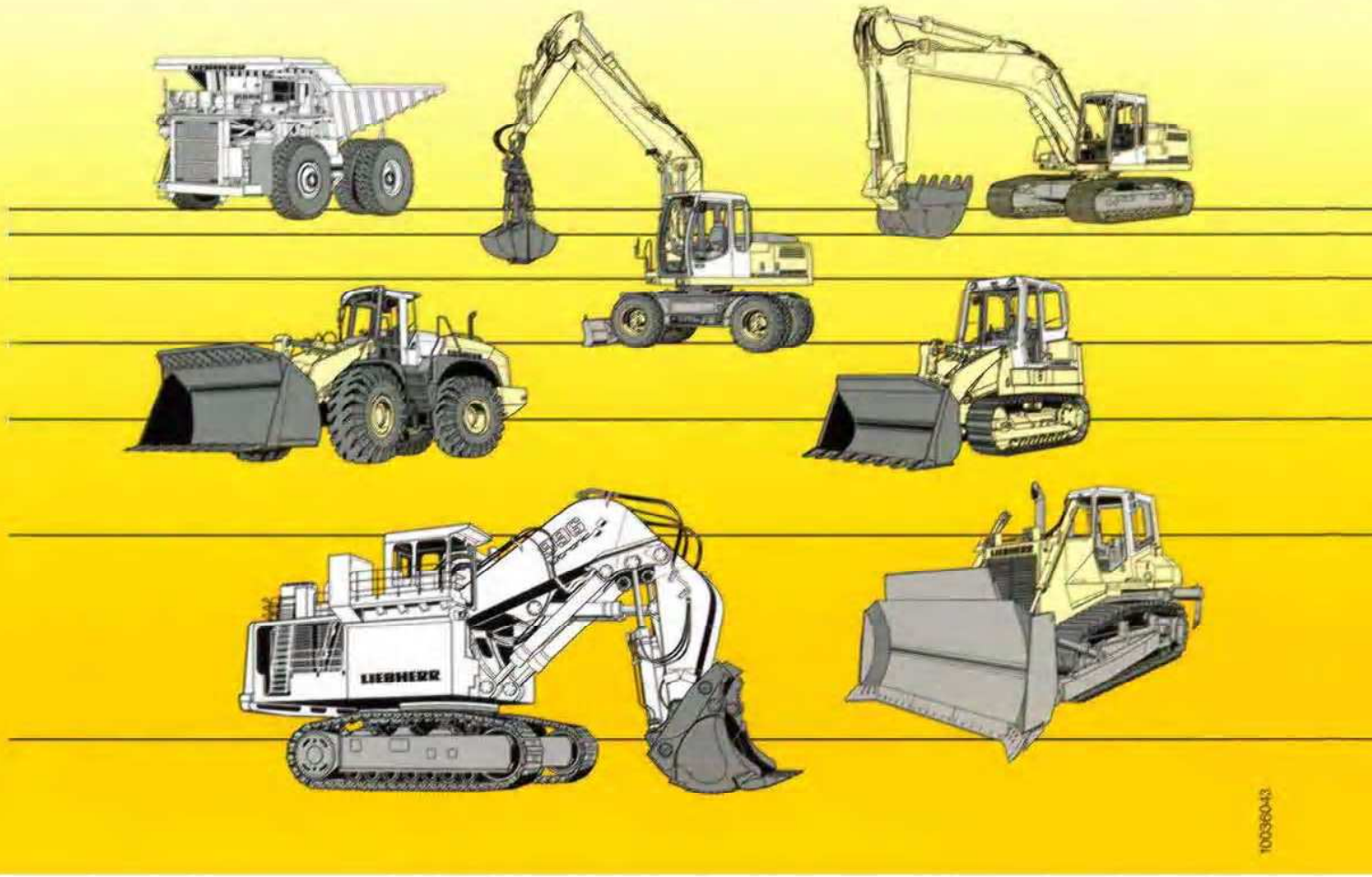
Operating manual

Diesel engine

D924T-E/TI-E - D926T-E/TI-E



LIEBHERR

en

Operating manual

Diesel engine

D924 T-E/TI-E - D926 T-E/TI-E

Document identification

Order number: 9076418

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Author: LMB/Abteilung-BE-MD3

Product identification

Type: D924 T-E/TI-E - D926 T-E/TI-E

Serial number: 2000010000

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

This operating manual has been compiled for the **operator** and the **maintenance personnel** of the diesel engine.
It includes information 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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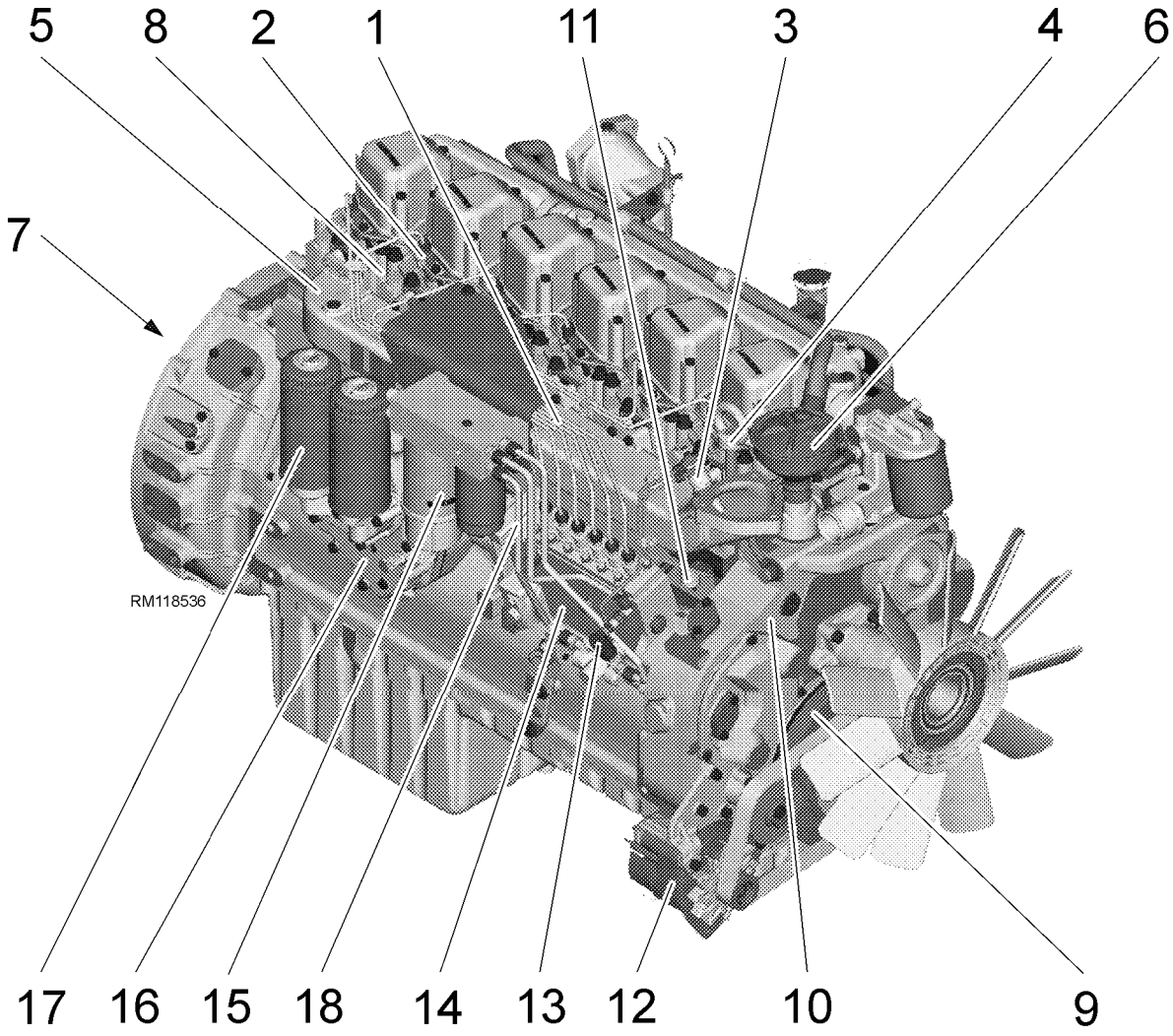
1 Product description

Equipment layout

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



Components of the diesel engine / as viewed from the front right-hand side

1 Injection lines
2 Injection nozzle
3 Flame glow plug
4 Transport device
5 Air induction pipe
6 Crankcase air vent
7 Flywheel
8 Cylinder head
9 Crankshaft / drive components
10 Aggregate carrier
11 Solenoid valve / Flame-type start system
12 Alternator
13 Manual delivery pump
14 Injection pump
15 Fuel filter
16 Oil cooler
17 Oil filter

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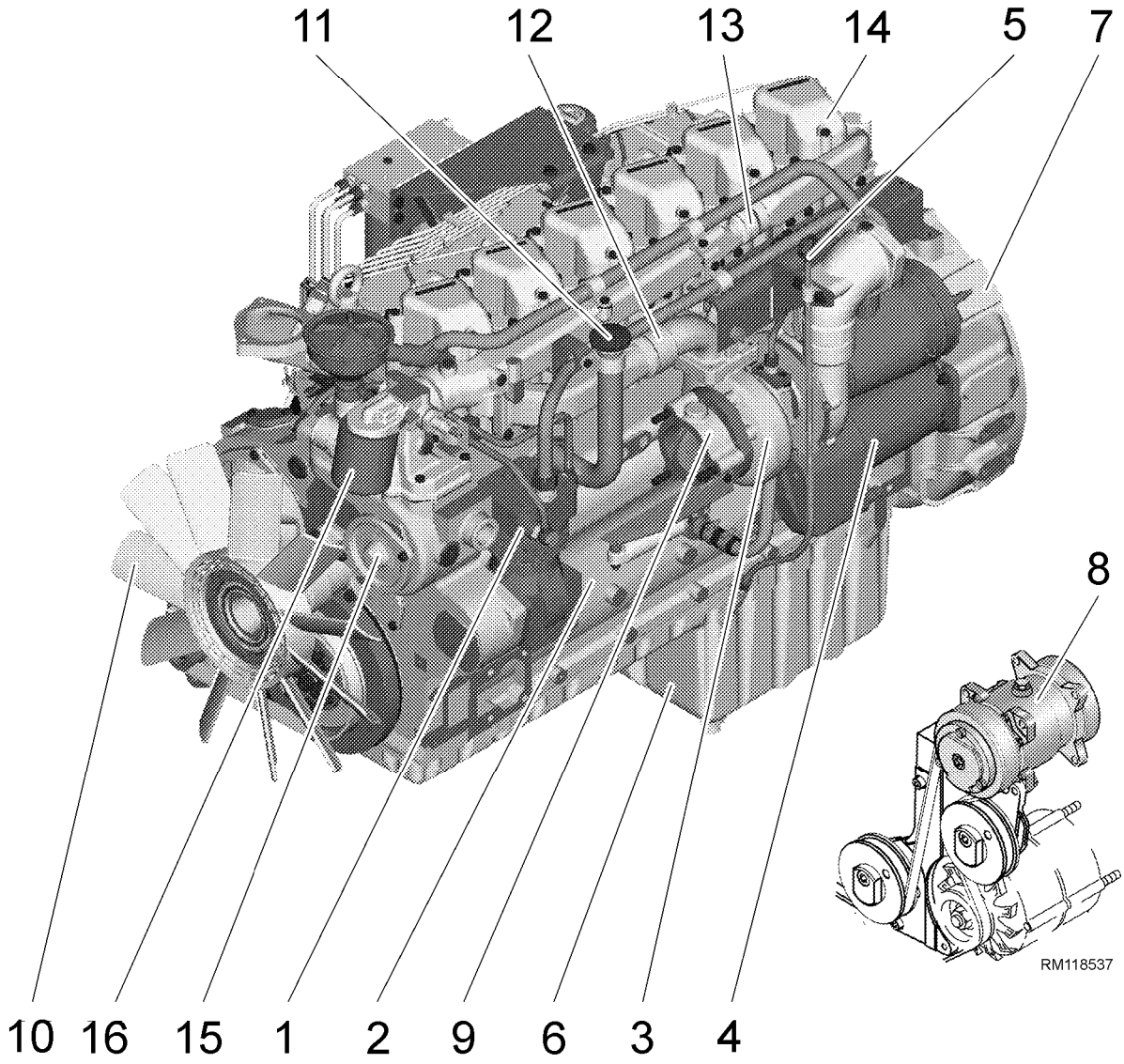

Components of the diesel engine / as viewed from the front left-hand side

1 Air compressor
2 Crankcase
3 Turbocharger
4 Starter
5 Oil dipstick
6 oil sump
7 Flywheel housing
8 Air-conditioning compressor
9 Diesel engine brake
10 Fan
11 Oil filling inlet
12 Exhaust gas pipe
13 Water collecting line
14 Cylinder head cover
15 Coolant pump
16 Water filter

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1.1 Technical data

1.1.1 Diesel engine

Name	Value	Units
Design	In-line diesel engine	
Number of cylinders (D924)	4	
Firing sequence (D924)	1–3–4–2	
Number of cylinders (D926)	6	
Firing sequence (D926)	1–5–3–6–2–4	
Bore	122	mm
Stroke	142	mm
Displacement (D924)	6.64	Litres
Displacement (D926)	9.96	Litres
Compression ratio	17.2:1	
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	
D924 Diesel engine weight (without water, without oil)	approx. 710	kg
D926 Diesel engine weight (without water, without oil)	approx. 900	kg

1.1.2 Injection pump

Name	Value	Units
Start of fuel delivery with TDC	see identification plate	°Crank-shaft be-fore or after TDC

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1.1.3 Injection nozzle

Name	Value	Units
Opening pressure new	225^{+8}	bar
Opening pressure in operation	217^{+8}	bar

1.1.4 Cylinder head

Name	Value	Units
Valve clearance intake cold	0.25	mm
Valve clearance exhaust cold	0.30	mm

1.1.5 Coolant pump

Name	Value	Units
Flow rate (at nominal speed 2000 min^{-1} and counter-pressure 0.6 bar)	408	Litres

1.1.6 Coolant thermostat

Name	Value	Units
Beginning of opening	79	°C
Fully opened	92	°C

1.1.7 Alternator

Name	Value	Units
Voltage	28	V
Amperage	55 / 80 / 120	A

1.1.8 Starter

Name	Value	Units
Voltage	24	V
Output	5.4 / 6.6 / 9	kW

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1.1.9 Flywheel housing

Name	Value	Units
Connection	SAE1 / SAE2	

1.1.10 Air compressor

Name	Value	Units
Flow rate at nominal speed 2000 min^{-1} and 6 bar	464	l/min
Speed ratio	1 : 1.275	
Water-cooled	Yes	

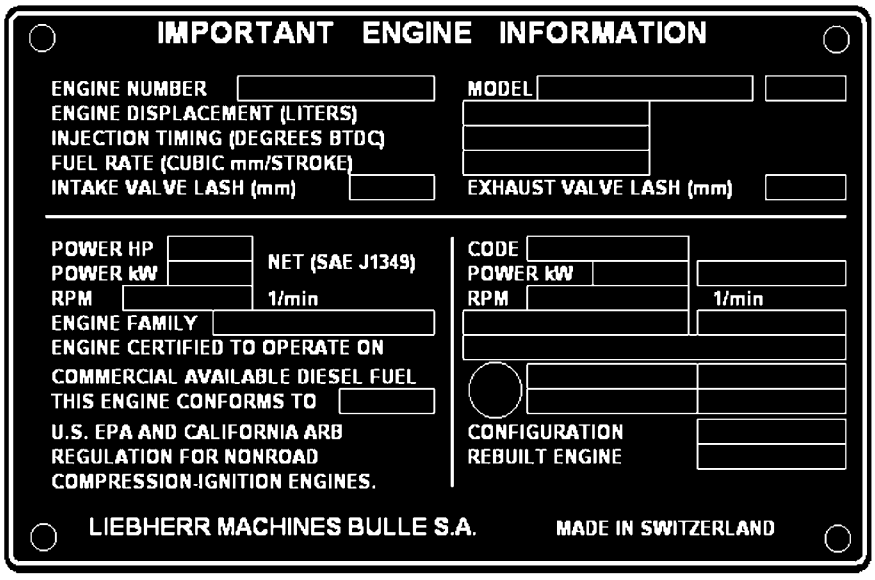
1.1.11 Explanation of type description

Type description

						Description
D	**92**	**6**	**T**	**I**	**–E**	**Type description**
D						Diesel engine
	92					Bore 122 mm, Stroke 142 mm
		6				Number of cylinders (6 cylinder)
			T			Turbocharged engine
				I		Intercooling
					–E	Emissions-optimised

