

Operating Instructions

Diesel engine
12 V 4000 G21R
12 V 4000 G41R

MS150064/01E



Power. Passion. Partnership.

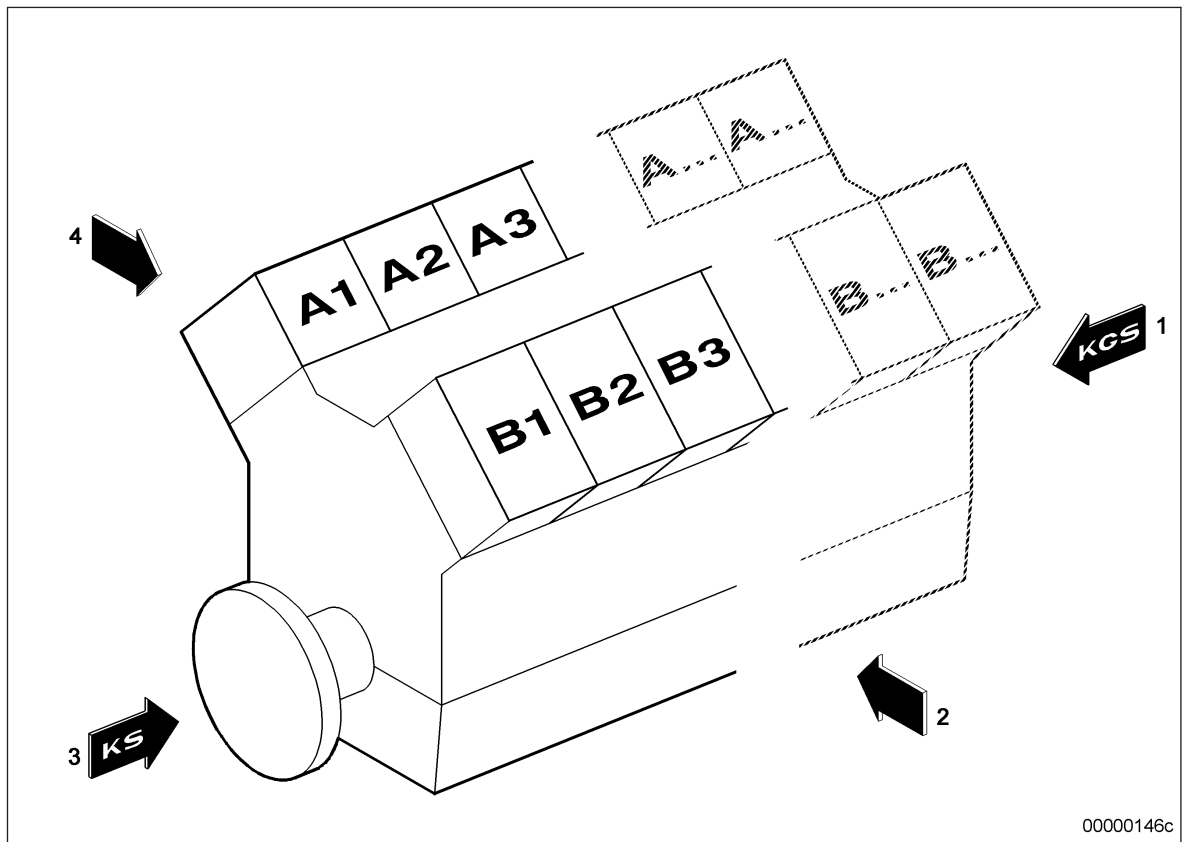
2 General Information

2.1 Engine side and cylinder designations

Engine sides are always designated as viewed from the driving end (KS).

The cylinders of the left engine side are designated "A" and those of the right side "B" (as per DIN ISO 1204). The cylinders of each bank are numbered consecutively, starting with No. 1 at the driving end of the engine.

Other components are numbered in the same way, i.e. starting with No. 1 on driving end.

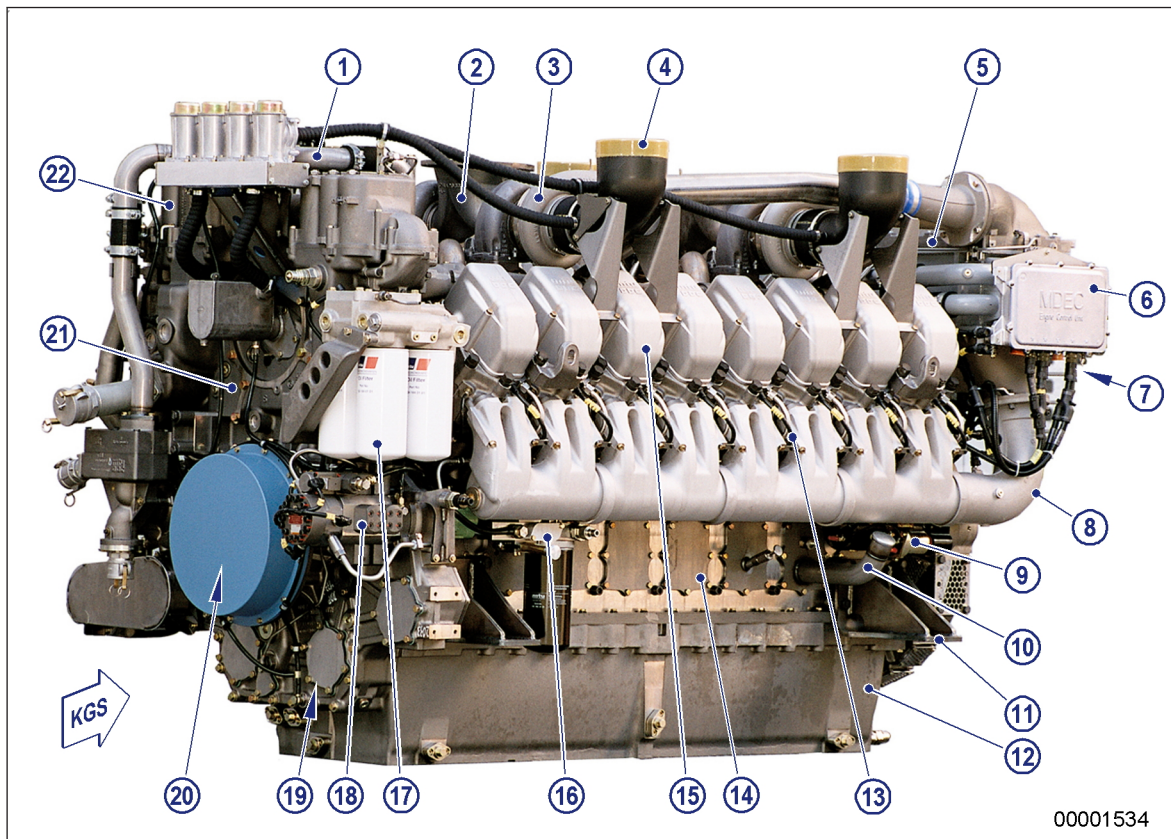


1 KGS = Free end
2 Right engine side

3 KS = Driving end
4 Left engine side

2.2 Engine layout

Illustration valid for 8/12/16V 4000 Gxy engines



- | | | |
|--|------------------------------|------------------------------|
| 1 Coolant line | 8 Air supply | 16 Fuel line (low pressure) |
| 2 Exhaust system | 9 Starting equipment | 17 Lube oil filter |
| 3 Exhaust turbocharger | 10 Oil filler neck | 18 Fuel pump (high pressure) |
| 4 Air intake | 11 Mounting / support | 19 Gear train |
| 5 Intercooler | 12 Oil pan | 20 Running gear |
| 6 Engine governor | 13 Fuel line (high pressure) | 21 Coolant system |
| 7 PTO systems, driving end and free end (coupling) | 14 Inspection port cover | 22 Lube oil system |
| | 15 Cylinder head | |

Engine model designation

Key to the engine model designations 8/12/16V 4000 Gxy

Designation	Meaning
8/12/16	Number of cylinders
V	Cylinder arrangement: V engine
4000	Series
G	Application
x	Application segment (2, 4, 6, 8)
y	Design index (1, 2,...)

3 Technical Data

3.1 12V 4000 engine data, continuous operation, variable 3B, optimized fuel consumption

Explanation

Abbr.	Meaning
DL	Ref. value: Continuous power
BL	Ref. value: Fuel stop power
A	Design value
G	Guaranteed value
R	Guideline value
L	Limit value, up to which the engine can be operated without changes (e.g. of power setting)
N	Not yet defined value
-	Not applicable
X	Applicable

REFERENCE CONDITIONS

Engine model			12V 4000 G21R	12V 4000 G21R	12V 4000 G41R
Application group			3B	3B	3B
Intake air temperature		°C	25	25	25
Charge-air coolant temperature		°C	55	55	55
Barometric pressure		mbar	1000	1000	1000
Site altitude above sea level		m	100	100	100

POWER-RELATED DATA (power ratings are net brake power as per ISO 3046)

Number of cylinders			12	12	12
Engine rated speed	A	rpm	1500	1800	1800
Continuous power ISO 3046 (10% overload capability) (design power DIN 6280, ISO 8528)	A	kW	1102	1246	1246

GENERAL CONDITIONS (for maximum power)

Number of cylinders			12	12	12
Intake air depression (new filter)	A	mbar	30	30	30
Intake air depression, max.	L	mbar	50	50	60
Exhaust pressure	A	mbar	30	30	30
Exhaust pressure, max.	L	mbar	51	51	51

CONSUMPTION

Number of cylinders			12	12	12
Lube oil consumption after engine run-in (B = hourly fuel consumption)	R	% of B	0.5	0.5	0.5

MODEL RELATED DATA (basic design)

Number of cylinders			12	12	12
Cylinder arrangement: V angle		Degrees (°)	90	90	90
Bore		mm	165	165	165
Stroke		mm	190	190	190
Displacement per cylinder		liter	4.06	4.06	4.06
Displacement, total		liter	48.7	48.7	65.0
Compression ratio			15.5	15.5	15.5
Number of inlet valves per cylinder			2	2	2
Number of exhaust valves per cylinder			2	2	2
Standard flywheel housing flange (engine main PTO)		SAE	00	00	00

COMBUSTION AIR / EXHAUST GAS

Number of cylinders			12	12	12
Charge air pressure before cylinder, BL	R	bar ABS	2.4	2.8	2.8

COOLING SYSTEM (HT circuit)

Number of cylinders			12	12	12
Coolant temperature (at engine outlet to cooling equipment)	A	°C	95	95	95
Coolant temperature after engine, alarm	R	°C	97	97	97
Coolant temperature after engine, shutdown	L	°C	99	99	99
Coolant antifreeze content, max.	L	%	50	50	50
Pressure loss in external raw water system, max.	L	bar	0.7	0.7	0.7

COOLING SYSTEM (LT circuit)

Number of cylinders			12	12	12
Coolant temperature before intercooler (at engine inlet from cooling equipment)	A	°C	55	55	55
Coolant antifreeze content, max.	L	%	50	50	50
Pressure loss in external raw water system, max.	L	bar	0.7	0.7	0.7

LUBE OIL SYSTEM

Number of cylinders			12	12	12
Lube oil temperature before engine, from	R	°C	85	85	85
Lube oil operating temperature before engine, to	R	°C	95	95	95
Lube oil temperature before engine, alarm	R	°C	95	95	95
Lube oil operating pressure before engine, from	R	bar	5.0	5.0	5.0
Lube oil operating pressure before engine, to	R	bar	6.0	6.0	6.0
Lube oil pressure before engine, alarm	R	bar	4.5	4.5	4.5
Lube oil pressure before engine, shutdown	L	bar	4.0	4.0	4.0

FUEL SYSTEM

Number of cylinders			12	12	12
Fuel pressure at supply connection to engine, min. (when engine is starting)	L	bar	-0.1	-0.1	-0.1
Fuel pressure at engine supply connection, max. (when engine is starting)	L	bar	1.5	1.5	1.5

GENERAL OPERATING DATA

Number of cylinders			12	12	12
Cold start capability: air temperature (w/o start aid, w/o preheating) (case A)	R	°C	5	10	10
Coolant preheating, preheating temperature (min.)	R	°C	32	32	32
Firing speed, from	R	rpm	80	80	80
Firing speed, to	R	rpm	120	120	120

CAPACITIES

Number of cylinders			12	12	12
Engine coolant capacity (without cooling equipment)	R	liter	160	160	160
Charge-air coolant capacity, engine side	R	liter	40	40	40
Engine oil at initial filling (standard oil system) (Option: max. operating inclinations)	R	liter	260	260	260
Oil pan capacity at dipstick mark "min." (standard oil system) (Option: max. operating inclinations)	L	liter	160	160	160
Oil pan capacity at dipstick mark "max." (standard oil system) (Option: max. operating inclinations)	L	liter	200	200	200

WEIGHTS / MAIN DIMENSIONS

Number of cylinders			12	12	12
Engine weight, dry (basic engine configuration acc. to scope of supply specification)	R	kg	5650	5650	5650

ACOUSTICS

Number of cylinders			12	12	12
Exhaust noise, unsilenced, BL (free-field sound pressure level Lp, 1m distance, ISO 6798, +3dB(A) tolerance)	R	dB(A)	115	118	115
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798+2dB(A) tolerance)	R	dB(A)	106	108	106

3.2 12V 4000 engine data, continuous operation, variable 3B, emissions optimized w/o certificate

Explanation

Abbr.	Meaning
DL	Ref. value: Continuous power
BL	Ref. value: Fuel stop power
A	Design value
G	Guaranteed value
R	Guideline value
L	Limit value, up to which the engine can be operated without changes (e.g. of power setting)
N	Not yet defined value
-	Not applicable
X	Applicable

REFERENCE CONDITIONS

Engine model			12V 4000 G21R	12V 4000 G41R
Application group			3B	3B
Intake air temperature		°C	25	25
Charge-air coolant temperature		°C	55	55
Barometric pressure		mbar	1000	1000
Site altitude above sea level		m	100	100

POWER-RELATED DATA (power ratings are net brake power as per ISO 3046)

Number of cylinders			12	12
Engine rated speed	A	rpm	1800	1800
Continuous power ISO 3046 (10% overload capability, design power DIN 6280, ISO 8528)	A	kW	1246	1246

GENERAL CONDITIONS (for maximum power)

Number of cylinders			12	12
Intake air depression (new filter)	A	mbar	30	30
Intake air depression, max.	L	mbar	50	50
Exhaust pressure	A	mbar	30	30
Exhaust pressure, max.	L	mbar	51	51

CONSUMPTION

Number of cylinders			12	12
Lube oil consumption after engine run-in (B = hourly fuel consumption)	R	% of B	0.5	0.5

MODEL RELATED DATA (basic design)

Number of cylinders			12	12
Number of cylinders			12	12
Cylinder arrangement: V angle		Degrees (°)	90	90
Bore		mm	165	165
Stroke		mm	190	190
Displacement per cylinder		liter	4.06	4.06
Displacement, total		liter	48.7	48.7
Compression ratio			15.5	15.5
Number of inlet valves per cylinder			2	2
Number of exhaust valves per cylinder			2	2
Standard flywheel housing flange (engine main PTO)		SAE	00	00

COMBUSTION AIR / EXHAUST GAS

Number of cylinders			12	12
Charge air pressure before cylinder, BL	R	bar ABS	3.1	3.1

COOLING SYSTEM (HT circuit)

Number of cylinders			12	12
Coolant temperature (at engine outlet to cooling equipment)	A	°C	95	95
Coolant temperature after engine, alarm	R	°C	97	97
Coolant temperature after engine, shutdown	L	°C	99	99
Coolant antifreeze content, max.	L	%	50	50
Pressure loss in external raw water system, max.	L	bar	0.7	0.7

COOLING SYSTEM (LT circuit)

Number of cylinders			12	12
Coolant temperature before intercooler (at engine inlet from cooling equipment)	A	°C	55	55
Coolant antifreeze content, max.	L	%	50	50
Pressure loss in external raw water system, max.	L	bar	0.7	0.7

LUBE OIL SYSTEM

Number of cylinders			12	12
Lube oil temperature before engine, from	R	°C	85	85
Lube oil operating temperature before engine, to	R	°C	95	95
Lube oil temperature before engine, alarm	R	°C	95	95
Lube oil operating pressure before engine, from	R	bar	5.0	5.0

Number of cylinders			12	12
Lube oil operating pressure before engine, to	R	bar	6.0	6.0
Lube oil pressure before engine, alarm	R	bar	4.5	4.5
Lube oil pressure before engine, shutdown	L	bar	4.0	4.0

FUEL SYSTEM

Number of cylinders			12	12
Fuel pressure at supply connection to engine, min. (when engine is starting)	L	bar	-0.1	-0.1
Fuel pressure at engine supply connection, max. (when engine is starting)	L	bar	1.5	1.5

GENERAL OPERATING DATA

Number of cylinders			12	12
Cold start capability: air temperature (w/o start aid, w/o preheating) (case A)	R	°C	5	10
Coolant preheating, preheating temperature (min.)	R	°C	32	32
Firing speed, from	R	rpm	80	80
Firing speed, to	R	rpm	120	120

CAPACITIES

Number of cylinders			12	12
Engine coolant capacity (without cooling equipment)	R	liter	160	160
Charge-air coolant capacity, engine side	R	liter	40	40
Engine oil at initial filling (standard oil system) (Option: max. operating inclinations)	R	liter	260	260
Oil pan capacity at dipstick mark "min." (standard oil system) (Option: max. operating inclinations)	L	liter	160	160
Oil pan capacity at dipstick mark "max." (standard oil system) (Option: max. operating inclinations)	L	liter	200	200

WEIGHTS / MAIN DIMENSIONS

Number of cylinders			12	12
Engine weight, dry (basic engine configuration acc. to scope of supply specification)	R	kg	5650	5650

ACOUSTICS

Number of cylinders			12	12
Exhaust noise, unsilenced, BL (free-field sound pressure level L_p , 1m distance, ISO 6798, +3dB(A) tolerance)	R	dB(A)	117	117
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level L_p , 1m distance, ISO 6798+2dB(A) tolerance)	R	dB(A)	107	107

3.3 12V 4000 engine data, continuous operation, variable 3B, emissions optimized (TA-Luft)

Explanation

Abbr.	Meaning
DL	Ref. value: Continuous power
BL	Ref. value: Fuel stop power
A	Design value
G	Guaranteed value
R	Guideline value
L	Limit value, up to which the engine can be operated without changes (e.g. of power setting)
N	Not yet defined value
-	Not applicable
X	Applicable

REFERENCE CONDITIONS

Engine model			12V 4000 G21R
Application group			3B
Intake air temperature		°C	25
Charge-air coolant temperature		°C	55
Barometric pressure		mbar	1000
Site altitude above sea level		m	100

POWER-RELATED DATA (power ratings are net brake power as per ISO 3046)

Number of cylinders			12
Engine rated speed	A	rpm	1500
Continuous power ISO 3046 (10% overload capability) (design power DIN 6280, ISO 8528)	A	kW	1102

GENERAL CONDITIONS (for maximum power)

Number of cylinders			12
Intake air depression (new filter)	A	mbar	30
Intake air depression, max.	L	mbar	50
Exhaust pressure	A	mbar	30
Exhaust pressure, max.	L	mbar	51

CONSUMPTION

Number of cylinders			12
Lube oil consumption after engine run-in (B = hourly fuel consumption)	R	% of B	0.5

MODEL RELATED DATA (basic design)

Number of cylinders			12
Number of cylinders			12
Cylinder arrangement: V angle		Degrees (°)	90
Bore		mm	165
Stroke		mm	190
Displacement per cylinder		liter	4.06
Displacement, total		liter	48.7
Compression ratio			15.5
Number of inlet valves per cylinder			2
Number of exhaust valves per cylinder			2
Standard flywheel housing flange (engine main PTO)		SAE	00

COMBUSTION AIR / EXHAUST GAS

Number of cylinders			12
Charge air pressure before cylinder, BL	R	bar ABS	3.0

COOLING SYSTEM (HT circuit)

