 1000	Every 2000	Special intervals	**By maintenance personnel** ■ One-off activity ● Repetition interval ✦ If necessary ❄ Annually at the start of the cold season **By authorised qualified personnel** □ One-off activity ❍ Repetition interval ✧ If necessary
						✧	Replace dry air filter main element (in accordance with maintenance display / yearly)
						✧	Replace dry air filter safety element (with every third replacement of the main element / yearly)
Electrical system							
			❍	❍	❍		Check control unit mounting for sound condition
			❍	❍	❍		Check sensoric and cable connections for sound condition

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5.2 Lubricant chart, Filling quantities

5.2.1 Table of filling quantities

	Name	Medium	Dosage	Units
 06sy04ab	Diesel engine D9508, engine only	Coolant	approx. 45	Litres
 06sy04ab	Diesel engine D9508, engine only with eAGR—modules	Coolant	approx. 60	Litres
 06sy05ab	Diesel engine D9508 with oil filter (1.5 l per filter)	Oil	approx. 60	Litres

5.2.2 Lubricant chart

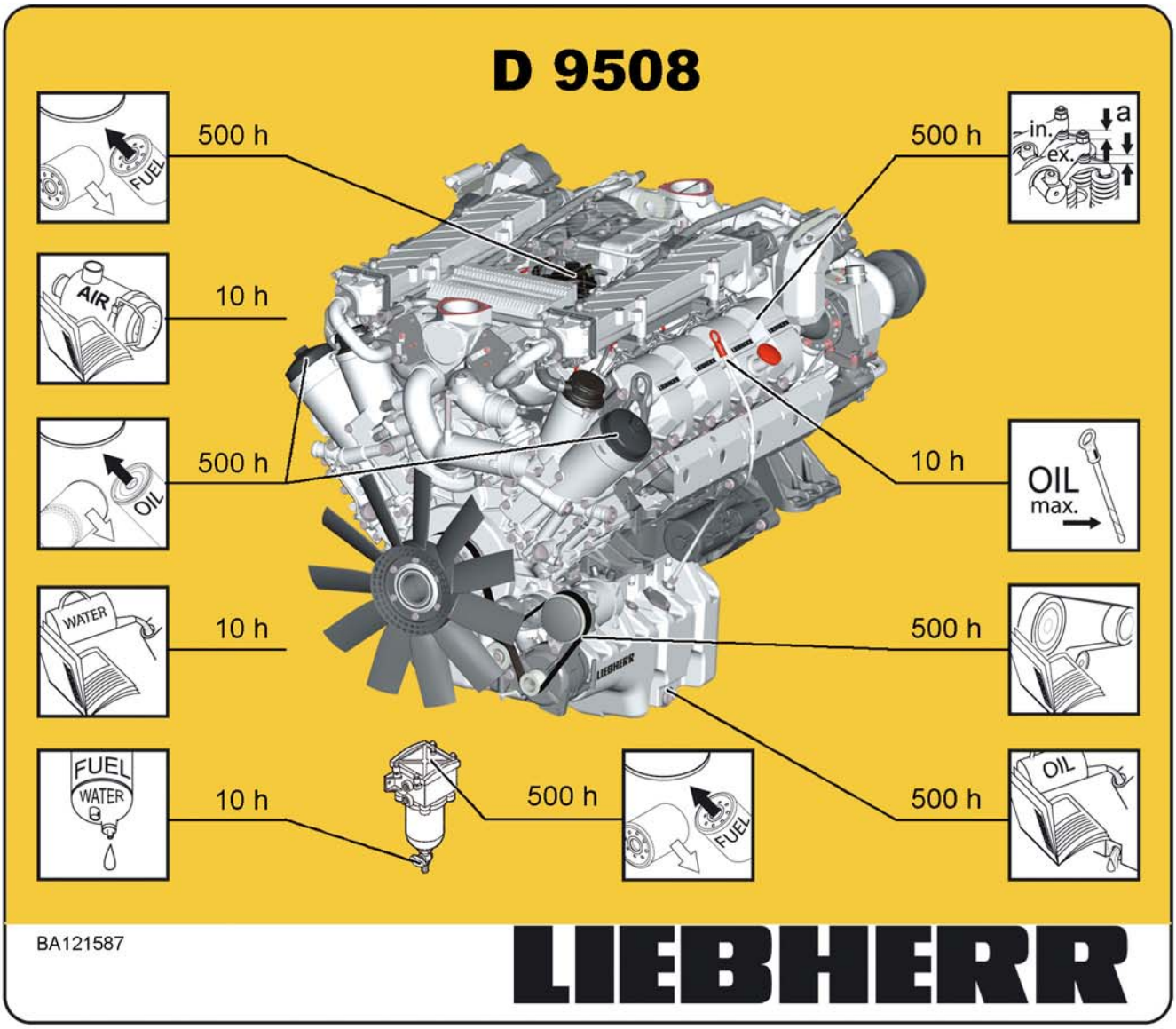
The lubrication chart serves as a summary for the location of maintenance points on the diesel engine and the maintenance interval periods.

Detailed information can be obtained in the section “Maintenance and Inspection Chart”, as well as in the individual descriptions regarding the carrying out of maintenance tasks, see the section, “Maintenance tasks...”.

For detailed information regarding the necessary fuels and lubricants, see the section, “Fuels and Lubricants”.

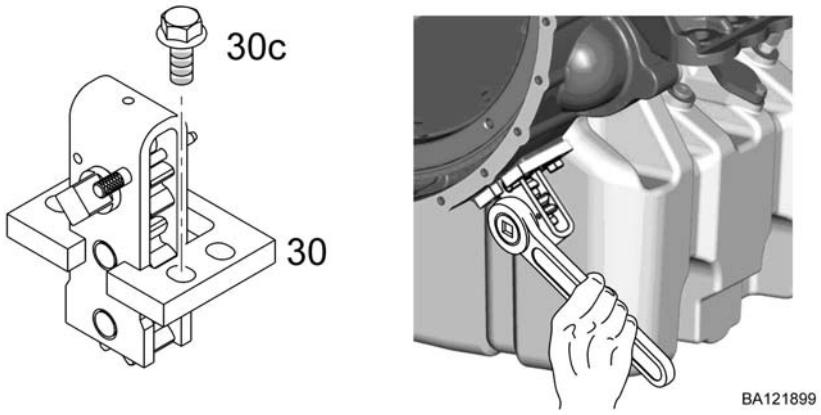
For information regarding the necessary filling amounts, “see the section, Filling Amounts Chart”.

Lubrication chart

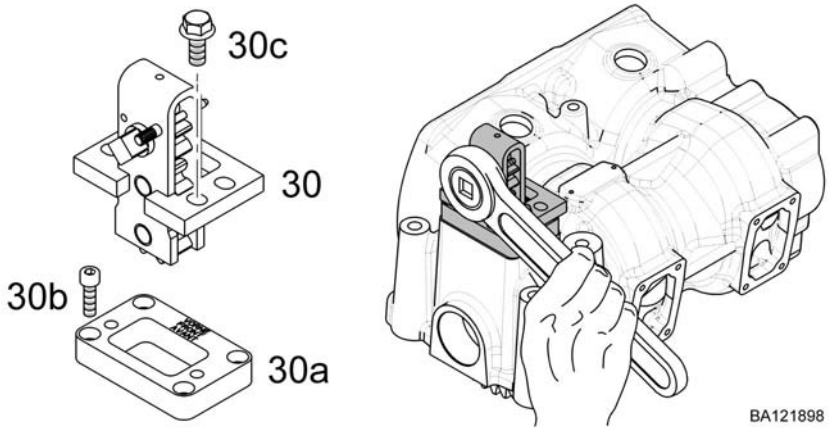


5.3 Maintenance tasks

5.3.1 Special tools for maintenance tasks



Turning gear — Mounting the flywheel housing special tool no. 30 and 30c



Turning gear — Mounting the air compressor special tool no. 30 to 30c

Note
When mounting the adapter special tool no. 30a
! The marking “front” must be pointing toward the air compressor

No.	Ident. no.	Model	See section
30	9078688	Turning gear	Checking / adjusting valve clearance
30a	10117021	Adapter	Checking / adjusting valve clearance
30b	4980868	Cylinder head screw M6x20	Checking / adjusting valve clearance
30c	10030519	Hexagonal screw with flange M6x20	Checking / adjusting valve clearance

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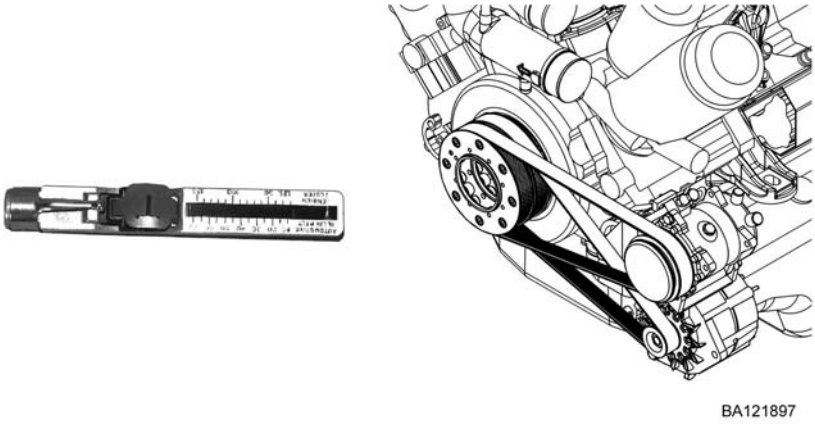

V-belt measuring device-Krikit 2 — special tool no. 8

No.	Ident. no.	Model	See section
8	8042829	V-belt measuring device-Krikit 2	Checking ribbed V-belt tension

5.3.2 Preparatory tasks for maintenance

Before carrying out diverse maintenance tasks, the diesel engine, unless otherwise expressly specified in the description, must be brought into the maintenance position.
Diverse maintenance tasks are for example:
– Checking the oil level or changing the oil,
– Replacing the filter, as well as adjustment or repair tasks.

Safety precautions for maintenance
It is imperative that the safety guidelines are observed when carrying out maintenance tasks! See the chapter, Safety Guidelines
Maintenance points
The diesel engine is in the maintenance position when:
– the diesel engine is positioned horizontally,
– the diesel engine is switched off,
– the diesel engine is cooled,
– the battery main switch (if featured) is switched off and the key for the battery main switch has been removed.

5.3.3 Maintenance tasks (daily) every 10 operating hours

It must be ensured that:
– the diesel engine is in the maintenance position

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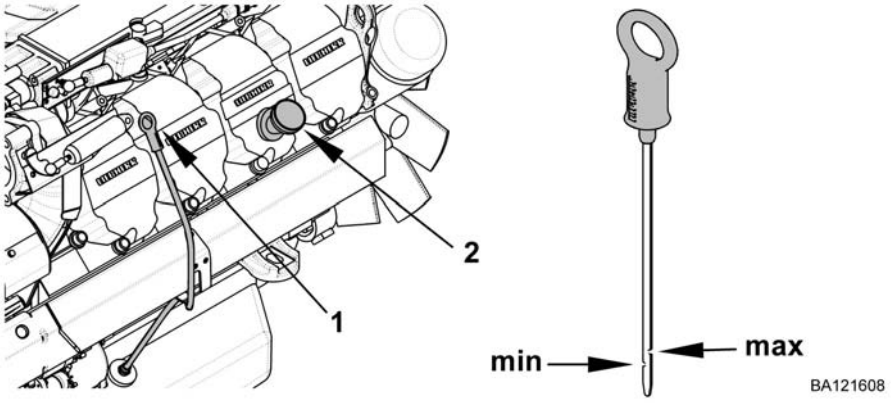
Checking the oil level

Arrangement of the oil dipstick and the oil filler nozzle varies depending on the diesel engine circumference, e.g. oil dipstick on the left-hand or right-hand side of the engine, oil filler nozzle is located on the oil sump, flywheel or on the cylinder head cover..



Example oil dipstick - oil filler nozzle

- Remove the oil dipstick **1** , wipe clean and reinsert.
- Pull out the oil dipstick once again and determine the oil level.

The oil level must be within min and max.

Troubleshooting

It has been determined that the oil level is too low:

- Fill in oil via the oil filler nozzle **2** (for oil quality, see the chapter “Fuel and Lubricants”).

Do not fill above the uppermost marking 'max.' of the oil dipstick

- Clean the oil filler cap, replace onto the oil filler nozzle and tighten.

Checking the coolant level

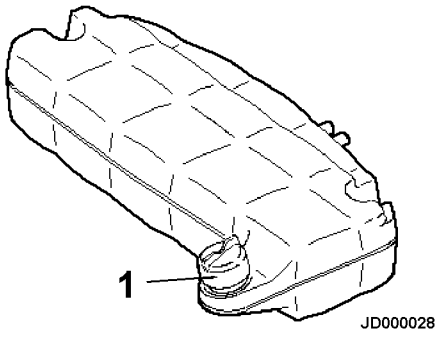
The coolant level is indicated externally on the transparent expansion tank. Machines featuring non-transparent expansion tank: Check the coolant level in the filler neck, if the level is correct the coolant is visible.

Procedure

Caution

Danger of scalding as a result of coolant being squirted out!

! Only open the sealing cap 1 on the expansion tank when the diesel engine has cooled - the coolant temperature display on the segment field of the display unit should be in the lower third of the segment field.



Coolant expansion tank

- Check coolant level, see documentation of the manufacturer.

Troubleshooting

It has been determined that the oil level is too low:

- Do not start the diesel engine.
- Turn the sealing cap on the expansion tank anticlockwise slightly until the excess pressure is dissipated, then open.