Diesel engine type identification plate

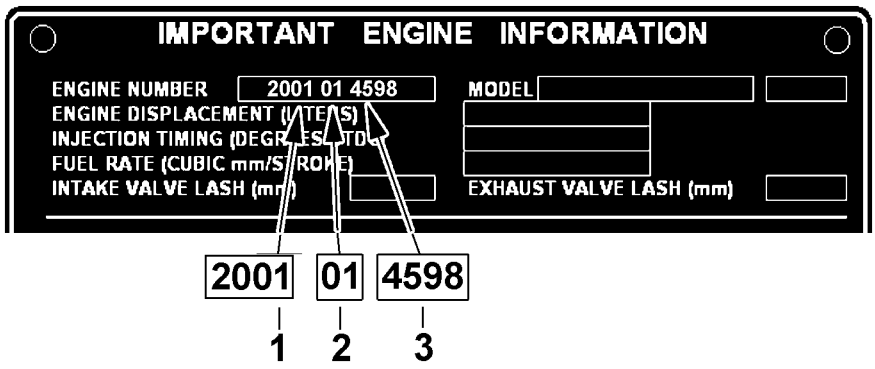
The diesel engine identification plate is mounted on the right-hand side of the crankcase looking at the flywheel. Depending on the design, a second identification plate is mounted on the air induction pipe



Identification plate

Diesel engine number

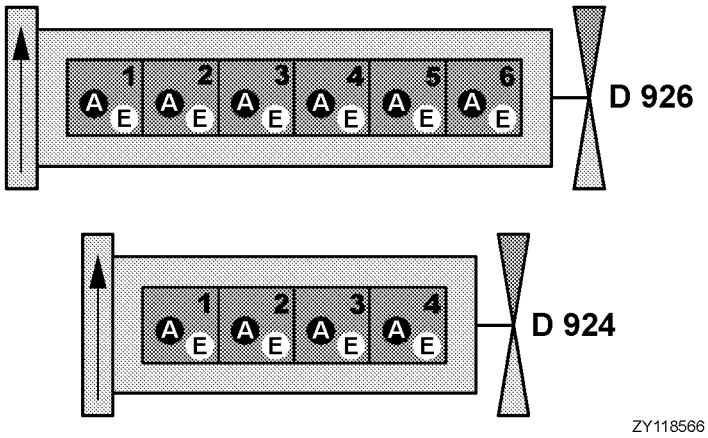
The diesel engine number is stamped onto the diesel engine identification plate and in the crankcase. The diesel engine number is located on the crankcase at the end of the top surface of cylinder 4 or 6 depending on the number of cylinders of the diesel engine.



Diesel engine number

1 Date (2 or 4 digits)
2 Number of cylinders (01 = 4 cylinders, 02 = 6 cylinders)
3 Serial number

Cylinder description, rotational direction



Cylinder description — Rotational direction

A = Exhaust valveE = Intake valve

Cylinder 1 is located on the same side as the flywheel. The cylinder numbers, as well as the firing sequence, are cast onto the right-hand upper side of the crankcase looking at the flywheel.

1.1.12 Design features

Design

Water-cooled 4-cylinder and 6-cylinder in-line diesel engine with LIEBHERR-direct injection and exhaust turbocharging.

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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.

Engine The 4-cylinder diesel engines feature a steel crankshaft with 5 bearing points / the 6-cylinder diesel engines feature a steel crankshaft with 7 bearing points, with inductive hardened running surfaces and 8 / 12 forged-on counterweights.

A torsion damper is mounted on the crankshaft on the same side as the fan. Forge pressed, diagonally-sectioned connecting rod, transmission bearing in lead bronze-triplex-friction bearings or Sputter bearing. Smooth-rod three ring piston made of aluminium alloy featuring ring inserts and combustion recess in the piston crown. Replaceable, wet cylinder liners

Housing Crankcase designed as one unit made of alloyed cast iron. Individual cylinder heads featuring swirl inlet 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 respectively per cylinder suspended in the cylinder head (ohv.). Actuated by steel-camshaft featuring 5 or 7 bearing points via bimetal tappet, push rod and rocker arm. Drive of the camshaft, injection pump, lube oil pump, air compressor, water pump and auxiliary hydraulic pumps from the crankshaft via nitrified gears on the same side as the fan.

Lubrication Forced-feed lubrication with gear pump for crankshaft bearing, connecting rod bearing and camshaft bearing, as well as small end bush, tappet and rocker arm.

Oil filtering via two cartridge filters in the main flow. Accessories such as injection pump and air compressor are connected to the diesel engine lube oil circuit. The diesel engine oil cooler is integrated in the cooling water circuit.

Cooling Double-thermostatic regulated liquid cooling with centrifugal pump. Individual supply of each cylinder unit via cast distributor ducts in the crankcase.

Piston cooling via oil spraying from the lube oil circuit of the diesel engine.

Injection system and regulation Maintenance-free BOSCH in-line injection pump with mechanical BOSCH-centrifugal governor or electronic governor (EDC), or distributor-type injection pump with mechanical BOSCH-centrifugal governor, fuel delivery pump, fuel filter, BOSCH-six-hole nozzle.

Flame-type start system The flame-type start system is a cold-start aid for low ambient temperatures. It reduces emissions of white smoke following start-up of the diesel engine.

Curtailment of the start time moreover, conserves the starter and the batteries.

The flame glow plug, installed in the air induction pipe, is supplied with fuel via a solenoid valve with batching nozzle and can be ignited.

Electrical equipment Starter and alternator: 24 Volt.

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

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1.1.13 Auxiliary equipment for the diesel engine

Diesel engine brake

The diesel engine exhaust gas brake flap is installed in the 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 diesel engine braking action is generated via closing of the diesel engine exhaust gas brake flap.

Diesel engine brake and auxiliary brake system

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.

Electromagnetic fan clutch

The fan is driven via a multi-stage electromagnetic clutch, depending on the design. The fan speed is regulated electromagnetically up to maximum speed.

Electronic diesel engine regulation

The electronic diesel engine governor (EDC) serves to regulate speed and torque in LIEBHERR diesel engines.
The governor performs all the functions of the mechanical governor (variable speed governor, moment regulation, torque limitation, LDA-pressure compensator function), and depending on the application, provides even further functions (diagnoses via CAN and vehicle management).
The EDC is essentially comprised of the sensors, the control unit and the actuator. Devices installed on the diesel engine or the machine are connected to the EDC-control unit via separate, prefabricated cable harnesses. Communication between the diesel engine control unit and the machine control system is resulted via CAN (Control-Area-Network).

Air-conditioning compressor

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

Air compressor

The air compressor is flange-mounted to a power take-off integrated on the aggregate carrier. Cooling or lubrication of the air compressor is connected to the respective circuits of the diesel engine.

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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 engine.
Make sure that you possess, have read, and have understood any additional instructions relevant to the engine'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.

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5. Ensure regularly that personnel are conscientious of the 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 which 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.
   Avoid sparks and naked flames.

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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.
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.

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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 engine with water, steam jet (high-pressure cleaner) or other cleaning agents, seal or cover all openings into which no water/steam/cleaning agents may 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 engine 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 pull the plug from the control unit if electrical welding tasks are 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.
8. Incorrect polarity of the control units voltage or supply voltage (e.g. via 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 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 diesel engine must be operated or controlled by the following elements:

- **The electronics indicator lamp** shows the operating status of the diesel engine.
- **The oil pressure gauge** indicates the oil pressure of the diesel engine
- **The ammeter or charge control lamp** indicates the charging current in the electrical system
- **The coolant thermometer** indicates the temperature of the coolant in the diesel engine
- **The tachometer** indicates the diesel engine speed in rpm
- **The operating hour meter** indicates the operating hours of the diesel engine
  The operating hour meter must be used for the scheduling of regular maintenance.
- **The air filter maintenance indicator** indicates the degree of contamination in the air filter.
- **The speed regulation** indicates the diesel engine speed

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3.2 Operation

3.2.1 Preparing for initial start-up

CAUTION!
If the application site is located 3000 metres or more above sea level, the output must be reduced following consultation with the factory. If the output is not reduced, the diesel engine will become thermally overloaded and will lead to malfunctioning.

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 initial start-up oils assist the run-in process and allow the first oil change to be carried out at normal oil change intervals.

For filling amounts and quality, see the chapter Fuel and Lubricant Specifications.

Filling in fuels

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

– **Diesel engine oil**
  For replacement engines or engines which have undergone a general overhaul, use authorised diesel engine oil, see the chapter Fuel and Lubricant 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 articulated shafts, cables, ball sockets, grease nipples and ring gear with oil or grease.
- Check the batteries. Use fully charged batteries which have undergone regular maintenance only.
- Bleed the fuel system (see the chapter, Maintenance)
- 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 minutes at medium speed. Then check the coolant level again and refill as necessary.
- 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

JD000025

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

- If a fuel shut-off valve is available:
  Open the fuel shut-off valve.
- Increase the speed control lever to full load.

or

If the diesel engine is warm:

- Reduce speed of the diesel engine to idle.
- Start up the diesel engine with the ignition key.

or

- Start up the diesel engine with the starter push-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.

- Following start-up, allow the diesel engine to run warm at medium load.
- 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.

Operation

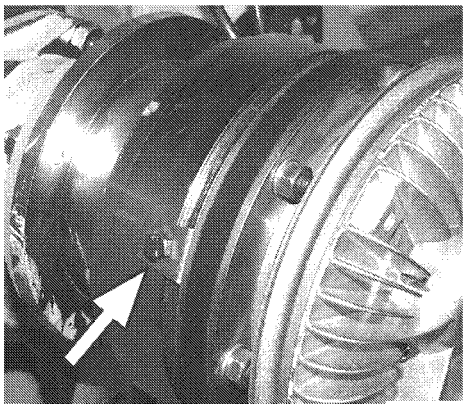
- Checking the diesel engine in operation.

– 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 are determined?

- Switch off diesel engine immediately.

Note:
If an electromagnetic fan clutch has been fitted to the fan drive, the fan clutch may seize mechanically if the drive speed of the fan drive is not reached, for example, due to a fault in the power supply etc.



Fan clutch

- Screw in two M 6x10 screws tightly through the angle into the thread in the cooling fin ring.

3.2.4 Precautions for starting up in icy temperatures

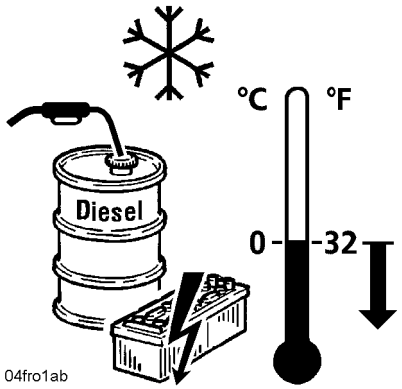
Low temperatures

The starting behaviour can thus be considerably improved 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!

! Refrain from using ether-based starting aids.



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 start procedure, see documentation of the manufacturer.

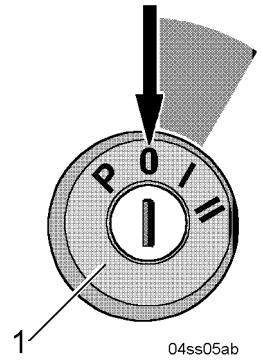
3.2.5 Shutting down

Switching off the diesel engine.

Caution

Risk of the diesel engine becoming damaged!
If the diesel engine is shut down suddenly, the turbocharger continues to run for a short while without oil supply.

! Do not shut down the diesel engine suddenly from full-load speed. This point is to be noted in particular for turbo-diesel engines.



Start switch – 0-position

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- 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:

Error codes are indicated on the machine display for diagnosis of the diesel engine faults. 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 afterwards	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 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
	Heater flange or flame-type kit faulty (with cold temperatures)	Check heater flange or flame-type kit and replace if necessary

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Fault	Possible cause	Remedy
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 or flame-type kit faulty (with cold temperatures)	Check heater flange or flame-type kit and replace if necessary
	Fault in the electronics	Read out error memory from engine control unit, consult LIEBHERR AFTER-SALES-SERVICE
Diesel engine shuts down without warning	Power 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 over 1800 metres above sea level	No remedy, diesel engine output was reduced automatically
	Diesel engine brake flap faulty (if available)	Functional and visual inspection; Consult LIEBHERR AFTER-SALES-SERVICE
	Injection nozzles getting stuck or not spraying	Check injection nozzles, adjust or replace, consult LIEBHERR AFTER-SALES-SERVICE
	Diesel engine - insufficient compression	Check compression, if not OK; 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 brake action	Diesel engine brake flap not functioning	Functional and 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	Check; Consult LIEBHERR AFTER-SALES-SERVICE
Diesel engine emitting black smoke	Injection nozzles getting stuck or not spraying	Check injection nozzles, adjust or replace, consult LIEBHERR AFTER-SALES-SERVICE
	Diesel engine brake flap faulty	Functional and visual inspection; Consult LIEBHERR AFTER-SALES-SERVICE
	Turbocharger faulty (boost pressure too low)	Check functioning of turbocharger; 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 or flame-type kit faulty (with cold temperatures)	Check heater flange or flame-type kit and replace if necessary
Diesel engine knocking	Combustion disorder	Consult LIEBHERR AFTER-SALES-SERVICE
Diesel engine rattling	Valve clearance too big	Adjusting valve clearance
	Injection nozzles faulty or carbonised	Check injection nozzles, readjust, or if necessary replace; 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	Replace turbocharger; Consult LIEBHERR AFTER-SALES-SERVICE

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Fault	Possible cause	Remedy
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 due to diesel fuel)	Drain oil, fill in prescribed oil
	Oil pressure gauge or pressure sensor faulty	Check oil pressure and replace faulty oil sensor or pressure gauge; Consult LIEBHERR AFTER-SALES-SERVICE
	Final check valve not functioning correctly or dirt in final check valve	Check final check valve, clean or replace and reset; Consult LIEBHERR AFTER-SALES-SERVICE
	Bearing clearance too great due to wear or bearing damaged	Remount engine or carry out over-haul;consult LIEBHERR AFTER-SALES-SERVICE
Lube oil in the cooling system	Oil cooler or oil cooler grill leaking	Conduct pressure test, replace if leaks are determined; Consult LIEBHERR AFTER-SALES-SERVICE
Cooling water in the lube oil	O-rings on the cylinder liners not tight	Replace O-rings; Consult LIEBHERR AFTER-SALES-SERVICE
	Oil cooler or oil cooler grill leaking	Conduct pressure test, replace if leaks are determined; Consult LIEBHERR AFTER-SALES-SERVICE

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5 Maintenance

5.1 Maintenance and inspection schedule

Abbreviations used in this section:
Bh = 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 (Bh).
– 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 correspond to: upon commissioning and every 500, 1000, 2000 operating hours (Bh).

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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 (contamination, damages)
			○	○	○		Checking the diesel engine brake
			○	○	○		Change or replace diesel engine oil: CAUTION, the operating hours specified are only valid with the appropriate lube oil quality / difficulty factors, see Fuel and Lubricants
			○	○	○		Replace the oil filter
			○	○	○		Check batteries and cable connections
			○	○	○		Check viscous coupling
			□	○	○		Check induction and exhaust system for sound condition and for leaks
				○	○		Check / adjust diesel engine regulation
				○	○		Lubricate ring gear on the flywheel
				○	○		Check oil sump and diesel engine bracket for secure seating
				○	○	❄	Depending on the design: Check flame-type kit or heater flange
						3000h	Replace the oil separator (or at the latest, every 2 years)
							Cylinder head
				○	○		Check / adjust valve clearance
						3000h	Checking / adjusting, and if necessary, replacing the injection valve
							Cooling system
	●	●	○	○	○		Checking the coolant level
			○	○	○		Check cooling system for leaks and for sound condition
			○	○	○		Replace water filter
			○	○	○	❄	Check anticorrosive and antifreeze, as well as DCA 4 concentration in the coolant
						3000h	Replace coolant (or at the latest, every 2 years)
						✧	Lubricate cooling system
						✧	Decalcify and derust cooling system
							Fuel system
	●	●	○	○	○		Check water separator on the fuel pre-filter and drain water as required
		●	○	○	○		Draining water and sediment in the fuel tank
			○	○	○		Check oil system and fuel system for leaks and for sound condition
				○	○	✧	Depending on the design: Replace fuel pre-filter or clean or replace pre-filter insert
				○	○		Replace the fuel fine filter (distributor-type injection pump)

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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 the fuel fine filter (in-line injection pump)
						✧	Bleed fuel system
Air filter system							
	●	●	❍	❍	❍		Air filter low-pressure display
		●	❍	❍	❍		Clean dust-discharge valve of the air filter
						✧	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)

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5.2 Lubricant chart, Filling quantities

5.2.1 Table of filling quantities

	Name	Medium	Dosage	Units
 06sy04ab	Diesel engine D924 (without water cooler)	Coolant	14.5	Litres
 06sy04ab	Diesel engine D926 (without water cooler)	Coolant	19.5	Litres
 06sy05ab	Diesel engine D924 (with oil filter) depending on the design	Oil	approx. 20.5	Litres
 06sy05ab	Diesel engine D926 (with oil filter) depending on the design	Oil	approx. 20 — 25	Litres

5.2.2 Lubricant chart

The maintenance 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”.

