

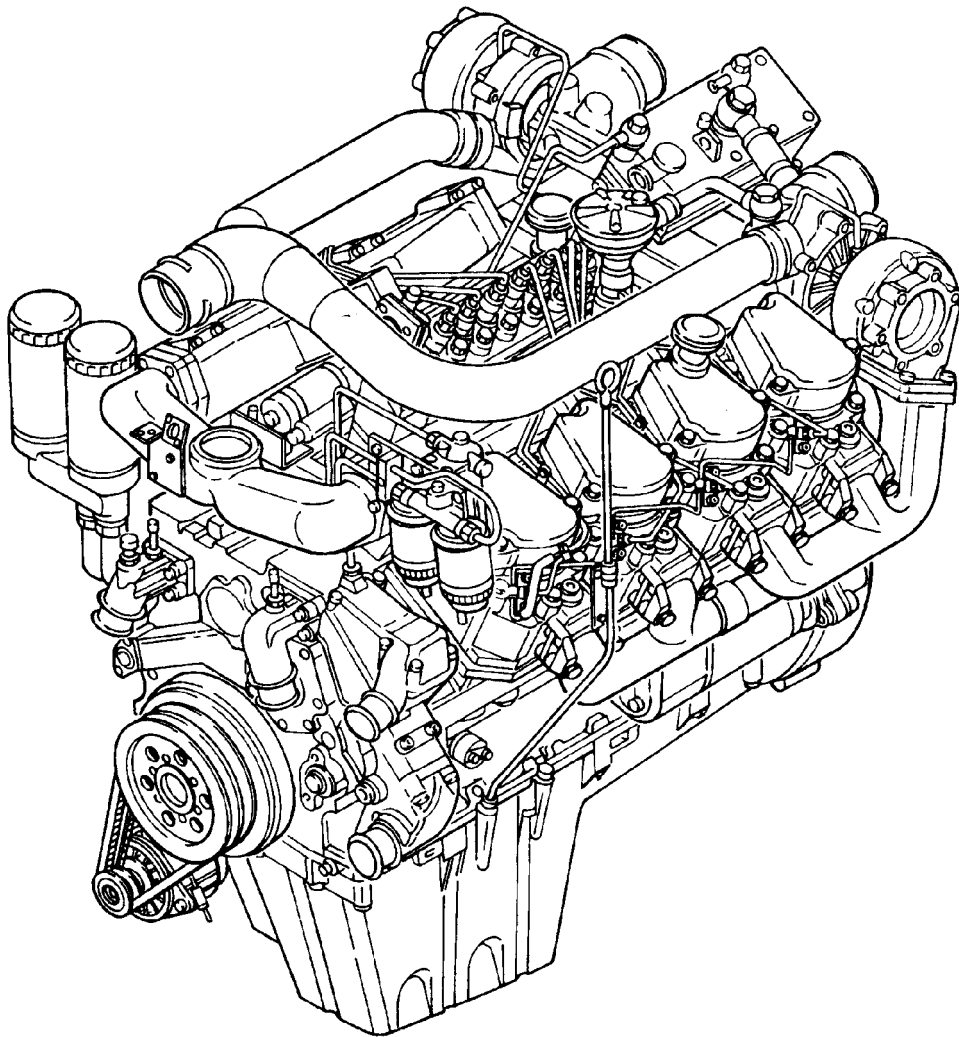
# **LIEBHERR - Diesel engines**

## **D 9306 / 9308 TI**

## **D 9406 / 9408 TI, TI-E**

### **Operating Instructions**

### **Betriebsanleitung**





**LIEBHERR**  
**DIESEL ENGINE**

**D 9306 / 9308 TI**  
**D 9406 / 9408 TI, TI-E**

**Operating instructions**

**BAL -No. 14110-05-02**

pages : 1 up to 61

**LIEBHERR-WERK EHINGEN GmbH, Postfach 1361, D-89582 Ebingen / Donau**

**Telefon (07391) 5 02-0, Telefax (07391) 5 02-33 99**

**www.lwe.liebherr.de, E-mail: info@lwe.liebherr.com**



This operating manual comprises the most important points for proper operation and service of **LIEBHERR diesel engines**.

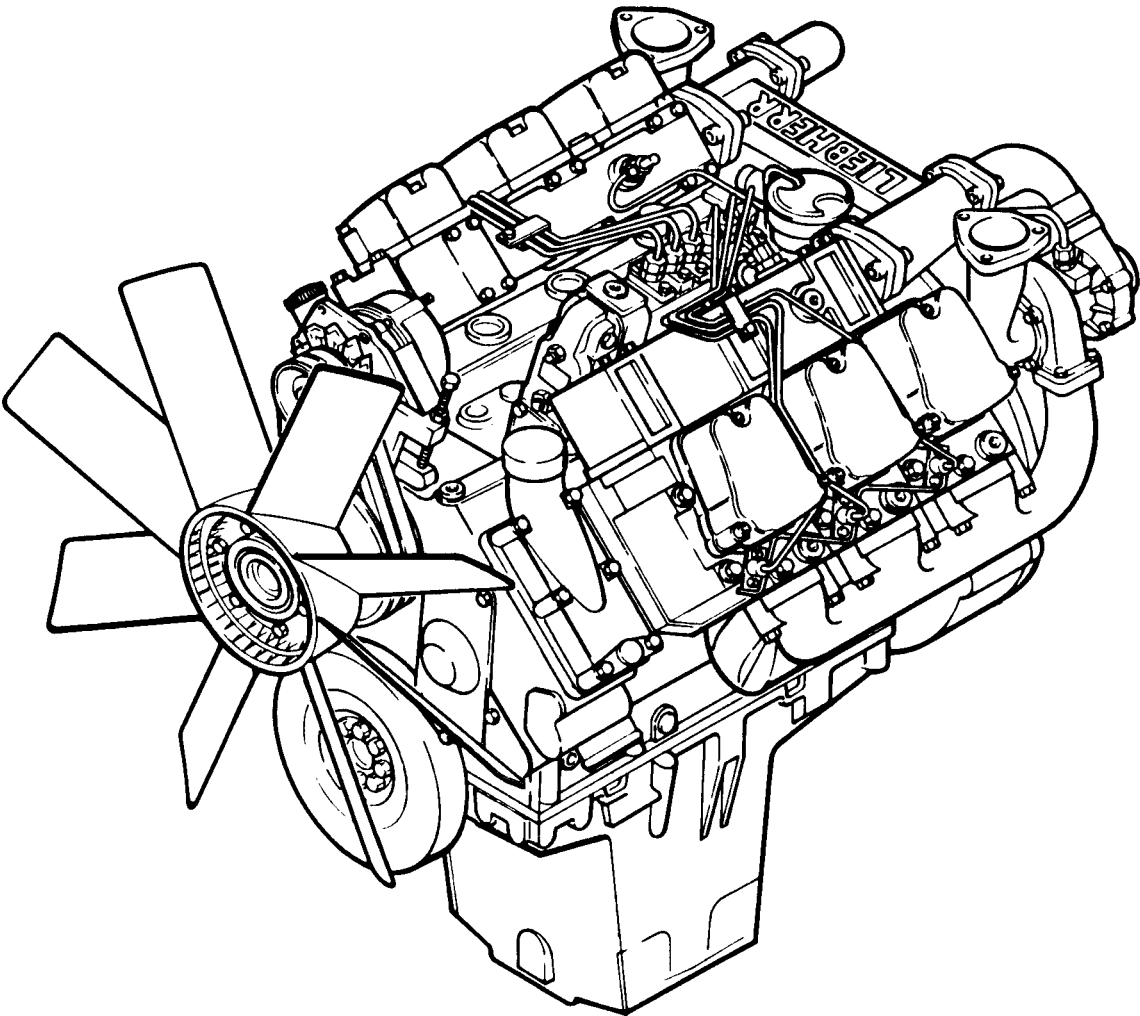
We urgently advise that the specified maintenance work be carried out carefully and punctually. This will ensure that the engine is fully operational at all times.

You will appreciate that we cannot consider guarantee claims for damage caused by improper operation or inadequate maintenance.

**IMPORTANT:** **LIEBHERR will annul without notice all obligations undertaken by LIEBHERR and/or its authorized dealers, such as guarantee agreements, service contracts etc., if any spare parts other than original parts manufactured LIEBHERR or sold by LIEBHERR are used for maintenance and repair.**  
**We recommend that the sales and service offices (also Liebherr Bagger) listed in the chapter AUTHORIZED DEALERS be consulted for maintenance and repair of LIEBHERR engines.**

The technical data, illustrations and dimensions provided in this manual are subject to alteration, and cannot be used as a basis for claims of any nature. We reserve the right to undertake improvements to the engine design without changing these instructions.

CONTENTS



**CONTENTS**

**1.00    DESCRIPTION OF ENGINE ..... 6**

**2.00    ENGINE OPERATION ..... 22**

**3.00    LUBRICANTS AND SERVICE FLUIDS ..... 26**

**4.01    MAINTENANCE SCHEDULE ..... 32**

**4.02    MAINTENANCE WORK ..... 34**

**4.03    CERTIFICATION OF COMPLETED MAINTENANCE WORK ..... 52**

**5.00    TROUBLESHOOTING ..... 58**

**Technical description****Engine design**

Water cooled, 6 and 8 cylinder V-engine, v-shaped, located at a 90° angle, with LIEBHERR direct injection system.

For explanation of additional descriptions, refer to paragraph **Engine Designation**.

**Characteristics**

A simple and robust basic construction and generous dimensions provide the foundation for high operating safety and long service life. Low fuel consumption, low noise emission and cleaner exhaust fumes are achieved due to a special combustion system matched to the requirements. The overall cost efficiency is enhanced by the low maintenance requirements of the easily accessible components and by a diverse range of optional accessories.

**Power train**

The 6 cylinder engines feature a steel crankshaft with 4 bearings with inductively hardened bearing surfaces and 4 forged on counterweights.

The 8 cylinder engines feature a steel crankshaft with 5 bearings with inductively hardened bearing surfaces and 8 forged on counterweights.

A vibration damper is attached on the fan side of the crankshaft.

Drop forged, angle split connecting rod, lead bronze, tri metal, sliding type bearings, smooth shaft, three ring aluminum alloy pistons with ring support and combustion chamber in the piston bottom.

Replaceable, wet cylinder liners.

**Housing**

The crankcase is a one piece alloy iron casting. Single piece cylinder heads with cast-in swirl inlet port and replaceable valve seats and valve guides. The rear flywheel housing, the front gear box with the accessory drives and the aluminum oil pan on the underside complete the engine.

**Engine timing**

Per cylinder, one intake and exhaust valve is located in the cylinder head (ohv), actuated by 4 or 5 bearing steel camshaft via a Bimetall tappet, push rod and rocker arm. Camshaft, injection pump, lubrication pump, air compressor, water pump, cooling fan and auxiliary hydraulic pump are driven by the crankshaft via nitride hardened gears on the flywheel and fan side.



**Lubrication system**

Pressure-lubricated by a gear pump for crankshaft, connecting rod and camshaft bearings as well as piston pin bushing, tappet and rocker arm.

Oil filtration with two disposable cartridge filters in the full flow circuit. Auxiliary components, such as injection pump and air compressor are connected to the engine lubrication circuit.

The engine oil cooler is integrated in the coolant circuit.

**Cooling system**

Dual thermostat regulated cooling system with centrifugal pump.

Each cylinder is individually supplied via cast-in distributor channels in the crankcase.

Nozzles spray a continuous jet of oil from the lube oil circuit onto the underside of the piston crowns to dissipate heat.

