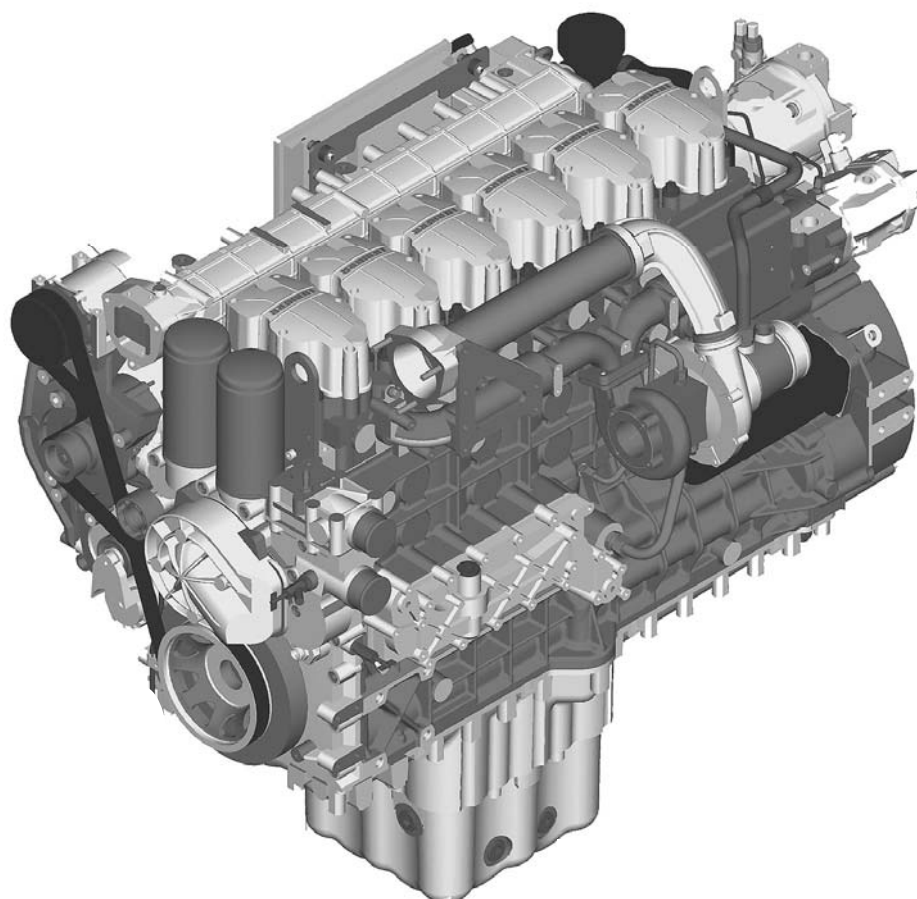


LIEBHERR Diesel engine

D934 - D936 - D946

BAL: 10115602-07-en

Operating manual



en

Operating manual

Diesel engine
D934- D936- D946

Document identification

Order number: 10115602
Version: 01.01.2009
Document version: 07
Author: LMB/Abteilung-BE-MD3

Product identification

Type: D934- D936- D946
Serial number: 2009030001/2009040001

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:

. . / . . / . .

Foreword

These operating instructions have been compiled for the **user** and for the **maintenance personnel** of the diesel engine.

The manual includes descriptions regarding:

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

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

Tasks with/on the diesel engine include for example:

- **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 data, 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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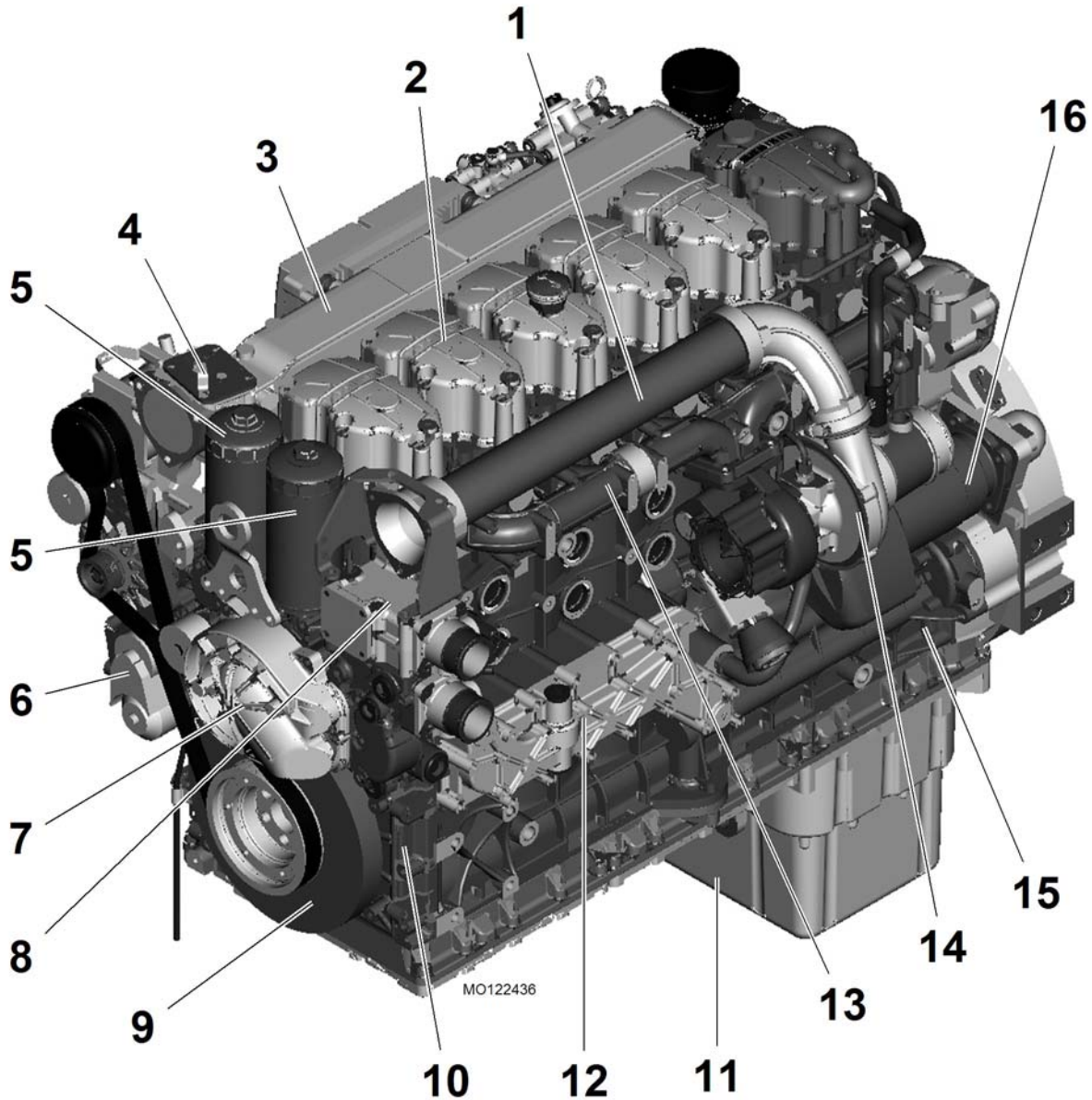
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LIEBHERR D934- D936- D946-/2009030001/2009040001

1 Product description

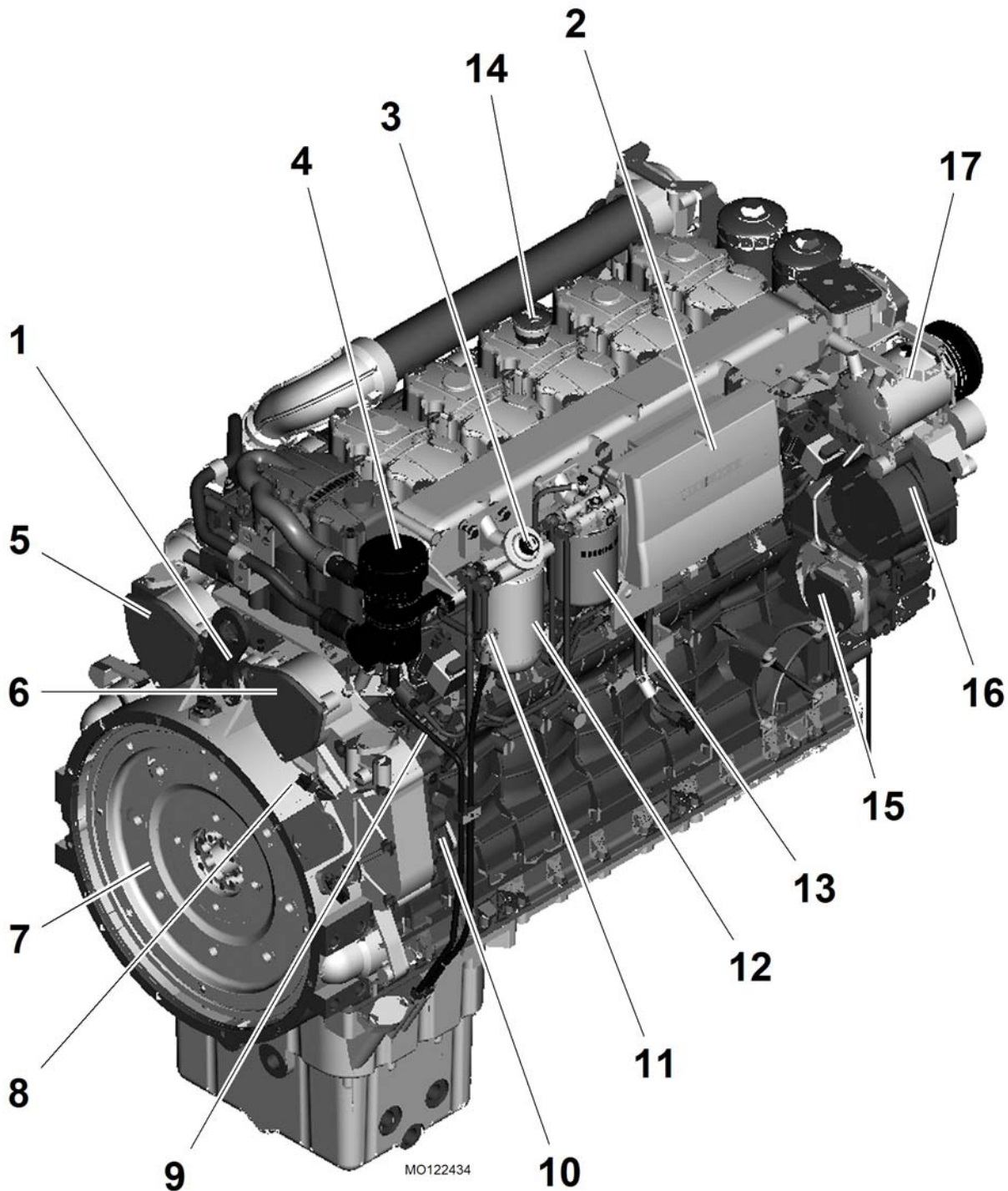
Equipment layout

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



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

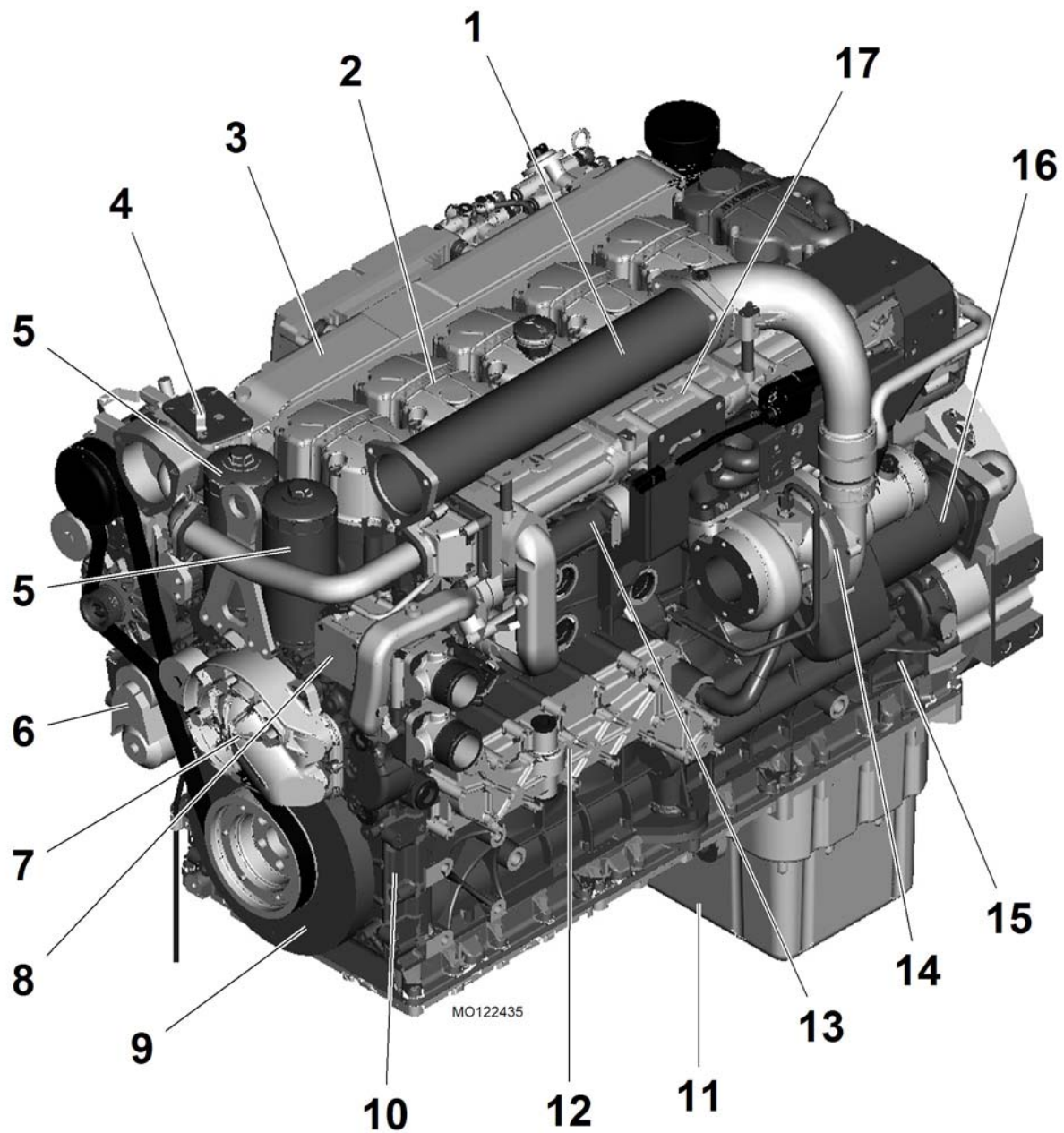
- | | | |
|----------------------------|---------------------------------|-------------------------|
| 1 Charge air duct | 7 Water pump | 13 Exhaust gas pipe |
| 2 Cylinder head | 8 Thermostat housing | 14 Exhaust turbocharger |
| 3 Air induction pipe | 9 Crankshaft / vibration damper | 15 Crankcase |
| 4 Heater flange | 10 Aggregate carrier | 16 Starter |
| 5 Oil filter | 11 Oil sump | |
| 6 Automatic tension pulley | 12 Oil cooler | |