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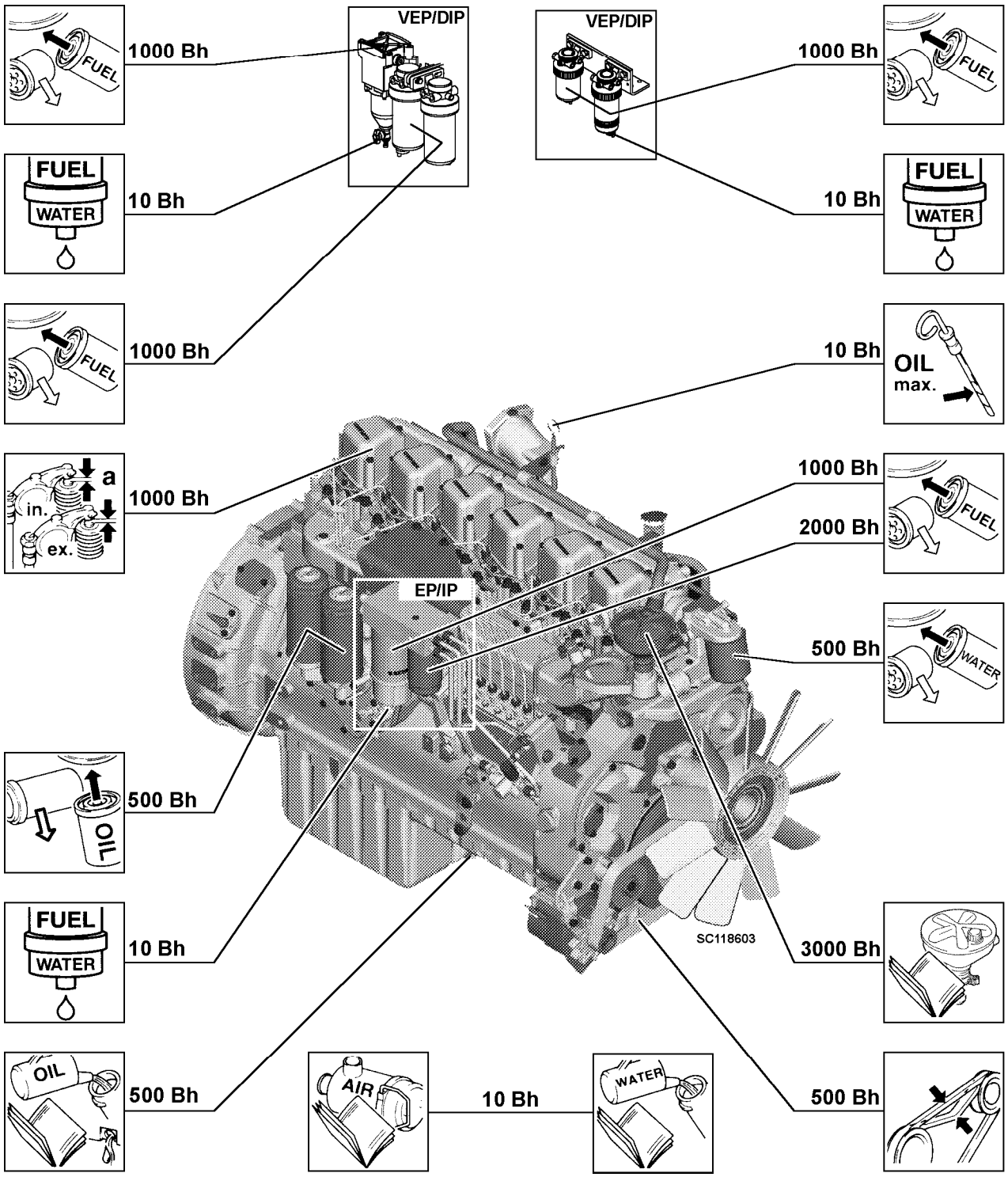

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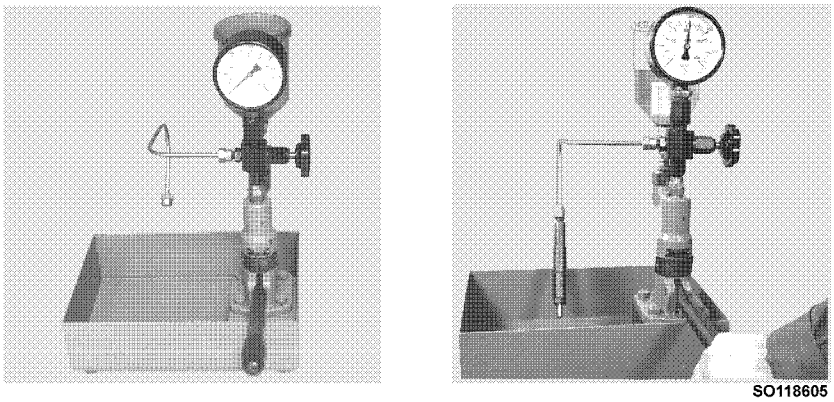
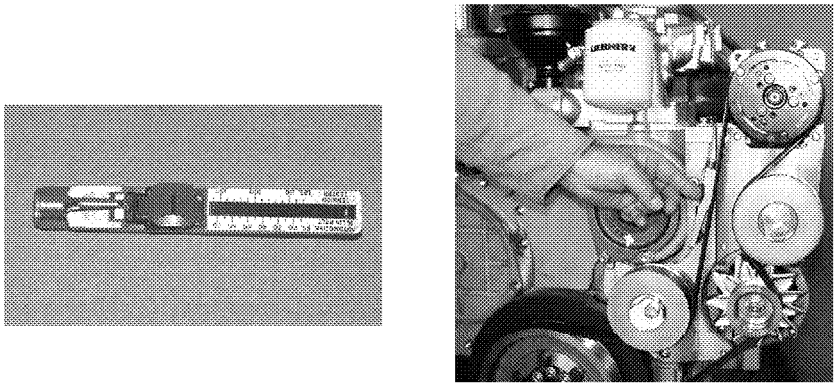
5.3 Maintenance tasks

5.3.1 Special tools for maintenance tasks



Nozzle tester — special tool no. 3

No.	Ident. no.	Model	See section
3	7361236	Nozzle tester	Checking the injection valve



V-belt measuring device-Krikit 2 — special tool no. 9.1

No.	Ident. no.	Model	See section
9.1	8042829	V-belt measuring device-Krikit 2	Checking ribbed V-belt tension

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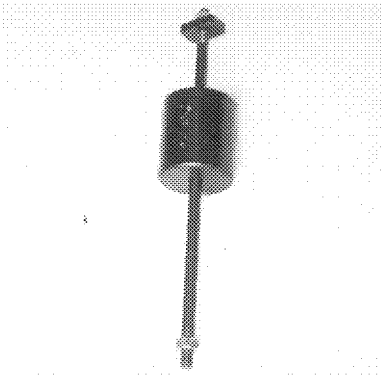
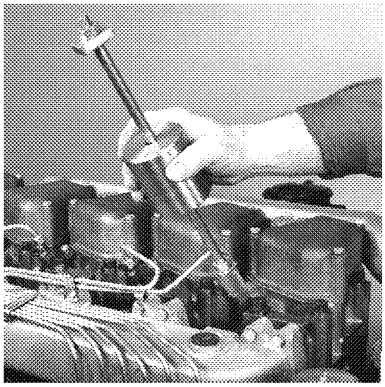
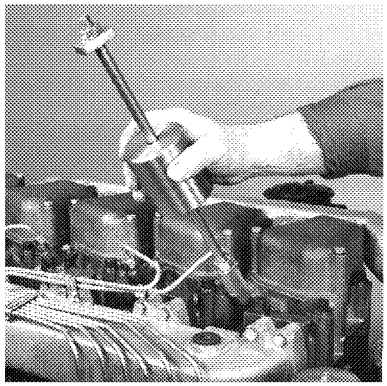




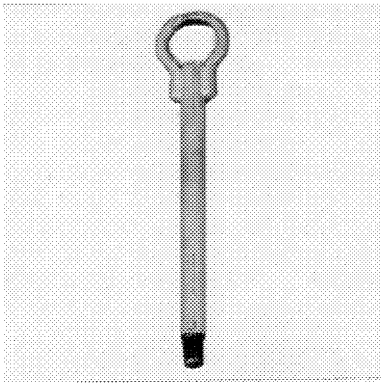
Extractor — special tool no. 18

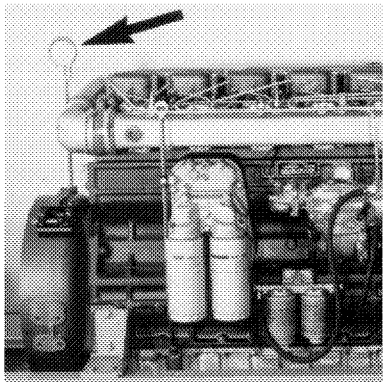
No.	Ident. no.	Model	See section
18	0524072	Extraction device	Replacing the injection valve



Adapter — special tool no. 19

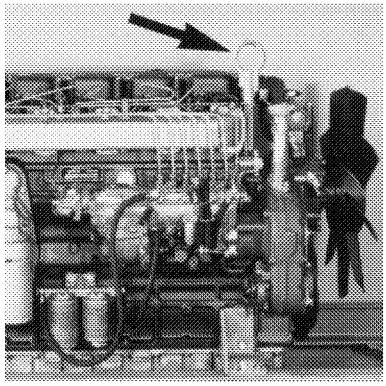
No.	Ident. no.	Model	See section
19	0524029	Adapter	Replacing the injection valve





Eyelet bolt — special tool no. 21

No.	Ident. no.	Model	See section
21	0701650	Eyelet bolt	Lifting device



Eyelet bolt — special tool no. 22

No.	Ident. no.	Model	See section
22	0701651	Eyelet bolt	Lifting device

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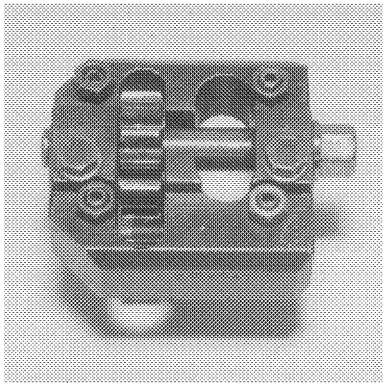

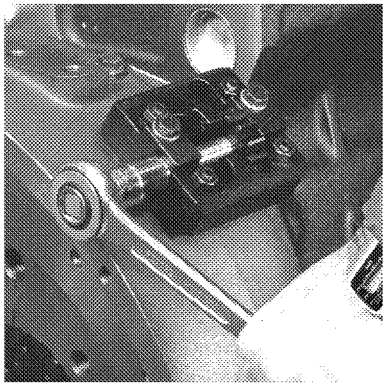

Turning gear — special tool no. 30

No.	Ident. no.	Model	See section
30	0524045	Turning gear	Check / adjust valve clearance

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 of the oil level or oil change
– 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
– the diesel engine is warm
– a collecting vessel has been prepared

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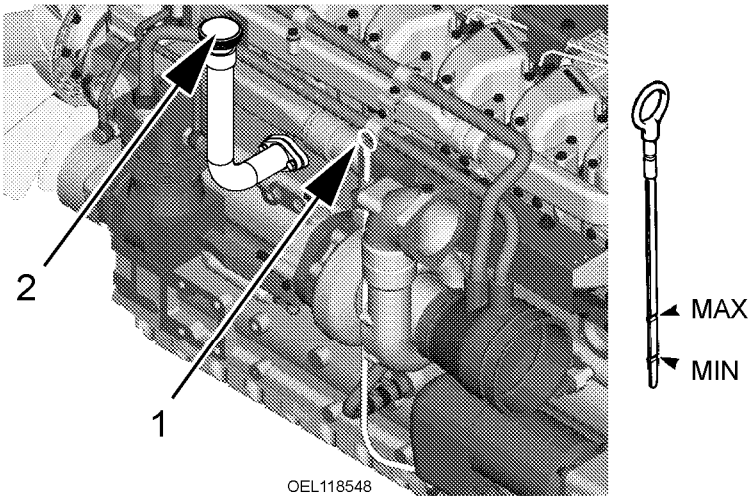
Checking the oil level

The oil dipstick and oil filler nozzle may be mounted in different positions depending on the diesel engine accessories, e.g. the oil dipstick on the left or right-hand of the diesel engine, the oil filler nozzle is located on the aggregate carrier, oil sump, crankcase or on the cylinder head cover.



Example oil dipstick - oil filler nozzle

- Pull out the oil dipstick**1** , wipe clean and then 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 refill above the upper marking max. of the oil dipstick.

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

Checking the coolant level

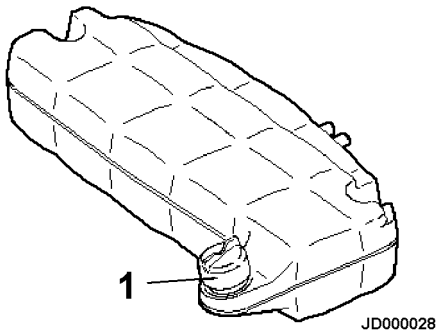
The coolant level externally indicated via the transparent expansion tank.
Machines featuring non-transparent expansion tank: Check the coolant level in the filler neck, if the level is correct the coolant is visible.

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 slightly anticlockwise until the excess pressure is dissipated, then open.

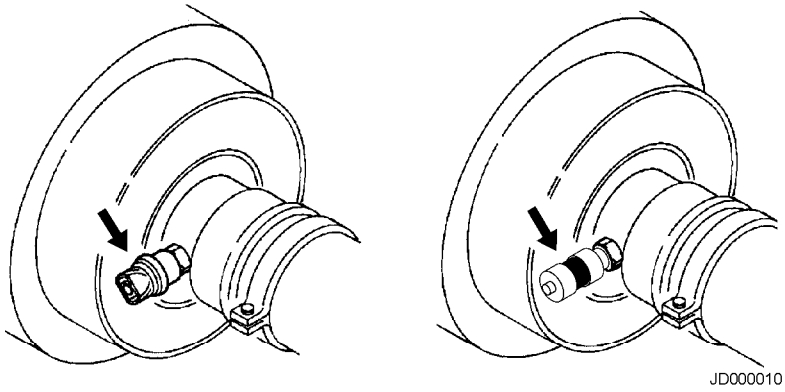
- Only fill in prepared coolant with 50 vol. – % anticorrosive / antifreeze at the expansion tank
- Fill cooling system to maximum level.
- Remount the sealing cap on the expansion tank and tighten.
- Start the diesel engine and allow to run warm.
- Check the coolant level again and top up as required.

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

Check the air filter low-pressure display

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

Troubleshooting

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

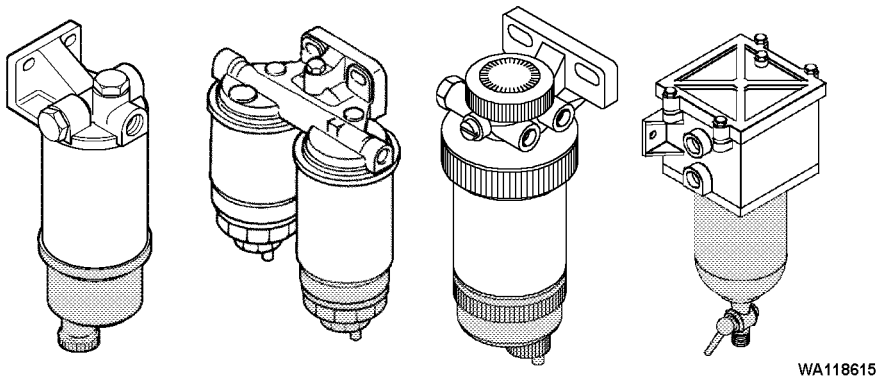
- Do not start the diesel engine.
- **The air filter safety element may not be cleaned**.
  Clean or replace the air filter main element.