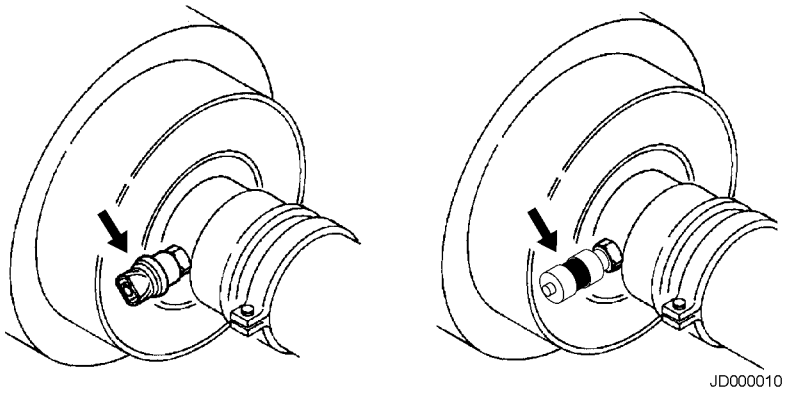
- Only fill in authorised coolant with 50 Vol.– % anticorrosive/antifreeze at the expansion tank
- Fill cooling system to maximum level.
- Remount the sealing cap on the expansion tank and tighten.
- Start the diesel engine and allow to run warm.
- Check the coolant level again when the diesel engine has cooled and refill as required.

Ensure that the coolant contains at least 50% anticorrosive / antifreeze (for coolant, see chapter “Fuel and Lubricants”).

Checking the air filter low-pressure display

For installation position and design of the air filter low-pressure display, see documentation of the machine manufacturer.

When the maximum permissible low pressure is reached, the mechanical air filter low-pressure display on the purified air connection of the air filter is in the red area or, with an electrical maintenance display, the indicator lamp lights up.



Air filter low-pressure display

- Checking the air filter low-pressure display

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Troubleshooting
If a display is in the red area, or if an indicator lamp is lit:

- Do not start the diesel engine.
- **Replace the air filter main element**.
- The air filter safety element is to be replaced after every third change of the air filter main element.

- Tasks to be carried out in compliance with the documentation of the manufacturer.
- If a reset button is featured on the air filter low-pressure display:
  After carrying out maintenance of the air filter, push in the reset button and release.

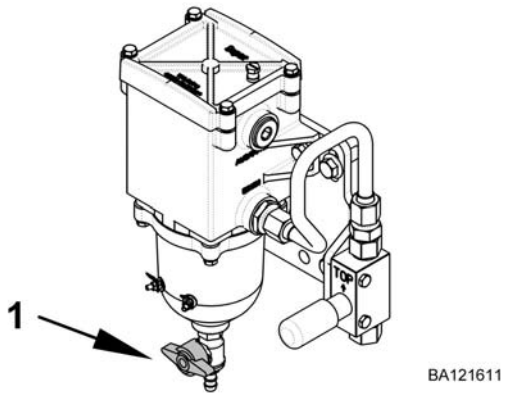
The display is reset in green.

Checking / draining the water separator of the fuel prefilter

The fuel prefilter with water separator and fuel manual delivery pump is mounted away from the diesel engine, the exact position varying in accordance with configuration of the machine.

Fuel pre-filter with water separator

Danger
Risk of fire and explosion!
! No smoking.
! Avoid naked flames.
! Only work on the diesel engine when the diesel engine is switched off.



Draining the fuel prefilter

- Check water separator of the fuel pre-filter

Troubleshooting
Should water be determined in the water separator of the fuel pre-filter:

- Do not start the diesel engine.
- Position a collecting vessel beneath the fuel water separator and if necessary, attach a drainage hose.
- Press in the drain tap handle **1** and turn in a clockwise direction, drain water until fuel flows out.

- When fuel begins to flow:
  Close drain tap 1

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Visual inspection (leaks, contamination, damages)

- Check the diesel engine for leaks via visual inspection.
- Check lines and hoses for leaks via visual inspection.
- Ensure sound condition without indication of damage, correct arrangement without the occurrence of wear and correct fastening of all lines and hoses.

5.3.4 Maintenance tasks (weekly) every 50 operating hours

Before carrying out the weekly maintenance tasks, the daily maintenance tasks must first be carried out.
See the section “maintenance tasks (daily) every 10 operating hours”.
It must be ensured that:
– the diesel engine is in the maintenance position

Draining water and sediment in the fuel tank

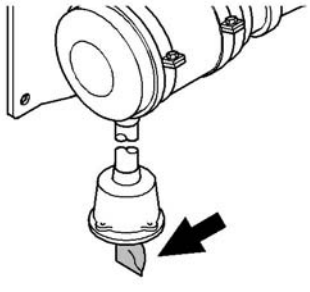
Ensure utmost cleanliness.

Danger
Risk of fire and explosion!
! No smoking.
! Avoid naked flames.
! Only work on the diesel engine when the diesel engine is switched off.

- Do not drain fuel onto the ground, use a suitable collecting vessel.
- Drain water and sediment in the fuel tank, see “Manufacturer's Machine Documentation”.
- When refuelling, maintain the level of fuel as high as possible in the tank, in order that condensation be reduced to a minimum.

Cleaning the dust discharge valve of the air filter

Maintenance of the air filter is not generally required if otherwise indicated on the maintenance display on the air filter or via an indicator lamp for filter maintenance.
Important:
A damaged or hardened dust-discharge valve renders functioning of the service cover ineffective, resulting in a reduced life-expectancy of the filter elements.



Dust-discharge valve

- Press the rubber lip on the dust-discharge valve repeatedly to empty the service cover.
- Empty the dust-discharge valve regularly when working in extremely dusty conditions.

Troubleshooting

The dust-discharge valve is damaged or is stuck in the open position:

- Replace the dust-discharge valve.

5.3.5 Maintenance tasks every 500 operating hours

Before carrying out the 500 operating hours maintenance tasks:

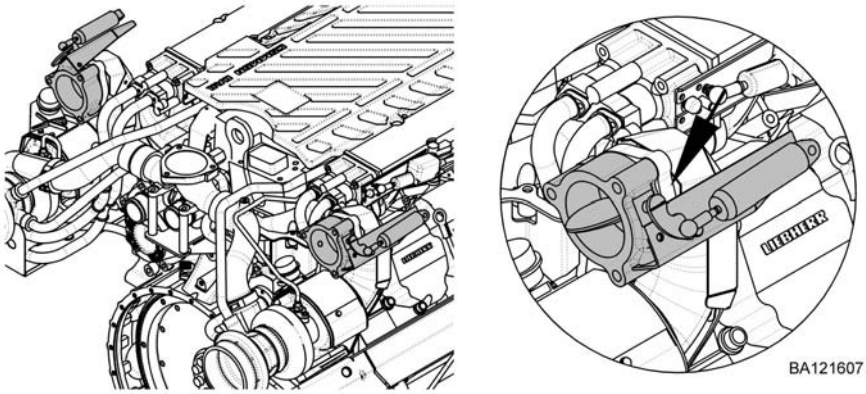
– carry out the daily maintenance tasks, see the section “Maintenance tasks (daily) every 10 operating hours”.
– carry out the weekly maintenance tasks, see the section “Maintenance tasks (weekly) every 50 operating hours”.

It must be ensured that:

– the diesel engine is in the maintenance position

Checking the flap of the diesel engine brake

A diesel engine brake is mounted on the turbocharger on the left-hand and right-hand side of the diesel engine.



Diesel engine brake – flap

- Check and grease the joints of the actuating cylinder.
- Actuate the brake flap.

Ensure that the flap returns correctly into the starting position following actuation.

This can be observed on the outside of the brake flap shaft, see arrow (fig. diesel engine brake – flap). The notch must be positioned parallel to the exhaust pipe.

The flap becoming caught causes the diesel engine to overheat and thus to the diesel engine becoming damaged.

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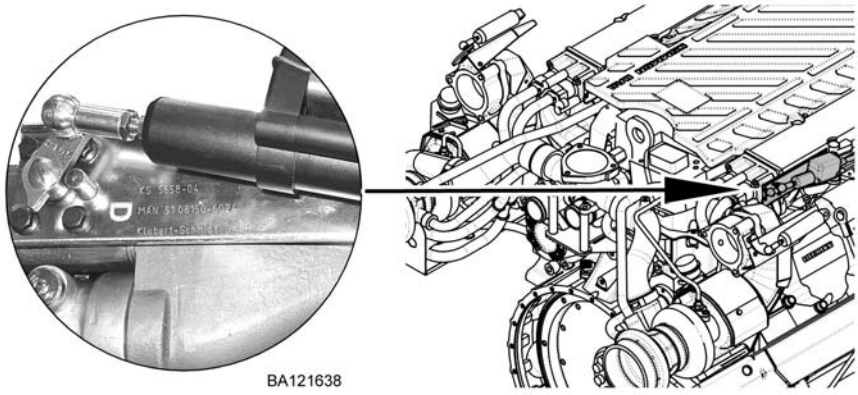
Checking the shut-off flap for exhaust gas recirculation

An exhaust gas recirculation module is mounted on the left-hand and right-hand side of the diesel engine.



Exhaust gas recirculation shut-off flap

- Check and grease the joints of the actuating cylinder.
- Actuate the exhaust gas recirculation shut-off flap

Ensure that the flap returns correctly into the starting position following actuation (all the way to the stop).
The emissions value will deteriorate if the flap is getting stuck.

Checking batteries and cable connections

- Use fully charged batteries which have undergone regular maintenance only.
  Maintenance, see manufacturer's documentation.
- Coat the terminals with terminal grease.
- Ensure sound condition without indication of damage, correct arrangement without the occurrence of wear and correct fastening of all lines and hoses.

Damaged lines have been determined?
Replace faulty lines or cable harnesses.

Checking, replacing and adjusting the ribbed V-belt

The belt drives are located at the front or at the rear of the diesel engine, the design and belt run vary depending on the circumference of the diesel engine, e.g. with generator drive and generator drive with air-conditioning compressor.
It must be ensured that:
– new ribbed V-belts are on-hand.
– a socket and lever bar are on-hand
Damages to the ribbed V-belt include:
– Rib fractures
– Transversal fractures in several ribs
– Rubber nodules in between the ribs
– Deposition of dirt or stones
– Ribs becoming loosened at the base of the ribs
– Transversal fractures on the belt exterior

- Check the ribbed V-belt for damage

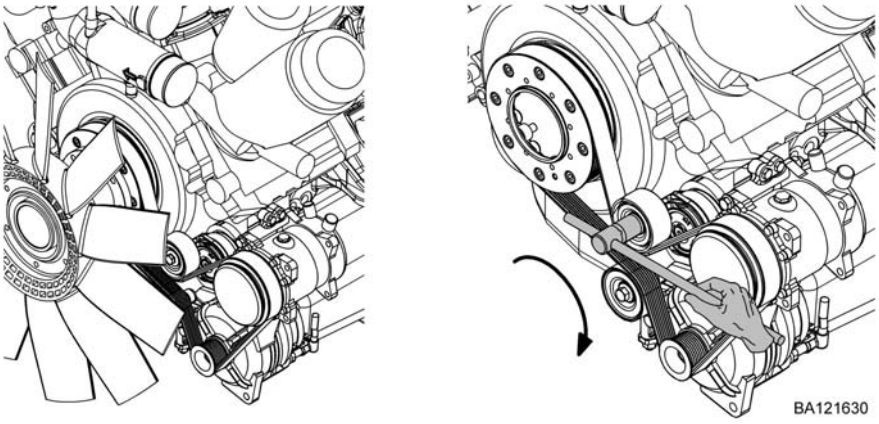
Troubleshooting

Damage has been determined?

- Replace the ribbed V-belt

Replacing and setting the ribbed V-belt for air-conditioning compressor and generator mounting. Drive of the crankshaft

Note
This mounting is self-tensioning and maintenance-free.
! Only the ribbed V-belt must be checked for wear.



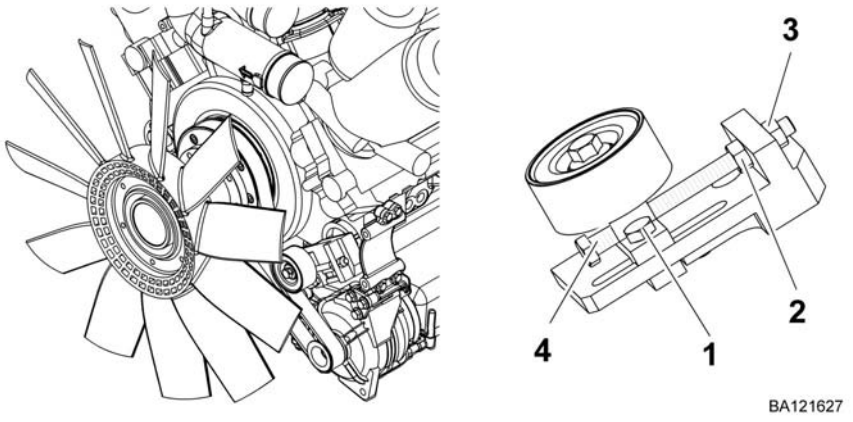
Ribbed V-belt for air-conditioning compressor and generator — drive of the crankshaft

- Place the socket and lever bar onto the screw for the tensioning pulley (tensioning pulley screw has left-handed thread).
- Swing back the tensioning device against the spring force in a clockwise direction all the way to the stop and remove the ribbed V-belt.
- Ensure sound condition and correct clearance of the belt pulleys and tension pulley (e.g. wear of belt pulley profiles or damage to the tension pulleys).

If parts are damaged, replace the parts

- With the tensioning device swung back, mount new ribbed V-belt onto all pulleys and tension pulleys ensuring a sound fit.
- Return the tensioning device into the tensioning position.

Replacing and setting the ribbed V-belt for the generator. Drive of the crankshaft



Generator ribbed V-belt — drive of the crankshaft

- Loosen screws **1,2,3**
- Unscrew the hexagonal nut **2** until the ribbed V-belt becomes loose.
- Remove the ribbed V-belt.

