

Operator's manual **Diesel engine**

D944 A7-05 / LWE From serial number 2018030001

www.liebherr.com



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Manufacturer's representative in the EU according to (EU) 2016/1628

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Change history

Preface

About the document

Content

This operator's manual describes the use, maintenance and technical data of Liebherr diesel engines.

Spare parts

Part information in this operator's manual (part numbers, thread sizes, dimensions) are informational. Order spare parts by means of the spare parts catalog included in the scope of delivery.

Lubricants and operating fluids

Only lubricants and operating fluids according to the Liebherr specification may be used for the operation of Liebherr diesel engines. Liebherr will cancel all possible obligations undertaken by Liebherr and/or its dealers, such as guarantee commitments, service agreements and others, without prior notice if lubricants and operating fluids other than those approved by Liebherr are used.

Usage instructions

If illustrations in this operator's manual have details that differ from your engine, perform the work concerned in accordance with this operator's manual. Additional information can be obtained via Liebherr customer service or as part of training courses at the Liebherr training academy. The service information released by Liebherr Machines Bulle SA serves as a supplement after the publication of the operator's manual.

Compliance

In accordance with US Regulation 40 CFR Part 1039 and 1068 (§1039.125 and §1068.110), the owner has the option to select any qualified repair shop for proper maintenance, replacement or repair of emission-related components with original parts or equivalent replacement parts. The owner is required to have warranty and recall services paid for by Liebherr performed by an authorized Liebherr dealer/service center.

This operator's manual contains the legally required information for end users in accordance with US Regulation 40 CFR Parts 1039 and 1068.

This operator's manual contains the legally required information for end users in accordance with EU Regulation (EU) 2017/654.

Warning notice according to the requirements of California Proposition 65.

\land WARNING

This product can expose you to chemicals including lead and lead compounds, which are known to the State of California to cause cancer.

For more information go to

www.P65Warnings.ca.gov

This product can expose you to chemicals including lead and lead compounds, which are known to the State of California to cause birth defects or other reproductive harm.

For more information go to www.P65Warnings.ca.gov

\land WARNING

Breathing diesel engine exhaust exposes you to chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

- Always start and operate the engine in a well-ventilated area.
- If in an enclosed area, vent the exhaust to the outside.
- Do not modify or tamper with exhaust system.
- Do not idle the engine except as necessary.

For more information go to www.P65warnings.ca.gov/diesel

Warning message according to the requirements of California Proposition 65

Graphic symbols in this manual

Symbol	Meaning	
	Note	
	Identifies useful information and tips.	
	Prerequisite	
	Identifies conditions for the following action steps.	
Call to action		
	Identifies action steps.	
	Result	
	Identifies results of one or more action steps.	
-	Itemization	
	Identifies individual points of a list.	

Graphic symbols

The colors and gray scales used in the graphics serve for delimitation and better differentiation of the components.

Changes, conditions, copyright

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1 Product description

1.1 Technical description

1.1.1 Engine components



Fig. 1: Ancillary support housing side

- **1** Torsional vibration damper
- 2 Air conditioning compressor (optional)
- **3** Tensioner (self tensioning)
- 4 Coolant pump
- 5 V-ribbed belt
- 6 Lifting eye
- 7 Oil filter

- 8 Cooler supply
- **9** Compensation tank supply
- **10** Exhaust manifold
- 11 Exhaust gas turbocharger
- 12 Exhaust gas stub
- 13 Oil cooler
- 14 Cooler return



Fig. 2: Flywheel side

- 1 Flywheel
- 2 Lifting eye
- **3** Cylinder head cover
- 4 Fuel fine filter
- **5** Crankcase breather system
- 6 Air intake manifold

- 7 Control unit
- 8 Heating flange
- **9** Alternator
- **10** Fuel high pressure pump
- 11 Oil pan
- 12 Cable harness

1.1.2 Exhaust aftertreatment system SCRFilter (single-flow)



Fig. 3: Exhaust aftertreatment system, diesel exhaust fluid pump and diesel exhaust fluid injector

- **1** Sensor pipe
- 2 Outlet module
- **3** Diesel exhaust fluid injector
- 4 Mixing pipe
- 5 Diesel oxidation catalyst (DOC)
- 6 Inlet module
- 7 Filter module

- 8 Nitrogen oxides sensor
- 9 SCR NH3 sensor
- **10** Control unit SCR NH_3 sensor
- **11** Temperature sensor
- **12** Diesel exhaust fluid pump
- **13** Differential pressure sensor

Diesel exhaust fluid pump



Fig. 4: Diesel exhaust fluid pump

- 1 Coolant outlet
- 2 Diesel exhaust fluid pressure sensor and temperature sensor
- **3** Coolant inlet
- 4 Diesel exhaust fluid connection from diesel exhaust fluid tank
- **5** Diesel exhaust fluid pump electrical connection
- **6** Diesel exhaust fluid pump
- 7 Inlet air connection

- 8 Switchover valve
- **9** Switchover valve electrical connection
- **10** Diesel exhaust fluid connection to mixing section
- **11** Air connection to mixing section
- **12** Air pressure sensor
- 13 Sensor block

Control unit SCR NH₃ sensor



Fig. 5: Control unit SCR NH₃ sensor

1 Control unit connection

2 SCR NH_3 sensor connection

Exhaust aftertreatment system control and warning lamps

The various states of the exhaust aftertreatment system are shown to the operator through the illumination of the corresponding control lamps in the display. The pictograms are examples and can differ in the various devices and depending on the exhaust aftertreatment system installed.

Lamp	Designation	Meaning
=	EESF lamp (Engine emission system failure)	Exhaust aftertreatment system malfunction or reduction agent tank fill level not OK
	MIL lamp (Malfunction Indi- cator Lamp)	
	Reduction agent lamp	
<mark>-≣3</mark>) -∰3)	Filter module lamp (filter module)	Illuminates depending on the soot load.

Technical description

Lamp	Designation	Meaning
U	AWL lamp (Amber Warning Lamp)	Action required during the next maintenance
бтор	RSL lamp (Red Stop Lamp)	Engine stop required
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		Manual interruption or termination of the regenera- tion
⇒ <mark>.</mark> , <b>F</b> .3,	<b>HEST lamp</b> (High Exhaust System Temperature)	High exhaust temperatures
*()*		Torque limitation to unload the exhaust gas after- treatment system.

Tab. 1: Exhaust aftertreatment system control and warning lamps

### Exhaust aftertreatment system warning and malfunction strategies

The exhaust aftertreatment with SCR (Selective Catalytic Reduction) describes a technique for the conversion or reduction of nitrogen oxides  $(NO_x)$  in the exhaust into nitrogen  $(N_2)$  and water  $(H_2O)$  by adding a reducing agent (urea solution).

The exhaust aftertreatment system is monitored by a diagnostics system. If the diagnostics system detects an error, a warning or malfunction strategy is activated.

Operating the device with a malfunction over several operating hours will have the result that the power limitation cannot be deactivated, even through an ignition change. A repair of the device is absolutely necessary. If an additional error detection takes place after resolving the problem, the limitations will be run through in a shorter period of time.



#### Note

The restrictions occur in stages.

Display (pictograms are e	examples)	System status	Restric- tions	Remedy
MIL off Reducing agent lights up yellow continuously.	Acoustic signal	Reduction agent level < 10 % or malfunction of exhaust aftertreat- ment system.	No restric- tion	Refill reduction agent. In case of malfunction, contact Liebherr customer service.

Display (pictograms are e	examples)	System status	Restric- tions	Remedy
MIL flashes or lights up yellow continuously Reducing agent lights up yellow continuously.	Acoustic signal	Reduction agent level < 5 % or malfunction of exhaust aftertreat- ment system	Low power limitation	
MIL flashes or lights up yellow continuously. Reducing agent flashes or lights up red continu- ously.	Acoustic signal	Reduction agent level < 2.5 % or malfunction of exhaust aftertreat- ment system	High power limi- tation	
MIL flashes or lights up red continuously. Reducing agent flashes or lights up red continu- ously.	Acoustic signal	Reduction agent level < 0 % or malfunction of exhaust aftertreat- ment system		

Tab. 2: Exhaust aftertreatment system warning and malfunction strategies

### **Stationary operation**

Note

The reduction agent tank is deemed empty as of a fill level of <2.5%.



Fig. 31: Warning and malfunction strategy sequence for low reduction agent level

1Reduction agent fill level3Available torque curveSee next page for continuation of the image legend3Available torque curve

2 Available torque



*Fig. 32: Warning and malfunction strategy sequence when errors occur in the exhaust aftertreatment system* 

- 1 Time elapsed
- 2 Available torque

- **3** Occurrence of the error
- **4** Torque reduction curve

#### **Driving operation**



#### Note

The speed limitation is only used for applications that are approved for road use.



Fig. 33: Warning and malfunction strategy sequence for low reduction agent level

1 Reduction agent fill level

**3** Speed curve

2 Available speed



Fig. 34: Warning and malfunction strategy sequence when errors occur in the exhaust aftertreatment system

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- 1 Time elapsed
- 2 Speed

- 3 Occurrence of the error Speed curve

#### Repeated occurrence of an error

A repeated occurrence of a malfunction is defined as two or more error messages with activated warning system, which occur within a period of 40 engine operating hours. The repeated occurrence of a malfunction applies for the recurrence of all error codes that trigger the warning system, with the exception of errors relating to the reduction agent level, and is not limited to the repetition of the same error code. The repeated occurrence of a malfunction leads to the final warning level being reached within 30 minutes.



Fig. 35: Time reduction of the warning and malfunction strategy sequence for repeated error detection

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- 1 Time elapsed in minutes
- 2 Available torque or speed (depending on application) in %
- Torque reduction curve for first error detection
- 4 Torque reduction curve for repeated error detection

### Use / handling of reduction agent

#### NOTICE

Escaping reducing agent!

Damage to painted surfaces or aluminum surfaces.

Rinse affected surfaces with water immediately.

#### NOTICE

Adding special additives and diluting the reducing agent (for example with tap water)! Legally prescribed emission limits are not observed. Destruction of the exhaust aftertreatment system!

- ► Keep the reducing agent absolutely pure.
- Make sure that no dirt gets into the reducing agent.
- Do not fill any operating fluids in the reducing agent tank.
- Do not fill any reducing agent in the diesel fuel tank.

#### NOTICE

Diesel fuel filled in the reducing agent tank or vice versa! Destruction of the engine or the exhaust aftertreatment system.

- ▶ Keep the reducing agent absolutely pure.
- Do not reuse reducing agent that has been drained.

#### NOTICE

Operation without reducing agent! Legally prescribed emission limits are not observed and power is severely limited. Operator is liable to prosecution.

- Operate the system with reducing agent.
- ▶ Refill the reducing agent on time.

The reducing agent consumption is based on the use of the vehicle. Refilling is not dependent on maintenance. The reducing agent tank fill level is shown via a tank display in the device cabin. For procedure or information on refilling, see documentation from the device manufacturer.

### Filter module

In order to reduce the soot particles in the diesel engine exhaust to a legally permissible level, a filter module is necessary. The filter module filters the soot particles in the exhaust gas flow and stores them. If the temperature of the exhaust gas flow is high enough, the stored soot particles in the filter are removed.

So that the filter module does not become clogged and the exhaust back pressure in the diesel engine does not get too high, the particles stored in the filter must be removed from time to time. This process is called regeneration.

Ash is produced through the running of the engine, which is deposited in the filter. It can only be removed by cleaning.

#### **Passive regeneration**

Depending on the design and load of the engine, the exhaust temperature is high enough to remove the soot particles during operation. No intervention is required by the engine or the user. This ideal condition is described as "passive regeneration".

#### Active regeneration

If too many soot particles are stored in the filter module, the back pressure in the exhaust gas flow increases. An "active regeneration" of the filter module is required to reduce the particle load.

For active regeneration, a distinction is made between

- automatic regeneration (device in driving condition)
- manual regeneration (device standstill)

Manual regeneration is initiated by the operator with the help of a switch.

The duration of the manual regeneration is approx. 45 minutes. Depending on the application, a fuel post-injection can be used in order to achieve the required exhaust temperature for the active regeneration. The injection quantity is regulated to achieve the exothermic reaction of the exhaust in the diesel oxidation catalyst. The soot particles in the filter module are thereby burned up and the filter module is regenerated.

#### **Regeneration switch**



Tab. 3: Symbols used for the regeneration switch differ depending on the application

The device operator can initiate the manual (active) regeneration using the regeneration switch. The engine speed is independently controlled by the engine control unit during this process and the device must remain at a standstill. The required regeneration time depends on the load condition of the filter module, the ambient temperature and the exhaust temperature. The normal regeneration time is approx. 45 minutes.



Note

Only initiate manual regeneration when it is required by the displays (illumination) of the filter

module lamp

Lamp	Meaning
<u>~</u> ??	Suppress or terminate the filter module regeneration Application in potentially flammable environments, for example
- <u>I</u> I-3>	Manual filter module regeneration is initiated

Tab. 4: Regeneration switch functions

#### Regeneration of the filter module

The filter module must be regenerated after a certain soot load.

The following table explains in which situations which types of regeneration can be initiated.

Zone	1	2	3	4	5
Indicator	1	2	3	4	5
Manual stand regeneration		Yes, but only us	se when absolut	ely necessary.	No, notify service tech- nician.

Technical description

Zone	1	2	3	4	5
Automatic high tempera- ture regenera- tion during operation	N	0	Yı	es	No, notify service tech- nician.
Driver can prevent the high tempera- ture regenera- tion			13 13		
RSL lamp		0	ff		бтор
Filter module lamp		Off		yellow/static	red/blinking
Torque limita- tion		0	ff		Torque limita- tion to 50%
Error text				8D/8C+D0077 "High soot load - perform regeneration soon"	8D/8C+D0078 "Critical soot load - notify service"

Tab. 5: Regeneration of the filter module

5000h since the last filter module replacement	6000h since the last filter module replacement	
	Permanent error (P13E2)	
Warning (P242F) is shown in the device display when the igni- tion is switched on	MIL lamp (illuminates.	
	Low power limitation	

Tab. 6: Ash load of the filter module

For optimum filter module operation, it is recommended not to interrupt a manually running regeneration. However, if there is a risk of fire, it is imperative that a manual regeneration is terminated.

## Cleaning hydrocarbon (HC) deposits

#### NOTICE

Fuel deposits in the exhaust aftertreatment system Damage to or destruction of the catalyst Replacement of the exhaust aftertreatment system outside the warranty

► Follow instructions for handling with accumulations of HC in the exhaust aftertreatment system.(→ 5.10.4 Troubleshooting hydrocarbon (HC) deposits, p. 138)

During operation of the engine with low load and low speed, HC particles may accumulate and deposit in the exhaust aftertreatment system. The operating range is therefore monitored and the engine idling speed is increased, if necessary.

The following errors can be displayed:

#### P339A-00:

- Warning of overloading of diesel oxidation catalyst and SCR element due to deposited hydrocarbon

#### P339B-00:

- Critical warning of overloading of diesel oxidation catalyst and SCR element due to deposited hydrocarbon
- Damage to or destruction of diesel oxidation catalyst and SCR element
- Reduction of the available torque to 50%.
- 2.5h after occurrence of the error: Reduction of the available torque to 25%, a regeneration is then no longer possible.

Procedure when an error occurs: ( $\rightarrow$  5.10.4 Troubleshooting hydrocarbon (HC) deposits, p. 138)

Lamp	Torque limitation	Display
U.	Torque limitation to 50%	Note to the operator through the device display.

Tab. 7: Cleaning HC deposits

## **1.1.3** Engine type itemization

En	Engine type designation						
D	94	4	A7	-05	Description		
D					Engine type: D = diesel engine		
	93 / 94				Family (l/cylinder): 93: 1.59 l/cylinder 94: 2 l/cylinder		
4				Number of cylinders			
A7		A7		Injection system: A7 = Common Rail System			
		-05	Emission standard: Stage V / Tier 4 Final Exhaust gas aftertreatment system: SCRFilter (Selective Catalytic Reduction with diesel particle filter)				

Tab. 8: Engine type designation

# 1.1.4 Company name plate



Fig. 51: Company name plate

- 1 Manufacturer
- 2 Data matrix code
- **3** US type approval information
- 4 Engine power at rated speed
- 5 Part number
- 6 Engine variant (Liebherr internal type)
- 7 Engine type
- 8 Capacity
- 9 Engine serial number
- 10 Manufacturing date

- **11** US performance category
- 12 EU exemption
- **13** Minimum requirements for fuel
- **14** EU type approval information
- **15** ECE type approval information
- **16** Chinese engine family
- **17** Chinese emission limit stage
- **18** Chinese type approval number
- 19 Liebherr

### Attachment point



Fig. 52: Company name plate on the crankcase and on the air intake pipe

Company nameplate on the crankcase
 Company nameplate on the air intake pipe

### Itemization of engine serial numbers

The engine serial number is engraved on the company nameplate in the field SERIAL NO..

2019	03	0001	Engine serial number
2019			Year of manufacture
	03		Type series: 03 = D944
		0001	Sequential production number

Tab. 9: Engine serial number

# 1.1.5 Firing order, cylinder designation and engine serial number



Fig. 53: Cylinder designation, engine serial number (example) and firing order

- 1 Engine serial number 3
  - **3** Cylinder designation

2 Firing order

# **1.1.6** Cylinder designation and direction of rotation



Fig. 54: Cylinder designation and direction of rotation

- 1 Driving end 2 Free end
- = Exhaust valve

🛨 = Intake valve

Viewed from the flywheel, the crankshaft turns counterclockwise.

6

## 1.1.7 Engine control unit type plate



Fig. 55: Engine control unit type plate (example)

- 1 Supplier number
- 2 Control unit serial number
- **3** Manufacturing date

- 4 Software version at delivery
- **5** Part number of control unit
- **6** Data matrix code



- Fig. 56: Mounting position
- 1 Company name plate on engine control unit

# 1.1.8 Exhaust aftertreatment system type plate

## Type plate



Fig. 57: Sample type plate

- 1 DMC code
- 2 Identification number
- **3** Serial number

- 4 Supplier part number
- **5** Date of manufacture



## DOC, mixing pipe and sensor pipe

Fig. 58: Type plate on DOC, mixing pipe and sensor pipe

1 Type plate for individual components



## Exhaust aftertreatment system SCRFilter (single-flow)

Fig. 59: Type plate on inlet module, filter module and outlet module

1 Type plate for individual components 2 Type plate for complete system

# 1.2 Technical data

# 1.2.1 Diesel engine

Description	Unit	Value
Construction		In-line diesel engine
Number of cylinders		4
Firing order		1-3-4-2
Hole	mm	130
Stroke	mm	150
Displacement	l	8,0
Compression ratio		17.5:1
Direction of rotation of the diesel engine		Viewed from the flywheel: counter- clockwise
Power group		LG 0 to LG 2
Rated power		see company name- plate
Rated speed		see company name- plate
Emission limits		Tier 4 Final / Stage V

# 1.2.2 Valve clearance

Name	Value
Valve clearance, inlet, cold	0.3 mm
Valve clearance, outlet, cold	0.4 mm

Tab. 10: Settings

Name	Value
Valve clearance, inlet, cold	0.3 mm
Valve clearance, outlet, cold	0.6 mm
Valve clearance, ABS, cold	0.4 mm

Tab. 11: Settings for engines with auxiliary brake system

# 1.2.3 Thermostat start of opening



#### Fig. 60: Thermostat

1 Area in which the start of opening is engraved

Thermostat	Value
Opening temperature	82 ^{±2.0} °C
Temperature at full opening	90 ^{±2.0} °C
Stroke at full opening	Min. 15.0 mm
Maximum permissible temperature	120 °C

Tab. 12: Technical data
# **1.3 Functional description**





Fig. 61: Exhaust gas aftertreatment system functional diagram

- 1 Coolant supply
- 2 Coolant return
- **3** Compressed air
- 4 Ventilation
- 5 Diesel exhaust fluid suction module
- 6 Diesel exhaust fluid suction line heating system
- 7 Coolant control valve
- 8 Coolant control valve
- **9** Diesel exhaust fluid pump
- **10** Air pressure sensor
- **11** Air switch over valve
- 12 Diesel exhaust fluid temperature pressure sensor

- 13 Diesel exhaust fluid pump module
- 14 Diesel exhaust fluid pressure line heating system
- **15** Diesel exhaust fluid injector
- 16 Mixing pipe temperature sensor
- 17 Diesel oxidation catalyst (DOC) inlet temperature sensor
- **18** Inlet nitrogen oxides sensor
- 19 Exhaust inlet
- 20 Exhaust outlet
- 21 Mixing pipe
- 22 Diesel oxidation catalyst (DOC)
- 23 Differential pressure sensor
- 24 Outlet SCR NH3 sensor

- 25 Outlet nitrogen oxides sensor
- 26 Outlet temperature sensor
- 27 Air line
- 28 Coolant line
- **29** Diesel exhaust fluid suction line
- **30** Differential pressure line
- 31 Engine exhaust pipe
- 32 Control unit SCR NH3 sensor
  - **33** Filter module
  - 34 Diesel exhaust fluid pressure line

Product description

# 2 Safety

# 2.1 Labeling of warnings



This is the warning sign. It warns of a potential risk of injury. Follow all measures that are indicated with this warning sign in order to prevent injuries or death.

Tab. 13

The warning sign always appears in connection with the signal words.

DANGER
WARNING
CAUTION

Ŵ	DANGER	Identifies an immediately dangerous situation that will result in death or serious bodily injuries if it is not avoided.
$\underline{\mathbb{N}}$	WARNING	Identifies a dangerous situation that could result in death or serious bodily injuries if it is not avoided.
Ŵ	CAUTION	Identifies a dangerous situation that could result in minor or moderate bodily injuries if it is not avoided.
	ATTENTION	Identifies a dangerous situation that could result in property damage if it is not avoided.