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

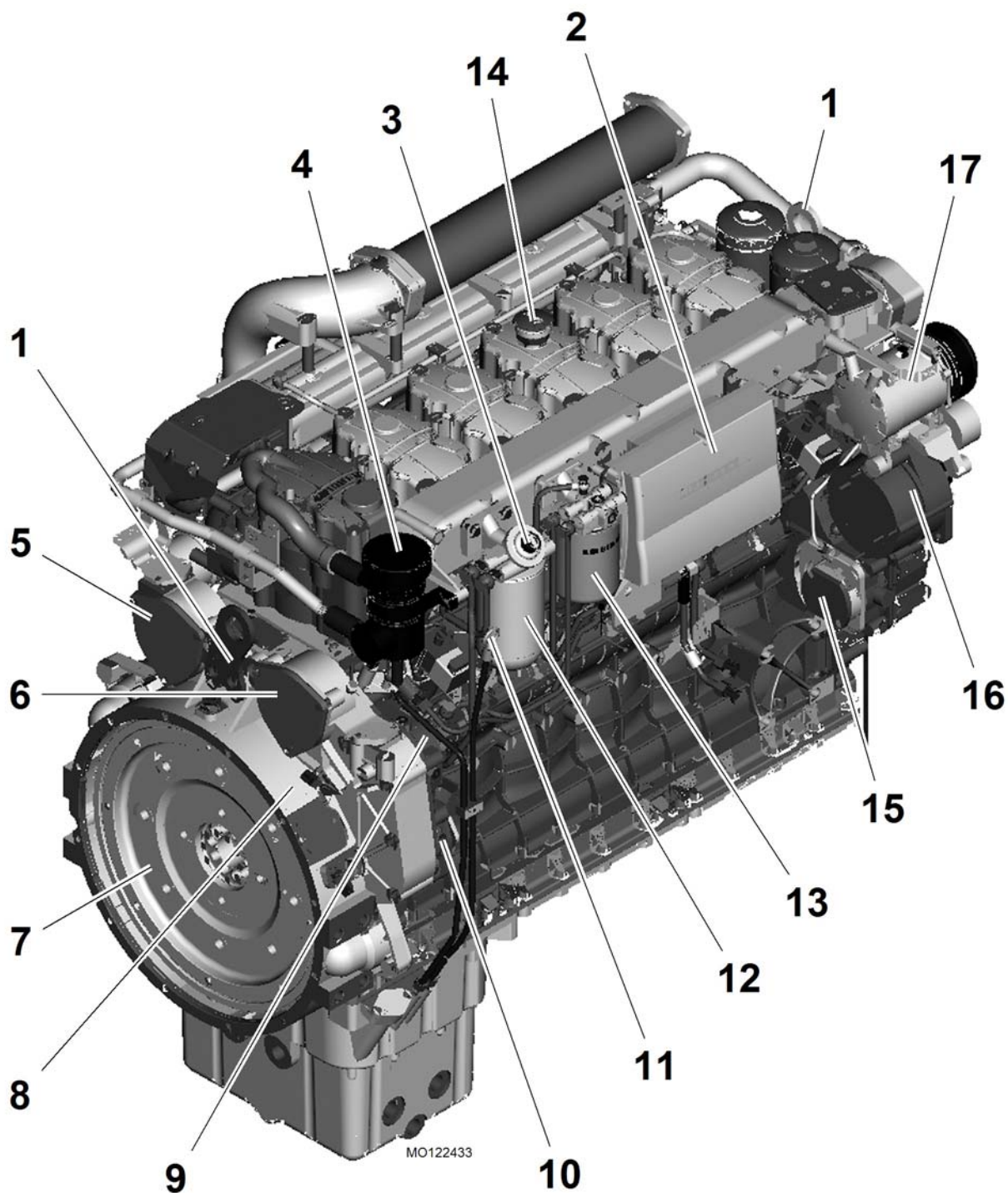
- | | | |
|------------------------|-----------------------|--------------------------------|
| 1 Transport device | 7 Flywheel | 13 Fuel fine filter |
| 2 Control unit | 8 Flywheel housing | 14 Oil intake |
| 3 Manual delivery pump | 9 Fuel delivery pump | 15 Power take-off NA4 |
| 4 Crankcase breather | 10 Power take-off NA3 | 16 Alternator |
| 5 Power take-off NA2 | 11 Oil dipstick | 17 Air-conditioning compressor |
| 6 Power take-off NA1 | 12 Fuel prefilter | |

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

- | | | |
|----------------------------|---------------------------------|-------------------------|
| 1 Charge air duct | 7 Water pump | 13 Exhaust gas pipe |
| 2 Cylinder head | 8 Thermostat housing | 14 Exhaust turbocharger |
| 3 Air induction pipe | 9 Crankshaft / vibration damper | 15 Crankcase |
| 4 Heater flange | 10 Aggregate carrier | 16 Starter |
| 5 Oil filter | 11 Oil sump | 17 eAGR module |
| 6 Automatic tension pulley | 12 Oil cooler | |



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

- | | | |
|------------------------|-----------------------|--------------------------------|
| 1 Transport device | 7 Flywheel | 13 Fuel fine filter |
| 2 Control unit | 8 Flywheel housing | 14 Oil intake |
| 3 Manual delivery pump | 9 Fuel delivery pump | 15 Power take-off NA4 |
| 4 Crankcase breather | 10 Power take-off NA3 | 16 Alternator |
| 5 Power take-off NA2 | 11 Oil dipstick | 17 Air-conditioning compressor |
| 6 Power take-off NA1 | 12 Fuel prefilter | |

1.1 Technical data

1.1.1 Diesel engine

Name	Value	Units
Design	Inline diesel engine	
Number of cylinders (D934)	4	
Firing sequence (D934)	1–3–4–2	
Number of cylinders (D936/D946)	6	
Firing sequence (D936/D946)	1–5–3–6–2–4	
Bore (D934/D936)	122	mm
Bore (D946)	130	mm
Stroke S / L	136 / 150	mm
Displacement (D934S/L)	6.4 / 7.0	Litres
Displacement (D936S/L)	9.5 / 10.5	Litres
Displacement (D946L)	11.95	Litres
Compression ratio	17:1 / 18:1	
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
Nominal speed	see identification plate	rpm
Emission standards	see identification plate	
D934 diesel engine weight (without water, without oil)	approx. 900	kg
D936 / D946 Diesel engine weight (dry)	approx. 1150	kg

1.1.2 Cylinder head, standard

Name	Value	Units
Valve clearance intake cold	see identification plate	mm
Valve clearance exhaust cold	0.4	mm

1.1.3 Cylinder head with engine auxiliary brake system (ZBS)

Name	Value	Units
Valve clearance intake cold	see identification plate	mm
Valve clearance exhaust valve fitting/rocker arm cold	0.4	mm
Valve clearance exhaust valve fitting/retainer cold	0.2	mm

1.1.4 Coolant pump

Name	Value	Units
Flow rate (at nominal speed 1900 rpm and counterpressure 0.6 bar)	D934 approx. 315	l
Flow rate (at nominal speed 1900 rpm and counterpressure 0.6 bar)	D936/D946 ca. 475	l
Flow rate (at nominal speed 1900 rpm and counterpressure 0.6 bar)	D936 mit eAGR ca. 400 (475–75)	l

1.1.5 Coolant thermostat

Name	Value	Units
Beginning of opening	79 / 83	°C
Fully opened	92 / 98	°C

1.1.6 Generator

Name	Value	Units
Voltage	28	V
Amperage	80 / 110	A

1.1.7 Starter

Name	Value	Units
Voltage	24	V
Output	5.4 / 6.6 / 7.8	kW

1.1.8 Flywheel housing

Name	Value	Units
Connection	SAE1 / SAE2	

1.1.9 Air compressor

Name	Value	Units
Flow rate at nominal speed 1900 rpm and 6 bar	465	l/min
Gear transmission ratio	1:1.388	
Water-cooled	Yes	

1.1.10 Explanation of type description**Type description**

				Description
D	93	6	L	Type description
D				Diesel engine
	93			Bore 122 mm (94= Bore 130 mm)
		6		Number of cylinders (6 cylinder)
			L	Long / S= Short, stroke L=150 / S=136 mm

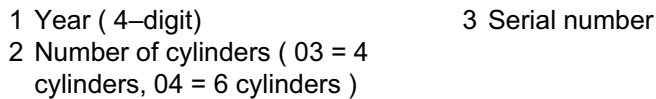
Diesel engine type identification plate

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

EMISSION CONTROL INFORMATION	
ENGINE NUMBER	MODEL 型号
DISPLACEMENT (LITRES)	CODE
FUEL RATE (mm ³ /stroke)	CONFIGURATION
INTAKE VALVE LASH (mm)	
EXHAUST VALVE LASH (mm)	
功率	
ENGINE FAMILY THIS ENGINE COMPLIES WITH U.S. EPA AND CARB REGULATIONS FOR NONROAD DIESEL ENGINES. EMISSION CONTROL DEVICES:	
中国认证 阶段	
LOW SULFUR FUEL ONLY. 核准号码	
● LIEBHERR MACHINES BULLE SA Made in Switzerland ●	

Identification plate

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



D934

D936/D946

RM120470a

A = Exhaust valve E = Intake valve

Cylinder 1 is 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.

Design	Water-cooled 4-cylinder and 6-cylinder inline diesel engine with LIEBHERR direct injection and exhaust turbocharging with intercooling.
---------------	---

Features	A rugged basic design and largely-dimensioned size form the basis for optimum operating safety and long life-expectancy. Reduced fuel-consumption, as well as low noise and exhaust emissions due to a combustion process which is specially adapted to suit the requirements. Reduced maintenance to easily accessible components and a multitude of mounting options for special equipment contribute to optimum overall efficiency of the diesel engines.
Engine	The 4-cylinder diesel engines feature a steel crankshaft with 5 bearing points with 2 mass equalising shafts / the 6-cylinder diesel engines feature a steel crankshaft with 7 bearing points with inductive-hardened running surfaces and 8 / 8 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. Three-ring piston made of aluminium ally or steel 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 cast integral swirl inlet, as well as replaceable valve seat rings and valve guides. Flywheel housing, front-mounted aggregate carrier and oil sump mounted on the underside encase the diesel engine.
Drive control	Two intake valves and exhaust valves respectively per cylinder suspended in the cylinder head. Actuated by steel camshaft featuring 5 or 7 bearing points via roller tappet, push rod and rocker arm. Drive of the camshaft, fuel delivery pump, lube oil pump, air compressor and auxiliary hydraulic pumps from the crankshaft via nitrified gears on the same side as the flywheel, and water pump on the same side as the aggregate carrier.
Lubrication	Forced-feed lubrication with gear pump crankshaft bearing, connecting rod bearing and camshaft bearing, as well as small end bush and rocker arm. Oil filtering via two replaceable cartridge filters in the main flow. Accessories such as individual injection pumps, water pump, turbocharger, power take-offs, fuel delivery 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 water pump. Individual supply of each cylinder unit via cast distributor ducts in the crankcase. Piston cooling via oil spraying or cooling duct from the lube oil circuit of the diesel engine.
Injection system	PLD (pump, line and nozzle) fuel delivery pump, fuel filter, individual injection pump, short injection line and injection nozzle.
Heater flange	The heater flange is a cold-start aid. The heater flange installed in the air induction pipe warms the combustion air for the start procedure. Curtailement of the start time conserves the starter and the batteries.
Electrical equipment	Starter and alternator: 24 Volt.
Exhaust gas recirculation (AGR)	With the internal AGR, part of the exhaust gas is pushed into the intake stroke during the exhaust stroke and then sucked in again upon the next intake stroke. This ensures lower NOx emissions. With external AGR, part of the combusted hot exhaust is supplied again to the cylinder charge via a heat exchanger integrated in the engine cooling system. This ensures reduced combustion temperatures and lower NOx emissions.

Electronic diesel engine regulation	The electronic diesel control (EDC) regulates the speed, injection begin and torque of the LIEBHERR diesel engines. The EDC is comprised essentially of sensors and the control unit. Devices located on the same side as the diesel engine and on the same side as the vehicle are connected to the EDC-control unit via cable harnesses.
Electronic sensors on the engine side	Charge air pressure sensor, temperature sensor for coolant, charge air and fuel, speed sensors and oil pressure sensor are interfaces for external monitoring and control functions. The individual functions and error reports are described in the respective user documentation.
Mounting options for pumps	The mounting of hydraulic pumps is possible on up to 4 power take-offs of the diesel engine.

1.1.12 Special 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 brake flap is actuated via a cylinder pressurised with compressed air, whereby the diesel engine braking action is generated via closing of the diesel engine exhaust gas brake flap.
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.
Air-conditioning compressor	The air-conditioning compressor can be mounted directly onto the diesel engine and powered via a magnetic clutch featuring a ribbed V-belt. When the air-conditioning is switched on, the magnetic clutch is active and the compressor is working.
Air compressor	The air compressor is flange-mounted to a power take-off integrated on the flywheel housing. Cooling or lubrication of the air compressor is connected to the respective circuits of the diesel engine.
Cold start package	The interfaces for the retrofitting of preheating devices, e.g. for coolant, fuel and diesel engine oil, are already integrated.

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 opportunistically 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"

signifies an immediately dangerous situation which could result in fatalities or serious injury if it is not prevented.



"Warning"

signifies a dangerous situation which could result in fatalities or serious injury if it is not prevented.



Caution signifies a dangerous situation which could result in minor or significant injury if it is not prevented.



"Note"

signifies useful notes and tips.

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

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

2.2 General safety guidelines

1. Familiarise yourself with the operating and maintenance instructions before starting up the machine.
Make sure that you possess, have read, and have understood any additional instructions relevant to the machine's optional features.
2. Only expressly authorised personnel may operate, maintain or repair the diesel engine.
Observe the legal, permissible minimum age!
3. Employ only trained or instructed personnel and allocate definitive responsibility for personnel regarding operation, setting up, maintenance and repair.
4. Personnel who are still undergoing training, or are involved with a general apprenticeship, should only be allowed to work on the diesel engine while under constant supervision of an experienced person.

5. Ensure regularly that personnel are conscientious of safety and dangers while working, and are observing the operating instructions.
6. Do not remain in direct proximity of the diesel engine while the diesel engine is running.

Persons with pacemakers should not approach within 20 cm of the running diesel engine. Do not touch voltage-carrying parts on the electrical connection of the solenoid valve-controlled individual injection pumps (Unit Pumps UP) while the diesel engine is running.

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 into machinery.

2.3 Use as directed

1. This diesel engine has been designed exclusively for the intended use defined by the manufacturer and stipulated in the scope of delivery (use as directed). Any other form of use is not considered use as directed. The manufacturer can not be held responsible for any damage which occurs as a result. The user bears full responsibility.
2. Use as directed also includes the adherence of operating, maintenance and repair requirements prescribed by the manufacturer. The diesel engine may only be operated, maintained and repaired by persons who are familiar with these tasks and are fully aware of the dangers.
3. The manufacturer does not bear responsibility for any material damage or injury to persons which occurs as a result of unauthorised modifications to the diesel engine.

Likewise, manipulation of the injection system and servo system could influence output and exhaust characteristics of the diesel engine, whereby compliance of the legal environmental regulations can no longer be guaranteed.

2.4 Notes on the prevention of crushing and burns

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

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.

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 is 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 with the diesel engine switched off.
7. When carrying out maintenance and repair tasks, tighten the loosened screw connections with the respective tightening torque.
8. Clean the diesel engine of oil, fuel or detergents, in particular connections and threaded unions, before commencing maintenance/repair tasks. Do not use any aggressive cleaning agents. Use fibre-free cleaning cloths. Do not use any flammable liquids for cleaning the diesel engine.
9. Before cleaning the machine with water, steam jet (high-pressure cleaner) or other cleaning agents, seal or cover all openings into which water/steam/cleaning agents should not be allowed to penetrate due to reasons of safety or functionality.

The crankcase breather, electronics box, starter and generator are at particular risk.

Additional tasks:

- After cleaning, remove the covers/bondings completely.
 - After cleaning, examine all fuel lines, diesel engine oil lines and engine oil lines for leaks, loose connections, points of wear and damages.
 - Remedy any determined faults immediately.
10. Observe the safety guidelines valid for the product when handling oils, greases and other chemical substances.
 11. Ensure a safe and environmentally-sound disposal of fuels and consumables, as well as replacement parts.
 12. Observe caution when handling hot fuels and consumables (danger of burning and scalding).
 13. Always wear gloves when searching for leaks. A fine jet of liquid, when pressurised, could penetrate the skin.
 14. Shut down the diesel engine before loosening oil lines.
 15. Combustion engines may only be operated in sufficiently ventilated areas. Ensure sufficient ventilation before initiating operation in enclosed areas. Observe the valid guidelines for the respective jobsite.
 16. Do not try to lift heavy parts. Suitable lifting gear featuring sufficient lift capacity must be used for these tasks.

Procedure:

- Tighten and secure individual parts and larger assemblies carefully to the hoist when replacing heavy parts, in order that no danger is resulted.
- Only use suitable and technically-sound hoists, as well as load carrying equipment featuring sufficient lift capacity.

It is prohibited to remain or work beneath suspended loads.