Number of cylinders			12
Coolant temperature (at engine outlet to cooling equipment)	A	°C	95
Coolant temperature after engine, alarm	R	°C	97
Coolant temperature after engine, shutdown	L	°C	99
Coolant antifreeze content, max.	L	%	50
Pressure loss in external raw water system, max.	L	bar	0.7

COOLING SYSTEM (LT circuit)

Number of cylinders			12
Coolant temperature before intercooler (at engine inlet from cooling equipment)	A	°C	55
Coolant antifreeze content, max.	L	%	50
Pressure loss in external raw water system, max.	L	bar	0.7

LUBE OIL SYSTEM

Number of cylinders			12
Lube oil temperature before engine, from	R	°C	85
Lube oil operating temperature before engine, to	R	°C	95
Lube oil temperature before engine, alarm	R	°C	95
Lube oil operating pressure before engine, from	R	bar	5.0
Lube oil operating pressure before engine, to	R	bar	6.0
Lube oil pressure before engine, alarm	R	bar	4.5
Lube oil pressure before engine, shutdown	L	bar	4.0

FUEL SYSTEM

Number of cylinders			12
Fuel pressure at supply connection to engine, min. (when engine is starting)	L	bar	-0.1
Fuel pressure at engine supply connection, max. (when engine is starting)	L	bar	1.5

GENERAL OPERATING DATA

Number of cylinders			12
Cold start capability: air temperature (w/o start aid, w/o preheating) (case A)	R	°C	5
Coolant preheating, preheating temperature (min.)	R	°C	32
Firing speed, from	R	rpm	80
Firing speed, to	R	rpm	120

CAPACITIES

Number of cylinders			12
Engine coolant capacity (without cooling equipment)	R	liter	160
Charge-air coolant capacity, engine side	R	liter	40
Engine oil at initial filling (standard oil system) (Option: max. operating inclinations)	R	liter	260
Oil pan capacity at dipstick mark "min." (standard oil system) (Option: max. operating inclinations)	L	liter	160
Oil pan capacity at dipstick mark "max." (standard oil system) (Option: max. operating inclinations)	L	liter	200

WEIGHTS / MAIN DIMENSIONS

Number of cylinders			12
Engine weight, dry (basic engine configuration acc. to scope of supply specification)	R	kg	5650

ACOUSTICS

Number of cylinders			12
Exhaust noise, unsilenced, BL (free-field sound pressure level Lp, 1m distance, ISO 6798, +3dB(A) tolerance)	R	dB(A)	115
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798+2dB(A) tolerance)	R	dB(A)	106

3.4 Final compression pressure

Final compression pressure

Final compression pressure at 120 rpm	24 bar to 28 bar
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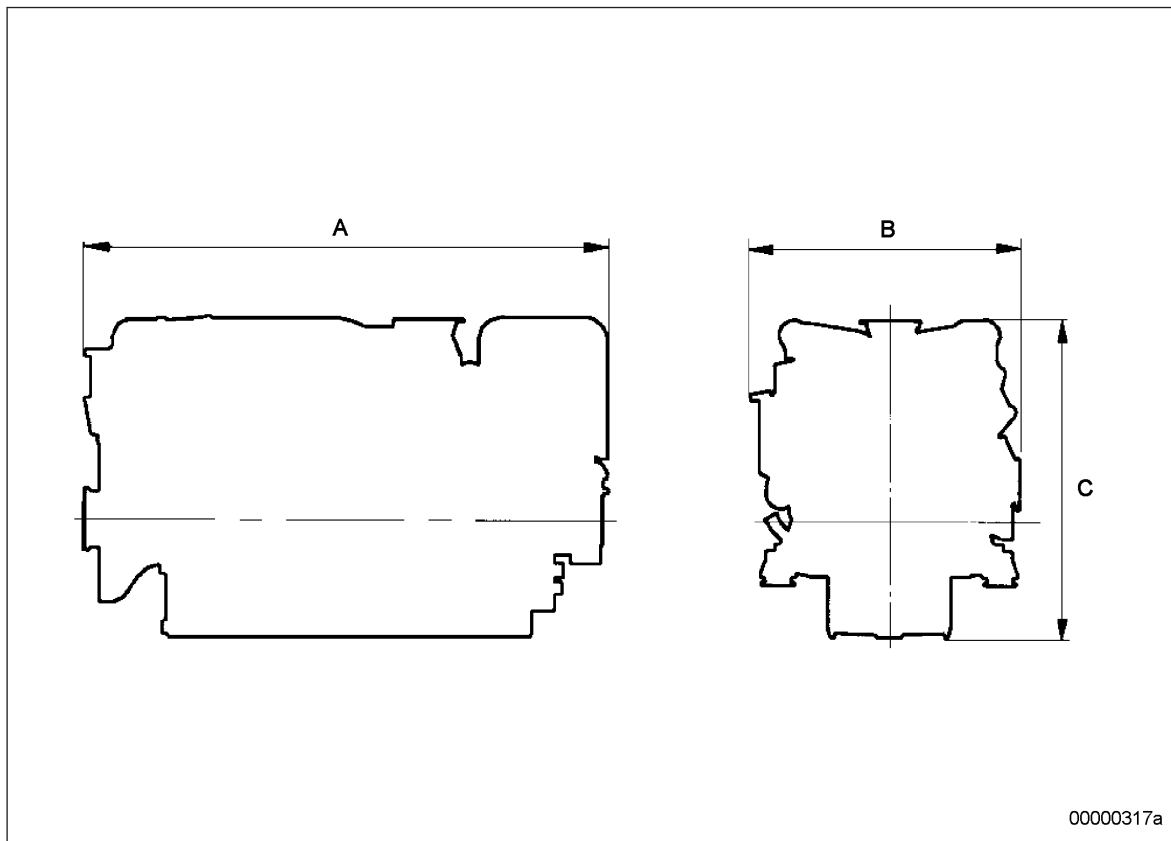
3.5 Firing order

Firing order

Number of cylinders	Firing order
8V	A1-B4-A4-A2-B3-A3-B2-B1
12V	A1-B2-A5-B4-A3-B1-A6-B5-A2-B3-A4-B6
16 V	A1-A7-B4-B6-A4-B8-A2-A8-B3-B5-A3-A5-B2-A6-B1-B7
20 V	A1-B5-A8-B7-A5-B2-A7-B10-A2-B3-A10-B6-A3-B4-A6-B9-A4-B1-A9-B8

3.6 Engine – Main dimensions

Engine – Main dimensions



Engine model	Length (A)	Width (B)	Height (C)
8 V 4000 Gxy	approx. 1940 mm	approx. 1550 mm	approx. 1760 mm
12 V 4000 Gxy	approx. 2410 mm	approx. 1550 mm	approx. 1760 mm
16 V 4000 Gxy	approx. 2880 mm	approx. 1550 mm	approx. 1760 mm

4 Operation

4.1 Putting the engine into operation after extended out-of-service periods (>3 months)

Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ MTU Fluids and Lubricants Specification (A001061/..) is available.

Putting the engine into operation after extended out-of-service-periods (>3 months)

Item	Task
Engine	Depreserve (→ MTU Fluids and Lubricants Specification A001061/..).
Valve Gear	Lubricate valve gear (→ Page 72);
Lube oil system	Check oil level (→ Page 98);
Fuel prefilter	Prime (→ Page 90).
Fuel prefilter, pressure gauge	Align adjustable pointer with position of pressure indicator (→ Page 86).
Fuel system	Vent (→ Page 83).
Cooling system	If engine is out of service for more than one year, change engine coolant (→ Page 106); Change charge-air coolant (→ Page 114).
Cooling system	Check engine coolant level (→ Page 105); Check charge-air coolant level (→ Page 113).
Cooling system	Preheat coolant with preheating unit.
ECU	Check plug-in connections (→ Page 127).
Monitoring equipment	Carry out lamp test (see manufacturer's documentation).
Engine/generator control system	Switch ON; Select operating mode, e.g. MANUAL OPERATION, AUTOMATIC OPERATION.

4.2 Putting the engine into operation after scheduled out-of-service-period

Preconditions

- Engine is stopped and starting disabled.



Putting the engine into operation

Item	Task
Lube oil system	Check oil level (→ Page 98);
Cooling system	Check engine coolant level (→ Page 105); Check charge-air coolant level (→ Page 113).
Cooling system	Preheat coolant with preheating unit.
Fuel prefilter	Drain (→ Page 87).
Monitoring equipment	Carry out lamp test (see manufacturer's documentation).
Engine/generator control system	Switch ON; Select operating mode, e.g. MANUAL OPERATION, AUTOMATIC OPERATION.

4.3 Start engine in manual mode (testing mode)

Preconditions

- ☑ Generator (if provided) not connected to network.
- ☑ External start interlock is not activated.

DANGER	 <p>Unguarded rotating and moving engine components. Risk of serious injury – danger to life!</p> <ul style="list-style-type: none"> • Before barring or starting the engine, make sure that nobody is in the danger zone.
WARNING	 <p>Engine noise above 85 dB (A). Risk of damage to hearing!</p> <ul style="list-style-type: none"> • Wear ear protectors.

Preparation

Item	Task
Operating mode selector switch (if provided)	Change to manual mode.
Preheating pump (if provided)	Switch ON.

Starting the engine

Item	Task
Switchgear cabinet, control panel etc. (depending on manufacturer)	<p>If coolant temperature is</p> <ul style="list-style-type: none"> • > 40 °C (with preheating equipment), or • > 5 °C (without preheating equipment): <p>Press start button.</p> <ul style="list-style-type: none"> • Automatic starting sequence is performed; • Engine speed display instrument indicates increasing crankshaft speed; • After the starting sequence is completed, engine is running at rated speed.

Connect generator to network (if provided), run engine to reach operating temperature)

Item	Task
Switchgear cabinet, control panel etc. (depending on manufacturer)	Close the generator circuit breaker.
Engine	Apply full load only after engine has reached operating temperature (coolant temperature approx. 75 °C).

4.4 Starting the engine in emergency situations (override mode)

CAUTION



Safety functions and engine shutdown alarms will be disregarded.

Serious damage to plant!

- Initiate emergency start only in emergency situations.

Preparation

Item	Task
Operating mode switch	Set to emergency mode.



Starting the engine in emergency situations

Item	Task
Control cabinet	Actuate switch/button for ECU override input.
Control cabinet	<ul style="list-style-type: none"> • Automatic starting procedure is performed; any safety functions and alarms leading to engine shutdown are disregarded; • Tachometer indicates increasing crankshaft speed; • Engine is running at rated speed when the starting sequence is completed.

Connecting the generator (if fitted) to mains

Item	Task
Control cabinet	If generator is not connected to mains: Close generator circuit breaker.
Engine	Operate engine at rated power.

4.5 Operational checks

DANGER	 <p>Unguarded rotating and moving engine components. Risk of serious injury – danger to life!</p> <ul style="list-style-type: none"> • Take special care when working on a running engine.
WARNING	 <p>Engine noise above 85 dB (A). Risk of damage to hearing!</p> <ul style="list-style-type: none"> • Wear ear protectors.

Operational checks

Item	Task
Control and display panels	Check indicated operating parameters (speed, temperatures, pressures).
Engine under load Engine at nominal speed	Check engine/system and lines for leak-tightness, perform maintenance work on lines showing leakage while motor is turned off (exhaust manifolds and turbocharger turbine housing may be glowing with heat. If maximum exhaust temperatures are within the limit, restricted engine operation is not required); Check for abnormal running noises and vibrations.
HP pump	Check relief bore (→ Page 76).
Fuel prefilter	Check if suction-side pressure indicated at the fuel prefilter pressure gauge is within the limit (→ Page 86).
Exhaust system	Check exhaust color (→ Page 48).
Intercooler	Check condensate drain(s) for water discharge and obstruction (→ Page 92).
Air filter	Check signal ring position of service indicator (→ Page 95); Replace air filter (→ Page 93), if the signal ring is completely visible in the service indicator control window.
Engine coolant pump	Check relief bore (→ Page 111).
Charge-air coolant pump	Check relief bore (→ Page 120).
Compressed-air system (if installed)	Check operating pressure at pressure gauge. Fill compressed-air tank to maximum pressure. Drain condensate from compressed-air tank, pressure drop must not exceed 1 bar.

4.6 Stop engine in manual mode (testing mode)

Preconditions

- Generator (if provided) not connected to network.
- Engine is running in manual mode.

CAUTION



Stopping the engine when it is running at full load causes extreme stress to the engine.

Risk of overheating, damage to components!

- Before stopping the engine, operate it at idle speed until operating temperatures decrease and stable values are indicated.

Preparing the generator drive (only with generator breaker)

Item	Task
Engine	After opening the generator breaker (if provided), allow to cool down off-load for approx. 5 minutes.

Preparing the pump drive (diesel-mechanical/diesel-electric)

Item	Task
Engine	Allow to cool down for approx. 5 minutes at reduced engine speed. Observe natural resonance of engine (installation-dependent)!

Stopping the engine

Item	Task
Switchgear cabinet, control panel etc. (depending on manufacturer)	Press stop button. <ul style="list-style-type: none">• Automatic stopping sequence is performed;• Engine is stopped.

After stopping the engine

Item	Task
Coolant pump	Allow to run on for sufficient time after stopping.

4.7 Emergency stop

CAUTION



An emergency stop causes extreme stress to the engine.

Risk of overheating, damage to components!

- Initiate emergency stop only in emergency situations.

Emergency stop from LOP

Item	Task
EMERGENCY STOP button	Press. <ul style="list-style-type: none">• Engine is stopped by switching off power supply to ECU;• Signalization (e.g. by horn, flashing lamp) is released.

After emergency stop from LOP

Item	Task
Switching cabinet, control panel etc. (depending on manufacturer)	Press button for alarm acknowledgement. <ul style="list-style-type: none">• Audible and visual signalization stops.

4.8 After stopping the engine – Engine remains ready for operation

After stopping the engine

Item	Action
Engine/generator/pump control	Select operating mode, e.g. MANUAL, AUTOMATIC OPERATION.

4.9 After stopping the engine – putting the engine out of service

Preconditions

- ☑ MTU Fluids and Lubricants Specifications (A001061/..) is available.

After stopping the engine

Item	Task
Cooling system	Drain engine coolant (→ Page 107); Drain charge-air coolant (→ Page 115) if: <ul style="list-style-type: none">• freezing temperatures are expected and the engine is to remain out of service for an extended period and coolant has no antifreeze additive;• the engine room is not heated;• the coolant is not maintained at a suitable temperature;• the antifreeze concentration is insufficient for the engine-room temperature;• antifreeze concentration is 50 % and engine-room temperature is below -40°C.
Engine/generator/pump controller	Switch OFF.
Air intake and exhaust system	If the engine is to remain out of service for more than 1 week, seal the engine's air and exhaust sides. If the engine is to remain out of service for more than 1 month, preserve engine (→ MTU Fluids and Lubricants Specifications A001061/..).




4.10 Plant – Cleaning

Preconditions

- Engine is stopped and starting disabled.
- Operating voltage is not applied.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Steam jet cleaner	-	1
Cleaner (Hakupur 312)	30390	1

WARNING 	<p>Compressed air</p> <p>Risk of injury!</p> <ul style="list-style-type: none"> • Do not direct compressed-air jet at persons. • Wear protective goggles / safety mask and ear protectors.
WARNING 	<p>Water jet.</p> <p>Risk of injury and scalding!</p> <ul style="list-style-type: none"> • Do not direct water jet at persons. • Wear protective clothing, gloves, and goggles / safety mask.
CAUTION 	<p>Excessive reaction time of cleaning agents on components.</p> <p>Damage to component!</p> <ul style="list-style-type: none"> • Observe manufacturer's instructions. • Wear protective clothing, gloves, and goggles / safety mask.

Note: There is a risk of damaging sensors with compressed air.

Plant – Cleaning

1. Carry out plant cleaning only in areas where an appropriate oil separator is provided (environmental protection).
2. Prior to putting the cleaning unit into operation, read the Operating Instructions of the water/steam jet unit carefully and observe the safety precautions.
3. For external cleaning with high-pressure jet, use a flat-mouth nozzle only.
4. Carry out external cleaning as follows:
 - a) Remove coarse dirt.
 - b) Spray on cleaner sparingly and leave it for 1 to 5 minutes.
 - c) Use the high-pressure jet to remove the loosened dirt.
 - d) During external cleaning of the plant with water/steam-jet units, the pressure of the high-pressure jet (cleaning jet) must not exceed 50 bar. A minimum distance between spray nozzle and plant of 1 m must be observed. The temperature of the cleaning medium must not exceed 80 °C.

5 Maintenance

5.1 Maintenance task reference table [QL1]

The maintenance tasks and intervals for this product are defined in the Maintenance Schedule. The Maintenance Schedule is a stand-alone publication.

The task numbers in this table provide reference to the maintenance tasks specified in the Maintenance Schedule.

Task	Maintenance tasks	
W0500	Check engine oil level	(→ Page 98)
W0501	Visually inspect engine for leaks and general condition	(→ Page 41)
W0502	Check intercooler drain (if fitted)	(→ Page 92)
W0503	Check signal ring position of service indicator on air filter	(→ Page 95)
W0504	Check HP fuel pump weep holes	(→ Page 41)
W0505	Check relief bores of coolant pump(s)	(→ Page 111)
W0506	Check engine for abnormal running noises, exhaust color and vibrations	(→ Page 41)
W0507	Drain water and contaminants from fuel prefilter (if fitted)	(→ Page 41)
W0508	Check reading on differential pressure gauge of fuel prefilter (if fitted)	(→ Page 41)
W0534	Carry out test run, minimum duration: until steady-state temperature is reached, no less than 1/3 load (monthly)	(→ Page 65)
W1001	Replace fuel filter or fuel filter element	(→ Page 84)
W1002	Check valve clearance	(→ Page 73)
W1003	Check drive belt condition and tension, replace if necessary	(→ Page 121)
W1005	Replace air filter	(→ Page 93)
W1006	Replace fuel injectors	(→ Page 77)
W1008	Replace engine oil filter at each oil change or when the time limit (years) is reached, at the latest	(→ Page 102)
W1009	Check layer thickness of oil residue, clean and replace filter sleeve (if fitted)	(→ Page 103)
W1011	Perform endoscopic inspection of combustion chambers	(→ Page 66)
W1046	Crankcase breather: Replace filter or filter element	(→ Page 70)

Table 1: Maintenance task reference table [QL1]

6 Troubleshooting

6.1 Troubleshooting

Engine does not turn when starter is actuated

Component	Probable cause	Task
Battery	Low or defective	Charge or replace (see manufacturer's documentation).
	Cable connections defective	Check if cable connections are properly secured (see manufacturer's documentation).
Starter (electric)	Engine wiring or starter defective	Check cable connections for secure seating, Contact Service.
Starter (compressed air)	Cabling on starting valve or starter defective	Check cable connections for secure seating, Contact Service.
Engine wiring	Defective	Check (→ Page 125).
Engine/generator control system	Secure seating of assemblies or connectors not provided	Perform visual inspection (see manufacturer's documentation).
Engine Governor	Plug-in connections are loose	Check plug connections (→ Page 127).
Engine	Running gear blocked (engine cannot be barred manually)	Contact Service.

Engine turns but does not fire

Component	Probable cause	Task
Starter (electric)	Poor rotation by starter: Battery low or defective	Charge or replace battery (see manufacturer's documentation).
Starter (compressed air)	Poor rotation by starter: Air pressure too low	Check compressed air system.
Engine wiring	Defective	Check (→ Page 125).
Fuel system	Not vented	Vent fuel system (→ Page 83).
Engine Governor	Defective	Contact Service.

Engine fires unevenly

Component	Probable cause	Task
Fuel injection equipment	Injector defective	Replace (→ Page 77).
Engine wiring	Defective	Check (→ Page 125).
Fuel system	Not vented	Vent fuel system (→ Page 83).
Engine Governor	Defective	Contact Service.