Tab. 14

# 2.1.1 Additional labels



**Note** Identifies useful information and tips.

Tab. 15

# 2.2 Target group

Preventive maintenance					Corrective maintenance in an emer- gency
Service Level	Service Level 0 (SL0) daily maintenance	Service Level 1 (SL1) main- tenance	Service Level 2 (SL2) main- tenance	Service Level 3 (SL3) main- tenance	

Preventive maintenance					Corrective maintenance in an emer- gency
Activities to be performed	Visual inspec- tions of various engine components	Basic mainte- nance work For example: Refill engine oil.	Maintenance work that involves a partial dismantling of the engine on site (service after half of the service life). For example: Replacement of pumps	Maintenance work requiring the complete dismantling of the engine and a test system.	Repair work and the replacement of compo- nents required to remedy defects or faults.
Groups of people authorized for perform- ance	Customer, end customer or Liebherr customer service Operator's manual		Customer, end customer or Liebherr customer service	Customer, end customer or Liebherr customer service	Customer (end customer in an emergency) or Liebherr customer service
Activity described in			Repair instructi	ons	

Tab. 16: Target group

# **i**)

Note

The manufacturer of the machine is responsible for:

- Checking the know-how and skills of personnel
- > Defining the necessary additional, refresher, and further training
- Defining the responsibilities and authorizations
- Applying ILO-"C138 Minimum Age Convention 1973", with a minimum age for the work permit of 14 years
- Providing the necessary tools and spare parts

# 2.2.1 International Standard Classification of Occupations

According to the International Standard Classification of Occupations (ISCO-08) of the International Labor Organization (ILO), the following occupational groups are listed as references to define the target groups, occupations and joint tasks.

## 2.2.2 Occupational references

The occupations listed perform the following work in accordance with the "General safety instructions" chapter:

- The main tasks described in this manual or these instructions
- The tasks identified as requirements to prepare the main tasks

Service Level 1: Maintenance technician (service technician)

In relation to ILO – Motor vehicle mechanics and repairers – unit group 7231 / ISCED-2011 level 2.

The tasks on engines, machines as well as mechanical and electronic equipment include:

- Operating the machine and equipment
- Performing scheduled maintenance work
- Assembly, installation, assessment, adjustment, testing and maintenance
- Locating defects
- Recording the repair and maintenance work performed

#### Service Level 2: Technician (service technician)

In relation to ILO – Motor vehicle mechanics and repairers – unit group 7231 / ISCED-2011 level 4.

The tasks on engines, machines as well as mechanical and electronic equipment include:

- Operating the machine and equipment
- Performing scheduled maintenance work
- Assembly, installation, assessment, adjustment, testing and maintenance
- Locating and diagnosing errors
- Dismantling and reassembly of the machine as well as the mechanical and electronic equipment
- Ensuring compliance with standards and specifications
- Recording the repair and maintenance work performed

#### Service Level 3: Mechanics (experienced technicians / mechatronics)

In relation to ILO – Motor vehicle mechanics and repairers – unit group 7231 / ISCED-2011 level 4.

The tasks on engines, machines as well as mechanical and electronic equipment include:

- Operating the machine and equipment
- Performing scheduled maintenance work
- Assembly, installation, assessment, adjustment, testing and maintenance
- Locating and diagnosing errors
- Dismantling and reassembly of the machine as well as the mechanical and electronic equipment
- Replacement of complete engines or components
- Repair of mechanical, hydraulic and electronic equipment
- Checking the acceptability of repair work
- Examination and testing of new machines and equipment
- Ensuring compliance with standards and specifications
- Recording the repair and maintenance work performed

### 2.2.3 Unauthorized personnel

All other persons, including operators, supervisors and trainees, are classified as "unauthorized personnel" for maintenance work.

They are not permitted to maintain the engine or access the engine compartment or engine cowling without a designated technician (SL1 or higher) present to supervise the safety of the personnel.

The health and safety officer or technician manager assumes responsibility for applying, ensuring, and enforcing all local safety regulations and requirements.

# 2.3 Intended use

Only operate the engine within the intended load range.

Only operate the engine in the device within the test range (NTE range) for the corresponding engine category.

- Use the engine for the intended purpose.
  - Observe the following conditions from the manufacturer:
    - Operating conditions
    - Maintenance conditions
  - Servicing conditions
- Ensure that the following activities are only performed by persons according to the target group definition:
  - Use engine.
  - Maintain engine.
  - · Service engine.

#### $(\rightarrow 2.2 \text{ Target group, p. 39})$

- Install contactors and protective devices prior to commissioning and ensure their function.
- Observe safety instructions and operating instructions.
- Operate the engine in flawless condition.
- Operate the engine in the speed range prescribed by the manufacturer.
- Screw the engine with the attached engine brackets to the machine or to the respective operation site with the respective tightening instructions provided by the customer.
- Have engine brackets that were not installed by the manufacturer approved by the manufacturer.
- Only operate the engine in areas that are not publicly accessible.
- Only operate the engine with an enclosure or engine compartment cover.

# 2.4 Limitation of liability

These instructions have been prepared according to the applicable standards and regulations and according to the state of the art.

Liebherr assumes no liability for:

- Disregarding the instructions
- Improper use
- Use of personnel that does not meet the requirements according to the target group.
- Changes and conversions to the engine which were carried out without approval from Liebherr.
- Use of operating fluids and auxiliary materials that are not approved by Liebherr
- Use of spare parts that are not approved by Liebherr, including any damages arising as a
  result
- Circumventing and disregarding safety regulations
- Disregarding international and national regulations for occupational safety
- Disregarding international and national regulations for environmental protection
- Unauthorized changes to the engine
- Manipulation to the injection system and control system
- Emergency operation with limited safety function is deemed improper use. The manufacturer is not liable for damage due to improper use.

EU type approval expires for:

- Manipulation to the engine
- Manipulation to the injection system and control system
- Manipulation to the exhaust aftertreatment system

The actual scope of delivery of the engine can differ from the relevant information in these instructions due to situational adaptations to customer requirements.

# 2.5 General safety instructions

- Fulfill the requirements of the target groups for the work. ( $\rightarrow$  2.2 Target group, p. 39)
- In order to guarantee help in the event of an accident:
  - A second person is present.
  - Ensure that the emergency situation will be detected and help with take place.
- Ensure that the personnel is familiar with this manual before installation work.
- Only allow the following personnel to work on the engine under the constant supervision and responsibility of a technician in accordance with the target group definition.
  - Personnel to be trained
  - Personnel to be taught
  - Personnel to be instructed
  - Personnel in apprenticeships
  - (→ 2.2 Target group, p. 39)
- Check the safety and hazard-conscious work of the personnel under the following conditions:
  - Observe the accident prevention regulations.
  - Observe the generally recognized safety and occupational health rules.
  - Observe the manual.
- Make sure that the personnel wear the prescribed work clothing. ( $\rightarrow$  2.7 Personal protective equipment, p. 45)
- Do not wear the following:
  - Rings
  - Wristwatches
  - Neckties
  - Scarves
  - Open jackets
  - Loose-fitting clothing
- Make sure that the following equipment is available for the assembly, clean, complete and undamaged:
  - Basic tool kit
  - Required devices
  - Required special tools
- Replace damaged tools.
- Keep the workplace clean and orderly.
- Make preparations for emergencies that could occur.
- Have a fire extinguisher and first aid kit ready.
- Have emergency telephone numbers available.
- Make sure that the workplace has sufficient lighting.
- Perform installation work only when the engine is secured.
- Ensure that the engine is not started by unauthorized individuals.

# 2.6 Preventing personal injuries

# 2.6.1 Crushing

- Do not lift heavy parts by hand.
- Fasten and simultaneously secure individual parts and larger assemblies carefully to lifting equipment during the replacement.
- Use Liebherr lifting gear according to the operator's manual.
- Comply with the provisions for lifting points.
- Only use undamaged load handling attachments.
- Only use load handling attachments with sufficient load bearing capacity.
- Make sure that no one resides under loads.
- When the engine is running, objects can be flung back: Make sure that no objects come in contact with moving parts.

### 2.6.2 Burns and scalds

The engine at operating temperature is hot.

- Only work on the cooled down engine.
- Touch hot parts with thermal protection gloves for repair purposes.
- Before work on the cooling system:
- Let the engine cool down
- Release the pressure in the cooling system on the device side.
- Avoid contact with parts carrying coolant.

When the engine is at operating temperature, the engine oil is hot.

- Avoid any skin contact with hot engine oil or parts carrying engine oil.

## 2.6.3 Fires and explosions

- Smoking is prohibited in the immediate vicinity of the engine.
- Avoid fires, sparks and open flames when handling fuels and flammable liquids.
- Start the engine according to the provisions of the repair instructions and assembly instructions.
- Repair any leaks and replace damaged components. Fuel and lubricating oil that squirts out from leaks can lead to fires.
- When working on batteries: Put on safety goggles and safety gloves.
- After maintenance and repair work, remove and clean residues of operating materials (e.g. lubricating oils, lubricating greases, fuel, coolant).
- Remove rags that are soaked with flammable liquids.
- When working on the electrical system: Disconnect the electrical power supply.

### 2.6.4 Poisoning

- Only allow the engine to run in closed rooms when there is sufficient ventilation.
- Never ingest operating fluids.
- Do not use beverage bottles to store operating fluids.

Escaping liquids can penetrate the skin and will lead to blood poisoning:

- Do not open any lines and hoses that are under pressure.
- Do not remove any lines and hoses that are under pressure.
- Protect hands, face and body against escaping liquids when searching for leaks on lines and hoses that are under pressure.(→ 2.7 Personal protective equipment, p. 45)

# 2.6.5 High pressure injection (ejection of liquids under high pressure)

When the engine is running, the fuel lines are constantly under a fuel pressure of up to 2400 bar. Escaping liquids can penetrate the skin and will lead to injuries.

Only work on the fuel and injection system when the engine is turned off. If the engine has been turned off:

- Wait at least 20 minutes until the pressure in the injection system has been relieved.
- Check pressure reduction with the diagnostic program (must have dropped below 20 bar).
- Use suitable protective equipment when working on the fuel and injection system (for example, protective gloves, safety goggles etc.).
- Do not open any fuel lines and fuel hoses that are under pressure.
- Do not remove any fuel lines and fuel hoses that are under pressure.
- When searching for leaks, do not touch pressurized fuel lines and fuel hoses with your hands. No body parts near possible leaks.
- Bring the engine into a clean area of the workshop, in which no work is being performed that could cause dust to be dispersed (grinding, welding work, brake repairs, brake and power tests etc.).

### 2.6.6 Electrical energy

- People with pacemakers have no access to the safety zones around the operational engine.
- Do not touch live parts.
- Before work on the electrical system, disconnect the electrical power supply and secure it against being switched back on.

### 2.6.7 Danger due to noise

Permanent hearing impediments are possible at noise levels of 84dB(A) and above. Sound level up to 110dB possible!

- Keep all sound-insulating protective devices for the system closed when the engine is running.
- Only reside near the running engine with hearing protection matched to the noise level.
- Observe the hearing protection measures according to the repair instructions of the device manufacturer.

Access to the safety zones is prohibited for the operator and unauthorized personnel when the engine is ready for operation or in operation.

# 2.7 Personal protective equipment

- Wear protective equipment for direct access to engines.
- Make sure that:
  - Protective equipment is in good condition.
  - Protective function is guaranteed.

The following protective equipment is required to access the engine:

#### Protective work clothing



 Tight-fitting protective clothing that is not tear-resistant to protect against injuries and simple chemical substances

Wear protective work clothing in the immediate vicinity of the engine.



#### Safety helmet

Protection against

- Falling or flying object
- Bumping your head

Wear a safety helmet in the immediate vicinity of the engine.



#### Safety shoes

- Foot protection against
  - Falling objects
  - Pinching of the foot in heavy parts
  - Against slipping

Wear safety shoes in the immediate vicinity of the engine.



#### Safety gloves

Protection against hot elements and chemicals

Wear safety gloves when working with hot parts, for example,

- shrinking the gear ring onto the flywheel.
- Working with operating fluids (See manufacturer's specifications for the operating fluids and safety data sheet for the operating fluid.)



#### Safety goggles

- Protection against:
  - Flying fragments
    - Chemical splashes
- Wear safety goggles when:
  - Handling operating fluids (See manufacturer's specifications for the operating fluids and safety data sheet for the operating fluid.)
  - Wear during mechanical interventions, for example, using compressed air.

#### Hearing protection

- Protection against noise
  - Wear hearing protection around the diesel engine when it is running.



#### Respirator

Protection against breathing in harmful substances

# 2.8 Operating areas and maintenance areas

## 2.8.1 Safety instructions

Trapping points and mechanical parts flying around when the engine is ready for operation or in operation

Serious injuries and risk of death:

- Keep away from the operational engine.
- Wear personal protective equipment.
- Technicians may reside in safety zone "A" for measurement purposes, if nothing else has been stated by the device manufacturer.

Hot parts when the engine is ready for operation or in operation.

Risk of burns:

- Keep away from the operational engine.
- Wear personal protective equipment.
- Let the engine cool down sufficiently.

High electric short-circuit currents during maintenance work

Risk of burns from electric shock:

- Access to safety zones in maintenance condition, according to target group definition
- Disconnect the electrical power supply.
- Wear personal protective equipment.

### 2.8.2 Operating areas



Fig. 74: Safety zones for the engine that is ready for operation or in operation

**a** Horizontal plan (view from above)

**b** Vertical plan (view from driving end)

Do not enter the following zones:

- Safety zone for free end A
- Safety zone next to the engine **B**
- Safety zone for driving end **C**
- Safety zone above the engine D
- Safety zone below the engine **E**

## 2.8.3 Maintenance areas

Maintenance areas are the safety zones that are to be entered for maintenance work and troubleshooting.



#### WARNING

Hot components! Leads to serious burns.

- ▶ Let the engine cool down to below 50 °C.
- ▶ Wear heat-resistant safety gloves and heat-resistant work clothes.



Fig. 75: Safety zones for maintenance and repairs

**a** Horizontal plan (view from above)

- The following zones are accessible:
- Safety zone for free end A
  Safety zone next to the engine B
- Safety zone for driving end C
- Safety zone above the engine D

Do not enter the following zones:

- Safety zone below the engine E

# 2.8.4 Securing the engine against unexpected start-up and releasing it

Access to the engine must be secured against unexpected start-up before entering the safety zones.

#### Procedure:

Secure the engine against unexpected start-up:

- Disconnect the diesel fuel supply.
- Mark the cut-off point with a tag.
- Disconnect the electrical power supply and secure it against being switched back on.
- Mark the cut-off point with a tag.

Make the engine operational (release it):

- The following activities have been completed:
  - Installation activities
  - Maintenance activities
  - Repair activities
- All foreign objects are removed.
- All protectives devices are installed and are functioning.
- No outsiders are residing in the danger zones.
- The tags for the fuel supply are removed.

**b** Vertical plan (view from driving end)

- Fuel supply is connected.
- The tag for the electrical power supply is removed.
- The electrical power supply is established.

### 2.8.5 Emergency stop

An emergency stop is available for hazardous situations which require an immediate shutdown of the engine. The power supply to the engine is interrupted immediately. The engine control unit continues to have power.

Examples of hazardous situations:

- Fire
- Person suffers an electric shock
- Engine will not stop
- Engine accelerates uncontrollably

Only actuate the emergency stop in emergency situations. Actuating the emergency stop can permanently damage the engine. The emergency stop may not be used for an operational stop of the engine.



# Signage

#### Note

- Signs must be attached so they are clearly visible and are in the immediate vicinity of the safety zones.
- Signs must withstand the environmental conditions. The end user must ensure that signs remain visible and legible during the entire life cycle.
- Additional warning symbols or adaptations to product standards (ISO 8528–13) are possible.



#### ISO 7010 / W012 Warning against dangerous electrical voltage:

 Only personnel who know the dangers of electricity may work in the designated area. Unauthorized individuals may only enter the safety zone if the electrical power supply is disconnected.



#### ISO 7010 / W017 Warning against hot surfaces:

- There are hot surfaces on the engine which are not immediately apparent. Wait a sufficient cooling time.
- Touch any potentially hot components using suitable protective gloves.



#### ISO 7010 / W025 Warning of entanglement hazard:

- Possible trapping points exist on the engine in the area of the V-ribbed belt and the alternator for battery charging.
- Attach a warning sign if trapping points are not secured by protective devices (optional). Enter safety zone only after engine is turned off.
- Secure the engine against unexpected start-up.



#### ISO 7010 / P007 No access for people with pacemakers or implanted defibrillators:

- Possible EMC radiation, which can affect pacemakers and implanted defibrillators.



#### ISO 7010 / M002 Observe instructions:

 To ensure that personnel is familiar with all residual risks, the system documentation must be read and understood.

Ensure that all residual risks according to the risk assessment of the device manufacturer are reflected in the system documentation.

Make documentation available to the personnel without restrictions according to the "target group". ( $\rightarrow$  2.2 Target group, p. 39)

# 2.10 Preventing property damage

Preventing property damage:

- Replace sealing material, for example, o-rings and seals.
- Check removed, reusable parts for reusability, see corresponding information in the repair instructions.
- Replace removed, not reusable parts.
- If no specific tightening torques and tightening instructions are specified: Tighten screwed assemblies according to the standard tightening torques. (→ 9.3 Tightening torques, p. 171)
- Replace self-locking screwed assemblies.
- Thoroughly clean the engine, connections and screwed assemblies of engine oil, combustion residues or care products before installation.
- Use lint-free cleaning cloths.
- Do not touch electrical contacts. Connection will be affected by contamination or components will be destroyed by electrostatic discharge.
- Before cleaning the engine: Cover or seal openings into which no water, steam or cleaning agents may enter due to safety or functional reasons.
- Remove covers or adhesives after cleaning.
- Check gas-conveying lines, engine oil lines and hydraulic lines for the following defects:
  - Leaks
  - Loose connections
  - Abrasion points
  - Damage
- Make sure that the electrical power supply is securely connected when starting.
- Before disconnecting the electrical power supply: Turn off engine.
- Use suitable test leads for measurements on plug connections.
- If no mating connector is attached: Protect the engine control unit against dust and water.
- When working on the electrical system: Disconnect the battery (if present).
- Disconnect the negative pole first and connect it last.
- During electric welding on the machine, remove the plug from the control unit.

# **3** Transport and storage

# 3.1 Dimensions and weights



Description	Unit	Value
Length	mm	1221
Width	mm	823
Height	mm	1154
Engine weight without operating fluids	kg	870



#### Note

1

2

The stated dimensions and the engine weight apply for an example application. For exact values, see technical data sheet.



# 3.2 Lifting the engine



#### DANGER

Pulling out of the lifting devices on the engine and falling of the diesel engine! Leads to death or serious crushing.

- Make sure that no one is standing or walking under suspended loads.
- Maintain safety distance.
- Observe maximum weight for lifting points.
- Maintain a maximum of a 10° deviation from the vertical to the engine axis.
- Use a Liebherr lifting traverse.
- Take safety instructions / warning signs from the operator's manual of the lifting traverse into account.
- Observe national and international guidelines for lifting heavy loads. ►
- Make sure that no persons reside in the danger zone (see safety chapter). ►
- Remove the gearbox or other attachments before lifting the diesel engine.



#### Fig. 82: Lifting the engine

- A Transport device detail view
- Front / rear view of two lateral transport В devices
- С Side engine view
- See next page for continuation of the image legend
- Tolerance for maximum deviation of 1 motor axis 2
- Crankcase
- 3 Lifting traverse

Engine lifting traverse lifting point

Tolerance for maximum horizontal devia-

(observe maximum total load)

- **D** Front / rear view of lateral transport device
- **E** Lifting traverse lifting point detail view
- **F** Take lifting traverse warning signs, lifting traverse operator's manual into account.
- Lift the engine: Attach correct lifting traverse 3 to the transport devices A provided for this.

4

5

tion

# 3.3 Transport

### 3.3.1 Transport attachment



Fig. 83: Transport attachment



#### DANGER

Instability during transport! Leads to death or serious injuries.

- Only use the original transport device.
- Secure the transport device, including the mounted engine, against slipping and falling down.
- Make sure that transport device is in technically perfect condition.
- Secure the transport device against slipping and falling down in all directions.
- Observe the center of gravity.
- ▶ Bolt engine securely to transport device.



#### DANGER

Tipping of engine during loading or unloading! Leads to death or serious injuries.

- ▶ Make sure that only authorized personnel load/unload the engine.
- Make sure that the crane or forklift is suitable for the weight to be lifted.
- If the engine is being lifted with a crane:
- Use a lifting traverse.
- ▶ Make sure that no persons reside in the danger zone during the loading / unloading.
- Observe information on the center of gravity.

### 3.3.2 Transport device

#### Wood transport device

#### DANGER

Instability during transport! Leads to death or serious injuries.

- Only use the original transport device.
- Secure the transport device, including the mounted engine, against slipping and falling down.
- Make sure that transport device is in technically perfect condition.
- Secure the transport device against slipping and falling down in all directions.
- ▶ Observe the center of gravity.
- ▶ Bolt engine securely to transport device.



Fig. 84: Wood transport device

• Only transport the engine using the transport device.

### Steel transport device



#### DANGER

Instability during transport! Leads to death or serious injuries.

- Only use the original transport device.
- Secure the transport device, including the mounted engine, against slipping and falling down.
- Make sure that transport device is in technically perfect condition.
- Secure the transport device against slipping and falling down in all directions.
- Observe the center of gravity.
- ▶ Bolt engine securely to transport device.



Fig. 85: Steel transport device

• Only transport the engine using the transport device.