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

The display is reset in green.

Check / drain the water separator of the fuel pre-filter

Arrangement and design of the fuel prefilter with water separator may differ depending on the diesel engine accessories.



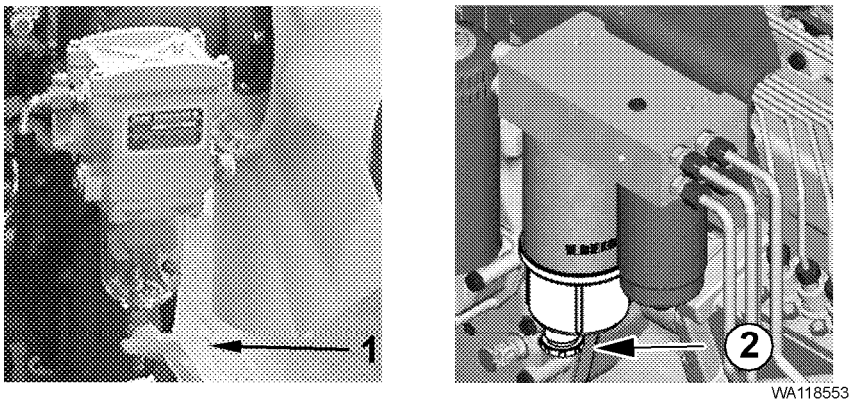
Fuel prefilter with water separator

Fuel prefilter with water separator

Danger

Risk of fire and explosion!

! No smoking.
! Avoid naked flames.
! Only work on the diesel engine while 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:

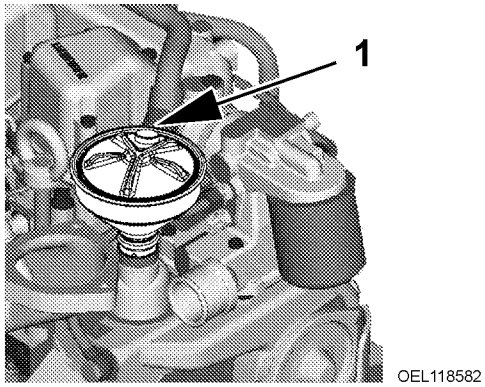
- Do not start the diesel engine.
- Position a collecting vessel beneath the fuel-water separator and, if necessary, attach a drainage hose..
- Push in the drain tap handle **1** and turn in an anticlockwise direction or loosen the drain plug**2** , and allow water to drain until fuel flows out.

- When fuel begins to flow:
  Close drain tap 1 or tighten drain plug 2.

Visual inspection (contamination, damages)

- Check the diesel engine for leaks via visual inspection. Sealing points which are exuding only insignificant amounts of water may be overlooked.

Troubleshooting
Should major leaks with continuous oil loss or a damaged water separator be determined:
A damaged oil separator, e.g. dented cover, oil vapour escaping at the diaphragm ventilation**1** , impairs functioning.



Oil separator

- Replace the oil separator and remedy any leaks immediately.

- 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 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 while the diesel engine is switched off.

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

Clean dust-discharge valve of the air filter

Maintenance of the air filter is not generally required if this is indicated for example by 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.

- 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”.

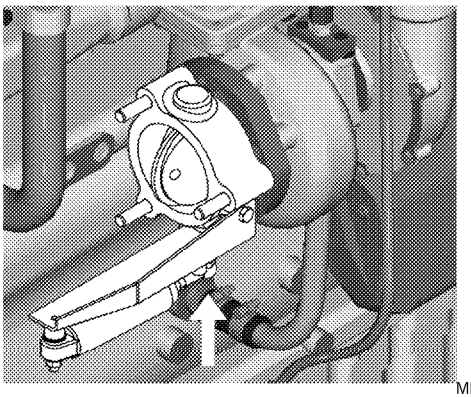
– carry out the weekly maintenance tasks, see the section “Maintenance Tasks (weekly), every 50 operating hours,”.

It must be ensured that:

– the diesel engine is in the maintenance position

Checking the diesel engine brake

The diesel engine brake is mounted on the turbocharger on the left-hand side of the diesel engine.



Diesel engine brake – flap

- Check and oil 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 stuck will cause overheating of the diesel engine, an increase in fuel consumption and thick smoke being emitted from the exhaust

Check cooling system for leaks and for sound condition

- 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.

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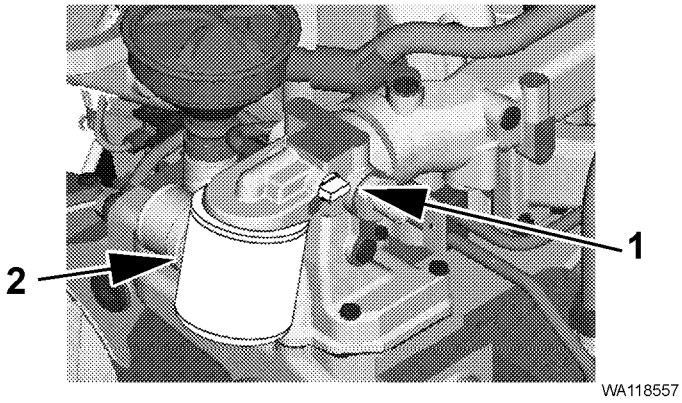
Replace water filter

The water filter is mounted at the front of the diesel engine on the thermostat housing.
The water filter contains an anticorrosive additive which ensures additional anticorrosive properties of the cooling system.
It must be ensured that:
– a water filter is on-hand.



Water filter

- Close the shut-off valve **1** on the filter housing,
- Unscrew the filter element**2** ,
- Lightly oil the sealing ring on the new filter element,
- Screw on the new filter element until the sealing ring is resting on the filter head

When the sealing ring is resting on the filter head:

- Tighten the filter element around ½ - ¾ of a turn. (do not use any tools for tightening).
- Open the shut-off valve **1** again (ON).

Check anticorrosive and antifreeze, as well as DCA 4 concentration in the coolant

The coolant is to be checked for effectiveness if corrosion protection and frost protection is to be guaranteed.

A coolant test strip kit is a simple and effective method of checking the freezing point and the additive content (DCA 4).

- Take a coolant sample and analyse using the coolant test strip kit.

If the analysis indicates too low a frost protection, or too low a DCA 4 concentration, the mix ratio is to be rectified, see the section Fuel and Lubricants.

Check oil system and fuel system for leaks and for sound condition

- Check oil sump, oil filter, injection 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

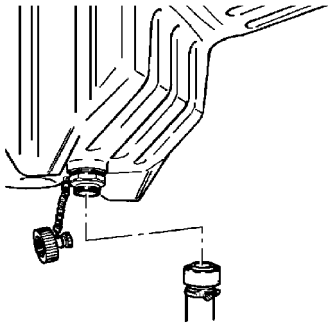
Determine any leaks in the oil and fuel system:

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

Replacing the diesel engine oil

The oil drain valve is beneath the diesel engine on the oil sump.
It must be ensured that:

– the diesel engine is positioned horizontally
– the diesel engine is switched off
– the diesel engine is warm
– a suitable container with approx. 26 l volumetric capacity, as well as an oil drain hose and the diesel engine oil which complies with the specifications, are on-hand

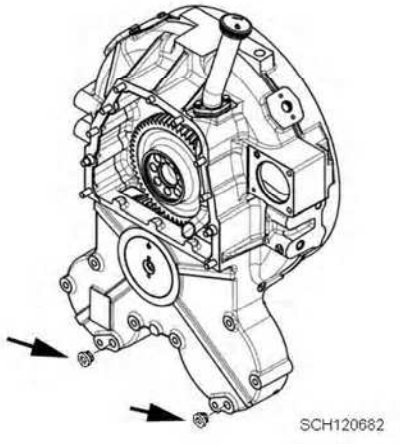


Drain valve with drainage hose

- Unscrew the sealing cap on the oil drain valve on the oil sump.
- Screw the oil drain hose onto the oil drain valve.
- Allow the oil to drain into the container provided.
- Unscrew the oil drain hose and screw the sealing cap onto the oil drain valve.

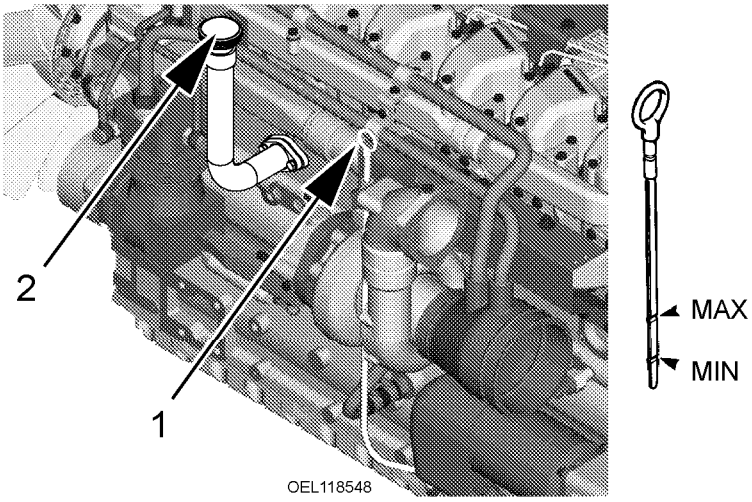
Note:

For diesel engines with integrated power take-offs on the bottom of the flywheel housing, the drain plugs must be opened when changing the diesel engine oil.



Flywheel housing with power take-offs

- Unscrew both screw plugs
- Allow the oil to drain into the container provided.
- Screw in both screw plugs



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 and check the oil pressure.
- Switch off the diesel engine and after 2 - 3 minutes check the oil level on the dipstick.

Troubleshooting

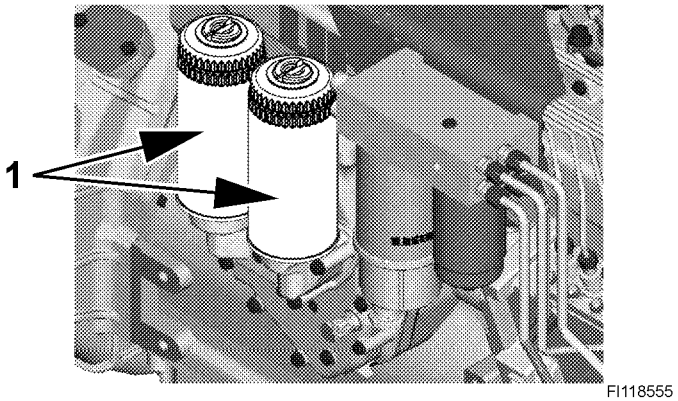
The oil level is not within min. and max.?

- Rectify the oil level.

Replace the oil filter

The oil filters are fitted upright or suspended, either on the right-hand side of the diesel engine or at a sufficient distance from the diesel engine, depending on the diesel engine accessories.
It must be ensured that:

– a strap spanner, a suitable container and original LIEBHERR oil filter cartridges (2 x) are on-hand



Oil filter

- Position the suitable container under the diesel engine
- Loosen the oil filter cartridge **1** using a strap spanner and unscrew the filter.
- Clean the sealing faces of the filter bracket.

The old filter seal and all of its remnants must be removed.

- Apply a thin coat of diesel engine oil to the rubber sealing ring on the new oil filter cartridge.
- Screw on the new oil filter cartridge until the sealing ring is resting on the filter bracket

When the sealing ring is resting on the filter bracket:

- Tighten the oil filter cartridge around ½ - ¾ of a turn. (do not use any tools for tightening).
- 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.

Checking the condition of the ribbed V-belt

The ribbed V-belt is located at the front on the diesel engine, running of the ribbed V-belt varies depending on the diesel engine accessories, e.g. with generator and generator drive with air-conditioning compressor.
It must be ensured that:

– a ratchet DIN 3122 D 12.5 (1/2 “), as well as a new ribbed V-belt, 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

Replacement of the ribbed V-belt without self-tensioning device

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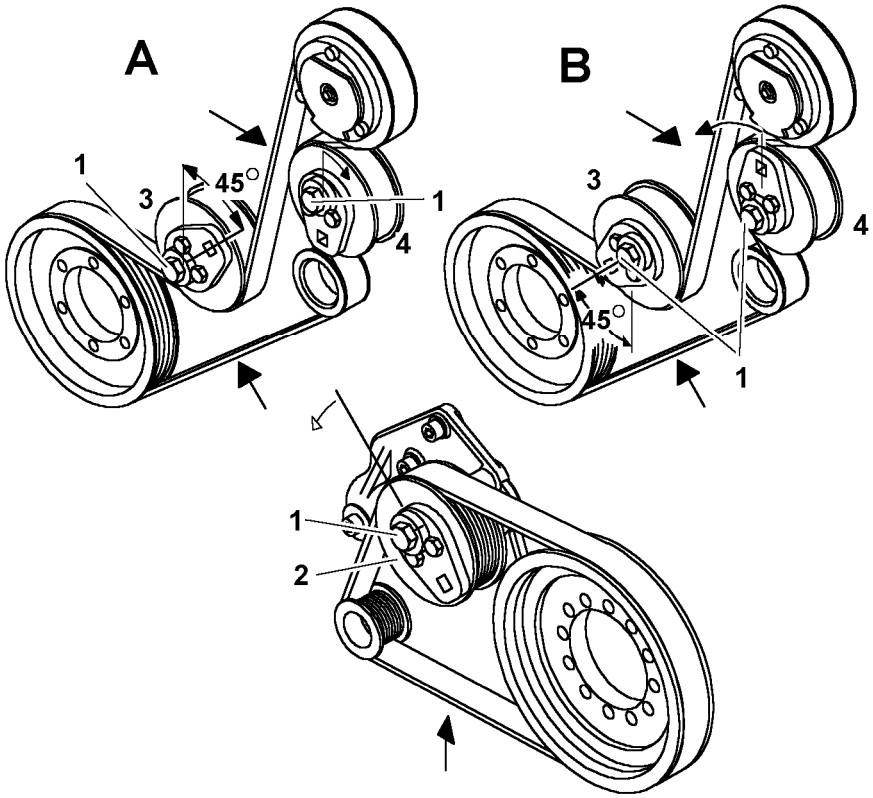

Generator ribbed V-belt and generator drive with air-conditioning compressor

- Loosen screw**1** .
- Turn tension pulley **2** or (design B) tension pulley **3** and **4** in a clockwise direction or (design A) in an anticlockwise direction using the ratchet, relieve tension in the ribbed V-belt and remove.
- Check tension pulley and belt pulley for sound condition (e.g. worn bearing of tension pulley, as well as wear of the belt pulley profile).

If parts are damaged, replace the parts

- Mount new ribbed V-belt on all belt pulleys and tension pulleys.
- If installed, preset tension pulley 3 (designs A and B) to 45° as illustrated and tighten screw 1.
- **Setting the ribbed V-belt tension**
  Turn tension pulley 2 or tension pulley 4 (design B) in an anticlockwise direction or (design A) in a clockwise direction using the ratchet, until the correct tension has been attained in the ribbed V-belt, and tighten screw 1.
- Allow to run for 10 to 15 minutes
  Check the tension again and readjust as required

Replacing the ribbed V-belt with self-tensioning device

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Mounting the ribbed V-belt with tensioning device

- Insert the ratchet, complying with standard DIN 3122 D 12.5 (1/2”) into the square hole of the tensioning device.
- Swing back the tensioning device against the spring force in an anticlockwise direction up to the stop and remove the ribbed V-belt.
- Check tension pulley and belt pulley for sound condition (e.g. worn bearing of tension pulley, as well as wear of the belt pulley profile).

If parts are damaged, replace the parts

- With the tensioning device swung back, mount the new ribbed V-belt onto the belt pulleys of the crankshaft, air-conditioning compressor, generator and deflection pulley, then return the tensioning device into the tensioning position.