17. Do not use ropes which are damaged, or do not feature sufficient lift capacity. Always wear industrial gloves when handling wire cables.
18. Tasks to electrical equipment on the machine may only be carried out by an electrical specialist or by trained personnel under the supervision and instruction of an electrical specialist in compliance with the electro-technical regulations.

19. Disconnect the battery when working on the electrical system and also remove the plug from the control unit if electric welding is to be carried out on the machine.
Always disconnect the negative terminal first and reconnect last.

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 terminal clips must be disconnected 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. If temperatures exceeding 80 °C (e.g. drying kiln) are expected, the control units must be removed.
10. Only use suitable test leads for measurements at the plug connections.
11. 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.
12. 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.
13. 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).

If 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.

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 appropriate environmental or recycling centre. Incorrect disposal of waste products can harm the environment and the ecology.

3 Operation, Handling

3.1 Control elements and operating elements

The control elements and operating elements are integral parts of the equipment and are described in the documentation of the manufacturer.

Data regarding oil pressure, coolant temperature, speed, operating hours and service code, for example, are transferred to the equipment via the electronic interface on the diesel engine for operation and regulation of the diesel engine.

3.2 Operation

3.2.1 Preparing for initial start-up

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

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

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

Filling in fuels

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

- **Diesel engine oil**
With replacement engines or engines which have undergone a general overhaul, use authorised diesel engine oils only, see the chapter, Fuels and Lubricants-Specifications.
- **Coolant**
For coolant composition, see the chapter, Fuel and Lubricant 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 starting ring gear with oil or grease.
- Check the batteries. Only use fully charged batteries which have undergone regular maintenance.
- Bleed the fuel system. (see the chapter, Maintenance)
- If a fuel shut-off valve is featured:
Open the fuel shut-off valve.
- Start the diesel engine.
- Check the oil pressure gauge immediately after starting the diesel engine.

Troubleshooting

No oil pressure has been attained within 5 seconds?

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

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

Tasks during and following the test-run

Bleeding the cooling system:

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

Checking the diesel engine oil level:

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

Checking the diesel engine

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

3.2.2 Maintenance tasks before daily start-up

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

3.2.3 Starting the diesel engine**Start procedure**

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

- If a fuel shut-off valve is featured:
Open the fuel shut-off valve.
- Speed adjusting device in idle speed.
- Start the diesel engine with the ignition key or starter button.



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Operating instructions

Troubleshooting

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

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

- Check the oil pressure gauge immediately after starting the diesel engine.
 - The oil pressure is not displayed within 5 seconds.
 - Switch off diesel engine immediately.
- Do not subject the engine to full load immediately after starting. After a brief (10–15 sec.) spell at idle speed, allow the diesel engine to run warm at medium speed and medium load.

Operation

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

Troubleshooting

Faults have been determined?

- Switch off diesel engine immediately.

3.2.4 Precautions for starting up in icy temperatures**Low temperatures**

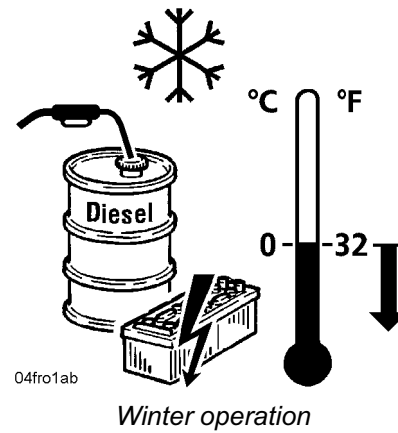
The following will ensure a considerably improved starting behaviour in low temperatures:

**Warning**

Danger of the diesel engine exploding!

There is a serious risk of the engine exploding if ether-based starting aids are used for starting the diesel engine with preheating system!

! Ether-based start aids are prohibited.



- 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).
- Preheat the diesel engine, see documentation of the manufacture.

3.2.5 Shutting down

Switching off the diesel engine.

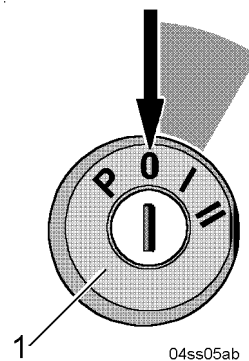


Caution

Risk of the diesel engine becoming damaged!

When switching off the diesel engine, the turbocharger continues to run briefly with no supply of oil.

! Never switch off the diesel engine directly from running at full load.



Start switch – 0-position

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

The diesel engine has been shut down.

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4 Malfunctions

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



Note:

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:

- Familiarity with 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 and tighten loose connections
	Battery voltage too low	Recharge or replace battery
	Starter electric circuit interrupted 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 and tighten loose connections
	Ambient temperature too low	Observe the measures for winter operation
Diesel engine will not start or cuts out again shortly after starting	Fuel tank is empty	Refuel, bleed the fuel system
	Fuel filter is clogged	Replace fuel filter
	Fuel line, pre-cleaner or sieve in fuel tank is clogged	Clean and bleed the fuel system
	Fuel system or filter leaking	Seal and bleed
	Air in the fuel system	Bleeding the fuel system
	Fuel not frost-resistant	Clean pre-filter, replace fuel filter; Use winter fuel
	Ambient temperature too low	Observe the measures for winter operation
	Heater flange faulty (with cold temperatures)	Check heater flange and replace as necessary
Diesel engine has difficulty starting	Leakages or insufficient pressure in the fuel low-pressure circuit	Inspection for leaks (visual inspection); to be carried out by LIEBHERR AFTER-SALES-SERVICE

Error code tables

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

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

Error code tables

Fault	Possible cause	Remedy
Lube-oil in the cooling system	Oil cooler or oil cooler grill leaking	Consult LIEBHERR AFTER-SALES-SERVICE
Cooling water in the lube oil	O-rings on the cylinder liners not tight	Consult LIEBHERR AFTER-SALES-SERVICE
	Oil cooler or oil cooler grill leaking	Consult LIEBHERR AFTER-SALES-SERVICE

5 Maintenance

5.1 Maintenance and inspection schedule

Abbreviations used in this section:

Bh = operating hours

BA = operating instructions

WH = Workshop handbook

AFP = authorised, specialist personnel

WP = maintenance personnel

Different symbols (circle or box filled in or circle or box blank) divide the maintenance tasks into two groups.

Meaning of symbols:

- Circle, box – filled 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 or box left blank means that the specialist personnel authorised by the LIEBHERR company, or their appointed dealers, must carry out or supervise the maintenance and inspection tasks.
The maintenance intervals apply: upon commissioning and every 500, 1000, 2000 operating hours (Bh)

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

Maintenance/inspection according to operating hours							Special intervals	TASKS TO BE PERFORMED	
On delivery	Every 10	Every 50	Every 500	Every 1000	Every 2000	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 oil level (for Mobil cranes UW/OW: After each third time of refuelling)
	●	●	○	○	○				Visual inspection (leaks, contamination, damages)
			○	○	○				Checking the flap of the diesel engine brake
			○	○	○				Check the exhaust return shut-off flap
			○	○	○				Change the diesel engine oil (however at least once a year): CAUTION! Only engine oil E4, E6, E7 may be used. Other oil qualities and difficulty factors: see Fuel and Lubricants
			○	○	○				Replace the oil filter element (however at least once a year)
				○	○				Replace the oil separator filter element
			○	○	○				Checking batteries and cable connections
			○	○	○				Check condition of belt drive, replace as necessary / check tension of ribbed V-belt and adjust as necessary
			□	○	○				Check induction and exhaust system for sound condition, secure fastening and for leaks
				○	○				Lubricate flywheel starter ring gear
				○	○				Check oil sump, engine mounting and diesel engine brackets for secure fastening
							*		Check the heater flange
						10000h			Change the heater flange
						3000h			Check vibration damper for distortion
Cylinder head - valves									
				○	○				Check / adjust valve clearance
Cooling system									
	●	●	○	○	○				Checking the coolant level
			○	○	○				Checking the cooling and heating systems for sound condition and for leaks
			○	○	○		*		Check anticorrosive and antifreeze concentrations in the coolant
						3000h			Replace coolant (or at the latest, every 2 years)
Fuel system									
	●	●	○	○	○				Check water separator on the fuel pre-filter and drain water as required
		●	○	○	○				Drain water and sediment in the fuel tank
			○	○	○				Checking lubrication system and fuel system for leaks and for sound condition
				○	○				Replace the fuel pre-filter (or with output deficiency)
				○	○				Replace the fuel fine filter
							✧		Bleed the fuel system (CAUTION! Injection lines are to be replaced each time they have been loosened three times).

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

Maintenance/inspection according to operating hours							Special intervals	TASKS TO BE PERFORMED	
On delivery	Every 10	Every 50	Every 500	Every 1000	Every 2000	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	
Air filter									
	●	●	○	○	○			Check low-pressure display of the air filter	
		●	○	○	○			Clean the 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)	
Electrical system									
			○	○	○			Check control unit mounting for sound condition	
			○	○	○			Check sensoric and cable connections for sound condition	

5.2 Lubricant chart, Filling quantities

5.2.1 Table of filling quantities

	Name	Medium	Dosage	Units
 06sy04ab	Diesel engine D934, engine only	Coolant	approx. 15	l
 06sy04ab	Diesel engine D936/D946 in Engine	Coolant	approx. 20	l
 06sy05ab	Diesel engine D934 with oil filter (1.5 l per filter)	Oil	approx. 31	l
 06sy05ab	Diesel engine D936/D946 with oil filter (1.5 l per filter)	Oil	approx. 43	l

5.2.2 Lubricant chart

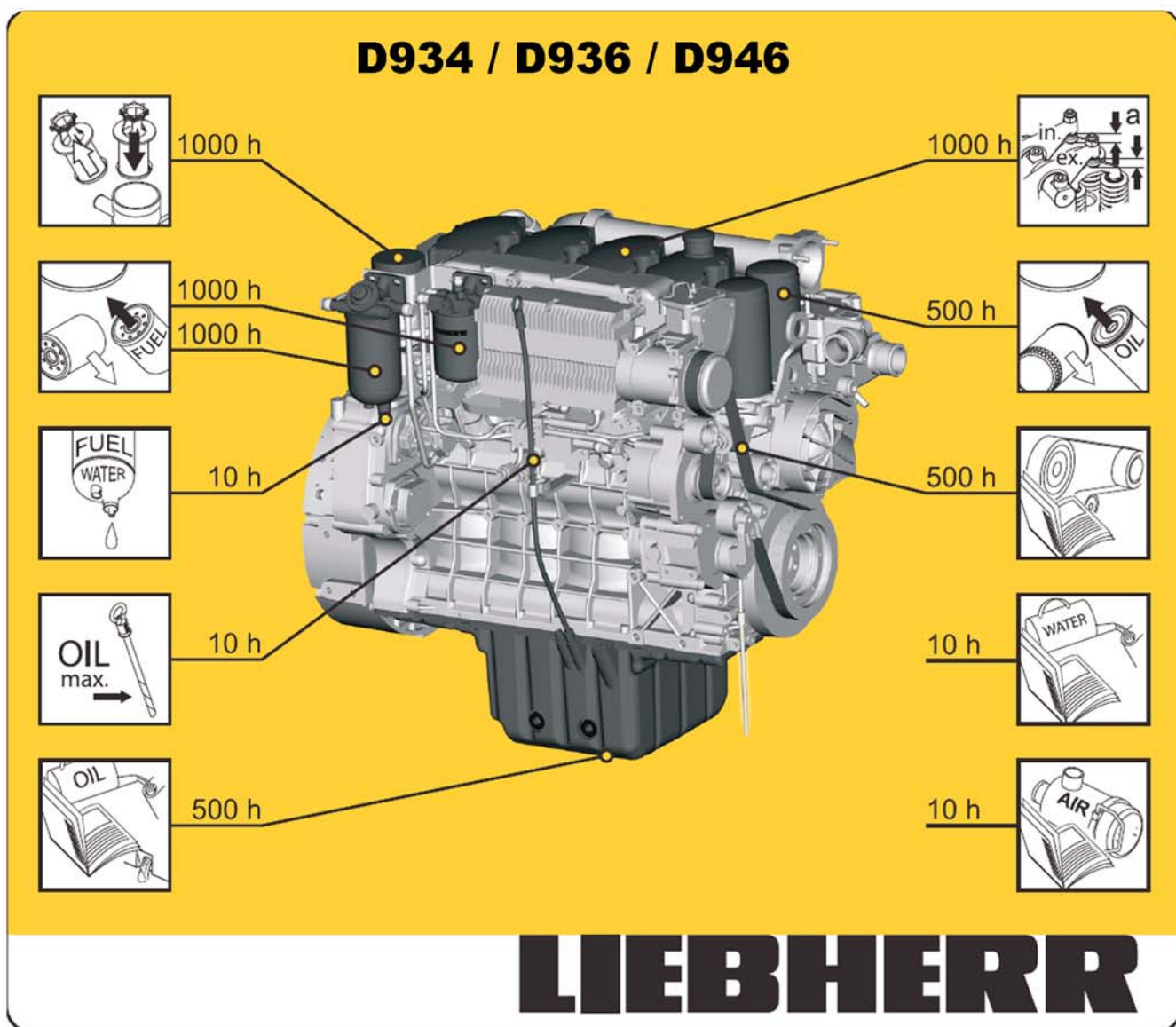
The lubrication chart serves as a summary for the location of maintenance points on the diesel engine and the maintenance interval periods.

Detailed information can be obtained in the section "Maintenance — 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 fuel and lubricants, see the section "Fuel and Lubricants".

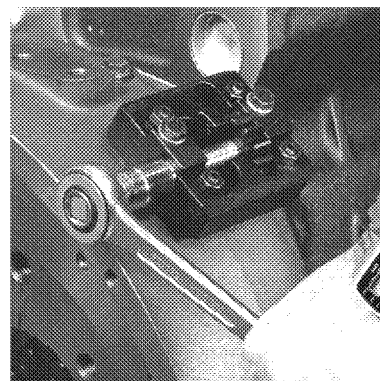
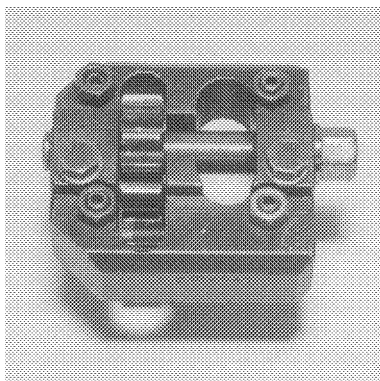
For information regarding the necessary filling amounts, "see the section, Filling Amounts Chart".

Lubrication chart



5.3 Maintenance tasks

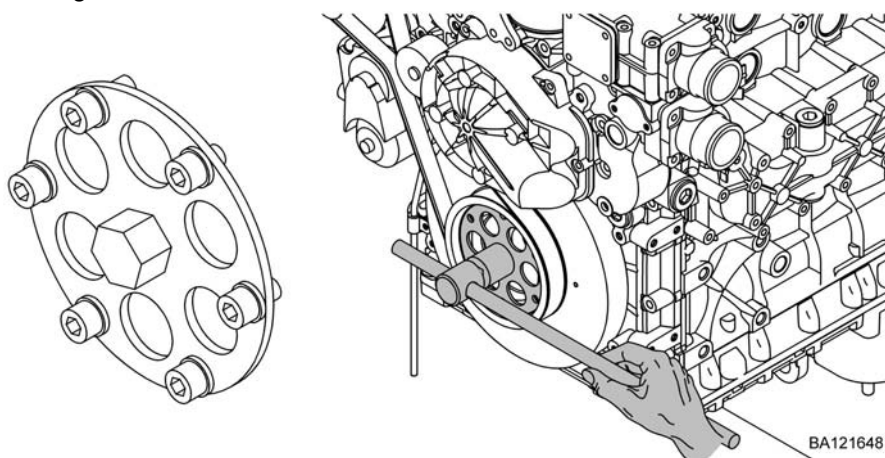
5.3.1 Special tools for maintenance tasks



Special tool no. 30 — Mounting the flywheel housing

No.	ID. no.	Description	See section
30	0524045	Turning gear	Checking / adjusting valve clearance

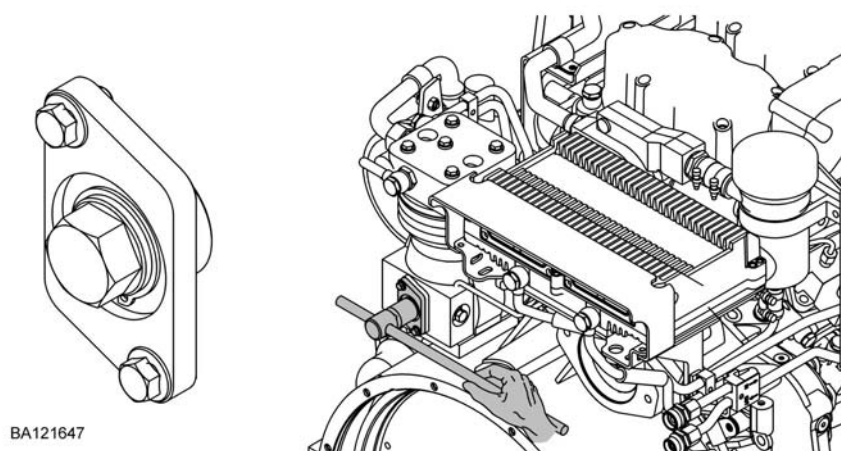
The turning gear special tool no. 30 can be mounted on any flywheel housing.