# 3.4 Storage

### 3.4.1 Storage

Note



Liebherr recommends:

- ▶ Keep storage times as short as possible.
- ▶ Immediately install repair kits, sealing kits and modification kits, as well as engines.
- ▶ Use the "first in first out" logistics method.

Make sure that the following prerequisites are met:

- Storage space in closed buildings (preferably brick or concrete buildings)
- □ No direct contact with atmospheric conditions (weather)
- □ Storage space is well ventilated.
- □ Storage space is protected against frost.
- Building is not in the immediate vicinity of fresh water resources or salt water resources.
- □ No direct sunlight, only low light irradiation permissible
- □ Regularly falling below the dew point not permissible
- □ Engine must be covered with suitable devices to protect against UV exposure.
- Storage at high storage locations in high-bay warehouses only permissible in fully air-conditioned storage spaces.
- □ Recommended storage temperature: 18 °C to 23 °C (air-conditioned warehouse)
- □ Approved storage temperature: 5 °C to 35 °C
- □ Approved relative humidity 30 60 %
- □ Engine stored shock-resistant, slip-resistant.

### Preservation with VCI corrosion protection film



#### CAUTION

Skin contact with chemical substances!

Skin irritation possible due to skin contact with VCI corrosion protection film.

- Put on protective gloves.
- ▶ Wash hands after using VCI corrosion protection film.

Products that are not painted or that have bare surfaces are packed in VCI corrosion protection film to protect against water and oxygen. When the volatile corrosion inhibitor "VCI" diffuses from the film to the metallic product, an atmosphere consisting of amines and nitrides arises and protects the product against the formation of rust and verdigris. The atmosphere evaporates without residues after unpacking.

Make sure that the following prerequisites are met:

- □ Engine has been packed in enclosed spaces with low humidity and constant temperatures.
- □ Engine is clean and dry.
- Temperature of the engine is identical to the ambient temperature (formation of condensation).

VCI film cover LxWxH	ID no.
2100x1100x2150	10165707
1250x850x1500	10042128
1250x850x2100	11694088

ID no.
11067328
11826670
11826671
11067327
11067326
10331822

Tab. 17: VCI film cover

VCI bag LxW	ID no.
300x200	11170517
345x260	11170521

Tab. 18: VCI bag

- Loosely apply VCI corrosion protection film on engine so it is sealed tight.
   Air can circulate.
  - Dash The protective atmosphere will have formed by 24h at the latest. The engine is protected.

### Disposal



CAUTION

Skin contact with chemical substances! Skin irritation possible due to skin contact with VCI corrosion protection film.

- Put on protective gloves.
- ▶ Wash hands after using VCI corrosion protection film.
- ▶ Dispose of VCI corrosion protection film.
- Observe national statutory provisions for protection of the environment.

#### Depreservation

After preservation with VCI corrosion protection film, no depreservation is necessary.

#### Preservation with corrosion protection wax

All bare outer surfaces of an engine are exposed to corrosive attack when the engine is decommissioned. The corrosion is comparable to wear and shortens the life of the affected parts.

Preservation work is only permitted by trained personnel who are familiar with the work and informed about the dangers.

Make sure that the following prerequisites are met when applying corrosion protection wax:  $\hfill \label{eq:matrix}$  Ambient temperature is at least 15 °C.

- □ Protective equipment is used.
- Drying time of 3 hours is given.

Name		Description		
	WAXOYL 120-4	Spray can 500 ml ^A )	8504472	
		Long-term protection for up to 2 years		

Tab. 19: Corrosion protection wax

A) Treat a preservation surface of approximately 5 m² with one liter of Waxoyl. The low temperature resistance of WAXOYL 120-4 corrosion protection wax is above -40 °C or -40 °F.

#### NOTICE

Decommissioning at freezing temperatures! Leads to damage to engine.

- ► Contact Liebherr customer service.
- Remove the engine from the device or system.
- Set the engine down on a level, dry and firm surface and simultaneously secure it against rolling away.



#### CAUTION

Slippery surface! Injuries possible.

- Watch out for wax residues on the floor.
- Remove wax residues on the floor.
- Clean engine.
- Carefully dry electronic components and damp areas of the engine using a compressed air gun.
- Make sure that engine is clean and dry before starting preservation.
- Check engine for damage.
- Check engine for paint damage.

If any damage exists:

Repair the damage.

The following materials are synthetic materials:

- Plastic parts
- Hoses
- Rubber
- Cover synthetic materials with suitable devices due to UV exposure.

#### Disposal

- Dispose of corrosion protection wax.
- Observe national statutory provisions for protection of the environment.

#### Depreservation

 $\blacktriangleright$  ( $\rightarrow$  Cleaning, p. 61)

### Cleaning

#### Cleaning with cleaning agents

#### NOTICE

Impermissible cleaning agent! Leads to damage to surfaces and sealing elements.

- Only use suitable, mild cleaning agents.
- Only use lint-free cleaning cloths.
- ▶ Remove lubricants and contaminants.
- Remove water residues.
- ▶ Warm up the engine.

#### Cleaning with steam jet cleaner

#### NOTICE

Impermissible use of the steam jet cleaner! Leads to damage to electronics and seals of engine.

Do not use a steam jet cleaner until after the first 2 months following the curing time of the paint.

Make sure that the following prerequisites are met:

- □ Shafts and flanges are lubricated.
- Openings are covered or taped with protecting caps and guards.
- □ Seals and closures are tight.
- □ Lance distance is at least 50 cm from the surface which is being cleaned.
- □ Water temperature is a maximum of 60 °C.
- Commercial car cleaner used (neutral cleaner, added two to three percent)

# **j**

Liebherr recommends:

Avoid getting water on regulator, electronic components and plug connections.

#### NOTICE

Note

Steam jet touches temperature sensors! Activation of the extinguishing system.

• Keep hot steam jet away from temperature sensors of fire alarm and extinguishing system.

#### NOTICE

High pressure cleaner touches sensitive components! Leads to damage to electronics and seals of engine.

- Do not point the high pressure cleaner at sensitive components. (For example, rotary shaft lip seals, electrical connections, electronic components)
- ▶ Blow the engine dry with a compressed air gun.
- Remove protective covers completely.

If defects exist:

- ▶ Inspect motor cables for leaks, loosened connections, abrasion points and damage.
- ► Remove water residues.

### 3.4.2 Storage time

Condition	Up to 1 month	1 to 6 months	6 to 24 months
New (as originally packaged)	Dry, in a ventilated place Outdoors, possible using VCI and under UV-resistant tarpaulin	Dry, in a ventilated place	Possible using VCI corrosion protection film Possible using corrosion protec- tion wax
Used		Possible using VCI corros Possible using corrosion	ion protection film protection wax

Tab. 20: Storage time

▶ Observe the storage time.

# **4** Operation

# 4.1 Preliminary work for the initial commissioning of the engine

- Check engine for proper installation, see documentation from the device manufacturer.
- ▶ Provide a suitable engine oil for the engine.
- Fill engine oil. ( $\rightarrow$  Filling the engine oil, p. 91)
- Check oil filter connection.
- ▶ Provide coolant with the correct coolant composition. (→ 5.6.3 Checking the concentration of the antifreeze agent in the coolant, p. 113)
- Fill the coolant, see documentation from the device manufacturer.
- Check coolant line connections..
- Connect charge air pipe, see documentation from the device manufacturer.
- Connect exhaust gas aftertreatment system, see documentation from the device manufacturer.
- Connect fuel supply, see documentation from the device manufacturer.
- ▶ Provide diesel fuel with approved fuel specification. ( $\rightarrow$  5.11.4 Approved fuels, p. 156)
- ▶ Fill the diesel fuel.(→ 5.11.4 Approved fuels, p. 156)
- ▶ Ventilate the fuel system. ( $\rightarrow$  5.7.6 Ventilating the fuel system, p. 122)
- Check fuel prefilter connection, see documentation from the device manufacturer.
- Check fuel fine filter connection.
- Connect electrical power supply, see documentation from the device manufacturer.
- ▶ Upload current software update to engine control unit.

# 4.2 Starting the engine

Make sure that the following prerequisites are met:

- □ During the initial commissioning: Preliminary work for initial commissioning of engine has been performed. (→ 4.1 Preliminary work for the initial commissioning of the engine, p. 63)
- Oil level is correct.
- □ Coolant is filled, see documentation from the device manufacturer.
- □ Charge air is connected, see documentation from the device manufacturer.
- Exhaust gas disposal is ensured.
- □ The electrical power supply is ready.
- □ Fuel supply is connected.
- □ Every eight operating hours: Perform required activities from maintenance schedule.
   (→ 5.1 Maintenance schedule, p. 67)



#### DANGER

Unexpected movements! Death or serious injuries possible.

- ► Never bypass the starter.
- ▶ Never activate the starter directly.



#### DANGER

Unexpected movement of the system! Death or serious injuries possible.

- Make sure that no persons reside in the danger zones of the engine.
- ▶ Bring all protective devices into the protective position.
- Close the enclosure.
- Secure external parts against unexpected movement.

#### NOTICE

Insufficient lubrication! Damage to engine.

• Make sure that oil pressure builds up immediately after starting the engine.

If the oil pressure warning light does not go out within 5 seconds:

- ► Turn off the engine immediately.
- ▶ Determine cause and rectify.( $\rightarrow$  6.1 Faults Cause Remedy, p. 159)

#### NOTICE

Continuous operation! Damage to starter.

Let the starter run a maximum of 30 seconds.

Start engine.

If the engine does not start:

- ▶ Wait at least two minutes until the next attempt.
- Start engine.

If the engine does not start with the second attempt:

▶ Wait at least five minutes until the next attempt.

▶ Start engine.

If the engine does not start with the third attempt:

- **b** Determine cause and rectify. ( $\rightarrow$  6.1 Faults Cause Remedy, p. 159)
- Check oil pressure gauge immediately after starting the engine.

If no oil pressure is built up within 5 seconds:

- Turn off engine immediately.
- **b** Determine cause and rectify. ( $\rightarrow$  6.1 Faults Cause Remedy, p. 159)

#### NOTICE

Impermissible loading of the engine in cold condition! Damage to engine.

• Let the engine warm up until the operating temperature is reached.

#### NOTICE

Continuous operation at low speed! Damage to exhaust gas aftertreatment system

If engine is operated continuously (>15 h) at low speed:

• Contact Liebherr customer service.

If engine start was successful:

- ▶ Warm up the engine.
  - ▷ Coolant temperature >60 °C

# 4.3 Turning off the engine

#### NOTICE

Turning off the engine at full load speed! Damage to engine.

- ► Turn off the engine at idling speed.
- ▶ Reduce engine speed to idling speed.
- Let the engine run for 15 s unburdened at an idle.
- ► Turn off the engine.
- ► Turn off ignition.
  - ▷ The blow-out function of the exhaust gas aftertreatment system begins one minute after turning off the ignition.

#### NOTICE

Blow-out function of the exhaust gas aftertreatment system is not performed! Damage to reduction agent lines and valves.

Do not actuate the emergency stop switch until at least five minutes after turning off the engine.

When the blow-out function of the exhaust gas aftertreatment system is complete:► Turn off engine with emergency stop switch.

# **5** Maintenance

# 5.1 Maintenance schedule

#### Abbreviations

h = operating hours



#### Note

When operating under less than ideal conditions, such as intense heat, dust-laden air or poor operating fluid quality, more frequent maintenance than scheduled in the inspection plan can be required.

Power groups	Devices
LG 0 - LG 2	Mobile construction cranes (MK cranes), mobile cranes, crawler cranes, duty- cycle crawler cranes, crawler cranes, rotary drilling rigs, piling and drilling rigs (LRB series), hanging and swing leader (LRH series), reachstacker, maritime cranes

Tab. 21: Power groups

Customer:			Machine type: Serial no.: Operating hours:	.Dat	e:		
			Tasks to be performed				
intervals (the earlier date is decisive)		ervals ate is decisive)	By maintenance staffBy authorized specialist staff■ Once-only activity□ Once-only activity● Repeat interval○ Repeat interval+ If necessary◇ If necessary* Annually before the winter	Confirm tasks	See page		
			Diesel engine				
	•	1000 h	Check V-ribbed belt.		71		
	•	1000 h	Check belt drive.		72		
	•	1000 h	Check engine mount.		79		
■ 500 h	•	1000 h	Check the intake system.		79		
■ 500 h	•	1000 h	Check exhaust system.		80		
	0	5000 h / every five years	Replace belt drive.		75		
			Engine oil system				
	•	10 h	Check engine oil system for leaks and damage.		82		
	•	10 h	Check engine oil level.		85		
	$\circ$	1000 h / every two years	Replace engine oil and oil filter.		86		
	0	1000 h / every two years	Replace oil separator filter insert.		92		
	O 1000 h		Cylinder head	_			
			Check and set valve clearance.		105		
			Cooling system	_			
	•	10 h	Check cooling system and heating system for leaks and damage.		112		
	•	Daily	Check coolant level.		113		
	0	2000 h / *	Check concentration of antifreeze agent in coolant.		113		
	0	6000 h / every four years	Replace coolant.		114		
			Fuel system				
	•	10 h	Check fuel system for leaks and damage.		118		
	0	1000 h	Replace fuel prefilter.		119		
	0	1000 h	Replace fuel fine filter.		120		
Air filter			Air filter	_			
	•	Daily	Check air filter low pressure indicator.		124		
	•	50 h	Clean air filter dust discharge valve.		124		
		<b>~</b>	Replace dry air filter main element.		124		
			Replace dry air filter safety element.		124		
			Electrical system				
	•	1000 h	Check engine control unit bearings for damage.		125		
■ 500 h	•	1000 h	Check the batteries.		125		
■ 500 h		1000 h	Check cable set plug.		125		

intervals (the earlier date is decisive)		Tasks to be performed		
		By maintenance staffBy authorized specialist staff■ Once-only activity□ Once-only activity● Repeat interval○ Repeat interval+ If necessary◇ If necessary* Annually before the winter	Confirm tasks	See page
■ 500 h	• 1000 h	Check sensors, actuators, cable holders and plugs for damage.		126
	*	Check heating flange.		129
	<b>O</b> 10000 h	Replace heating flange, if present.		132
Exhaust aftertreatment system				
	• 10 h	Check exhaust gas aftertreatment system for leaks and damage.		135
■ 50 h	• 1000 h	Checking the components		137
	<b>O</b> 5000 h	Replace the filter module.		139

# 5.2 Preliminary work

## 5.2.1 Bringing the engine into maintenance position

▶ Make sure that the engine is level.

If the engine is hot:

• Let the engine cool down to ambient temperature.

If a battery master switch is present:

► Turn off the battery master switch.

If a master switch key is present:

Pull out master switch key.

# 5.3 Diesel engine

### 5.3.1 Checking the V-ribbed belt for damage

Make sure that the following prerequisites are met:

- □ Fan drive is removed (if present).
- Cover is removed (if present).
- □ Engine is in maintenance position. (→ 5.2.1 Bringing the engine into maintenance position, p. 70)



Fig. 86: Damages to V-ribbed belt

Possible damages to the V-ribbed belt are:

- Brittle ribs
- Rubber lumps on the bottom of the belt
- Dirt deposits
- Stone deposits
- Ribs detached from the bottom of the belt
- Transverse cracks on the back
- Transverse cracks in multiple ribs
- Check V-ribbed belt for damage.

If the V-ribbed belt is damaged:

Replace V-ribbed belt.

# 5.3.2 Checking the V-ribbed belt for tension

### Tension pulley (self-tensioning)



#### Note

Checking the tension of the V-ribbed belt is not necessary for belt drives that use a self-tensioning tension pulley.



- Fig. 87: Tension pulley (self-tensioning)
- **1** Tension pulley (self-tensioning)

### 5.3.3 Checking the belt drive

Make sure that the following prerequisites are met:

- Fan drive is removed (if present).
- Cover is removed (if present).
- Engine is in maintenance position. (→ 5.2.1 Bringing the engine into maintenance position, p. 70)
## Checking the (optional) air conditioning compressor belt drive Removing the belt



Fig. 88: Removing the air conditioning compressor belt

1 V-ribbed belt

3 Internal square

- 2 Tension pulley (self-tensioning)
- Attach the 1/2" socket wrench transition piece (external square) with lever to the internal square 3 of the tension pulley (self-tensioning) 2.
- Move tension pulley (self-tensioning) 2 counterclockwise to relieve the V-ribbed belt 1.
- Remove V-ribbed belt 1.
- ▶ Replace belt drive, see repair instruction.

#### Checking the belt drive



Fig. 89: Checking the air conditioning compressor belt drive

- **1** Air conditioning compressor
- 2 Tension pulley (self-tensioning)
- **3** Deflection pulley
- Check components for damage.

If components are damaged:

- Do not start engine.
- ▶ Replace defective components, see repair instruction.
- 4 Alternator
- 5 Coolant pump
- 6 Belt pulley on the crankshaft

#### Installing the belt



*Fig. 90: Installing the air conditioning compressor belt* 

1 V-ribbed belt

**3** Internal square

- 2 Tension pulley (self-tensioning)
- ▶ Install new V-ribbed belt **1**.
- Slowly turn back tension pulley (self-tensioning) 2.
- Remove the 1/2" socket wrench transition piece (external square) with lever from the internal square 3 of the tension pulley (self-tensioning) 2.

## 5.3.4 Replacing the belt drive

Make sure that the following prerequisites are met:

- Fan drive is removed (if present).
- Cover is removed (if present).
- Engine is in maintenance position. (→ 5.2.1 Bringing the engine into maintenance position, p. 70)

# Replacing the (optional) air conditioning compressor belt drive Removing the V-ribbed belt



Fig. 91: Replacing the V-ribbed belt

1 Internal square

**3** Tension pulley (self-tensioning)

- 2 V-ribbed belt
- Attach the 1/2" socket wrench transition piece (external square) with lever to the internal square 1 of the tension pulley (self-tensioning) 3.
- Turn back the tension pulley (self-tensioning) 3 at the internal square 1 counterclockwise against the spring force to the limit stop.
   The V-ribbed belt 2 is relaxed.
- Remove V-ribbed belt **2**.
- Carefully turn back the tension pulley (self-tensioning) 3 at the internal square 1 clockwise to the limit stop.

### Replacing the deflection pulleys and tension pulley (self-tensioning)

Make sure that the following prerequisites are met: □ Cover is removed (if present).



Fig. 92: Replacing the deflection pulleys and tension pulley (self-tensioning)

- 1 Deflection pulley Tension pulley (self-tensioning) 2
- 3 Hex bolt

Hex bolt 4

- Unscrew hex bolt 3.
- Remove deflection pulley 1.
- Unscrew hex bolt 4.
- Remove tension pulley (self-tensioning) 2.
- ▶ Install new tension pulley (self-tensioning) 2.

Tightening instruction for M10x80 8.8 FLZN cylinder screw			
Lubricant	-		
Locking agent	LOCTITE 243		
Part contact surfaces	-		
Screws	not reusable		
Stage	Tightening torque		
1.	Standard torque		

Tab. 22: Tightening instruction

- ▶ Tighten hex head screw 4 according to tightening instruction.
- ▶ Install new deflection pulley **1**.
- ▶ Tighten hex bolt 3.

#### Installing the V-ribbed belt



#### Fig. 94: Replacing the V-ribbed belt

1 Internal square

**3** Tension pulley (self-tensioning)

- 2 V-ribbed belt
- Swivel back tension pulley (self-tensioning) **3** counterclockwise against the spring force to the limit stop.
- ▶ Fit V-ribbed belt 2 with swiveled back tension pulley (self-tensioning) 3 on the belt pulleys of the crankshaft, alternator, coolant pump and other deflection pulleys.

Turn tension pulley (self-tensioning) 3 carefully into the original position.
 The V-ribbed belt 2 is tensioned.

## 5.3.5 Checking the engine mount

▶ For procedure to check the engine mount, see documentation from the device manufacturer.

## 5.3.6 Checking the intake system for leaks and damage



Fig. 95: Components to be checked

- 1 External hex bolt (4x)
- 2 External hex bolt (4x)
- 3 Seal
- Check device side suction lines between the air intake pipe and exhaust gas turbocharger, see documentation from the device manufacturer.

4

5

Air intake pipe

Heating flange

- Check components for damage.
- Check components for leaks.
- ► Check components for tight fit.
- If components are damaged:
- Do not start the engine.
- Replace damaged device side components, see documentation from the device manufacturer.
- ▶ Replace damaged components, see repair instruction.

## 5.3.7 Checking the exhaust system



Fig. 96: Components to be checked

- 1 Exhaust gas stub
- 2 Exhaust manifold seal
- 3 Exhaust manifold
- Check components for damage.
- ► Check components for leaks.
- Check components for tight fit.
- Check connection points between device side exhaust piping and exhaust gas stub 1, see documentation from the device manufacturer.

4

5

Exhaust gas turbocharger

Engine brake flap actuator

- Check connection points between exhaust gas turbocharger 4 and device side connection line, see documentation from the device manufacturer.
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If components are damaged:

- Do not start the engine.
- Replace damaged components, see repair instruction or documentation from the device manufacturer.

# 5.4 Engine oil system

## 5.4.1 Checking the engine oil system for leaks and damage



#### WARNING

Hot engine oil! Serious burns possible.

- ▶ Let the engine cool down to ambient temperature.
- Avoid skin contact with hot engine oil or parts carrying oil.



## CAUTION

When opening the lines of the engine oil system, possible lubricant contact with the environment, eyes, mouth or skin!

Possible poisoning or skin reaction. Harmful to aquatic organisms with continuing effects.

- ► Wear chemical safety gloves.
- ▶ Wear chemical safety glasses.
- ▶ Wear chemical safety shoes.
- ▶ Wear chemical work clothing.
- Avoid releasing into the environment.
- ▶ Dispose of contents and container in accordance with local regulations.