Testing tension of the ribbed V-belt without self-tensioning device

Measuring point: in the middle between crankshaft-belt pulley – generator belt pulley or in the middle between tension pulley 3 and the belt pulley from the air-conditioning compressor (see arrow in the diagram, “generator ribbed V-belt and generator drive with air-conditioning compressor”).
It must be ensured that:
– a measuring device “Krikit 2” (special tool no. 9.1) is on-hand.
Measured values for checking the tension by hand are:
– Ribbed V-belt pre-tension: 120 N
– Indentation depth: 13 mm

- Check ribbed V-belt tension at the measuring points

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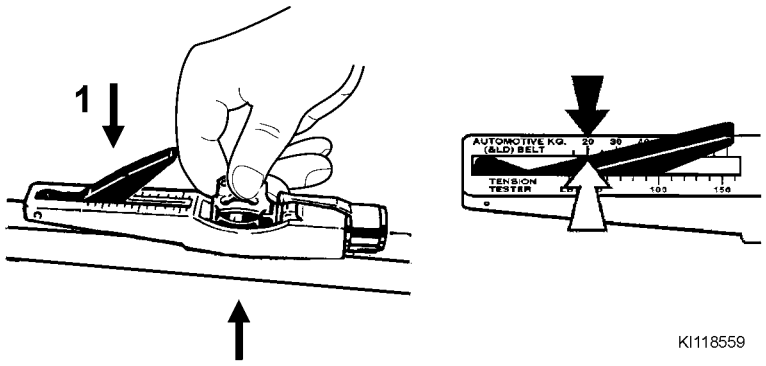
Troubleshooting

If the prescribed measured values are not attained?

- Relieve or apply tension in the ribbed V-belt
- Measuring point between crankshaft belt pulley and generator belt pulley.
  Loosen tension pulley 2 or tension pulley 4, turn in a clockwise or an anticlockwise direction with the ratchet until the correct tension of the ribbed V-belt has been attained and tighten.
- Measuring point between tension pulley 3 and belt pulley of the air-conditioning compressor.
  Loosen tension pulley 3, turn in a clockwise or an anticlockwise direction with the ratchet until the correct tension of the ribbed V-belt has been attained and tighten.

Measured values for testing the tension with a measuring device “Krikit 2 ”(special tool no. 9.1) 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. 9.1):

- With measuring device Krikit 2 (special tool no. 9.1)
  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 ribbed V-belt slowly and evenly 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
- Measuring point between crankshaft belt pulley and generator belt pulley.
  Loosen tension pulley 2 or tension pulley 4, turn in a clockwise or an anticlockwise direction with the ratchet until the correct tension of the ribbed V-belt has been attained and tighten.
- Measuring point between tension pulley 3 and belt pulley of the air-conditioning compressor.
  Loosen tension pulley 3, turn in a clockwise or an anticlockwise direction with the ratchet until the correct tension of the ribbed V-belt has been attained and tighten.

Check batteries and cable connections

- Only use fully charged batteries which have been maintained.
  Maintenance, see manufacturer's documentation.
- Coat the terminals with acidproof grease (terminal grease).
- Ensure sound condition without indication of damage, correct arrangement without the occurrence of wear and correct fastening of all electrical lines.

Should damaged lines be determined?
Replace faulty lines or cable harnesses.

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”.

5.3.7 Diesel engine

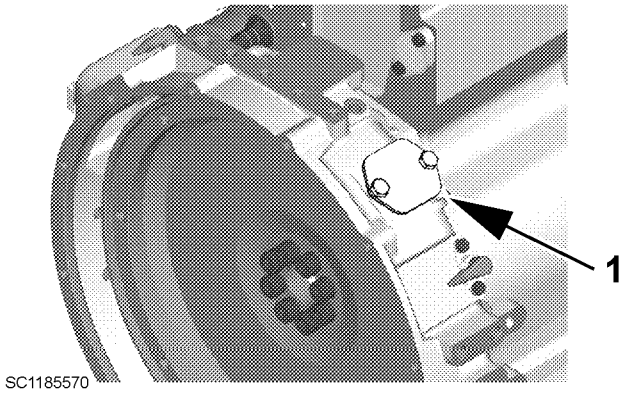
Check / adjust diesel engine regulation

It must be ensured that:
– the documentation of the manufacturer is on-hand.

- Check the diesel engine regulation in accordance with the manufacturer's documentation, adjust as necessary.

Lubricate 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 on the flywheel

- Unscrew the maintenance cover **1** from the flywheel housing
- Do not apply too much grease to the ring gear, otherwise the speed sensors will become smeared and subsequently malfunction.
  Check ring gear and, if necessary, grease lightly with regular lubricating grease
- Screw on the maintenance cover again.

Check oil sump and diesel engine bracket for secure seating

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

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

Check induction and exhaust system for sound condition and for leaks

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

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

5.3.8 Cylinder head - valves

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 on the flywheel side
– Rotational direction on the left-hand side looking at the flywheel
– Exhaust valve of the respective cylinder on the flywheel side

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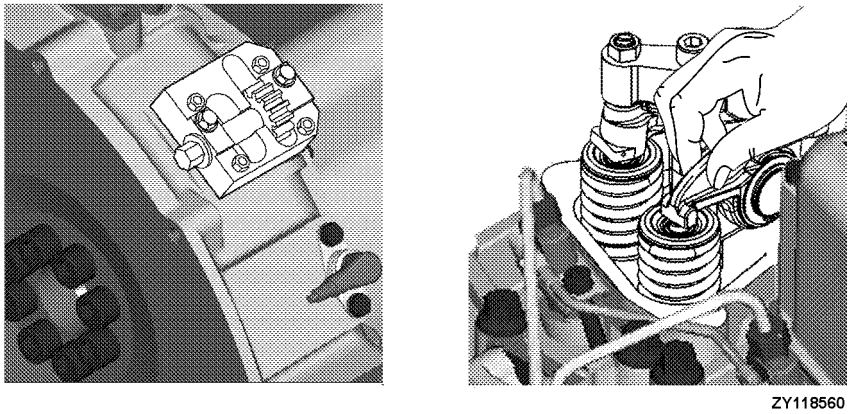
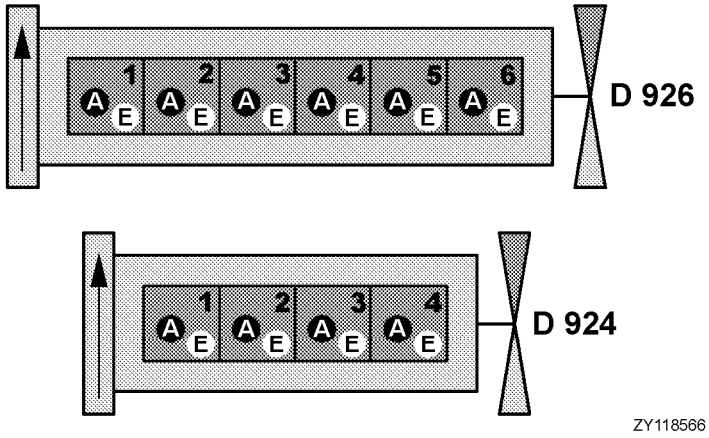


Turning gear — valve overlap

- Dismantle the cylinder head cover, mount the turning gear, special tool no. 30, on the flywheel housing
- Turn the crankshaft in the direction of rotation until the cylinder to be adjusted overlaps the opposite valve.

See table for details:



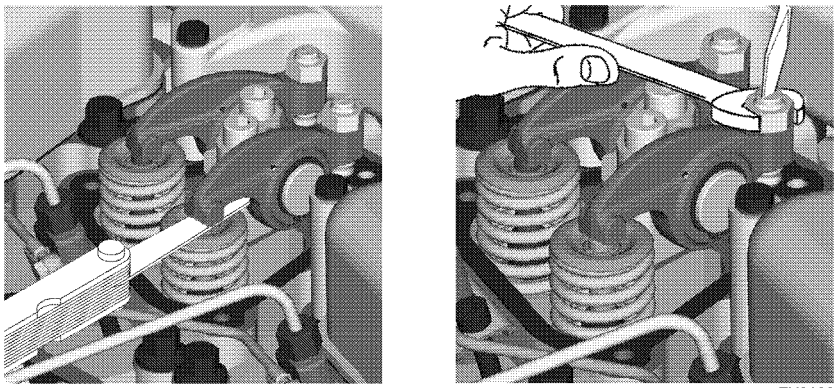
Valves of the cylinder

A = Exhaust valveE = Intake valve

Valves of the cylinder D926						
overlap	6	2	4	1	5	3
adjust	1	5	3	6	2	4
Valves of the cylinder D924						
overlap	4	2	1	3		
adjust	1	3	4	2		

Checking and adjusting standard valve clearance

Checking / adjusting valve clearance



Checking / adjusting valve clearance

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

Troubleshooting

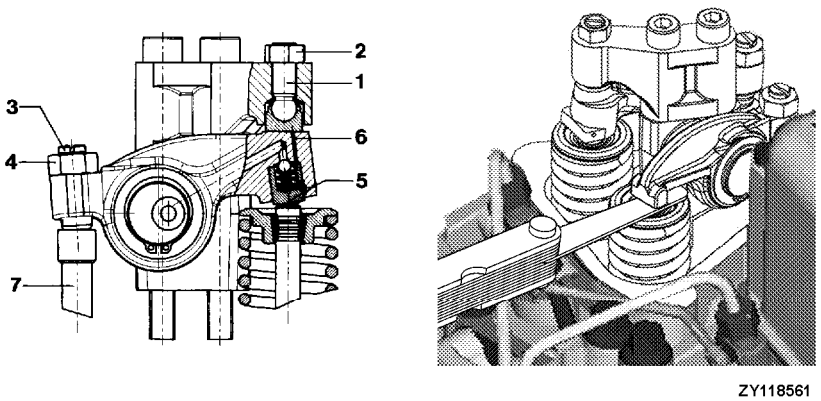
The clearance does not correlate with the adjustment values, see “Technical Data”, Valve clearance?

- Loosen the lock nut on the adjusting screw of the respective rocker arm and correct the adjustment.
- Tighten the lock nut

- Check adjustment again
- After checking or adjusting all valves, mount the cylinder head covers with new seals.
- Dismantle the turning gear

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

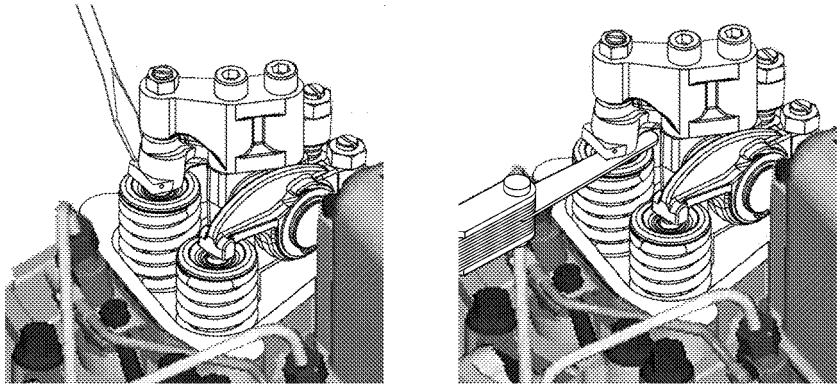
Checking the intake valves:



Checking the intake valves:

- Insert the feeler gauge between valve and rocker arm and check the valve clearance, adjust as necessary

Checking the exhaust valves:



ZY118562

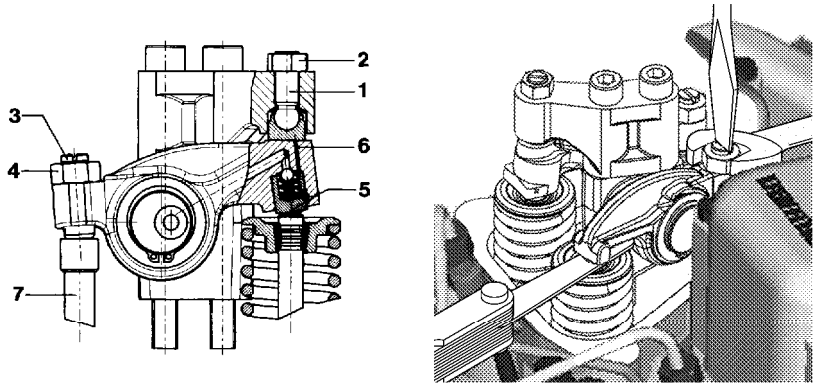
Checking the exhaust valves:

- Push the rocker arm at piston **5** several times against the valve using a screwdriver, until no more oil is flowing out of the pressure relief bore**6** .

Has the oil been forced completely from the plunge chamber ?

- Insert the feeler gauge between the exhaust valve and piston **5** and check the valve clearance, adjust as necessary

Setting the intake valves:

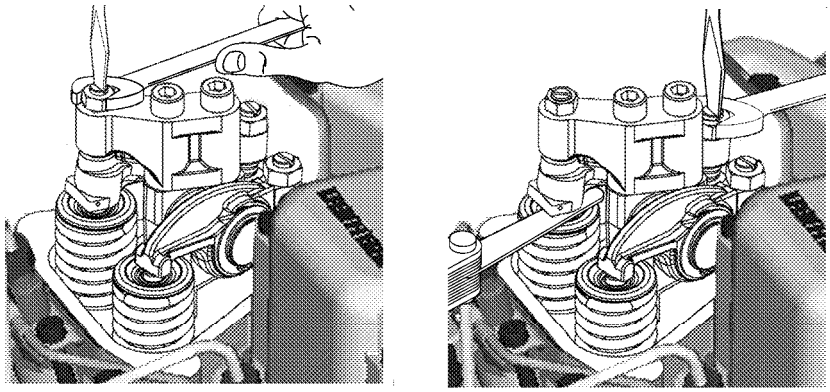


ZY118563

Setting the intake valves:

- Loosen the lock nut on the adjusting screw of the respective rocker arm and adjust the setting.
- Tighten the lock nut again.
- Check the setting again after tightening the lock nut.

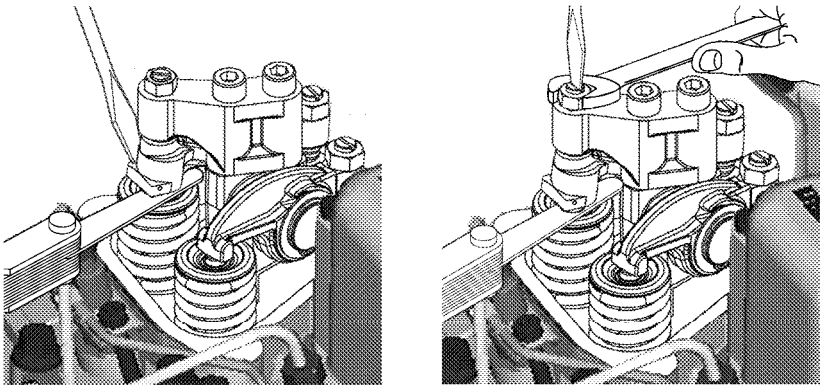
Setting the exhaust valves:



ZY118564

Setting the exhaust valves:

- Loosen the lock nut **2** and unscrew the adjusting screw **1** as far as possible without applying force.
- Loosen the lock nut **4** and turn back the adjusting screw **3** until the 0.50 mm feeler gauge can be inserted between the piston **5** and the valve.
- Screw in the adjusting screw **3** until the feeler gauge becomes jammed. The piston **5** is pushed back.
- Set a valve clearance of 0.50 mm at the adjusting screw**3** .
- Tighten the lock nut**4** .



ZY118565

Setting the exhaust valve

- Insert the 0.30 mm feeler gauge between the piston **5** and the valve.
- Push the rocker arm at piston **5** against the valve using a screwdriver, until piston **5** reaches the stop.

Has the oil been forced completely from the plunge chamber ?

- Hold the piston **5** pressed down and screw in the adjusting screw **1** until the valve clearance has been set.
- Tighten the lock nut**2**

Note:

Turn the push rod to check whether adjustment was successful, the push rod must indicate clearance.

- After setting all valves, mount the cylinder head covers with new seals
- Dismantle the turning gear

5.3.9 Flame-type kit

Check the flame-type kit

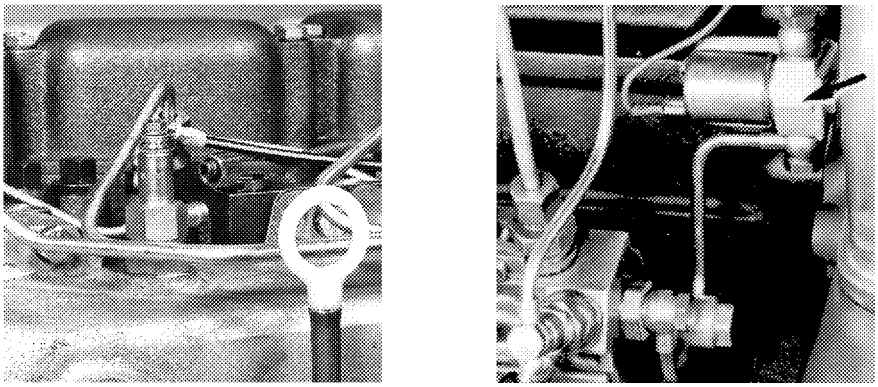
Arrangement and design of the flame-type kit may differ depending on the diesel engine accessories.
Ensure that the following are on-hand:
– a collecting vessel for the fuel

Danger

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

- Position a collecting vessel beneath the diesel engine.