Engine does not reach nominal speed

Component	Probable cause	Task
Fuel supply	Fuel prefilter clogged	Replace (→ Page 90).
	Easy-change fuel filter clogged	Replace (→ Page 84).
Air supply	Air filter clogged	Check signal ring position of service indicator (→ Page 95).
Fuel injection equipment	Injector defective	Replace (→ Page 77).
Engine wiring	Defective	Check (→ Page 125).
Engine	Overloaded	Contact Service.

Engine speed not steady

Component	Probable cause	Task
Fuel injection equipment	Injector defective	Replace (→ Page 77).
Speed sensor	Defective	Contact Service.
Fuel system	Not vented	Vent fuel system (→ Page 83).
Engine Governor	Defective	Contact Service.

Charge-air temperature too high

Component	Probable cause	Task
Engine coolant	Incorrect coolant concentration	Check (MTU test kit).
Intercooler	Contaminated	Contact Service.
Engine room	Air-intake temperature too high	Check fans and air supply / ventilation ducts.

Charge air pressure too low

Component	Probable cause	Task
Air supply	Air filter clogged	Check signal ring position of service indicator (→ Page 95).
Intercooler	Contaminated	Contact Service.
Exhaust turbocharger	Defective	Contact Service.

Coolant leaks on intercooler

Component	Probable cause	Task
Intercooler	Leaking, major coolant discharge	Contact Service.

Exhaust gas black

Component	Probable cause	Task
Air supply	Air filter clogged	Check signal ring position of service indicator (→ Page 95).
Fuel injection equipment	Injector defective	Replace (→ Page 77).
Engine	Overloaded	Contact Service.

Exhaust gas blue

Component	Probable cause	Task
Engine oil	Too much engine oil in the engine	Drain engine oil (→ Page 99).
	Oil separator of crankcase breather contaminated	Replace (→ Page 70).
Exhaust turbocharger, cylinder head, piston rings, cylinder liner	Defective	Contact Service.

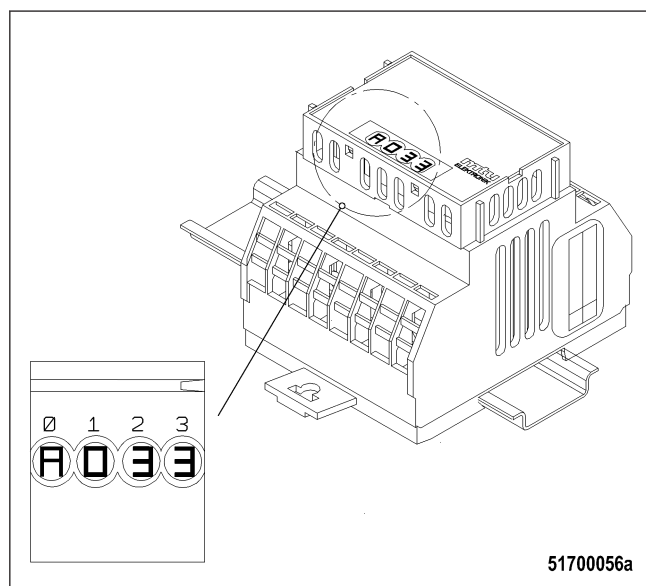
Exhaust gas white

Component	Probable cause	Task
Engine	Not at operating temperature	Run engine to reach operating temperature.
Fuel system	Water in fuel	Check fuel system on fuel prefilter. Drain fuel prefilter (→ Page 87).
Intercooler	Leaking	Contact Service.

6.2 Fault messages on engine governor

The engine governor generates alarms which are indicated in different ways depending on the equipment configuration:

- as four-digit code on a PIM
- as alarm text on a display
- as four-digit code on a dialog PC



The four-digit code consists of one letter and three figures:

- The letter encodes when the fault occurred the last time:
 - A = currently present
 - B = within the last operating hour
 - C = one to four operating hours ago
 - D = four to twelve operating hours ago
 Alarms that occurred more than twelve hours ago are deleted automatically.
- The three figures encode the fault itself as listed in the table below.

Alarms can also be caused by defective sensors / actuators. If troubleshooting in accordance with the following table is not successful, contact Service to have the sensors / actuators checked and, if required, replaced.

Fault code	Alarm text	Meaning	Task
005	L1 T-CHARGE AIR	Charge-air temperature too high (1st limit value)	Reduce power. Change over to idle and contact Service.
006	L2 T-CHARGE AIR	Charge-air temperature too high (2nd limit value)	Reduce power. Change over to idle and contact Service.
009	L1 T-INTER-COOLER	Charge-air coolant temperature too high (1st limit value)	Reduce power. Change over to idle and contact Service.
015	L1 P-LUBE OIL	Lube oil pressure too low (1st limit value)	Check engine-oil level and top up, if required (→ Page 98).
016	L2 P-LUBE OIL	Lube oil pressure too low (2nd limit value) automatic engine shutdown	<ol style="list-style-type: none"> 1. Check engine-oil level and top up, if required (→ Page 98). 2. Try to re-start the engine (→ Page 39). 3. Contact Service.

Fault code	Alarm text	Meaning	Task
023	L1 COOLANT LEVEL	Engine coolant level too low	Check coolant level and top up, if required (→ Page 105).
024	L2 COOLANT LEVEL	Engine coolant level too low	Check coolant level and top up, if required (→ Page 105).
030	ENGINE OVER-SPEED	Engine overspeed; automatic engine shutdown	<ol style="list-style-type: none"> 1. Acknowledge alarm. 2. Try to re-start the engine (→ Page 39). 3. Contact Service.
044	L1 LEVEL INTERCOOLER	Charge-air coolant level too low (1st limit value)	Check coolant level and top up, if required (→ Page 113).
045	L2 LEVEL INTERCOOLER	Charge-air coolant level too low (2nd limit value)	<ol style="list-style-type: none"> 1. Check coolant level and top up, if required (→ Page 113). 2. If fault occurs repeatedly: Contact Service.
051	L1 T-LUBE OIL	Lube oil temperature too high (1st limit value)	Reduce power. Change over to idle and contact Service.
052	L2 T-LUBE OIL	Lube oil temperature too high (2nd limit value)	<ol style="list-style-type: none"> 1. Reduce power. Change over to idle and contact Service. 2. If fault occurs repeatedly: Contact Service.
065	L1 P-FUEL	Fuel supply pressure too low (1st limit value)	<ol style="list-style-type: none"> 1. Check fuel lines for leaks; repair defective lines. 2. Clean fuel prefilter (→ Page 85); 3. Flush fuel prefilter (→ Page 88); 4. Replace filter element of fuel prefilter (→ Page 90); 5. Replace fuel filter (→ Page 84); 6. If fault is not rectified: Contact Service.
066	L2 P-FUEL	Fuel supply pressure too low (2nd limit value)	<ol style="list-style-type: none"> 1. Check fuel lines for leaks; repair defective lines. 2. Clean fuel prefilter (→ Page 85); 3. Flush fuel prefilter (→ Page 88); 4. Replace filter element of fuel prefilter (→ Page 90); 5. Replace fuel filter (→ Page 84); 6. If fault is not rectified: Contact Service.
067	L1 T-COOLANT	Coolant temperature too high (1st limit value) warning	Reduce power. Change over to idle and contact Service.
068	L2 T-COOLANT	Coolant temperature too high (2nd limit value) automatic engine shutdown	<ol style="list-style-type: none"> 1. Allow the engine to cool down. 2. Check coolant cooler (elements etc.) and clean contaminated parts (see manufacturer's documentation). 3. Re-start the engine (→ Page 39); 4. If fault occurs repeatedly: Contact Service.
069	L1 T-EXTERN 1	Violation of first limit for external temperature channel 1	(Depending on the corresponding measuring point, which is read via CAN bus)

Fault code	Alarm text	Meaning	Task
070	L2 T-EXTERN 1	Violation of second limit for external temperature channel 1	(Depending on the corresponding measuring point, which is read via CAN bus)
071	L1 T-EXTERN 2	Violation of first limit for external temperature channel 2	(Depending on the corresponding measuring point, which is read via CAN bus)
072	L2 T-EXTERN 2	Violation of second limit for external temperature channel 2	(Depending on the corresponding measuring point, which is read via CAN bus)
073	L1 P-EXTERN 1	Violation of first limit for external pressure channel 1	(Depending on the corresponding measuring point, which is read via CAN bus)
074	L2 P-EXTERN 1	Violation of second limit for external pressure channel 1	(Depending on the corresponding measuring point, which is read via CAN bus)
075	L1 P-EXTERN 2	Violation of first limit for external pressure channel 2	(Depending on the corresponding measuring point, which is read via CAN bus)
076	L2 P-EXTERN 2	Violation of second limit for external pressure channel 2	(Depending on the corresponding measuring point, which is read via CAN bus)
077	LIM EXT.COOLANT LEV.	Alarm from external coolant level monitoring	(Depending on the corresponding measuring point, which is read via CAN bus)
078	LIM INTER-COOLER LEV.	Alarm from external charge-air coolant level monitoring	(Depending on the corresponding measuring point, which is read via CAN bus)
079	L Bin-EXTERN 3	Alarm from external binary channel 3	(Depending on the corresponding measuring point, which is read via CAN bus)
080	L Bin-EXTERN 4	Alarm from external binary channel 4	(Depending on the corresponding measuring point, which is read via CAN bus)
081	RAIL LEAKAGE	HP fuel system leaking, system contains air	Contact Service.
082	RAIL PRESSURE HIGH	Pressure in HP fuel system exceeds specified value; Solenoid valve of HP fuel control block jamming or wiring to solenoid valve defective	Contact Service.
083	RAIL PRESSURE LOW	Pressure in HP fuel system lower than the specified value; HP fuel control block defective or system leaking NOTE: With very large generators having a run-out time of more than > 20 sec this alarm is not a relevant fault.	Contact Service.
089	ENGINE SPEED LOW	Engine speed lower than 200 rpm; automatic engine shutdown	Re-start the engine (→ Page 39);
090	IDLE SPEED LOW	Idle speed not reached within a specified period; Termination of starting procedure.	Note further alarms.

Fault code	Alarm text	Meaning	Task
091	RUN UP SPEED LOW	Run-up speed not reached within a specified period; Termination of starting procedure.	Note further alarms.
092	START SPEED LOW	Starter speed not reached within a specified period; Termination of starting procedure.	Note further alarms.
093	PREHEAT TEMP. LIMIT2	Coolant preheating temperature too low during start (2nd limit value); Termination of starting procedure (depending on project design)	Check preheating pump / preheating system (see manufacturer's documentation).
094	PREHEAT TEMP. LIMIT1	Coolant preheating temperature too low during start (1st limit value)	Check preheating pump / preheating system (see manufacturer's documentation).
100	EDM NOT VALID	Check sum error of measuring-point data in EDM	If fault occurs repeatedly: Contact Service.
101	IDM NOT VALID	Check sum error of measuring-point data in IDM	If fault occurs repeatedly: Contact Service.
102	INVALID FUEL CONS. 1	Check sum error of accumulated fuel consumption data in EDM (redundant data record 1)	If fault occurs repeatedly: Contact Service.
103	INVALID FUEL CONS. 2	Check sum error of accumulated fuel consumption data in EDM (redundant data record 2)	If fault occurs repeatedly: Contact Service.
104	OP HOURS1 NOT VALID	Check sum error of hour meter data in EDM	If fault occurs repeatedly: Contact Service.
105	OP HOURS2 NOT VALID	Check sum error of hour meter data in IDM	If fault occurs repeatedly: Contact Service.
106	ERR REC1 NOT VALID	Check sum error of fault memory in EDM (redundant data record 1)	If fault occurs repeatedly: Contact Service.
107	ERR REC2 NOT VALID	Check sum error of fault memory in EDM (redundant data record 2)	If fault occurs repeatedly: Contact Service.
118	L1 SUPPLY VOLT. LOW	Supply voltage too low (1st limit value)	Check engine governor supply voltage.
119	L2 SUPPLY VOLT. LOW	Supply voltage too low (2nd limit value)	Check engine governor supply voltage.
120	L1 SUPPLY VOLT. HIGH	Supply voltage too high (1st limit value)	Check engine governor supply voltage.

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Fault code	Alarm text	Meaning	Task
121	L2 SUPPLY VOLT. HIGH	Supply voltage too high (2nd limit value); automatic engine shutdown (depending on project design)	Check engine governor supply voltage. If engine was stopped: Start engine (→ Page 39).
122	L1 T-ELECTRONIC	Temperature in engine governor housing too high (1st limit value)	1. Improve engine room ventilation. 2. Reduce engine power. Change over to idle and contact Service.
134	15V POS ECU DEFECT	Electronic equipment defective; automatic engine shutdown	Contact Service.
136	15V NEG ECU DEFECT	Electronic equipment defective; automatic engine shutdown	Contact Service.
137	L1 5V BUFFER TEST	Power supply for pressure sensors defective.	1. Disconnect connectors X2 and X3 from engine governor. If alarm does not disappear: Contact Service. 2. Check wiring (pressure sensors). 3. Contact Service.
138	SENSORPOWERDEFECT	Power supply for pressure sensors defective.	1. Disconnect connectors X2 and X3 from engine governor. If alarm does not disappear: Contact Service. 2. Check wiring (pressure sensors). 3. Contact Service.
139	L1 TE BUFFER TEST	Internal electronic fault (temperature sensors)	Contact Service.
140	TE BUF. ECU DEFECT	Internal electronic fault (temperature sensors)	Contact Service.
142	BANK1 ECU DEFECT	Internal electronic fault; Engine does not start	Contact Service.
144	BANK2 ECU DEFECT	Internal electronic fault; Engine does not start	Contact Service.
145	15V_GOOD ECU DEFECT	Electronic equipment defective; automatic engine shutdown	Contact Service.
146	L1 AD-TEST1 SUPPLY	A/D-converter supply voltage too low	Contact Service.
147	AD-TEST1 ECU DEFECT	Electronic equipment defective; automatic engine shutdown	Contact Service.
148	L1 AD-TEST2 SUPPLY	A/D-converter supply voltage too low	Contact Service.
149	AD-TEST2 ECU DEFECT	Electronic equipment defective; automatic engine shutdown	Contact Service.
150	L1 AD-TEST3 SUPPLY	A/D-converter supply voltage too low	Contact Service.

Fault code	Alarm text	Meaning	Task
151	AD-TEST3 ECU DEFECT	Electronic equipment defective; automatic engine shutdown	Contact Service.
170	MI MODULE FAIL	Module in maintenance predictor either defective or missing	Contact Service.
171	MI NOT ACTIVE	Maintenance predictor no more activated	Contact Service.
173	MODULE WRITE LIMIT	EEPROM write limit reached	Contact Service.
180	CAN1 NODE LOST	At least one device not detected on Default CAN bus	1. Check wiring (CAN bus). 2. Contact Service.
181	CAN2 NODE LOST	At least one device not detected on Redundant CAN bus	1. Check wiring (CAN bus). 2. Contact Service.
182	CAN WRONG PARAMETERS	Consistency error in CAN parameters	Contact Service.
183	CAN NO PU-DATA	Error during project design data download in engine governor.	Contact Service.
184	CAN PU-DATA EE-FAIL	Error during project design data download in EEPROMs	Contact Service.
185	CAN LESS MAILBOXES	Error during CAN initialization.	Contact Service.
186	CAN1 BUS OFF	Severe fault on Default CAN bus; automatic change-over to Redundant CAN bus	Contact Service.
187	CAN1 ERROR PASSIVE	Light fault on Default CAN bus (e.g. short-time overload)	(none)
188	CAN2 BUS OFF	Severe fault on Redundant CAN bus; automatic change-over to Default CAN bus	Contact Service.
189	CAN2 ERROR PASSIVE	Light fault on Redundant CAN bus (e.g. short-time overload)	(none)
201	SD T-COOLANT	Sensor defect (coolant temperature)	1. Check wiring. 2. Contact Service.
202	SD T-FUEL	Sensor defect (Fuel temperature)	1. Check wiring. 2. Contact Service.
203	SD T-CHARGE AIR	Sensor defect (charge-air temperature)	1. Check wiring. 2. Contact Service.
205	SD T-COOLANT INTERC.	Sensor defect (charge-air coolant temperature)	1. Check wiring. 2. Contact Service.
208	SD P-CHARGE AIR	Sensor defect (charge-air pressure)	1. Check wiring. 2. Contact Service.

Fault code	Alarm text	Meaning	Task
211	SD P-LUBE OIL	Sensor defect (lube oil pressure)	1. Check wiring. 2. Contact Service.
215	SD P-RAIL FUEL	Sensor defect (common rail pressure); HP controller in emergency mode	1. Check wiring. 2. Contact Service.
216	SD T-LUBE OIL	Sensor defect (lube oil temperature)	1. Check wiring. 2. Contact Service.
220	SD COOLANT LEVEL	Sensor defect (coolant level)	1. Check wiring. 2. Contact Service.
223	SD LEVEL INTERCOOLER	Sensor defect (charge-air coolant level)	1. Check wiring. 2. Contact Service.
229	SD ENG.SPEED SENSORS	Sensor defect (crankshaft speed) and sensor defect (camshaft speed)	1. Check wiring. 2. Contact Service.
230	SD CRANK-SHAFT SPEED	Sensor defect (crankshaft speed)	1. Check wiring. 2. Contact Service.
231	SD CAMSHAFT SPEED	Sensor defect (camshaft speed)	1. Check wiring. 2. Contact Service.
240	SD P-FUEL	Sensor defect (fuel pressure)	1. Check wiring. 2. Contact Service.
245	SD POWER SUPPLY	Sensor defect (engine governor operating voltage)	Contact Service.
246	SD T-ELECTRONIC	Sensor defect (temperature in engine governor)	Contact Service.
250	SD CAN SPEED DEMAND	Sensor defect (CAN nominal speed demand)	1. Check speed transmitter. 2. Check wiring (CAN bus). 3. Contact Service.
266	SD SPEED DEMAND AN.	Sensor defect (analog nominal speed demand)	1. Check speed transmitter. 2. Check wiring. 3. Contact Service.
267	SD SP.DEM.TEST BENCH	Sensor defect (analog speed demand); NOTE: Only used in test-stand operation.	1. Check speed transmitter. 2. Check wiring. 3. Contact Service.
270	SD SPEED DEMAND FI1	Sensor defect (frequency input for speed demand);	1. Check speed transmitter. 2. Check wiring. 3. Contact Service.
271	SD T-EXTERN 1	External device defective (CAN T-EXTERN 1)	Contact Service.
272	SD T-EXTERN 2	External device defective (CAN T-EXTERN 2)	Contact Service.
273	SD P-EXTERN 1	External device defective (CAN P-EXTERN 1)	Contact Service.
274	SD P-EXTERN 2	External device defective (CAN P-EXTERN 2)	Contact Service.