Special tool no. 30a — Mounting the belt pulley crankshaft

No.	ID. no.	Description	See section
30a	10116805	Turning gear	Checking / adjusting valve clearance

The turning gear special tool no. 30a is only included within the diesel engine scope of delivery, and mounted, in certain instances, whereby the mounting of a turning gear on the flywheel housing or air compressor is not possible due to the installation position of the diesel engine.



Special too no. 30b — Mounting the power take-off air compressor

No.	ID. no.	Description	See section
30b	10117936	Turning gear	Checking / adjusting valve clearance

The turning gear special tool no. 30b is optional for air compressor with integrated power take-off.

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 manoeuvred into the maintenance position.

Diverse maintenance tasks include 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 has cooled,
- the battery main switch (if featured) is switched off and the key for the battery main switch has been removed.

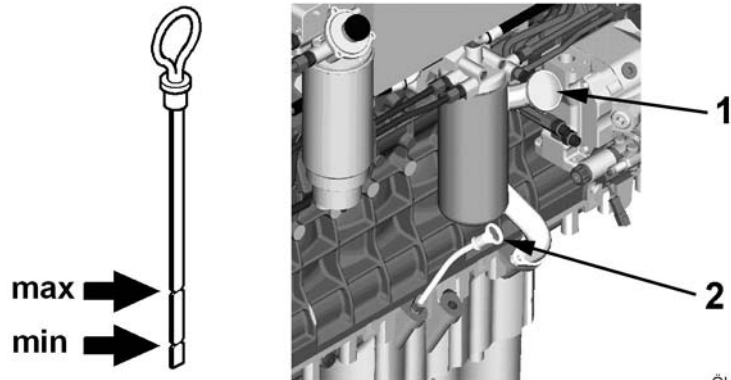
5.3.3 Maintenance Tasks (daily), every 10 operating hours

It must be ensured that:

- the diesel engine is in the maintenance position

Check the oil level

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



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Example oil dipstick - oil filler nozzle

- Remove the oil dipstick **2**, wipe clean and reinsert.
- Pull out the oil dipstick once again and determine the oil level.

The oil level must be within min and max.

Troubleshooting

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

- Fill in oil via the oil filler nozzle **1** (for oil quality, see the chapter "Fuel and Lubricants").

Do not refill above the max. upper marking of the oil dipstick

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

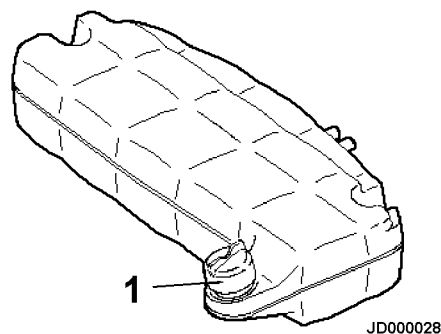
Checking the coolant level

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

Procedure**Caution**

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

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



Coolant expansion tank

- Check coolant level, see documentation of the manufacturer.

Troubleshooting

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

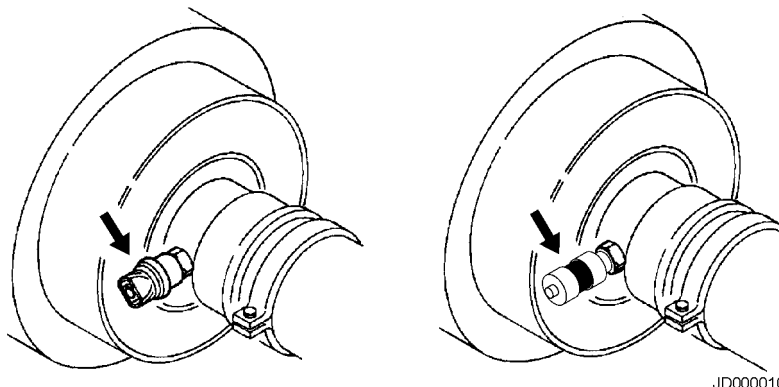
- Do not start the diesel engine.
 - Turn the sealing cap on the expansion tank slightly anticlockwise until the excess pressure is dissipated, then open.
-
- Only fill in authorised coolant with 50 vol.-% anticorrosive/antifreeze at the expansion tank
 - Fill cooling system to maximum level.
 - Remount the sealing cap on the expansion tank and tighten.
 - Start the diesel engine and allow to run warm.
 - Check the coolant level again when the diesel engine has cooled and refill as required.

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

Check air filter low-pressure display

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

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



Air filter low-pressure display

- Checking the air filter low-pressure display

Troubleshooting

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

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

- Tasks to be carried out in compliance with the documentation of the manufacturer.

- If a reset button is featured on the air filter low-pressure display:
After carrying out maintenance of the air filter, push in the reset button and release.

The display is reset in green.

Draining water from the fuel pre-filter with water separator

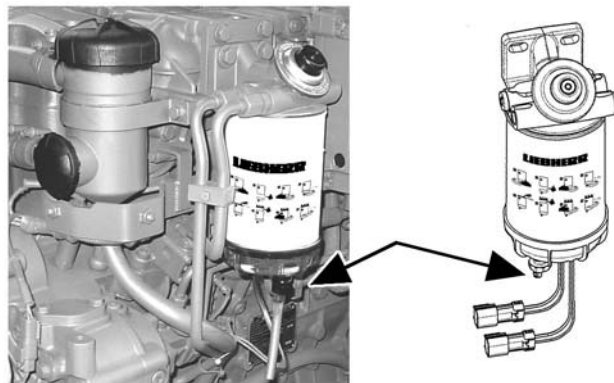
Upon activation (the indicator lamp lights up) of the integrated water level sensor in the fuel pre-filter, the water collecting vessel is to be drained.



Danger

Risk of fire and explosion!

- ! No smoking.
- ! Avoid naked flames.
- ! Only work on the diesel engine when the diesel engine is switched off.



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Draining the fuel pre-filter

Visual inspection (leaks, contamination, damages)

- Do not start the diesel engine.
- Place the collecting vessel beneath the fuel pre-filter and if necessary, attach a drainage hose.
- Loosen the drain plug and drain water until bubble-free fuel flows out
- When fuel begins to flow:
Tighten the drain plug.
- Check the diesel engine for leaks via visual inspection.
- Check lines and hoses for leaks via visual inspection.
- Ensure sound condition without indication of damage, correct arrangement without the occurrence of wear and correct fastening of all lines and hoses.

5.3.4 Maintenance tasks (daily) every 50 operating hours

Before carrying out the weekly maintenance tasks, the daily maintenance tasks must first be carried out.

See the section "Maintenance Tasks (daily), every 10 operating hours".

It must be ensured that:

- the diesel engine is in the maintenance position

Drain water and sediment in the fuel tank

Ensure utmost cleanliness.



Danger

Risk of fire and explosion!

- ! No smoking.
- ! Avoid naked flames.
- ! Only work on the diesel engine when the diesel engine is switched off.

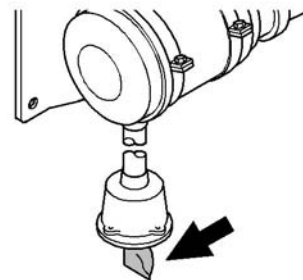
- Do not drain fuel onto the ground, use a suitable collecting vessel.
- Draining water and sediment in the fuel tank, see "manufacturer's documentation".
- When refuelling, maintain the level of fuel as high as possible in the tank, in order that condensation is reduced to a minimum.

Clean the dust-discharge valve of the air filter

Maintenance of the air filter is not generally required if otherwise indicated on the maintenance display on the air filter or via an indicator lamp for filter maintenance.

Important:

A damaged or hardened dust-discharge valve renders functioning of the service cover ineffective, resulting in a reduced life-expectancy of the filter elements.



LU120476

Dust-discharge valve

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

Troubleshooting

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

- Replace the dust-discharge valve.

5.3.5 Maintenance Tasks, every 500 operating hours

Before carrying out the 500 operating hours maintenance tasks:

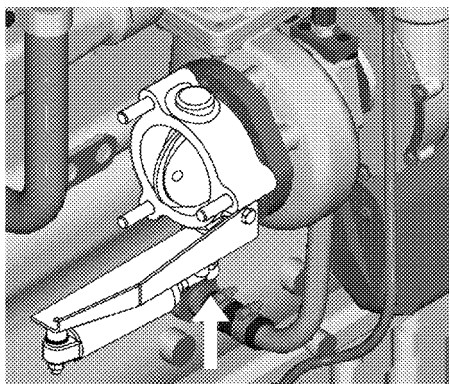
- carry out the daily operating tasks, see the section “carry out the maintenance tasks (daily) every 10 operating hours”.
- the weekly maintenance tasks, see the section “Maintenance tasks (weekly) every 50 operating hours,”.

It must be ensured that:

- the diesel engine is in the maintenance position

Checking the flap of the diesel engine brake

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



MB118556

Diesel engine brake flap

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

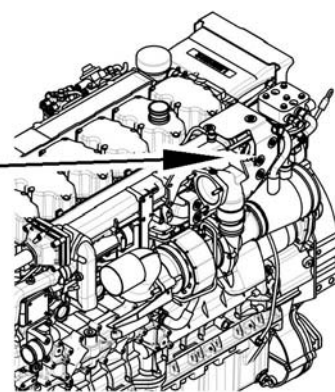
Ensure that the flap returns correctly into the starting position following actuation.

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

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

Checking the shut-off flap for exhaust gas recirculation

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



AGR122428

Exhaust gas recirculation shut-off flap

- Check and grease the joints of the actuating cylinder.

Checking batteries and cable connections

- Actuate the exhaust gas recirculation shut-off flap

Ensure that the flap returns correctly into the starting position following actuation (all the way to the stop).

The emissions value will deteriorate if the flap is getting stuck.

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

Damage has been determined on the lines?

Replace faulty lines or cable harnesses.

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 dimensions e.g. with generator drive and generator drive with air-conditioning compressor.

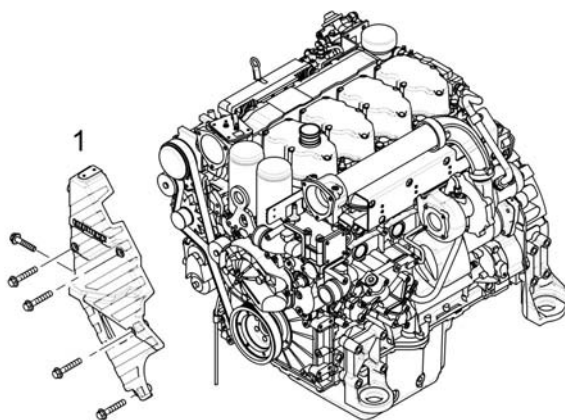
The diesel engine is equipped with a tensioning device for the ribbed V-belt. This is self-tightening and therefore requires no maintenance.

It must be ensured that:

- a ratchet, complying with DIN 3122 D 12,5 (1/2"), as well as a new ribbed V-belt is 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



SCH121570

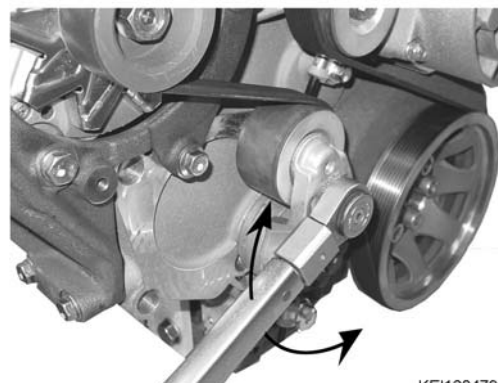
Ribbed V-belt guard

- Dismantle the ribbed V-belt guard (optional)
- Check the ribbed V-belt for damage

Troubleshooting

Damage has been determined?

- Replace the ribbed V-belt

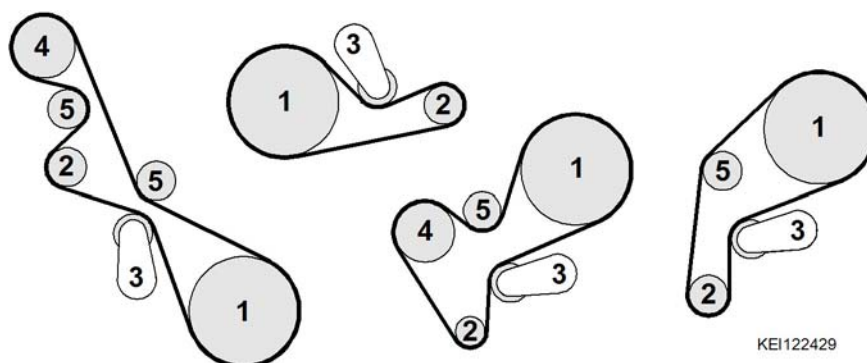


KEI120479

Ribbed V-belt generator drive with air-conditioning compressor

- Pivot back the tensioning device against the spring force in an anticlockwise direction as far as it will go.
- 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



KEI122429

Run of the ribbed V-belt

- 1 Belt pulley crankshaft
- 2 Belt pulley generator
- 3 Tensioning device

- 4 Belt pulley air-conditioning compressor
- 5 Deflection pulley

- Mount new ribbed V-belt with pivoted back tensioning device onto the belt pulley of the crankshaft, air-conditioning compressor, generator and deflection pulley.
- Mount the ribbed V-belt guard (optional)

Checking induction and exhaust system for sound condition and for leaks

**Note**

The standard interval is at 1000 operating hours!

! These maintenance tasks are only to be carried out once after 500 operating hours.

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

- Check the suction lines between air filter and diesel engine for sound condition, leaks and secure fastening.
- Check exhaust lines for sound condition, leaks and secure fastening.
- Check oil sump, oil filter, fuel delivery pump and fuel filter for leaks.
- Check all lines and hoses of the oil and fuel systems, ensure that they are correctly arranged without abrading one another, are free of damage and are securely fastened.

Troubleshooting

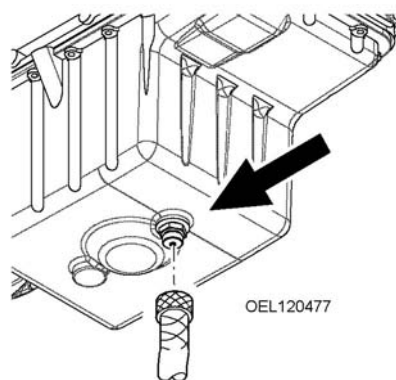
Determine any leaks in the oil and fuel system:

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

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 in the maintenance position
- the diesel engine is switched off
- the diesel engine is warm
- a suitable container with approx. 40 l volumetric capacity, as well as an oil drain hose and the diesel engine oil which complies with the specifications are on-hand

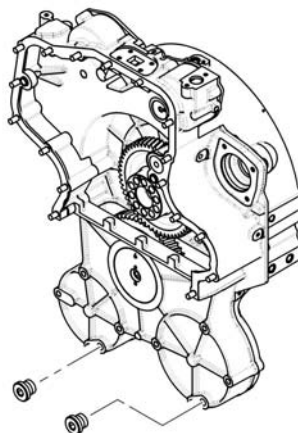


Drain valve with drainage hose

- 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.