Checking the solenoid valve:



Flame glow plug — solenoid valve

- Unscrew the fuel line from the flame glow plug.
- Position the Start-Stop lever on the injection pump to Stop.
- Crank the diesel engine using the starter.

Fuel flows from the fuel line

- Manoeuvre the Start-Stop Lever on the injection pump from Stop into the neutral position and start the diesel engine.

The flow of fuel to the fuel line stops.

Troubleshooting
If no fuel is supplied when cranking the diesel engine, or if the flow of fuel does not stop when the diesel engine is running !

- Replace the solenoid valve. When replacing, observe the throughflow direction indicated via the arrow.

Checking the flame glow plug:

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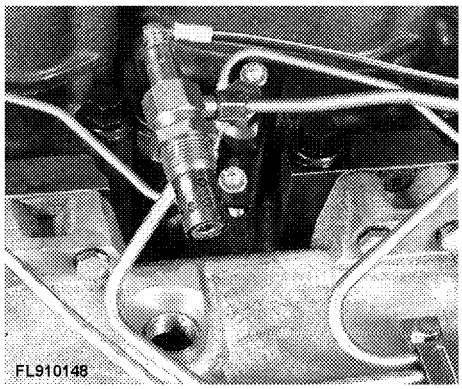


Checking the flame glow plug:

- Remove the flame glow plug and connect to the fuel line or electrical line.
- Position the Start-Stop lever on the injection pump to Stop and preheat.

Upon completion of the preheating period, the flame glow plug is glowing red on the coiled filament.

- Crank the diesel engine using the starter.

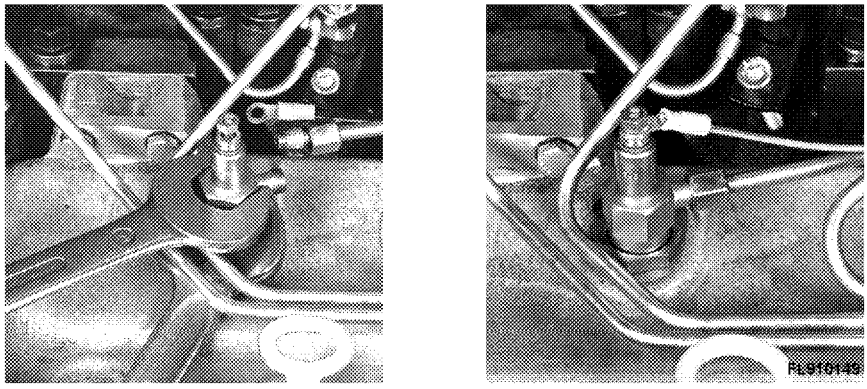
The incoming fuel vaporises on the glowing coiled filament.

Troubleshooting

If the coiled filament on the flame glow plug is not glowing, or if no fuel is being supplied to the coiled filament when cranking the diesel engine !

- Replace the flame glow plug.

Removing the flame glow plug:



Removing the flame glow plug — Installing the flame glow plug

- Shut off the electrical line and the fuel line.
- Loosen lock nut and unscrew flame glow plug from the induction pipe.

Installing the flame glow plug:

- Apply a coating of sealing compound, Hylomar SQ 32 M, Omnivisic 1050 or Reinzoplast to the thread of the flame glow plug and screw into the induction pipe.
- Screw on and tighten the fuel line.
- Tighten the lock nut on the flame glow plug and connect the electrical line.

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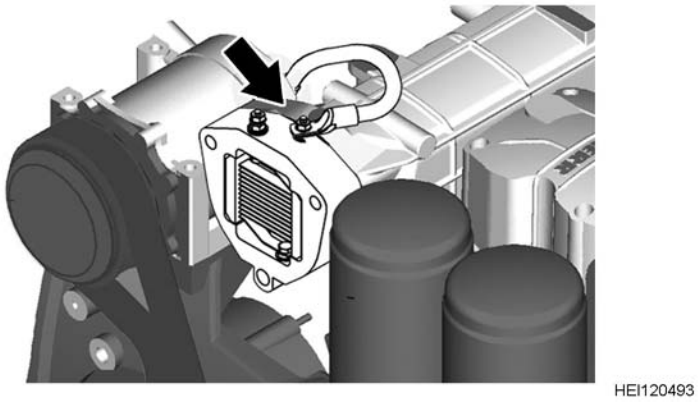
5.3.10 Check heater flange

The heater flange is mounted at the inlet of the air induction pipe.
Correct functioning of the heater flange is to be checked every year before the onset of the cold season.
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



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 ohms +/– 10% at 20 °C is not 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.

5.3.11 Fuel pre-filter

Preparing for replacement of the fuel prefilter

Arrangement and design of the fuel prefilter with water separator may differ depending on the diesel engine accessories.
Ensure that the following are on-hand:
– a collecting vessel for the fuel
– an original Liebherr filter cartridge or a filter element

Danger

Risk of fire and explosion!

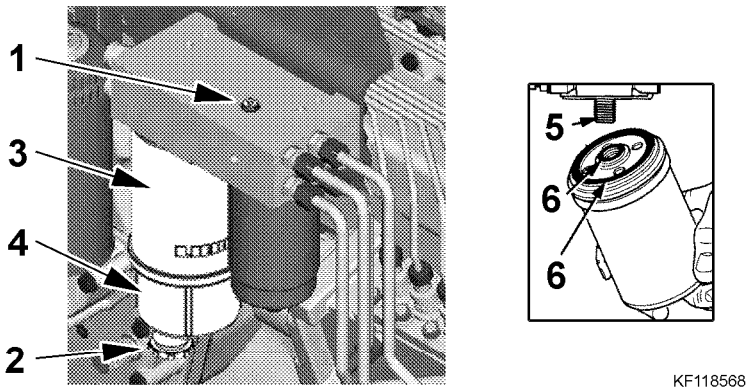
! No smoking.

! Avoid naked flames.

! Only work on the diesel engine while the diesel engine is switched off.

- If a fuel shut-off valve is available:
  Close the fuel shut-off valve.
- Position a collecting vessel beneath the fuel filter.
- Clean fuel pre-filter and surrounding area thoroughly.

Variant I — Replacing the fuel prefilter



Replacing the fuel prefilter

- Drain fuel: Unscrew the bleed screw **1** and drain plug**2** .
- Loosen filter cartridge **3** with strap spanner or similar tool and unscrew.
- Unscrew the water separator reservoir **4** from the filter cartridge.
- Dispose of the old filter cartridge.
- Clean the water separator reservoir with water and dry with compressed air.
- Screw the water separator reservoir onto the filter cartridge.
- Check that the filter base is clean and ensure that the thread adapter **5** is sitting securely in the filter base.
- If the filter base is dirty:
  Clean the filter base.
- Lubricate the sealing rings **6** of the new filter cartridge with clean fuel. Screw the new filter cartridge onto the filter base and tighten finger-tight only.
- Open the fuel shut-off valve and bleed the fuel prefilter.
- Close the bleed screw

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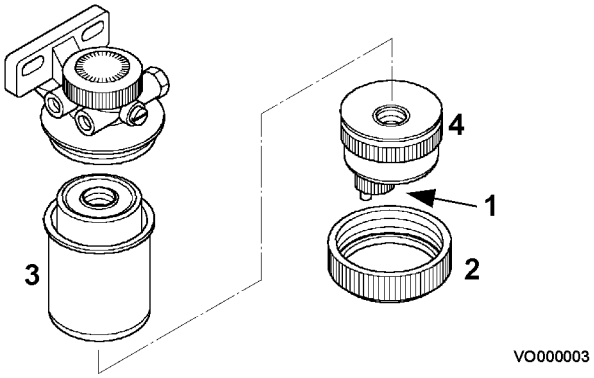
Variant II — Replacing the fuel prefilter



Replacing the fuel prefilter

- Drain the fuel: Unscrew drain plug**1** .
- Push the snap ring **2** upwards and turn around 1/4 of a turn in an anticlockwise direction.
- Remove the filter element **3** with snap ring (2) by pulling downwards.
- Unscrew the water separator reservoir **4** from the filter element.
- Dispose of the old filter element.
- Clean the water separator reservoir with water and dry with compressed air.
- Screw the water separator reservoir onto the filter element.
- Ensure the filter base is clean.
- If the filter base is dirty:
  Clean the filter base.
- Mount the new filter element onto the filter base. Ensure that the slot of the filter base and the cams of the filter element align.
- Tighten the snap ring by hand around 1/3 of a turn in a clockwise direction.

The snap ring engages the notch with a click.

- Open the fuel shut-off valve and bleed the fuel prefilter.

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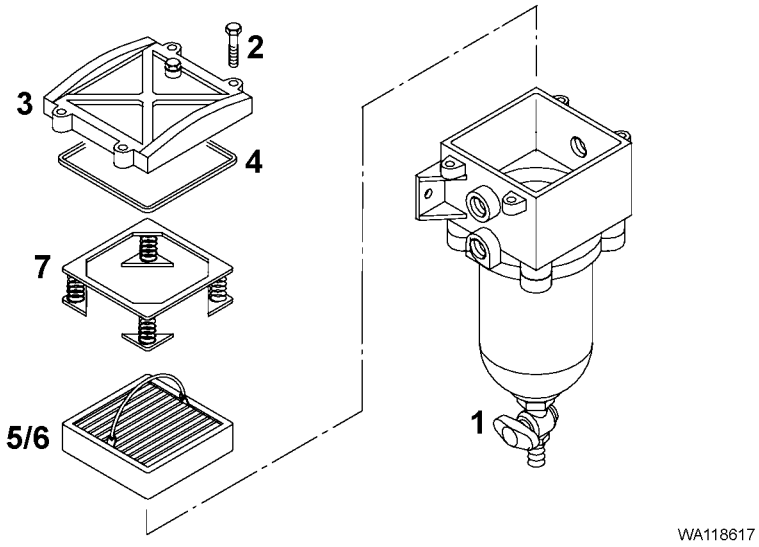
Variant III — Cleaning / replacing the fuel prefilter filter element



Fuel prefilter

- Push in the drain tap handle **1** and turn in an anticlockwise direction, drain the fuel.
- Unscrew the screws **2** and remove the cover **3** with seal**4** .
- Remove the paper filter element **5** or filter insert **6** together with the spring cartridge**7**
- Dispose of the paper filter element **5** or clean or replace the filter insert**6** .
- Reinstall the new paper filter **5** or cleaned filter element**6** .
- Check seal 4, replace if necessary and reassemble in reverse order.
- Open the fuel shut-off valve and bleed the fuel prefilter.

5.3.12 Maintenance Tasks, every 2000 operating hours

Before carrying out the 2000 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”.
– carry out the 1000 operating hours maintenance tasks, see the section “Maintenance Tasks, every 1000 operating hours”.

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5.3.13 Fuel fine filter

Preparing for replacement of the fuel fine filter

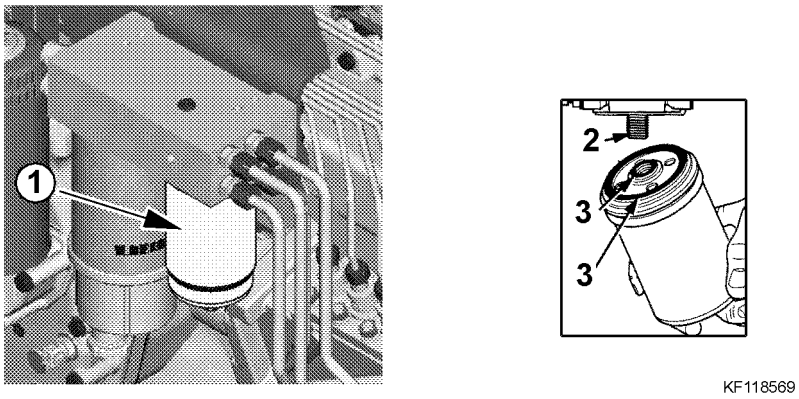
Arrangement and design of the fuel fine filter may differ depending on the diesel engine accessories.
Ensure that the following are on-hand:
– a collecting vessel for the fuel
– an original Liebherr filter cartridge

Danger

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

- If a fuel shut-off valve is available:
  Close the fuel shut-off valve.
- Position a collecting vessel beneath the fuel filter.
- Clean fuel fine-filter and surrounding area thoroughly.

Variant I — Replacing the fuel fine filter



Replace fuel fine filter

- Loosen filter cartridge **1** with strap spanner or similar tool and unscrew.
- Dispose of the old filter cartridge.
- Check that the filter base is clean and ensure that the thread adapter **2** is sitting securely in the filter base.
- If the filter base is dirty:
  Clean the filter base.
- Lubricate the sealing rings **3** of the new filter cartridge with clean fuel. Screw the new filter cartridge onto the filter base and tighten finger-tight only.
- Open the fuel shut-off valve and bleed the fuel fine filter.

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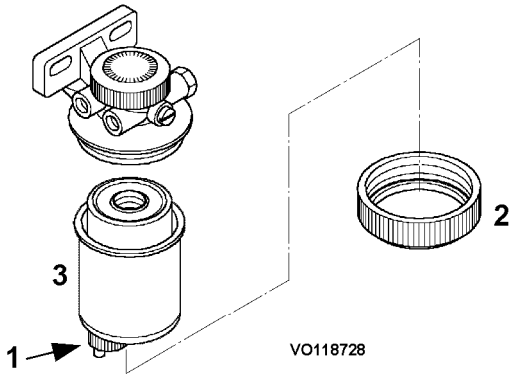
Variant II — Replacing the fuel fine filter



Replace fuel fine filter

- Drain the fuel: Unscrew drain plug**1** .
- Push the snap ring **2** upwards and turn around 1/4 of a turn in an anticlockwise direction.
- Pull away the filter element **3** with snap ring (2) from beneath.
- Dispose of the old filter element.
- Ensure the filter base is clean.
- If the filter base is dirty:
  Clean the filter base.
- Mount the new filter element onto the filter base. Ensure that the slot of the filter base and the cams of the filter element align.
- Tighten the snap ring by hand around 1/3 of a turn in a clockwise direction.

The snap ring engages the notch with a click.

- Open the fuel shut-off valve and bleed the fuel fine filter.

5.3.14 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 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”.
– 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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5.3.15 Cylinder head - injection valves

Checking / adjusting, and if necessary, replacing the injection valve

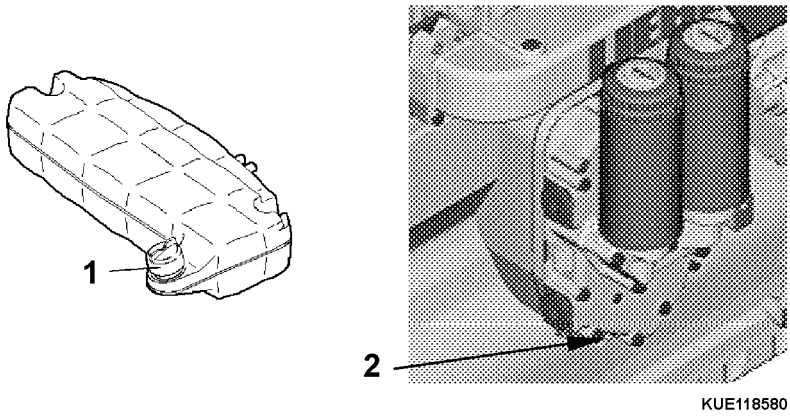
For the following maintenance tasks:
– Checking the injection valve
– Setting the injection valve
– Replacing the injection valve
please contact LIEBHERR AFTER-SALES-SERVICE.

5.3.16 Cooling system

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 with DCA 4, mix ratio see “Fuel and Lubricants”, filling amount see the “manufacturer's documentation”, are on-hand.

Draining the coolant



Draining the coolant

- Avoid opening the sealing cap **1** if the diesel engine is too warm.
- Turn the sealing cap very slightly anticlockwise until the excess pressure is dissipated, then open.
- Position the container under the diesel engine
- Open the drain plug **2** on the oil cooler housing on the right-hand side of the diesel engine.
- Open the drain plug on the coolant pump.
- Open the drain plug on the radiator (see manufacturer's documentation).