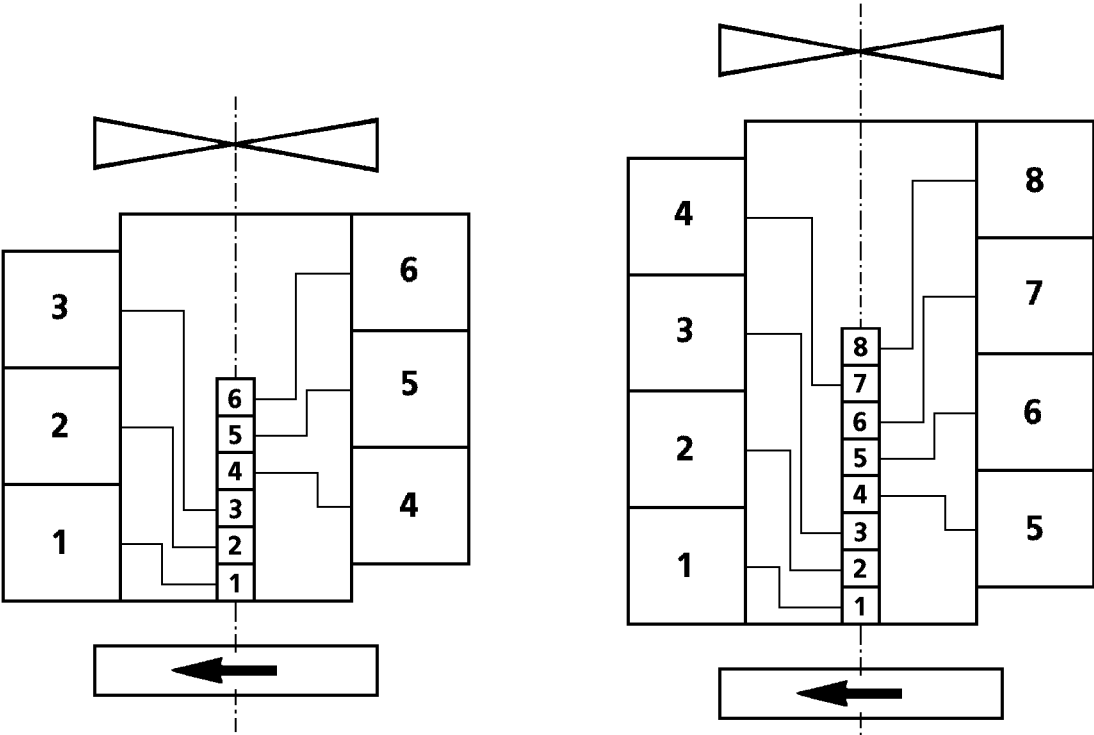
injection nozzles

**Fuel injection system and regulation**

Maintenance free BOSCH in-line fuel injection pump with mechanical BOSCH - RQV governor, fuel pump and fuel filter, BOSCH - fuel injection nozzles.

**Electrical equipment**

Starter and alternator: 24 Volt.



<b>LIEBHERR</b>			
TYP		MOT. NR	
CODE	KW	1/min	LIEFERUMFANG

**Cylinder description, direction of rotation**

Cylinder 1 is located on the left side when viewed from the flywheel.

The cylinder numbers are cast into the top of the crankcase housing, in firing order.

The engine rotates counterclockwise (to the left) when viewed from the flywheel.

**Engine data tag**

The engine data tag is located on the left hand side of the crankcase when viewed from the flywheel.

Depending on the engine, there might be a second data tag .

**Engine serial number**

The engine serial number is stamped into the engine data tag and the crankcase.

On the crankcase, the engine serial number is stamped into the top of cylinder 4 (6 cylinder engine) or cylinder 5 (8 cylinder engine).

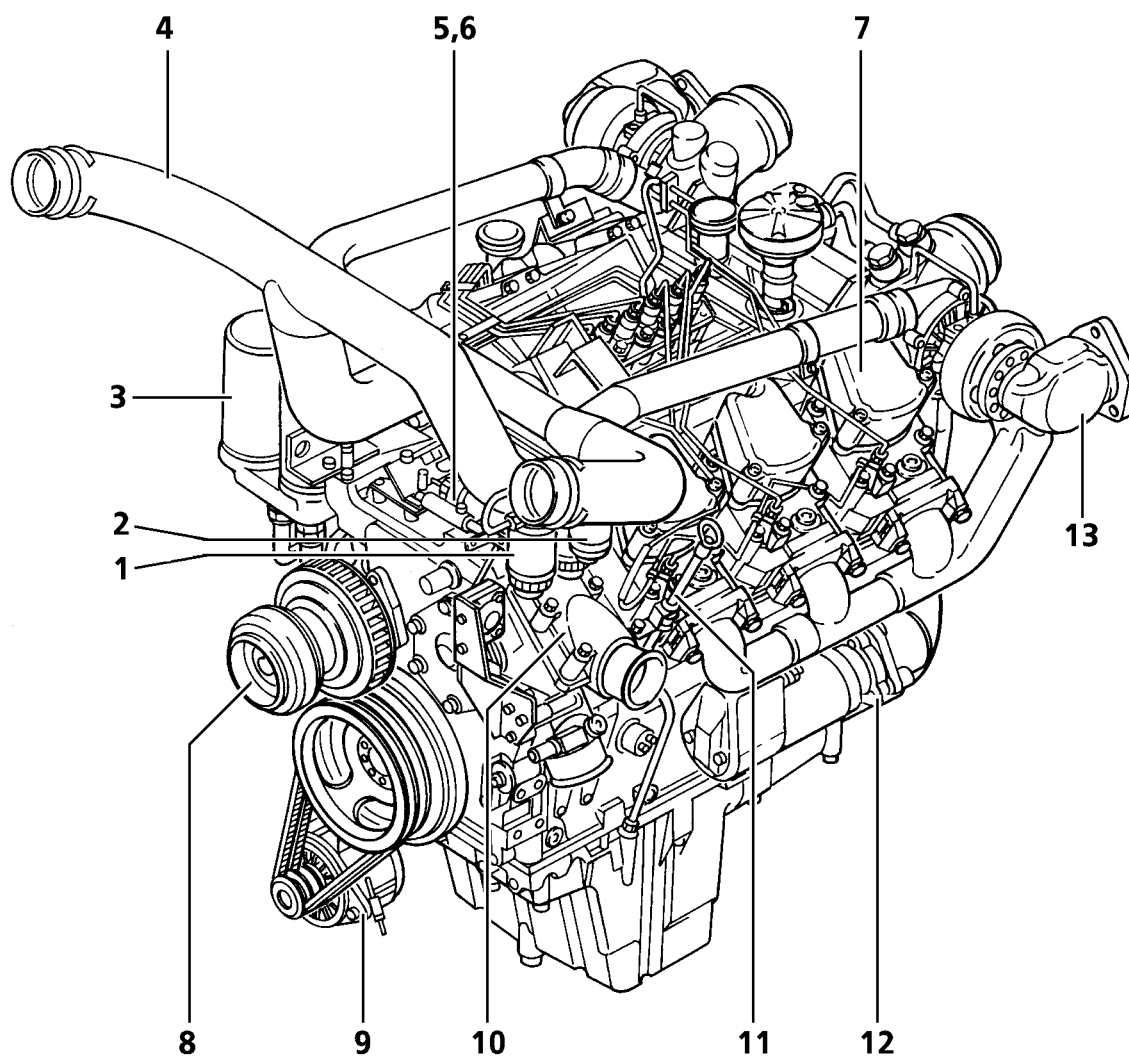
**Data:**

TYPE	=	For example: D 9308 TI-E
MOT.NR.	=	Engine serial number
CODE	=	For additional data, if required
KW	=	Engine output in kW
1/min	=	Rated engine speed
LIEFERUMFANG	=	Identification number of engine configuration

**Engine identification**

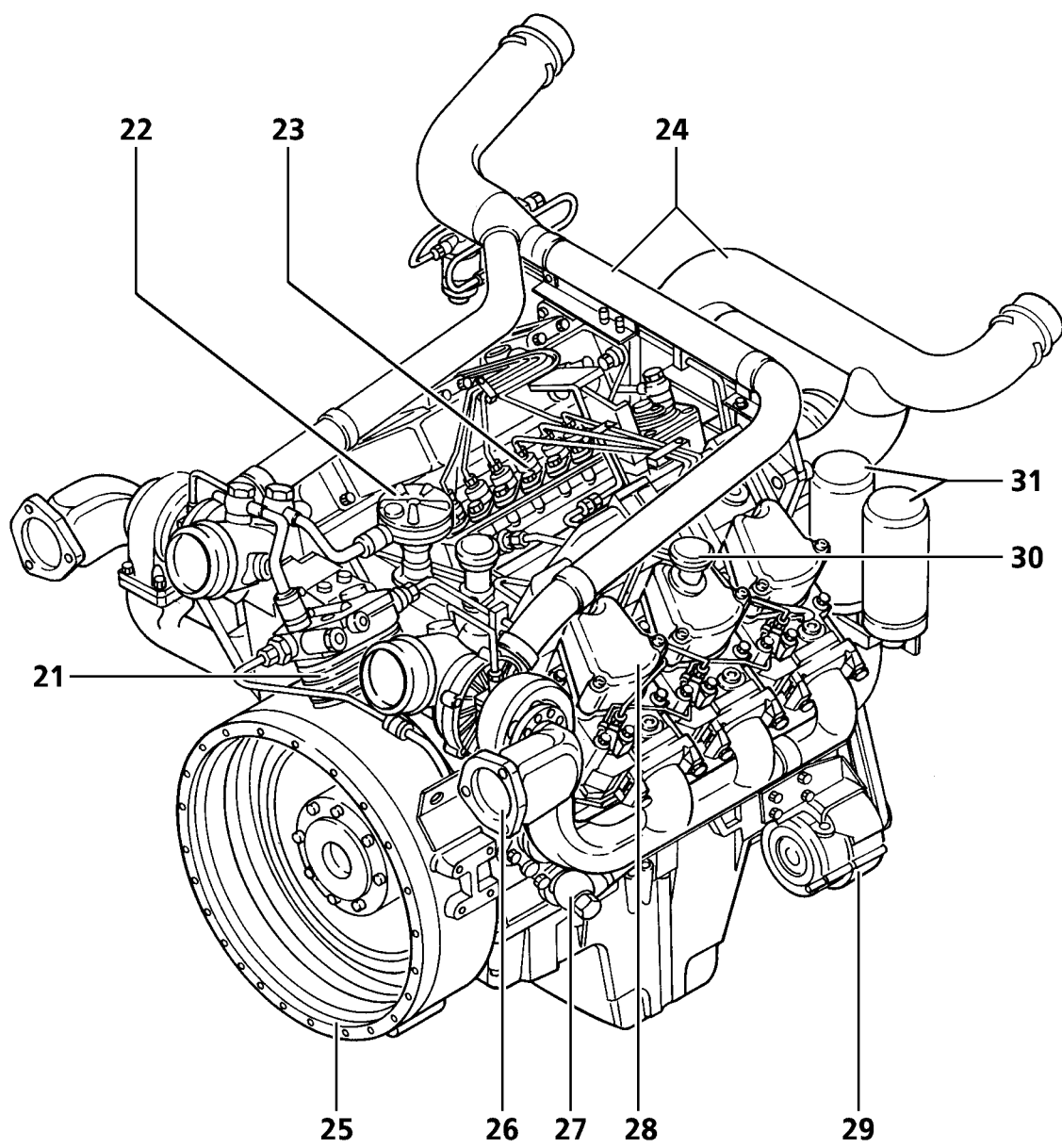
D	=	Diesel engine
93	=	Bore Ø 130 mm, stroke 150 mm
94	=	Bore Ø 135 mm, stroke 150 mm
06	=	Number of cylinders (6 cylinders)
08	=	Number of cylinders (8 cylinders)
TI-E	=	Additional identification

Additional Identification:	TB	=	Moderately turbocharged
	T	=	Turbocharged
	TI	=	Turbocharged and intercooled
	E	=	Exhaust optimized
	A1	=	Distributor injection pump
	A2	=	In-line injection pump