Fault code	Alarm text	Meaning	Task
275	SD EXT.COOL- ANT LEVEL	External coolant-level monitor- ing defective (CAN)	Contact Service.
276	SD INTERCOOL- ER LEVEL	External charge-air coolant- level monitoring defective (CAN)	Contact Service.
277	SD BIN-EXTERN 3	External device defective (CAN BIN-EXTERN 3)	Contact Service.
278	SD BIN-EXTERN 4	External device defective (CAN BIN-EXTERN 4)	Contact Service.
301	TIMING CYLIN- DER A1	Injection timing fault cylinder A1	If fault occurs repeatedly: Contact Serv- ice.
302	TIMING CYLIN- DER A2	Injection timing fault cylinder A2	If fault occurs repeatedly: Contact Serv- ice.
303	TIMING CYLIN- DER A3	Injection timing fault cylinder A3	If fault occurs repeatedly: Contact Serv- ice.
304	TIMING CYLIN- DER A4	Injection timing fault cylinder A4	If fault occurs repeatedly: Contact Serv- ice.
305	TIMING CYLIN- DER A5	Injection timing fault cylinder A5	If fault occurs repeatedly: Contact Serv- ice.
306	TIMING CYLIN- DER A6	Injection timing fault cylinder A6	If fault occurs repeatedly: Contact Serv- ice.
307	TIMING CYLIN- DER A7	Injection timing fault cylinder A7	If fault occurs repeatedly: Contact Serv- ice.
308	TIMING CYLIN- DER A8	Injection timing fault cylinder A8	If fault occurs repeatedly: Contact Serv- ice.
309	TIMING CYLIN- DER A9	Injection timing fault cylinder A9	If fault occurs repeatedly: Contact Serv- ice.
310	TIMING CYLIN- DER A10	Injection timing fault cylinder A10	If fault occurs repeatedly: Contact Serv- ice.
311	TIMING CYLIN- DER B1	Injection timing fault cylinder B1	If fault occurs repeatedly: Contact Serv- ice.
312	TIMING CYLIN- DER B2	Injection timing fault cylinder B2	If fault occurs repeatedly: Contact Serv- ice.
313	TIMING CYLIN- DER B3	Injection timing fault cylinder B3	If fault occurs repeatedly: Contact Serv- ice.
314	TIMING CYLIN- DER B4	Injection timing fault cylinder B4	If fault occurs repeatedly: Contact Serv- ice.
315	TIMING CYLIN- DER B5	Injection timing fault cylinder B5	If fault occurs repeatedly: Contact Serv- ice.
316	TIMING CYLIN- DER B6	Injection timing fault cylinder B6	If fault occurs repeatedly: Contact Serv- ice.
317	TIMING CYLIN- DER B7	Injection timing fault cylinder B7	If fault occurs repeatedly: Contact Serv- ice.
318	TIMING CYLIN- DER B8	Injection timing fault cylinder B8	If fault occurs repeatedly: Contact Serv- ice.
319	TIMING CYLIN- DER B9	Injection timing fault cylinder B9	If fault occurs repeatedly: Contact Serv- ice.

Fault code	Alarm text	Meaning	Task
320	TIMING CYLINDER B10	Injection timing fault cylinder B10	If fault occurs repeatedly: Contact Service.
321	WIRING CYLINDER A1	Faulty wiring to solenoid valve cylinder A1; Misfiring	1. Check wiring. 2. Contact Service.
322	WIRING CYLINDER A2	Faulty wiring to solenoid valve cylinder A2; Misfiring	1. Check wiring. 2. Contact Service.
323	WIRING CYLINDER A3	Faulty wiring to solenoid valve cylinder A3; Misfiring	1. Check wiring. 2. Contact Service.
324	WIRING CYLINDER A4	Faulty wiring to solenoid valve cylinder A4; Misfiring	1. Check wiring. 2. Contact Service.
325	WIRING CYLINDER A5	Faulty wiring to solenoid valve cylinder A5; Misfiring	1. Check wiring. 2. Contact Service.
326	WIRING CYLINDER A6	Faulty wiring to solenoid valve cylinder A6; Misfiring	1. Check wiring. 2. Contact Service.
327	WIRING CYLINDER A7	Faulty wiring to solenoid valve cylinder A7; Misfiring	1. Check wiring. 2. Contact Service.
328	WIRING CYLINDER A8	Faulty wiring to solenoid valve cylinder A8; Misfiring	1. Check wiring. 2. Contact Service.
329	WIRING CYLINDER A9	Faulty wiring to solenoid valve cylinder A9; Misfiring	1. Check wiring. 2. Contact Service.
330	WIRING CYLINDER A10	Faulty wiring to solenoid valve cylinder A10; Misfiring	1. Check wiring. 2. Contact Service.
331	WIRING CYLINDER B1	Faulty wiring to solenoid valve cylinder B1; Misfiring	1. Check wiring. 2. Contact Service.
332	WIRING CYLINDER B2	Faulty wiring to solenoid valve cylinder B2; Misfiring	1. Check wiring. 2. Contact Service.
333	WIRING CYLINDER B3	Faulty wiring to solenoid valve cylinder B3; Misfiring	1. Check wiring. 2. Contact Service.

Fault code	Alarm text	Meaning	Task
334	WIRING CYLINDER B4	Faulty wiring to solenoid valve cylinder B4; Misfiring	1. Check wiring. 2. Contact Service.
335	WIRING CYLINDER B5	Faulty wiring to solenoid valve cylinder B5; Misfiring	1. Check wiring. 2. Contact Service.
336	WIRING CYLINDER B6	Faulty wiring to solenoid valve cylinder B6; Misfiring	1. Check wiring. 2. Contact Service.
337	WIRING CYLINDER B7	Faulty wiring to solenoid valve cylinder B7; Misfiring	1. Check wiring. 2. Contact Service.
338	WIRING CYLINDER B8	Faulty wiring to solenoid valve cylinder B8; Misfiring	1. Check wiring. 2. Contact Service.
339	WIRING CYLINDER B9	Faulty wiring to solenoid valve cylinder B9; Misfiring	1. Check wiring. 2. Contact Service.
340	WIRING CYLINDER B10	Faulty wiring to solenoid valve cylinder B10; Misfiring	1. Check wiring. 2. Contact Service.
341	OPEN_LOAD CYL. A1	Disconnection in wiring to solenoid valve cylinder A1; Misfiring	1. Check wiring. 2. Contact Service.
342	OPEN_LOAD CYL. A2	Disconnection in wiring to solenoid valve cylinder A2; Misfiring	1. Check wiring. 2. Contact Service.
343	OPEN_LOAD CYL. A3	Disconnection in wiring to solenoid valve cylinder A3; Misfiring	1. Check wiring. 2. Contact Service.
344	OPEN_LOAD CYL. A4	Disconnection in wiring to solenoid valve cylinder A4; Misfiring	1. Check wiring. 2. Contact Service.
345	OPEN_LOAD CYL. A5	Disconnection in wiring to solenoid valve cylinder A5; Misfiring	1. Check wiring. 2. Contact Service.
346	OPEN_LOAD CYL. A6	Disconnection in wiring to solenoid valve cylinder A6; Misfiring	1. Check wiring. 2. Contact Service.
347	OPEN_LOAD CYL. A7	Disconnection in wiring to solenoid valve cylinder A7; Misfiring	1. Check wiring. 2. Contact Service.

Fault code	Alarm text	Meaning	Task
348	OPEN_LOAD CYL. A8	Disconnection in wiring to solenoid valve cylinder A8; Misfiring	1. Check wiring. 2. Contact Service.
349	OPEN_LOAD CYL. A9	Disconnection in wiring to solenoid valve cylinder A9; Misfiring	1. Check wiring. 2. Contact Service.
350	OPEN_LOAD CYL. A10	Disconnection in wiring to solenoid valve cylinder A10; Misfiring	1. Check wiring. 2. Contact Service.
351	OPEN_LOAD CYL. B1	Disconnection in wiring to solenoid valve cylinder B1; Misfiring	1. Check wiring. 2. Contact Service.
352	OPEN_LOAD CYL. B2	Disconnection in wiring to solenoid valve cylinder B2; Misfiring	1. Check wiring. 2. Contact Service.
353	OPEN_LOAD CYL. B3	Disconnection in wiring to solenoid valve cylinder B3; Misfiring	1. Check wiring. 2. Contact Service.
354	OPEN_LOAD CYL. B4	Disconnection in wiring to solenoid valve cylinder B4; Misfiring	1. Check wiring. 2. Contact Service.
355	OPEN_LOAD CYL. B5	Disconnection in wiring to solenoid valve cylinder B5; Misfiring	1. Check wiring. 2. Contact Service.
356	OPEN_LOAD CYL. B6	Disconnection in wiring to solenoid valve cylinder B6; Misfiring	1. Check wiring. 2. Contact Service.
357	OPEN_LOAD CYL. B7	Disconnection in wiring to solenoid valve cylinder B7; Misfiring	1. Check wiring. 2. Contact Service.
358	OPEN_LOAD CYL. B8	Disconnection in wiring to solenoid valve cylinder B8; Misfiring	1. Check wiring. 2. Contact Service.
359	OPEN_LOAD CYL. B9	Disconnection in wiring to solenoid valve cylinder B9; Misfiring	1. Check wiring. 2. Contact Service.
360	OPEN_LOAD CYL. B10	Disconnection in wiring to solenoid valve cylinder B10; Misfiring	1. Check wiring. 2. Contact Service.
361	POWER STAGE FAIL 1	Defect in engine governor (solenoid valve power stage)	Contact Service.
362	POWER STAGE FAIL 2	Defect in engine governor (solenoid valve power stage)	Contact Service.

Fault code	Alarm text	Meaning	Task
363	STOP POWER STAGE 1	Solenoid valve or wiring or engine governor defective automatic engine shutdown	1. Check wiring. 2. Try to re-start the engine (→ Page 39). 3. Contact Service.
364	STOP POWER STAGE 2	Solenoid valve or wiring or engine governor defective automatic engine shutdown	1. Check wiring. 2. Try to re-start the engine (→ Page 39). 3. Contact Service.
365	STOP MV-WIRING	Solenoid-valve wiring faulty; automatic engine shutdown	1. Check wiring. 2. Try to re-start the engine (→ Page 39). 3. Contact Service.
381	TRAN.OUT1 PLANT DEF	Binary transistor output plant 1 defective	Contact Service.
382	TRAN.OUT2 PLANT DEF	Binary transistor output plant 2 defective	Contact Service.
383	TRAN.OUT3 PLANT DEF	Binary transistor output plant 3 defective	Contact Service.
384	TRAN.OUT4 PLANT DEF	Binary transistor output plant 4 defective	Contact Service.
385	TRAN.OUT5 PLANT DEF	Binary transistor output plant 5 defective	Contact Service.
386	TRAN.OUT6 PLANT DEF	Binary transistor output plant 6 defective	Contact Service.

7 Task Description

7.1 Engine

7.1.1 Engine – Barring manually

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Barring device	F6555766	1
Ratchet with extension	F30006212	1

DANGER



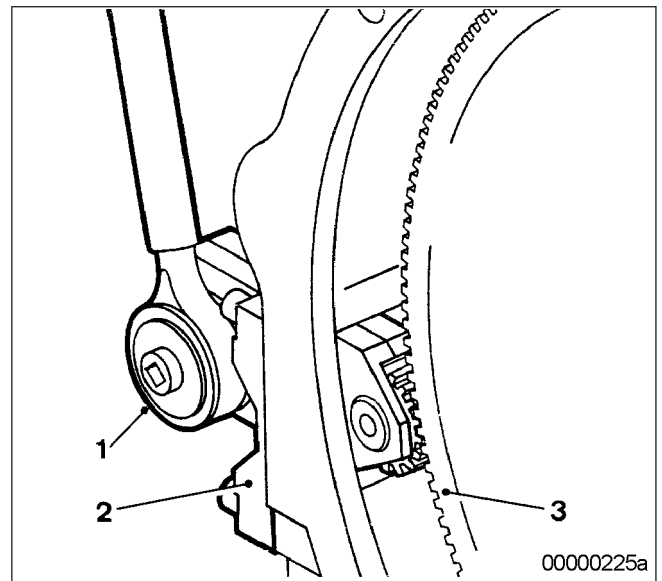
Unguarded rotating and moving engine components.

Risk of serious injury – Danger to life!

- Before barring the engine, ensure that nobody is in the danger zone.

Engine – Barring manually

1. Remove guard plate.
2. Engage barring device (2) with ring gear (3) and install on flywheel housing.
3. Place ratchet (1) onto barring device (2).
4. Rotate crankshaft in engine direction of rotation. Apart from the normal compression resistance, there should be no further resistance.
5. For barring device removal, follow reverse sequence of working steps.



7.1.2 Engine – Barring with starting system

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Connector pliers	0135315483	1

DANGER



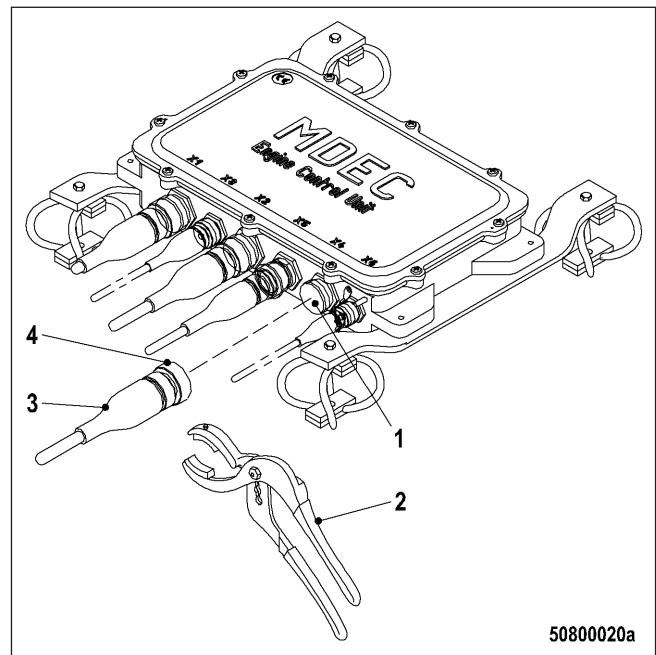
Unguarded rotating and moving engine components.

Risk of serious injury – danger to life!

- before barring or starting the engine, ensure that nobody is in the danger zone.
- After working on the engine, check that all protective devices have been reinstalled and all tools removed from the engine.

Engine – Barring with starting system

1. Disengage the bayonet coupling (4) of connector X4 with connector pliers (2) and withdraw connector (3) from engine governor.
2. Bar engine in unloaded condition: Press START button.
3. Let the crankshaft rotate until oil pressure is indicated.
4. Engine start is automatically interrupted when specified starting period is expired. If necessary, re-start the engine after approx. 20 seconds.
5. Plug connector X4 (3) and use connector pliers (2) to secure the bayonet coupling (4) by turning it clockwise until it latches into place.



7.1.3 Engine – Test run

DANGER



Unguarded rotating and moving engine components.

Risk of serious injury – danger to life!

- Before barring or starting the engine, make sure that nobody is in the danger zone.

WARNING



Engine noise above 85 dB (A).

Risk of damage to hearing!

- Wear ear protectors.

Engine – Test run

1. Start engine (→ Page 39).
2. Perform test run not below 1/3 load and at least until steady-state temperature is reached.
3. Carry out operational checks (→ Page 41).
4. Stop engine (→ Page 42).

7.2 Cylinder Liner

7.2.1 Cylinder liner – Endoscopic examination

Preconditions

- Engine is stopped and starting disabled

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Rigid endoscope	Y20097353	1

Preparatory steps

1. Remove cylinder head cover (→ Page 75).
2. Remove injector (→ Page 78).

Positioning crankshaft at BDC

1. Using barring device, turn crankshaft until crankshaft journal of the cylinder to be tested has reached BDC.
2. Insert endoscope into cylinder liner through injector seat.

Endoscopic examination of cylinder liner

Findings	Measure
<ul style="list-style-type: none"> • Thin carbon coating on circumference of carbon scraper ring • Slight localized additive deposits at top edge • Localized smooth areas at bottom edge • Carbon deposits on circumference in clearance between top piston ring and bottom edge of carbon scraper ring • First signs of marks left by top piston ring • Bright mark on entire circumference • Consistent honing pattern without objections • First signs of marks left by lower cooling bores • Running pattern seems darker 	No action required
<ul style="list-style-type: none"> • Dark areas with even or varying degrees of discoloration • Beginning and end of the discoloration are not sharply defined and do not cover the entire stroke area • Dark areas in the upper section of the cooling bore, remaining circumference without objections • Piston rings without objections 	Further endoscopic examination required as part of maintenance work
<ul style="list-style-type: none"> • On the entire circumference, apart from light areas of discoloration (that do not impair operation) clearly darker stripes that start at the top piston ring • Heat discoloration in the direction of stroke and honing pattern damage • Heat discoloration of piston rings 	Cylinder liner must be replaced; Service must be contacted

1. Compile endoscopic report using the table.
2. Use technical terms for description of the liner surface (→ Page 68).
3. Depending on findings:
 - Do not take any action or
 - carry out a further endoscopic examination as part of maintenance work or
 - contact Service; cylinder liner must be replaced.

Final steps

1. Install injector (→ Page 78).
2. Install cylinder head cover (→ Page 75).

7.2.2 Cylinder liner - Instructions and comments on endoscopic and visual examination

Terms used for endoscopic examination

Use the terms listed below to describe the condition of the cylinder-liner surface in the endoscopic examination report.

Findings	Measure
Minor dirt scores	<p>Minor dirt scores can occur during the assembly of a new engine (honing products, particles, broken-off burrs). Removed cylinders clearly show such scoring on the running surface under endoscope magnification. Cannot be felt with the fingernail.</p> <p>Findings not critical.</p>
Single scores	<p>Clearly visible scores caused by hard particles. They usually start in the TDC area and cross through the hone pattern in the direction of stroke.</p> <p>Findings not critical.</p>
Scored area	<p>These areas consist of scores of different length and depth next to one another. In most cases, they are found at the 6-o'clock and 12-o'clock positions (inlet/exhaust) along the transverse engine axis.</p> <p>Findings not critical.</p>
Smoothened area	<p>Smoothened areas are on the running surface but almost the whole honing pattern is still visible. Smoothened areas appear brighter and more brilliant than the surrounding running surface.</p> <p>Findings not critical.</p>
Bright area	<p>Bright areas are on the running surface and show local removal of the honing pattern. Grooves from honing process are not visible any more.</p>
Discoloration	<p>This is caused by oxidation (surface discoloration through oil or fuel) and temperature differences around the liner. It appears rather darker within the honed structure in contrast to the bright metallic running surface. The honing pattern is undisturbed. Discolorations extend in stroke direction and may be interrupted.</p> <p>Findings not critical.</p>
Corrosion fields / spots	<p>Corrosion fields / spots result from water (condensed water) with the valves in the overlap (open) position. They are clearly visible due to the dark color of the honing groove bottom.</p> <p>This corrosion is not critical unless there is corrosion pitting.</p>
Black lines	<p>Black lines are a step towards heat discoloration. They are visible as a clear discoloration from TDC to BDC in the running surface and the start of localized damage to the honing pattern.</p> <p>Cylinder liners with a large number of black lines around the running surface have limited service life and should be replaced.</p>

Findings	Measure
Burn mark	<p>This is caused by a malfunction in the liner / ring tribosystem. Usually they run over the whole ring-travel area (TDC/BDC), starting at the first TDC-ring and becoming more visible from the second TDC-ring 2 onwards and less pronounced from TDC-ring 1. The honing pattern is usually no longer visible and displays a clearly defined (straight) edge to the undisturbed surface. The damaged surface is usually discolored. The circumferential length varies.</p> <p>Liners with burn marks, or heat discoloration, starting in TDC ring 1 have to be replaced.</p>
Seizure marks, scuffing	<p>Irregular circumference lengths and depths. Can be caused either by the piston skirt or the piston crown. Material deposits on the liner (smear), heavy discoloration. Severe, visible scoring.</p> <p>Replace liner.</p>

Evaluation of findings and further measures

The findings in the start phase of oxidation discoloration and heat discoloration are similar. A thorough investigation and compliance with the above evaluation criteria allow an unambiguous evaluation. To avoid unnecessary disassembly work, it is recommended that another inspection be carried out after further operation of the engine.