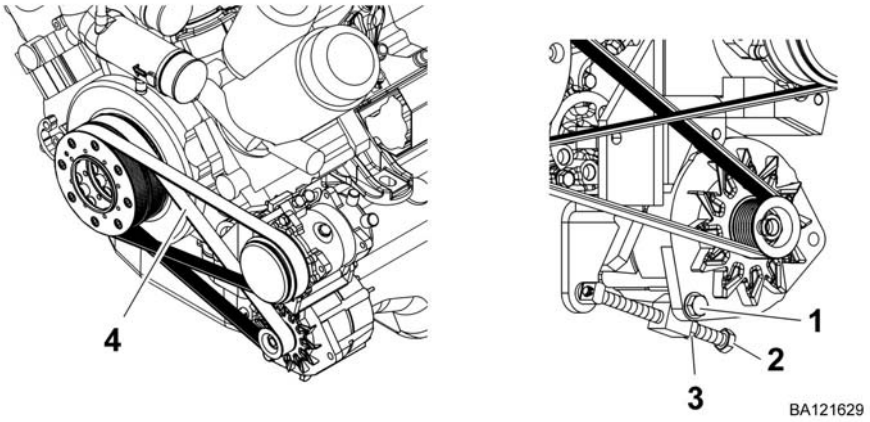
- Ensure sound condition of belt pulleys (e.g. wear of belt pulley profiles).

If parts are damaged, replace the parts

- Mount new ribbed V-belt ensuring a sound fit.
- **Setting the ribbed V-belt tension**
  Turn the hexagonal nut **2** to the right, at the same time counterholding the hexagonal screw **4** until the correct ribbed V-belt tension is attained, see “Checking tension of the ribbed V-belt”.
- Tighten all screws **1,2,3** again.
- Allow to run for 10 to 15 minutes
  Check the tension again and readjust as required

Replacing and setting the ribbed V-belt for the generator. Drive of the crankshaft

Note
The ribbed V-belt for air-conditioning compressor operation
! must be dismantled beforehand or mounted afterwards.



Generator ribbed V-belt — drive of the crankshaft

- Loosen screw **1** and lock nut **3**
- Unscrew the adjusting screw **2** until the ribbed V-belt becomes loose.
- Remove the ribbed V-belt **4** .
- Ensure sound condition of belt pulleys (e.g. wear of belt pulley profiles).

If parts are damaged, replace the parts

- Mount new ribbed V-belt **4** ensuring a sound fit.
- **Setting the ribbed V-belt tension**
  Screw in the adjusting screw **2** until correct tension of the ribbed V-belt is attained.
- Tighten the screw **1** and lock nut **3** again.
- Allow to run for 10 to 15 minutes
  Check the tension again and readjust as required

Replacing and setting the ribbed V-belt for the air-conditioning compressor. Drive of the crankshaft

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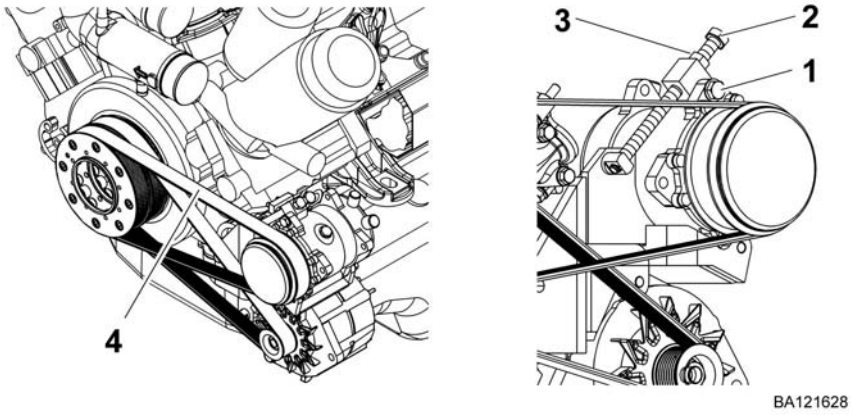


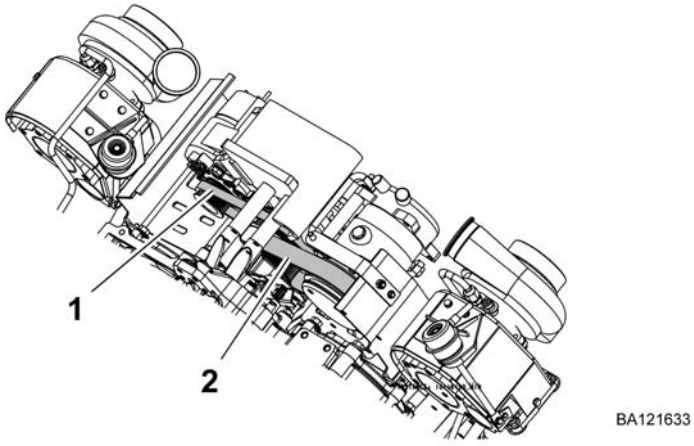
Ribbed V-belt air-conditioning compressor — drive of the crankshaft

- Loosen screw **1** and lock nut **3**
- Unscrew the adjusting screw **2** until the ribbed V-belt becomes loose.
- Remove the ribbed V-belt **4** .
- Ensure sound condition of belt pulleys (e.g. wear of belt pulley profiles).

If parts are damaged, replace the parts

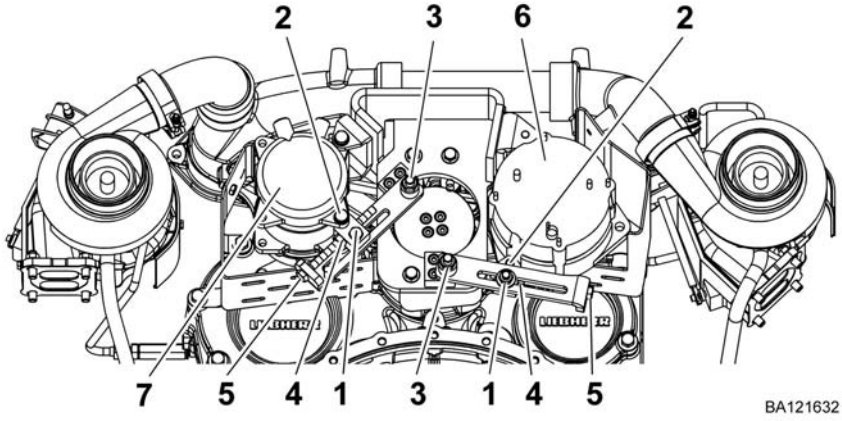
- Mount new ribbed V-belt **4** ensuring a sound fit.
- **Setting the ribbed V-belt tension**
  Screw in the adjusting screw **2** until correct tension of the ribbed V-belt is attained.
- Tighten the screw **1** and lock nut **3** again.
- Allow to run for 10 to 15 minutes
  Check the tension again and readjust as required

Replacing and setting the ribbed V-belt for generator / air-conditioning compressor. Drive of the fuel high-pressure pump



Ribbed V-belt for generator / air-conditioning compressor

When replacing the ribbed V-belt **2** for the air-conditioning compressor drive the ribbed V-belt **1** for the generator drive must first be dismantled, or subsequently remounted.
The following procedure applies to both the generator drive and air-conditioning compressor drive.



Ribbed V-belt for generator / air-conditioning compressor — drive of the fuel high-pressure pump

- Loosen the hexagonal screws **1, 2** , hexagonal nuts **3** and lock nut **4**
- Unscrew the adjusting screw **5** until the ribbed V-belt becomes loose.
- Remove the ribbed V-belt
- Ensure sound condition of belt pulleys (e.g. wear of belt pulley profiles).

If parts are damaged, replace the parts

- Mount new ribbed V-belt ensuring a sound fit.
- **Setting the ribbed V-belt tension**
  Screw in the adjusting screw **5** until correct tension of the ribbed V-belt is attained.
- Tighten the hexagonal screws **1, 2** hexagonal nuts **3** and lock nut **4** once again.
- Allow to run for 10 to 15 minutes
  Check the tension again and readjust as required

Checking tension of the ribbed V-belt

Measuring point: in the middle between crankshaft belt pulley – generator belt pulley or in the middle between crankshaft belt pulley and belt pulley air-conditioning compressor.
It must be ensured that:
– a measuring device “Krikit 2” (special tool no. 8) is on-hand.
Measured values for checking the tension by hand are:
– Sag: approx. 10 mm for generator drive or approx. 10 mm for air-conditioning compressor drive.

- Check ribbed V-belt tension at the measuring points

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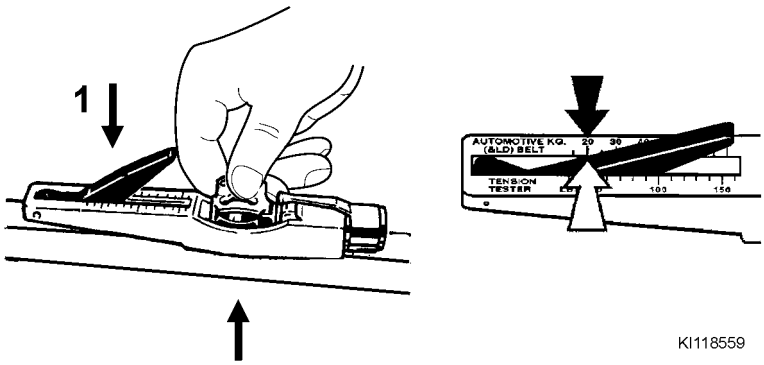
Troubleshooting

If the prescribed measured values are not attained?

- Relieve or apply tension in the ribbed V-belt
- see section: Checking condition of the ribbed V-belts, replacing and setting.

Measured values for testing the tension with a measuring device “Krikit 2 ”(special tool no. 8) are:

Ribbed V-belt	New ribbed V-belt KG scale	Used ribbed V-belt KG scale
8 grooves, width approx. 28 mm	50	40 to 50



Measuring device Krikit 2 (special tool no. 8):

- With measuring device Krikit 2 (special tool no. 8)
  Lower the indicator arm **A** all the way into the measuring device
- Place the measuring device onto the measuring point on the upper side of the ribbed V-belt
- Apply pressure to the V-belt slowly and evenly with the pressure key until the compression spring snaps. This should be both audibly and physically perceptible.

The indicator arm now indicates the tension of the ribbed V-belt.

- Carefully lift the measuring device and read off the measured value on the intersection point of the “KG” scale and the indicator arm (see arrow).

Troubleshooting

The value which is displayed does not correspond with the value in the table ?

- Relieve or apply tension in the ribbed V-belt
- see section: Checking condition of the V-belts and ribbed V-belts, replacing and setting.

Checking induction and exhaust systems for sound condition, secure fastening and leaks

Note
The standard interval is at 1000 operating hours!
! These maintenance tasks are only to be carried out once after 500 operating hours.

- Check suction lines between air filter and diesel engine for sound condition, leaks and secure fastening.
- Check exhaust lines for sound condition, leaks and secure fastening.

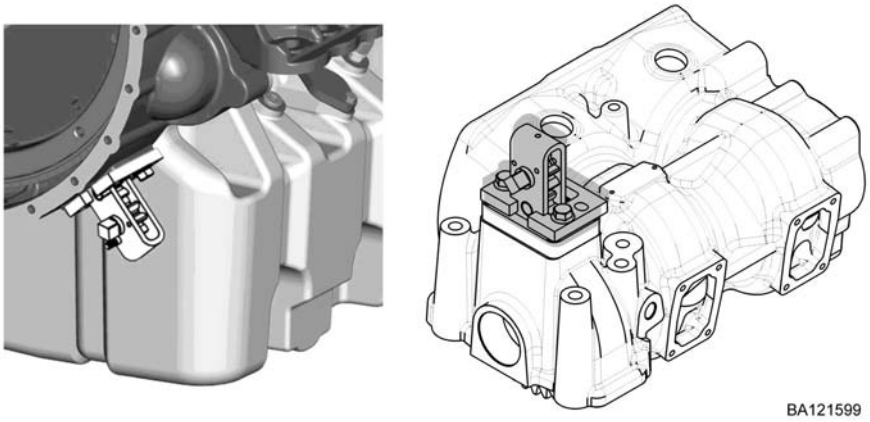
Preparation for checking and adjustment of valve clearance

It must be ensured that:
– the diesel engine is in the maintenance position,
– the diesel engine is cooled,
– a special tool no. 30 is on-hand.
– new seals for the cylinder head cover are on-hand.

This check should only be carried out when the diesel engine is cool, for adjustment values, see “Technical Data” valve clearance.

Note

! Cylinder 1 is located on the opposite side of the flywheel on the right.
! Rotational direction on the left-hand side looking at the flywheel



Turning gear — valve overlap

- Dismantle the cylinder head covers, mount the turning gear, special tool no. 30, on the flywheel housing or, if available, with adapter special tool no. 30a on the air compressor. The marking “front” must be pointing toward the air compressor.

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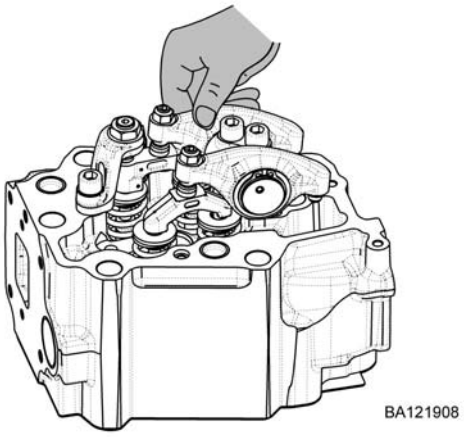
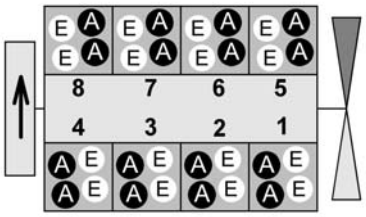


Overlapping valves

- Turn the crankshaft in the direction of rotation until the valves in the cylinder being adjusted overlap, see table for details.