Fig. 97: Components to be checked

- 1 Oil pan
- 2
- Locking part Cylinder head gasket 3
- Oil filter 4
- 5 Cylinder head cover seal

- Oil separator 6
- Cylinder head cover Oil supply line 7
- 8
- Oil return line 9
- 10 Oil cooler



Fig. 98: Components to be checked

- 1 Oil level sensor
- 2 **Oil dipstick**
- Check components for leaks.
- Check components for damage.
- Check components for proper fastening.
- Check oil loss at other components.
- If components are leaking or damaged:
- Do not start engine.
- ▶ Replace damaged components, see repair instruction.

- 3 Crankcase breather system oil line 4
  - Oil filler cap

## 5.4.2 Checking the engine oil level



#### CAUTION

When opening the lines of the engine oil system, possible lubricant contact with the environment, eyes, mouth or skin!

Possible poisoning or skin reaction. Harmful to aquatic organisms with continuing effects.

- ▶ Wear chemical safety gloves.
- Wear chemical safety glasses.
- Wear chemical safety shoes.
- Wear chemical work clothing.
- Avoid releasing into the environment.
- Dispose of contents and container in accordance with local regulations.



3

**Oil dipstick** 

#### Fig. 99: Checking the engine oil level

- Oil filler neck cover 1
- 2 Oil filler neck
- ► Start the engine.
- ▶ Bring engine to operating temperature 80 ±2 °C.
- ► Turn off the engine.
- ▶ Wait 5 minutes.
- Pull out the oil dipstick 3.

- ▶ Wipe engine oil off of oil dipstick **3** with a clean cloth.
- Insert oil dipstick 3.
- Pull out the oil dipstick **3**.



Fig. 100: Oil dipstick

1 Maximum

- 2 Minimum
- Check that the oil level is between Maximum **1** and Minimum **2** on the oil dipstick **3**.

If the oil level is above the Maximum **1** mark:

▶ Drain oil.

If the oil level is below the Minimum **2** mark:

- Refill the oil.( $\rightarrow$  Filling the engine oil, p. 91)
- Insert oil dipstick 3.
- Check oil level again.

## 5.4.3 Changing the engine oil

Make sure that the following prerequisites are met:

- □ The engine is level.
- □ The engine is turned off.
- □ The engine temperature is at least 20°C or ambient temperature.
- □ A suitable drain hose is available.
- $\hfill\square$  A suitable collection container is available.
- □ Engine oil is available.
- □ Engine oil specification

## Draining the engine oil

Graphic repre- sentation	Description	Required number	Identification number
0	Drain hose	1	12690422
6	Drain hose 90°	1	12690423

Tab. 23: Special tool



#### WARNING

Hot components! Leads to serious burns.

- ▶ Let the engine cool down to below 50 °C.
- Wear heat-resistant safety gloves and heat-resistant work clothes.



#### CAUTION

When opening the lines of the engine oil system, possible lubricant contact with the environment, eyes, mouth or skin!

Possible poisoning or skin reaction. Harmful to aquatic organisms with continuing effects.

- Wear chemical safety gloves.
- ▶ Wear chemical safety glasses.
- ▶ Wear chemical safety shoes.
- ▶ Wear chemical work clothing.
- Avoid releasing into the environment.
- ▶ Dispose of contents and container in accordance with local regulations.



3

Drain hose

Fig. 103: Draining the engine oil

- **1** Oil drain valve
- 2 Protecting cap
- ► Unscrew protecting cap **2** from oil drain valve **1**.
- ▶ Place end of drain hose 4 in collection container.
- Connect drain hose 3 to oil drain valve 1.
   The oil drain valve 1 opens and the oil drains.
- Remove drain hose 3.
- Seal oil drain valve **1** with the protecting cap **2**.

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## Replacing the oil filter

#### Removing the oil filter



## WARNING

Hot components! Leads to serious burns.

- ▶ Let the engine cool down to below 50 °C.
- ▶ Wear heat-resistant safety gloves and heat-resistant work clothes.



#### CAUTION

When opening the lines of the engine oil system, possible lubricant contact with the environment, eyes, mouth or skin!

Possible poisoning or skin reaction. Harmful to aquatic organisms with continuing effects.

- ▶ Wear chemical safety gloves.
- ▶ Wear chemical safety glasses.
- ▶ Wear chemical safety shoes.
- ▶ Wear chemical work clothing.
- Avoid releasing into the environment.
- Dispose of contents and container in accordance with local regulations.



Oil filter (2x) 2

Unscrew oil filter 2.

Nozzle (2x)

#### Cleaning

1

► Clean sealing surface with a lint-free cloth.

## Installing the oil filter

#### WARNING

Hot components! Leads to serious burns.

- ▶ Let the engine cool down to below 50 °C.
- ▶ Wear heat-resistant safety gloves and heat-resistant work clothes.



#### CAUTION

When opening the lines of the engine oil system, possible lubricant contact with the environment, eyes, mouth or skin!

Possible poisoning or skin reaction. Harmful to aquatic organisms with continuing effects.

- ▶ Wear chemical safety gloves.
- ▶ Wear chemical safety glasses.
- ▶ Wear chemical safety shoes.
- ▶ Wear chemical work clothing.
- Avoid releasing into the environment.
- ▶ Dispose of contents and container in accordance with local regulations.



Fig. 105: Installing the oil filter

- 1
   Nozzle (2x)
   2
   Oil filter (2x)
- Coat seal on new oil filter **2** lightly with engine oil.
- Screw on new oil filter 2.

Tightening instruction for M30 x 2 oil filter				
Lubricant	-			
Locking agent	-			
Part contact surfaces	Engine oil	e e		
Screws	-			
Stage	Tightening torque			
1.	Screw on by hand until the seal is in contact			
2.	20 Nm			

Tab. 24: Tightening instruction

▶ Tighten new oil filter **2** according to the tightening instruction.

## Filling the engine oil



Fig. 107: Filling the engine oil (example filling on cylinder head cover)

- 1 Oil filler neck
  - Oil filler cap

Oil dipstick 3

- ▶ Unscrew oil filler cap **2**.

2

- Fill oil via oil filler neck **1**.
- Check engine oil level. ( $\rightarrow$  5.4.2 Checking the engine oil level, p. 85)
- Insert oil dipstick 3.
- Check oil level again.

If a partial quantity of oil has been drained:

- ▶ Fill oil in small quantities.
- Clean oil filler cap 2.
- ▶ Put oil filler cap 2 on the oil filler neck 1 and tighten it.
- Start the engine.
- Check the oil pressure gauge, see documentation from the device manufacturer.



Note

Resetting the oil change interval is a condition for active regeneration through post-injection.

Reset the oil change interval by means of diagnostics software or via machine display.

## 5.4.4 Replacing the oil separator filter insert

### Removing the oil separator filter insert



#### WARNING

Hot components!

Leads to serious burns.

- ▶ Let the engine cool down to below 50 °C.
- ▶ Wear heat-resistant safety gloves and heat-resistant work clothes.



#### CAUTION

When opening the lines of the engine oil system, possible lubricant contact with the environment, eyes, mouth or skin!

Possible poisoning or skin reaction. Harmful to aquatic organisms with continuing effects.

- ▶ Wear chemical safety gloves.
- Wear chemical safety glasses.
- ▶ Wear chemical safety shoes.
- Wear chemical work clothing.
- Avoid releasing into the environment.
- Dispose of contents and container in accordance with local regulations.



Fig. 108: Removing the housing cover

- 1 Housing cover 2 Screwdriver
- Open housing cover **1** with a screwdriver **2**.



Fig. 109: Replacing the oil separator filter insert

- 1 Oil separator filter housing Oil separator filter insert 2
- 3 Housing cover

- Remove housing cover 3.
- Remove oil separator filter insert **2**.

## Installing the oil separator filter insert



#### WARNING

Hot components! Leads to serious burns.

- ▶ Let the engine cool down to below 50 °C.
- ▶ Wear heat-resistant safety gloves and heat-resistant work clothes.



#### CAUTION

When opening the lines of the engine oil system, possible lubricant contact with the environment, eyes, mouth or skin!

Possible poisoning or skin reaction. Harmful to aquatic organisms with continuing effects.

- ► Wear chemical safety gloves.
- ▶ Wear chemical safety glasses.
- ▶ Wear chemical safety shoes.
- ▶ Wear chemical work clothing.
- ► Avoid releasing into the environment.
- ▶ Dispose of contents and container in accordance with local regulations.



• Clean housing cover **3** and oil separator filter housing **1** with a lint-free cloth.

# 5.5 Cylinder head

## 5.5.1 Checking and setting the valve clearance

# Setting the cylinder to top dead center (TDC) using the diagnostic software

Make sure that the following prerequisites are met:

- Installed license type: Technician Service or Technician Expert
- □ Engine has engine control unit ECU2, ECU2-HD or ECU3.
- □ *Valve clearance compensation* button is available on start page of diagnostic software.
- Click Valve clearance compensation 1 button on start page of diagnostic software.
   Valve clearance compensation function is opened.



Fig. 111: Valve clearance compensation function

Actuate starter motor: Press Switch the starter motor button.
 Starter motor rotates crankshaft.

While the starter motor is rotating the crankshaft, the diagnostics software displays several notes.



Fig. 112: Unintended movement warning





Fig. 113: Flywheel is rotating warning

After the crankshaft has been rotated by the starter motor, the diagnostics software highlights the valves to be set in color. Intake valves in blue, exhaust valves in red



- 2 Cylinder designation
- ► Check and set valve clearance at valves highlighted in color. (→ Checking and setting the valve clearance at the intake valve and exhaust valve, p. 105)
- Mark set values with a check mark  $\checkmark$  in the check box 3.
- ▶ Rotate starter motor: Press *Switch the starter motor* **(** button.
- ▶ Repeat procedure until valve clearance is set on all cylinders.





Fig. 115: Cylinder head cover

- **1** External hex bolt (5x)
- 2 Cylinder head cover
- **3** External hex bolt
- 4 Electrical plug connection
- **5** Cylinder head cover seal
- **6** Electrical connection for the injector
- **7** Nut (2x)
- ▶ Disconnect the electrical line from the electrical plug connection 4.
- ▶ Unscrew the external hex bolt **3**.
- Unscrew the external hex bolts 1.
- Remove the cylinder head cover **2**.
- ▶ Release the hex nuts 7.
- Remove the seal **5**.
- Repeat the process for all cylinder head covers.

## **Cleaning and checking**

- Clean sealing surface of cylinder head cover.
- Clean sealing surface of cylinder head.
- Clean screw connection of injector and hex nuts.
- ► Clean cylinder head cover seal.

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• Check cylinder head cover seal for cracks, breaks and deformation.

If the cylinder head cover seal is damaged:

► Replace cylinder head cover seal.

## Removing the locking part



3

External hex bolt

Fig. 116: Removing the locking part

- 1 Flywheel housing opening
- 2 Locking part
- Unscrew external hex bolt **3**.
- ▶ Remove locking part **2**.

## Installing the turning device on the flywheel housing

Make sure that the following prerequisite is met:  $\Box$  Locking piece is removed. ( $\rightarrow$  Removing the locking part, p. 99)

Graphic repre- sentation	Description	Required number	Part number
	Turning device	1	0524045



#### NOTICE

Gear teeth of turning device does not optimally engage in gear teeth of flywheel! Damage to gear teeth of flywheel and turning device.

- ▶ Make sure that gear teeth of turning device engages evenly in gear teeth of flywheel.
- Make sure that turning device turns smoothly.



Fig. 118: Installing the turning device on the flywheel housing

- 1 Flywheel housing
- 2 Adjusting screw (4x)

- **3** Hex head screw (2x)
- 4 Turning device
- Install turning device 4 on flywheel housing 1.
- Screw in hex head screws **3**.
- Align turning device 4 with adjusting screws 2 so that engine can be turned smoothly.
- ▶ Make sure that gearing of turning device engages evenly in gearing of flywheel.

## Installing the turning device on the belt pulley

Make sure that the following prerequisite is met: Cover, if present, is removed.

Graphic repre- sentation	Description	Required number	Part number
	Turning device	1	10116805





*Fig. 120: Installing the turning device on the belt pulley* 

1 Socket head screw (6x)

**3** Belt pulley

- 2 Turning device
- ▶ Install turning device **2** on belt pulley **3**.
- ► Tighten hexagon socket screw 1.

## Installing the turning device on the crankshaft

Make sure that the following prerequisite is met: Cover, if present, is removed.

Graphic repre- sentation	Description	Required number	Part number
	Turning device	1	10118801

Tab. 27: Special tool



*Fig. 122: Installing the turning device on the crankshaft* 

1 Turning device

2 Crankshaft

▶ Install turning device **1** on crankshaft **2**.

## Setting the cylinder to top dead center (TDC)

One cylinder is always in ignition TDC position and one cylinder is in overlapping TDC position at the same time.

TDC type	Ignition TDC	Overlapping TDC
Position of the piston	Between "compression" and "combustion" strokes	Between "exhaust" and "intake" strokes
Position of the valves	closed	overlapping
Rocker arms	do not press on the valve bridges	press on the valve bridges

TDC type	Ignition TDC	Overlapping TDC
Rocker arm movable by hand	Yes	No
Setting valve clearance possible.	Yes	No

Tab. 28: Differences between ignition TDC and overlapping TDC



Fig. 123: Valve overlap

## Setting table

Table shows in which cylinder valves overlap (overlapping TDC) and on which cylinder the valve clearance is to be set (ignition TDC).

Valves of the cylinder				
set (ignition TDC)	1	3	4	2
overlap (overlapping TDC)	4	2	1	3

Tab. 29: Valves of the cylinder

## Setting cylinder 1 to ignition TDC

Make sure that the following prerequisite is met:  $\Box$  Turning device is installed. ( $\rightarrow$  Installing the turning device on the flywheel housing, p. 99)



Fig. 124: TDC marks: Ignition TDC for cylinder 1

1 TDC marking of flywheel

- 2 TDC marking of flywheel housing
- Turn turning device counterclockwise.
   DC marking of flywheel 1 and TDC marking of flywheel housing 2 align.
- Make sure that the cylinder 1 rocker arm can be moved by hand. (→ Setting the cylinder to top dead center (TDC), p. 102)
  - $\triangleright$  Cylinder 1 is in ignition TDC position.
  - $\,\triangleright\,$  The valve clearance of cylinder 1 is ready to be checked.

If cylinder 1 rocker arm cannot be moved by hand:

▶ Turn crankshaft 360°.

## Set cylinder 2 to 4 to ignition TDC.

Make sure that the following prerequisite is met:

- $\Box$  Turning device is installed. ( $\rightarrow$  Installing the turning device on the flywheel housing, p. 99)
- $\Box$  Cylinder head cover is removed. ( $\rightarrow$  Removing the cylinder head cover, p. 98)
- ▶ Turn crankshaft with turning device counterclockwise 180°.
- Check if cylinder rocker arm can be moved by hand. (→ Setting table, p. 103)
   ▷ Cylinder rocker arm can be moved by hand.
  - $\triangleright$  Cylinder is in ignition TDC position.

 $\triangleright$  The valve clearance of the cylinder is ready to be checked.

# Checking and setting the valve clearance at the intake valve and exhaust valve

Make sure that the following prerequisites are met:

- □ Engine is in maintenance position.
- $\Box$  Cylinder head covers are removed. ( $\rightarrow$  Removing the cylinder head cover, p. 98)
- □ The cylinder to be checked is at ignition TDC. (→ Setting cylinder 1 to ignition TDC, p. 104) (→ Set cylinder 2 to 4 to ignition TDC., p. 104)

For settings, see table. ( $\rightarrow$  1.2.2 Valve clearance, p. 35)( $\rightarrow$  Setting the cylinder to top dead center (TDC), p. 102)



- 4 Allen wrench
- Slide feeler gauge 1 between valve bridge 2 and tappet 6.
- Check valve clearance.

If the valve clearance does not correspond to the settings: ► Release lock nut **3** on adjusting screw **5** of tappet **6**.

- Correct setting by turning adjusting screw 5.
- ► Hold onto adjusting screw 5.

Tightening instruction for lock nut			
Lubricant (thread and head contact surface)	-		
Locking agent (thread)	-		
Screws	Reusable		
Stage	Tightening torque	MINL!	
1.	45 Nm		

Tab. 30: Tightening instruction

- ▶ Tighten locknut **3** according to tightening instruction.
- Check setting again.
- ▶ Repeat process for all cylinders.

When valves have been checked and set:

▶ Install cylinder head cover. (→ Installing the cylinder head cover, p. 110)

### Removing the turning device from the flywheel housing



#### DANGER

Parts or tools flying around! Serious injuries.

Before commissioning the diesel engine, make sure that no parts or tools have been left on the diesel engine.

#### NOTICE

Turning device is installed! Damage to gearing of flywheel and turning device.

▶ Make sure that the turning device is removed before commissioning the diesel engine.



Fig. 127: Removing the turning device from the flywheel housing

1 Flywheel housing

**3** Hex head screw (2x)

2 Adjusting screw (4x)

- 4 Turning device
- ► Unscrew hex head screws **3**.
- Remove turning device 4 from flywheel housing 1.



## Removing the turning device from the belt pulley

Fig. 128: Removing the turning device from the belt pulley

**1** Socket head screw (6x)

**3** Belt pulley

- 2 Turning device
- Unscrew socket head screw 1.
- ▶ Remove belt pulley **3** from turning device **2**.

## Removing the turning device from the crankshaft



#### DANGER

Parts or tools flying around! Serious injuries.

Before commissioning the diesel engine, make sure that no parts or tools have been left on the diesel engine.


*Fig. 129: Removing the turning device from the crankshaft* 

- 1 Turning device 2 Crankshaft
- ▶ Remove turning device **1** from crankshaft **2**.

# Installing the locking part



Fig. 130: Installing the locking part

- 1 Flywheel housing opening
- 2 Locking part

**3** External hex bolt

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- ▶ Install locking part **2**.
- ► Tighten external hex bolt **3**.

## Installing the cylinder head cover



Fig. 131: Cylinder head cover

- 1 External hex bolt (5x)
- 2 Cylinder head cover
- **3** External hex bolt
- 4 Electrical plug connection
- Degrease cylinder head cover seal **5**.
- ▶ Install the cylinder head cover seal **5**.
- Connect the electrical connection for the injector **6**.
- **5** Cylinder head cover seal
- **6** Electrical connection for the injector
- 7 Nut (2x)

Tightening instruction for	nut	
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	-	
Stage	Tightening torque	
1.	1.8 ^{+0.2} Nm	



- ▶ Tighten hex nuts 7 according to tightening instruction.
- ► Install the cylinder head cover **2**.

Tightening instruction for nut		
Lubricant (thread and head contact surface)	-	Tightening sequence
Locking agent (thread)	-	5
Screws	-	
Stage	Tightening torque	
1.	16 Nm	1 2
2.	24 Nm	
		3 4

Tab. 32: Tightening instruction

- ► Tighten hex head screws **1** according to tightening instruction.
- ► Tighten the external hex bolt **3**.
- Connect the electrical line to the electrical plug connection 4.

# 5.6 Cooling system

# 5.6.1 Checking the cooling system and heating system for leaks and damage



#### WARNING

Hot cooler parts and hot coolant! Leads to serious burns.

- ▶ Let engine cool down to below 100 °C before all work.
- ▶ Wear protective gloves and safety goggles.



Fig. 134: Components to be checked

- 1 Drain plug
- 2 Water cooler supply
- **3** Coolant pump
- 4 Expansion tank return
- Check components for leaks.
- Check components for damage.

- **5** Cylinder head gasket
- 6 Expansion tank supply
- 7 Oil cooler
- 8 Water cooler return

- Check the expansion tank (device side), see documentation from the device manufacturer.
- Check the coolant line connections (device side), see documentation from the device manufacturer.
- Check the completeness of all components, see documentation from the device manufacturer.

If components are leaking or damaged:

- Do not start engine.
- ▶ Replace damaged components, see repair instructions.

# 5.6.2 Checking the coolant level



#### WARNING

Hot cooler parts and hot coolant! Leads to serious burns.

- ▶ Let engine cool down to below 100 °C before all work.
- Wear protective gloves and safety goggles.
- ▶ For procedure to check the coolant level, see documentation from the device manufacturer.

If the coolant level is too low or too high:

- Do not start the engine.
- ▶ Refill the coolant, see documentation from the device manufacturer.(→ 5.6.3 Checking the concentration of the antifreeze agent in the coolant, p. 113)

# 5.6.3 Checking the concentration of the antifreeze agent in the coolant

## Checking the concentration of the antifreeze agent



#### WARNING

Hot cooler parts and hot coolant! Leads to serious burns.

- ▶ Let engine cool down to below 100 °C before all work.
- Wear protective gloves and safety goggles.
- Open sealing cap on filler neck. See documentation from the device manufacturer.
- Take a coolant sample.
- Analyze the sample using a suitable test method.
- If necessary, correct the mixing ratio of the antifreeze agent in the coolant.

#### Correcting the concentration of the antifreeze agent

► If necessary, calculate the missing quantity of antifreeze agent according to the calculation formula (→ fig. 135, p. 114).

#### NOTICE

Concentration of the antifreeze agent too high! Damage to engine.

▶ Make sure that the concentration of the antifreeze agent is between 50% and 60%.



Fig. 135: Calculation formula for refilling quantity of antifreeze agent, example 29 vol.%

- 1 Coolant fill quantity in liters
- **3** Refilling quantity of antifreeze agent in liters
- 2 Measured concentration in vol. %
- > Drain the calculated refilling quantity from the cooling system.
- ▶ For coolant fill quantity, see documentation from the device manufacturer.
- Fill the calculated refilling quantity of the antifreeze agent.