7.3 Crankcase Breather

7.3.1 Crankcase breather – Oil separator replacement, diaphragm check and replacement

Preconditions

- Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 6-50 Nm	F30027336	1
Ratchet adapter	F30027340	1
Engine oil		
Filter element	(→ Spare Parts Catalog)	
Diaphragm	(→ Spare Parts Catalog)	
Seal	(→ Spare Parts Catalog)	

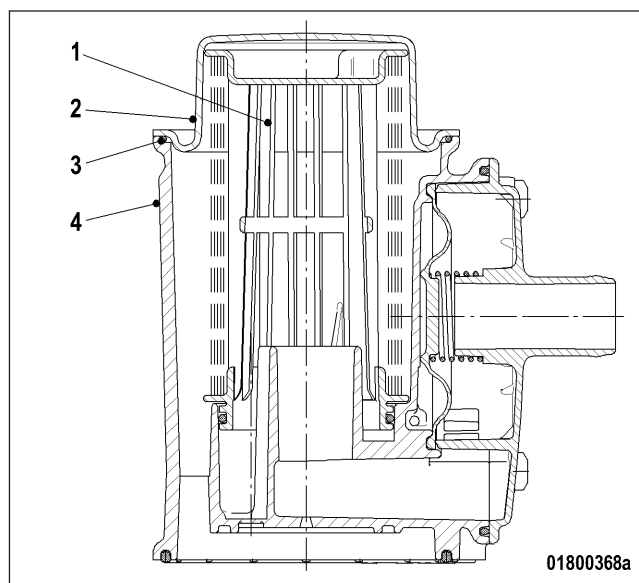
WARNING



- Hot oil.
Oil can contain combustion residues which are harmful to health.
Risk of injury and poisoning!
- Wear protective clothing, gloves, and goggles / safety mask.
 - Avoid contact with skin.
 - Do not inhale oil vapor.

Replacing oil separator

1. Remove cover (2) with O-ring (3).
2. Remove filter element (1) from housing (4).
3. Insert new filter element in housing (4).
4. Fit cover (2) with new O-ring.



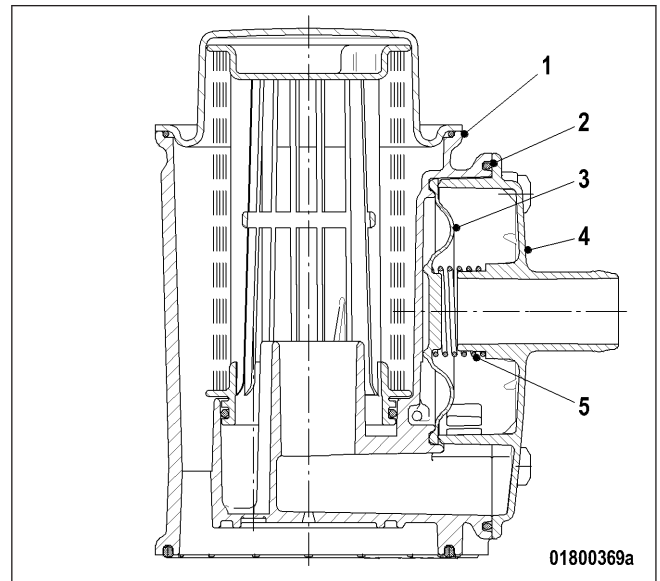
5. Use torque wrench to tighten the screws of cover (2) to the specified torque.

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque	(Engine oil)	6 Nm +2 Nm

6. Replace further oil separator elements in the same way.

Checking diaphragm

1. Remove cover (4).
2. Remove spring (5), seal (2) and diaphragm (3).
3. Check diaphragm (3) for damage, fit new diaphragm if used one is damaged.
4. Install diaphragm (3) on housing (1).
5. Install new seal (2) and spring (5) together with cover (4).



6. Use torque wrench to tighten the screws of cover (4) to the specified torque.

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque	(Engine oil)	6 Nm +2 Nm

7. Check diaphragms in further oil separators in the same way.

7.4 Valve Drive

7.4.1 Valve gear – Lubrication

Preconditions

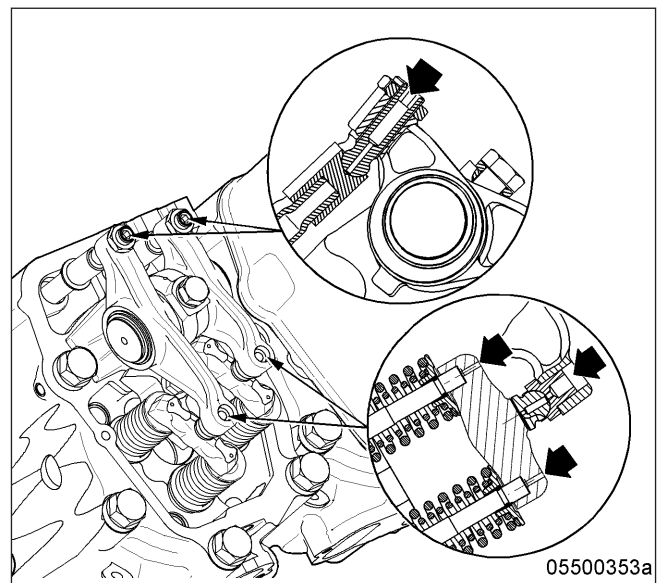
- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine oil		

Valve gear – Lubrication

1. Remove cylinder head covers (→ Page 75).
2. Fill oil chambers of valve bridges with oil.
3. Fill oil chambers of rocker arms and adjusting screws with oil.
4. Install cylinder head covers (→ Page 75).



7.4.2 Valve clearance – Check and adjustment

Preconditions

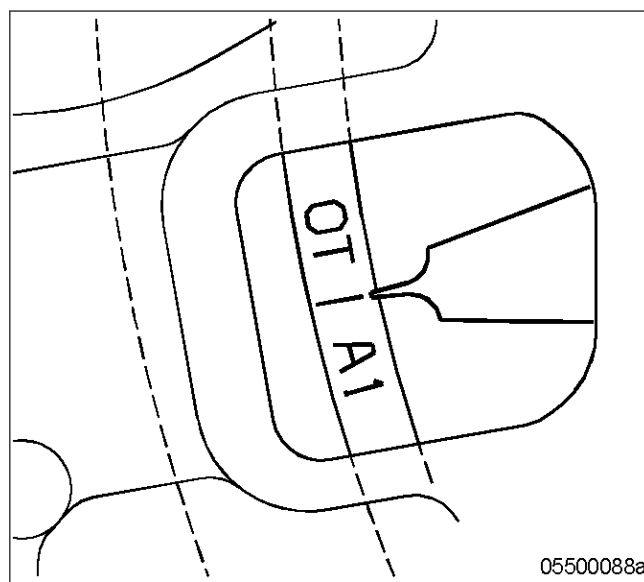
- Engine is stopped and starting disabled.
- Engine coolant temperature is max. 40 °C.
- Valves are closed.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Feeler gauge	Y20010128	1
Torque wrench, 60-320 Nm	F30047446	1
Allen key	F30002817	1
Socket wrench, 24 mm	F30039526	1
Engine oil		

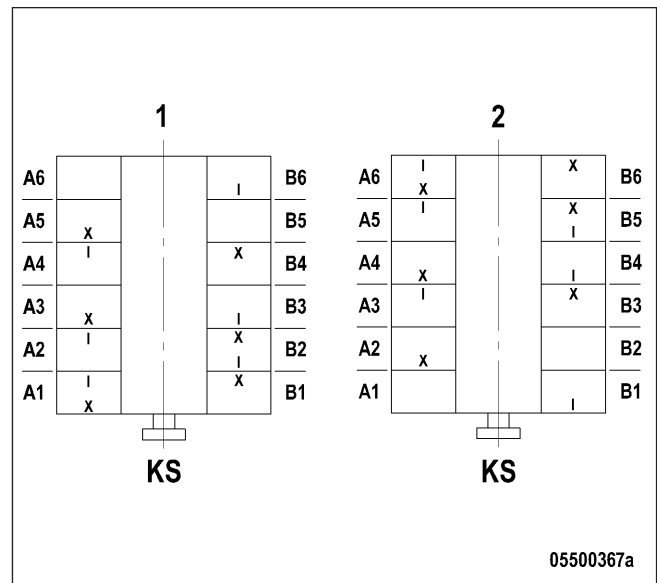
Preparatory steps

1. Remove cylinder head cover (→ Page 75).
2. Install barring tool (→ Page 63).
3. Rotate crankshaft with barring tool in engine direction of rotation until marking "OT-A1" and pointer are aligned.



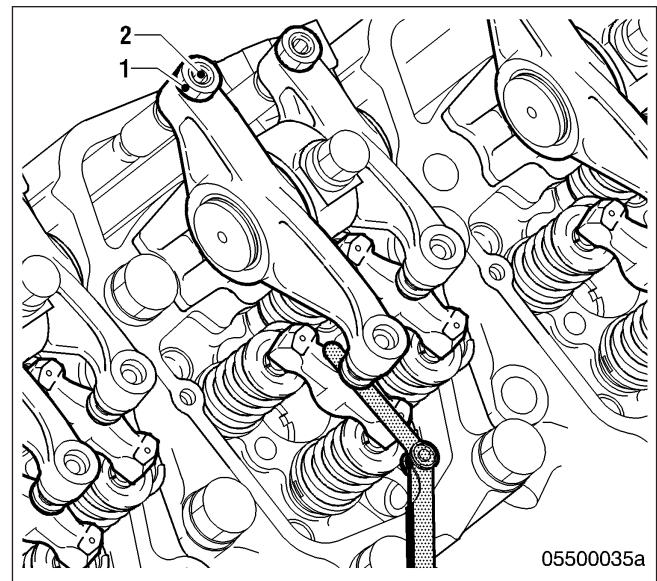
Checking valve clearance at two crankshaft positions

- Check TDC position of piston in cylinder A1:
 - If the rocker arms are unloaded on cylinder A1, the piston is in firing TDC.
 - If the rocker arms are under load on cylinder A1, the piston is in overlap TDC.
- Check valve clearance with cold engine:
 - Inlet valves (long rocker arm) = 0.2 mm
 - Exhaust valves (short rocker arm) = 0.5 mm
- Check all valve clearances in two crankshaft positions (firing TDC and overlap TDC of cylinder A1) as per diagram.
 - Cylinder A1 is in firing TDC
 - Cylinder A1 is in overlap TDC
 - Inlet valve
 - Exhaust valve
- Use feeler gauge to determine the distance between valve bridge and rocker arm.
- If the deviation from the set value exceeds 0.1 mm, adjust valve clearance.



Adjusting valve clearance

- Release locknut (1).
- Insert feeler gauge between valve bridge and rocker arm.
- Using Allen key, set adjusting screw (2) so that the specified valve clearance is provided.
- Feeler gauge must just pass through the gap.



- Tighten locknut (1) with torque wrench to the specified tightening torque, holding the adjusting screw (2) to prevent it from turning.

Name	Size	Type	Lubricant	Value/Standard
Locknut	M16 x 1.5	Tightening torque	(Engine oil)	90 Nm +9 Nm

- Replace or rectify adjusting screws and/or locknuts which do not move freely.
- Check valve clearance.

Final steps

- Remove barring tool (→ Page 63).
- Install cylinder head cover (→ Page 75).

7.4.3 Cylinder head cover – Removal and installation

Preconditions

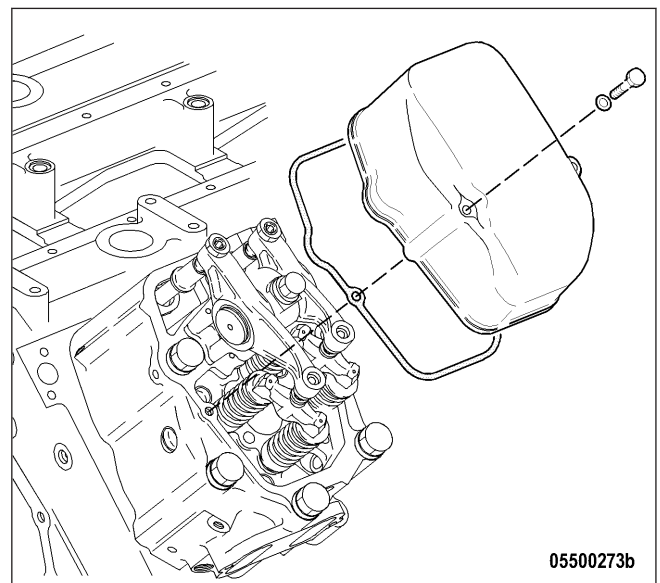
- Engine shut down and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Gasket	(→ Spare Parts Catalog)	

Removing cylinder head cover

1. Clean cylinder head covers prior to removal if they are heavily soiled.
2. Remove screws.
3. Remove cylinder head cover with gasket from cylinder head.



Installing cylinder head cover

1. Clean mating face.
2. Check condition of gasket, replace if necessary.
3. Place gasket and cylinder head cover on cylinder head.
4. Install cylinder head cover.

7.5 Injection Pump / HP Pump

7.5.1 HP pump – Relief bore check

DANGER



Unguarded rotating and moving engine components.

Risk of serious injury – danger to life!

- Take special care when working on a running engine.

WARNING



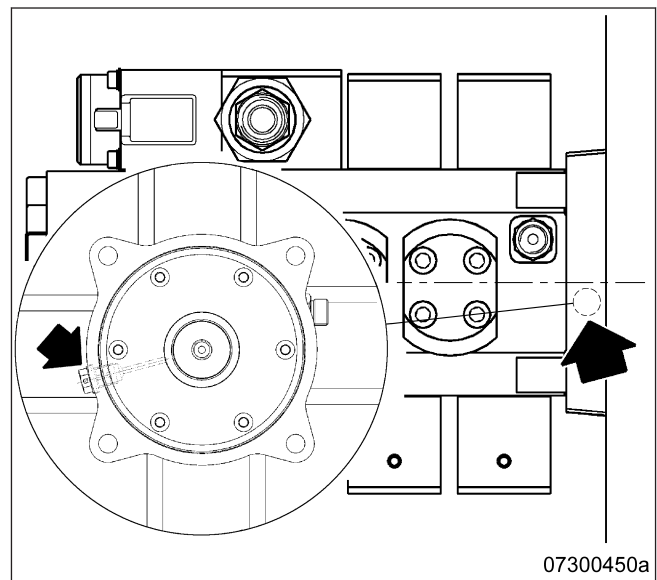
Engine noise above 85 dB (A).

Risk of damage to hearing!

- Wear ear protectors.

Checking HP pump relief bore

1. Check relief bore for oil and fuel discharge by visual inspection.
2. If relief bore is contaminated, stop the engine, disable engine start, and clean relief bore.
3. Note the following in case of fluid discharge:
 - Heavy discharge means continuous discharge of fluids (leakage). Contact Service.
 - Minor discharge of fluids up to 10 drops per day is normal (moistening) and not considered a leakage.



7.6 Injection Valve / Injector

7.6.1 Injector – Replacement

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Injector	(→ Spare Parts Catalog)	

Replacing injector

- ▶ Remove injector and install new injector (→ Page 78).

7.6.2 Injector – Removal and installation

Preconditions

- Engine shut down and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Installation and removal tool for injector	F6790161	1
Milling cutter	F30452739	1
Slotted nut screwdriver	F30452578	1
Torque wrench, 0.5-5 Nm	0015384230	1
Torque wrench, 10-60 Nm	F30510423	1
Torque wrench, 60-320 Nm	F30047446	1
Assembly paste (Optimoly Paste White T)	40477	1
Grease (Kluth Hakuform 30-10/emulsifier)	X00058060	1
Engine oil		

WARNING



Fuels are combustible.

Risk of fire and explosion!

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

CAUTION



Removal of all injectors.

Damage to component!

- Ensure that the high-pressure fuel accumulator is secured on the engine through two HP lines.

CAUTION



Cable damage during operation.

Fire hazard!

- Twist cables when installing.
- Ensure that cables do not touch components.

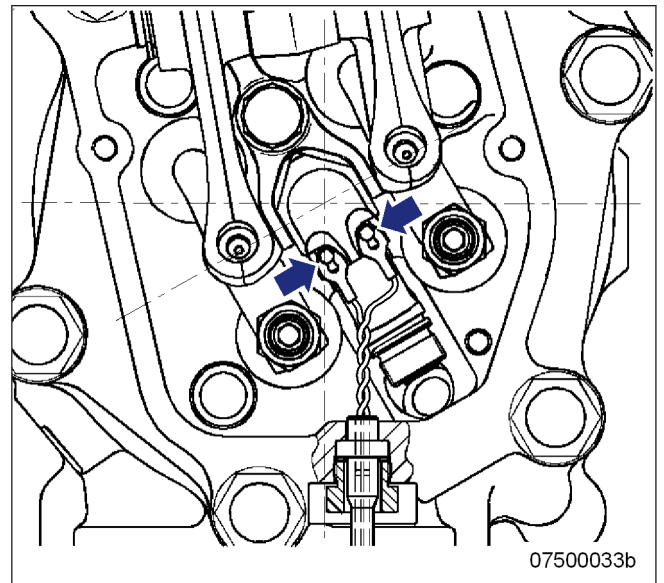
Preparatory steps

1. Shut off fuel inlet to engine.
2. Remove cylinder head cover (→ Page 75).

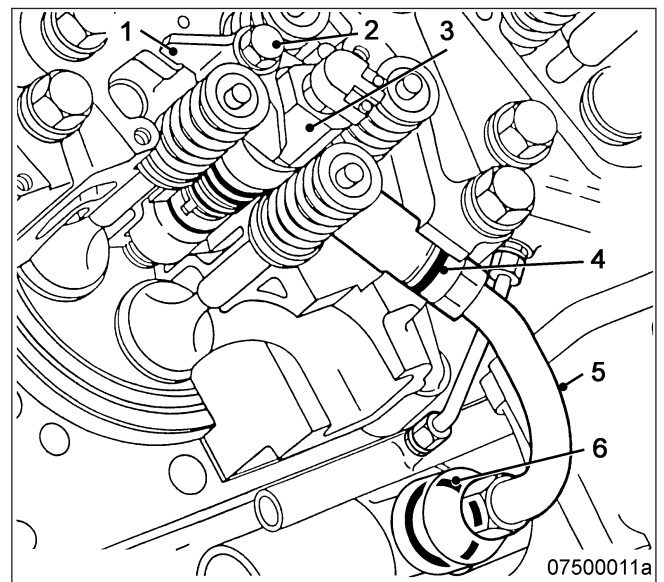
Removing injector

Note: Always replace the first and last injectors of one engine side first. Replace the inner injectors only after the installation of the outer injectors on this engine side is completed.

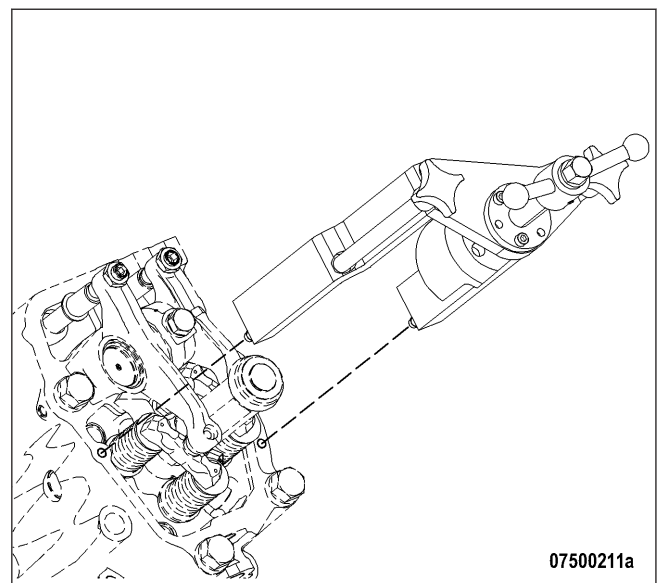
1. Undo cable terminal screws (arrow) on injector and remove cable terminals.