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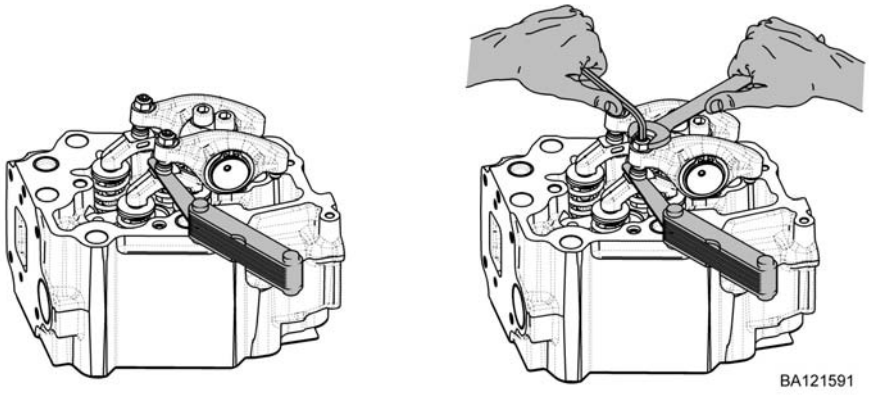
Valves of the cylinder

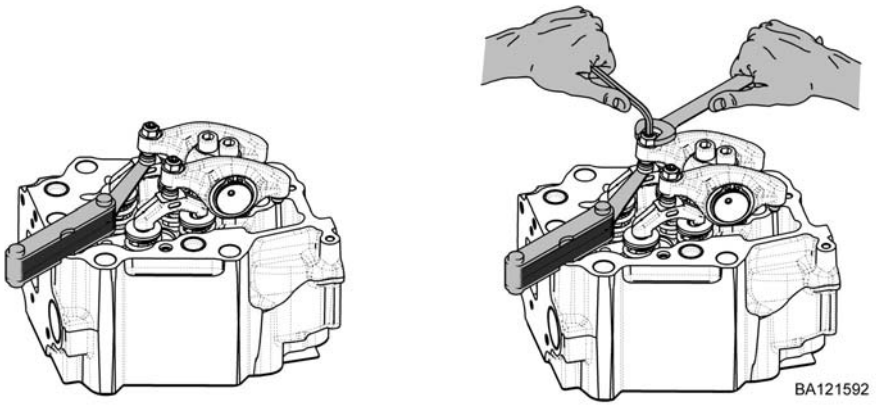
A = Exhaust valve E = Intake valve

Valves of cylinder D9508								
overlap	1	5	7	2	6	3	4	8
adjust	6	3	4	8	1	5	7	2

Checking and adjusting valve clearance standard



Checking / adjusting intake valve clearance



Checking / adjusting exhaust valve clearance

- Insert feeler gauge between valve fitting and rocker arm and check the valve clearance

Troubleshooting

The clearance does not correlate with the adjustment values ? See “Technical data”, Valve clearance

- Loosen the lock nut on the adjusting screw of the respective rocker arm and adjust the setting.
- Tighten lock nut with 45 Nm

- Check adjustment again
- Following checking or adjustment of all valves on the cylinder head covers, fit new seals.
- Dismantle the turning gear

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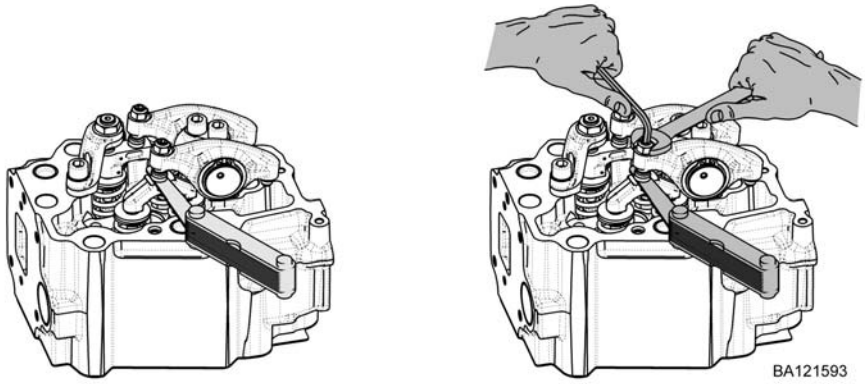
Checking and adjusting the valve clearance with engine auxiliary brake system (ZBS)

Checking the intake valves:



Checking / adjusting intake valve clearance

- Insert feeler gauge between valve fitting and rocker arm and check the valve clearance

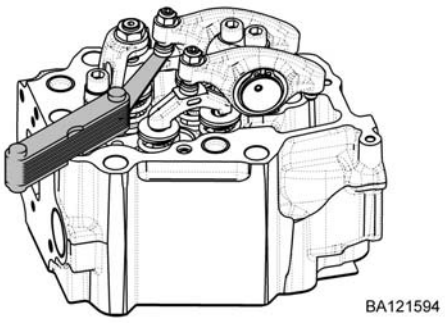
Troubleshooting

The clearance does not correlate with the adjustment values? See “Technical data”, Valve clearance

- Loosen the lock nut on the adjusting screw of the respective rocker arm and adjust the setting.
- Tighten lock nut with 45 Nm

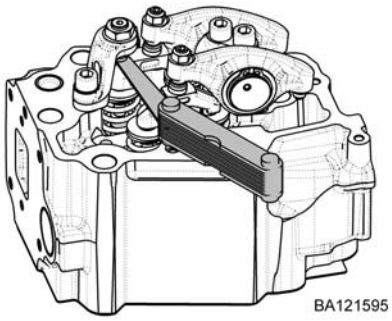
- Check adjustment again

Checking exhaust valve clearance:



Valve clearance exhaust valve fitting/rocker arm

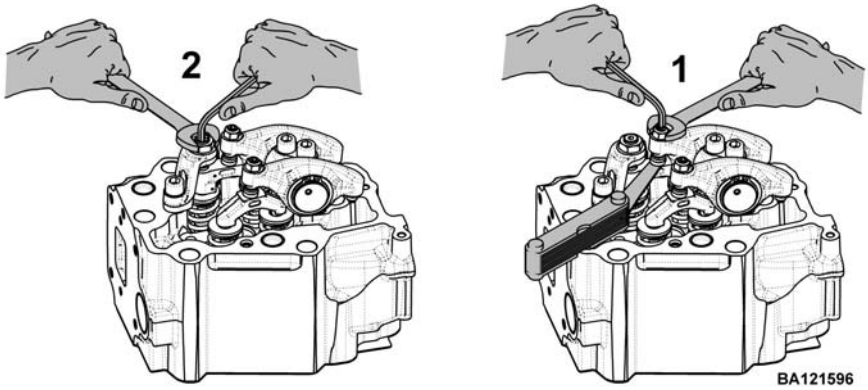
- Insert the feeler gauge between exhaust valve fitting and adjusting screw — rocker arm and check valve clearance, adjust as necessary



Valve clearance exhaust valve fitting/retainer

- Insert the feeler gauge between exhaust valve fitting and adjusting screw—retainer and check valve clearance, adjust as necessary

Adjusting exhaust valve clearance:



Valve clearance exhaust valve fitting/rocker arm

- Turn back the adjusting screw **2** until the contact face of the adjusting screw disappears inside the retainer.
- Turn back the adjusting screw **1** until it is possible to insert the feeler gauge which corresponds to the respective adjustment value.
- Screw in the adjusting screw **1** until the piston in the exhaust valve fitting reaches the stop and clamps the feeler gauge.
- Loosen the adjustment screw **1** until it is possible to remove the feeler gauge against moderate resistance (suction).
- Tighten the lock nut with 45 Nm.

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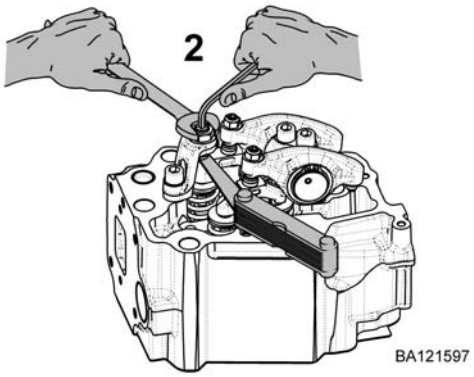

Valve clearance exhaust valve fitting/retainer

- Screw in the adjusting screw **2** with the feeler gauge corresponding to the respective adjustment value inserted, until the piston of the valve fitting reaches the stop and the feeler gauge becomes clamped.
- Loosen the adjustment screw **2** until it is possible to remove the feeler gauge against moderate resistance (suction).
- Tighten lock nut with 45 Nm.

Note
The push rod must indicate clearance!
! Check following successful adjustment.

- Following adjustment of all valves, fit cylinder head covers with new seals.
- Dismantle the turning gear

Replacing the fuel prefilter

The fuel prefilter with water separator and fuel manual delivery pump is mounted away from the diesel engine, the exact position varying in accordance with configuration of the machine.
Depending on the diesel engine circumference, the fuel prefilter features fuel pre-heating.
Ensure that the following are on-hand:
– a collecting vessel for the fuel
– a fuel prefilter element

Danger
Risk of fire and explosion!
! No smoking.
! Avoid naked flames.
! Only work on the diesel engine when the diesel engine is switched off.

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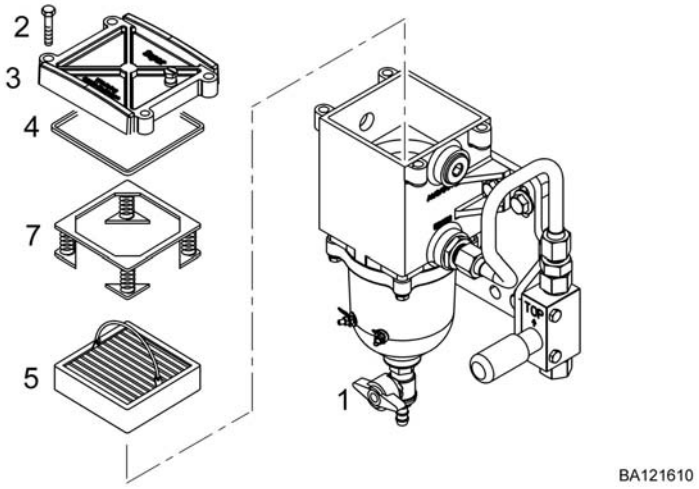

Fuel prefilter

- If a fuel shut-off valve is available:
  Close the fuel shut-off valve.
- Position the collecting vessel beneath the fuel prefilter.
- Press in the drain tap handle **1** and turn in a clockwise direction, drain fuel.
- Unscrew the screws **2** and remove the cover **3** with seal **4** .
- Remove the paper filter element **5** together with the spring cassette**7**
- Dispose of the paper filter element**5**
- Install the new paper filter **5** again.
- Check seal 4, replace if necessary and reassemble in reverse order.
- Open the fuel shut-off valve and bleed the fuel prefilter, see “Maintenance task with special interval”.

Replacing the fuel fine filters

The fuel fine filters are located at the top in the "V" space of the diesel engine below the kick plate.
Ensure that the following are on-hand:
– a collecting vessel for the fuel
– two original LIEBHERR fuel filter elements
– a suitable drainage hose from the manufacturer is on-hand.

Danger
Risk of fire and explosion!
! No smoking.
! Avoid naked flames.
! Only work on the diesel engine when the diesel engine is switched off.

- If a fuel shut-off valve is available:
  Close the fuel shut-off valve.

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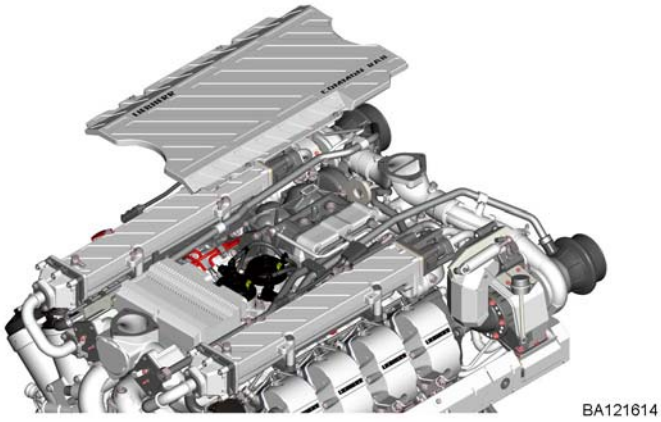
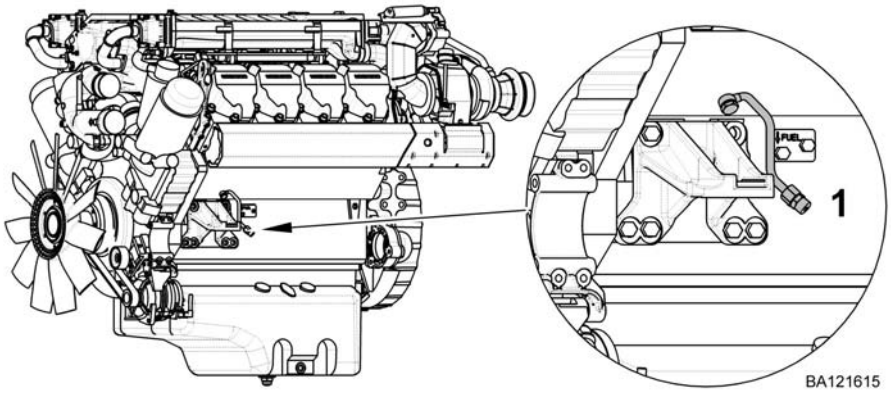


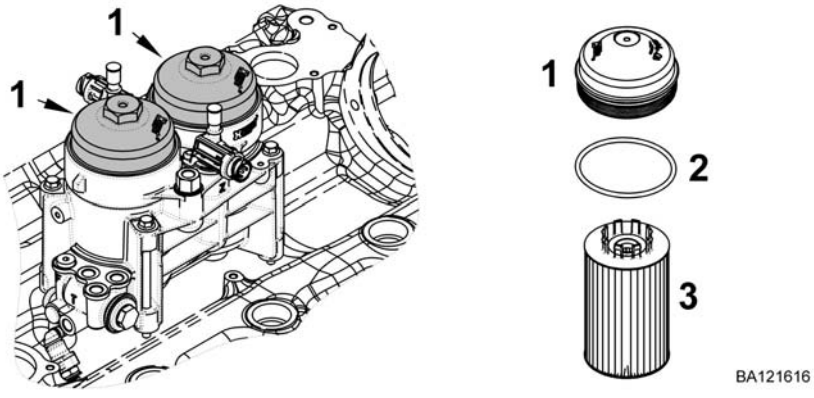
Kick plate

- Dismantle the kick plate



Fuel drainage line

- Dismantle the screw fitting**1**
- Position collecting vessel beneath the fuel drainage line.
- Clean the fuel fine filter and the surrounding area thoroughly.