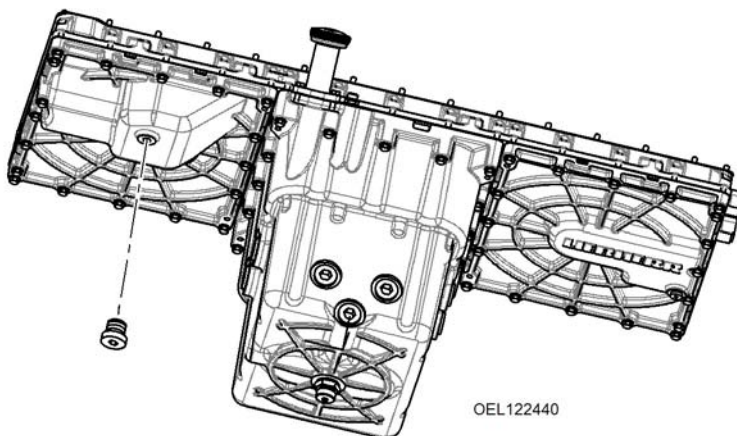
BA121646

Flywheel housing with power take-offs

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

**Note**

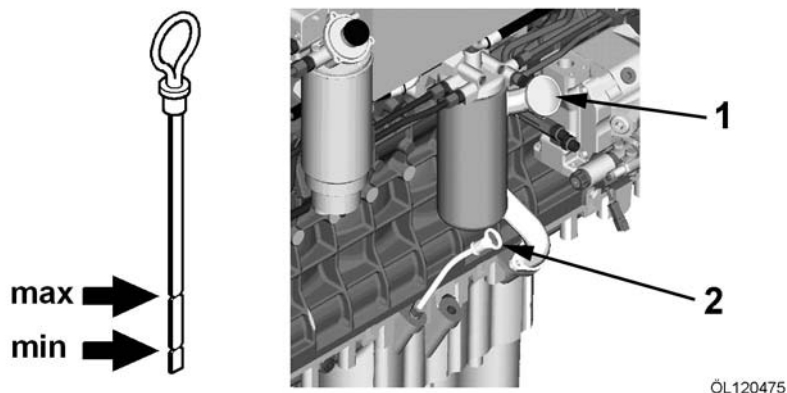
! For diesel engines featuring oil sump (small sump), the drain plug must be open when replacing the diesel engine oil.



OEL122440

Oil sump (small sump)

- Unscrew the screw plug
- Allow approx. 3 litres of oil to drain into the container provided.
- Screw in the screw plug.



Diesel engine-oil filler nozzle

- Fill in oil via the oil filler nozzle **1** to within the min. and max. markings on the oil dipstick **2**.
- 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.?

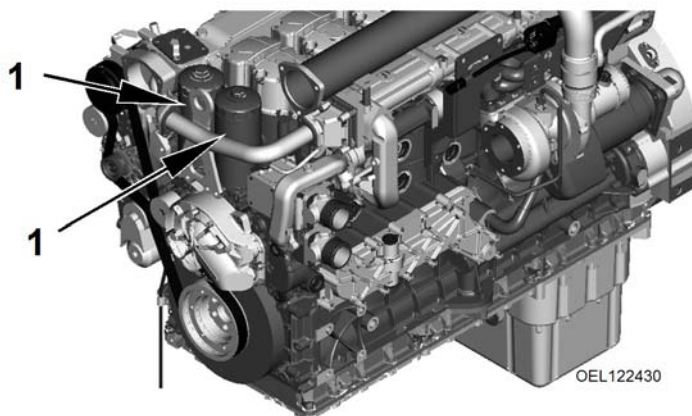
- Rectify the oil level.

Replacing the oil filter

The oil filters are arranged in an upright position on the aggregate carrier of the diesel engine.

It must be ensured that:

- a strap wrench or a hexagonal wrench SW 30, a suitable container, as well as an original LIEBHERR oil filter cartridge (2 x) are on-hand



Oil filter

- Position the suitable container under the diesel engine

**Note**

Protect the ribbed V-belt against escaping oil when replacing the oil filter cartridge!

! After replacing the oil filter, remove all traces of oil on the diesel engine, as well as behind the vibration damper in order that this will not be later diagnosed as leaks in the rotary shaft seal.

- Loosen the oil filter cartridges **1** with a strap wrench or a hexagonal wrench SW 30 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 cartridges around $\frac{3}{4}$ of a turn -20 Nm -5 Nm (o 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 filters.
- 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.?

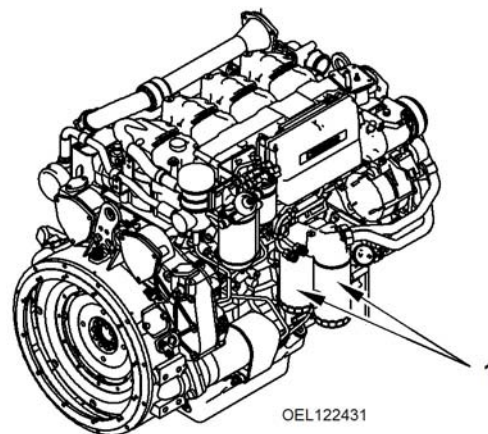
- Rectify the oil level.

Changing the oil filters with suspended oil filters

The oil filters are mounted in a suspended position at a distance from the engine.

It must be ensured that:

- a strap wrench or a hexagonal wrench SW 30, a suitable container, as well as an original LIEBHERR oil filter cartridge (2 x) are on-hand



Oil filter

- Position the suitable container under the diesel engine

**Note**

Protect the ribbed V-belt against escaping oil when replacing the oil filter cartridge!

! After replacing the oil filter, remove all traces of oil on the diesel engine, as well as behind the vibration damper in order that this will not be later diagnosed as leaks in the rotary shaft seal.

- Loosen the oil filter cartridges **1** with a strap wrench or a hexagonal wrench SW 30 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 cartridges around $\frac{3}{4}$ of a turn -20 Nm -5 Nm (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 filters.
- 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 cooling and heating systems for sound condition and for leaks

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

Troubleshooting

Leaks are determined in the cooling system:

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

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

It has been determined that the coolant level is too low.

When using coolant which features anticorrosive / antifreeze, supplement the loss of coolant with a mixture of water and min. 50 Vol.% anticorrosive / antifreeze.

**Note**

Do not use more than 60% of anticorrosive / antifreeze!

! A higher ratio will impair the cooling effect and the frost protection. This will subsequently cause damage to the diesel engine.

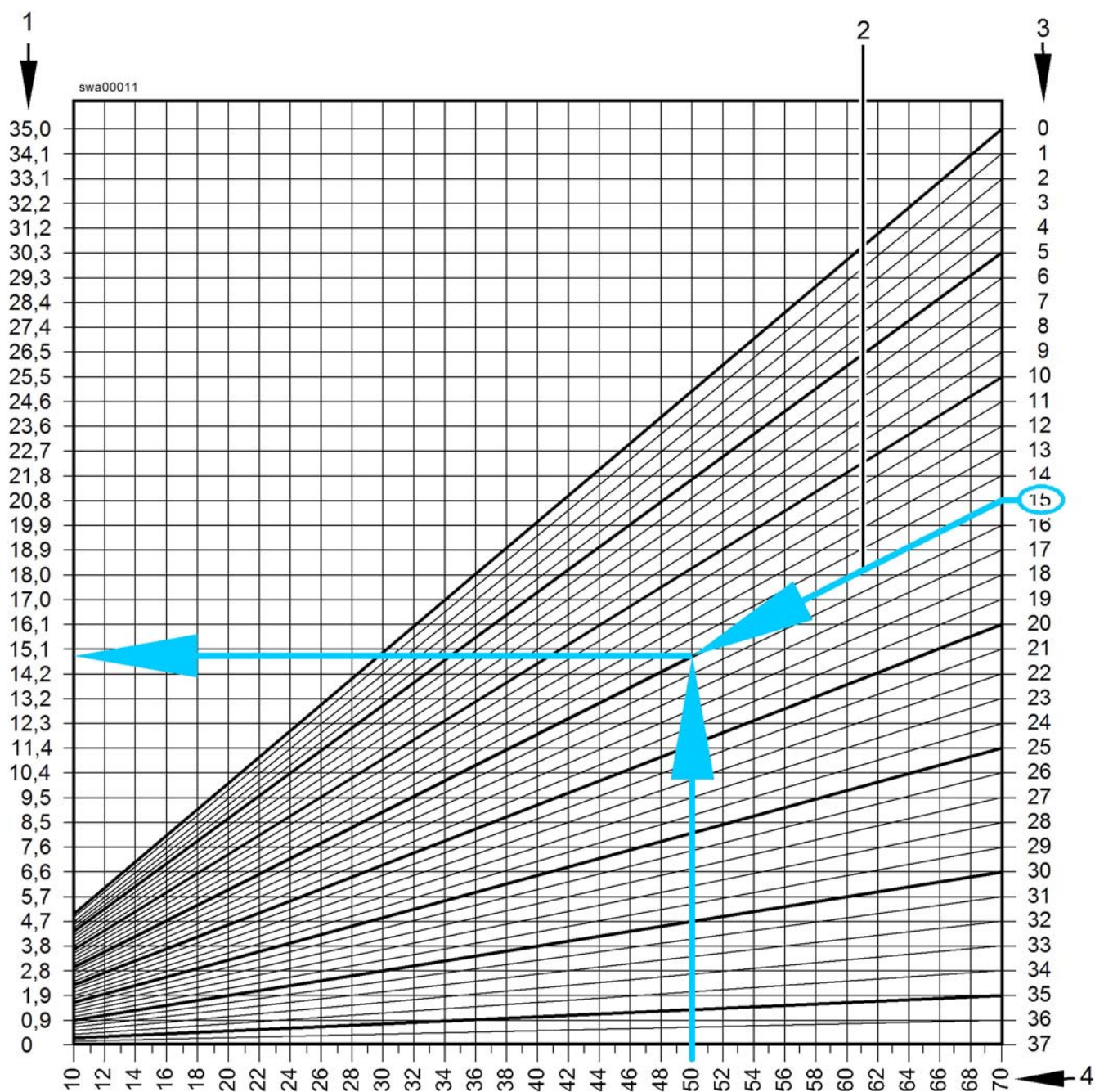
**Checking anticorrosive /
antifreeze concentration in the
coolant**

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

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

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

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



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

- 1 Anticorrosive / antifreeze (concentrate) — amount to be refilled (litres)
2 Reference line

- 3 Max. frost protection temperature (minus C°) in the cooling system

- 4 Amount of coolant (litres) in the cooling system

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

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

- To reproduce the correct mix ratio, at least the amount previously determined must be drained from the cooling system.
- Fill in the determined amount of pure anticorrosive/antifreeze.
- To attain the required coolant level, refill the remainder with the previously drained coolant.

Checking the anticorrosive without antifreeze / concentration in the coolant

When using DCA 4

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

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

When using water-soluble anticorrosive:

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

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

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

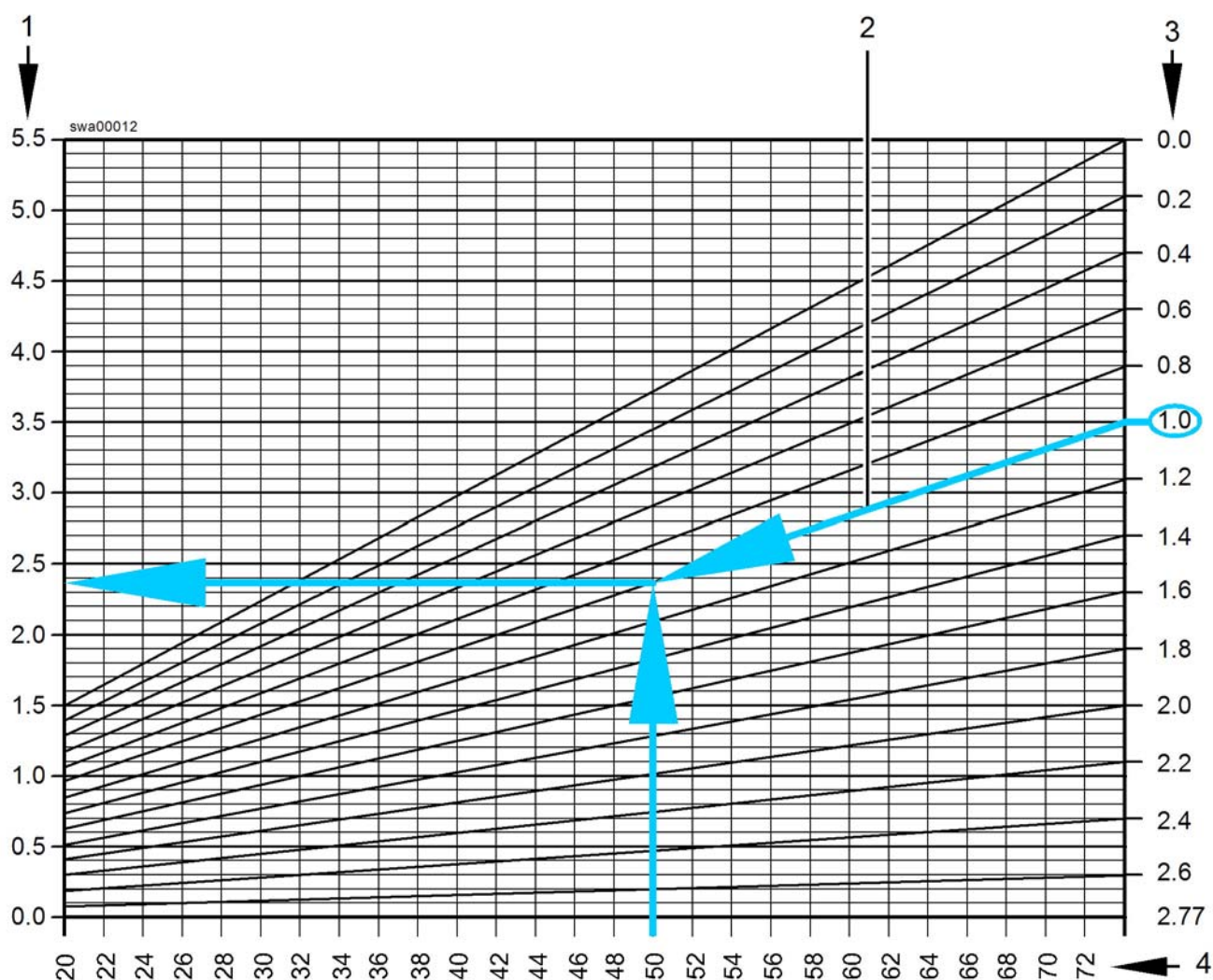


RE120464

Gefo Refractometer no. 2710

Refractometer

- Adjusting screw for setting to the 0-line (water line)
 - The visual acuity is adjusted by turning the ocular.
 - Soft eye-piece on the ocular.
 - Dimensionally-stable metal housing
 - Non-slip grip made of rubber armouring
- Clean cap and prism carefully
 - Apply 1–2 drops of test fluid to the prism.
 - The test fluid is distributed by closing the flap.
 - Look through the ocular at a bright background and focus the scale.
 - Read the values on the blue separation line.



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

1 Anticorrosive — Amount to be refilled (litres)
2 Reference line

3 Refractometer reading in % Brix

4 Amount of coolant (litres) in the cooling system

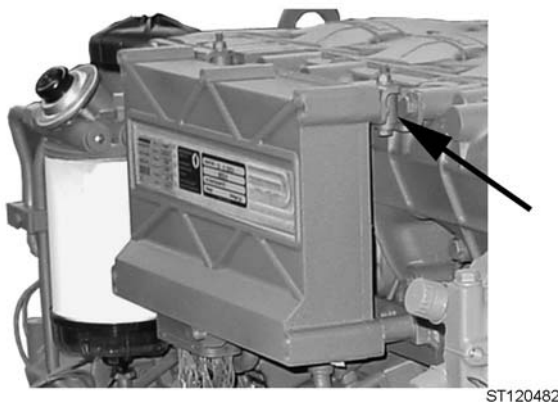
If a value of 1% Brix is measured in the cooling system, follow reference line 2 (starting from measured value 1 Brix) downwards to the left to the vertical line for the amount of coolant in the cooling system 4 (50 litres) and from this point out to the left horizontally (2.4 litres of pure anticorrosive 1)

The amount of pure anticorrosive 1 that needs to be refilled can thus be obtained in order to once again attain the required value of 2.8 Brix.

To reproduce the correct mix ratio, at least the amount previously determined must be drained from the cooling system.