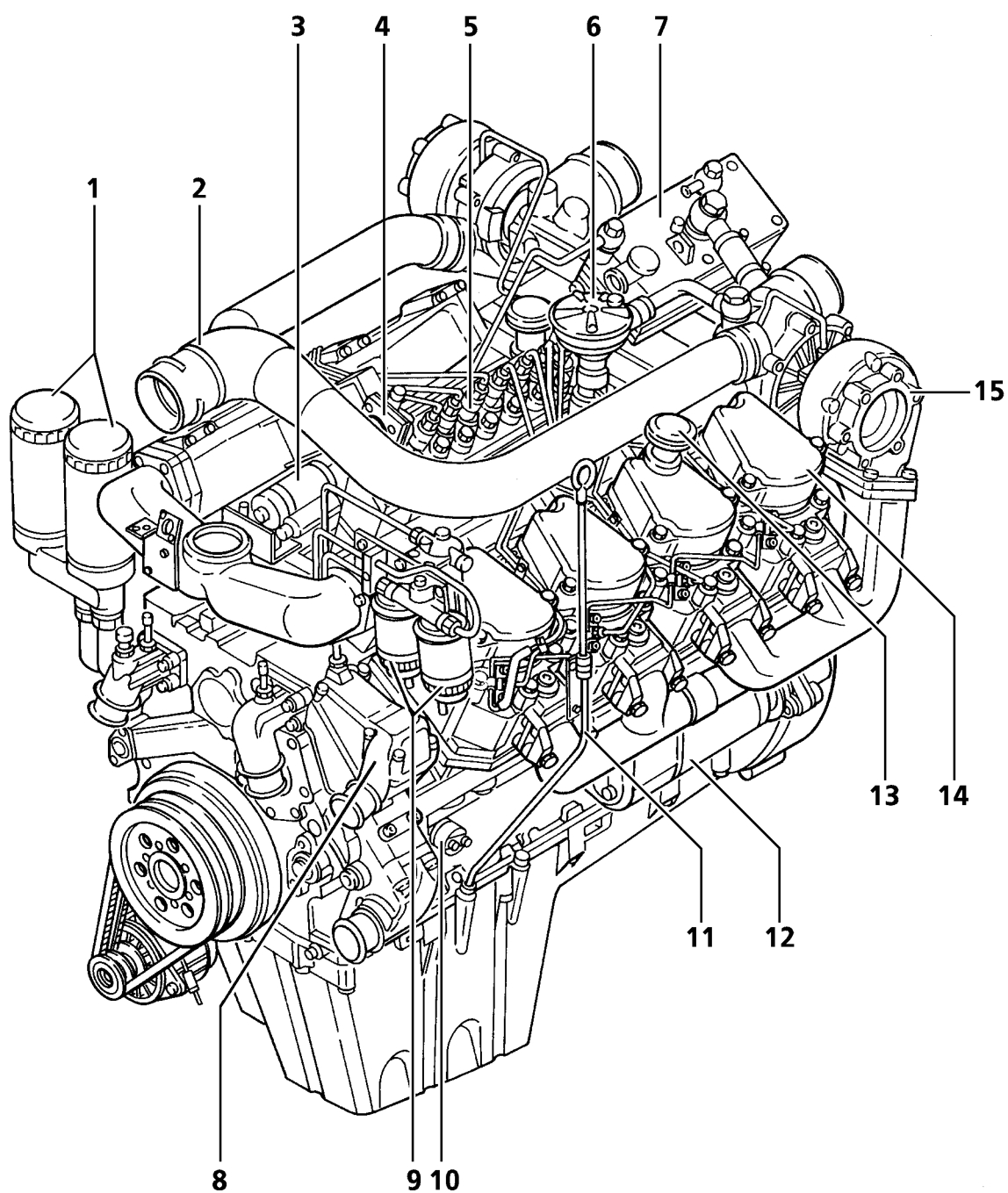
**6 Cylinder V-Engine**

- 1 Fuel filter**
- 2 Fuel prefilter**
- 3 Oil filter cartridge**
- 4 Intake manifold**
- 5 Engine speed regulation**
- 6 Engine regulating cylinder**
- 7 Cylinder head cover**
- 8 Fan drive**
- 9 Alternator**
- 10 Dual thermostat**
- 11 Oil dipstick**
- 12 Starter**
- 13 Turbocharger**



**6-cylinder V-engine**

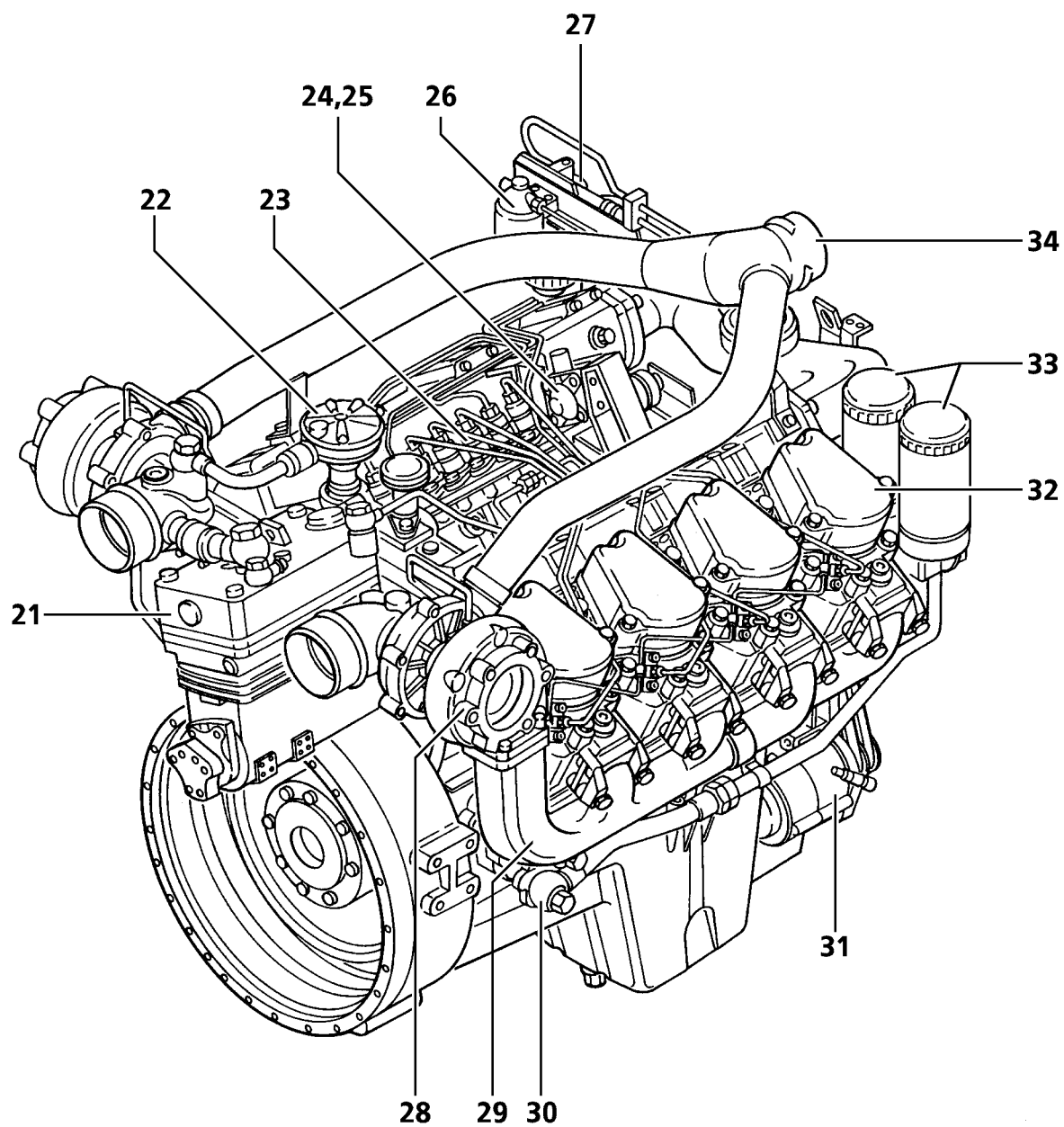
- 21 Air compressor**
- 22 Oil separator**
- 23 Fuel injection pump**
- 24 Intake manifold**
- 25 Flywheel housing**
- 26 Turbocharger**
- 27 Heat exchanger**
- 28 Cylinder head cover**
- 29 Alternator**
- 30 Oil filler neck**
- 31 Oil filter cartridges**





**8-Cylinder V-engine**

- 1 Oil filter element**
- 2 Intake manifold**
- 3 Engine speed regulation**
- 4 Engine regulating cylinder**
- 5 Fuel injection pump**
- 6 Oil separator**
- 7 Air compressor**
- 8 Dual thermostat**
- 9 Fuel filter**
- 10 Oil pressure switch**
- 11 Oil dipstick**
- 12 Starter**
- 13 Oil filler neck**
- 14 Cylinder head cover**
- 15 Turbocharger**



**8-Cylinder V-engine**

- 21 Air compressor**
- 22 Oil separator**
- 23 Fuel injection pump**
- 24 Engine regulating cylinder**
- 25 Engine speed regulation**
- 26 Fuel prefilter**
- 27 Fuel filter**
- 28 Turbocharger**
- 29 Exhaust pipe**
- 30 Heat exchanger**
- 31 Alternator**
- 32 Cylinder head cover**
- 33 Oil filter element**
- 34 Intake manifold**

TECHNICAL DATA		D 9306 TI	D 9308 TI
Exhaust emission		EURO 1	EURO 1
Model		6-cyl. turbocharged	8-cyl. turbocharged
Bore - diameter Ø	mm	130	130
Piston stroke	mm	150	150
Displacement, total	cm <sup>3</sup>	11 946	15 928
Firing order		1 - 6 - 3 - 5 - 2 - 4	1 - 8 - 4 - 2 - 7 - 3 - 6 - 5
Compression ratio		15,5 : 1	15,5 : 1
Compression pressure at starter speed	bar	18 ... 26	18 ... 26
Direction of rotation, when viewed looking at the flywheel		left	left
Flywheel housing		SAE 1	SAE 1
Cooling		Water circulation	Water circulation
Fuel-injection pump	Type	in-line injection pump	in-line injection pump
Weight of engine, dry, without cooling system	kg	approx. 1020	approx. 1300
ENGINE TUNE-UP SPECIFICATIONS		D 9306 TI	D 9308 TI
Valve clearance, Intake cold	mm	0.25	0.25
Valve clearance, Exhaust cold	mm	0.30	0.30
Begin of delivery	°KW v OT	15° ± 1°	15° ± 1°
Opening pressure of fuel injector nozzles			
new	bar	225 <sup>+8</sup>	225 <sup>+8</sup>
in operation	bar	217 <sup>+8</sup>	217 <sup>+8</sup>
OUTPUT RATINGS		according to ECE R 24/03	according to ECE R 24/03
Engine output	kW	270	360
Rated speed (RPM)	min <sup>-1</sup>	2100	2100
RPM (med. -max.)	min <sup>-1</sup>	1400	1400
Max. torque	Nm	1575	2050

TECHNICAL DATA		D 9406 TI	D 9408 TI
Exhaust emission		EURO 2	EURO 2
Model		6-cyl. turbocharged	8-cyl. turbocharged
Bore - diameter Ø	mm	135	135
Piston stroke	mm	150	150
Displacement, total	cm <sup>3</sup>	12 882	17 177
Firing order		1 - 6 - 3 - 5 - 2 - 4	1 - 8 - 4 - 2 - 7 - 3 - 6 - 5
Compression ratio		17,2 : 1	17,2 : 1
Compression pressure at starter speed	bar	20 ... 28	20 ... 28
Direction of rotation, when viewed looking at the flywheel		left	left
Flywheel housing		SAE 1	SAE 1
Cooling		Water circulation	Water circulation
Fuel-injection pump	Type	in-line injection pump	in-line injection pump
Weight of engine, dry, without cooling system	kg	approx. 1020	approx. 1300
ENGINE TUNE-UP SPECIFICATIONS		D 9406 TI	D 9408 TI
Valve clearance, Intake cold	mm	0.25	0.25
Valve clearance, Exhaust cold	mm	0.30	0.30
Begin of delivery	°KW v OT	14° ± 1°	16° ± 1°
Opening pressure of fuel injector nozzles			
new	bar	225 <sup>+8</sup>	225 <sup>+8</sup>
in operation	bar	217 <sup>+8</sup>	217 <sup>+8</sup>
OUTPUT RATINGS		according to ECE R 24/03	according to ECE R 24/03
Engine output	kW	300	400
Rated speed (RPM)	min <sup>-1</sup>	2100	2100
RPM (med. -max.)	min <sup>-1</sup>	1400	1400
Max. torque	Nm	1700	2250



TECHNICAL DATA		D 9406 TI-E	D 9408 TI-E
Exhaust emission		EUROMOT 1	EURO 2
Model		6-cyl. turbocharged	8-cyl. turbocharged
Bore - diameter Ø	mm	135	135
Piston stroke	mm	150	150
Displacement, total	cm <sup>3</sup>	12 882	17 177
Firing order		1 - 6 - 3 - 5 - 2 - 4	1 - 8 - 4 - 2 - 7 - 3 - 6 - 5
Compression ratio		17,2 : 1	17,2 : 1
Compression pressure at starter speed	bar	20 ... 28	20 ... 28
Direction of rotation, when viewed looking at the flywheel		left	left
Flywheel housing		SAE 1	SAE 1
Cooling		Water circulation	Water circulation
Fuel-injection pump	Type	in-line injection pump	in-line injection pump
Weight of engine, dry, without cooling system	kg	approx. 1020	approx. 1300
ENGINE TUNE-UP SPECIFICATIONS		D 9406 TI-E	D 9408 TI-E
Valve clearance, Intake cold	mm	0.25	0.25
Valve clearance, Exhaust cold	mm	0.30	0.30
Begin of delivery	°KW v OT	see engine rating plate	see engine rating plate
Opening pressure of fuel injector nozzles			
new	bar	225 <sup>+8</sup>	225 <sup>+8</sup>
in operation	bar	217 <sup>+8</sup>	217 <sup>+8</sup>
OUTPUT RATINGS		according to ISO 9249	according to ECE R 24/03
Engine output	kW	300	420
Rated speed (RPM)	min <sup>-1</sup>	1900	2100
RPM (med. -max.)	min <sup>-1</sup>	1400	1500
Max. torque	Nm	1710	2300

## Operation

### Starting the engine and turning it off

For procedure to start the engine if temperatures are below freezing, refer to the chapter describing the "Cold Season Operation".