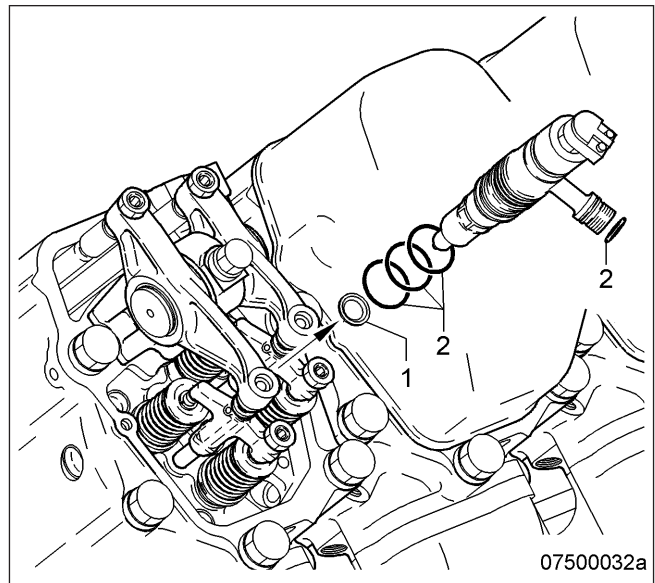
2. Remove screw (2) and take off hold-down clamp (1).
3. Remove high-pressure fuel line (5).



4. Install installation/removal device on cylinder head.
5. Remove injector with installation/removal device.
6. Remove installation/removal device.

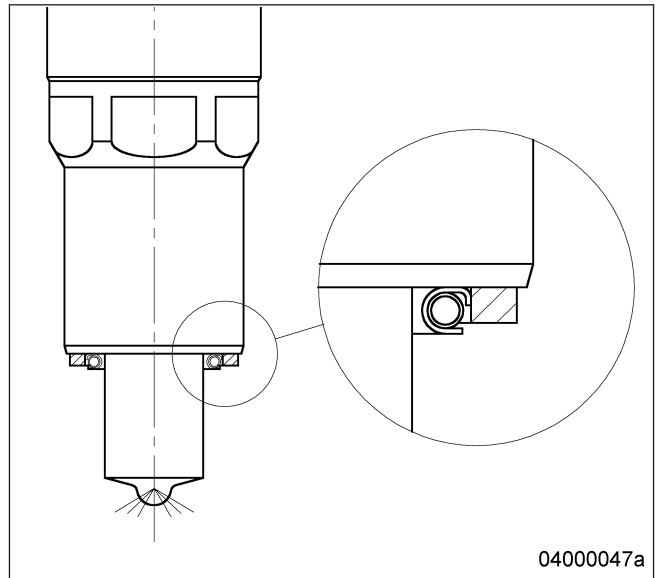


7. Remove sealing ring (1) from injector or use a self-made wire hook to extract it from the cylinder head.
8. Remove O-rings (2) from injector.
9. Cover all connections and bores, or seal with suitable plugs.

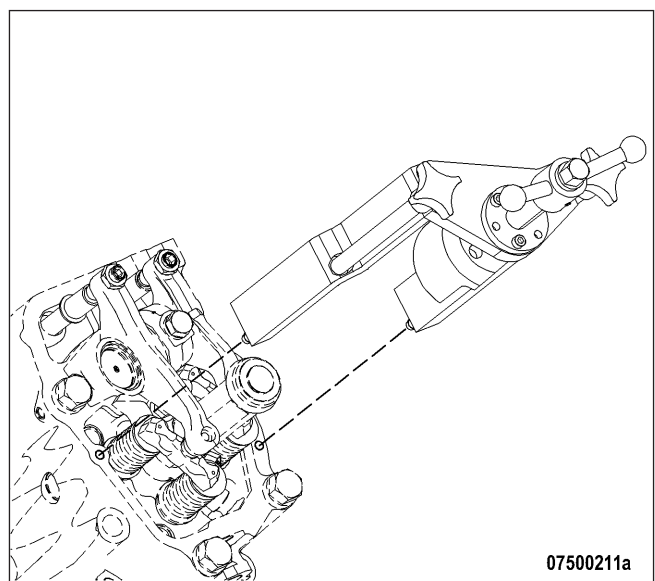


Installing injector

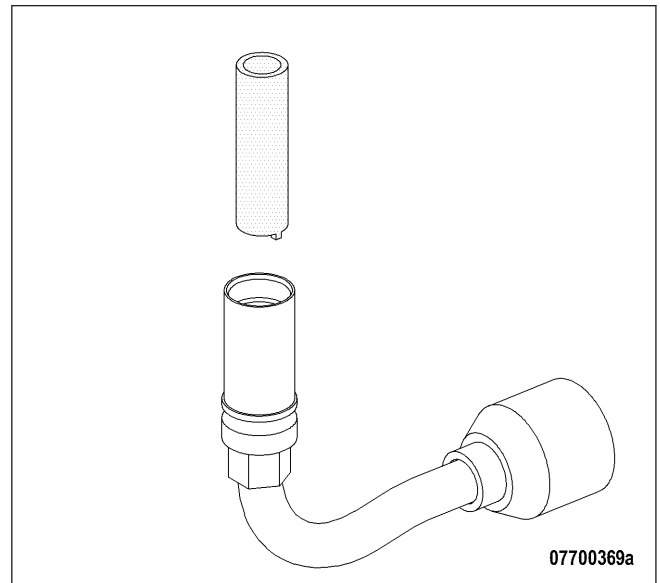
1. Remove all plugs before installing.
2. Coat nozzle retaining nut area of injector with assembly paste.
3. Fit new O-rings on injector and coat with grease.
4. Fit new sealing ring on injector with grease ensuring correct installation position of sealing ring.



5. Clean sealing surface on cylinder head and protective sleeve with milling cutter.
6. Insert injector into cylinder head ensuring that the HP line connection is aligned correctly.
7. Press in injector with installation/removal device.
8. Remove installation/removal device.



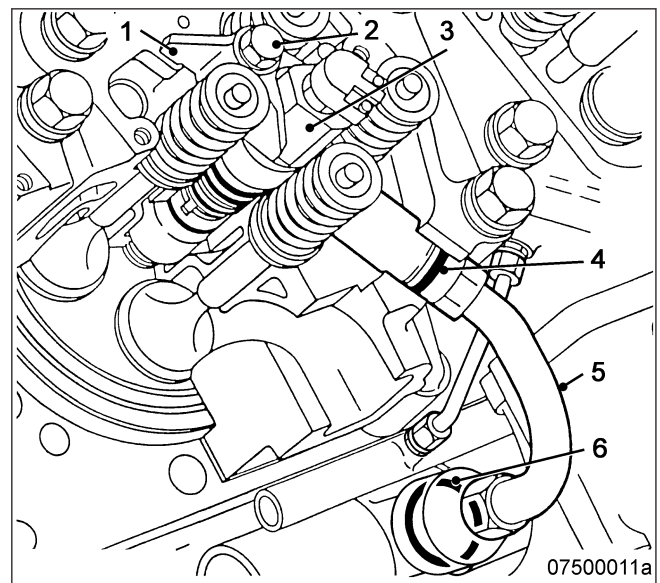
9. Use slotted screwdriver to check thrust ring at both line ends for secure seating.



10. Tighten loose thrust ring to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Thrust ring		Tightening torque		5 Nm to 10 Nm

11. Coat screw head mating face (2) and thread with engine oil.



12. Place hold-down clamp (1) in correct installation position. Tighten screw (2) with torque wrench to the specified initial tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw	M12	Preload torque	(Engine oil)	5 Nm to 10 Nm

13. Fit O-rings (4) and (6) on high-pressure fuel line (5) and coat with grease.

14. Tighten high-pressure fuel line (5) to the specified initial tightening torque.

Name	Size	Type	Lubricant	Value/Standard
HP line		Preload torque	(Engine oil)	5 Nm to 10 Nm

15. Tighten screw (2) to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Screw	M12	Tightening torque		100 Nm + 10 Nm

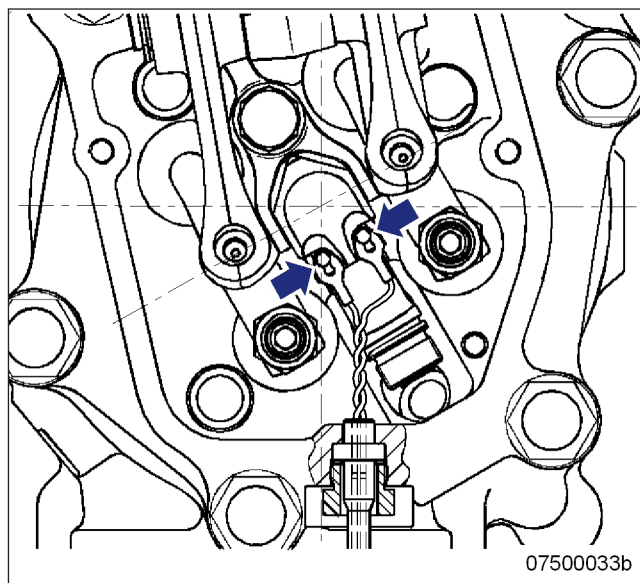
16. Tighten union nut of connecting piece (limiting valve) to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Union nut		Tightening torque		140 Nm + 10 Nm

17. Tighten union nut of connecting piece (injector) to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Union nut		Tightening torque		120 Nm +10 Nm

18. Twist cable several times.



19. Insert cable terminals (arrows) underneath screws on injector and tighten screws to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque		1.5 Nm

Final steps

1. Install cylinder head cover (→ Page 75).
2. Open up fuel inlet to engine.

7.7 Fuel System

7.7.1 Fuel system – Venting

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Diesel fuel		

WARNING



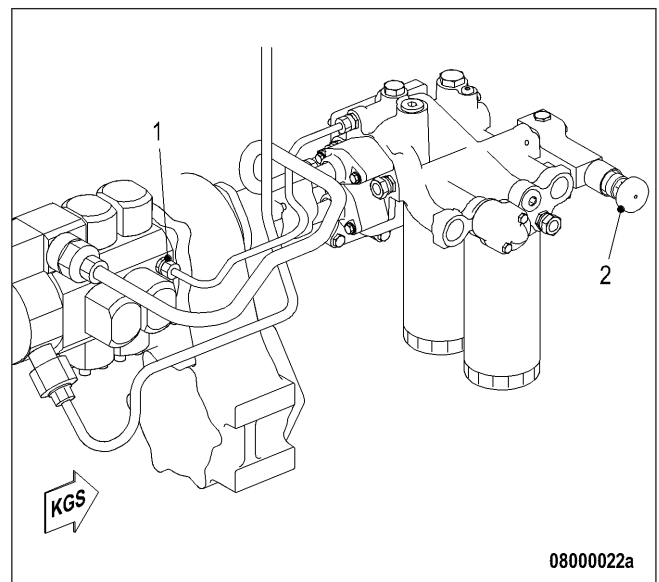
Fuels are combustible.

Risk of fire and explosion!

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Venting LP fuel system

1. Loosen flushing/return line of HP pump at connection (1).
2. Unlock fuel priming pump (2), screw out handle.
3. Operate the fuel priming pump (2) with the handle until bubble-free fuel comes out of the connection (1).
4. Lock fuel priming pump (2), screw in handle.
5. Verify that fuel priming pump (2) is locked: Handle must be tightened.
6. Tighten connection (1) of flushing/return line.



7.8 Fuel Filter

7.8.1 Fuel filter – Replacement

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Filter wrench	F30379104	1
Engine oil		
Easy-change filter	(→ Spare Parts Catalog)	

WARNING



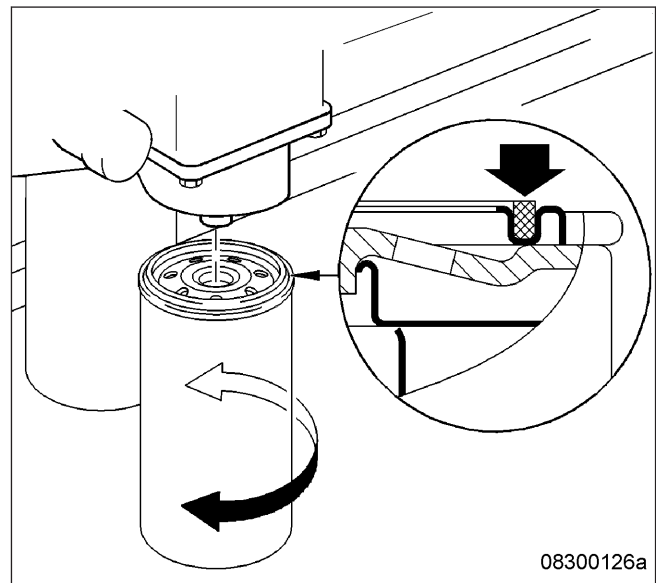
Fuels are combustible.

Risk of fire and explosion!

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Replacing fuel filter

1. Remove easy-change filter using filter wrench.
2. Clean sealing surface on filter head.
3. Slightly lubricate seal on the easy-change filter.
4. Screw on easy-change filter by hand until the seal connects and tighten manually.
5. Vent fuel system (→ Page 83).
6. Replace other easy-change filters in the same way.



7.8.2 Fuel prefilter cleaning

Preconditions

- Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Diesel fuel		
Sealing ring	(→ Spare Parts Catalog)	

WARNING



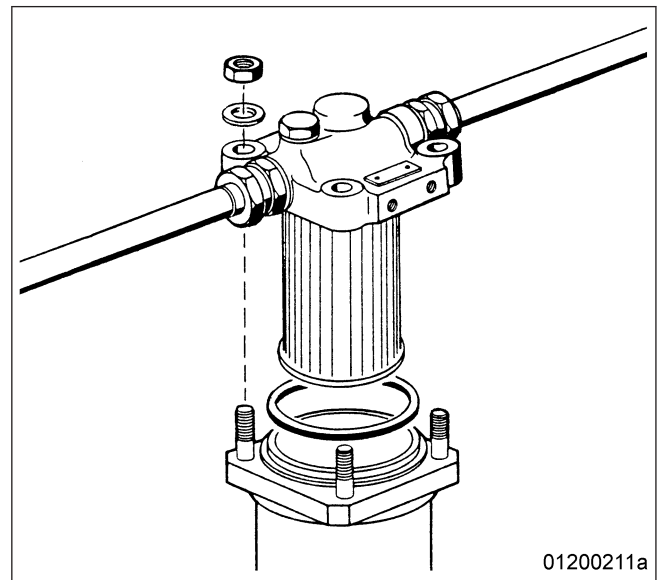
Fuels are combustible.

Risk of fire and explosion!

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Fuel prefilter cleaning

1. Shut off fuel supply.
2. Remove nuts from filter head.
3. Take off filter housing and drain fuel into appropriate container.
4. Remove filter-element securing nut and remove filter element by pulling it downwards.
5. Wash filter element in clean fuel using a smooth brush.
6. Wash filter housing with clean fuel.
7. Insert filter element into filter housing and secure with nut.
8. Place new sealing ring into groove in filter head.
9. Fit cover with seal and secure it with nuts crosswise.
10. Open fuel supply.



7.8.3 Fuel prefilter – Differential pressure gauge check and adjustment

DANGER



Unguarded rotating and moving engine components.
Risk of serious injury – danger to life!
• Take special care when working on a running engine.

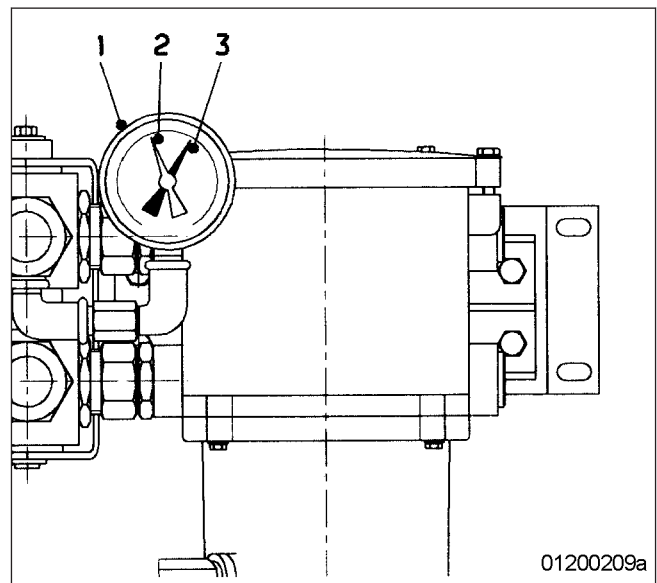
WARNING



Engine noise above 85 dB (A).
Risk of damage to hearing!
• Wear ear protectors.

Adjusting differential pressure gauge

1. When installing the new filter element: align adjustable pointer (2) with pressure-indicating pointer (3) of pressure gauge (1).
2. Check differential pressure.



Checking differential pressure of fuel prefilter

1. With the engine running at full load or rated power, read off pressure at gauge (1).
2. If differential pressure as indicated between position of adjustable pointer (2) and pressure-indicating pointer (3) of pressure gauge is ≥ 0.3 bar, flush filter element of the cut-in filter (→ Page 88).

7.8.4 Fuel prefilter – Draining

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Diesel fuel		
Gasket	(→ Spare Parts Catalog)	

WARNING



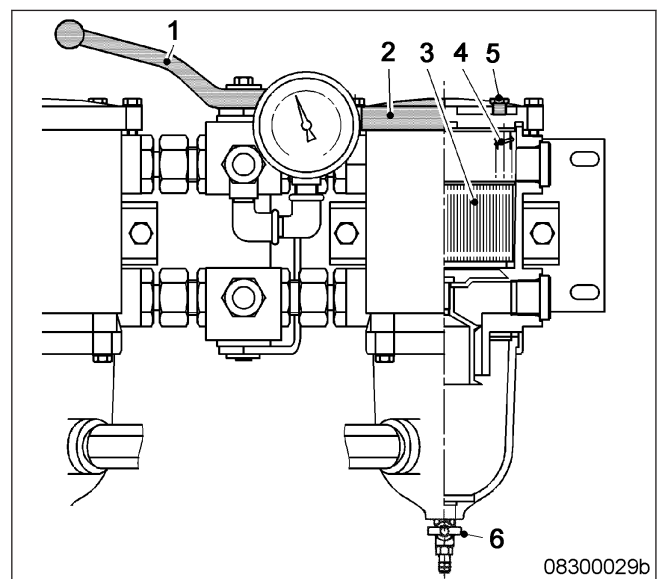
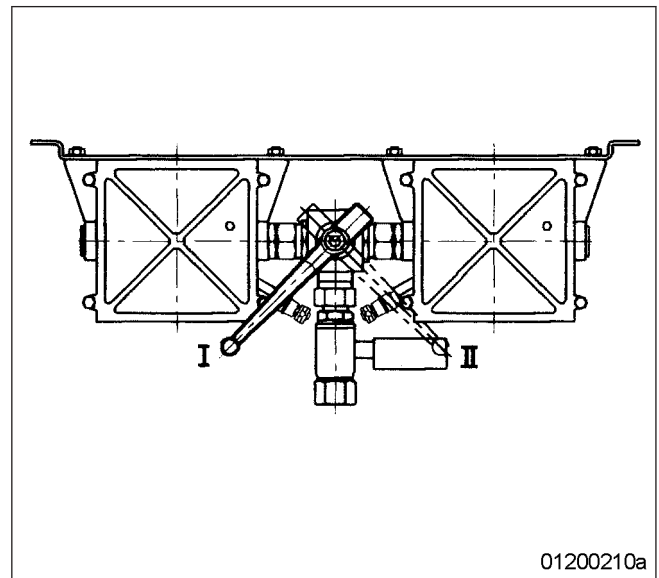
Fuels are combustible.

Risk of fire and explosion!

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Fuel prefilter – Draining




1. Cut out filter to be drained.
 - I Left filter cut in
 - II Right filter cut in
2. Open threaded vent plug (5) of filter to be drained.
3. Unlock drain valve (6) by pressing toggle and open it.
4. Drain water and contaminants from filter until pure fuel emerges.
5. Close drain valve (6).
6. Remove screws for cover and take off cover (2).
7. Fill filter housing with clean fuel.
8. Place new gasket in cover (2).
9. Fit cover with gasket and secure it with screws.
10. Cut in the cut-out filter again.
11. Close threaded vent plug (5) when fuel emerges.