The coolant from the oil cooler housing, coolant pump and cooler flows into the vessel.

- Has the coolant been drained from the cooling system.

Then close the drain plug on the oil cooler housing, coolant pump and cooler again.

Filling in coolant.

- Only fill in prepared coolant with 50 vol. – % anticorrosive / antifreeze and DCA 4 at the expansion tank.

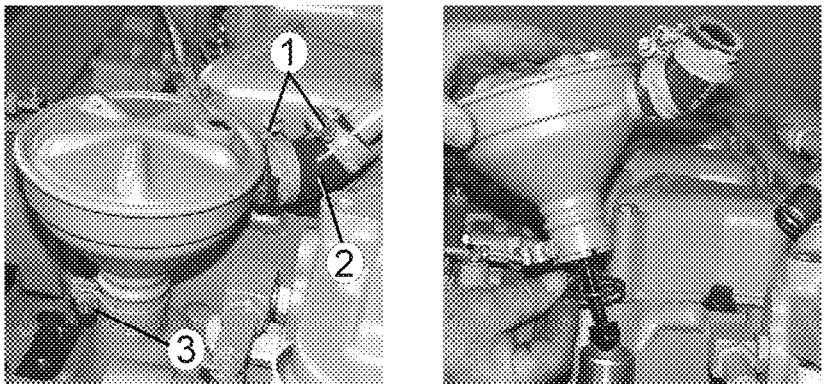
- Fill cooling system to maximum level.
- Fit and lock the sealing cap on the expansion tank.
- Start the diesel engine and allow to run warm.
- Check the coolant level again and top up as required.

Ensure that the coolant contains at least 50 vol.– % anticorrosive / antifreeze and DCA 4.

Replacing the oil separator

It must be ensured that:
– the diesel engine is in the maintenance position
– an oil separator with new O-ring is on-hand

Removing the oil separator:



Removing — Installing

- Loosen the hose clamps **1** and push the hose **2** from the oil separator.
- Loosen the fastening clamp **3** and remove the oil separator.

Installing the oil separator:

- Insert a new O-ring in the oil separator.
- Push the oil separator onto the pipe or support in the aggregate carrier and tighten the fastening clamp.
- Mount the brackets, slide on the hose and tighten the hose clamps.

5.3.17 Maintenance tasks as required

It must be ensured that:
– the diesel engine is in the maintenance position
– a collecting vessel has been prepared
– the respective maintenance material is on-hand

5.3.18 Dry-air filter

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

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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.

- Replacement of the main element, see documentation of the manufacturer“”.

Replacing the dry air filter safety element

The safety element only needs replacing with every third replacement of the main element, **however at least once a year**.

- Replacement of the safety element, see documentation of the manufacturer“”.

5.3.19 Fuel system

Preparing for bleeding of the fuel system

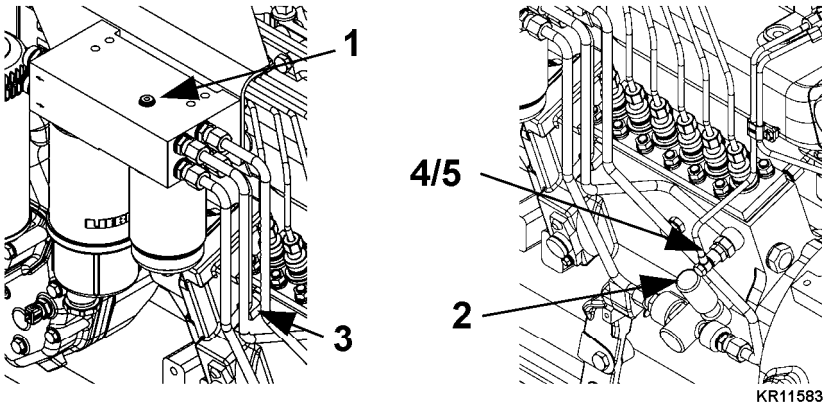
It is necessary to bleed the fuel system following:
– replacement of the fuel filter
– cleaning of the fuel tank
– repairs to the fuel system
– running the fuel tank empty
It must be ensured that:
– the diesel engine is in the maintenance position,
– a collecting vessel for the fuel is on-hand.

Danger

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

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

Bleeding the fuel system (in-line injection pump)



Bleeding the fuel system (in-line injection pump)

- Loosen the bleed screw **1** on the filter head and unscrew 2 to 3 turns of thread.
- Actuate the hand pump**2** .

When the fuel flowing out of the bleed screw no longer contains bubbles!

- Tighten bleed screw **1** again.

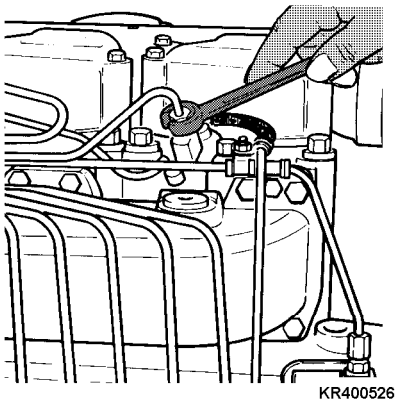
- Loosen the fuel line **3** on the injection pump.
- Actuate the hand pump**2** .

When the fuel flowing out of the fuel line no longer contains bubbles!

- Tighten the fuel line **3** again.
- Loosen the overflow oil return-flow line **4** with overflow valve**5** .
- Actuate the hand pump**2** .

When the fuel flowing out no longer contains bubbles!

- Tighten the overflow valve **5** and overflow oil return-flow line **4** again.



Injection valves

- Loosen the cap nuts on the injection lines to the injection valves.
- Actuate the starter

When the fuel flowing out no longer contains bubbles!

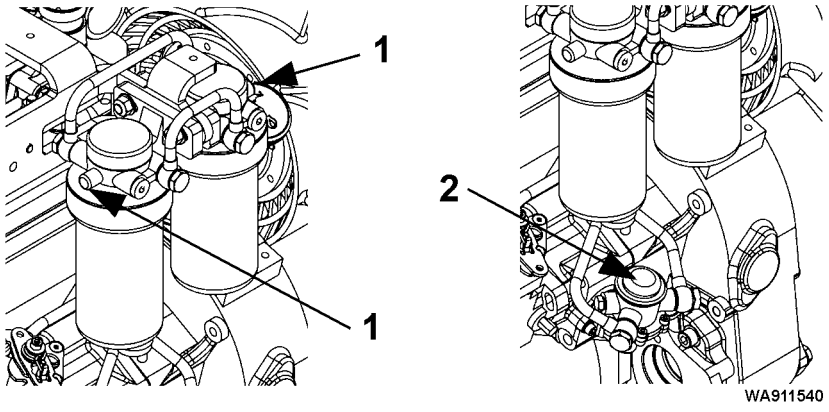
- Tighten cap nuts again.
- Start the diesel engine and check the seals at the connections.

Troubleshooting

The diesel engine will not continue to run after starting?

- Repeat the bleeding procedure.

Bleeding the fuel system (distributor-type injection pump)



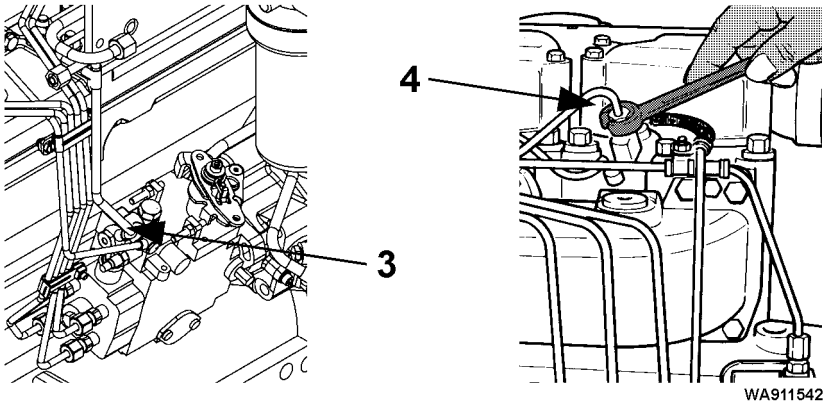
Fuel fine filter — fuel delivery pump

- Unscrew the bleed screws **1** on the fuel fine filters around 2 or 3 turns of thread

- Actuate the lever on the fuel delivery pump**2** .

When the fuel flowing out of the bleed screw no longer contains bubbles!

- Tighten the bleed screw **1** again.



Fuel return-flow line — injection line

- Loosen the fuel return-flow line **3** to the tank at the injection pump.
- Actuate the lever on the fuel delivery pump**2** .

When the fuel flowing out of the fuel line no longer contains bubbles!

- Tighten the fuel return-flow line **3** again.
- Loosen the cap nuts on the injection lines to the injection valves.
- Actuate the starter

When the fuel flowing out no longer contains bubbles!

- Tighten the cap nuts **4** again.
- Start the diesel engine and check the seals at the connections.

Troubleshooting

The diesel engine will not continue to run after starting?

- Repeat the bleeding procedure.

5.3.20 Cooling system

Lubricate cooling system

It may be necessary to degrease the cooling system if leaks at the:
– cylinder head gaskets,
– oil cooler seals,
– oil cooler and oil cooler grill
allows diesel engine oil to run into the cooling water circuit.

Following rectification of any damage, the cooling system must be degreased before coolant is filled in.
It must be ensured that:
– the diesel engine is in the maintenance position,
– the maintenance task “Drain coolant” has been carried out.
– a degreasing agent: 5%-diluted solution of P3 Standard or P3T 5124, supplier: Henkel company, is on-hand and the manufacturer's instructions are adhered to.
– a seal for the thermostat housing is on-hand.
– a collecting vessel and coolant with DCA 4, mix ratio see “Fuel and Lubricants”, filling amount see the “manufacturer's documentation”, are on-hand.

- Remove both coolant thermostats, lock in an open position and reinstall
- Fill cooling system completely with a mixture of water and 5% degreasing agent.
- Run the diesel engine with heating switched on until a coolant temperature of 90° C has been attained.
- Allow the diesel engine to run for approx. 5 minutes at this temperature.
- Switch off diesel engine and allow cooling system to cool to approx. 50° C.

When the cooling system has cooled to approx. 50° C.

Caution

Danger of scalding as a result of degreasing agent being squirted out!
! Only open the sealing cap 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.

- Drain degreasing agent.
- Fill cooling system with fresh water.
- Allow the diesel engine to run for approx. 5 minutes for scavenging.
- Drain scavenging water, fill cooling system once again with fresh water and repeat the scavenging procedure.
- Remove coolant thermostats, readjust them back to the normal position and install with new thermostat housing.
- Perform the maintenance task “Fill in coolant”.

Decalcifying and derusting the cooling system

Decalcifying and derusting of the cooling system is necessary if coolant has been filled:

– which is not permissible,
– or has too low a mix ratio.

Impermissible coolant can lead to sedimentation or corrosion in the cooling system.

Sedimentation can cause leaks in the coolant pumps or deficient cooling capacity due to the interior of the cooler becoming clogged.

It must be ensured that:

– the diesel engine is in the maintenance position,
– the maintenance task “Drain coolant” has been carried out.
– a decalcifying or derusting agent: 10%-diluted solution of citric acid, tartaric acid, or oxalic acid, obtainable from chemical dealers, is on-hand
– a seal for the thermostat housing is on-hand.
– a collecting vessel and coolant with DCA 4, mix ratio see “Fuel and Lubricants”, filling amount see the “manufacturer's documentation”, are on-hand.

- Remove both coolant thermostats, lock in an open position and reinstall
- Fill cooling system completely with a mix of water 10% decalcifying or derusting agent.
- Run the diesel engine with heating switched on until a coolant temperature of 90° C has been attained.
- Allow the diesel engine to run for approx. 10 minutes at this temperature.
- Switch off diesel engine and allow cooling system to cool to approx. 50° C.

When the cooling system has cooled to approx. 50° C.

Caution

Danger of scalding as a result of decalcifying or derusting agent squirting out!

! Only open the sealing cap 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.

- Drain decalcifying or derusting agent .
- Fill cooling system with fresh water.
- Allow the diesel engine to run for approx. 5 minutes for scavenging.
- Drain scavenging water, fill cooling system once again with fresh water and repeat the scavenging procedure 3 to 5 times.
- Remove coolant thermostats, readjust them back to the normal position and install with new thermostat housing.
- Perform the maintenance task “Fill in coolant”.

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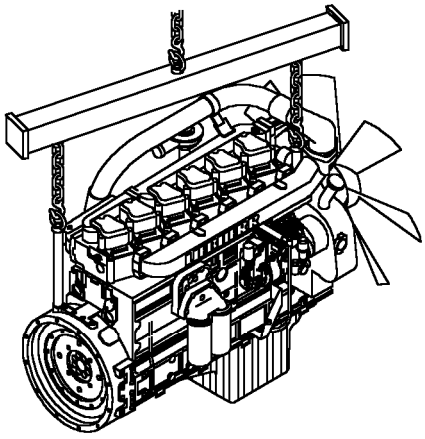
5.3.21 Transport

Lifting device

It must be ensured that:
- a suitable lifting device,
- a transport device or special tool nos. 21 and 22 are on-hand if required.



Lifting device

- If not already available, mount transport rings or special tool nos. 21 and 22.
- A proper lifting device must be used when moving the diesel engine. Hang the diesel engine on the lifting lugs provided.

5.3.22 Storage

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.

Should the specified measures be deviated from, whereby the preserved diesel engine is submitted to less favourable conditions (longer periods of storage in the open air or storage in damp, unventilated places etc.), a curtailment of the preservation protection period must be considered.

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.

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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 electrical parts, plug connections and rubber or plastic parts, as well as water temperatures exceeding 80 °C should be avoided to prevent irreversible damage.

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

5.3.23 Confirmation of maintenance tasks which have been carried out

Maintenance details

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

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. Seals on the injection pump and on the governor are not to be broken !
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 oil filter, as well as all further maintenance tasks must be carried out by a LIEBHERR-trained, authorised mechanic.

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5.3.24 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
  • poor oil quality,

the prescribed oil-change intervals must be halved, 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				
14000				
14500				
15000				
15500				
16000				
16500				
17000				
17500				
18000				
18500				
19000				
19500				
20000				

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5.3.25 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				

5.3.26 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				
18 years				
20 years				

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5.4 Lubricants and fuels

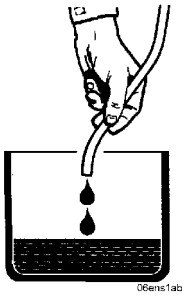
5.4.1 Handling lubricants and fuels

Conscientious adherence of the guidelines for handling fuel and lubricants increases reliability and life-expectancy of the diesel engine.
It is of particular importance that the prescribed lubricant qualities are adhered to.
The diverse details regarding the prescribed intervals can be obtained in the chapters “Maintenance and Inspection Chart”
Miscellaneous details for carrying out: lubrication, the checking of levels and changing of fuels 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 measures

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

5.4.3 Disposing of recyclables



Recyclables include for example:
– Oils, lubricants, coolant, refrigerating agents for air-conditioning systems etc.
– Fuels
– Filter, oil filter cartridge etc.

- Observe the guidelines for environmental-protection when disposing of recyclables.
- Collect all recyclables 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.

5.4.4 Lubricant and fuel specifications

Adhering to the guidelines for fuel and lubricants increases reliability and life-expectancy of the diesel engine.
It is of particular importance that the prescribed specifications are adhered to.

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5.4.5 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. 350 mg/kg = max. 0.035 weight% sulphur content is permissible.
"Low-sulphur" diesel fuels featuring a sulphur content of 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.400 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 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:
Authorisation can be granted in accordance with the diesel engine lube oil quality !

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 fuel in accordance with ASTM D975. A cetane number above 50 is preferable, especially with 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.
In moderate climates, cold-flow properties of up to:
0°C from 15.04. 30.09.
-10°C from 01.10. - 15.11./1.3. 14.04.
-20°C from 16.11. 29.02.

is guaranteed in accordance with DIN EN 590.
If the cold-flow properties of the diesel fuel is insufficient, or with even lower ambient temperatures than –20°C, we recommend that a fuel filter heating be used.

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5.4.6 Coolant for diesel engines

General recommendations

The cooling system will only function reliably if it is working under initial 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 us guarantee sufficient protection against cold, corrosion and cavitation, do not corrode seals and hoses and do not foam up.