Open the shut off valve (if installed) on the fuel tank. Insert the ignition key (refer to the Crane Operating Instructions ). The battery charge indicator light must turn on.

Start the engine by turning the ignition key.

If the engine does not start after approximately 5 seconds, slowly press the gas pedal all the way down.

If necessary, interrupt the starting procedure after approximately 20 seconds and then repeat the starting procedure after approximately one minute.

The starter should only be cranked three times for 20 seconds per starting procedure, with a 1 minute break in between.

Immediately after the engine starts, observe the oil pressure gauge. If no oil pressure is shown , turn the engine off immediately, to prevent engine damage.

**CAUTION:** The AC generator is essentially different from the DC generator. Therefore, the following points must be observed:

1. The AC generator must always be connected to the batteries during operation. As long as the engine is running, never remove or interchange a generator cable nor a battery terminal nor the plug of the regulator.
2. The batteries may only be charged with a rapid battery charger if the positive and negative terminals have been loosened or removed.
3. For any welding operation anywhere on the crane or chassis with an arc welder, the ground terminal must be connected directly to the part to be welded. The negative and positive battery terminals must be disconnected from the battery!

### Turning the engine off

Relieve the engine load, slowly reduce the engine speed with the throttle control lever to prevent the coolant from heating up, then let the engine run at low idle speed. This is especially important for turbocharged engines, since it allows the turbocharger, which runs at high speed, some time to slow down. If the engine would be stopped abruptly, the turbocharger would continue to run for some time without oil supply.

Stop the engine by actuating the shut off solenoids (engine shut off button depends on engine model) .



**Engine operation**

The gauges and indicators, such as engine oil pressure gauge, coolant temperature gauge, RPM gauge etc. should be checked regularly.

From time to time, check the fuel, lube oil and coolant lines as well as the intake and exhaust lines and pipes **for leaks**.

During continuous operation, every 10 hours, turn the engine off and check the **lube oil level** in the oil pan, if necessary, add oil. The dipstick is calibrated to the standard engine installation position.

Keep an eye on the **vacuum indicator** for the dry air filter. If the red range in the vacuum indicator becomes visible, then the filter element must be cleaned. (Refer to the chapter describing this procedure: "Maintenance of Dry Air Filter").

The **low idle speed** is 700 RPM. When the crane is supported with outriggers, the RPMs may be increased to 1500 RPM.

**Fuel level**

Do not run the engine until the fuel tank is empty, since contaminants in the bottom of the tank can be drawn into the fuel system, necessitating it to be cleaned and bled.

From time to time, drain off any water or other contaminants in the bottom of the fuel tank.

**The engine must be turned off immediately :**

- if the engine oil pressure drops or fluctuates severely,
- if the engine power or engine speeds drops without a change in the position of the throttle control lever,
- if the exhaust is smoking excessively,
- if the coolant temperature increases,
- if any abnormal noise can be heard coming from the engine or turbocharger.

**Cold season operation**

Before the start of the cold season, check the following instructions for operating fluids and starting procedure:

**Fuel:** refer to chapter **LUBRICANTS AND SERVICE FLUIDS**

**Lubricants:** refer to chapter **LUBRICANTS AND SERVICE FLUIDS**

**Coolant:** refer to chapter **LUBRICANTS AND SERVICE FLUIDS**

During the cold season, special attention must be paid to the batteries. Always try to maintain a full battery charge through careful battery maintenance and lower power consumption. The starter capacity is greatly reduced in low temperatures; for example, at - 10 °C, the starter functions only at approximately 60% of its normal capacity. Therefore, during the cold season, after the engine has been turned off, the batteries should be removed and stored in a heated area, such as a garage.

**Starting procedure if ambient temperatures are below -25 °C (-13 °F)**

Under extremely low temperatures, the engine should be preheated to assure proper engine start and sufficient engine oil lubrication. If requested by the customer, engines can be equipped with connections for preheater units for use in extremely cold regions.

- Contact the Liebherr-Werk Ehingen for further information.

**Starting procedure if ambient temperatures are below 0 °C (32 °F)**

- see next page

## Cold season operation

### Starting the engine with the flame glow starting device

At temperatures below freezing, always start the engine by using the flame glow plug. Adjust for the longer preheat time. This will not only reduce the start limit temperature, but also makes the engine easier to start at temperatures which actually do not yet require a starting aid. Starter soot emission can be prevented by using the flame glow plug for every starting procedure.

The flame glow starting device heats the combustion air by burning small quantities of fuel with a flame glow plug on the front of the suction tube. The flow of fuel from the fuel injection pump is controlled by an electronic control via a solenoid valve.

- Note:**
- a) If the engine oil temperature is above +20 °C (68 °F), then the flame glow system is turned off automatically!
  - b) If the flame glow plug is not functioning properly, the preheat indicator light does **not** light up.

### Starting procedure with ambient temperatures below 0 °C (32 °F)

#### 1. Preheating

Turn the ignition key to position "1" (travel) to begin a preheat time of approximately 40 to 50 seconds. The preheat time is indicated to the operator by an indicator light, which lights up on the instrument panel.

If the starting procedure is already initiated during the preheat time, preheating is automatically interrupted. (In this case, repeat the preheat procedure.)

#### 2. Starting the engine

After the preheat time, the indicator light on the instrument panel begins to flash and the engine is ready to start for about 30 seconds. Continue to turn the ignition key to position "2" (Start) to start the engine.

If the engine is not started within this readiness period, starting readiness automatically lapses. (In this case, repeat steps 1 and 2.)

Engine oils

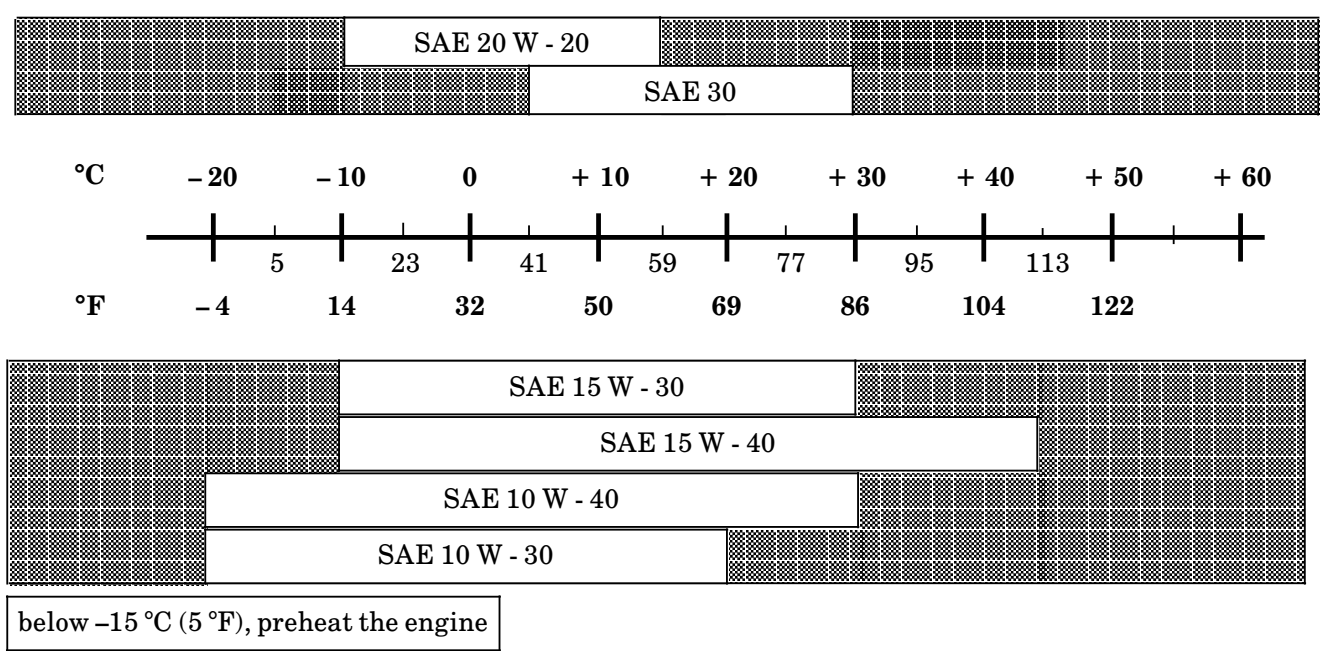
1. Oil change intervals

		Oil change intervals Naturally aspirated engine		Oil change intervals Turbocharged engine	
Operating cond. ambient temp.	Sulfur content of fuel	Oil / Grade CC	Oil / Grade CF-4/CF/CE/D4	Oil / Grade CF-4/CF/CE/D4	Oil / Grade SHPD / D5
to -10 °C (14 °F)	up to 0.5%	250 hrs.	500 hrs.	250 hrs.	500 hrs.
to -10 °C (14 °F)	above 0.5%	125 hrs.	250 hrs.	125 hrs.	250 hrs.
below -10 °C (14 °F)	up to 0.5%	125 hrs.	250 hrs.	125 hrs.	250 hrs.
below -10 °C (14 °F)	above 0.5%	-	125 hrs.	-	125 hrs.

2. Oil Quality / Grade

- CC / CF-4 / CF / CE : API classification (American Petroleum Institute)
- D4 / D5 : ACEA (CCMC) Association des Constructeurs Européens de l'Automobile
- SHPD : Super High Performance Diesel Oil
- CC : MIL-L-2104B / MIL-L-46152B / MIL-L-46152D
- CF-4 / CF / CE / D4 : MIL-L-2104E

3. Oil viscosity



## Engine oils

### 1. Oil change intervals

The first oil and filter change should be carried out between 50 and 100 operating hours. Subsequent filter changes should occur every 500 operating hours, however, at least once a year.

Change the oil according to operating conditions and oil quality, in accordance with the chart shown on the opposite page. However, the oil must be changed at least once a year.

It is not permitted to extend the oil change intervals by using partial flow filters!

For **quantities**, refer to the MOBILE CRANE operating manual.

### 2. Oil quality / specification

For modern Diesel engines, only highly alloyed lube oils are used today. They consist of basic oils and additives.

The lube oil specifications for LIEBHERR Diesel engines is based on CCMC specifications, API classification and / or US military specifications.

Depending on the engine type and the amount of load it is subjected to, certain minimum standards must be met, some superior quality oils might permit an extension of oil change intervals.

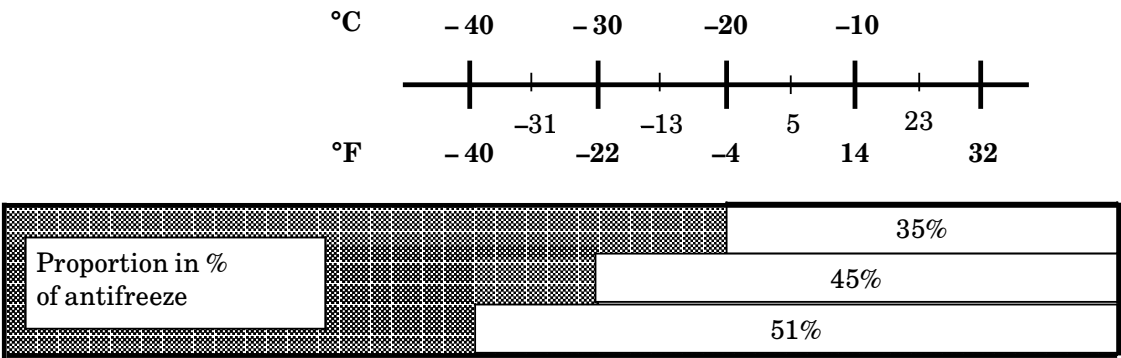
If extended oil change intervals are desired, oil qualities above the CF-4 / CF / CE / D4 classification are available, for example SHPD / D5.

### 3. Oil viscosity

In addition to oil specification, the oil must also conform to a certain viscosity which is determined by the ambient temperature surrounding the engine. The selection is made according to SAE classifications (Society of Automotive Engineers).

A viscosity which is too high can lead to starting difficulties, a viscosity which is too low can endanger the efficiency of engine lubrication.

The temperature ranges shown in the chart on the opposite page are merely guidelines and operation above or below these values is permitted for a short period only!



### Coolant

Use only clean, soft water for the coolant mixture. Often, but not always, drinking water meets these requirements. Sea water, brackish water, brine and industrial water is not suitable.

To assure the corrosion protection of the coolant system, a year round mixture of at least 50% corrosion preventative and antifreeze fluid and 50% water is specified, it assures freeze protection to approximately minus 35 °C (-31 °F).