7.8.5 Fuel prefilter – Flushing

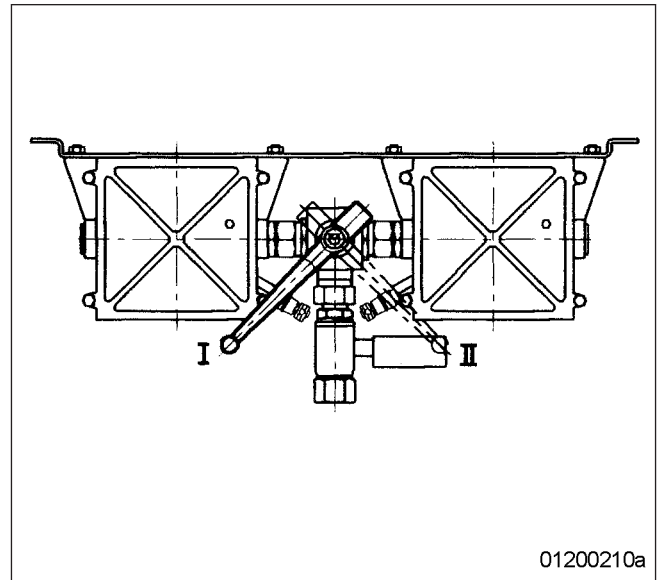
Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Diesel fuel		
Gasket	(→ Spare Parts Catalog)	

DANGER 	<p>Unguarded rotating and moving engine components. Risk of serious injury – danger to life!</p> <ul style="list-style-type: none">• Take special care when working on a running engine.
WARNING 	<p>Fuels are combustible. Risk of fire and explosion!</p> <ul style="list-style-type: none">• Avoid open flames, electrical sparks and ignition sources.• Do not smoke.
WARNING 	<p>Engine noise above 85 dB (A). Risk of damage to hearing!</p> <ul style="list-style-type: none">• Wear ear protectors.

Fuel prefilter – Flushing

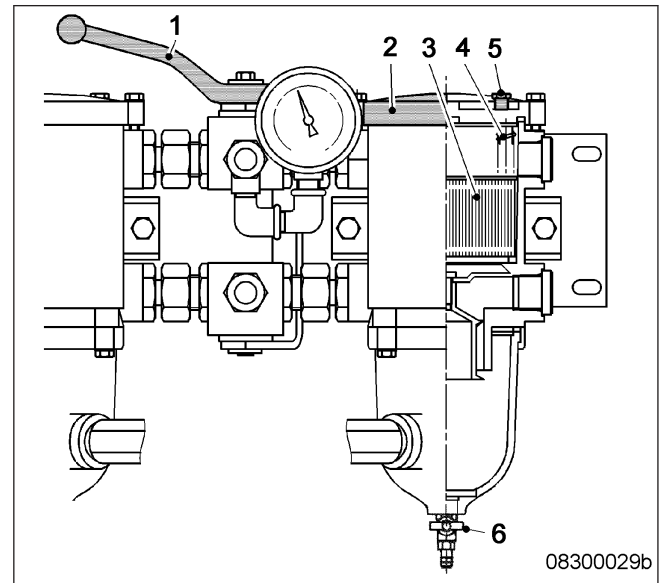
1. Cut out clogged filter.
 - I Left filter cut in
 - II Right filter cut in



2. Open threaded vent plug (5) of filter to be flushed.
3. Unlock drain valve (6) by pressing toggle, open it and drain fuel.

Result: Fuel flows from filtered side back to the un-filtered side, flushing the filter deposits downwards out of the filter.

4. Close threaded vent plug (5) and drain valve (6).



Fuel prefilter – Topping up with fuel

1. Stop engine (→ Page 42) and disable engine start.
2. Remove screws for cover and take off cover (2).
3. Fill filter housing with clean fuel.
4. Place new gasket in cover (2).
5. Fit cover with gasket and secure it with screws.
6. Check differential pressure (→ Page 86).

Result: If flushing did not lead to an improvement of the differential pressure, replace filter element of fuel prefilter (→ Page 90).

7.8.6 Fuel prefilter – Filter element replacement

Preconditions

- Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Diesel fuel		
Filter element	(→ Spare Parts Catalog)	
Gasket	(→ Spare Parts Catalog)	

WARNING



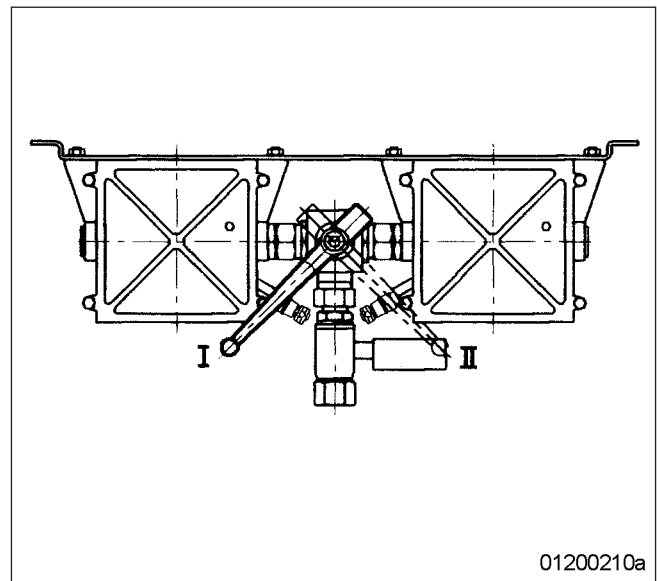
Fuels are combustible.

Risk of fire and explosion!

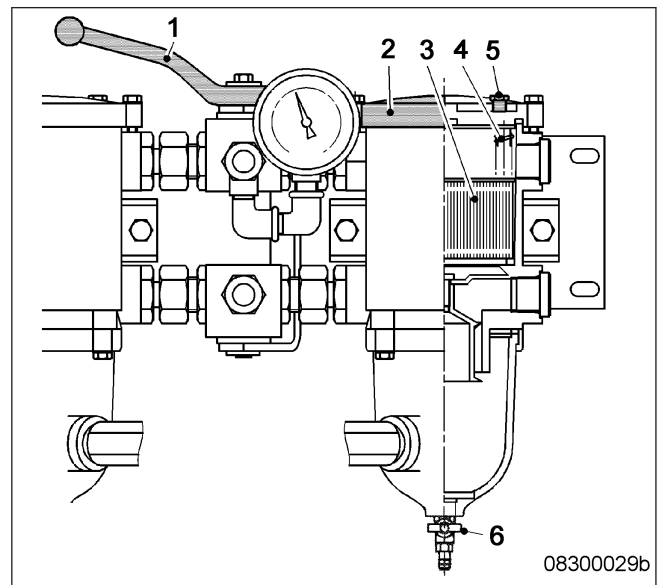
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Replacing filter element

1. Cut out filter to be drained.
 - I Left filter cut in
 - II Right filter cut in



2. Open threaded vent plug (5) of contaminated filter.
3. Unlock drain valve (6) by pressing toggle and open it.
4. Drain water and dirt from filter.
5. Close drain valve (6).
6. Remove screws securing the cover and take off cover (2).
7. Remove spring housing (4) and filter element (3).
8. Insert new filter element (3) and spring housing (4).
9. Fill filter housing with clean fuel.
10. Place new gasket in cover (2).
11. Fit cover with gasket and secure it with screws.
12. Cut in the cut-out filter again.
13. Close threaded vent plug (5) when fuel emerges.
14. Adjust the differential pressure gauge (→ Page 86).



7.9 Charge-Air Cooling

7.9.1 Intercooler – Check drain for coolant leakage and obstruction

DANGER



Unguarded rotating and moving engine components.
Risk of serious injury – danger to life!

- Take special care when working on a running engine.

WARNING



Engine noise above 85 dB (A).
Risk of damage to hearing!

- Wear ear protectors.

WARNING

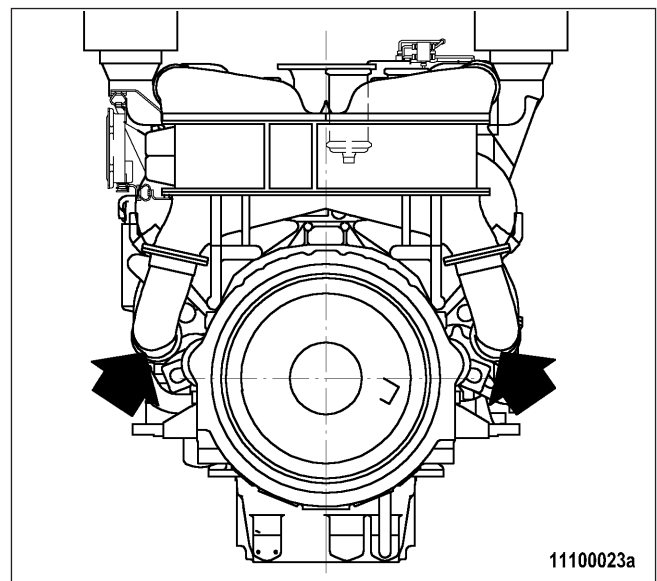


Compressed air
Risk of injury!

- Do not direct compressed-air jet at persons.
- Wear protective goggles / safety mask and ear protectors.

Intercooler – Check drain for coolant leakage and obstruction

1. Verify that air emerges from condensate drain bore(s) on left and right engine sides at driving end when engine is running. If no air emerges:
 - Clean drain bore(s)
 - Blow out with compressed air
2. If a large amount of coolant is continuously discharged, the intercooler is leaking. Contact Service.



Emergency measures prior to engine start with a leaking intercooler

1. Remove injectors (→ Page 78).
2. Bar engine manually (→ Page 63).
3. Crank engine on starting system to blow out combustion chambers (→ Page 64).
4. Install injectors (→ Page 78).

7.10 Air Filter

7.10.1 Air filter – Replacement

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Air filter	(→ Spare Parts Catalog)	

Air filter – Replacement

1. Remove air filter and install new one (→ Page 94).
2. Reset signal ring of service indicator (→ Page 95).

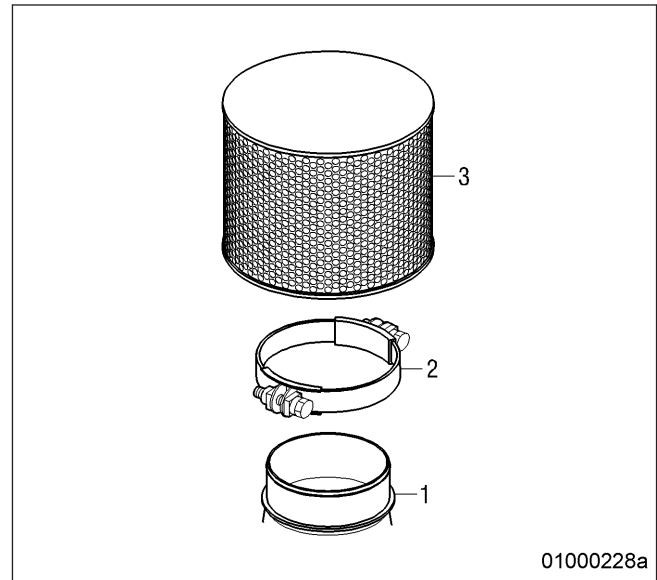
7.10.2 Air filter – Removal and installation

Preconditions

- Engine is stopped and starting disabled.

Air filter – Removal and installation

1. Release clamp (2).
2. Remove air filter (3) and clamp (2) from flange of intake housing (1).
3. Verify that there are no objects in the flange of the intake housing (1) and clean it.
4. Place new air filter (3) with clamp (2) onto intake housing (1).
5. Tighten clamp (2).



7.11 Air Intake

7.11.1 Contamination indicator – Signal ring position check

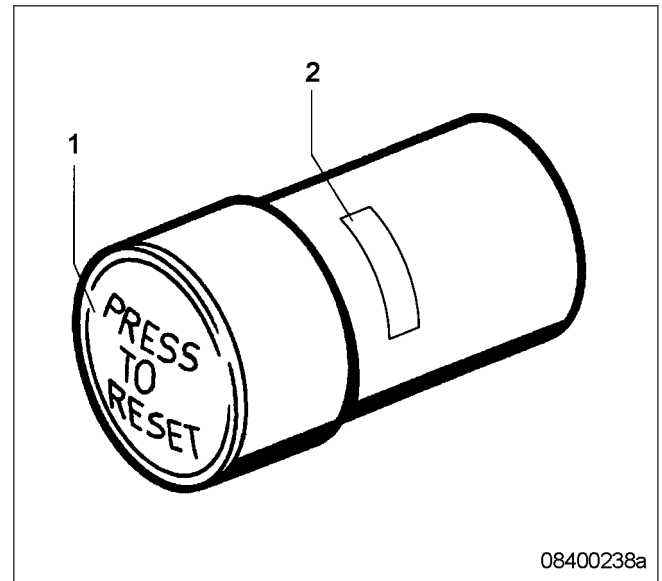
Preconditions

- ☑ Engine is stopped and starting disabled.

Checking signal ring position

1. If the signal ring is completely visible in the control window (2), replace air filter (→ Page 93).
2. After installation of new filter, press reset button (1).

Result: Engaged piston with signal ring moves back to initial position.



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7.12 Starting Equipment

7.12.1 Air starter – Manual operation

DANGER



Unguarded rotating and moving engine components.

Risk of serious injury – danger to life!

- Before barring or starting the engine, make sure that nobody is in the danger zone.

WARNING



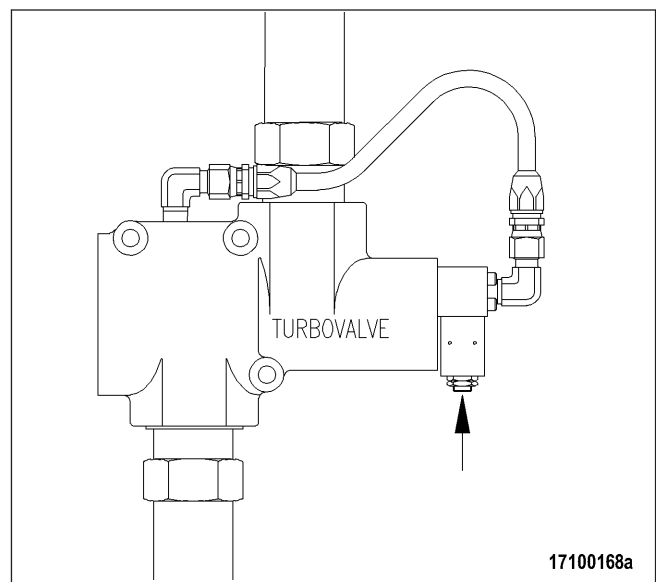
Engine noise above 85 dB (A).

Risk of damage to hearing!

- Wear ear protectors.

Air starter – Manual operation

1. Operate pushbutton for manual start (arrow) and hold.
2. Allow compressed air to enter the air starter, until the engine fires evenly.
3. Release pushbutton.



7.12.2 Starter – Condition check

Preconditions

- Engine is stopped and starting disabled.

Checking starter condition

1. Check securing screws of starter for secure seating and tighten if required.
2. Check wiring (→ Page 125).

7.13 Lube Oil System, Lube Oil Circuit

7.13.1 Engine oil level – Check

Preconditions

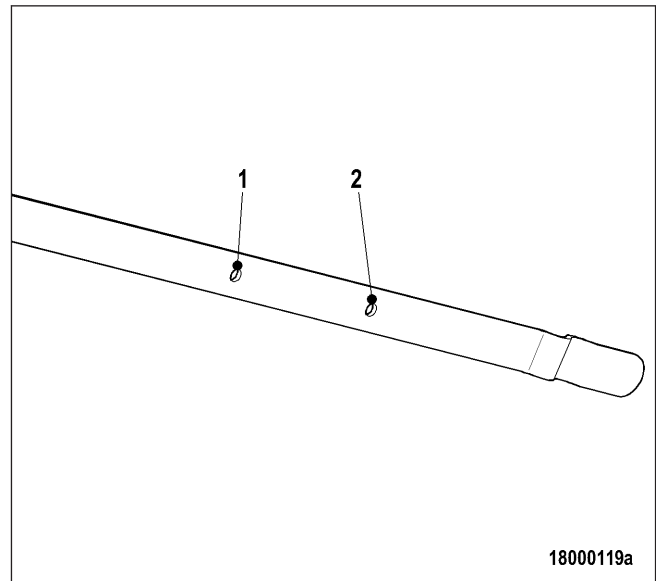
- Engine shut down and starting disabled.

Checking oil level prior to engine start

1. Withdraw oil dipstick from guide tube and wipe it.
2. Insert oil dipstick into guide tube up to stop, withdraw after approx. 10 seconds and check oil level.

Note: After extended standstill, the oil level may exceed the mark (1) by up to 2 cm. This can be caused by oil flowing from e.g. oil filter or heat exchanger back to the oil pan.

3. The oil level must reach mark (1) or exceed mark (1) by up to 2 cm.
4. Top up with oil to mark (1) as necessary (→ Page 99).
5. Insert oil dipstick into guide tube up to the stop.



Checking oil level after the engine is stopped

1. 5 minutes after stopping the engine, remove oil dipstick from the guide tube and wipe it.
2. Insert oil dipstick into guide tube up to stop, withdraw after approx. 10 seconds and check oil level.
3. Oil level must be between marks (1) and (2).
4. Top up with oil to mark (1) as necessary (→ Page 99).
5. Insert oil dipstick into guide tube up to the stop.

7.13.2 Engine oil – Change

Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ Engine is at operating temperature.
- ☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 40-200 Nm	F30027337	1
Ratchet adapter	F30027341	1
Engine oil		
Sealing ring	(→ Spare Parts Catalog)	

WARNING



- Hot oil.
Oil can contain combustion residues which are harmful to health.
Risk of injury and poisoning!
- Wear protective clothing, gloves, and goggles / safety mask.
 - Avoid contact with skin.
 - Do not inhale oil vapor.

Oil change without semirotary hand pump: Draining engine oil at drain plug(s) on oil pan

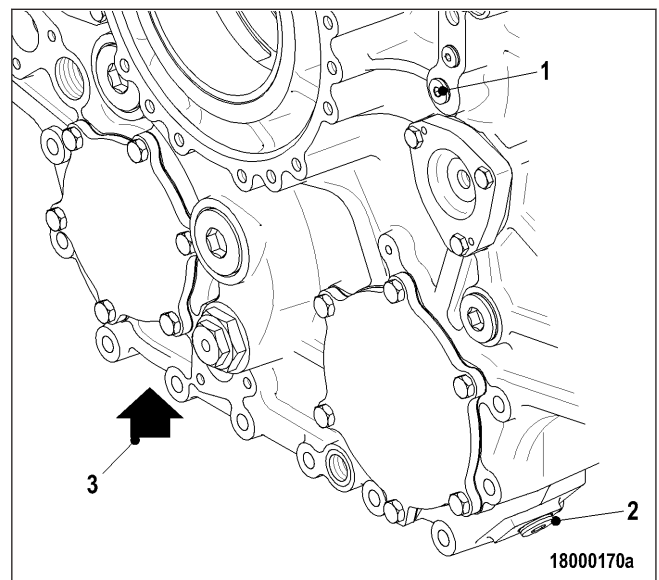
1. Provide a suitable container in which to collect the engine oil.
2. Remove drain plug(s) and drain engine oil.
3. Install drain plug(s) with new sealing ring.

Oil change with semirotary hand pump: Extracting engine oil

1. Provide a suitable container in which to collect the engine oil.
2. Extract all engine oil from oil pan using the semirotary hand pump.

Draining residual oil from equipment carrier (only with unscheduled engine oil change)

1. Provide a suitable container in which to collect the engine oil.
2. Remove drain plug (1) and drain engine oil from engine oil heat exchanger and from engine oil filter.
3. Remove drain plugs (2) and (3) and drain engine oil.
4. Replace engine oil filter (→ Page 102).
5. Install drain plug(s) with new sealing ring.