# 5.6.4 Replacing the coolant

Make sure that the following prerequisites are met:

- Heating valves are open.
- A collection container with the necessary capacity is available.
- A suitable drain hose is available, see documentation from the device manufacturer.
- The necessary quantity of coolant is available, see documentation from the device manufacturer.

## Draining the coolant on the device

Drain the coolant via the device side outlet, see documentation from the device manufacturer.

# Draining the coolant on the engine

Make sure that the following prerequisites are met:

- □ Heating valves are open.
- □ A collection container with the necessary capacity is available.
- □ A suitable drain hose is available, see documentation from the device manufacturer.
- The necessary quantity of coolant is available, see documentation from the device manufacturer.

Graphic representationDescriptionRequired numberIdentification numberDrain hose112690422Drain hose 90°112690423





#### WARNING

Hot cooler parts and hot coolant! Leads to serious burns.

- ▶ Let engine cool down to below 100 °C before all work.
- ▶ Wear protective gloves and safety goggles.

#### NOTICE

Escaping coolant! Injuries

- ► Avoid skin contact with coolant.
- ► Follow the manufacturer's instructions.
- ▶ When mixing coolant, wear rubber gloves and safety goggles.
- ▶ Wash coolant in the eyes or on the skin off with water immediately.



- Release the end cover on the device side compensation tank.
   Excess pressure escapes from the cooling system.
- Put a collection container under the drain valve 2.
- Unscrew protecting cap 1.
- Screw drain hose 4 onto drain valve 2.
   Coolant runs out.

When the coolant has drained completely:

► Tighten protecting cap 1.

#### Filling the coolant

- ► Fill the coolant via the device side filler neck. (→ Correcting the concentration of the antifreeze agent, p. 113)
- Fill cooling system up to maximum.
- ▶ Place the sealing cap on the compensation tank and close it.
- Replace sealing cap on expansion tank with a new part. See documentation from the device manufacturer.
- Let the engine warm up.
   Coolant temperature > 80 °C.
- ▶ Turn off the engine. ( $\rightarrow$  4.3 Turning off the engine, p. 66)
- ► Let the engine cool down.
- Check coolant level. ( $\rightarrow$  5.6.2 Checking the coolant level, p. 113)

If the coolant level is too low or too high:

Correct the coolant level, see documentation from the device manufacturer.

# 5.7 Fuel system

# 5.7.1 Safety instructions for working on the fuel system

# **Preventing personal injuries**



#### DANGER

When the engine is running, the fuel lines are constantly under a fuel pressure of up to 2400 bar (34810 psi)!

Escaping liquids can penetrate the skin and will lead to injuries.

- Only work on the fuel and injection system when the engine is turned off.
- Reduce the pressure to below 10 bar (145 psi) with diagnostics software.
- Check the residual pressure with diagnostics software. (variables: 6996 Fuel Pressure High 1/ 6997 Fuel Pressure High 2)
- ► Use suitable protective equipment when working on the fuel and injection system. (→ 2.7 Personal protective equipment, p. 45)
- Do not open any fuel lines and hoses that are under pressure.
- ▶ Do not remove any fuel lines and hoses that are under pressure.
- Protect hands, face and body against escaping liquids when searching for leaks 1-18n on lines and hoses that are under pressure. (→ 2.7 Personal protective equipment, p. 45)
- Screw connections on injection system tight with prescribed tightening torques.

# Preventing material damages

Components in the fuel and injection system are high-precision parts that are exposed to extreme stresses. Even the smallest dirt particles can cause the failure of certain components. - Pay attention to the utmost cleanliness during work on the fuel and injection system.

Pay attention to the following before starting work:

- Perform work on the fuel and injection system in areas in which no dust is raised or where diverse dirt particles could enter the working area.
- Use an appropriate workshop or assembly shop for work on the fuel and injection system.
- Cover the hood with a clean protective sheet.
- Before removing parts: clean and dry the relevant area of the engine thoroughly.
- Perform a visual inspection for leaks or damage to the fuel and injection system.
- Use clean and undamaged tools.
- Replace any damaged tools promptly.
- Change any working clothes that have been worn for dirty work beforehand.
- Wash hands before starting work.
- Use lint-free cleaning rags.

Pay attention to the following during work:

- If the clean side of the fuel system is opened: do not use compressed air.
- Remove loose dirt (for example paint slivers) during work.
- Open line connections must be sealed off to protect them from dust and moisture.
- Removed parts must be packed away and stored to protect them from dust and moisture. Do
  not dismantle removed parts of the injection system (high pressure pump, injector connector
  tube, injector).
- Only remove "new" parts from their original packing shortly before installation and check their suitability for use.
- Pay attention to the utmost cleanliness when working on removed components.

- Use fresh cleaning fluids.
- If removed components are being shipped: always use the original packing of the "new" part.

# 5.7.2 Reducing the pressure in the fuel system

If the engine is running:

- Turn off engine.
- Check pressure reduction with diagnostics software (variables: 6996 Fuel Pressure High 1/ 6997 Fuel Pressure High 2). (→ 7.2 Diagnostic tools, p. 166)
   ▷ Pressure is below 10 bar.

# 5.7.3 Checking the fuel system for leaks and damage



#### WARNING

When the engine is running, the fuel lines are constantly under a fuel pressure of up to 2400 bar

Escaping liquids can penetrate the skin and will lead to injuries.

- Only work on the fuel and injection system when the engine is turned off.
- ▶ Reduce pressure to below 20 bar with diagnostics software.
- Check the residual pressure with diagnostics software.
- > Put on suitable protective equipment when working on the fuel and injection system.
- ▶ Do not open any fuel connections that are under pressure.
- Do not remove any fuel lines and hoses that are under pressure.
- Protect hands, face and body against escaping liquids when searching for leaks on lines and hoses that are under pressure.
- Screw connections on injection system tight with prescribed tightening torques.



Fig. 139: Components

- 1 Fuel high pressure pump
- 2 Fuel fine filter
- **3** Fuel fine filter console
- 4 Injection pipes
- Check components for damage.
- Check components for proper fastening.
- Check fuel tank and fastening, see documentation from the device manufacturer.
- Check tank lid, see documentation from the device manufacturer.
- Check fastening of fuel line to the fuel tank, see documentation from the device manufacturer.
- If components are damaged:
- Do not start the engine
- ▶ Replace defective components, see repair instruction.

# 5.7.4 Replacing the fuel prefilter



#### Note

The fuel prefilter with water separator is not attached directly to the diesel engine and is installed differently depending on the device design, see documentation from the device manufacturer.

- 5 Fuel line
- **6** Distributor block
- 7 Fuel return line

Make sure that the following prerequisites are met: A collection container for escaping fuel is available.

#### NOTICE Dirt!

Damage to common rail system.

- Make sure that no dirt comes in contact with fuel-carrying parts.
- Do not reuse fuel prefilter and fuel fine filter.
- Observe instructions for work on the Common Rail System.
- ▶ For procedure to replace the fuel prefilter, see documentation from the device manufacturer.
- ▶ Ventilate fuel system. ( $\rightarrow$  5.7.6 Ventilating the fuel system, p. 122)

# 5.7.5 Replacing the fuel fine filter

### Removing the fuel fine filter

Make sure that the following prerequisites are met: A collection container is available.

#### NOTICE

Dirt! Damage to common rail system.

- ▶ Make sure that no dirt comes in contact with fuel-carrying parts.
- ▶ Do not reuse fuel prefilter and fuel fine filter.
- Observe instructions for work on the Common Rail System.



Fig. 140: Replacing the fuel fine filter

1 Fuel fine filter

If the engine is running:

- Turn off the engine.
- Wait 20 minutes.
- ► Check pressure reduction with diagnostics software (variables: 6996 Fuel Pressure High 1/ 6997 - Fuel Pressure High 2). (→ 7.2 Diagnostic tools, p. 166)

If the pressure is below 10 bar:

- ▶ Put a collection container under the fuel fine filter.
- Close the fuel shut-off valve (device side).
- Clean the fuel fine filter console **2** and surrounding area.
- Remove fuel fine filter **1**.

## Cleaning

- Clean the thread and sealing surface of the fuel fine filter **1** with a lint-free cloth.
- Clean the thread and sealing surface of the fuel fine filter console **2** with a lint-free cloth.

## Installing the fuel fine filter

#### NOTICE

Dirt!

Damage to common rail system.

- ▶ Make sure that no dirt comes in contact with fuel-carrying parts.
- ▶ Do not reuse fuel prefilter and fuel fine filter.
- Observe instructions for work on the Common Rail System.

2 Fuel fine filter console



Fig. 141: Replacing the fuel fine filter

1 Fuel fine filter

- 2 Fuel fine filter console
- Lubricate the sealing surface of the fuel fine filter **1** with engine oil.

Tightening instruction for fuel fine filter SW 30 unlocking hex		
Lubricant	-	
Locking agent	-	
Part contact surfaces	Engine oil	
Screws	-	
Stage	Tightening torque	
1.	Screw on by hand until the seal is in contact	
Stage	Angle of rotation	
2.	by hand 3/4 of a revolu- tion	

Tab. 34: Tightening instruction

- ▶ Tighten new fuel fine filter **1** according to the tightening instruction.
- Open the fuel shut-off valve (device side).
- ▶ Ventilate the fuel system. ( $\rightarrow$  5.7.6 Ventilating the fuel system, p. 122)

# 5.7.6 Ventilating the fuel system

# Note

The fuel system is to be vented on the device side and is to be performed differently depending on the device design, see documentation from the device manufacturer.



*Fig.* 143: *Fuel diagram, external system (example)* 

- **1** Connection to engine
- 2 Fuel air cooler (optional)
- **3** Fuel prefilter

- 4 Water separator
- 5 Manual ventilation pump
- **6** Fuel tank
- ► Turn device side shut-off valve on manual ventilation pump **5** to "manual ventilation" position.
- Build up pressure in the fuel system with the manual ventilation pump **5**.
- Wait 1 minute.
   Pressure escapes through ventilation.
- Build up pressure at least three times via the manual ventilation pump **5**.
- ▶ Wait until the pressure has been released through ventilation.
- ▶ Turn the shut-off valve on the manual ventilation pump **5** to the "operation" position.

# 5.8 Air filter

# 5.8.1 Checking the air filter low pressure indicator

For procedure to check the air filter low pressure indicator, see documentation from the device manufacturer.

# 5.8.2 Cleaning the air filter dust discharge valve

► For procedure to clean the air filter dust discharge valve, see documentation from the device manufacturer.

# 5.8.3 Replacing the dry air filter main element

► For procedure to replace the dry air filter main element, see documentation from the device manufacturer.

# 5.8.4 Replacing the dry air filter safety element

► For procedure to replace the dry air filter safety element, see documentation from the device manufacturer.

# 5.9 Electrical system

# 5.9.1 Checking the batteries

- Check all components for contamination through a visual inspection, see documentation from the device manufacturer.
- Check all components for mechanical damage through a visual inspection, see documentation from the device manufacturer.

# 5.9.2 Checking the cable set plug

- Check all components for contamination through a visual inspection, see documentation from the device manufacturer.
- Check all components for mechanical damage through a visual inspection, see documentation from the device manufacturer.

# 5.9.3 Checking the engine control unit bearings for damage



Fig. 144: Engine control unit mounting

- 1 Engine control unit bearing
- Check engine control unit bearings **1** for damage.
- Check engine control unit bearings **1** for tight fit.

If bearings are damaged or worn:

- Do not start the engine.
- Replace bearings, see repair manual.

# 5.9.4 Checking sensors, actuators, cable holders and plugs

#### NOTICE

Disconnected plug connections! Damage to plug connections.

▶ Leave plug connections plugged in during the visual inspection.



Fig. 145: Cable harness (example application)

- **1** Speed sensor -B711
- 2 Interface for splitter box temperature sensor (optional) -X720
- 3 Phase sensor -B713

**4** Wastegate control valve -Y705 See next page for continuation of the image legend

- **13** Heating flange back measurement -E703
- 14 Heating flange E703
- **15** Generator back measurement -F705.X
- **16** Generator -G700

- **5** Pressure sensor -B702
- **6** Terminating resistor -X724.S
- 7 Engine brake flap actuator -M715
- 8 Volume control valve VCV -Y703
- 9 Pressure control valve PCV -Y707
- **10** Injectors -Y731/-Y732/-Y733/-Y734
- **11** Coolant temperature sensor -B708
- **12** Temperature sensor -B707
- Check components for tight fit.
- Check components for damage.
- Check components for abrasion-free laying.
- Check components for proper fastening.
- Check components for contamination through engine oil, fuel, coolant and urea solution.

If components are damaged:

- Do not start the diesel engine.
- ▶ Replace defective components, see repair instructions.

- **17** Pressure sensor -B703
- 18 Fuel temperature sensor -B709
- **19** Pressure sensor -B704
- **20** Oil pressure sensor -B701
- 21 Interface -X710.S
- 22 Oil temperature and level sensor -B730
- 23 Starter motor -M700
- 24 Starter motor battery line KL30

# Checking resistance in the heating flange

Make sure that the following prerequisite is met: Ohmmeter or multimeter is available.



#### Fig. 146: Heating flange

1 Heating flange

**3** Positive pole

2 Ground

If a battery master switch is present:

- Turn off the battery master switch.
- ▶ Disconnect the negative cable from the battery.
- Disconnect the electrical connection cable from the positive pole **3**.
- Connect the ohmmeter or multimeter to the positive pole **3** and to ground **2**.
- Measure the resistance.
- If the resistance at 20 ±23 °C falls below 230 ±23 mOhm:
- Check heating flange for sooting. ( $\rightarrow$  Checking the heating flange for sooting, p. 130)



#### ► Unscrew external hex bolt **4**.

▶ Remove heating flange 5.

#### NOTICE

Undiscovered damage on the exhaust gas turbocharger! Oil residues in the exhaust gas recycling pipe or connection line.

• Check the exhaust gas turbocharger for oil loss.

Checking the heating flange for sooting

- Check heating flange **5** for sooting.
- Check the air intake pipe **1** for sooting.
- Check the air intake pipe **1** for oil residues.

If the heating flange is sooted:

- Clean the heating flange with brake cleaner.
- Remove brake cleaner residues from the heating flange.
- ► Install heating flange.

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Tightening instruction f	or ground and positive pole	e M6 hex bolts
Lubricant	-	
Locking agent	-	
Part contact surfaces	-	
Screws	Reusable	
Stage	Tightening torque	
1.	8.5 * ¹ Nm	

Tab. 35: Tightening instruction

- ► Tighten hex head screws for ground **2** and positive pole **3** according to tightening instruction. Hold bottom nut in place while doing so.
- Connect the ohmmeter or multimeter to the positive pole **3** and to ground **2**.
- Measure the resistance.
- If the resistance at 20 ^{±23} °C falls below 230 ^{±23} mOhm:
- Replace the heating flange.
- Connect the electrical connection cable to the positive pole **3**.
- Connect the negative cable to the battery.

# 5.9.5 Replacing the heating flange

# Removing the heating flange



#### Fig. 149: Replacing the heating flange

- 1 Air intake pipe (example)
- **2** Positive pole

- **3** External hex bolt
- 4 Heating flange
- Disconnect the electrical line from the positive pole 2.
- ▶ Unscrew external hex bolt **3**.
- Remove heating flange **4**.

# Installing the heating flange



Fig. 150: Replacing the heating flange

- 1 Air intake pipe (example)
- 2 Positive pole
- ▶ Install new heating flange **4**.
- Screw in external hex bolt **3**.
- Connect the electrical line to the positive pole **2**.
- Connect the ground line to the battery.
- **3** External hex bolt
- 4 Heating flange

# 5.10 Exhaust aftertreatment system

# 5.10.1 Safety instructions for working on the exhaust aftertreatment system (SCR system)

#### Definition of terms

Water urea solution is used to reduce pollutants in the SCR catalytic converter. The term AdBlue® (brand name of the German Association of the Automotive Industry, VDA) or DEF (Diesel Exhaust Fluid) is also commonly used. In this document, the term reduction agent is used for water/diesel exhaust fluid.

# **Reduction agent**

In the SCR system (Selective Catalytic Reduction), reduction agent is used to reduce nitrogen oxide ( $NO_x$ ) components in the exhaust.

# **General safety instructions**

Only authorized technical staff may perform work on the exhaust aftertreatment system.

# Preventing personal injuries

When the engine is running, the lines and hoses for reduction agent are under a pressure of up to 15 bar.

Escaping reduction agent can lead to injuries.

- Only work on the exhaust aftertreatment system when the engine is turned off. Before starting work: After turning off the engine, wait at least 20 minutes until the pressure in the exhaust aftertreatment system has been released. Check the pressure reduction with the "LiDIA" diagnostics software.
- Reduction agent attacks an unprotected body. Make sure that hands, face and body do not come in contact with reduction agent. Use suitable protective equipment (for example, safety glasses, protective gloves, etc.) during all work on the exhaust aftertreatment system.
- Tighten connections on the exhaust aftertreatment system with the prescribed tightening torque.
- Keep reduction agent away from heat sources. When reduction agents are heated, ammonia vapors harmful to health are produced. Ensure sufficient ventilation.

During the work, observe the following:

- Let the exhaust aftertreatment system cool down to below 50 °C.
- At ambient temperature, reduction agent disintegrates over time and ammonia vapors are produced. Sufficiently ventilate the work area.
- If ammonia vapors are inhaled: Ensure a sufficient fresh air supply, consult a doctor if necessary.
- In case of skin contact with reduction agent: Clean respective body parts with water and soap, consult a doctor if necessary.
- Work clothing contaminated with reduction agent: Remove work clothing and wash respective areas with water and soap.
- In case of eye contact with reduction agent: Rinse eyes (also under eyelids) with plenty of water, consult a doctor if necessary.
- If reduction agent is swallowed: Do not induce vomiting. Drink plenty of water, consult a doctor if necessary.

# Serious poisoning

Ammonia gas due to improper repair.

- Let the exhaust system cool down to below 100 °C before all work.
- Do not heat diesel exhaust fluid deposits.
- Ensure sufficient ventilation.

Inhalation of toxic dust.

- Put on FFP3 protective mask.
- Minimize dust formation.

## Preventing property damage

During all work on the exhaust aftertreatment system, ensure that reduction agent and "old" parts are disposed in an environmentally friendly manner.

- Reduction agent may not get into the ground, sewage system or water in larger quantities.
- Collect reduction agent only in suitable containers and dispose properly.
- Before disposing or recycling waste materials, ask about the correct method at the responsible environmental or recycling center. Incorrect waste disposal can damage the environment and ecology.
- Reduction agent attacks unstable materials (for example, glass, paint, aluminum, copper, brass, etc.). Make sure that engine parts do not come in contact with reduction agent. Cover engine parts beforehand for relevant work.
- Components of the exhaust aftertreatment system consist of highly precise parts. Even the smallest particles of dirt can lead to failure of components. For all work on the exhaust aftertreatment system, ensure the utmost cleanliness.

Before starting work, observe the following:

- Perform work on the exhaust aftertreatment system only in areas, in which no dust is stirred up (for example, through grinding and welding work) and no other particles of dirt get into the work area.
- Before removing parts, thoroughly clean and then dry the respective area of the engine.
- Observe the blow-out times of the SCR system before disconnecting the electrical power supply.

During the work, observe the following:

- Perform a visual inspection for leaks or damage on the exhaust aftertreatment system, replace defective parts if necessary.
- If reduction agent leaks: Do not allow reduction agent to get into the ground, sewage system or water in larger quantities. Absorb with suitable binding agents and properly dispose contaminated binding agents.
- Rinse removed parts (e.g. lines, injector, etc.) with water and dry them.
- Package and store removed parts so they are dust and moisture proof.
- Do not remove "new" parts from the original packing until just before installation and check their reusability.
- If removed parts are being shipped, always use the original packing for the "new" part.

# 5.10.2 Checking the exhaust gas aftertreatment system for leaks and damage

# SCRFilter (single-flow)



**WARNING** Ammonia gas due to improper repair! Leads to serious poisoning.

▶ Let exhaust system cool down to below 100 °C before all work.



U-clamp (2x)

V-band clamp (3x)

V-band clamp (2x)

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#### Fig. 151: Components to be checked

- 1 V-band clamp (2x)
- 2 Sensor connection (13x)
- **3** Hinge bracket (2x)
- 4 Reduction agent injector (1x)
- Check components for leaks.
- Check components for tight fit.
- Check components for damage.

If components are damaged, leaking or loose:

Do not start engine.

► Tighten loose components.

▶ Replace damaged components, see repair instructions.

# 5.10.3 Checking the components

# SCRFilter (single-flow)



#### WARNING

Ammonia gas due to improper repair! Leads to serious poisoning.

▶ Let exhaust system cool down to below 100 °C before all work.



Fig. 152: Tightening torques (example)

- 1 V-band clamp (3x)
- 2 V-band clamp (2x)
- **3** V-band clamp (2x)
- 4 Hinge bracket (2x)

- 5 U-clamp (2x)
- 6 Diesel exhaust fluid injector (1x)
- 7 Temperature sensor/pressure sensor/ differential pressure line/screw fitting (13x)
- 8 Nitrogen oxides sensor/SCR NH₃ sensor (1x)

Part	Tightening torque
V-band clamp <b>1</b>	23 ^{±2} Nm
V-band clamp <b>2</b>	18 +2/ -1 Nm

Part	Tightening torque
V-band clamp <b>3</b>	23 ±2 Nm
Hinge bracket <b>4</b>	21 *1 Nm
U-clamp <b>5</b>	23 ^{±2} Nm
Diesel exhaust fluid injector <b>6</b>	5 <i>±0.5</i> Nm
Temperature sensor/pressure sensor/differential pressure line/ screw fitting <b>7</b>	35 ⁺⁵∕ -0 Nm
Nitrogen oxides sensor/SCR $NH_3$ sensor <b>8</b>	50 <i>±10</i> Nm

Tab. 36: Tightening torques

► Check component for tight fit.