The engine's cooling system should be filled all year round with a mixture of 50% water and 50% anticorrosive/antifreeze, guaranteeing a cold protection against temperatures as low as –37°.

Coolant with DCA 4 (Diesel Coolant Additives)


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Coolants which contain inadequate, or ill-prepared or incorrect anticorrosive/antifreeze, could cause a malfunctioning of aggregates or parts in the cooling circuit as a result of cavitational or corrosive damage. Furthermore, heat-insulating sedimentation can be resulted at heat exchanging parts, leading to an overheating, and then to malfunctioning, of the engine.

For a continuous, fault-free operation of Liebherr diesel engines, the coolant must comprise of 50% water and 50% anticorrosive/antifreeze.

Water filter accessories are used to improve quality of the coolant.

This ensures an additional filtering of the coolant in the induction current, purifying the coolant from particles of dirt or rust which cause leaks at the coolant pumps.

Additionally, a chemical admixture in the filter (DCA 4) protects the cooling system, or parts with which the coolant comes into contact such as coolant pumps, cylinder liners etc., against cavitation, corrosion, scale and the formation of foam.

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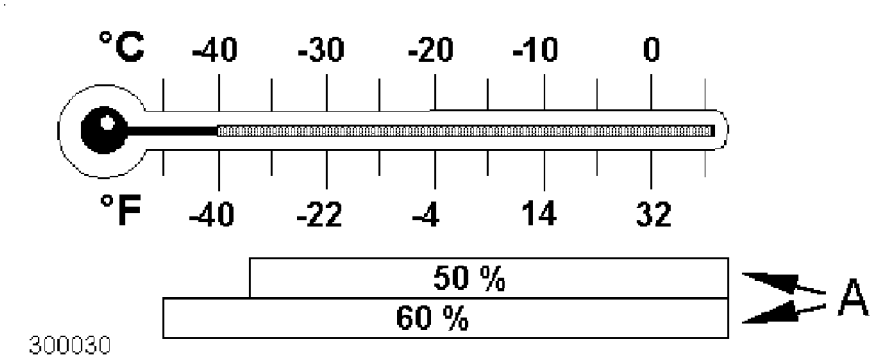
Mix chart / mix ratio water: Anticorrosive/antifreeze

	°C	°F	Water %	Anticorrosive/antifreeze %
Ambient temperature	–37	–34	50	50
Ambient temperature	–50	–58	40	60



Temperature-dependent selection of the mix ratio of anticorrosive and antifreeze

A = percentage (%) of the antifreeze

Refilling the cooling system

When refilling or topping up the cooling system following repair work, a liquid form of DCA 4 must also be mixed with the anticorrosive / antifreeze in addition to the DCA 4 concentration already contained in the water filters.

DCA 4 is also available in bottles (each containing approx. 0.47 litres).

Cooling system	**Required amount of DCA 4 – liquid**		**DCA 4 – water filter**
Content in litres	Bottles	Litres	Designated ident. no.
24 — 39	3	1.4	WF2071 7367045
40 — 59	4	1.9	WF2072 7381493
60 — 79	5	2.4	WF2073 7367052
80 — 115	8	3.8	WF2073 7367052

Required amount of DCA-4 for initial filling of the cooling system

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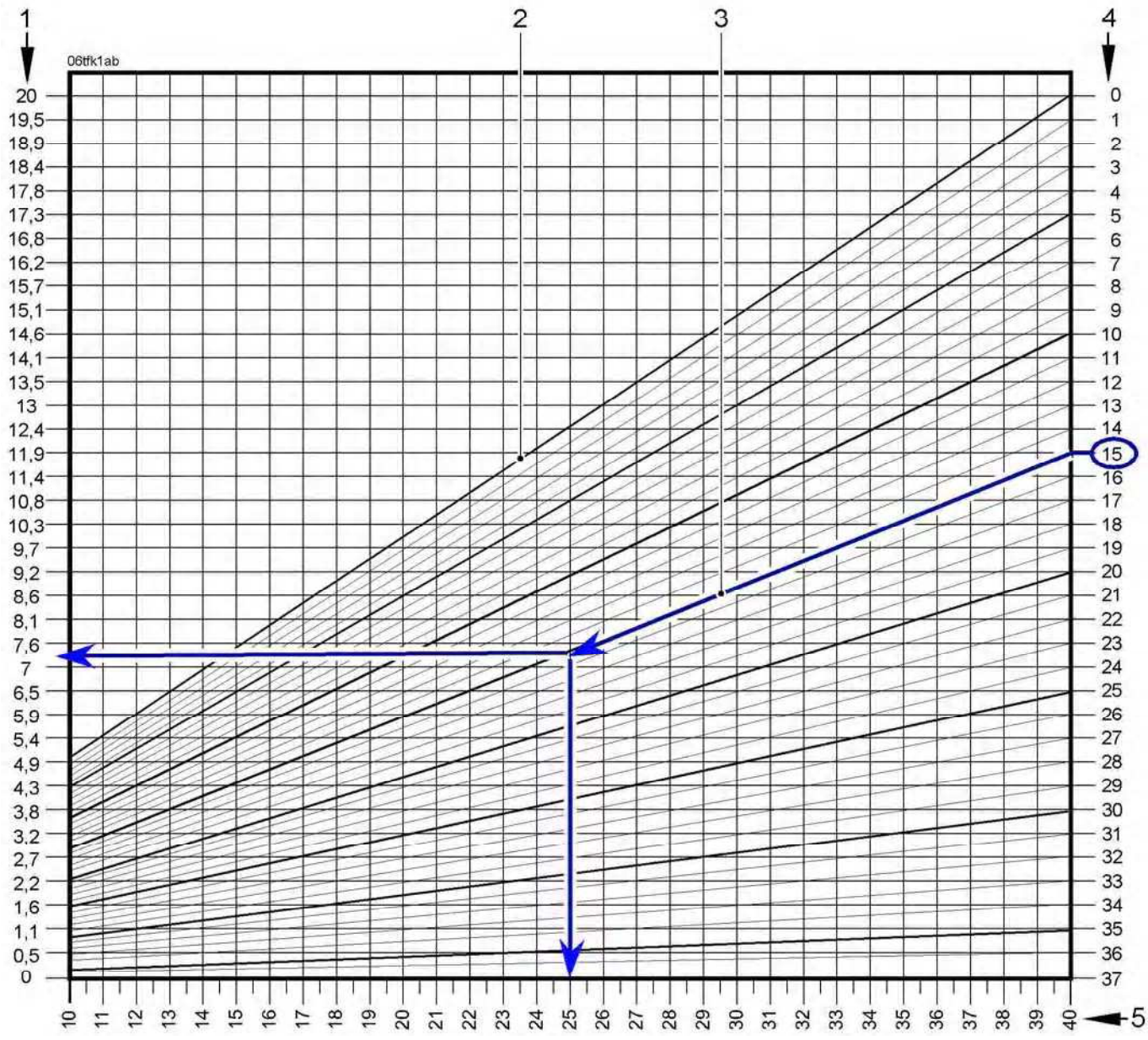
Checking and renewing the coolant

- Any loss of coolant must always be topped up with a mixture of water and min. 50 vol.% anticorrosive-antifreeze and DCA 4.
- The DCA 4 concentration must be between 0.3 and 0.8 units per litre. Test-kit CC 2602 M from Fleetguard is recommended for testing.
- Never allow the anticorrosive/antifreeze concentration to fall below 50 vol.%.
- Never use more than 60% anticorrosive/antifreeze, as the cooling effect and the frost protection is reduced with too high a percentage.



Selection of antifreeze concentration

– Procedure using -15 °C as an example: If a temperature of -15 °C is measured in the cooling system, follow help line 3 (starting from the temperature measured) downwards to the left until the vertical line filling amount - cooling system 5, and from this point, out to the left horizontally.

Each filling amount of pure anticorrosive-antifreeze 1 which must be topped up can thus be obtained in order that a freeze 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 and DCA 4-agent.
– To attain the required coolant level, refill the remainder with the previously drained coolant.

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.

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

Fresh water quality when using anticorrosive DCA 4

Drinking water analyses can be applied for from the communal authorities responsible.

Anticorrosive (inhibitors)

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) **without antifreeze**

When carrying out maintenance tasks, the DCA 4-concentration must be tested and rectified as necessary.

Test-kit CC 2602 M from Fleetguard is recommended for testing.

The DCA 4 concentration must be between 0.6 and 1.06 units per litre.

Product Caltex / Chevron Texaco / Havoline / Total without antifreeze

When carrying out maintenance tasks, the mix ratio must be tested and rectified as necessary.

The refractometer 2710 from the Gefo company is recommended for testing.

The correct mix ratio must be 7.5 % anticorrosive and 92.5 % water.

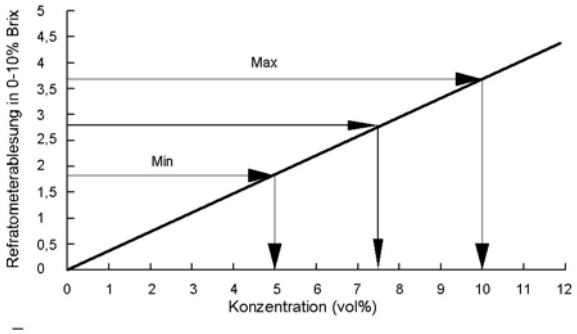
Checking the mix ratio using a refractometer

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

Measuring procedure
- 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.

Conversion chart



Concentration measured with a Brix refractometer for
- Chevron Texaco Heavy Duty Extended Life Corrosion Inhibitor Nitrite Free / Chevron Texaco
- Havoline Extended Life Corrosion Inhibitor (XLI) / ARTECO
- Caltex CL Corrosion Inhibitor Concentrate / Caltex
- Total WT Supra / Total

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Permissible anticorrosives (inhibitors) for diesel engine cooling systems

	Product designation	MANUFACTURER
D	DCA 4 Diesel Coolant Additives	Fleetguard
C	Caltex CL Corrosion Inhibitor Concentrate	Caltex
	Chevron Texaco Heavy Duty Extended Life Corrosion Inhibitor Nitrite Free	Chevron Texaco
H	Havoline Extended Life Corrosion Inhibitor (XLI)	ARTECO
T	Total WT Supra	Total

The coolant must be changed once a year.
The coolant is to be drained completely when changing from anticorrosive / antifreeze to anticorrosive or vice versa.

Disposing of anticorrosive/antifreeze

Undiluted anticorrosive/antifreeze should be treated as hazardous waste. When disposing of used refrigerants (mixture with water) the guidelines of the local authorities responsible are to be observed.

Permissible anticorrosive / antifreeze (concentrates) for diesel engine cooling systems

	Product designation	MANUFACTURER
A	Agip Antifreeze Plus	Agip Petroli S-P.A. / ROM
	Agip Langzeit-Frostschutz	Autol-Werke GmbH, Würzburg
	Antigel DB 486	Sotragal SA, St-Priest/France
	Aral Kühler-Frostschutz A	Aral AG, Bochum
	AVIA Frostschutz APN (G48-00)	Deutsche AVIA-Mineral-Oel-Ges.mbH Munich
B	BP anti frost X 2270 A	Deutsche BP AG, Hamburg
	BP Napgel C 2270/1	BP Chemicals Ltd., London/England
C	Caltex Engine Coolant DB	Caltex (UK) Ltd., London/England
	Caltex Extended Life Coolant	Caltex
	Castrol Anti-Freeze O	Deutsche Castrol Vertriebsges.mbH,Hamburg
	Century F.L. Antifreeze	Century Oils, Hanley, Stoke-on-Trent/England
	Chevron DEX-COOL Extended Life Anti-Freeze/Coolant	Chevron Texaco
D	DEUTZ Kühlschutzmittel 0101 1490	DEUTZ Service Intl. GmbH (DSI), Cologne
E	Esso Kühlerfrostschutz	Esso AG, Hamburg
F	Fricofin	Fuchs Mineralölwerke GmbH, Mannheim
	Frostschutz Motorex (G 48-00)	Bucher + Cie, Langenthal/Switzerland
	Frostschutz 500	Mobil Oil AG, Hamburg
G	Glacelf Auto Supra	Total
	Glycoshell AF 405	Shell
	Glycoshell N	Shell
	Glysantin (G48-00)	BASF AG, Ludwigshafen
H	Havoline XLC	ARTECO
	Havoline DEX-COOL Extended Life Anti-Freeze/Coolant	Chevron Texaco
I	Igol Antigel Type DB	Igol France, Paris/France

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	Product designation	MANUFACTURER
I	Labo FP 100	Labo Industrie, Nanterre/France
M	Motul Anti-Freeze	Motul SA, Aubervilliers Cedex/France
O	OMV-Frostschutzmittel	OMV AG, Schwechat/Austria
	Organifreeze	Total
	OZO Frostschutz S	Total Deutschland GmbH, Düsseldorf
T	Total Antigel S-MB 486	Total Deutschland GmbH, Düsseldorf
	Total Frostfrei	Total Deutschland GmbH, Düsseldorf
V	Veedol Antifreeze O	Deutsche Veedol GmbH, Hamburg
W	Wintershall Kühlerschutz	Wintershall Mineralöl GmbH, Düsseldorf

LIEBHERR anticorrosive / antifreeze / 50:50 + DCA 4 Premix for diesel engine cooling systems

LIEBHERR Anti-Freeze APN Mix + DCA 4
Ident. no. 10005347 – 20 litre drums

Permissible anticorrosive/antifreeze / 50:50 Premix for diesel engine cooling systems

	Product designation	MANUFACTURER
C	Caltex Extended Life Coolant Pre-Mixed 50/50 (ready-to-use-version)	Caltex
	Chevron DEX-COOL Extended Life Prediluted 50/50 Antifreeze coolant	Chevron Texaco
H	Havoline XLC, 50/50	ARTECO
	Havoline DEX-COOL Extended Life Prediluted 50/50 Antifreeze coolant	Chevron Texaco
O	Organicool 50/50	Total

5.4.7 Lube oils for the diesel engine

Lube oil quality


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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)	E3,E4, E5
API — Classification (American Petroleum Institute)	CF—4, CG–4, CH–4, CI-4 observe special oil-change intervals

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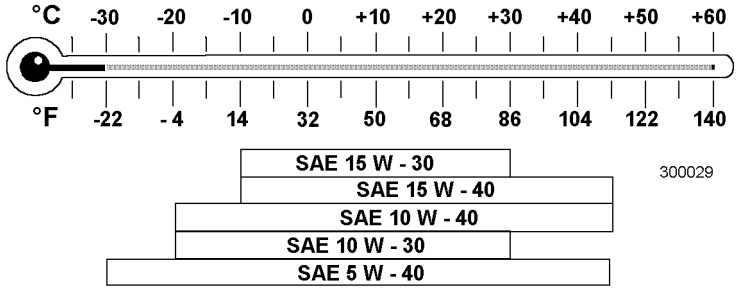
Lube oil viscosity

Selection of the lube oil-viscosity in accordance with the SAE-Classification (Society of Automotive Engineers).
The ambient temperature is definitive for the correct selection of 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 lubricating efficiency.
The temperatures listed in the diagram are guidelines and can be briefly exceeded or fallen short of.



Temperature-dependent selection of SAE-class

The following diesel engine oils are recommended (for ambient temperatures of –20°C / –4°F to +45°C / 113°F):

LIEBHERR diesel engine oil
- SAE 10W-40 / specification ACEA E4
- Ident. no. 8610049 – 20 litre drums

Lube-oil change intervals

Change intervals
- First oil change and replacement of the filter with utilisation of initial filling oil: 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 (Bh) have not expired within one year, the diesel engine oil and filter must be replaced at least once a year.

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Difficulty factors

Various difficulty factors or more difficult operating conditions reduce maintenance intervals.
Difficulty factors or difficult operating conditions include for example:

– frequent cold-starts
– sulphur content in fuel over 0.5%
– Application temperature below -10 °C

When working with difficulty factors or in tougher operating conditions, the oil change intervals prescribed in the “Maintenance and Inspection Chart” must be carried out in accordance with the following table.

Difficulty factor		**Oil quality**	
		CF-4	**E3**
		CG-4	**E4**
		CH-4	**E5**
		CI-4	
Operating conditions	**Sulphur content in the fuel**	**Interval**	
Temperature normal down to –10 °C	up to 0.5%	250 Bh	500 Bh
	over 0.5%	125 Bh	250 Bh
below –10 °C	up to 0.5%	125 Bh	250 Bh
	over 0.5%		125 Bh

Oil-change intervals in operating hours (Bh)

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