If temperatures fall below those temperature ranges, the corrosion / antifreeze ratio must be increased as shown on the chart on the opposite page.

**CAUTION:** The percentage of corrosion preventative / antifreeze fluid should not exceed 60%, a higher concentration will adversely affect freeze protection and heat transfer rates.

The chart on the opposite page shows the various mixture ratios.

If any antifreeze fluid has been lost and fluid is added, it must be ensured that the ratio of 50% is retained.

During regular maintenance, the ratio of the coolant mixture must be checked.  
The coolant must be drained and replaced every 2 years.

Regarding corrosion preventatives / antifreeze fluids, **only** LIEBHERR approved corrosion preventatives and antifreeze fluids may be used (refer to the MOBILE CRANE operating manual).

In exceptional cases, and if ambient temperatures constantly remain above freezing, such as in tropical regions, where there is no corrosion preventative / antifreeze fluid available, the following mixture may be used as coolant:

99% water and  
1% additive (corrosion protective oil).

Mixing procedure for adding coolant:

First add water, then the corrosion preventative. The coolant additive should be premixed in a small container and then added to the circulating coolant.

The fluid can also be mixed in commercially available mixing units.

For a first time mixture or when filling the coolant system after it has been drained or cleaned, an oil content of 1 to 1.5% has proven itself.

When using coolant refiners, always read and observe the manufacturer's guidelines!

The concentration must be checked during regularly scheduled maintenance work, the oil content may not drop below 1%.

**IMPORTANT:** When using coolant refiners, the coolant must be changed once a year.

When using coolant refiners, no glycol based antifreeze fluids or other antifreeze fluids may be used at the same time.

Before changing from corrosion preventative / antifreeze fluid to coolant refiners, the total coolant and heating circuit must first be flushed with water.

**Coolant filling quantity:** refer to MOBILE CRANE operating manual.





**Diesel fuels**

The Diesel fuel must meet the minimum specifications, as listed below. The sulfur content in the fuel must not exceed 0.5%.

A higher sulfur content can affect oil change intervals and engine service life.

**Permitted fuel specifications:**

**DIN EN 590**

**Nato Codes F 54, F 75**

**BS 2869 : A1 and A2**

**ASTM D 975 - 88 : 1 D and 2 D**

**CAUTION:** DO NOT add fuel to the mobile crane if the engine is running. The engine must be turned off before refueling!

**Diesel fuels in cold climates:**

When ambient temperatures are below 0 °C (32 °F), Diesel fuels normally used during the summer months may suffer a decline in fluidity due to paraffin separation. The same occurs if Diesel fuels normally used during the winter are used at temperatures below -12 °C (14 °F).

In order to prevent operating problems at these low temperatures, the Diesel fuel must be mixed with regular gasoline or petroleum.

Mixing regular gasoline should be considered as a last resort, and under no circumstances should the ratio of gasoline exceed 30%. Do not mix Super gasoline with regular gasoline.

Depending on the ratio of Diesel fuel to gasoline or petroleum, engine output may somewhat decline. For that reason, taking the ambient temperature into account, keep the amount of regular gasoline you add to the Diesel fuel as low as possible.

For safety reasons, mix the fuel only in the fuel tank. Add the specifically lighter regular fuel before adding the Diesel fuel. Then run the engine long enough to run the fuel mixture throughout the total fuel system.

**Mixing ratio**

Ambient temperature [°C]	Summer Diesel fuel [%]	Normal fuel or Petroleum [%]	Winter Diesel fuel [%]	Normal fuel or Petroleum [%]
0 to -10	70	30	100	-
-10 to -15	50	50	100	-
-15 to -20	-	-	70	30
-20 to -25	-	-	50	50 *

\* If an addition of 50% is necessary, use only petroleum (not regular gasoline)!

**Other Diesel fuel additives (flow improvers):**

Widely commercially available flow improvers also enhance Diesel fuel ability to perform reliably in cold climate conditions.

When using such flow improvers, closely follow the manufacturer's recommendations!

**Fuel tank capacity:** refer to MOBILE CRANE operating manual.



1	2	3	4	5	6	Maintenance Work	a	b	c	d	●	●●	●●●
x						Oil level in engine	x				1.		
x						Oil pressure	x						x
x						Coolant temperature and battery charge indicator light	x						x
x						Coolant level	x				9.		
x						Air filter vacuum indicator	x				10.		x
	x					Fluid level in battery (at least 1 × weekly)	x						x
	x					Water separator in fuel filter	x	x			4.		
	x					Dust collector of air filter		x			10.		
	x					Engine regulation and engine brake	x				12.		
		x				Radiator, pressure control valve (radiator cap), cooling fan	x	x	x		8.;13.		
		x				Heater connections and coolant hoses	x		x				x
		x				Fuel precleaner (or if performance drops)		x			6.		
	<sup>1)</sup>	x				Engine oil (first between 50 and 100 operating hours) *			x		2.		
	<sup>1)</sup>	x				Lube oil filter (at first oil change) 2 each			x		3.		
		x				Tension and condition of V-belt (as required)	x		x	x	11.		
		x				Valve play	x			x			x
			x			Fuel stage filter, stage 1			x		5.		
			x			Dry air filter			x		10.		
			x			Grease ring gear on flywheel	x		x				x
			x			Mounting of oil pan and engine support	x						x
			x			Mounting of intake and exhaust pipes	x						x
			x			Air intake line between air filter and engine	x						x
			x			Flame glow system (at the beginning of the cold season)	x	x					x
				x		Fuel stage filter, stage 2			x		5.		
				x		Injection valve (or if performance drops)	x		x	x			x
					x	Coolant with corrosion preventative and antifreeze			x		9.		
					x	Oil separator			x				x

**Intervals**

**1 : daily**  
**2 : every 100 hours**  
**3 : every 500 Hours (min. 1 × year)**  
**4 : also every 1000 hours**  
**5 : also every 2000 hours**  
**6 : also every 2 years**

**Procedure**

**a : check**  
**b : clean**  
**c : replace**  
**d : adjust**

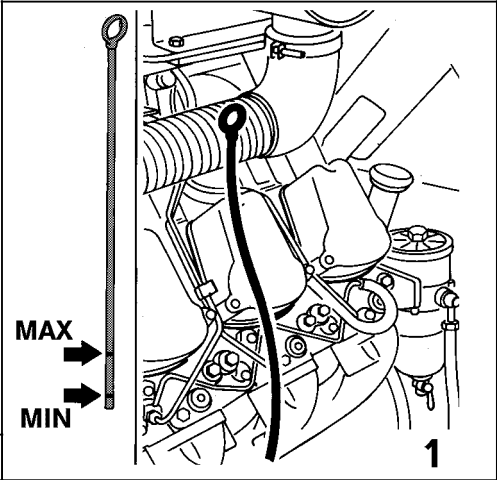
**Notes**

**● refer to chapter 4.02 paragraph ...**  
**●● refer to Service Manual "LIEBHERR" Engine**  
**●●● refer to MOBILE CRANE operating manual**

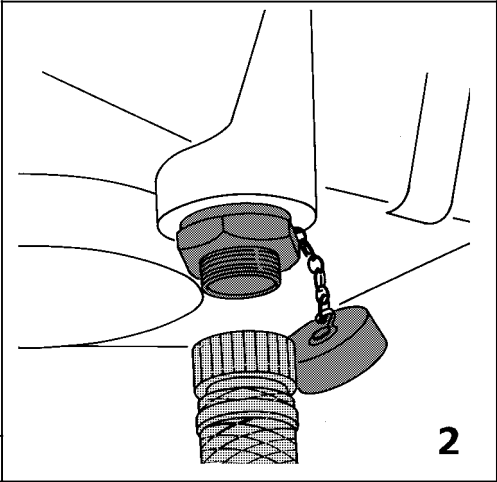
<sup>1)</sup> First and only maintenance interval

\* Pay attention to oil quality / grade, refer to chapter describing SERVICE FLUIDS

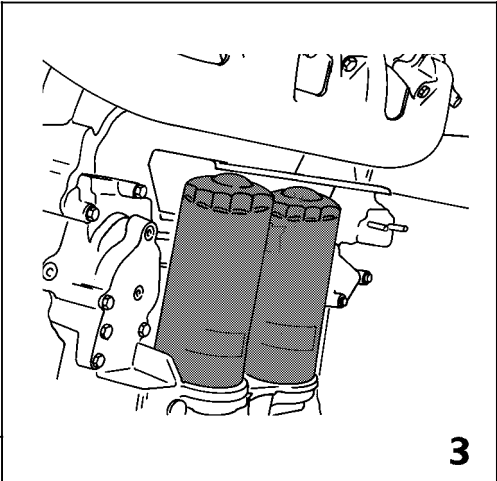
181494



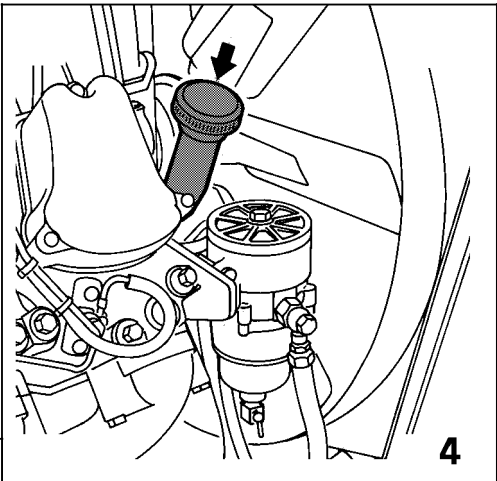
181495



181496



181497



**1. To check the oil level (fig. 1)**

- To check the oil level, the crane must be standing in horizontal position, on firm and level ground.
- Turn the engine off, wait 2 to 3 minutes, pull the dipstick out, wipe it off with a clean rag, reinsert the dipstick and pull it out again to check the oil level.
- If necessary, add more oil.

**Note:** The oil level must be between the MIN and MAX (minimum and maximum) mark on the dipstick.

- Never let the oil level fall below the lower (minimum) mark.

**2. To change the oil (fig. 2 and 4)**

- To change the oil, the engine must be warm, at operating temperature!
- Attach the drain hose (supplied in the tool kit), and drain the oil into an appropriate container.
- Close the oil drain plug again.
- Add oil to the top mark on the dipstick (See paragraph 1. for oil check procedure)

For oil specification: Refer to chapter OPERATING FLUIDS  
or chapter LUBRICATION CHART in the Operation and Maintenance Manual  
MOBILE CRANE.

Oil quantity: Refer to chapter CAPACITIES in the Operation and Maintenance Manual MOBILE  
CRANE.

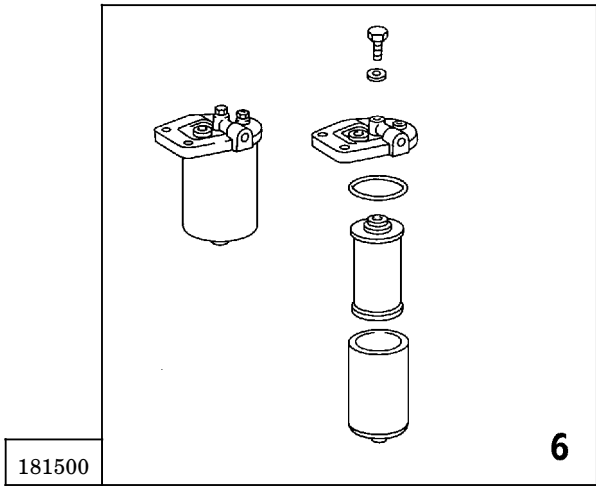
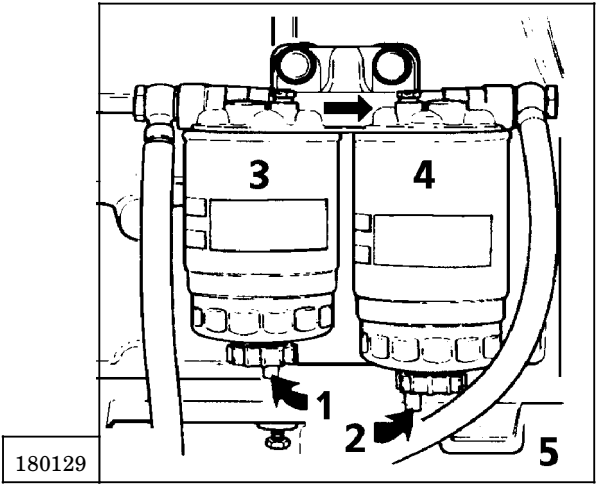
- Start the engine and check the oil pressure (refer to Operation and Maintenance Manual MOBILE CRANE)

**3. To change the oil filter (fig. 3)**

- Unscrew the lube oil filter cartridge.
- Clean the sealing surface on the filter mounting bracket.
- Lightly oil the rubber seal ring on the new filter cartridge and tighten the cartridge firmly, using both hands.