Replacing the fuel filter element

- Loosen both housing covers **1** from the fuel service centre using an appropriate tool. Open the cover until the respective vent hole is freed.
- Wait until the fuel from the filter housing has drained out into the collecting vessel.

- Dismantle both covers of the fuel service centre including the fuel filter element.
- Remove the fuel filter element **3** from the cover**1** .
- Dispose of old fuel filter elements.
- Replace the sealing ring**2,** , if necessary clean the cover.

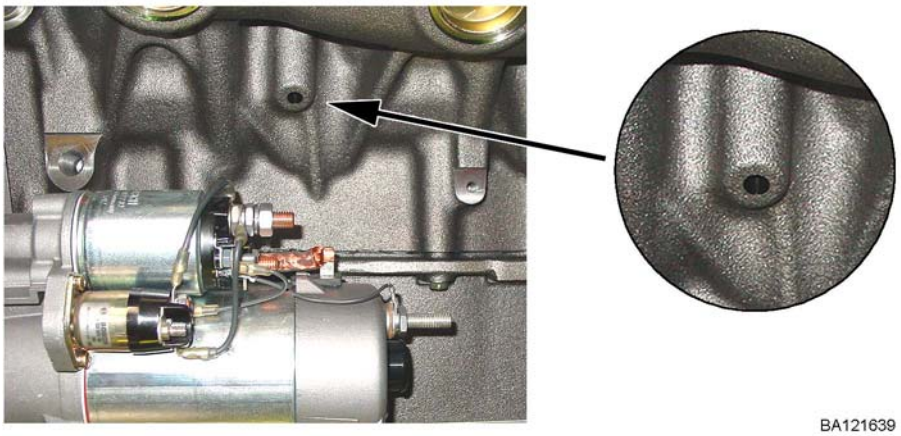
Warning
Dirt can cause ruination of the Common Rail System !

! Do not allow any dirt to enter into the clean side of the filter. Leave the remaining fuel in the filter housing, do not wipe out the filter housing with a rag.

! Do not reuse a fuel filter element once it has already been used.

- Use new original Liebherr fuel filter elements.
- Screw in the fuel filter element with cover and tighten (tightening torque 20^{+5}Nm).
- Seal the fuel drainage line with plug.
- Open the fuel shut-off valve and fill the fuel system using the hand pump.

Checking lubrication system and fuel system for leaks and for sound condition



V-compartment drainage bore

The diesel engine features a drainage bore through the crankcase-bulkhead. This will allow any liquids such as water, fuel etc. to be channelled out of the V-compartment

- Check oil sump, oil filter, fuel delivery pump and fuel filter for leaks.
- Check all lines and hoses of the oil and fuel systems, ensure that they are correctly arranged without abrading one another, are free of damage and are securely fastened.

Troubleshooting
Determine any leaks in the oil and fuel system:

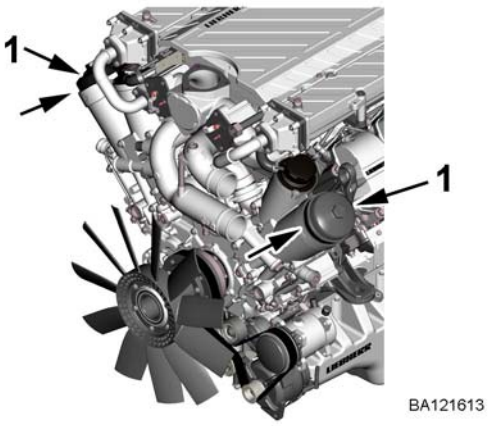
- Do not start the diesel engine.
- Determine and remedy the cause and replace any damaged parts.

Changing diesel engine oil and replacing the oil filter element

The oil drain valve is mounted on the diesel engine, either at the bottom or on the side of the oil sump.
The oil filter modules are arranged on the left-hand and right-hand side of the front of the diesel engine, on the opposite side of the flywheel.
It must be ensured that:

– the diesel engine is positioned horizontally
– the diesel engine is switched off
– the diesel engine is warm
– original LIEBHERR oil filter elements with the sealing rings (2, 3) have been provided
– a suitable container featuring approx. 80 l volumetric capacity, as well as a suitable oil drainage hose for the oil drain valve and diesel engine oil in compliance with the oil specification have been provided

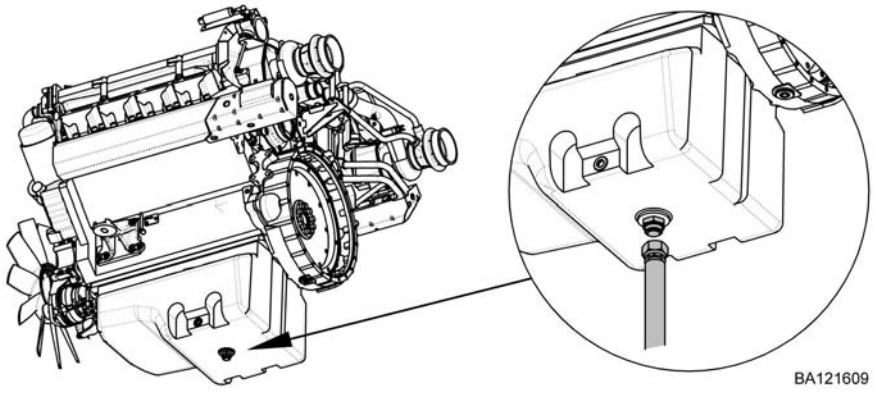
Draining the diesel engine oil



Oil filter modules

- Unscrew both oil filter covers **1** until the upper O-ring becomes visible.

The diesel engine oil flows back into the oil sump from the oil filter modules.



Oil drain valve

- Unscrew the sealing cap on the oil drain valve on the oil sump.
- Screw the oil drainage valve onto the oil drain valve, thus opening the oil drain valve.
- Drain used oil into the prepared container.

Replacing the oil filter element

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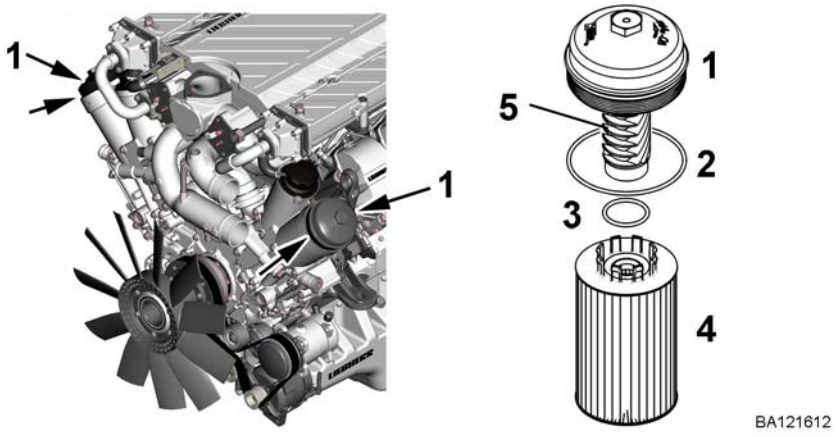


Oil filter modules

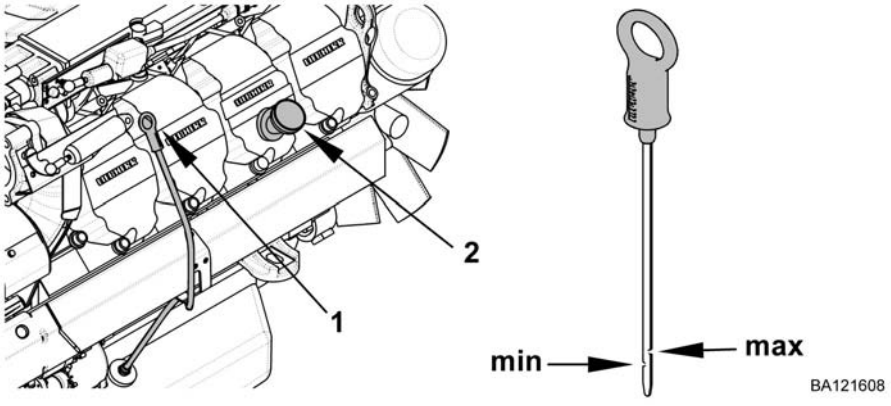
- Remove oil filter cover **1** with oil filter element
- Remove the old oil filter element **4** from the cover.

If the guide tube **5** gets stuck in the oil filter element**4**
Remove the guide tube **5** and fit onto the cover **1** once again.

- Dispose of the oil filter element, observing the notes on safety to ensure that no harm is caused to the environment.
- Install the new sealing rings **2, 3** .
- Install new oil filter element **4** .
- Insert oil filter cover **1** with oil filter element **4** and tighten with 40^{+10} Nm.

Filling diesel engine oil

- Unscrew the oil drainage hose and unscrew the sealing cap on the oil drain valve



Diesel engine-oil filler nozzle

- Fill in oil via the oil filler nozzle **2** to within the min. and max. markings on the oil dipstick**1** .
- Clean the oil filler cap, replace onto the oil filler nozzle and tighten.
- Start the diesel engine.
- Check oil pressure (diesel engine oil pressure display unit) and check seals on the oil filter.
- Switch off diesel engine.
- Check the oil level after 2 - 3 minutes on the dipstick.

Troubleshooting
The oil level is not within min. and max.?

- Rectify the oil level.

Check the cooling and heating systems for sound condition and for leaks

- Check cooler, coolant pump and heat exchanger for the heating system for leaks.
- Check all lines and hoses of the cooling and heating system for leaks, ensure that they are correctly arranged without abrading one another and that they are free of damage.
- The washers should not become clogged with dirt.
  Check cooler for external contamination.

Troubleshooting
Determine any leaks in the cooling system:

- Do not start the diesel engine.
- Determine and remedy the cause.

- Ascertain the coolant level, see documentation of the machine manufacturer.

Too low a coolant level has been determined.
When using coolant which features anticorrosive / antifreeze, supplement the loss of coolant with a mixture of water and min. 50 Vol.% anticorrosive / antifreeze.

Note
Do not use more than 60% of anticorrosive / antifreeze!
! A higher ratio will impair the cooling effect and the frost protection. This will subsequently cause damage to the diesel engine.

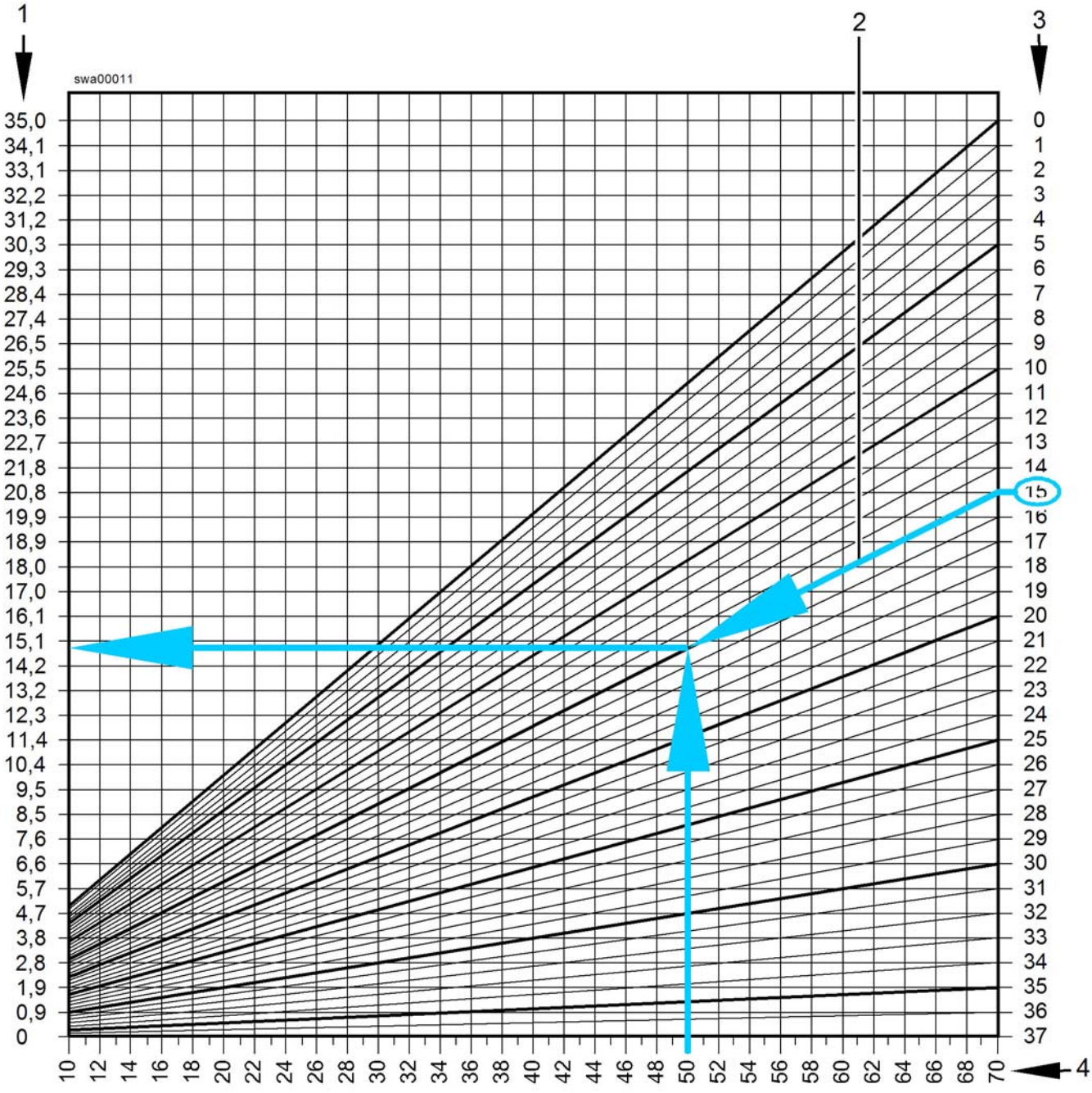
- When using coolant featuring anticorrosive without antifreeze, supplement any loss of coolant with a mixture of water and anticorrosive, see manufacturer's specifications.

Checking anticorrosive / antifreeze concentration in the coolant

The mix ratio of the coolant must correspond with a frost protection of -37 °C all year round.