If a component is loose:

▶ Tighten component with tightening torque according to tightening instruction.

# 5.10.4 Troubleshooting hydrocarbon (HC) deposits

#### NOTICE

Fuel deposits in the exhaust aftertreatment system Damage to or destruction of the catalyst Replacement of the exhaust aftertreatment system outside the warranty

► Follow instructions for handling with accumulations of HC in the exhaust aftertreatment system.(→ 5.10.4 Troubleshooting hydrocarbon (HC) deposits, p. 138)

# Error P339A-00: SCR system - Warning of overloading of catalyst due to deposited hydrocarbon

#### **Error text in LiDIA**

SCR system - hydrocarbon loading in catalyst too high

Tab. 37

▶ Read error on the device, see LiDIA operator's manual.

If the engine has an exhaust flap or has a way to increase the engine load:

- Bring device into maintenance position
  - $\triangleright$  Regeneration starts automatically.
  - $\triangleright$  Exhaust temperature increases.
  - ▷ Engine speed may increase. The device remains in maintenance position.
  - ▷ Regeneration is automatically completed when the diesel oxidation catalyst and SCR element are free.
  - $\triangleright$  Warning light is no longer displayed.

If the engine does not have an exhaust flap:

- Increase engine load manually and avoid idling speed.
- Continue to use the device until the warning light goes out.
   This takes place after a certain operating time with exhaust temperatures >230 °C

### Error P339B-00 SCR system - Critical warning of overloading of catalyst due to deposited hydrocarbon

#### **Error text in LiDIA**

SCR system - hydrocarbon loading in catalyst critically too high

Tab. 38

If the engine is equipped with an exhaust flap or a way to increase the load through the device:

- Read error on the device, see LiDIA operator's manual.
- Stop device.
- ▶ Bring device into maintenance position
  - ▷ Regeneration starts automatically.
  - ▷ Exhaust temperature increases.
  - ▷ Engine speed may increase. The device remains in maintenance position.
  - ▷ Regeneration is automatically completed when the catalyst is free.
  - $\triangleright$  Warning light goes out.

For engines without an exhaust flap:

- ▶ Increase load on engine manually and avoid idling speed.
- Continue to use the device until the warning light goes out.
   This takes place after a certain operating time with exhaust temperatures >230 °C

# 5.10.5 Replacing the filter module

The filter module replacement is based on an exchange principle. That means that during an upcoming maintenance interval, a cleaned replacement (AT) filter module is ordered and installed.

The filter module replacement is monitored by a diagnostics system. 5000h after the last filter module replacement, a warning appears on the device display that the filter module must be replaced. If this is not performed, after 6000h, the AWL lamp or MIL lamp appears or an error is permanently displayed, and a power limitation automatically takes place.

5000h since the last filter module replacement	6000h since the last filter module replacement
	Permanent error (P13E2)
Warning (P242F) is shown in the device display when the igni- tion is switched on	MIL lamp <b>(C)</b> illuminates.
	Low power limitation

Tab. 39: Ash load of the filter module

# Ordering the exchange part filter module

As soon as a filter module replacement is imminent, a replacement filter module can be ordered from Liebherr-Logistik GmbH. It is possible to purchase a new filter module or a cleaned filter module. The replacement filter module is delivered in original Liebherr packaging and includes a new or cleaned filter module, depending on the customer's order.

#### NOTICE

Improper maintenance Damage to the filter element

- The filter module requires an adapted / new cleaning technology and procedure for the periodic ash cleaning.
- The cleaning technology for Stage IIIB / Tier 4i and retrofit DPF may not be used under any circumstances!
- The procedure applied for the conventional DPF (CRT[®] or SCRT[®]) can lead to irreparable damage and destruction of the filter element for the filter module.
- Order a new exchange part filter module via the spare parts catalog.
- Unpack the new exchange part filter module.
- ▶ Keep the packing for the exchange part filter module.
- ► Check removed filter module for external damage and cracks in the substrate before the return shipment.(→ Checking the filter module before return, p. 144)

#### Removing the pressure measurement lines

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#### Note

Depending on the installation situation, removal of the pressure measurement lines may not be required.



#### Note

The hose line and the parts used for fastening may differ depending on the installation situation and are only described here as examples.



Fig. 153: Removing the pressure measurement lines

- 1 Pressure measurement line after particulate filter
- 2 Spring band clamp (4x)
- **3** Hose line
- 4 Pressure connection
- ▶ Release spring band clamps **2**.

- Differential pressure sensor
- 6 Hose line
- 7 Pressure measurement line before particulate filter
- 8 Reference pressure connection
- ▶ Remove hose line **3** from pressure measurement line after particulate filter **1**.
- ▶ Remove hose line **3** from reference pressure connection **8** on differential pressure sensor **5**.

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- ▶ Remove hose line 6 from pressure measurement line before particulate filter 7.
- ▶ Remove hose line 6 from pressure connection 4 on differential pressure sensor 5.
- Remove spring band clamps **2** from hose lines.
- Check hose lines for damage and replace if necessary.

# Remove filter module (single-flow)

Variant 1: Remove inlet module in order to remove the filter module



Fig. 154: Remove filter module

- 1 Inlet module
- 2 Hinge bracket
- 3 V-band clamp
- 4 Seal
- 5 V-band clamp
- **6** Mixing pipe

- 7 Seal
- 8 Filter module
- 9 V-band clamp
- **10** Seal
- 11 Hinge bracket
- 12 SCR outlet module
- Secure filter module **8** against falling with securing element (wooden block, sling, support).
- ▶ Release the V-band clamp **3** and slide it on the inlet module **1**.
- ▶ Release the V-band clamp **5** and slide it on the filter module **8**.
- ► Release the hinge bracket **2**.
- Push the inlet module 1 back at least 40 mm.
- ▶ Release the V-band clamp 9 and slide it on the SCR outlet module 12.
- ▶ Release filter module 8.
- ▶ Remove filter module 8.

# Í

Note

▶ While the filter module **8** is not installed, protect all openings against dirt and moisture.

- Remove seal 4.
- Remove seal 7.
- Remove seal 10.
- Seal openings.

#### Cleaning

Clean sealing surfaces.

#### Variant 2: Remove outlet module in order to remove the filter module



Fig. 155: Remove filter module

- 1 Inlet module
- 2 Hinge bracket
- **3** V-band clamp
- 4 Seal
- 5 V-band clamp
- 6 Mixing pipe

- 7 Seal
- 8 Filter module
- 9 V-band clamp
- 10 Seal
- 11 Hinge bracket
- 12 SCR outlet module
- Secure the filter module 8 against falling with a securing element (wooden block, sling, support).
- ▶ Release the V-band clamp **9** and slide it on the SCR outlet module **12**.
- ▶ Release V-band clamp **5** and slide it on filter module **8**.
- ▶ Release the hinge bracket **11**.
- ▶ Push the SCR outlet module **12** back at least 40 mm.
- ► Release filter module 8.
- ► Remove filter module **8**.
- Remove seal 7.
- Remove seal 10.
- Seal openings.

#### Cleaning

Clean sealing surfaces.

# Checking the filter module before return

#### Checking the filter housing

The filter module can be sent for cleaning if none of the following defects are visible:

- Center ring bent
- Dents on the filter housing



Tab. 40: Examples for damage to filter module and substrate

• Check removed filter module for external damage and cracks in the substrate before the return shipment.

#### Checking the substrate

The filter module can be sent for cleaning if none of the following defects are visible:

- Missing webs in the substrate
- Frayed edges of the substrate on the filter housing
- Cracks in the substrate


Tab. 41: Examples for damage to substrate

Check removed filter module for damage and cracks in the substrate before the return shipment.

### Packing the filter module for transport

## 1 Note

- ► Have the filter module cleaned by authorized Liebherr service centers.
- ▶ Pack the filter module to be cleaned in the packing of the new filter module.
- Send the filter module to an authorized Liebherr service center for cleaning.

## Installing the filter module (single-flow)

#### Variant 1: Installing the inlet module



Fig. 162: Installing the filter module

- 1 Inlet module
- 2 Hinge bracket
- 3 V-band clamp
- 4 Seal
- 5 V-band clamp
- 6 Mixing pipe
- 7 Seal

- 8 Filter module
- 9 V-band clamp
- 10 Seal
- **11** Hinge bracket
- 12 Outlet module
- **13** Flow direction



#### WARNING

Ammonia gas due to improper repair! Leads to serious poisoning.

- ▶ Let exhaust system cool down to below 100 °C before all work.
- ▶ Install new seal **4**.
- ▶ Install new seal 7.
- ▶ Install new seal **10**.
- Slide new profile clamp **5** on the filter module.
- Slide new profile clamp **9** on the filter module.
- ▶ Install new filter module 8.

#### NOTICE

Damage to the seal! Escaping exhaust.

▶ Do not turn filter module **8** in installed condition.

- Secure filter module 8 against falling with securing element (wooden block, sling, support).
- Slide new profile clamp **3** on the inlet module **1**.
- Slide the inlet module **1** in the direction of the filter module **8**.
- ▶ Tighten V-band clamp **3** according to tightening instruction.
- ▶ Tighten V-band clamp **5** according to tightening instruction.
- ▶ Tighten V-band clamp **9** according to tightening instruction.

#### NOTICE

Leak on the exhaust aftertreatment assembly! Escaping exhaust.

During tightening, distribute the tension in the profile clamps with gentle taps of a rubber mallet.

Then tighten V-band clamps an additional time to ensure firm seating:

- ▶ Tighten V-band clamp **3** according to tightening instruction.
- ▶ Tighten V-band clamp **5** according to tightening instruction.
- ▶ Tighten V-band clamp **9** according to tightening instruction.
- ▶ Tighten hinge bracket 2 according to tightening instruction.
- ▶ Release filter module **8**.

#### Variant 2: Installing the outlet module



See next page for continuation of the image legend

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Operator's manual

- V-band clamp 5
- 6 Mixing pipe
- 7 Seal

- Outlet module 12
- 13 Flow direction



#### WARNING

Ammonia gas due to improper repair! Leads to serious poisoning.

- ▶ Let exhaust system cool down to below 100 °C before all work.
- Install new seal 7.
- Install new seal 10.
- ▶ Slide new profile clamp 9 on the filter module.
- Slide new profile clamp **5** on the filter module.
- Install new filter module 8.
- Secure filter module 8 against falling with securing element (wooden block, sling, support).
- Slide outlet module 12 in direction of filter module 8.
- ▶ Tighten V-band clamp 9 according to tightening instruction.
- ▶ Tighten V-band clamp **5** according to tightening instruction.

Then tighten V-band clamps an additional time to ensure firm seating:

- ▶ Tighten V-band clamp **9** according to tightening instruction.
- ▶ Tighten V-band clamp **5** according to tightening instruction.
- ▶ Tighten hinge bracket **11** according to tightening instruction.
- ▶ Release filter module 8.

### Installing the pressure measurement lines



#### Note

For a reliable measurement of the pressure, the connection between the hose line and the pressure measurement line must always be airtight.



Fig. 164: Installing the pressure measurement lines

- 1 Pressure measurement line after particulate filter
- 2 Spring band clamp (4x)
- Hose line 3
- 4 Pressure connection
- ▶ Install new spring band clamps 2 on hose lines.
- Install hose line 3 with spring band clamp 2 on reference pressure connection 8.
- ▶ Install hose line **3** with spring band clamp **2** on pressure measurement line after particulate filter 1.

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- ▶ Install hose line 6 with spring band clamp 2 on pressure connection 4.
- Install hose line 6 with spring band clamp 2 on pressure measurement line before particulate filter 7.

Tightening instruction for differential pressure sensor			
Lubricant (thread and head contact surface)	-		
Locking agent (thread)	-		
Screws	Reusable		
Stage	Tightening torque		
1.	6 Nm		

Tab. 42: Tightening instruction

- ▶ Tighten screws of differential pressure sensor **5** according to tightening instruction.

- Differential pressure sensor
- Hose line
- Pressure measurement line before particulate filter 8
  - Reference pressure connection

## Resetting the ash load indicator

A reset code is needed to reset the ash load indicator.

#### Generating a reset code in MyLiebherr

## **i**)

Note

Only registered MyLiebherr users can generate a reset code.



Fig. 166: Product selection list in MyLiebherr

**1** Registered machines

**3** Available applications

- 2 Search field
- Search for machine in search field **2**.
- Select machine in list of registered machines 1.
- ▶ In Available applications for the machine **3**, select *Filter module exchange* application.

If the Filter module exchange application is not available:

- Contact Liebherr customer service.
- Before filter exchange, log into MyLiebherr with machine number and engine serial number.
   MyLiebherr checks the filter status.
  - ▷ After entering the new particulate filter serial number, MyLiebherr generates a reset code. MyLiebherr displays the code immediately and sends it to the user by e-mail.
- To reset the ash load: Enter reset code on machine display.
- ▶ For the correct entry of the reset code, see documentation from the device manufacturer.

#### Generating a reset code in Backend from MyLiebherr

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#### Note

Liebherr service partners can use Backend from MyLiebherr to generate a reset code for entry in the machine display or a reset code for entry in LiDIA. For additional information, contact Liebherr service partner.

 Log into Backend from MyLiebherr (protected area, only possible for Liebherr service partners).

LIEBHERR	Filtermodule Exchange Baci	kend	ENGLISH	FA	
MyApps Correction	an filter module	Generate reset code			— 1

Fig. 167: Available applications in the developer settings of MyLiebherr

- **1** Generate reset code application
- Click Generate reset code application 1 and follow the instructions.
   MyLiebherr checks the filter status.
  - After entering the new particulate filter serial number, MyLiebherr generates a reset code. MyLiebherr displays the code immediately and sends it to the user by e-mail.
- Enter reset code on machine display: See documentation from the device manufacturer.
- Enter reset code in LiDIA: Connect LiDIA to engine control unit.
- ► Call up Component exchange menu in LiDIA.

٢	と LIDIA				- I <b>¢</b> I-	×	
	🗲 Com	ponent E	xchange	<u>č</u>			
	ECU3 - Primar	У					
	ECU3		<b>DPF</b>			 	1
	Undiscovered						
		11 11	HD				
	EDC17	ECU2	ECU2-HD				

?

C Refresh

#### Fig. 168: Component exchange menu in LiDIA

- 1 Diesel particulate filter button
- Click *Diesel particulate filter* button **1**.

	🎖 LIDIA		□ ×	
	← Partic	ulate Filter		
	Question	Summary		
6 -	Engine-SN:	2022041349	<b>^</b>	
5 -	Filter-SN:	LR123456		
4 -	Code:	Bgw5Lvj50lxBEYIc4bDo5Erlos5r5MlbGlyjPBuriP3S7O3u9na/0u+nCmlf7g1L462qZ9A1JQlgX+lglxjBBg		
	Engine can be interrupted:	HELP BOX           The code should be requested on <a href="https://www.myliebherr.com/">https://www.myliebherr.com/</a> In case MyLiebherr is not reachable, you can contact your dealer customer service in order to get the code or send an email to <a href="https://www.myliebherr.com/">LMB-DPFFilter-Unlockers</a>	+	7
3 -		LIEBHERR		
		CUSTOMER 12345678		
2 -		SERIAL No XXXXXXXX		
		SUPPLER PATT No ISSUE LEVEL ABCD123		
		MANUFACTURE 01 / 02 / 03	~	
1 -			C	9
		Help	Replace	

#### Fig. 169: Entering the reset code

- **1** *Help* button
- 2 Filter module serial number
- 3 Help box
- 4 Input field for reset code
- **5** Input field for filter module serial number
- Click *Help* button **1**.

- **6** Engine serial number
- 7 Link to MyLiebherr Backend
- 8 E-mail link to request a reset code
- **9** *Replace* button

The Help box **3** contains an exemplary representation of the fields of the filter module type plate and the link to MyLiebherr Backend **7** to generate the reset code.

Click Link to MyLiebherr Backend 7 in Help box 3.

If link does not work:

- ► To obtain a reset code: Contact Liebherr customer service by e-mail at LMB-DPFFilter-Unlockers@liebherr.com.
- ▶ Take filter module serial number 2 from filter module type plate.
- Enter filter module serial number 2 in Input field for filter module serial number 5.
- Enter reset code in Input field for reset code 4.
- Click *Replace* button 9.
   Ash load is reset in engine control unit.

## 5.11 Lubricants and operating fluids

## $\mathbf{i}$

Observe safety data sheets and specifications at https://lubricants.liebherr.com.

## 5.11.1 Fill quantities

Note

Name	Fill quantity
Engine oil	25 l (including 1.5 l per filter)
Coolant (engine)	15 l
Reduction agent	See documentation from the device manufacturer.

Tab. 43: Fill quantities for oil change (reference values)

## 5.11.2 Approved engine oils

## Engines with emission limit stage Tier 4 Final

#### Liebherr products

When using original Liebherr lubricant products, the longest possible change interval according to the maintenance schedule can be used.

Sulfur content in fuel in ppm	Engine oil change interval
Up to 15	100 % (standard interval according to maintenance schedule)
Liebherr recom- mends using the following products.	Liebherr Motoroil 5W-30 LA Liebherr Motoroil 10W-40 LA
Lubricating oil specification	LH-00-ENG LA

Tab. 44: Engine oil change intervals when using Liebherr products

### Third party products



### Note

When using engine oils from other manufacturers
 Obtain information on the change intervals from the respective manufacturer or supplier.



#### Note

Engine oils used must correspond to the Liebherr specification LH-00-ENG LA. Obtain information on this from the respective manufacturer or supplier.

Depending on the oil quality and the fuel used, the following reductions to the oil change interval in comparison to the standard oil change interval will result.

Sulfur content in fuel in ppm	Engine oil change interval
15	50%
Lubricating oil specification	LH-00-ENG LA

Tab. 45: Change interval when using non-Liebherr products

### Engines with emission limit stage V

#### Liebherr products

When using original Liebherr lubricant products, the longest possible change interval according to the maintenance schedule can be used.

Sulfur content in fuel in ppm	Limit values
10	100% (standard interval according to maintenance schedule)
Liebherr recom- mends using the following products.	Liebherr Motoroil 5W-30 LA Liebherr Motoroil 10W-40 LA
Lubricating oil specification	LH-00-ENG LA

Tab. 46: Engine oil change intervals when using Liebherr products

#### Third party products



#### Note

When using engine oils from other manufacturers

Obtain information on the change intervals from the respective manufacturer or supplier.



#### Note

Engine oils used must correspond to the Liebherr specification LH-00-ENG LA. Obtain information on this from the respective manufacturer or supplier.

Depending on the oil quality and the fuel used, the following reductions to the oil change interval in comparison to the standard oil change interval will result.

Sulfur content in fuel in ppm	Limit values
10	50%
Lubricating oil specification	LH-00-ENG LA

Tab. 47: Engine oil change intervals when using non-Liebherr products

## 5.11.3 Coolant

#### Note

Mixing different antifreeze agents causes the properties of the coolant to deteriorate!

- ► Avoid combining different products.
- ▶ Do not mix silicate-containing and silicate-free coolants.

## Antifreeze

#### Liebherr recommendation

Туре	Name
Coolant ready mix: finished mixture (50 % water and 50 % anti-freeze)	Liebherr-Antifreeze OS Mix
Antifreeze: to be mixed at a ratio of 50:50 with water according to the minimum requirements	Liebherr-Antifreeze OS Concentrate

Tab. 48: Recommendations for anticorrosive and antifreeze agents

### Minimum requirements for the quality

#### Specification

LH-01-COL

Tab. 49: Minimum requirement for the quality

### Water

#### Liebherr recommends water having the following qualities.

Corresponds to the guideline for drinking water from the World Health Organization (WHO) from 2006.

Demineralized water (reverse osmosis water)

Tab. 50: Minimum requirements for the quality

## 5.11.4 Approved fuels

## Engines with emission limit stage Tier 4 Final according to ASTM D975 1-D S15/2-D S15

#### Minimum requirement for the quality

Criterion	Limit values
Maximum sulfur content in the fuel	15 ppm
Lubricity at 60 °C (HFRR)	≤460 µm
Fuel purity for tank filling according to ISO 4406:	18/17/14
Minimum cetane number	45

Criterion	Limit values
Maximum fatty acid methyl ester (FAME) content	≤6 vol. %

Tab. 51: Minimum requirement for diesel fuels

## Engines with emission limit stage V according to DIN EN 590

#### Minimum requirement for the quality

Criterion	Limit values
Maximum sulfur content in the fuel	10 ppm
Lubricity at 60 °C (HFRR)	≤460 µm
Fuel purity for tank filling according to ISO 4406:	18/17/14
Minimum cetane number	45
Maximum fatty acid methyl ester (FAME) content	≤7 vol. %

Tab. 52: Minimum requirement for diesel fuels

Specification
LH-00-FUEL

Tab. 53: Minimum requirement for the quality

## 5.11.5 Reduction agent

Approved reduction agent:

- Reduction agent standardized according to ISO 22241

#### Specification

LH-00-UREA

Tab. 54: Minimum requirement for the quality for better results

Designations:

- AdBlue® in Europe
- DEF (Diesel exhaust fluid) in the USA
- AUS 32 (aqueous urea solution)

Maintenance Lubricants and operating fluids

## **6** Malfunctions

See Faults - Cause - Remedy table for engine problems and corrective measures. ( $\rightarrow$  6.1 Faults - Cause - Remedy, p. 159)

The engine control unit has an error memory. Error entries are stored in the error memory. The remedy for the errors is described in the device documentation.