**Note:** Use only **Original LIEBHERR** filter cartridges.

- Start the engine, check for leaks and check the oil pressure.



**4. To clean the water separator (fig. 5)**

- Turn the water separator screws (1) and (2) to open.
- Drain off any water or condensation until clean fuel emerges, close the screws (1) and (2).
- Drain the water and / or fuel into an appropriate container and dispose of it properly.

**C A U T I O N:**     **Observe utmost cleanliness when performing any work on the fuel system!**  
**Flush all fuel lines before use!**

**5. To change the fuel filter (fig. 5)**

- Unscrew the fuel filter elements (3) and (4).
- Install new filter element, oil the rubber seal lightly.
- Bleed the fuel system.

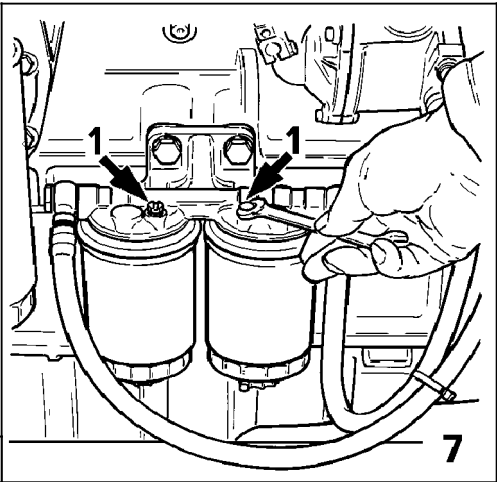
**Note:**             Use only **Original LIEBHERR** filter elements.

- Filter (3) = 1st stage
- Filter (4) = 2nd stage

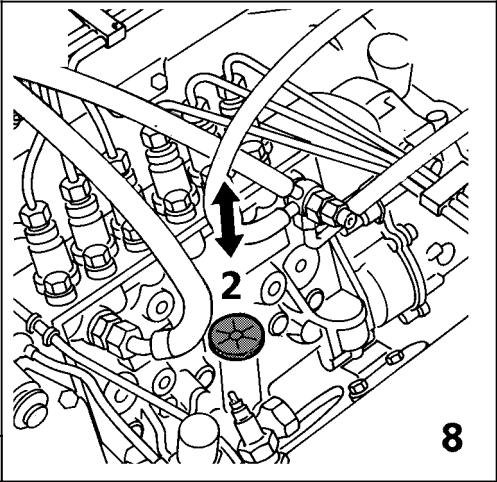
**6. To clean the fuel precleaner (fig. 6)**

- Close the shut off valve (if installed) on the fuel tank.
- Release the mounting screws.
- Remove the filter housing.
- Remove the filter and clean it in clean Diesel fuel, using a soft brush.
- Reinstall all parts.

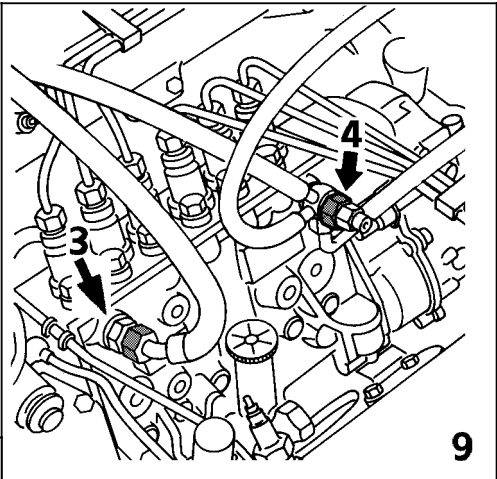
180131



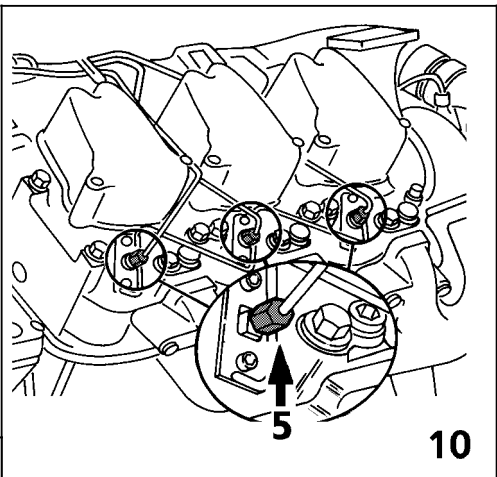
181486



181487



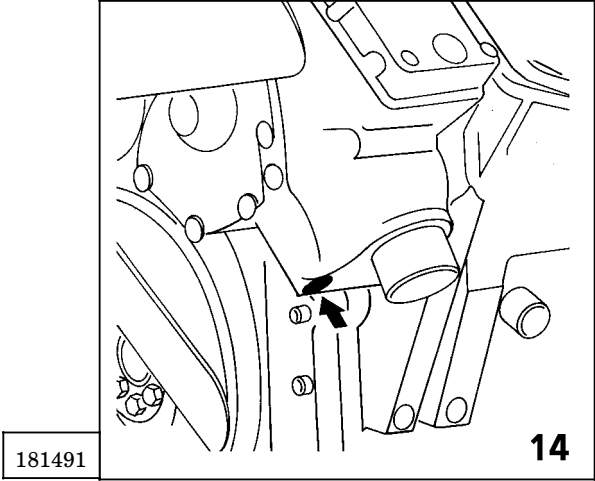
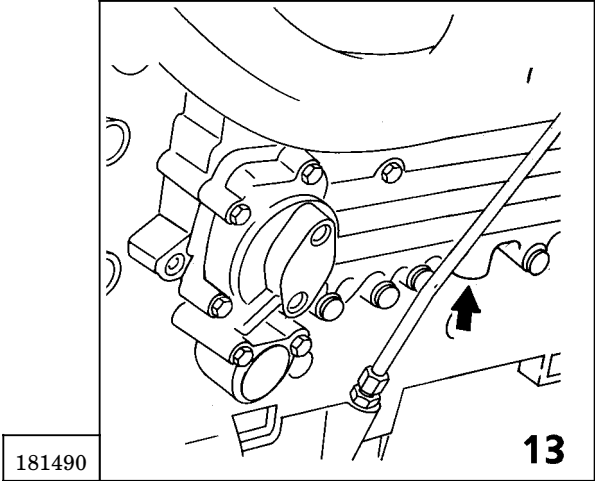
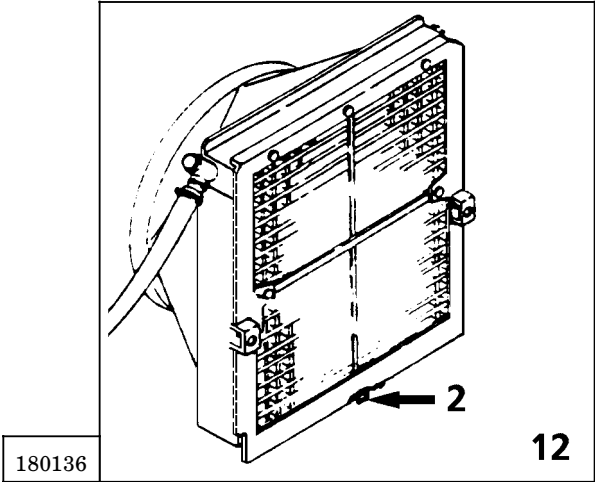
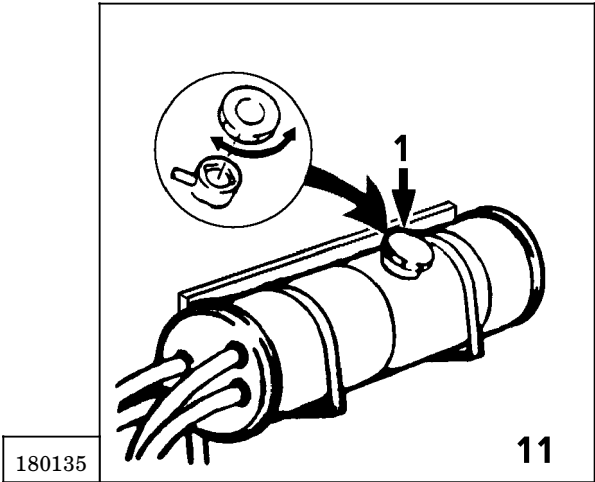
181488





**7. To bleed the fuel system (fig. 7, 8, 9 and 10)**

- Loosen the bleeder screw (1) on the top of the filter and turn it out about 2 to 3 turns (fig. 7).
- Release the hand pump (2) on the fuel pump by turning the rimmed knob until fuel that is free of any air bubbles (fig. 2) flows from the bleeder screw (1).
- Retighten the bleeder screw (1).
- Loosen the fuel line (3) on the injection pump (fig. 9)
- Actuate the hand pump (2) until there are no more air bubbles in the fuel, retighten the line (3).
- Loosen the leak oil return line with the overflow valve (4) (fig. 9)
- Actuate the hand pump (2) until there are no more air bubbles in the fuel.
- Retighten the overflow valve (4).
- Loosen the union nut on the injector valves (5) (fig. 10).
- Actuate the starter until there are no more air bubbles in the fuel.
- Retighten the union nut (5).
- Start the engine and repeat the bleeding procedure, if necessary.



**8. Radiator and expansion tank (fig. 11 and 12)**

- On the radiator: Clean the cooling circuit if necessary.
- On the expansion tank: Change the cap (1) with pressure relieve valve in case of leaks.

**CAUTION:** Open the cap (1) on the cooling system only if the coolant temperature is below 90 °C (194 °F) .

- Turn the cap until the first notch to release pressure.
- Continue to turn the cap until the second notch and then remove it.

**9. To change the coolant fluid (fig. 11, 12, 13 and 14)**

Replace the total fluid content in the complete cooling system every two years.

**Note:** Change the coolant only when the engine is cold.

**To drain the coolant**

- Move the heater lever to "WARM".
- Open the drain valve on the coolant line (line from the radiator to the water pump), on the radiator (if necessary), on the drain plug and on the heaters heat exchangers.
- Open the drain plug on the oil cooler housing on the engine (fig. 13) and on the coolant pump (fig. 14).

**CAUTION:** To completely drain the engine (for example, if the machine is placed out of service for a longer period of time), the coolant must also be drained from the coolant pump (fig. 14).

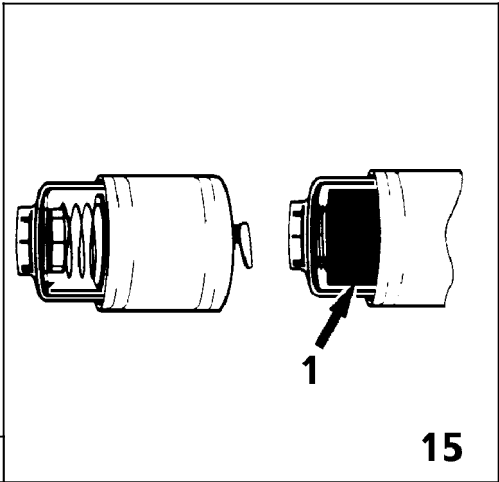
**To add coolant**

- Close the drain plug on the coolant line (line from the radiator to the water pump), on the radiator, on the drain plug and on the heaters heat exchangers.
- Set the heater lever to "WARM".
- Add coolant on the expansion tank, until the coolant fluid is visible in the filler neck (1) (fig. 11).
- Start the engine and let it run until it is at operating temperature.
- Recheck the coolant level. If necessary, add more coolant.
- For **quantity**, refer to chapter CAPACITIES in the Operation and Maintenance Manual of the MOBILE CRANE.

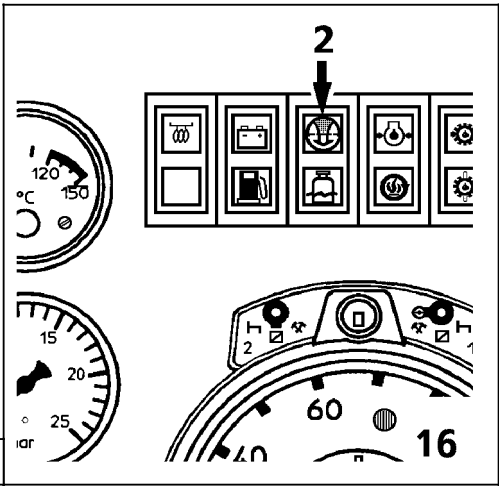
**CAUTION:** To assure the corrosion protection of the coolant system, the coolant fluid must contain at least 50% corrosion protective / Antifreeze fluid (refer to chapter SERVICE FLUIDS).