- Take a sample of the coolant and analyse with an appropriate test procedure.

If analysis indicates a lower frost protection, the mix ratio must be rectified.



Determining the amount which needs to be refilled using -15 °C as an example

1 Anticorrosive / antifreeze (concentrate) — amount to be refilled (litres)
2 Reference line
3 Max. frost protection temperature (minus C°) in the cooling system
4 Amount of coolant (litres) in the cooling system

– If a frost protection temperature of -15 °C is measured in the cooling system, follow reference line 2 (starting from the frost protection temperature measured) downwards to the left to the vertical line for amount of coolant 4 (50 litres) and from this point out to the left horizontally (14.8 litres of concentrate).

Each filling amount of anticorrosive / antifreeze (concentrate) 1 which must be topped up can thus be obtained in order that frost protection against temperatures as low as -37 °C can once again be guaranteed.

– To reproduce the correct mix ratio, at least the amount previously determined must be drained from the cooling system.
– Fill in the determined amount of pure anticorrosive / antifreeze.

• To attain the required coolant level, fill the remainder with the previously drained coolant.

Anticorrosive without antifreeze / concentration in the coolant

When using DCA 4

• Remove a sample of coolant and analyse with test kit CC 2602 M from Fleetguard.

If the analysis does not indicate a DCA 4 concentration of between 0.6 — 1.06 units per litre, the mix ratio is to be rectified, see manufacturer's specifications.

When using water-soluble anticorrosive:

– Caltex XL Corrosion Inhibitor Concentrate
– Chevron Heavy Duty Extended Life Corrosion Inhibitor Nitrite Free
– Havoline Extended Life Corrosion Inhibitor (XLI)
– Total WT Supra

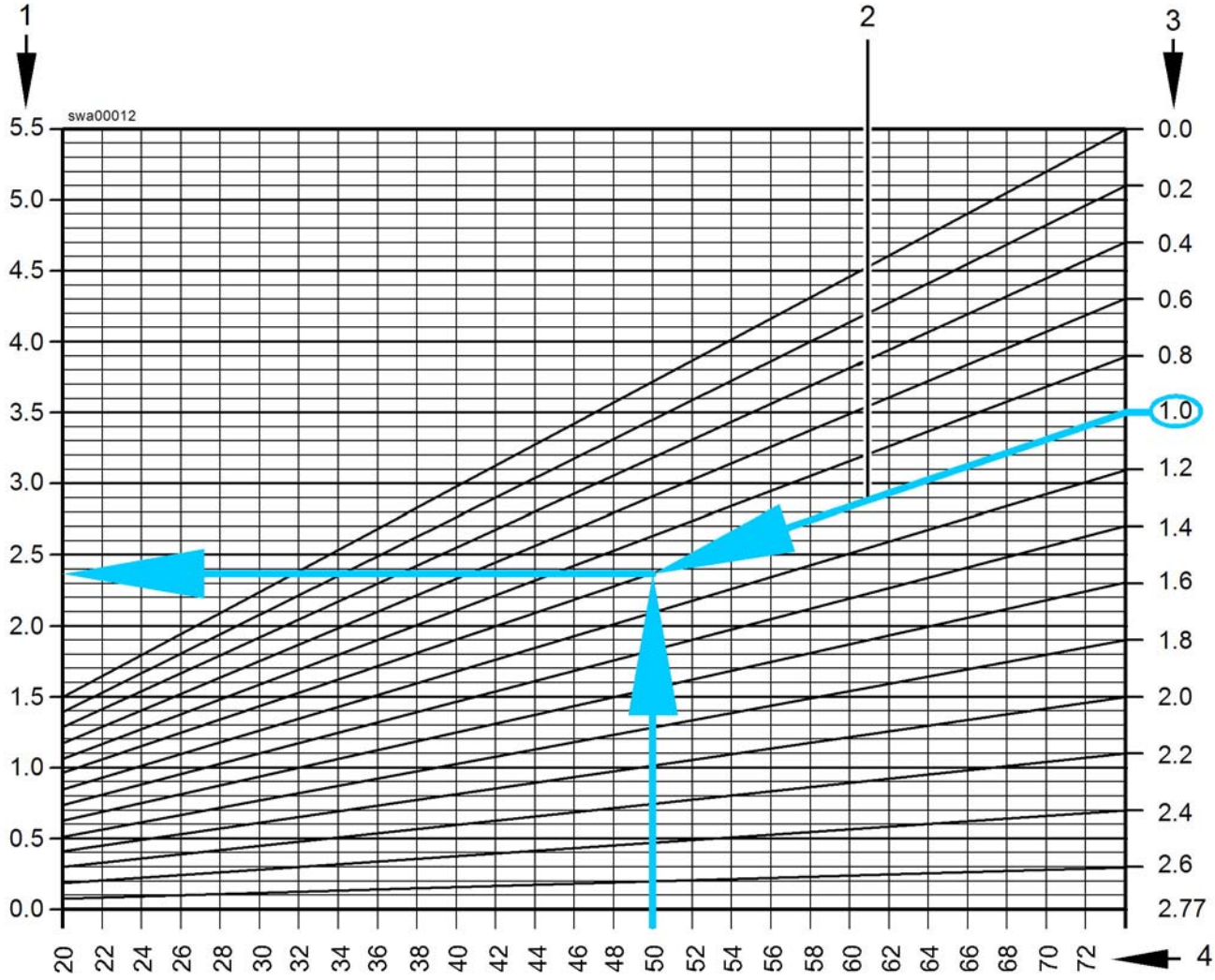
The mix ratio must indicate a value of $2.8_{-0.9}^{+0.9}$ % Brix at all times. This corresponds to 5–10% anticorrosive and 95–90 % water.

• Remove a sample of coolant and analyse using refractometer 2710 from the Gefo Company.

Gefo refractometer no. 2710

Refractometer
– Adjusting screw for setting the 0–line (water line)
– The visual acuity is adjusted by turning the ocular.
– Soft eye-piece on the ocular.
– Dimensionally-stable metal housing
– Non-slip grip made of rubber armouring

- Clean cap and prism carefully
- Apply 1–2 drops of test fluid to the prism.
- The test fluid is distributed by closing the flap.
- Look through the ocular at a bright background and focus the scale.
- Read the values on the blue separation line.



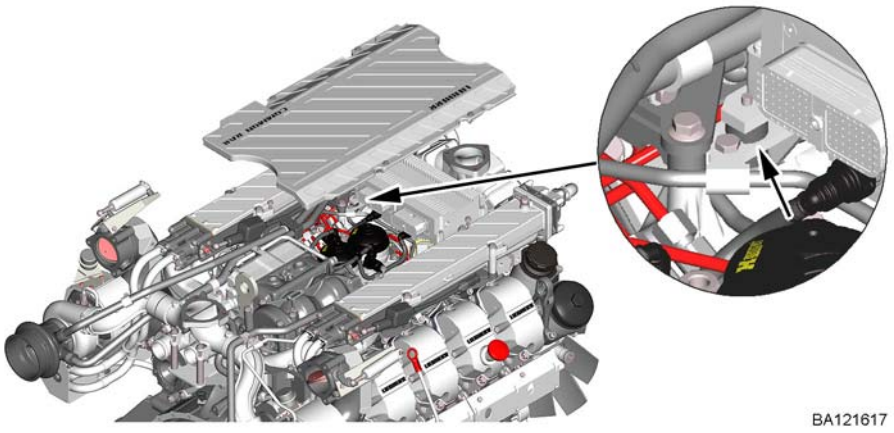
Determining the amount which needs to be refilled using 1% Brix as an example

1 Anticorrosive — Amount to be refilled (litres)
2 Reference line
3 Refractometer reading in % Brix
4 Amount of coolant (litres) in the cooling system

If a value of 1% Brix is measured in the cooling system, follow reference line 2 (starting from measured value 1 Brix) downwards to the left to the vertical line for the amount of coolant in the cooling system 4 (50 litres) and from this point out to the left horizontally (2.4 litres of pure anticorrosive 1)
The amount of pure anticorrosive 1 that needs to be refilled can thus be obtained in order to once again attain the required value of 2.8 Brix.
To reproduce the correct mix ratio, at least the amount previously determined must be drained from the cooling system.

- Fill in the determined amount of pure anticorrosive / antifreeze.
- To attain the required coolant level, fill the remainder with the previously drained coolant.

Checking the control unit mounting for sound condition



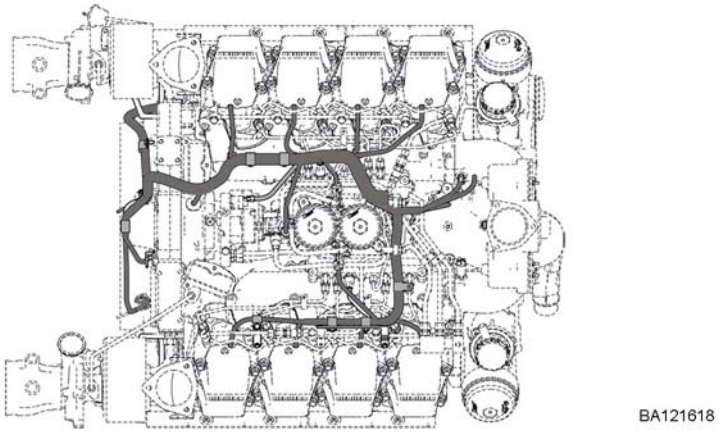
Control unit mounting

- Remove the kick plate
- Check the control unit mounting for damage and secure fastening.

Troubleshooting
If the support is determined as being damaged:

- Do not start the diesel engine.
- Replace all supports

Checking the condition of sensoric and cable connections



Sensoric and cable connections

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- Check all sensors and cable connections for secure fastening and sound condition
- Ensure sound condition without indication of damage, correct arrangement without the occurrence of wear and correct fastening of all cables and cable harness.

Troubleshooting
Should damage to cable connections, cable harness or sensors be determined:

- Do not start the diesel engine.
- Replace faulty parts.

5.3.6 Maintenance tasks every 1000 operating hours

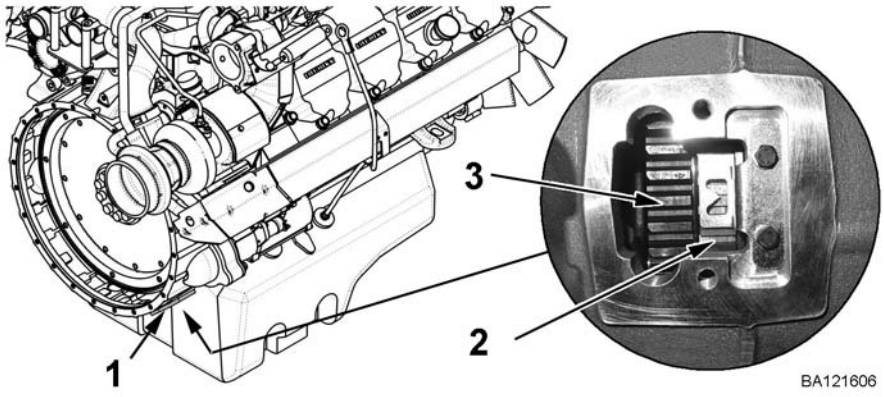
Before carrying out the 1000 operating hours maintenance tasks:
– carry out the daily maintenance tasks, see the section “Maintenance tasks (daily) every 10 operating hours,”.
– carry out the weekly maintenance tasks, see the section “Maintenance tasks (weekly) every 50 operating hours,”.
– carry out the 500 operating hours maintenance tasks, see the section “Maintenance tasks every 500 operating hours ”.

Checking the induction and exhaust system for sound condition and leaks

- Check the suction lines between air filter and diesel engine for sound condition, leaks and secure fastening.
- Check exhaust lines for sound condition, leaks and secure fastening.

Lubricating the starter ring gear on the flywheel

The maintenance cover is mounted on the right-hand side of the diesel engine on flywheel housing.
It must be ensured that:
– the diesel engine is in the maintenance position

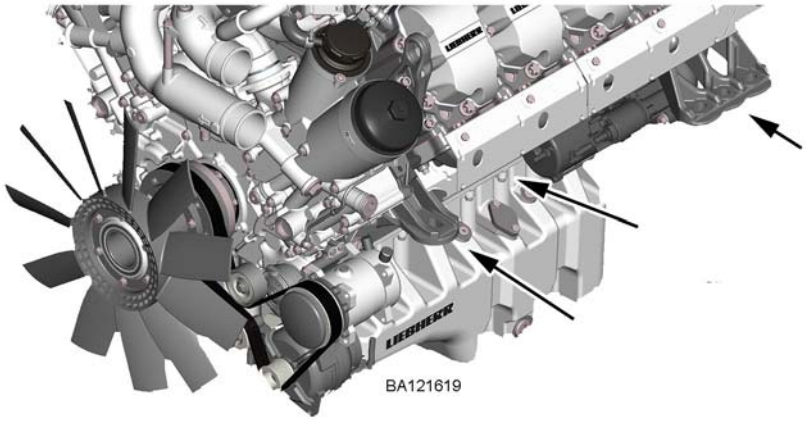


Maintenance cover — starter ring gear

- Dismantle the maintenance cover **1** from the flywheel housing
- Grease the starter ring gear **3** only, the sensor ring gear **2** must remain free of grease.
  Check ring gear and, if necessary, grease lightly with regular lubricating grease
- Remount the maintenance cover.

Checking the oil sump, engine mounting and diesel engine bracket for secure fastening

It must be ensured that:
– the diesel engine is in the maintenance position



Oil sump — engine brackets

- Check oil sump for secure fastening, if necessary tighten the screws.
- Ensure sound condition and secure fastening of diesel engine brackets and engine mount, if necessary, retighten screws.

5.3.7 Maintenance tasks every 2000 operating hours

Carry out all maintenance tasks in the same way as is described for 1000 operating hours.