The following are available for error identification:

- Warning lights in the device display
- Diagnostics software ( $\rightarrow$  7.2 Diagnostic tools, p. 166)

## 6.1 Faults - Cause - Remedy

Malfunction / error	Cause	Remedy	
Starter does not crank.	Main fuse defective	▶ Replace fuse.	
Starter does not crank.	Battery connections loose or corroded	<ul> <li>Clean and tighten loose connections.</li> </ul>	
		► Clean contacts.	
Starter does not crank.	Battery voltage too low	► Charge or replace battery.	
Starter does not crank.	Starter circuit interrupted	<ul> <li>Contact Liebherr customer service.</li> </ul>	
Starter does not crank.	Contacts corroded	► Clean contacts.	
Starter does not crank.	Starter defective	<ul> <li>Contact Liebherr customer service.</li> </ul>	
Starter cranks slowly.	Battery voltage too low	► Charge or replace battery.	
Starter cranks slowly.	Battery connections loose or corroded	<ul> <li>Clean and tighten loose connections.</li> </ul>	
Starter cranks slowly.	Outside temperature too low	<ul> <li>Follow measures for winter operation.</li> </ul>	
Starter cranks slowly.	Engine under load	Disconnect the unit from the auxiliary output.	
		Make sure that frictional connection between the engine and transmission is discon- nected.	
Engine stops immediately after	Fuel tank empty	▶ Refuel.	
starting.		Ventilate the fuel system.	
Engine stops immediately after starting.	Fuel fine filter clogged	Replace the fuel fine filter.	
Engine stops immediately after starting.	Fuel prefilter clogged	Replace the fuel prefilter.	

Faults - Cause - Remedy

Malfunction / error	Cause	Remedy	
Engine stops immediately after starting.	Fuel line, pre-cleaner or sieve in fuel tank clogged	<ul> <li>Clean fuel line, pre-cleaner or sieve in fuel tank.</li> </ul>	
		<ul> <li>Ventilate the fuel system.</li> </ul>	
Engine stops immediately after	Fuel not cold-resistant	<ul> <li>Clean the fuel prefilter.</li> </ul>	
starting.		<ul> <li>Replace the fuel fine filter.</li> </ul>	
		<ul> <li>Use winter fuel.</li> </ul>	
Engine stops immediately after starting.	Outside temperature too low	<ul> <li>Follow measures for winter operation.</li> </ul>	
Engine stops immediately after starting.	Heating flange defective (at cold temperatures)	<ul> <li>Check heating flange, replace if necessary.</li> </ul>	
Engine stops immediately after starting.	Exhaust gas system dirty	<ul> <li>Clean exhaust gas system.</li> </ul>	
Engine stops immediately after	Exhaust flap closed	<ul> <li>Check exhaust flap control.</li> </ul>	
starting.		<ul> <li>Contact Liebherr customer service.</li> </ul>	
Engine starts poorly.	Leak or too low pressure in the fuel low pressure circuit	<ul> <li>Perform leak test (visual inspection).</li> </ul>	
		<ul> <li>Contact Liebherr customer service.</li> </ul>	
Engine starts poorly.	Engine compression too low	<ul> <li>Contact Liebherr customer service.</li> </ul>	
Engine starts poorly.	Heating flange defective (at cold temperatures)	<ul> <li>Check heating flange, replace if necessary.</li> </ul>	
Engine starts poorly.	Fault of the electronics	<ul> <li>Contact Liebherr customer service.</li> </ul>	
Engine starts poorly.	Rail pressure too low	Inspect fuel rail for leaks.	
Engine starts poorly.	Air in fuel system	Ventilate the fuel system.	
Engine starts poorly.	Air filter clogged	<ul> <li>Check air filter for contamina- tion.</li> </ul>	
Engine starts poorly.	Inferior fuel quality	<ul> <li>Only use fuel recommended by Liebherr.</li> </ul>	
Engine starts poorly.	Injector defective	<ul> <li>Contact Liebherr customer service.</li> </ul>	
Engine starts poorly.	For engines without hydraulic tappets: Valve clearance not set correctly. For engines with hydraulic tappets: Hydraulic tappet defective.	For engines without hydraulic tappets: Check valve clearance. If necessary, set valve clear- ance. For engines with hydraulic tappets: Contact Liebherr customer service.	
Engine turns off inadvertently.	Voltage supply interrupted	<ul> <li>Contact Liebherr customer service.</li> </ul>	

Malfunction / error	Cause	Remedy
Engine turns off inadvertently.	Leak or too low pressure in the fuel low pressure circuit	<ul> <li>Perform leak test (visual inspec- tion).</li> </ul>
		<ul> <li>Have checked by Liebherr customer service.</li> </ul>
Engine turns off inadvertently.	Fault of the electronics	<ul> <li>Contact Liebherr customer service.</li> </ul>
Engine turns off inadvertently.	Fuel supply not ensured	<ul> <li>Check fuel system.</li> </ul>
Power reduction of the engine	Fuel system defective	<ul> <li>Perform visual inspection.</li> </ul>
		▶ Replace filter.
Power reduction of the engine	Charging pressure too low	<ul> <li>Check clamps, seals, hoses and air filter.</li> </ul>
Power reduction of the engine	Charge air temperature too high	<ul> <li>Check charge air cooler, fan and ambient temperature.</li> </ul>
Power reduction of the engine	Coolant temperature too high	• Check cooler for contamination.
		▶ Check fan.
		<ul> <li>Check thermostat.</li> </ul>
		<ul> <li>Check coolant level.</li> </ul>
Power reduction of the engine	Fuel temperature too high	<ul> <li>Contact Liebherr customer service.</li> </ul>
Power reduction of the engine	Oxygen content of the air too low since application > 1800 m above sea level	No defect, engine power automati- cally reduced
Power reduction of the engine	Injectors stick or do not spray.	<ul> <li>Contact Liebherr customer service.</li> </ul>
Power reduction of the engine	Engine compression too low	<ul> <li>Contact Liebherr customer service.</li> </ul>
Power reduction of the engine	Fault of the electronics	Read error memory of the engine control unit.
Power reduction of the engine	Exhaust gas aftertreatment system blocked	<ul> <li>Contact Liebherr customer service.</li> </ul>
Power reduction of the engine	For engines without hydraulic tappets: Valve clearance not set correctly. For engines with hydraulic tappets: Hydraulic tappet defective.	For engines without hydraulic tappets: Check valve clearance. If necessary, set valve clear- ance. For engines with hydraulic tappets: Contact Liebherr customer service.
Power reduction of the engine	Too little diesel exhaust fluid in diesel exhaust fluid tank	Fill up reducing agent.
Insufficient engine brake power	Exhaust flap without function	<ul> <li>Check exhaust flap for function and damage.</li> </ul>
		<ul> <li>Contact Liebherr customer service.</li> </ul>
Insufficient engine brake power	Fault of the electronics	<ul> <li>Contact Liebherr customer service.</li> </ul>

Faults - Cause - Remedy

Malfunction / error	Cause	Remedy	
Hot engine (according to coolant temperature display)	Too little coolant <a> Refill.</a>		
Hot engine (according to coolant Cooler dirty inside or calcified,		▶ Clean cooler.	
temperature displayJ	cooler dirty outside	<ul> <li>Decalcify cooler.</li> </ul>	
Hot engine (according to coolant	Thermostat defective	<ul> <li>Check thermostat.</li> </ul>	
temperature display)		<ul> <li>If necessary, replace thermo- stat.</li> </ul>	
Hot engine (according to coolant temperature display)	Coolant temperature sensor defec- tive	<ul> <li>Check coolant temperature sensor.</li> </ul>	
		<ul> <li>If necessary, replace coolant temperature sensor.</li> </ul>	
Hot engine (according to coolant	Fan speed too low (only hydrostatic	<ul> <li>Check fan drive.</li> </ul>	
temperature displayJ	fan drivej	► If necessary, replace fan drive.	
Hot engine (according to coolant temperature display)	Coolant pump defective	Replace coolant pump.	
Hot engine (according to coolant temperature display)	V-ribbed belt tension insufficient	<ul> <li>Check V-ribbed belt tension. If necessary, replace tensioner (self tensioning).</li> </ul>	
Charging current indicator light illu- minates when engine is running.	V-ribbed belt torn	Replace V-ribbed belt.	
Charging current indicator light illu- minates when engine is running.	Cable connections loose or discon- Fasten or replace cable.		
Charging current indicator light illu- minates when engine is running.	Alternator, rectifier or controller defective	<ul> <li>Contact Liebherr customer service.</li> </ul>	
Charging current indicator light illu- minates when engine is running.	Open test circuit	<ul> <li>Contact Liebherr customer service.</li> </ul>	
Engine smokes black.	Exhaust gas aftertreatment system defective	<ul> <li>Contact Liebherr customer service.</li> </ul>	
Engine smokes black.	Injection system defective	<ul> <li>Contact Liebherr customer service.</li> </ul>	
Engine smokes black.	Charge air pressure sensor defec- tive	<ul> <li>Replace charge air pressure sensor.</li> </ul>	
Exhaust gases are blue.	Oil level in engine too high	<ul> <li>Correct oil level.</li> </ul>	
Exhaust gases are blue.	Engine oil burns in combustion chambers.	<ul> <li>Contact Liebherr customer service.</li> </ul>	
Exhaust gases are blue.	Compressor-side seal on the exhaust gas turbocharger defective	<ul> <li>Contact Liebherr customer service.</li> </ul>	
Exhaust gases are blue.	Exhaust gas-side seal on the exhaust gas turbocharger defective	<ul> <li>Contact Liebherr customer service.</li> </ul>	
Exhaust gases are blue.	Crankcase breather system defec- tive	Check, replace if necessary.	
Exhaust gases are blue.	Piston rings defective	<ul> <li>Contact Liebherr customer service.</li> </ul>	

Malfunction / error	Cause	Remedy
Exhaust gases are blue.	Valve stem seals defective	<ul> <li>Contact Liebherr customer service.</li> </ul>
Exhaust gases are white.	Injection delayed	<ul> <li>Contact Liebherr customer service.</li> </ul>
Exhaust gases are white.	Heating flange defective (tempera- ture < -10 °C)	<ul> <li>Check heating flange. If necessary, replace heating flange.</li> </ul>
Exhaust gases are white.	Coolant in combustion chamber	<ul> <li>Contact Liebherr customer service.</li> </ul>
Engine rattles.	Combustion faults	<ul> <li>Contact Liebherr customer service.</li> </ul>
Engine knocks.	Injection nozzles damaged or coked	<ul> <li>Contact Liebherr customer service.</li> </ul>
Engine knocks.	Bearing damage	<ul> <li>Contact Liebherr customer service.</li> </ul>
Engine knocks.	Piston rings worn, piston rings broken, piston scuffed	<ul> <li>Contact Liebherr customer service.</li> </ul>
Abnormal noises	Leaks on suction lines and exhaust pipes cause whistling noises.	<ul> <li>Eliminate leak. If necessary, replace seal.</li> </ul>
Abnormal noises	Foreign object in compressor or turbine	<ul> <li>Contact Liebherr customer service.</li> </ul>
Abnormal noises	Turbine wheel or compressor wheel rubbing against housing	<ul> <li>Contact Liebherr customer service.</li> </ul>
Abnormal noises	Seized bearings on rotating parts	<ul> <li>Contact Liebherr customer service.</li> </ul>
Lubricating oil pressure too low	Oil level in the oil pan too low	<ul> <li>Correct oil level.</li> </ul>
Lubricating oil pressure too low	Engine oil too thin	<ul> <li>Drain engine oil.</li> </ul>
		▶ Fill engine oil.
		<ul> <li>Determine cause of the oil dilu- tion and rectify.</li> </ul>
Lubricating oil pressure too low	Oil pressure sensor defective	<ul> <li>Check engine oil system.</li> </ul>
		<ul> <li>Replace damaged oil pressure sensor.</li> </ul>
Lubricating oil pressure too low	End control valve defective	<ul> <li>Contact Liebherr customer service.</li> </ul>
Lubricating oil pressure too low	End control valve dirty	<ul> <li>Contact Liebherr customer service.</li> </ul>
Lubricating oil pressure too low	Bearing play due to wear too great or bearing damage	<ul> <li>Contact Liebherr customer service.</li> </ul>
Lubricating oil pressure too low	Oil pump defective	Check oil pump.
		▶ Replace oil pump, if necessary.
Lubricating oil pressure too low	Oil filter clogged	Replace oil filter.

#### Malfunctions

Faults - Cause - Remedy

Malfunction / error	Cause	Remedy
Lubricating oil pressure too low	Oil pressure regulating valve defec- tive	<ul> <li>Contact Liebherr customer service.</li> </ul>
Engine oil in cooling system	Oil cooler or oil cooler plate is leaking.	<ul> <li>Contact Liebherr customer service.</li> </ul>
Coolant in engine oil	O-rings on cylinder liners are leaking.	<ul> <li>Contact Liebherr customer service.</li> </ul>
Coolant in engine oil	Oil cooler or oil cooler plate is leaking.	<ul> <li>Contact Liebherr customer service.</li> </ul>

## 7 Tools

## 7.1 Special tools

Representa- tion	Description	Required number	Part number
0	Drain hose	1	12690422
6	Drain hose 90°	1	12690423
	Turning device	1	10116805
	Turning device	1	10118801
	Turning device	1	0524045

Tab. 55: Special tool

## 7.2 Diagnostic tools

▶ For information on diagnostic tools, see diagnostics software operating instructions.

## 8 Assembly agents

Use the following locking agent, sealant and lubricating greases for repair and maintenance work. Refer to the respective work description for the application.



Note

Safety data sheets for assembly agents, see manufacturer's website.

Locking agent			
Designation	Part number	Quantity	Manufacturer information
Loctite® 243	811205708	50 ml	https://www.henkel-adhesives.com
Loctite® 278	811200908	50 ml	https://www.henkel-adhesives.com
Loctite [®] 572	8655023	50 ml	https://www.henkel-adhesives.com
Loctite® 648	870001914	50 ml	https://www.henkel-adhesives.com
Loctite® 2701	811208001	50 ml	https://www.henkel-adhesives.com

Tab. 56: Locking agent

Sealant			
Designation	Part number	Quantity	Manufacturer information
Loctite [®] 542	10288254	50 ml	https://www.henkel-adhesives.com
Loctite [®] 577	811201314	50 ml	https://www.henkel-adhesives.com
Loctite [®] 5910	10354595	300 ml	https://www.henkel-adhesives.com
Loctite [®] 5970	10167395	300 ml	https://www.henkel-adhesives.com
Weicon [®] Black-Seal	12697087	85 ml	https://www.weicon.de
Dinitrol® 4010	8460270	500 ml	https://www.dinitrol.shop/de/dini- trol-4010-500ml-spruhdose.html

Tab. 57: Sealant

Lubricants						
Designation	Part number	Quantity	Manufacturer information			
NBU 30 lubricating grease	10285708	1 kg	https://www.klueber.com			
Motorex copper paste	10002552	850 g	https://www.motorex.com			
Altemp QNB 50	10490569	80 g	https://www.klueber.com			
Klüberplus S 06-100	12694669	1 kg	https://www.klueber.com			
Barrierta L 55/3	8655029	1 kg	https://www.klueber.com			
Anti-Seize "High-Tech" Montagespray AS 400	861203005	400 ml	http://www.debus-spray.de			
Rock Valley Oil Rockcut	12696115	5 ml	http://www.rockvalleyoil.com/			
Innotec Ceramic Grease	11830242	0.295 kg	https://innotec.info			

Lubricants			
Molub-Alloy™ Paste White T	040710450	100 g	https://www.castrol.com
Molykcote [®] Longterm 2 Plus	8100714	1 kg	https://www.dupont.com/

Tab. 58: Lubricants

## **9** Screw connections

## 9.1 Tool recommendation

Use torque wrench / angle wrench to achieve the required accuracy and efficiency.

## 9.2 Threadlocker

Some screws are treated with pre-applied threadlocker (Precote^{*} or Tuflok^{*}) or threadlocker to be applied (Loctite^{*}).

Screws with pre-applied threadlocker (marked in color) are not reusable. Screws with Loctite[®] treatment are reusable, unless otherwise documented.

- Clean internal thread with tap.
- Clean reusable screws completely of Loctite[®] residues.

## 9.3 Tightening torques

# 9.3.1 Hex head screws / hexagon socket screws / hexalobular flange head screws

The standard tightening torques listed apply to screws with standard threads. A specific tightening instruction is specified for screws used with fine threads.



Tab. 59: Head shapes

Standard thread	Tightening torque		
Strength class	8.8	10.9	
M4	3 Nm	4 Nm	
M5	6 Nm	8 Nm	
M6	10 Nm	14 Nm	
M8	23 Nm	34 Nm	
M10	46 Nm	68 Nm	
M12	79 Nm	117 Nm	
M14	125 Nm	185 Nm	
M16	195 Nm	280 Nm	
M18	280 Nm	390 Nm	
M20	390 Nm	560 Nm	

Tab. 60: Tightening torques for metric standard thread

Head shape or shape of the nut	Surface treatment
	FLZN/480H (matte gray)

Tab. 61: Head shapes

Standard thread	Tightening torque		
Strength class	8.8	10.9	
M4	2.4 Nm	3.6 Nm	
M5	4.8 Nm	7 Nm	
M6	8.3 Nm	12 Nm	
M8	20 Nm	29 Nm	
M10	40 Nm	59 Nm	
M12	69 Nm	101 Nm	
M14	110 Nm	161 Nm	
M16	166 Nm	244 Nm	
M18	240 Nm	340 Nm	
M20	335 Nm	480 Nm	

Tab. 62: Tightening torques for metric standard thread

## 9.3.2 High temperature screws



Fig. 178: High temperature screws

High temperature screws with special markings and screw heads according to DIN 34801.

Standard thread	Tightening torque		
Marking	GA	SD	VW
M6	9 Nm	10 Nm	13 Nm
M8	23 Nm	25 Nm	30 Nm
M10	45 Nm	50 Nm	60 Nm

Standard thread	Tightening torque		
M12	75 Nm	85 Nm	100 Nm

Tab. 63: Tightening torques for high temperature screws

## 9.3.3 Screw plugs and banjo bolts with separate seal



Fig. 179: Screw plugs and banjo bolts

Screw plugs according to DIN 908

Banjo bolts according to DIN 7643

Screw plugs and banjo bolts with copper seal according to DIN 7603 or BS sealing ring

Standard thread	Tightening torque	Standard thread	Tightening torque
M6	7 Nm	M24	68 Nm
M8	7.5 Nm	M26	75 Nm
M10	15 Nm	M27	87 Nm
M12	20 Nm	M30	115 Nm
M14	30 Nm	M33	120 Nm
M16	40 Nm	M36	155 Nm
M18	40 Nm	M38	171 Nm
M20	47 Nm	M39	215 Nm
M22	57 Nm	M42	240 Nm

Tab. 64: Tightening torques for screw plugs and banjo bolts

## 9.3.4 VSTI screw plugs



Fig. 180: VSTI screw plugs

1 Screw plug with o-ring

2 Screw plug with ED seal

Standard thread	Tightening torque	Standard thread	Tightening torque
M10 x 1	10 Nm	M26 x 1.5	100 Nm
M12 x 1.5	20 Nm	M27 x 2	120 Nm
M14 x 1.5	30 Nm	M30 x 1.5	120 Nm
M16 x 1.5	40 Nm	M33 x 2	200 Nm
M18 x 1.5	50 Nm	M38 x 1.5	280 Nm
M20 x 1.5	60 Nm	M42 x 2	350 Nm
M22 x 1.5	80 Nm	M48 x 2	400 Nm
M24 x 1.5	90 Nm		

Tab. 65: Tightening torques for VSTI screw plugs

## 9.3.5 Threaded union for steel or cast iron mating materials



Fig. 181: Overview of threaded union

- 1 Form A With sealing ring (washer)
- 2 Form E Flat (ED) seal

- **3** Form F O-ring
- 4 Form F O-ring plus washer



#### Note

Tightening torques apply for steel or cast iron mating materials.

- ▶ For screw-in studs in stainless steel, lubricate thread with new engine oil before screwing in.
- Define series L or S through dimensioning of pipe diameter X and thread Y.

Pipe diameter X	Thread Y	Form A with sealing ring (washer)	Form E with flat (ED) seal	Form F with o- ring	Form F with o- ring plus washer
			Tightenin	g torque	
6 mm	M10 x 1.0	9 Nm	18 Nm	15 Nm	18 Nm
8 mm	M12 x 1.5	20 Nm	25 Nm	25 Nm	35 Nm
10 mm	M14 x 1.5	35 Nm	45 Nm	35 Nm	45 Nm
12 mm	M16 x 1.5	45 Nm	55 Nm	40 Nm	55 Nm
15 mm	M18 x 1.5	55 Nm	70 Nm	45 Nm	70 Nm
18 mm	M22 x 1.5	65 Nm	125 Nm	60 Nm	180 Nm
22 mm	M26 x 1.5	90 Nm	180 Nm	100 Nm	250 Nm
28 mm	M33 x 2.0	150 Nm	310 Nm	160 Nm	310 Nm
35 mm	M42 x 2.0	240 Nm	450 Nm	210 Nm	450 Nm
42 mm	M48 x 2.0	290 Nm	540 Nm	260 Nm	540 Nm

## Metric screw fittings series L (light)

Tab. 66: Tightening torques for metric screw fittings series L (light)

## Metric screw fittings series S (heavy)

Pipe diameter X	Thread Y	Form A with sealing ring (washer)	Form E with flat (ED) seal	Form F with o- ring	Form F with o- ring plus washer
			Tightenin	g torque	
6 mm	M10 x 1.0	-	23 Nm	-	-
6 mm	M12 x 1.5	20 Nm	40 Nm	35 Nm	35 Nm
8 mm	M14 x 1.5	35 Nm	40 Nm	45 Nm	60 Nm
10 mm	M16 x 1.5	45 Nm	70 Nm	55 Nm	95 Nm
12 mm	M18 x 1.5	55 Nm	90 Nm	70 Nm	120 Nm
14 mm	M20 x 1.5	55 Nm	125 Nm	80 Nm	-
16 mm	M22 x 1.5	65 Nm	135 Nm	100 Nm	190 Nm
20 mm	M27 x 2.0	90 Nm	180 Nm	170 Nm	190 Nm
25 mm	M33 x 2.0	150 Nm	310 Nm	310 Nm	500 Nm
30 mm	M42 x 2.0	240 Nm	450 Nm	330 Nm	600 Nm
38 mm	M48 x 2.0	290 Nm	540 Nm	420 Nm	600 Nm

Tab. 67: Tightening torques for metric screw fittings series S (heavy)

## 9.3.6 Threaded union for aluminum mating material



Fig. 182: Overview of threaded union

**1** Form A - With sealing ring (washer)

2 Form E - Flat (ED) seal



Note

Tightening torques apply for aluminum mating material.