If the coolant system becomes contaminated, the complete system must be cleaned with a commercially available cleaner.

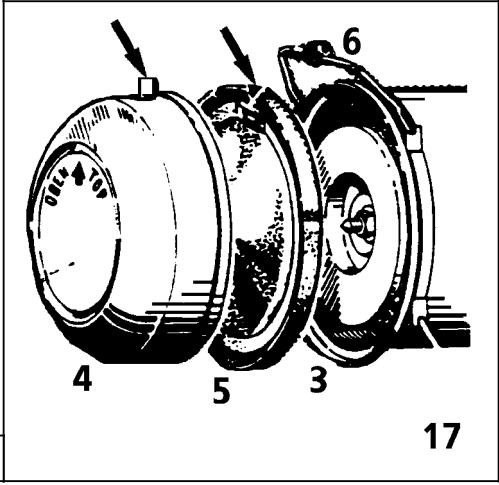
180139



180140



180141



## 10. Dry air filter (fig. 15, 16 and 17)

### Maintenance of the filter element

We strongly recommend to clean the filter element only when the maintenance indicator (fig. 15) or the vacuum indicator light (fig. 16) indicates so.

The filter element should therefore only be cleaned or replaced if necessary.

However, the element should be replaced once every 12 months or if the element has become contaminated.

**Note:** Use only **Original LIEBHERR** filter elements.

The filter element should be cleaned or replaced if the maintenance indicator remains in the red "service range" (1) when the engine is not running, or the yellow air filter indicator light (2) lights up when the engine is running.

Smoky exhaust fumes or declining engine power can also indicate that the air filter is dirty and requires cleaning.

### Dry cleaning procedure

Blow compressed air through the filter element (3) from the inside to the outside. The pressure on the nozzle (with an inside diameter of less than 3 mm) may not exceed 5 bar. Move the nozzle up and down while rotating the element, and hold it at a distance of at least 2 cm (1") from the element.

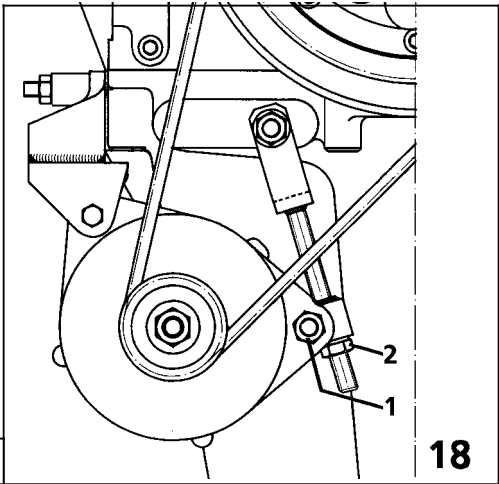
Cleaning is complete when no more visible dust escapes from the element. Wipe the filter housing and the sealing surface in the housing with a damp cloth. Do not blow out the housing with pressurized air!

**CAUTION:** The service life of the paper element depends on the timely cleaning of the dust collector (4). If this service is not performed properly and in a timely manner, dust quickly builds up in the element. For that reason, dust should never be allowed to accumulate to fill more than half of the area in the dust collector (4). If necessary, when working in dusty conditions for example, it might become necessary to empty the dust collector daily.

### To empty the dust collector

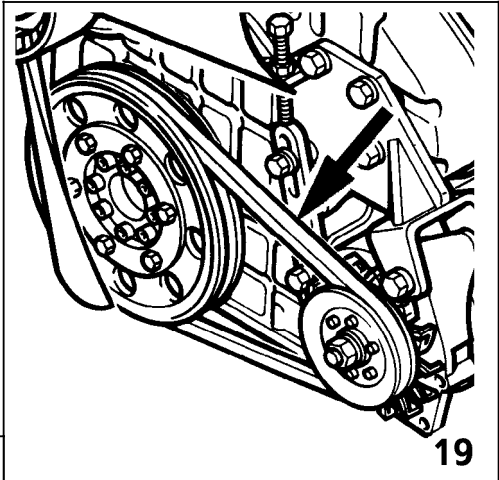
- Turn the engine off.
- Fold up the retainer bar (6) and remove the dust collector (4) together with the cover (5).
- Remove the cover (5) from the dust collector (4) and empty the container.
- Reinstall it in reverse order; the recesses, see arrows, must mesh.)
- Make sure that the filter is positioned horizontally and pay attention to the mark "TOP".

181492



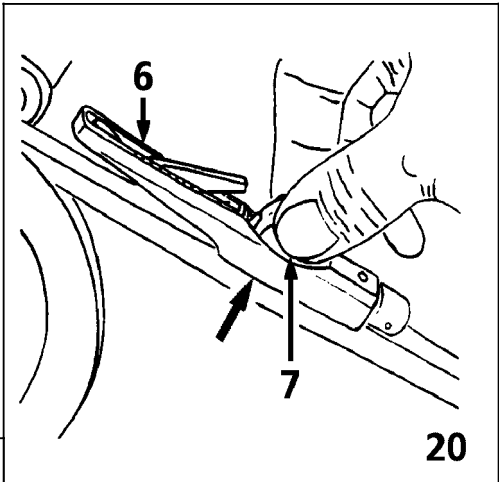
18

180143



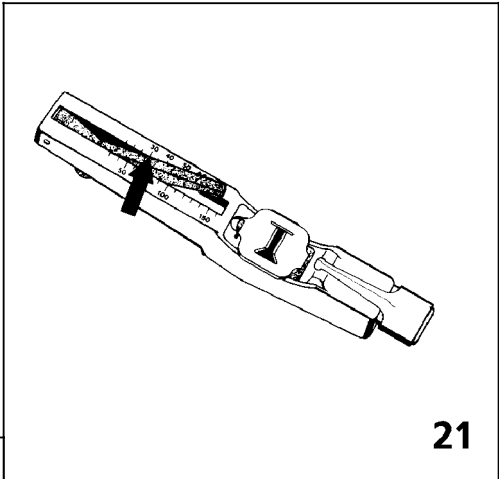
19

180144



20

181493



21

**11. V-belt****To change the V-belt (fig. 18)**

- Loosen the lock nut (1).
- Release the V-belt by turning the tension nut (2) to the right.
- Remove the V-belt over the pulley.
- Insert a new V-belt and turn the tension nut (2) to the left to tighten the V-belt to the proper tension.
- Retighten the lock nut (1).

**To check the V-belt tension by hand (fig. 19)**

The V-belt is tensioned correctly if, using your thumb, you can push down both V-belts in the center by approximately 10 mm (3/8").

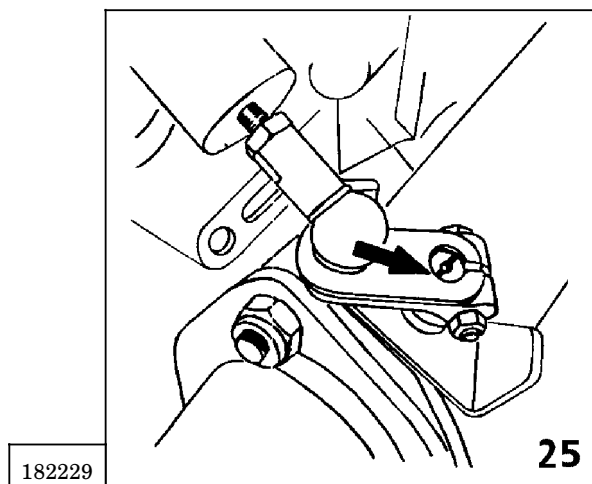
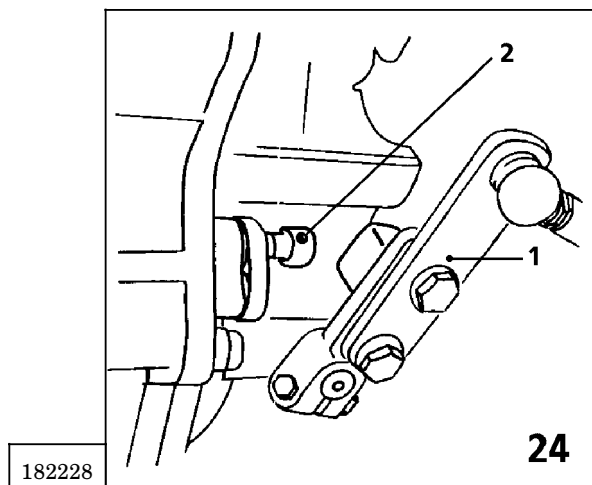
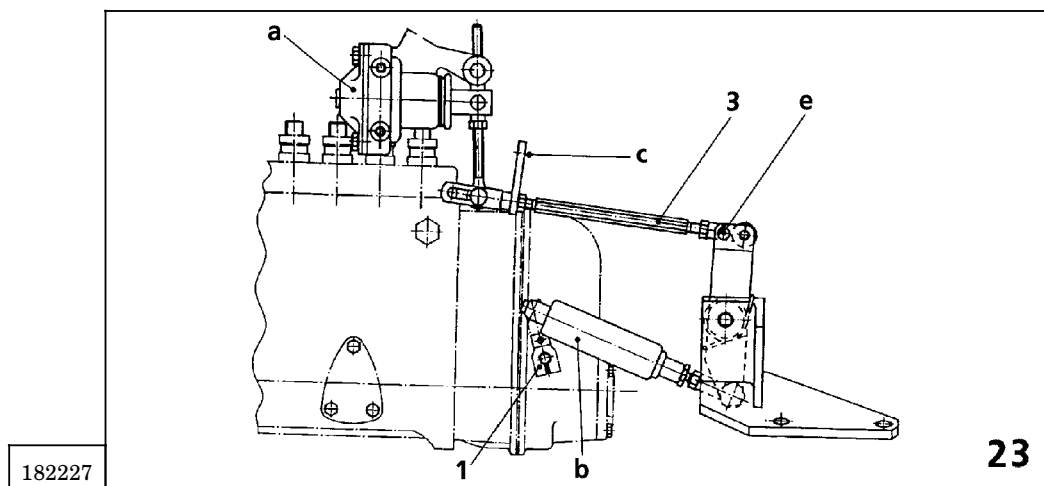
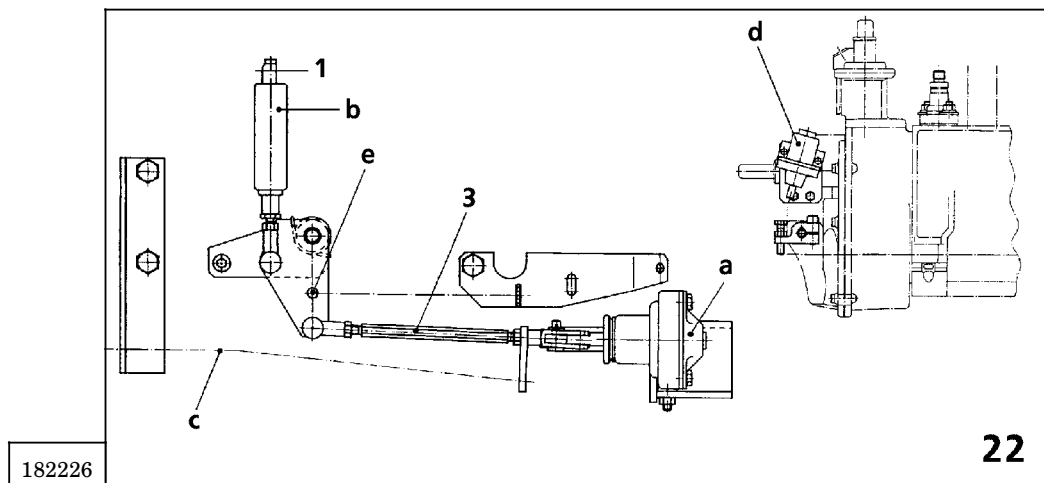
**To check the V-belt tension with the "Krikit" test unit made by Gates (fig. 20 and 21)**

- Push the indicator arm (6) in the test unit (fig. 20) down and set the test unit in the center of both V-belts, the stops must touch the sides of the V-belt.
- Press down the pressure button (7) evenly at a right angle to the V-belt until the spring is released.
- Carefully lift off the test unit and read the value on the "KG" scale and the indicator arm (see arrow, fig 21).
- Compare the test value with the chart below.

V-belt Profile width [mm]	New V-belt KG Scale	Used V-belt KG Scale
12.5	45	30 to 40

**To adjust the V-belt tension**

- Loosen the lock nut (1) (fig. 18).
- Adjust the tension nut (2) to the given V-belt tension value.
- Tighten the lock nut (1).
- Recheck the V-belt tension.