5.3.8 Maintenance tasks every 3000 operating hours

Before carrying out the 3000 operating hours maintenance tasks:
– carry out the daily maintenance tasks, see the section “Maintenance tasks (daily) every 10 operating hours,”.
– carry out the weekly maintenance tasks, see the sections “Maintenance tasks (weekly) every 50 operating hours,”.
– carry out the 500 operating hours maintenance tasks, see the section “Maintenance tasks every 500 operating hours”
– carry out the 1000 operating hours maintenance tasks, see the section “Maintenance tasks every 1000 operating hours”
– carry out the 2000 operating hours maintenance tasks, see the section “Maintenance tasks every 2000 operating hours”.

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Replacing the coolant

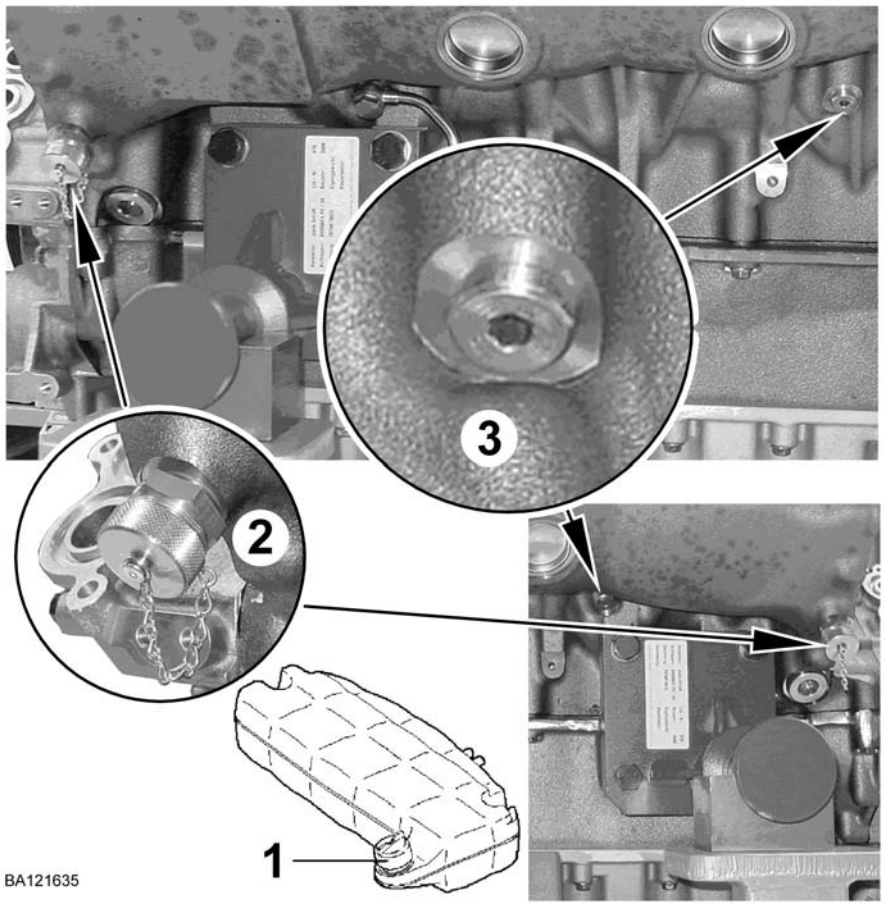
A coolant drain valve and a screw plug are located on the left-hand or right-hand side of the crankcase opposite the flywheel.

Both drain valves and screw plugs must be opened for replacing the coolant.

It must be ensured that:

– the diesel engine is in the maintenance position
– the diesel engine has cooled
– the heating taps, if featured, are open
– a collecting vessel and coolant, mix ratio see “Fuels and Lubricants”, filling amount see “Manufacturer's Documentation” are on-hand.
– a suitable drainage hose from the manufacturer is on-hand.

Draining the coolant



Draining the coolant

- Avoid opening the sealing cap **1** should the diesel engine become to hot.
- Turn the sealing cap slightly in an anticlockwise direction to allow excess pressure to dissipate, then open.
- Position the container under the diesel engine
- Open the protective cap **2** of the drain valve on the left-hand or the right-hand side of the diesel engine.
- Screw the drainage hose onto the drain valve, the drain valve opens.
- Open the screw plug **3** on the same side on the crankcase.
- Open the drain plug on the cooler (see machine manufacturer's documentation).

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The coolant from the oil cooler housing, the crankcase and the cooler flows out into the container.

- When the coolant has drained, unscrew the drainage hose from the drain valve and attach to the drain valve on the opposite side. Likewise, open the screw plug **3** on this side.
- When the coolant has also drained from this side, unscrew the drainage hose from the drain plug.
- Screw on both protective caps and fit the drain plug on the cooler and both screw plugs on the crankcase.

Filling in coolant.

- Only fill in prepared coolant featuring 50 Vol.– % anticorrosive / antifreeze at the expansion tank.
- Fill cooling system to maximum level.
- Mount the sealing cap on the expansion tank and close.
- Start the diesel engine and allow to run warm.
- Check the coolant level again when the diesel engine has cooled and refill as required.

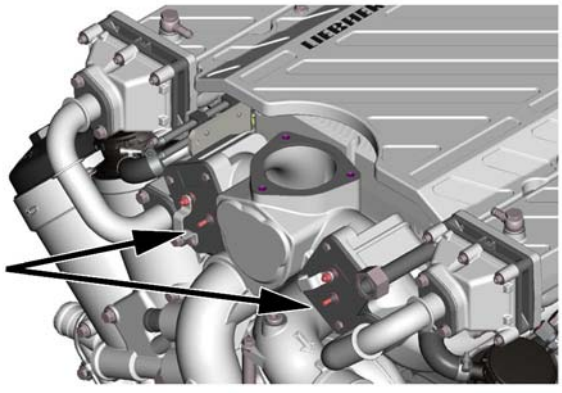
Ensure that the coolant contains at least 50 vol.– % anticorrosive / antifreeze.

5.3.9 Maintenance tasks as required

It must be ensured that:
– the diesel engine is in the maintenance position
– an ohmmeter or a multimeter is on-hand

Checking the heater flange

The heater flange is mounted on the inlet of the air induction pipe on the right-hand or left-hand side of the diesel engine opposite the flywheel.
Correct functioning of the heater flange is to be checked every year before the onset of the cold season.



Heater flange

- Switch off battery main switch if featured, and disconnect negative cable from the battery.
- Disconnect the electrical connecting cable on the heater flange.

- Connect the ohmmeter or the multimeter to the terminals and check the resistance.

If a resistance value of 250 MOhm +/– 10% at 20 °C is reached, the heater flange must be replaced.

- Connect the electrical connecting cable on the heater flange, as well as the negative cable from the battery.

Bleeding the fuel system

Bleeding of the fuel prefilter and of the fuel low-pressure system is necessary after:

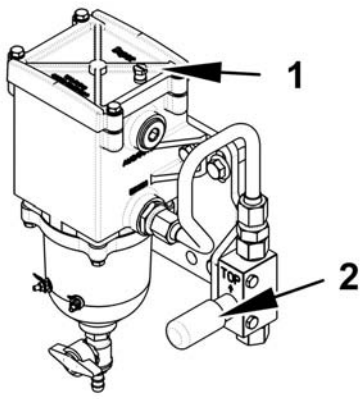
– replacement of the fuel filter
– running the fuel tank empty
– initial start-up of the diesel engine
– All tasks on components of the Common Rail System may only be carried out by specially trained personnel.
– Before commencing any work, the diesel engine must be switched off for at least one minute to allow any pressure still in the rail (pressure pipe) to dissipate.
– Utmost cleanliness must be observed for all tasks in all respective areas (e.g. hands have been washed, clean overalls). Avoid moisture at all costs.

Note
Contaminations in the Common Rail System lead to faults.
! No injection lines may be opened or loosened.

It must be ensured that:
– the diesel engine is in the maintenance position,
– a collecting vessel for the fuel is on-hand,

Danger
Risk of fire and explosion!
! No smoking.
! Avoid naked flames.
! Only work on the diesel engine when the diesel engine is switched off.

- Open shut-off valve on the fuel tank if featured.



Bleeding the fuel prefilter

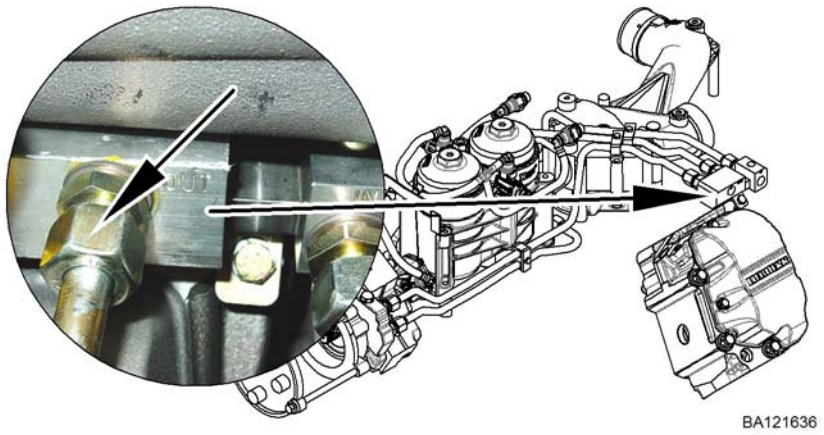
- Unscrew the bleed screw **1** on the filter head of the fuel prefilter two or three turns of thread.
- Actuate the hand pump **2** .

Note
Escaping fuel harms the environment.
! Catch the fuel and dispose of in accordance with the regulations.

•

When bubble-free fuel flows out of the bleed screw

• Tighten the bleed screw **1** .



Fuel return flow line

• Open the fuel return flow line, see arrow.

• Continue to actuate the hand pump

If bubble-free fuel is flowing out of the return flow line

• Tighten the fuel return-flow line again.

• Actuate the hand pump until a strong resistance can be felt.

• Start the diesel engine.

Troubleshooting
The engine has still not started after approx. 20 seconds?

• Wait for 1 minute.

• If this measure has been repeated three times:
Repeat the bleeding procedure.

Replacing the dry air filter main element

The dry air filters vary depending on the design of the machine .

If an air filter contamination continues to be displayed following maintenance of the main element, the safety element must also be replaced.
It must be ensured that:
– the diesel engine is in the maintenance position

• Replacing the main element, see the “Manufacturer's Documentation”.

Replacing the dry air filter safety element

The safety element is to be replaced after every third change of the main element, **but at least once a year**.

• Replacement of the safety element, see “Manufacturer's documentation”.

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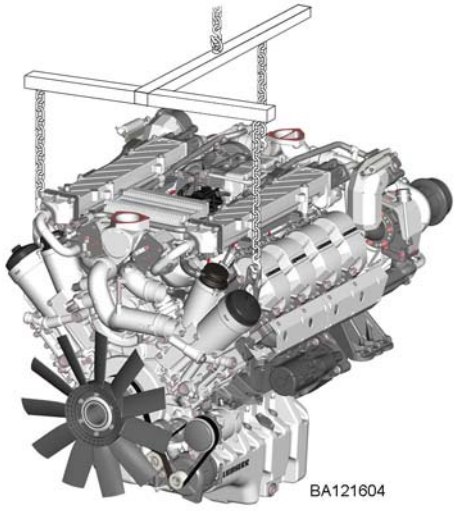
Lifting device

It must be ensured that:

– a suitable lifting device is on-hand.



Lifting device

- Only use proper lifting gear when lifting the diesel engine.
  Hook up the diesel engine using the lifting lugs provided.

Storage up to 6 months

The LIEBHERR diesel engine has been preserved from the date on which it was declared ready for shipment, with normal storage in a dry, well-ventilated area, the preservation protection period is 6 months.

If in addition, the diesel engine is covered with plastic sheeting, it may also be left out in the open for up to a month.

The cover must be watertight and be wrapped loosely around the diesel engine in order that the air can circulate around the diesel engine, thus preventing any condensation forming.

If the aforementioned measures are not strictly adhered to, whereby the preserved diesel engine is subjected to unfavourable conditions (left out in the open for lengthy periods of time or being stored in damp, poorly-ventilated areas etc.) a shorter preservation protection period must be estimated.

Storage for longer than 6 to 24 months

When storing for longer than 6 to 24 months, a full-scale preservation must be undertaken, consult LIEBHERR Service or a LIEBHERR authorised dealer.

Removing the preservation after 6 months of storage

- Remove all fitted connections.

Exterior preservation is to be removed with degreasing solvent, white spirit or petroleum wherever necessary (e.g. with a leak test).

If high-pressure cleaning equipment is used, white spirit is recommended as a solvent.

Intensive spraying of parts made of rubber or plastic, as well as water temperatures exceeding 80 °C, is to be avoided as this may cause irreversible damage

- Following installation and connection of the diesel engine
  Fill in permissible fuel to maximum level, see “Fuel and Lubricants”.

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5.3.10 Confirmation of maintenance tasks which have been performed

Maintenance details

Diesel engine - type:	.....
Diesel engine - no.:	.....
Start-up on:	.....
Customer:	.....
Location:	.....
Street:	.....
Liebherr - subsidiary:	.....
Location:	.....
Street:	.....
Telephone/Fax:	.....

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Note
Operation and maintenance are decisive as to whether a diesel engine is ready for operation at all times and remains in fully working order

! We strongly recommend that the prescribed maintenance tasks are performed thoroughly and punctually. Warranty claims only remain valid if this point is strictly adhered to. Under no circumstances may lead seals which have been fitted on the diesel engine be removed!

! The correct carrying out of maintenance tasks must be entered and confirmed in the following maintenance chart.

! The maintenance tasks for daily and 50 operating hours maintenance intervals must be performed by service personnel authorised by the customer.

! The first oil-change and replacement of the diesel engine, as well as all further maintenance tasks, must be carried out by a LIEBHERR-trained, authorised mechanic.