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

Checking the control unit mounting for sound condition



ST120482

Control unit mounting

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

Troubleshooting

If the support is determined as being damaged:

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

Check sensoric and cable connections for sound condition



SEN122432

Sensoric and cable connections

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

Troubleshooting

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

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

5.3.6 Maintenance Tasks, every 1000 operating hours

Before carrying out the 1000 operating hours maintenance tasks:

- carry out the daily operating tasks, see the section “Carry out the maintenance tasks (daily) every 10 operating hours”.
- the weekly maintenance tasks, see the section “Carry out the maintenance tasks (weekly) every 50 operating hours”.
- the 500 operating hours maintenance tasks, see the section “Maintenance tasks every 500 operating hours”.

Checking induction and exhaust system for sound condition and for leaks

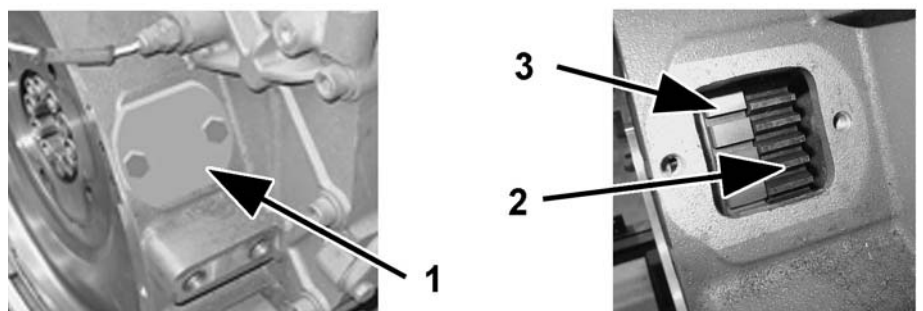
- Check the suction lines between air filter and diesel engine for sound condition, leaks and secure fastening.
- Check exhaust lines for sound condition, leaks and secure fastening.

Lubricating starter ring gear on the flywheel

The maintenance cover is mounted on the right-hand side of the diesel engine on flywheel housing.

It must be ensured that:

- the diesel engine is in the maintenance position



SC120531

Maintenance cover — starter ring gear

- Unscrew the maintenance cover 1 from the flywheel housing
- Grease flywheel starter ring gear 2 only, the sensor ring gear 3 must remain free of grease.
Check ring gear and, if necessary, grease lightly with standard lubricating grease
- Screw on the maintenance cover again.

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

Preparation for checking and adjustment of valve clearance

It must be ensured that:

- the diesel engine is in the maintenance position,
- the diesel engine has cooled,
- a special tool no. 30, 30a or 30b is on-hand.
- new seals for the cylinder head cover are on-hand.

Only carry out this inspection when the diesel engine has cooled, for adjustment values, see "Technical Data" Valve clearance.

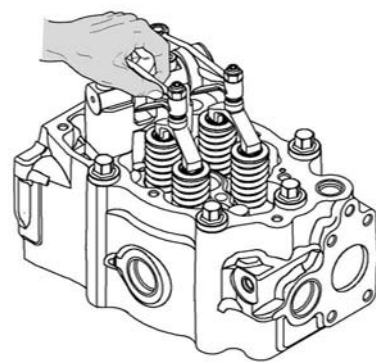
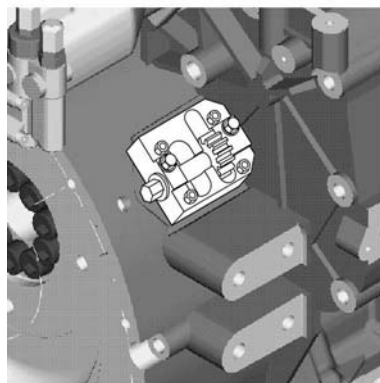


Note

Cylinder 1 on the flywheel side

! Rotational direction to the left as viewed looking at the flywheel

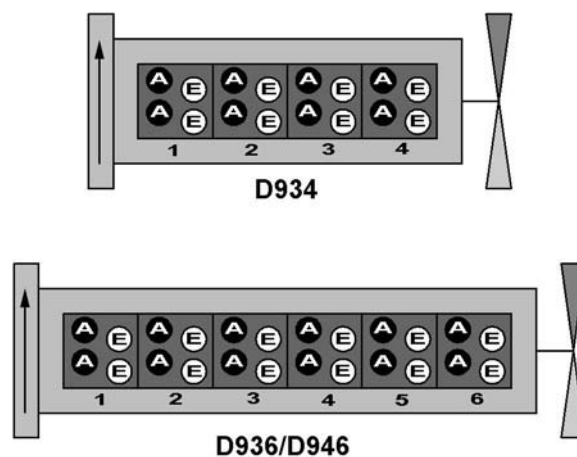
! Exhaust valve of the respective cylinder on the flywheel side



ZY120469

Turning gear — valve overlap

- Dismantle the cylinder head cover, mount turning gear special tool no. 30, 30a or 30b
- Turn the crankshaft in the direction of rotation until the valves in the cylinder being adjusted overlap, see table for details.



RM120470a

Valves of the cylinder

A = Exhaust valve

E = Intake valve

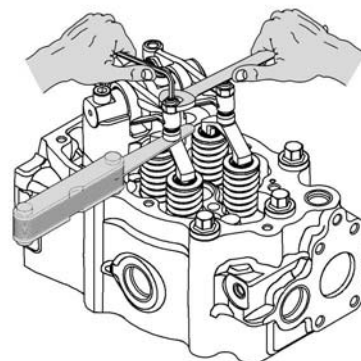
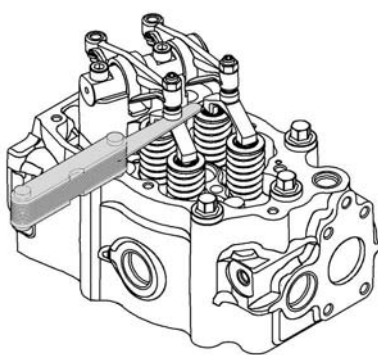
Valves of the cylinder						
overlap	4	2	1	3		
adjust	1	3	4	2		
Cylinder valves D936/D946						
overlap	6	2	4	1	5	3
adjust	1	5	3	6	2	4

**Note**

If adjustment is not carried out in compliance with the aforementioned table, the valve clearance may be set incorrectly due to the position of the cam nose on the camshaft (for actuation of the intake valve).

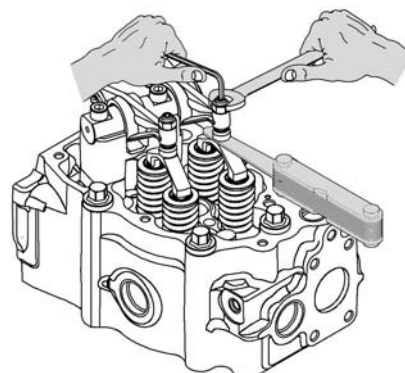
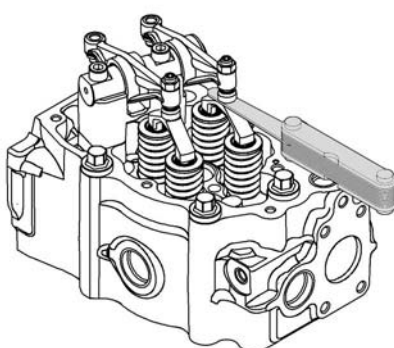
!

Checking and adjusting valve clearance standard



VE120480

Checking / adjusting intake valve clearance — cold



VE120481

Checking / adjusting exhaust valve clearance — cold

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

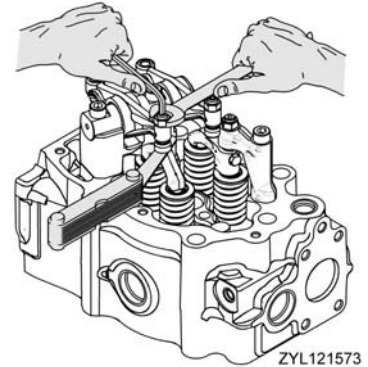
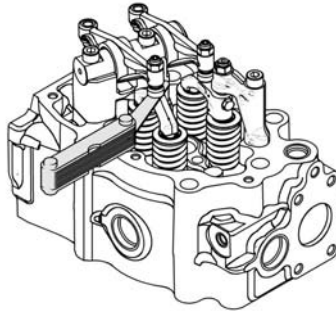
Troubleshooting

The clearance does not correspond with the adjustment values? See "Technical Data"

- Loosen the lock nut on the adjusting screw of the respective rocker arm and adjust the setting.
- Tighten lock nut with 40 Nm
- Check adjustment again
- Following checking or adjustment of all valves on the cylinder head covers, fit new seals.
- Dismantle the turning gear

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

Checking the intake valve clearance:



Checking / adjusting intake valve clearance — cold

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

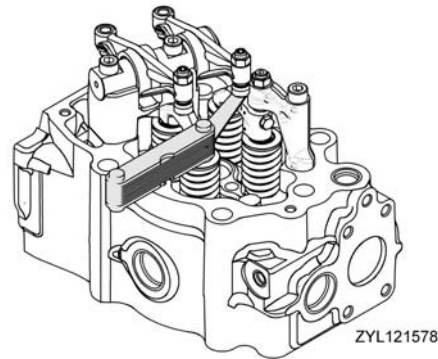
Troubleshooting

The clearance does not correspond with the adjustment values? See "Technical Data"

- Loosen the lock nut on the adjusting screw of the respective rocker arm and adjust the setting.
- Tighten lock nut with 40 Nm

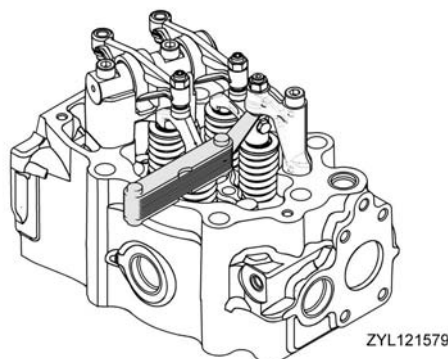
- Check adjustment again

Checking exhaust valve clearance:



Valve clearance exhaust valve fitting/rocker arm

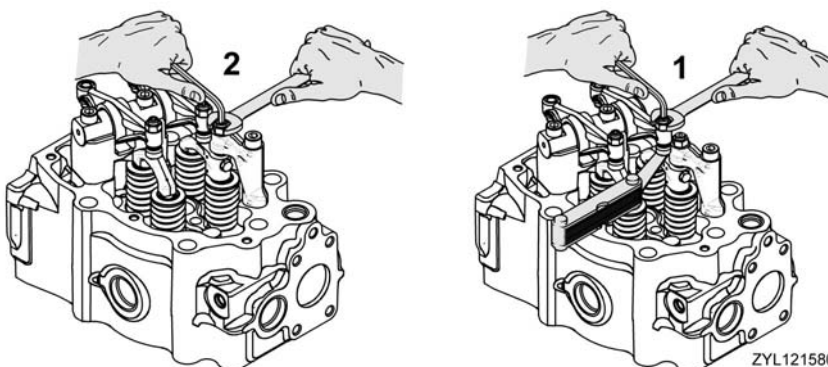
- Insert the feeler gauge between exhaust valve fitting and adjusting screw — rocker arm and check valve clearance, adjust as necessary



Valve clearance exhaust valve fitting/retainer

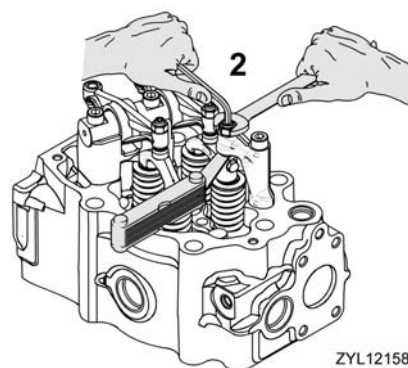
- Insert the feeler gauge between exhaust valve fitting and adjusting screw—retainer and check valve clearance, adjust as necessary

Adjusting exhaust valve clearance:



Valve clearance exhaust valve fitting/rocker arm

- Turn back the adjusting screw **2** until the contact face of the adjusting screw disappears inside the retainer.
- Turn back the adjusting screw **1** until it is possible to insert the feeler gauge which corresponds with the respective adjustment value.
- Screw in the adjusting screw **1** until the piston in the exhaust valve fitting reaches the stop and clamps the feeler gauge.
- Loosen the adjusting screw **1** until the feeler gauge can be withdrawn against moderate resistance (suction).
- Tighten the lock nut with 40 Nm.



Valve clearance exhaust valve fitting/retainer

- Screw in the adjusting screw **2** with the feeler gauge which corresponds with the respective adjustment value inserted until the piston of the valve fitting reaches the stop and clamps the feeler gauge.
- Loosen the adjusting screw **2** until the feeler gauge can be withdrawn against moderate resistance (suction).
- Tighten lock nut with 40 Nm.



Note

Checks following successful adjustment:

! The push rod must indicate clearance!

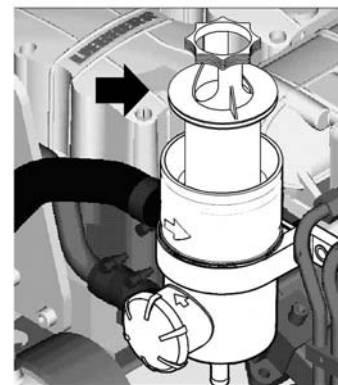
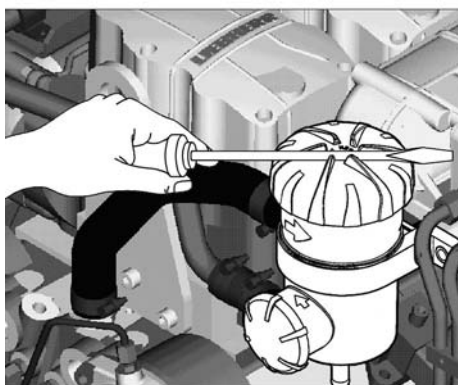
- Following adjustment of all valves, fit cylinder head covers with new seals.
- Dismantle the turning gear

Replace the oil separator filter element

The oil separator is mounted on the right-hand side of the diesel engine on the same side of the flywheel.

It must be ensured that:

- the diesel engine is in the maintenance position
- an original LIEBHERR oil separator filter element is on-hand



ÖLA120485

Oil separator

- Clean the oil separator and the surrounding area thoroughly.
- Unscrew and remove the oil separator sealing cap, if necessary use a screwdriver.

- Pull out the oil separator filter element and dispose of in an environmentally-friendly manner.
- Insert new oil separator filter element and push in up to the stop.
- Mount the oil separator sealing cap and tighten by hand to the stop.

Replacing the fuel prefilter

The fuel pre-filter with water separator, water level sensor and integrated fuel manual delivery pump is located on the right-hand side of the diesel engine.

The fuel pre-filter may feature fuel pre-warming, depending on the diesel engine circumference.

The fuel pre-filter is to be drained of water upon activation of the water level sensor. For details regarding procedure, see the section "Maintenance task with special interval".

Ensure that the following are on-hand:

- a collecting vessel for the fuel
- an original LIEBHERR fuel pre-filter cartridge

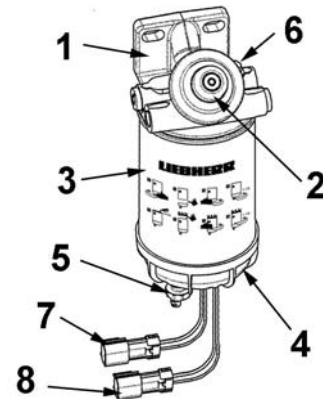


Danger

Risk of fire and explosion!

- ! No smoking.
- ! Avoid naked flames.
- ! Only work on the diesel engine when the diesel engine is switched off.