▶ For screw-in studs in stainless steel, lubricate thread with new engine oil before screwing in.

## Metric screw fittings series L (light) for aluminum

Pipe diameter X	Thread Y	Form A with sealing ring (washer)	Form E with flat (ED) seal		
		Tightening torque			
6 mm	M10 x 1.0	15 Nm	12 Nm		
8 mm	M12 x 1.5	-	20 Nm		
10 mm	M14 x 1.5	30 Nm	30 Nm		
12 mm	M16 x 1.5	40 Nm	40 Nm		
15 mm	M18 x 1.5	-	50 Nm		
18 mm	M22 x 1.5	80 Nm	90 Nm		
22 mm	M26 x 1.5	80 Nm	130 Nm		
28 mm	M30 x 1.5	-	180 Nm		
28 mm	M33 x 2.0	-	220 Nm		
35 mm	M42 x 2.0	-	320 Nm		
42 mm	M48 x 2.0	-	380 Nm		

Tab. 68: Tightening torques for metric screw fittings series L for aluminum

## 9.3.7 Nut for cutting ring screw fittings



Fig. 183: Cutting ring screw fittings

Series	Pipe diameter X	Standard thread Z	Tightening torque
LL	6 mm	M10 × 1	14 Nm
L	6 mm	M12 x 1.5	14 Nm
	8 mm	M14 x 1.5	20 Nm
	10 mm	M16 x 1.5	30 Nm
	12 mm	M18 x 1.5	60 Nm
	15 mm	M22 x 1.5	105 Nm
	18 mm	M26 x 1.5	150 Nm
	22 mm	M30 x 2	200 Nm
	28 mm	M36 x 2	250 Nm
	35 mm	M45 x 2	450 Nm
	42 mm	M52 x 2	600 Nm
S	16 mm	M24 x 1.5	150 Nm
	20 mm	M30 x 2	250 Nm
	25 mm	M36 x 2	450 Nm
	30 mm	M45 x 2	600 Nm
	38 mm	M52 x 2	750 Nm

Tab. 69: Tightening torques for cutting ring screw fittings

## 9.3.8 Nut for Triple Lok® screw fittings



Fig. 184: Triple Lok[®] screw fittings



#### Note

► For stainless steel threaded unions, lubricate thread and sealing cone with new engine oil before screwing in.

Series	Pipe diameter X	Standard thread Z	Steel	Stainless steel
		UN/UNF	Tightenir	ng torque
4	6 mm	7/17-20	15 Nm	30 Nm
5	8 mm	1/2-20	20 Nm	40 Nm
6	10 mm	9/16-18	30 Nm	60 Nm
8	12 mm	3/4-16	60 Nm	115 Nm
10	14 mm 15 mm 16 mm	7/8-14	75 Nm	145 Nm
12	18 mm 20 mm	1 1/16-12	110 Nm	180 Nm
16	22 mm	1 5/16-12	135 Nm	225 Nm
	25 mm	1 5/16-12	175 Nm	255 Nm
	28 mm	1 5/8-12	260 Nm	295 Nm
20	30 mm 32 mm	1 5/8-12	260 Nm	295 Nm
	35 mm	1 7/8-12	340 Nm	345 Nm
24	38 mm	1 7/8-12	340 Nm	345 Nm
28	42 mm	2 1/4-12	380 Nm	400 Nm
32	50 mm	2 1/2-12	450 Nm	470 Nm

Tab. 70: Tightening torques for Triple Lok[®] screw fittings

## 9.3.9 Adapter for plastic quick couplings



Fig. 185: Adapter for plastic quick couplings

Standard thread	Tightening torque
M8 x 1	7 Nm
M10 x 1	12 Nm
M12 x 1.5	20 Nm
M14 x 1.5	30 Nm
M16 x 1.5	35 Nm
M18 x 1.5	45 Nm

Tab. 71: Tightening torques for adapter for plastic quick couplings

## 9.3.10 Stud bolts



#### Fig. 186: Stud bolts

Standard thread	Tightening torque
M6	5 Nm
M8	10 Nm
≥M10	15 Nm

Tab. 72: Tightening torques for stud bolts

Screw connections Tightening torques
## **10** Appendix

# 10.1 Information for customers in the USA (49 states) and California

## 10.1.1 Emission warranty

Liebherr warrants to the initial and subsequent owners of an off-road equipment certified diesel engine that such engine is:

- Designed, manufactured and equipped to conform at the time of sale with all applicable emission regulations adopted by (a) the state of California and the California Air Resources Board ("CARB") and (b) the United States Environmental Protection Agency ("EPA") under Section 213 of the Clean Air Act.
- Free from defects in materials and workmanship with respect to the warranted emission control system and components for a period of five (5) years or 3000 hours of total operation by all persons, whichever event occurs first, after date of delivery to the initial owner.

If any warranted part that is scheduled for replacement as required maintenance fails prior to the first scheduled replacement point for that part, that part will be repaired or replaced by Liebherr. If a component of the emission control system fails during the warranty period, it will be repaired or replaced under warranty and warranted for the remainder of the warranty period. Liebherr will provide the repair or replacement of any component warranted to the off-road equipment engine owner. The warranty period begins on the date the engine (in service) or machine (in production) is delivered to the initial owner, and upon any sale of the engine by such initial owner to a subsequent owner, the warranty period does not restart, but rather the remaining balance of the warranty period transfers to the subsequent owner.

## 10.1.2 Warranted parts

The following parts (as equipped) are warranted under this warranty for all Liebherr engines:

- Fuel Injection System
- Air Induction System
- Turbocharger System
- Charge Air Cooling System
- Exhaust Gas Recirculation (EGR) System
- EGR Control System
- Exhaust Manifold
- Ignition System
- Diesel Particulate Filter System
- Diesel Oxidation Catalyst
- Fuel Additive Devices or Exhaust Aftertreatment Devices
- Selective Catalyst Reduction
- Reductant Containers
- Electronic Control Unit, Sensors, Solenoids, and Wiring Harnesses
- Emission Control Information Label
- Crankcase Ventilation Valves

## **10.1.3 RESPONSIBILITIES & LIMITATIONS**

This warranty is subject to the following conditions.

Liebherr's Responsibilities:

Information for customers in the USA (49 states) and California

In case an emission-related defect is found in a warranted component during the warranty period, Liebherr will provide:

- New, remanufactured, or properly repaired components, approved pursuant to applicable regulations, required to correct the defect.
- Reasonable and customary labor as established by Liebherr, during normal working hours, required to make the warranted repairs, including labor to remove and install the engine, if so required. For machines or engines located in California during the warranty period, the failure of a warranted part will be repaired or replaced at no charge to the owner.
- Parts replaced under this warranty become the property of Liebherr.

#### Owner's Responsibilities:

During the warranty period, the owner of the off-road equipment engine is responsible for:

- Premium or overtime labor costs (except for engines or equipment located in California).
- Costs to investigate engine problems which are not caused by a defect in Liebherr's material or workmanship (except for engines or equipment located in California).
- Liebherr may deny warranty coverage if the heavy-duty off-road engine or a part thereof has failed due to abuse, neglect, improper maintenance, or unapproved modifications.
- Providing timely notice of a warranted failure to Liebherr, and to promptly make the equipment or engine available to Liebherr for repair.
- Proper scheduled and preventive maintenance as outlined in the Operation & Maintenance Manual supplied with the equipment. This includes, but is not limited to, valve adjustment, fuel and oil filter changes, and any other maintenance procedure related to emission control.
- Using only the proper fuel in the engine, as specified in the Operator's Manual. Engines other than Tier 4 diesel engines shall only be operated on commercially available diesel fuel. The Tier 4 diesel engines shall only be operated on ultra-low sulfur diesel fuel. Use of any fuel in any engine other than the permitted fuel specified above and in the Operator's Manual would harm the engine's emission control system and may result in the engine no longer operating in compliance with EPA or California emission requirements. Therefore, use of any fuel in any engine other than the permitted fuel specified above and in the Operator's Manual is prohibited and will invalidate this warranty.
- The owner is responsible for initiating the warranty process. Owners are advised to contact Liebherr to perform warranty service as soon as a problem arises. The warranty repairs should be completed by Liebherr as expeditiously as possible.

## 10.1.4 Exclusions

This warranty does not cover:

- This warranty shall only apply to Liebherr Machines Bulle SA engines.
- Malfunctions in any part caused by abuse, misuse, alterations, tampering, disconnection, or improper or inadequate maintenance, including, without limitation, any malfunctions caused by using any fuel that is not permitted in such engine as specified the Owner's Responsibilities paragraph above and the Operator's Manual.
- Attachments, accessories or components not supplied or approved by Liebherr.
- Damage resulting from fire, accident, negligence, act of God or other events beyond the control of Liebherr.
- Consequential damages such as loss of use of the engine or equipment powered by the engine, towing, machine transportation, loss of time, downtime, inconvenience, telephone, travel, lodging, or any other indirect or direct damages.
- Loss or damage to personal property, loss of revenue, commercial loss or any other matters not specifically included in this warranty statement.
- Any warranted part that was required to be previously replaced as part of required scheduled maintenance.
- Owner's unreasonable delay in making the equipment available after being notified of a potential product problem.
- Any engines in which any fuel that is not permitted in such engine as specified in the Owner's Responsibilities paragraph above and the Operator's Manual has been used.

This warranty is in addition to the Liebherr Standard Warranty and any extended warranty (if applicable) for the equipment and engine involved. Remedies under this warranty are limited to the provisions as specified in this warranty statement.

IN NO EVENT SHALL LIEBHERR NOR ITS COMPONENT SUPPLIERS BE LIABLE FOR ANY DELAY, WORK STOPPAGE, LOSS OF USE OF EQUIPMENT, LOSS OF TIME, INCONVENIENCE, LOSS OF PROFITS, OR ANY INDIRECT, INCIDENTAL, SPECIAL, OR CONSEQUENTIAL DAMAGES RESULTING FROM OR ATTRIBUTABLE TO, DEFECTS IN LIEBHERR PRODUCTS OR SERVICE, WHETHER RESULTING FROM NEGLIGENCE (INCLUDING GROSS NEGLIGENCE) OR OTHER TORT WARRANTY, CONTRACT, INDEMNITY, BREACH OF THE PROMISE TO REPAIR OR REPLACE CONTAINED HEREIN, STRICT LIABILITY OR OTHERWISE.

IN ADDITION, LIEBHERR AND ITS COMPONENT SUPPLIERS SHALL NOT BE LIABLE IN TORT OR STRICT LIABILITY FOR ANY ECONOMIC LOSS RESULTING, IN WHOLE OR IN PART, FROM THE MANUFACTURE OR SUPPLY OF THE PRODUCT, PARTS, COMPONENTS AND/OR LABOR.

NOTWITHSTANDING ANYTHING IN THIS WARRANTY TO THE CONTRARY, THE MAXIMUM LIABILITY, IF ANY, OF LIEBHERR AND ITS COMPONENT SUPPLIERS FOR ALL DIRECT DAMAGES SHALL NOT EXCEED THE PRICE OF THE PARTICULAR DEFECTIVE PRODUCT, PART OR SERVICE, AS APPLICABLE.

THE STANDARD WARRANTY, THE EMISSION CONTROL WARRANTIES, AND THE EXTENDED LIMITED MACHINE AND POWERTRAIN WARRANTIES, IF APPLICABLE, ARE THE ONLY WARRAN-TIES APPLICABLE TO LIEBHERR PRODUCTS AND COMPONENTS USED IN LIEBHERR PRODUCTS AND ARE EXPRESSLY IN LIEU OF ANY WARRANTIES OR CONDITIONS OTHERWISE IMPLIED BY LAW (INCLUDING ANY WARRANTY OTHERWISE IMPLIED BY LAW FOR THE PRODUCT BY THE MANUFACTURER OR ITS COMPONENT SUPPLIERS), INCLUDING, BUT NOT LIMITED TO, IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE AND IS NOT A WARRANTY OF FUTURE PERFORMANCE.

THE REMEDIES UNDER THIS WARRANTY SHALL BE THE ONLY REMEDIES AVAILABLE TO THE OWNER OF LIEBHERR PRODUCTS OR ANY OTHER PERSON, AND LIEBHERR ASSUMES NO OTHER OBLIGATION OR RESPONSIBILITY WITH RESPECT TO THE CONDITION OF LIEBHERR PRODUCTS, AND AUTHORIZES NO OTHER PERSON TO ASSUME FOR ANY OF THEM, ANY OTHER OBLIGATION OR LIABILITY.

Liebherr reserves the right to make changes in design or add any improvements on its products at any time without incurring any obligation to install same on units previously delivered.

If the original owner sells the engine and machine, the remaining period of this warranty shall be transferred to the new owner.

"Liebherr" means both Liebherr USA Co., a division of Liebherr-America, Inc., as well as the Liebherr company that manufactured the product.

Liebherr requests that each owner of the engine and machine complete and provide the following requested information, sign in the space indicated, retain a completed and signed copy of this statement for the owner's records, and return a completed and signed copy of this statement to Liebherr. Failure to complete, sign, or return this form will not affect any owner's rights or Liebherr's obligations under this warranty statement and will not result in denial of warranty coverage by Liebherr.

MODEL: _____ PIN (Prod. Id. No.): _____ - ____

NAME OF OWNER

SIGNATURE OF AUTHORIZED REPRESENTATIVE OF OWNER

CITY / STATE / ZIP CODE OF OWNER

DATE MACHINE PLACED INTO SERVICE

Fig. 187

### 10.1.5 CALIFORNIA EMISSION CONTROL WARRANTY STATEMENT (CALIFORNIA ONLY)

#### YOUR WARRANTY RIGHTS AND OBLIGATIONS

The California Air Resources Board is pleased to explain the emission control system warranty on your 2024, 2025 and 2026 Model Year engines. In California, new heavy-duty off-road engines must be designed, built and equipped to meet the State's stringent anti-smog standards. Liebherr must warrant the emission control system on your engine for the periods of time listed below, provided there has been no abuse, neglect or improper maintenance of your engine.

Your emission control system may include parts such as the fuel injection system and the air induction system. Also included may be hoses, belts, connectors and other emission-related assemblies.

Where a warrantable condition exists, Liebherr USA, Co ("Liebherr") will repair your heavy-duty off-road engine at no cost to you, including diagnosis, parts and labor.

#### MANUFACTURER'S WARRANTY COVERAGE:

The 2024, 2025 and 2026 Model Year heavy-duty off-road engine emission control systems are warranted for five (5) years or 3000 hours of total operation by all persons, whichever event occurs first, after date of delivery to the initial owner. If any emission-related part on your engine is defective, the part will be repaired or replaced by Liebherr.

#### WARRANTED PARTS

The emission-related parts (as equipped) that are warranted under this warranty for all Liebherr engines may include the following:

- Fuel Injection System
- Air Induction System

- Turbocharger System
- Charge Air Cooling System
- Exhaust Gas Recirculation (EGR) System
- EGR Control System
- Exhaust Manifold
- Ignition System
- Diesel Particulate Filter System
- Diesel Oxidation Catalyst
- Fuel Additive Devices or Exhaust Aftertreatment Devices
- Selective Catalyst Reduction
- Reductant Containers
- Electronic Control Unit, Sensors, Solenoids, and Wiring Harnesses
- Emission Control Information Label
- Crankcase Ventilation Valves

#### **OWNER'S WARRANTY RESPONSIBILITIES:**

As the off-road engine owner, you are responsible for the performance of the **required maintenance listed in your owner's manual**. Liebherr recommends that you retain all receipts covering maintenance of your off-road engine, but Liebherr cannot deny warranty solely for the lack of receipts or for your failure to ensure the performance of all scheduled maintenance.

As the off-road engine owner, you should however be aware that Liebherr may deny warranty coverage if your off-road engine or a part has failed due to abuse, neglect, improper maintenance or unapproved modifications.

Your engine is designed to operate on the fuel specified in your owner's manual. Use of any other fuel may result in your engine no longer operating in compliance with California's emissions requirements.

You are responsible for initiating the warranty process. The California Air Resources Board suggests that you present your off-road engine to Liebherr's dealer as soon as a problem exists. The warranty repairs should be completed by the dealer as expeditiously as possible.

If you have any question regarding your warranty rights and responsibilities, you should contact Liebherr at 1-877-806-1588.

#### Appendix Information for customers in the USA (49 states) and California



## Manufacturer Confirmation

Liebherr-Werk Ehingen GmbH

Mobilkrane Mobile Cranes

Raupenkrane Crawler Cranes

## Statement of engine CO₂ emission results:

To comply with Annex XIV, § 6 of regulation (EU) 2017/654, we confirm the CO₂ emissions of Stage V engines determined during the EU type-approval process.

This  $CO_2$  measurement results from testing over a fixed test cycle under laboratory conditions a(n) (parent) engine representative of the engine type (engine family) and shall not imply or express any guarantee of the performance of a particular engine.

Test conditions:

NRSC/RMC: Non-Road Steady-state test Cycle/ Ramped Modal Cycle; 'steady-state test cycle' means a test cycle in which engine speed and torque are held at a finite set of nominally constant values; steady-state tests are either discrete mode tests or ramped-modal tests

NRTC: Non-Road Transient test Cycle; 'transient test cycle' means a test cycle with a sequence of normalized speed and torque values that vary on a second-by-second basis with time

Measurement of CO ₂ emissions							
Engine Type	Power/ Speed	EC	CO ₂ Emission by NRSC	CO ₂ Emission by NRTC			
		Stage	or RMC [g/kWh]	[g/kWh]			
D 936 A7 -05	270kW/1900 min ⁻¹	V	674,09	707,70			
D 936 A7 -05	300kW/1900 min ⁻¹	V	669,36	689,99			
D 936 A7 -05	320kW/1900 min ⁻¹	V	667,43	684,93			
D 944 A7 -05	230kW/1900 min ⁻¹	V	671,15	683,61			
D 946 A7 -05	330kW/1900 min ⁻¹	V	675,60	697,10			
D 946 A7 -05	400kW/1900 min ⁻¹	V	664,88	679,35			
D 9508 A7 -05	455kW/1900 min ⁻¹	V	724,83	739,75			
D 9508 A7 -05	505kW/1900 min ⁻¹	V	719,13	731,18			
B6.7/Q313	201kW/2000 min ⁻¹	V	-	-			
B6.7/Q313	243kW/2100 min-1	V	-	-			



## Herstellerbestätigung

#### Liebherr-Werk Ehingen GmbH

Mobilkrane Mobile Cranes Raupenkrane Crawler Cranes

## Erklärung der Motor-CO2-Emissionsergebnisse:

Zur Erfüllung des Anhang XIV, § 6 der Verordnung (EU) 2017/654 bestätigen wir die CO₂-Emissionen von Motoren der Stufe V, die während des EU-Typgenehmigungsverfahrens ermittelt wurden.

Diese CO₂-Messung ist das Ergebnis der Erprobung eines für den Motortyp bzw. die Motorenfamilie repräsentativen (Stamm-)Motors in einem festen Prüfzyklus unter Laborbedingungen und stellt keine ausdrückliche oder implizite Garantie der Leistung eines bestimmten Motors dar.

Test-Bedingungen:

NRSC/RMC: Non-Road Steady-state test Cycle/ Ramped Modal Cycle; "stationärer Prüfzyklus" ein Prüfzyklus, bei dem die Drehzahl und das Drehmoment des Motors eine endliche Zahl nominell konstanter Werte annehmen; stationäre Prüfungen sind entweder Einzelphasen-Prüfzyklen oder gestufte modale Prüfzyklen

NRTC: Non-Road Transient test Cycle; "dynamischer Prüfzyklus" ein Prüfzyklus, bei dem normierte Drehzahl- und Drehmomentwerte im Sekundentakt wechseln

Messung der CO ₂ Emissions							
Motor Typ	Leistung/ Drehzahl	EU	CO ₂ Emission bei	CO ₂ Emission bei			
		Stufe	NRSC or RMC [g/kWh]	NRTC [g/kWh]			
D 936 A7 -05	270kW/1900 min ⁻¹	V	674,09	707,70			
D 936 A7 -05	300kW/1900 min ⁻¹	V	669,36	689,99			
D 936 A7 -05	320kW/1900 min ⁻¹	V	667,43	684,93			
D 944 A7 -05	230kW/1900 min ⁻¹	V	671,15	683,61			
D 946 A7 -05	330kW/1900 min ⁻¹	V	675,60	697,10			
D 946 A7 -05	400kW/1900 min ⁻¹	V	664,88	679,35			
D 9508 A7 -05	455kW/1900 min ⁻¹	V	724,83	739,75			
D 9508 A7 -05	505kW/1900 min ⁻¹	V	719,13	731,18			
B6.7/Q313	201kW/2000 min ⁻¹	V	-	-			
B6.7/Q313	243kW/2100 min-1	V	-	-			