5.3.11 Every 500 operating hours / at least once a year

– With more difficult operating conditions
  • repeated cold-starts,
  • fuel sulphur content above 0.5 %,
  • application temperature below -10 °C,

the prescribed oil-change interval must be reduced in accordance with the difficulty factor, see “Fuel and Lubricants”

Hours	Date	Mechanic	Signature	Remark
500				
1000				
1500				
2000				
2500				
3000				
3500				
4000				
4500				
5000				
5500				
6000				
6500				
7000				
7500				
8000				
8500				
9000				
9500				
10000				
10500				
11000				
11500				
12000				
12500				
13000				
13500				

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Hours	Date	Mechanic	Signature	Remark
14000				
14500				
15000				
15500				
16000				
16500				
17000				
17500				
18000				
18500				
19000				
19500				
20000				

5.3.12 Additionally every 1000 / 2000 / 3000 operating hours

Hours	Date	Mechanic	Signature	Remark
1000				
2000				
3000				
4000				
5000				
6000				
7000				
8000				
9000				
10000				
11000				
12000				
13000				
14000				
15000				
16000				
17000				
18000				
19000				
20000				

5.3.13 Additionally every 2 years

Hours	Date	Mechanic	Signature	Remark
2 years				
4 years				
6 years				
8 years				
10 years				
12 years				
14 years				
16 years				

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Hours	Date	Mechanic	Signature	Remark
18 years				
20 years				

5.4 Lubricants and fuels

5.4.1 Handling lubricants and fuels

Conscientious adherence of the guidelines for handling fuel and lubricants increases reliability and life-expectancy of the machine.

It is of particular importance that the prescribed change intervals and lubricant qualities are adhered to.

Miscellaneous details regarding the prescribed intervals can be obtained in the chapter “Maintenance and Inspection Chart”.

Miscellaneous details for carrying out: lubrication, checking levels and changing fuel can be obtained in the chapter, “Maintenance” under “Maintenance Tasks” .

All handling of fuel and lubricants must be undertaken as follows and the environmental-protection guidelines must be observed.

5.4.2 Environmental-protection guidelines

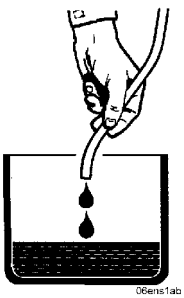
- The environmental-protection guidelines must be observed at all times.
- Note the guidelines which apply for the respective country.
- Ensure that correct disposal of any fluids has been arranged before commencing draining.

5.4.3 Disposing of recyclables

Recyclables include for example:

– Oils, lubricants, coolant, refrigerating agents for air-conditioning systems, etc.
– Fuels
– Filters, oil filter cartridges, etc.

- Observe the guidelines for environmental-protection when disposing of recyclables.
- Collect all recyclables separately in suitable containers, store in a safe place and dispose of in an environmentally-friendly manner at an official site.
- Note the guidelines which apply for the respective country.



Disposal

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5.4.4 Diesel fuels

Specification


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The diesel fuels must comply with the minimum requirements of the fuel specifications prescribed as follows.
Authorised fuel specifications:
– DIN EN 590
– ASTM D 975 (89a) 1D and 2D

Further fuel specifications only upon consultation with the Diesel Engine Development Department, LIEBHERR Machines Bulle S.A.

Sulphur content in the diesel fuel

In DIN EN 590, a max. 50 mg/kg = max. 0.005 weight.% sulphur content is permissible.
“Low-sulphur” diesel fuels featuring a sulphur content below / less than 0.05 % are only applicable if lubricity can be guaranteed with the admixture of additives. The diesel fuel lubricating proficiency must be a max.460 µm in accordance with the HFRR (60) test. [lubricity corrected “wear scar diameter” (1.4) at 60 °C]
For diesel fuels featuring a sulphur content of above / more than 0.5 weight.%, the oil-change intervals are to be halved.
Diesel fuels featuring a sulphur content of above / more than 1 % are not permissible.

Note
Fuel standard ASTM D 975 does not stipulate that the fuels must pass a fuel lubricity test.
! A written confirmation of the fuel supplier must be requested. Any additions should be undertaken by the supplier as he is responsible for the quality of the fuel. The addition of secondary-lubricity additives by the customer is not recommended.

A cetane number of at least 45 is required for fuels in accordance with ASTM D975. A cetane number above 50 is preferable, especially in temperatures below 0 °C or 32 °F.

Diesel fuel at low temperatures (winter operation)

Diesel fuel precipitates paraffin crystals as the temperature drops. This increases flow resistance in the fuel filter to such an extent that a sufficient supply of fuel to the diesel engine can no longer be guaranteed.

Note
A mixture of petroleum and regular petrol is not permissible, both as a safety precaution and for technical reasons.
! If the cold-flow properties of the diesel fuel is insufficient, or with lower ambient temperatures than -20 °C, we recommend that a fuel filter heating be used.
! Special fuels are available for applications in arctic climates.

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5.4.5 Lube oils for the diesel engine

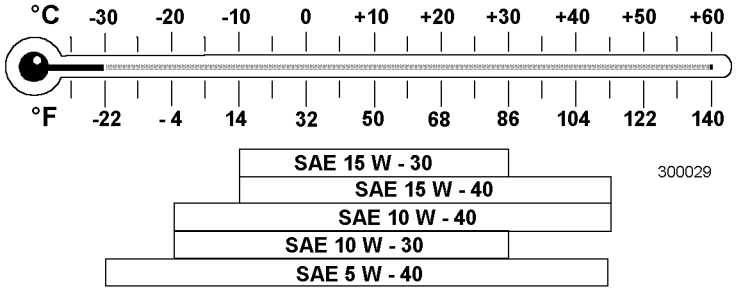
Lube oil specifications

Only high-alloy lube oils are used nowadays for modern diesel engines.
They are comprised of base oils which feature combined admixtures (additives).
The lube oil guidelines for LIEBHERR-diesel engines are based on the following specifications and guidelines:

Model	Specification
ACEA — Classification (Association des Constructeuers Européens de l'Automobile)	E4, E5, E6, E7 Caution: particle filter operation only permissible with E6
API — Classification (American Petroleum Institute)	CH-4, CI-4 Caution: observe the reduced oil-change interval

Lube oil viscosity

Selection of the lube oil viscosity in accordance with the SAE-classification (Society of Automotive Engineers).
The ambient temperature is definitive for correct selection of the SAE-class.
Selection of the SAE-classification gives no indication of the quality of a lube oil.
Too high a viscosity can lead to starting difficulties and too low a viscosity could jeopardise the starting efficiency.
The temperature ranges specified in the diagram are guidelines and can be briefly exceeded or fallen short of.



Temperature-dependent selection of the SAE-class

The following diesel engine oil is recommended for ambient temperatures of -20 °C / 4 °F to +45 °C / 113 °F:

Liebherr Motoroil 10W-40
Specification ACEA E4
Liebherr Motoroil low ash
Specification ACEA E6

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Lube oil change intervals

Change intervals
- Oil change and filter replacement: see the chapter “Maintenance and Inspection Chart”
- Oil-change respective of climatic zone, sulphur content in the fuel and oil quality in accordance with the following table

If the prescribed operating hours (h) have not expired within one year, the diesel engine oil and filter must be replaced at least once a year.

Difficulty factors

Varying difficulty factors or tougher operating conditions reduce maintenance intervals.
Difficulty factors or tough operating conditions include for example:
- frequent cold-starts
- sulphur content in the fuel above 0.5%
- application temperature below -10 °C

Should difficulty factors or tougher operating conditions arise, oil-change and filter replacement must be carried out in accordance with specifications in the following table.

Difficulty factor		**Oil quality**	
		CH-4	
		CI-4	
			E4
			E5
			E6
			E7
Operating conditions	**Sulphur content in the fuel**	**Interval**	
Temperature normal down to -10 °C	up to 0.5%	250 h	500 h
	over 0.5%	125 h	250 h
below -10 °C	up to 0.5%	125 h	250 h
	over 0.5%	not permissible	125 h

Oil-change intervals in operating hours (h)

5.4.6 Coolant for the diesel engine

General recommendations

The cooling system will only function reliably if it is working under pressure. It is therefore imperative that it is kept clean and watertight, that the radiator cap valve and working valves are functioning correctly and the necessary coolant level is maintained.
The anticorrosive / antifreeze authorised by LIEBHERR guarantees sufficient protection against cold, corrosion and cavitation, do not corrode seals and hoses and do not foam up.
Coolants which contain inadequate, or ill-prepared or incorrect anticorrosive / antifreeze, could cause a malfunctioning of aggregates as a result of cavitational or corrosive damage. Furthermore, heat-insulating sedimentation can be resulted at heat-exchanging parts, leading to an overheating, and subsequently to an overheating of the engine.

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Note
Emulsifiable corrosion inhibition oils are not permissible.
! In special cases, it is permissible to use anticorrosives (inhibitors).

Water (fresh water)

Suitable water is colourless, clear, free of mechanical contamination, drinkable tap water featuring the following restricted analysis values.
Sea water, brackish water, salt water and industrial waste water is not suitable.

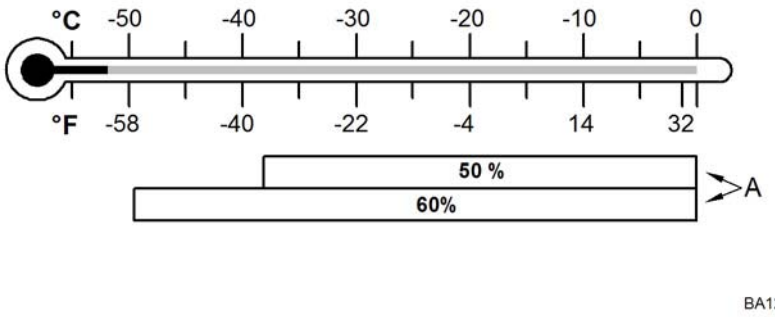
Fresh water quality	
Model	**Value and unit**
Total of alkaline earths (water hardness)	0.6 to 3.6 mmol/dm³ (3 to 20° d)
pH-value at 20 °C	6.5 to 8.5
Chloride-ion content	max. 80 mg/dm³
Sulphate-ion content	max. 100 mg/dm³

Fresh water quality when using DCA 4	
Model	**Value and unit**
Total of alkaline earths (water hardness)	0.6 to 2.7 mmol/dm³ (3 to 15° d)
pH-value at 20 °C	6.5 to 8.0
Chloride-ion content	max. 80 mg/dm³
Sulphate-ion content	max. 80 mg/dm³

Water analyses can be applied for from the communal authorities responsible.

Permissible coolant — mix ratio

All year round up to	**°C**	**°F**	**Water %**	**Anticorrosive / antifreeze %**
Ambient temperature	–37	–34	50	50
Ambient temperature	–50	–58	40	60



Temperature-dependent selection of mix ratio for anticorrosive / antifreeze

A = ratio of anticorrosive / antifreeze in the coolant as a percentage

Anticorrosive / antifreeze permitted for diesel engine cooling systems

Product designation	MANUFACTURER	Country
Liebherr Antifreeze Concentrate	LIEBHERR	D
Addinol Antifreeze Super	Addinol Lube Oil GmbH, Leuna	D
Agip Antifreeze Plus	Aral AG, BochumEni S.p.A., Rome	I
Agip Langzeit-Frostschutz	Eni S.p.A., Würzburg	D
Antigel DB 486	Sotragal SA, St-Priest	F
Aral Antifreeze Extra	Aral AG, Hamburg	D
Avia Antifreeze APN G48	Avia Mineralöl AG, Munich	D
BP Isocool	BP p.l.c. London	GB
Caltex Extended Life Coolant	Chevron Texaco	*
Castrol Antifreeze NF	Castrol, London	GB
Chevron Extended Life Coolant	Chevron Texaco	*
DEUTZ Kühlerschutzmittel 0101 1490	DEUTZ Service International GmbH, Cologne	D
ESA Frostschutz G48	ESA Burgdorf	CH
Fuchs Fricofin Kühlerfrostschutz	Fuchs Petrolub AG, Mannheim	D
Glacelf Auto Supra (antifreeze)	Total, Paris	F
GlycoShell Longlife	Shell International Petroleum Company, London	GB
Glycoshell N	Shell International Petroleum Company, London	GB
Glysantin G48	BASF AG, Ludwigshafen	D
Havoline Extendend Life Antifreeze / Coolant	Chevron Texaco	*
Havoline XLC	ARTECO	B
Motorex Antifreeze Protect G48	Bucher AG, Langenthal	CH
Motul Inugel Optimal Ultra	Motul SA, Aubervilliers Cedex	F
OMV Kühlerfrostschutz / Coolant Plus	OMV Refining & Marketing GmbH, Vienna	A
Do not mix products with one another! * = global / worldwide		

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Anticorrosive / antifreeze premixes (50% water: 50% anticorrosive / antifreeze) permitted for diesel engine cooling systems

Product designation	MANUFACTURER	Country
Liebherr Antifreeze Mix	LIEBHERR	D
Caltex Extended Life Coolant premixed 50/50 (ready-to-use-version)	Chevron Texaco	*
Chevron DEX-COOL Extended Life Pre-Diluted 50/50 Anti-freeze Coolant	Chevron Texaco	*
Coolelf Auto Supra -37 °C	Total, Paris	F
Havoline XLC, 50/50	ARTECO	B
Havoline DEX-COOL Extended Life Pre-Diluted 50/50 Anti-freeze Coolant	Chevron Texaco	*
Do not mix products with one another! * = global / worldwide		

Anticorrosive (inhibitors) without antifreeze

In **exceptional cases** and **if ambient temperatures constantly remain above freezing point**, e.g. in tropical regions **where there is apparently no authorised anticorrosive / antifreeze available, the following may be used as coolant:**

Product DCA 4 (Diesel Coolant Additives 4)

Product Caltex / Chevron / Havoline / Total

When carrying out maintenance tasks, concentration must be tested and rectified as necessary.

The coolant must be changed once a year.

Note

The entire amount of coolant must be drained.

! When changing from anticorrosive / antifreeze to anticorrosive, or vice versa.

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Permissible water-soluble anticorrosives (concentrates) for diesel engine cooling systems

Product designation	MANUFACTURER	Country
DCA 4 Diesel Coolant Additives	Fleetguard / Cummins Filtration	*
Caltex XL Corrosion Inhibitor Concentrate	Chevron Texaco	*
Chevron Heavy Duty Extended Life Corrosion Inhibitor Nitrite Free (ELC)	Chevron Texaco	*
Havoline Extended Life Corrosion Inhibitor (XLI)	Chevron Texaco	*
Total WT Supra	Total, Paris	F
Do not mix products with one another! * = global / worldwide		