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

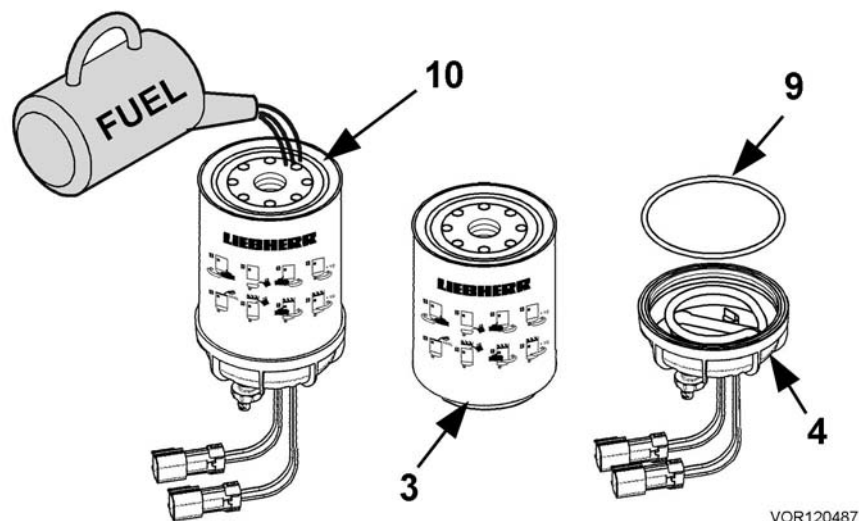


VOR120486

Replacing the fuel pre-filter cartridge

- | | |
|-----------------------------|---------------------------|
| 1 Filter head | 5 Drain plug |
| 2 Fuel manual delivery pump | 6 Bleed screw |
| 3 Fuel pre-filter cartridge | 7 Fuel preheating |
| 4 Water separator reservoir | 8 Water level sensor plug |

- Disconnect electrical connections of water level sensor and fuel preheating.
- Drain fuel: Unscrew bleed screw **6** and drain plug **5**.
- Loosen filter cartridge **3** with strap spanner or similar tool and unscrew.



Filter cartridge — water separator reservoir

- Unscrew the water separator container **4** from the filter cartridge **3**.
- Dispose of the old filter cartridge.
- Clean the water separator reservoir with water and dry with compressed air.
- Apply a light coating of oil to the O-ring **9** of the water separator container.
- Screw the water separator reservoir onto the new filter cartridge until the O—ring is resting on the filter cartridge.
- Tighten the water separator reservoir **by hand** around 1/2 a turn
- Tighten the drain plug **5**
- Check cleanliness of filter head and ensure that the thread adapter is sitting securely in the filter head.
- If the filter head is dirty:
Clean the filter head.
- Lubricate the sealing ring **10** of the new filter cartridge with clean fuel.
- Fill new filter cartridge with clean fuel and screw on until the sealing ring is resting on the filter head.
- Tighten the filter cartridge with filter spanner **by hand** around 1/2 a turn
- Reconnect the electrical connections, close the bleed screw and open the fuel shut-off valve.
- Bleeding the fuel system, see “the section, Maintenance with special interval”.

Replace the fuel fine filter

The fuel fine filter is located on the right-hand side of the diesel engine. Ensure that the following are on-hand:

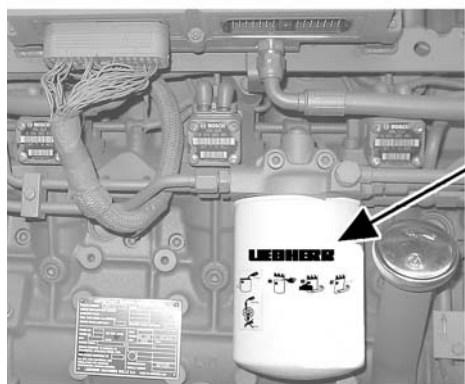
- a collecting vessel for the fuel
- an original LIEBHERR fuel fine filter cartridge

**Danger**

Risk of fire and explosion!

- ! No smoking.
- ! Avoid naked flames.
- ! Only work on the diesel engine when the diesel engine is switched off.

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



KF120488

Replacing the fuel fine filter

- Loosen filter cartridge **1** with strap spanner or similar tool and unscrew.
- Dispose of the old filter cartridge.
- Check cleanliness of filter base and ensure that the thread adapter is sitting securely in the filter base.
- If the filter base is dirty:
Clean the filter base.
- Lubricate the sealing ring **2** of the new filter cartridge with clean fuel.

**Warning**

Preventing contamination of the fuel system

- ! Only fill the new filter cartridge via the small, external openings.
- ! Avoid dirt entering the filter cartridge via the large opening.

- Fill new filter cartridge with clean fuel.
- Screw on the filter cartridge until the sealing ring is resting on the filter head.
- Tighten the filter cartridge with filter spanner **by hand** around 1/2 a turn
- Open the fuel shut-off valve and bleed the fuel system, see "Maintenance task with special interval".

5.3.7 Maintenance tasks every 2000 operating hours

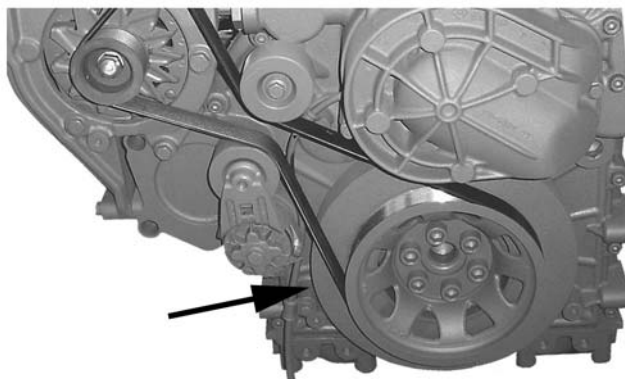
Carry out all maintenance tasks in the same way as is described for 1000 operating hours.

5.3.8 Maintenance Tasks every 3000 operating hours

Before carrying out the 3000 operating hours maintenance tasks:

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

Checking vibration damper for deformation



SCH120484

Vibration damper

- Check vibration damper for distortion

Troubleshooting

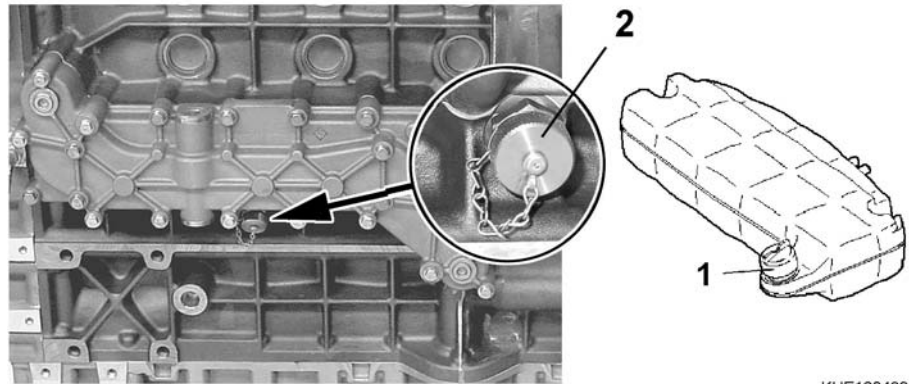
If distortion of the vibration damper is determined:

- Do not start the engine
 - Replace vibration damper.
-

Replacing the coolant

It must be ensured that:

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

Draining the coolant

KUE120489

Draining the coolant

- Avoid opening the sealing cap **1** when 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 protective cap **2** of the drain valve on the radiator grill on the diesel engine.
- Screw the drainage hose onto the drain valve, thus opening the drain valve.
- Open the drain plug on the radiator (see manufacturer's documentation).

The coolant from the oil cooler housing and cooler flows into the tank.

- When the coolant has been drained from the cooling system.

Unscrew the drainage hose from the drain plug and fasten the protective cap and close the radiator again.

Filling in coolant.

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

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

5.3.9 Maintenance Tasks every 10000 operating hours

Before carrying out the 10000 operating hours maintenance tasks:

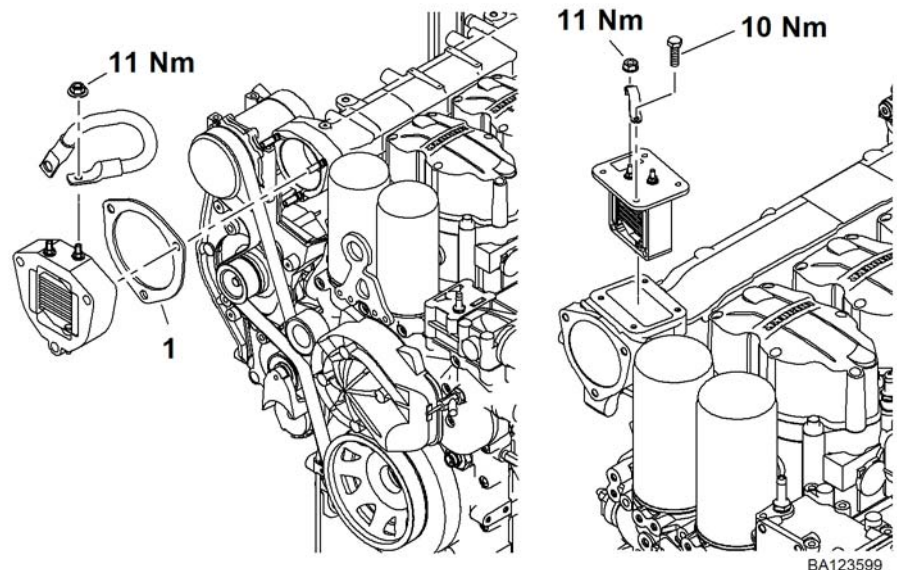
- carry out the daily maintenance tasks, see the section “Maintenance tasks (daily) every 10” operating hours.
- carry out the weekly maintenance tasks, see the section “Maintenance tasks (weekly) every 50 operating hours”.
- carry out the 500 operating hours maintenance tasks, see the section “Maintenance 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 ”.

Change the heater flange

The heater flange is installed at the inlet of the air induction pipe on the right-hand side of the diesel engine or inside the air induction pipe.

It must be ensured that:

- the diesel engine is in the maintenance position.
- A corresponding heater flange is on-hand.
- An original LIEBHERR seal 1 is on-hand should the heater flange be fitted to the air induction pipe.



Dismantling and installing the 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.
- Dismantle the heater flange.
- Install a new heater flange. If the heater flange is flange-mounted on the air induction pipe the heater flange must be installed with a new seal 1.
- Connect the electrical connecting cable on the heater flange, as well as the negative cable on the battery.

5.3.10 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

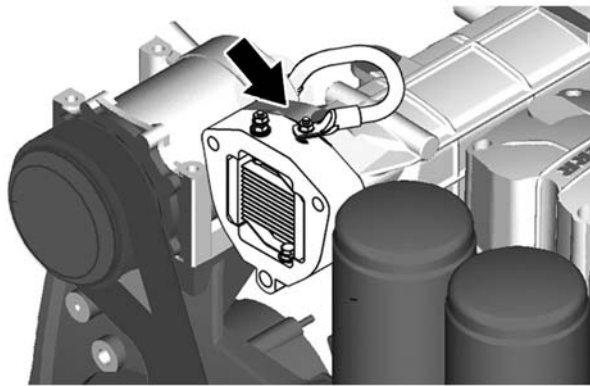
The heater flange is installed at the inlet of the air induction pipe on the right-hand side of the diesel engine or inside the air induction pipe.

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

Check the heater flange



HEI120493

Heater flange

- Switch off battery main switch, if featured, and disconnect negative cable from the battery.
- Disconnect the electrical connecting cable on the heater flange.
- Connect the ohmmeter or the multimeter to the terminals and check the resistance.

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

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

It must be ensured that:

- the diesel engine is in the maintenance position

Replacing the dry air filter main element

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

If air filter contamination continues to be displayed following maintenance of the main element, the safety element must also be replaced.

- For replacement of the main element, see "Manufacturer's Documentation".

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** .

- For replacement of the safety element, see the “Manufacturer’s Documentation”.

It is necessary to bleed the fuel filter following:

- Replacing the fuel filter

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

- running the fuel tank empty
- initial start-up of the diesel engine

It must be ensured that:

- the diesel engine is in the maintenance position,
- a collecting vessel for the fuel is on-hand,
- if necessary, new injection lines are on-hand.

Bleeding the fuel filter



Danger

Risk of fire and explosion!

- ! No smoking.
- ! Avoid naked flames.
- ! Only work on the diesel engine when the diesel engine is switched off.

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



BA500526

Bleeding the fuel filter



Warning

When bleeding the fuel filter, do not open any fuel lines / injection lines or threaded unions.

- ! Only open the bleed screw on the filter head of the fine filter.

- Unscrew the bleed screw **1** on the filter head of the fuel fine filter around 2 or 3 turns of thread.
- Actuate the hand pump **2** .

When bubble-free fuel flows out of the bleed screw

- Tighten the bleed screw **1** .
- Actuate the hand pump until a strong resistance becomes evident.
- Start the diesel engine.

Troubleshooting

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

- Wait for 1 minute.
- When this action has been repeated three times:
Repeat the bleed procedure.

Bleeding the fuel low-pressure system



Danger

Risk of fire and explosion!

- ! No smoking.
- ! Avoid naked flames.
- ! Only work on the diesel engine when the diesel engine is switched off.



Bleed screw on the filter head of the fuel pre-filter

- Unscrew the bleed screw **1** on the filter head of the fuel prefilter around 2 or 3 turns of thread.
 - Actuate the hand pump **2** .
- If bubble-free fuel flows out of the opening
- Tighten the bleed screw **1** .

Troubleshooting

If no fuel flows out!

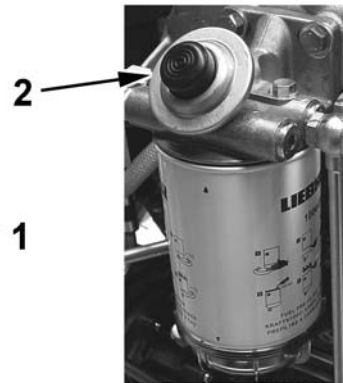
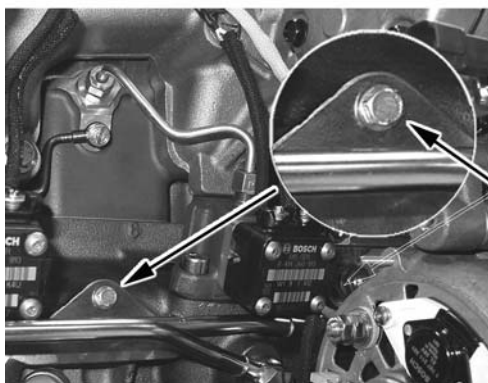
- Unscrew the bleed screw **1** completely and repeat the bleed procedure.
- Actuate the hand pump until a strong resistance becomes evident.



BA500526

Bleed screw on the filter head of the fuel fine filter

- Unscrew the bleed screw **1** on the filter head of the fuel fine filter around 2 or 3 turns of thread.
 - Actuate the hand pump **2**.
- When bubble-free fuel flows out of the bleed screw
- Tighten the bleed screw **1**.
 - Actuate the hand pump until a strong resistance becomes evident.



BA500528

Bleed screw on the crankcase

- Unscrew the bleed screw **1** on the crankcase around 2 or 3 turns of thread where featured.
 - Actuate the hand pump **2**.
- When bubble-free fuel flows out of the bleed screw
- Tighten the bleed screw **1**.
 - Actuate the hand pump until a strong resistance becomes evident.

Bleeding the fuel high-pressure system (up to software version 35)

The engine control unit version software version can be obtained by reading the engine control unit company nameplate.

It must be ensured that:

- the fuel low-pressure system has been bled



Danger

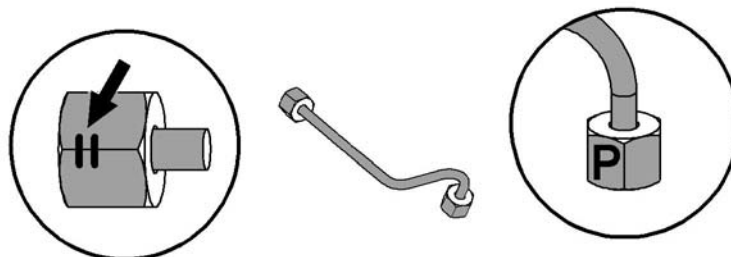
Risk of fire and explosion!

- ! No smoking.
- ! Avoid naked flames.
- ! Only work on the diesel engine when the diesel engine is switched off.