**12. Engine regulation (fig. 22, 23 and 24)****To check the regulating linkage on the injection pump**

Check the regulating linkage on the injection pump at full load, at idle and in stop position. When the foot pedal is fully depressed, the regulating lever (1) on the injection pump must fully touch the full load stop screw (2). If there is a gap between the regulating lever and the stop, then the linkage (3) must be adjusted. Lubricate the linkage and bearing points with a few drops of engine oil.

**Components:**

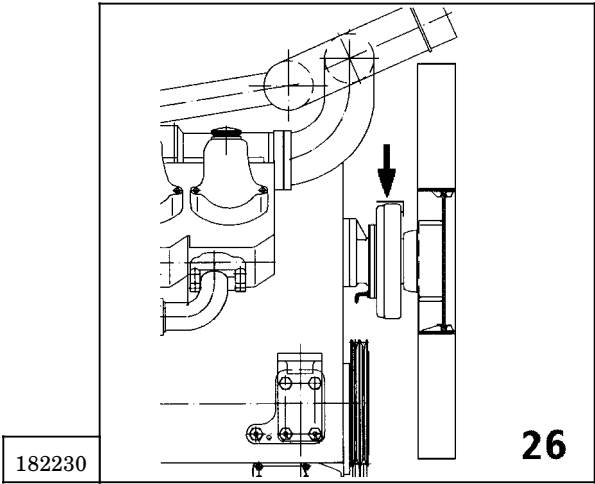
- a - Air regulating valve for engine regulation
- b - Return cylinder for engine regulation
- c - Throttle hand wire pull
- d - Air cylinder for engine RPM reduction during crane operation (only on machines with a Diesel engine)
- e - Modulator cords (only on machines with a automatic transmission)

**To check the regulating linkage on the engine brake (fig. 25)**

Check the linkage from the actuating cylinder for easy movement and lubricate the linkage with oil. Operate the brake flap. After operation, the flap must return to its original position without any problems.

This can be assured by checking the groove on the restrictor flap shaft. The groove must be positioned parallel to the exhaust pipe.

If the flap gets stuck, it causes the engine to overheat, increases fuel consumption and causes increased exhaust smoke.

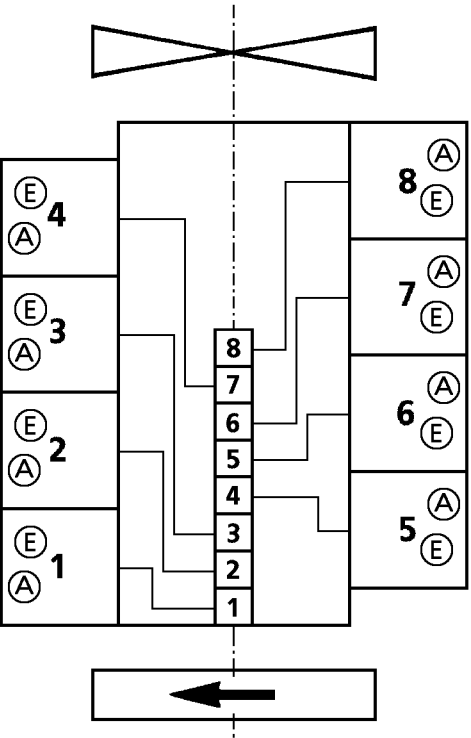
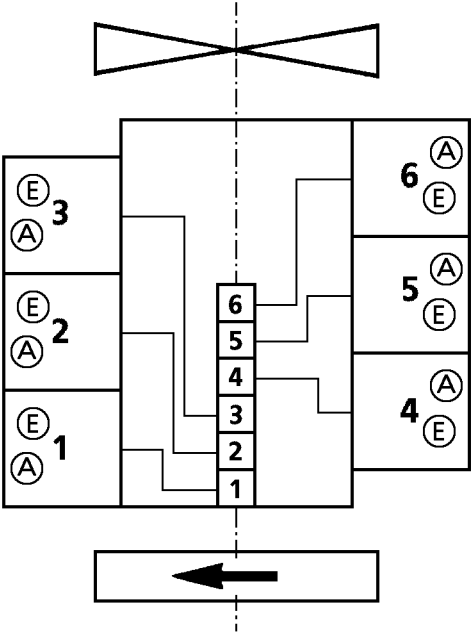


**13. Electromagnetic fan coupling (fig. 26)**

The integrated electromagnetic fan coupling is maintenance free. (It is only installed in the 6cylinder V-engine, type D 9306 T).

Should the electromagnetic fan coupling fail, then the coupling can be blocked mechanically.

- Tightly screw in the M 6×10 DIN 933-8.8 screw through the angle bar (see arrow) into the cooling fin ring.  
 $M_A = 10\text{Nm}$ .



14. Valve adjustment: E = Intake valve  
A = Exhaust valve

6-cyl. V-engine		8-cyl. V-engine	
overlap	adjustment	overlap	adjustment
5	1	7	1
2	6	3	8
4	3	6	4
1	5	5	2
6	2	1	7
3	4	8	3
		4	6
		2	5



**Details on maintenance**

Crane type: .....

Crane no.: .....

Engine type: .....

Engine no.: .....

Commissioned on: .....

Customer: .....

Town: .....

Street: .....

Liebherr Sales  
and Service Office: .....

Town: .....

Street: .....

Telephone/fax: .....

**Further notes:**

Service and maintenance play an important role in determining whether an engine is fully operative at all times and has a long service life.

We urgently recommend that the prescribed maintenance work be carried out carefully and in good time. Failure to comply with these instructions will affect claims made under guarantee. The lead seals at the fuel-injection pump and speed governor must never be removed!

Duly executed maintenance work must be entered and confirmed in the following maintenance chart.

- Note:**
1. Maintenance work specified as necessary on a daily or 100 operating hour basis must be carried out by the customer's service personnel.
  2. The first oil and oil filter change (after 50 to 100 operating hours) and all further upkeep must be carried out by a contracted fitter who has been trained by Liebherr.

every 500 hours / at least once a year

Operating hrs.	Date	Fitter	Signature	Comment
50 till 100 *				
500				
1 000				
1 500				
2 000				
2 500				
3 000				
3 500				
4 000				
4 500				
5 000				
5 500				
6 000				
6 500				
7 000				
7 500				
8 000				
8 500				
9 000				
9 500				

\* **only** oil and filter change (first-time)

**C A U T I O N :** When running the engine under difficult operating conditions or if using low-grade engine oils (see FUELS chapter), the specified oil and oil filter change interval must be halved.



every 500 hours / at least once a year

Operating hrs	Date	Fitter	Signature	Comment
10 000				
10 500				
11 000				
11 500				
12 000				
12 500				
13 000				
13 500				
14 000				
14 500				
15 000				
15 500				
16 000				
16 500				
17 000				
17 500				
18 000				
18 500				
19 000				
20 000				

**CAUTION:** When running the engine under difficult operating conditions or if using low-grade engine oils (see FUELS chapter), the specified oil and oil filter change interval must be halved.

additionally every 1000 / 2000 operating hours

Operating hrs.	Date	Fitter	Signature	Comment
1 000				
2 000				
3 000				
4 000				
5 000				
6 000				
7 000				
8 000				
9 000				
10 000				
11 000				
12 000				
13 000				
14 000				
15 000				
16 000				
17 000				
18 000				
19 000				
20 000				

additionally every 2 years

Operating hrs.	Date	Fitter	Signature	Comment
2 years				
4 years				
6 years				
8 years				
10 years				
12 years				
14 years				
16 years				
18 years				
20 years				

Fault	Cause	Remedy
<b>1) Engine refuses to start</b>	Fuel tank empty	Fill fuel tank and deaerate fuel system
	Fuel preliminary filter clogged	Clean filter
	Fuel filter clogged, due to paraffin separation in winter	Replace fuel filter and deaerate fuel system Use winter fuel
	Fuel lines leaking	Check line connections for leaks and tighten screw fittings
	Starter defective	Remove and have tested or repaired in workshop
	Battery run down	Test and charge battery
	Electrical connections at battery, starter or ignition key loose	Check and tighten cable
	Flame starting device defective (at low temperatures)	Check solenoid valve and flame glow plug. Replace if necessary
<b>2) Engine starts briefly, then stops</b>	All sources listed under point 1), except for electrical faults and flame starting device	see point 1)
	Aerator in fuel tank filler cap blocked	Verschlußdeckel reinigen
<b>3) Engine runs erratically, fails periodically, or power is reduced</b>	All sources listed under points 1) and 2), except for electrical faults and flame starting device	siehe Punkt 1) u. 2)
	Air filter clogged	Clean filler cap
	Throttle valve for exhaust brake closed or jammed	Check throttle valve position
	Overflow valve at fuel-injection pump outlet does not maintain pressure	Check and change if necessary
	Valves in fuel supply pump leaking	Have fuel supply pump tested in workshop, and replace if necessary
	Charge-air cooler clogged	Clean charge-air cooler

Fault	Cause	Remedy
<b>3) Engine runs erratically, fails periodically, or power is reduced</b>	Charge-air pressure too low	Check exhaust-gas turbocharger
	Fuel-injection pump delivery start misadjusted	Check delivery start, and adjust if necessary
	Injection nozzles catch or do not atomize	Check, adjust or replace injection nozzles
	Fuel-injection pump delivery quality misadjusted or control rod jammed	Have fuel supply pump tested in workshop
	Throttle linkage not at full-load stop	Check and adjust throttle linkage
	Engine compression too low	Check valves, piston and cylinders and replace if necessary
<b>4) Exhaust emissions are black</b>	Air filter clogged	Clean air filter
	Leak in suction system	Check / change hoses or lines
	Throttle valve for exhaust brake closed or jammed	Check throttle valve position
	Injection nozzles defective or carbon-encrusted	Test, adjust or replace injection nozzles
	Fuel-injection pump delivery start misadjusted	Check delivery start, adjust if necessary
	Fuel-injection pump delivery quantity excessive	Have fuel-injection pump tested in workshop
<b>5) Exhaust emissions are blue</b>	Lubricating oil level in engine too high	Rectify oil level
	Lubricating oil penetrates combustion chamber and is burned Clearance between valve stem and guides too large, piston rings worn, broken or jammed, scuff traces on pistons and cylinder liners	Overhaul or exchange cylinder heads, replace pistons and cylinder liners
	Compressor-sided seal at exhaust-gas turbocharger defective	Check exhaust-gas turbocharger, exchange if necessary

<b>Fault</b>	<b>Cause</b>	<b>Remedy</b>
<b>6) Exhaust emissions are white</b>	Cylinder head seal defective and cooling water penetrates combustion chamber	Renew cylinder head seal
	Injection nozzles leaky or do not atomize completely	Renew cylinder head seal
<b>7) "Diesel knock" in engine</b>	Fuel-injection pump delivery start misadjusted	Check, adjust injection nozzles, replace if necessary
	Injection nozzles defective or carbon-encrusted	Check delivery start, adjust if necessary
<b>8) Engine knocks</b>	Injection nozzles defective or carbon-encrusted	Check, adjust and, if necessary, replace injection nozzles
	Piston rings worn or broken, pistons scuffed	Check pistons and cylinder liners, change if necessary
	Main bearing or connecting rod bearing defective	Renew or repair engine bearing
<b>9) Cooling water temperature too high</b>	Not enough water in cooling system	Add cooling water
	Air in cooling system	Deaerate cooling system
	External dirt accumulation on radiator	Clean radiator network
	Radiator internally clogged or calcified	Decalcify radiator
	Thermostats defective	Check thermostats, renew if necessary
	Coolant pump defective	Check coolant pump, repair or replace if necessary
	Fan defective	Check fan and replace if necessary
<b>10) Lubricating oil pressure too low</b>	Oil level in oil sump too low	Fill oil up to specified marking
	Lubricating oil viscosity too low	Drain oil and fill prescribed grade

<b>Fault</b>	<b>Cause</b>	<b>Remedy</b>
<b>10) Lubricating oil pressure too low</b>	Oil pressure gauge or pressure transducer defective	Check oil pressure and replace defective transducer or gauge
	Lubricating oil pressure pump defective	Replace lubricating oil pressure pump
	Shutoff valve at lubricating oil pressure pump blocked in open state	Check shutoff valve at lubricating oil pressure pump and replace if necessary
	Excessive bearing clearances due to wear or bearing damage	Renew or repair engine bearing
<b>11) Lubricating oil in cooling system</b>	Oil cooler or cooler plate leaky	Pinch off seal, replace if still leaky
	Cylinder head seals leaky	Renew cylinder head seals
<b>12) Cooling water in lubricating oil</b>	Cylinder head seals leaky	Renew cylinder head seals
	O-rings at cylinder liners leaky	Renew O-rings