**Note**

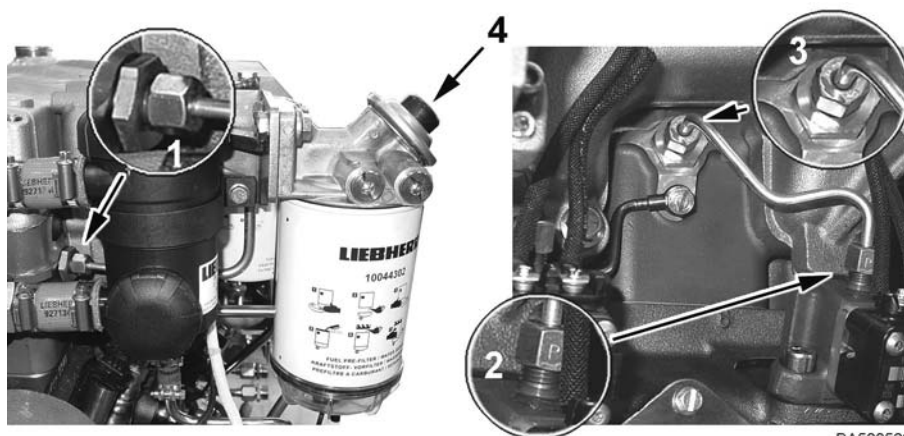
The injection lines must be marked each time they are opened.

! Following the third time of opening (markings) the injection lines must be replaced.



BA500525

Markings of the injection line



BA500529

Injection lines of cylinders 1 and 6 or 4

- **Loosen D934** injection line from cylinder 1 on the pressure pipe tube (nozzle side) **1** (ensure that this does not also turn simultaneously) and loosen the injection line from cylinder 4 pump side **2**.
- **Loosen D936/D946** injection lines of cylinders 1 and 6 on the pressure pipe tube (nozzle side) **1/3** (ensure that this does not also turn simultaneously!)
- Actuate the hand pump **4**.

When bubble-free fuel flows out of the injection lines

- Tighten the injection lines nozzle side **1/3** and pump side **2** once again with 25–30 Nm.
- Actuate the hand pump until a strong resistance becomes evident.
- Start the diesel engine.

Troubleshooting

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

- Wait for 1 minute.
- When this action has been repeated three times:
Repeat the bleed procedure.

Bleeding the fuel high-pressure system (upwards of software version 36)

It is possible upwards of engine control unit software version 36.0 to start the engine "in bleed mode".

The engine control unit version software version can be obtained by reading the engine control unit company nameplate.

It must be ensured that:

- the fuel low-pressure system has been bled
- Actuate the "bleed mode" with the program "Classify" or with diagnostic program "DcDesk 2000". On some machines, the "bleed mode" is also actuated via the equipment control, see "Manufacturer's Documentation".



Note

If the specifications for actuation of the engine control unit in the "bleed mode" is not featured.

! Bleed the fuel high-pressure system, see "up to software version 35."

- Start the engine in "bleed mode".

The fuel injection time is prolonged until the engine control unit recognises that

- the engine is running in idle,
- a pre-specified time has been exceeded.

An increased amount of smoke is generated when starting the engine "in bleed mode".

Troubleshooting

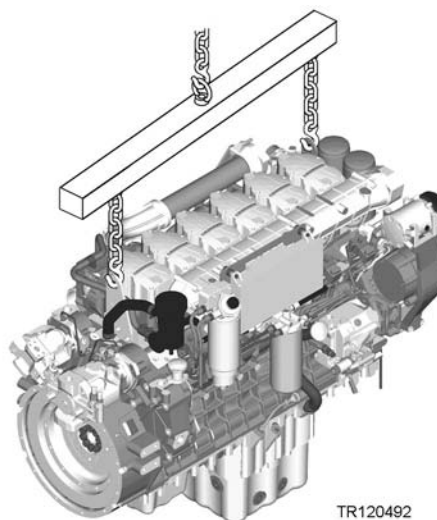
the engine is not running in idle,

- Wait for at least one minute, then initiate the start procedure again in "bleed mode".

Lifting device

It must be ensured that:

- a suitable lifting device is on-hand.



Lifting device

- A proper lifting device must be used when moving the diesel engine. Hook the diesel engine on the lifting lugs provided.

Storage up to 6 months

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

If the diesel engine is additionally 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 from forming.

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

Storage for between 6 and 24 months

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

Removing the preservation after 6 months of storage

- Remove all fitted connections.

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

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

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

- Following installation and connection of the diesel engine
Permissible fuels should be kept topped up to maximum levels, see "Fuel and Lubricants".

5.3.11 Confirmation of maintenance tasks which have been performed

Maintenance details

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



Note

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

- ! We strongly recommend that the prescribed maintenance tasks are performed punctually and thoroughly. Warranty claims only remain valid if this point is strictly adhered to. Under no circumstances may lead seals which have been fitted on the diesel engine be removed!
- ! The correct carrying out of maintenance tasks must be entered and confirmed in the following maintenance chart.
- ! The maintenance tasks for daily and 50 operating hours maintenance intervals must be performed by service personnel authorised by the customer.
- ! The first oil-change and replacement of the oil filter, as well as all further maintenance tasks, must be carried out by a LIEBHERR-trained, authorised mechanic.

5.3.12 Every 500 operating hours / at least once a year

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

the prescribed oil-change interval may have to be reduced depending on the difficulty factor, see "Fuel and Lubricants"

Hours	Date	Mechanic	Signature	Comment
500				
1000				
1500				
2000				
2500				
3000				
3500				
4000				
4500				
5000				
5500				
6000				
6500				
7000				
7500				
8000				
8500				
9000				
9500				
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16500				
17000				
17500				
18000				
18500				
19000				
19500				
20000				

5.3.13 Additionally every 1000 / 2000 / 3000 operating hours

Hours	Date	Mechanic	Signature	Comment
1000				
2000				
3000				
4000				
5000				
6000				
7000				
8000				

Hours	Date	Mechanic	Signature	Comment
9000				
10000				
11000				
12000				
13000				
14000				
15000				
16000				
17000				
18000				
19000				
20000				

5.3.14 Additionally every 2 years

Hours	Date	Mechanic	Signature	Comment
2 years				
4 years				
6 years				
8 years				
10 years				
12 years				
14 years				
16 years				
18 years				
20 years				

5.4 Lubricants and fuels

5.4.1 Handling lubricants and fuels

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

It is of particular importance that the specified change intervals and qualities of lubricant are respected.

Miscellaneous details regarding the prescribed intervals can be obtained in the chapters, "Maintenance and Inspection Chart"

Miscellaneous details for tasks including lubrication, level inspections and changing of fuel and lubricants can be obtained in the chapter "Maintenance" under "Maintenance Tasks".

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

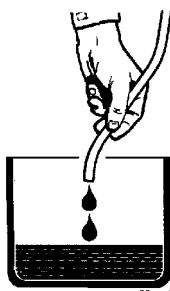
5.4.2 Environmental-protection guidelines

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

5.4.3 Disposal of used materials

Recyclables include for example:

- Oils, lubricants, coolants, refrigerants for air-conditioning systems etc.
- Fuels
- Filters, oil filter cartridges, etc.
- Observe the guidelines for environmental protection when disposing of recyclables.
- Collect all recyclables separately in suitable containers, store in a safe place and dispose of in an environmentally-friendly manner at an official site.
- Observe the guidelines which apply for the respective country.



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Disposal

5.4.4 Diesel fuels

Specification



High sulphur content in the diesel fuel

The diesel fuels must comply with the minimum requirements of the fuel specifications stipulated as follows.

Permissible fuel specifications:

- DIN EN 590
- ASTM D 975 (89a) 1D and 2D

- 1 Oil change intervals in correspondence with difficulty factors.
- 2 Diesel fuels featuring a sulphur content of above / more than 1 % (10000mg/kg) are not permissible.
- 3 For diesel engines featuring external exhaust gas return (eAGR), we recommend that diesel fuels with a sulphur content less than or equal to 0.005% (50mg/kg) be used.
- 4 With operation of diesel engines using engine oil E6 and standard oil change interval (500 operating hours), diesel fuel with a sulphur content in excess of 0.005% (50 mg/kg) is not permissible.



Note

Diesel fuel lubricity must not exceed 460 µm, as prescribed by HFRR (60) Test max.[lubricity corrected wearscar "diameter" (1.4) at 60 °C]

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.

Diesel fuel at low temperatures (winter operation)

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



Note

A mixture of petroleum and regular petrol is not permissible, both as a safety precaution and for technical reasons.

! Special fuels are available for applications in arctic climates.

! If the flow characteristics of the diesel fuel are inadequate or if temperatures are lower than -20 °C: use a starting aid (e.g. fuel filter heater).

5.4.5 Lube-oils for the diesel engine

Lube oil specifications



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Nowadays, only high-alloy lube oils are used for modern diesel engines. They consist of base oils which feature combined admixtures (additives). The lube oil guideline for LIEBHERR diesel engines is based on the following specifications and guidelines:

Description	Specification
ACEA — classification (Association des Constructeurs Européens de l'Automobile)	E4, E6, E7
API — classification (American Petroleum Institute)	CH-4, CI-4
	Caution: particle filter operation only permissible with E6
	Caution: respect the reduced oil change intervals

Lube-oil viscosity

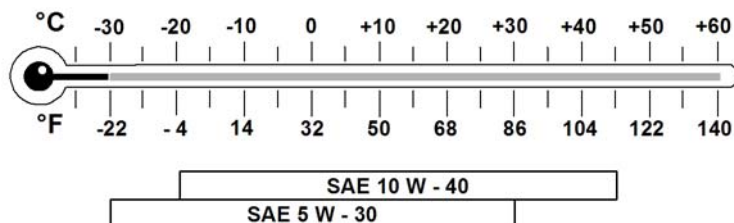
Selection of the lube oil viscosity in accordance with the SAE-classification (Society of Automotive Engineers).

The ambient temperature is definitive for the correct selection of the SAE-class.

Selection of the SAE-classification gives no indication of the quality of a lube-oil.

Too high a viscosity can lead to starting difficulties, and too low a viscosity could jeopardise the lubricating efficiency.

The temperature ranges specified in the diagram are guidelines and can be briefly exceeded or fallen short of.



300029

Temperature-dependent selection of the SAE-class

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

Liebherr engine oil 10W-40, Specification ACEA E4

Liebherr engine oil 10W-40 low ash, Specification ACEA E6

The following diesel engine oil is recommended for ambient temperatures of -30 °C / (-22 °F) to +30 °C / (+86 °F):

Liebherr engine oil 5W-30, Specification ACEA E4

Lube-oil change intervals

Change intervals: see chapter "Maintenance and Inspection Chart"

Oil-change respective of climatic zone, sulphur content in the fuel and oil quality in accordance with the following table

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

Varying **difficulty factors** (tougher operating conditions) alter the maintenance interval.

Difficulty factors include:

- repeated cold-starts
- Sulphur content in the fuel
- Application temperature

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

Difficulty factor		Oil quality	
		CH-4	
		CI-4	
			E4 / E7*
Operating conditions	Sulphur content in the fuel	Interval (h = operating hours)	
Temperature normal down to -10 °C	up to 0.5%	250 h	500 h
	over 0.5% up to 1%	125 h	250 h
below -10 °C	up to 0.5%	125 h	250 h
	over 0.5% up to 1%	not permissible	125 h
* TBN minimum 13 mgKOH/g			

Difficulty factor		Oil quality	
		E6	
Operating conditions	Sulphur content in the fuel	Interval (h = operating hours)	
Temperature normal down to -10 °C	up to 0.005%	500 h	
	over 0.005% up to 0.05%	250 h	
	over 0.0501% up to 0.1%	125 h	
below -10 °C	up to 0.005%	250 h	
	over 0.005% up to 0.05%	125 h	
	over 0.0501% up to 0.1%	not permissible	

Oil change intervals in correspondence with difficulty factors

5.4.6 Coolant for the diesel engine

Coolant is a mixture of water and additives for anticorrosive and anticorrosive/antifreeze. The products listed as follows can either be mixed or can be obtained ready-mixed (Permixon).

General recommendations

The cooling system will only function reliably if it is working under pressure. It is therefore imperative that it is kept clean and watertight, that the radiator cap valves and working valves are functioning correctly and the necessary coolant level is maintained.

The anticorrosive/antifreeze authorised by LIEBHERR guarantees sufficient protection against cold, corrosion and cavitation, do not corrode seals and hoses and do not foam up.

Coolants which contain inadequate, or ill-prepared or incorrect anticorrosive/antifreeze, could cause a malfunctioning of aggregates or parts in the cooling circuit as a result of cavitation 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.

**Note**

Emulsifiable corrosion inhibition oils are impermissible.

! Anticorrosives without antifreeze (e.g. DCA) are not generally used. It is possible, however, to introduce them in special cases (see anticorrosives (inhibitors) without antifreeze).

Water (fresh water)

Colourless, clear, drinkable tap water which is free of mechanical contamination, and featuring the following restricted analysis values, is suitable to use as fresh water

Sea water, brackish water, salt water and industrial waste water is not suitable.

Description	Value and unit
Sum of alkaline earths (water hardness)	0.6 to 3.6 mmol/dm ³ (3 to 20° d)
pH-value at 20 °C	6.5 to 8.5
Chloride-ion content	max. 80 mg/dm ³
Sulphate-ion content	max. 100 mg/dm ³

Fresh water quality

Description	Value and unit
Sum of alkaline earths (water hardness)	0.6 to 2.7 mmol/dm ³ (3 to 15° d)
pH-value at 20 °C	6.5 to 8.0
Chloride-ion content	max. 80 mg/dm ³
Sulphate-ion content	max. 80 mg/dm ³

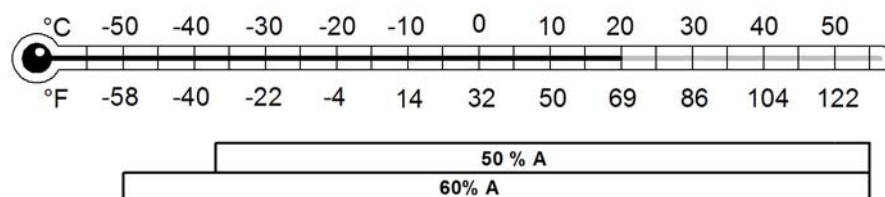
Fresh water quality when using DCA 4

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

Coolant — mix ratio

The coolant must contain at least 50 % anticorrosive/antifreeze **all year round**.

Ambient temperature up to		Mix ratio	
°C	°F	Water %	A %
-37	-34	50	50
-50	-58	40	60
A = anticorrosive/antifreeze			



Temperature-dependent selection of mix ratio for water + anticorrosive / antifreeze

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

Permitted anticorrosive / antifreeze

Product description	Manufacturer
Liebherr Antifreeze Concentrate	Liebherr



Note

If Liebherr coolant can not be obtained on the respective building site, coolants complying with the "Coolant specification for Liebherr diesel engines 10652041" are also permissible (please consult our after-sales services).

Mixing of different anticorrosive / antifreezes can impair the properties of the coolant.

! Do not combine different products.

Permissible ready-mixed coolants

Product description	Manufacturer
Liebherr Antifreeze Mix	Liebherr

Premix = ready-mix (50 % water and 50 % anticorrosive / antifreeze)



Note

If Liebherr coolant can not be obtained on the respective building site, coolants complying with the "Coolant specification for Liebherr diesel engines 10652041" are also permissible (please consult our after-sales services).

Mixing of different anticorrosive / antifreezes can impair the properties of the coolant.

! Do not combine different products.

Permitted anticorrosive / antifreeze (inhibitors) without antifreeze

In **exceptional cases** and with **ambient temperatures constantly above freezing point**, e.g. in tropical regions, there is apparently no approved anticorrosive/antifreeze available, the water must be mixed with the following inhibitors to act as a coolant:

Product DCA 4 (Diesel Coolant Additives 4)

Product Caltex / Chevron / Havoline / Total

In this case, the coolant must be changed once a year.

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

**Note**

Mixing of different anticorrosive / antifreezes can impair the properties of the coolant.

! Do not combine different products.

! Allow the coolant to drain completely before changing from anticorrosive / antifreeze to anticorrosive, or vice versa.

Product designation	MANUFACTURER
DCA 4 Diesel Coolant Additives	Fleetguard / Cummins Filtration
Caltex XL Corrosion Inhibitor Concentrate	Chevron Texaco
Chevron Heavy Duty Extended Life Corrosion Inhibitor Nitrite Free (ELC)	Chevron Texaco
Havoline Extended Life Corrosion Inhibitor (XLI)	Chevron Texaco
Total WT Supra	Total, Paris