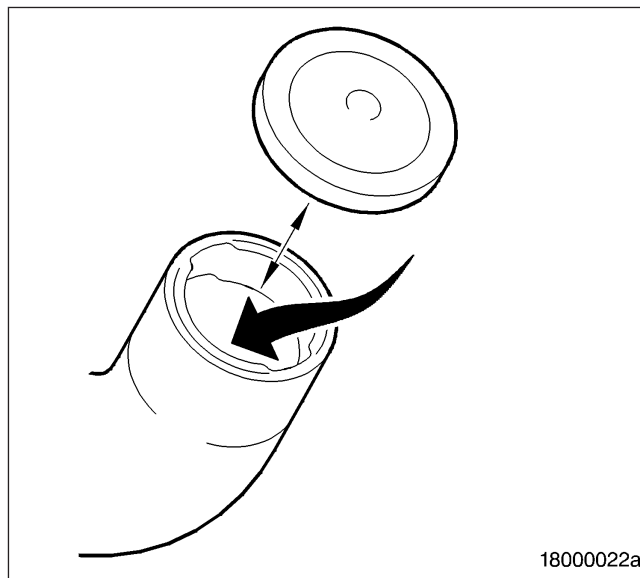


6. Tighten drain plugs (2) and (3) with torque wrench to the specified torque.

Name	Size	Type	Lubricant	Value/Standard
Screw	M26 x 1.5	Tightening torque	(Engine oil)	100 Nm +10 Nm

Filling with new engine oil

1. Open cap on filler neck.
2. Pour in engine oil at filler neck up to "max." mark on oil dipstick.
3. Close cap on filler neck.
4. Check engine oil level (→ Page 98).
5. After oil change and oil filter replacement, bar engine with starting system (→ Page 64).



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7.13.3 Engine oil – Sample extraction and analysis

Preconditions

- ☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

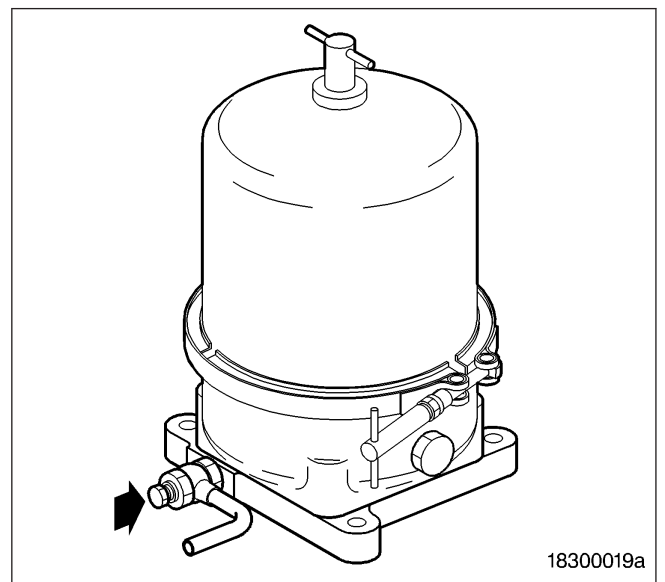
Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
MTU test kit	5605892099/00	1

DANGER 	Unguarded rotating and moving engine components. Risk of serious injury – danger to life! <ul style="list-style-type: none">• Take special care when working on a running engine.
WARNING 	Hot oil. Oil can contain combustion residues which are harmful to health. Risk of injury and poisoning! <ul style="list-style-type: none">• Wear protective clothing, gloves, and goggles / safety mask.• Avoid contact with skin.• Do not inhale oil vapor.
WARNING 	Engine noise above 85 dB (A). Risk of damage to hearing! <ul style="list-style-type: none">• Wear ear protectors.

Engine oil sample extraction and analysis

1. With the engine running at operating temperature, open screw on flange of centrifugal oil filter by 1 to 2 rotations.
2. Drain approx. 2 liters engine oil to flush out the oil sludge.
3. Drain approx. 1 liter engine oil into a clean container.
4. Close screw.
5. Using the equipment and chemicals of the MTU test kit, examine oil for:
 - Dispersing capacity (spot test);
 - Water content;
 - Fuel dilution.



7.14 Oil Filtration / Cooling

7.14.1 Engine oil filter – Replacement

Preconditions

- Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Filter wrench	F30379104	
Engine oil		
Oil filter	(→ Spare Parts Catalog)	

WARNING



Hot oil.

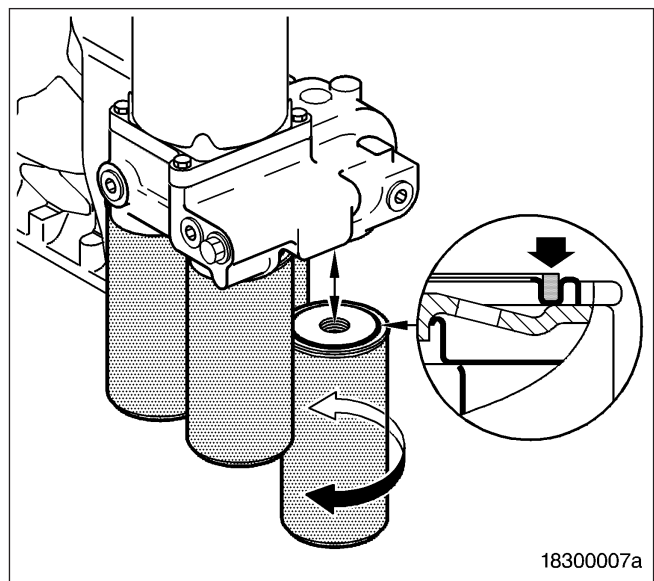
Oil can contain combustion residues which are harmful to health.

Risk of injury and poisoning!

- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

Replacing engine oil filter

1. Remove oil filter using filter wrench.
2. Clean sealing surface on connecting piece.
3. Check condition of new oil filter sealing ring and coat it with engine oil.
4. Screw on and tighten new engine oil filter by hand.
5. Replace other engine oil filters in the same way.
6. Crank engine on starting system after every oil change and filter replacement (→ Page 64).
7. Check engine oil level (→ Page 98).



7.14.2 Centrifugal oil filter – Cleaning and filter sleeve replacement

Preconditions

- Engine shut down and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Filter wrench	F30379104	1
Torque wrench, 6-50 Nm	F30027336	1
Ratchet adapter	F30027339	1
Cold cleaner (Hakutex 60)	50602	1
Grease (Kluth Hakuform 30-10/emulsifier)	X00029933	1
Filter sleeve	(→ Spare Parts Catalog)	
Sealing ring	(→ Spare Parts Catalog)	
Sealing ring	(→ Spare Parts Catalog)	

WARNING



- Hot oil.
Oil can contain combustion residues which are harmful to health.
Risk of injury and poisoning!
- Wear protective clothing, gloves, and goggles / safety mask.
 - Avoid contact with skin.
 - Do not inhale oil vapor.

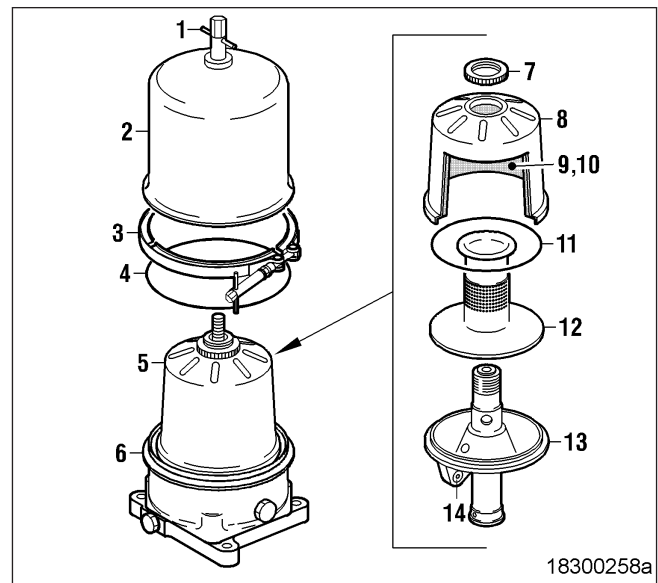
WARNING



- Compressed air
Risk of injury!
- Do not direct compressed-air jet at persons.
 - Wear protective goggles / safety mask and ear protectors.

Cleaning centrifugal oil filter and replacing filter sleeve

1. Undo screw (1) and remove.
2. Remove clamp (3) and take off hood (2).
3. Carefully remove rotor (5) from housing.
4. Hold rotor assembly (5) firmly in position with filter wrench and undo knurled nut (7).
5. Take off rotor cap (8).
6. Remove filter sleeve (9), stiffener plate (10) and sealing ring (11).
7. Measure thickness of oil residues on filter sleeve.
8. If maximum layer thickness of oil residues exceeds 30 mm, shorten maintenance interval.
9. Remove standpipe (12) from lower rotor section (13).
10. Wash hood (2), rotor cap (8), stiffener plate, (10) standpipe (12), rotor lower section (13) and nozzles (14) with cold cleaner and blow out with compressed air. Do not use sharp objects for cleaning.
11. Check nozzles (14) for obstructions.
12. Press standpipe (12) onto rotor lower section (13).
13. Insert new filter sleeve (9) with stiffener plate (10) into rotor cap (8), ensuring that smooth surface of filter sleeve (9) faces rotor cap (8).
14. Check sealing ring (11), replace if necessary. Coat sealing ring with grease and insert in groove of rotor cap (8).
15. Place rotor cap (8) onto standpipe (12).
16. Hold rotor assembly (5) firmly in position with filter wrench and tighten knurled nut (7).
17. Lubricate bearings of rotor (5) with oil, insert into housing (6) and check for ease of movement.
18. Check sealing ring (4), replace if necessary. Fit sealing ring on housing (6).
19. Fit hood (2).
20. Tighten screw (1) by hand.
21. Install clamp (3) and tighten to specified torque using a torque wrench.



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22. Tighten screw (1) to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Clamp		Tightening torque		6 Nm + 1 Nm

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque		6 Nm + 1 Nm

7.15 Coolant Circuit, General, High-Temperature Circuit

7.15.1 Coolant level - Check

Preconditions

- ☑ Engine shut down and starting disabled.
- ☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

WARNING



Coolant is hot and under pressure.

Risk of injury and scalding!

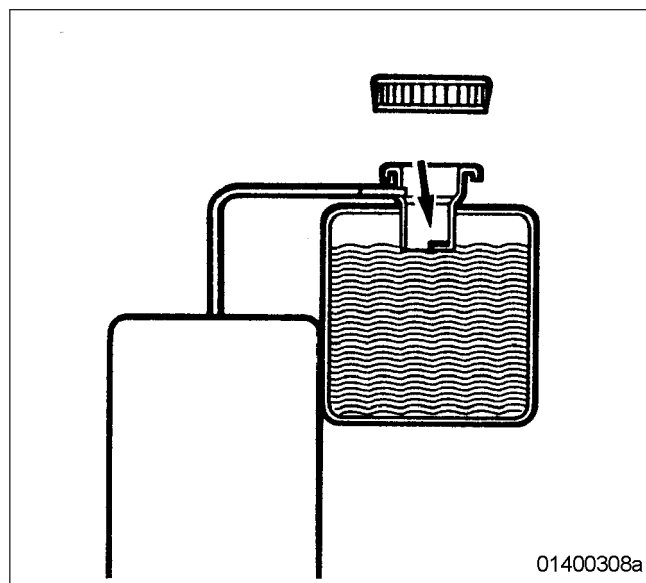
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Checking coolant level at filler neck:

1. Turn breather valve on coolant expansion tank counterclockwise to the first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.
3. Check coolant level (coolant must be visible at the lower edge of the cast-in eye).

Checking coolant level at remote cooler:

1. Check coolant level (coolant must be visible at marking plate).
2. Top up coolant if necessary (→ Page 108).
3. Check and clean breather valve.
4. Place breather valve on filler neck and close.



Coolant level check by means of level sensor:

1. Switch on engine control system and check readings on the display.
2. Top up coolant if necessary (→ Page 108).

7.15.2 Engine coolant – Change

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine coolant		

Changing engine coolant

1. Drain engine coolant (→ Page 107).
2. Fill with engine coolant (→ Page 108).

7.15.3 Engine coolant – Draining

Preconditions

- ☑ Engine is stopped and starting disabled.

WARNING



Coolant is hot and under pressure.

Risk of injury and scalding!

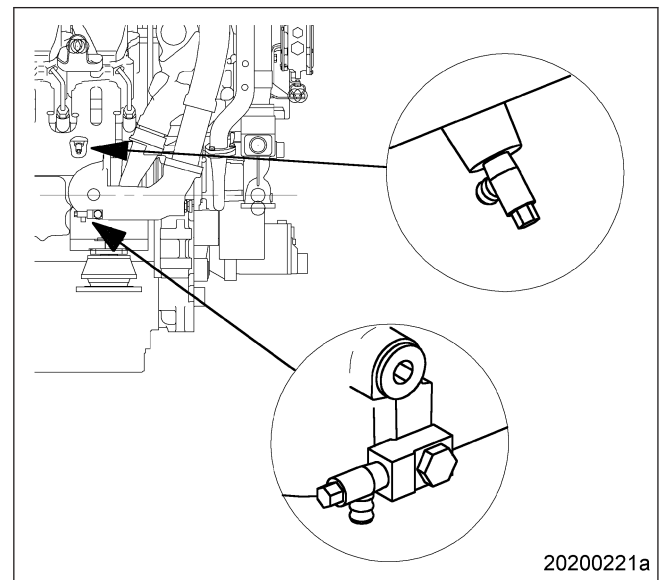
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Preparatory steps

1. Provide an appropriate container to drain the coolant into.
2. Switch off preheating unit.

Engine coolant – Draining

1. Turn breather valve of filler neck on coolant expansion tank counterclockwise to first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.
3. Draw off separated corrosion inhibitor oil in expansion tank through the filler neck.
4. Open drain valves and/or drain plugs and drain coolant at the following points:
 - At preheating unit;
 - At HT coolant pump elbow;
 - On crankcase, left and right side.
5. Close all open drain points.
6. Set breather valve onto filler neck and close it.



7.15.4 Engine coolant – Filling

Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine coolant		

WARNING



Coolant is hot and under pressure.

Risk of injury and scalding!

- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

CAUTION



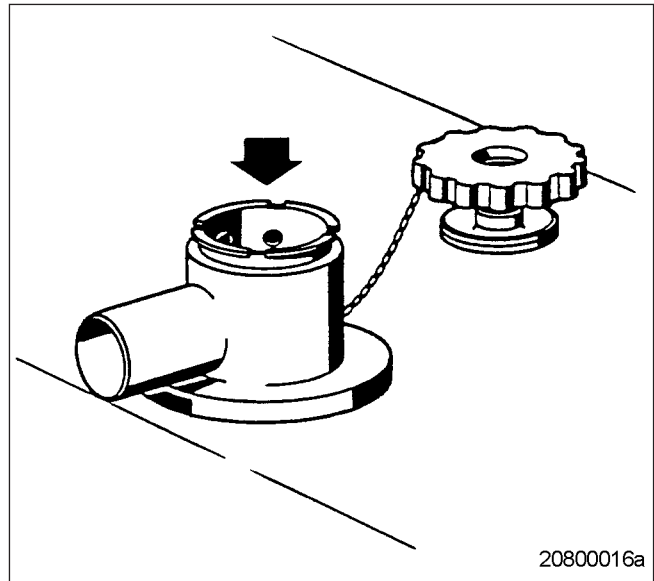
Cold coolant in hot engine can cause thermal stress.

Formation of cracks in components!

- Fill / top up coolant only into cold engine.

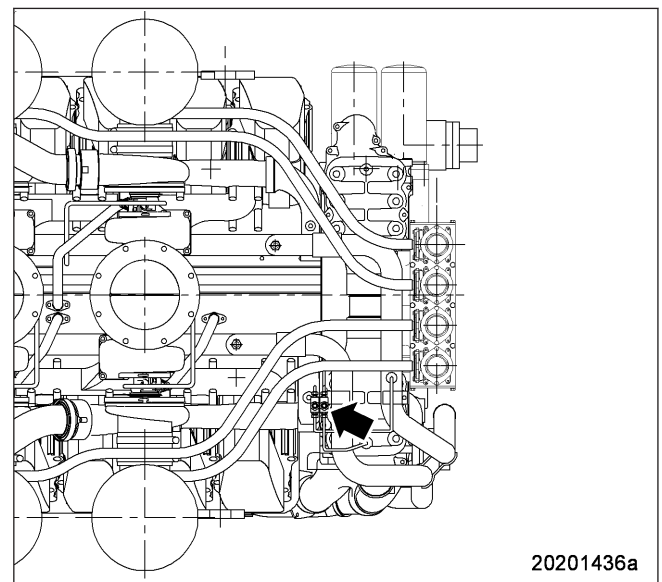
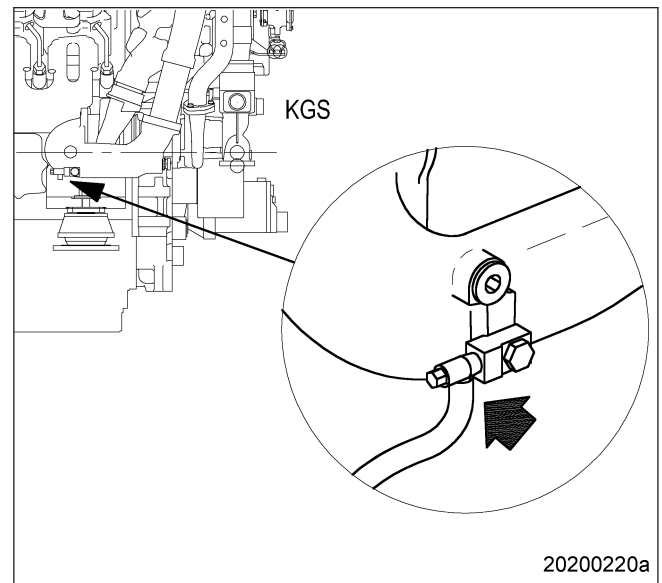
Preparatory steps

1. Turn breather valve of coolant expansion tank counterclockwise until the first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.



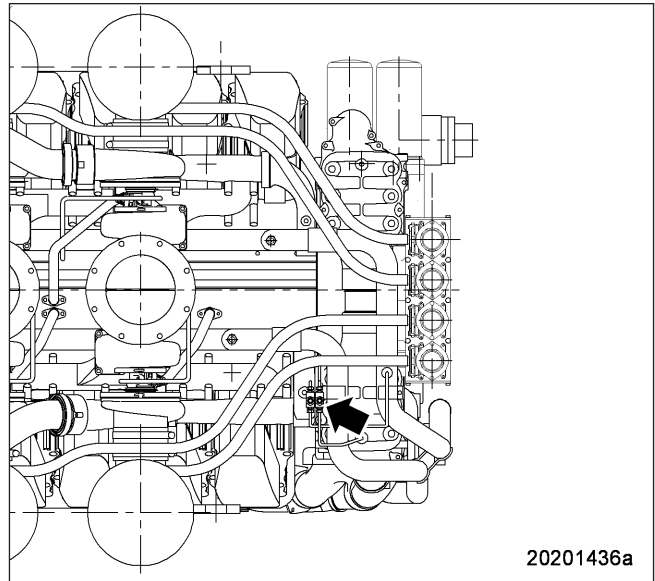
Filling with coolant using a pump

1. Connect suitable pump and hose to engine coolant pump drain valve (arrowed) or drain and filling line between engine and radiator.
2. Undo screw connection (arrowed) of the vent line on the distributor.
3. Open drain valve and pump coolant into engine with a pressure of at least 0.5 bar until coolant escapes from the open connection.
4. Tighten connection (arrowed).
5. Fill coolant expansion tank until coolant level reaches the bottom edge of the filler neck.
6. Close drain valve.
7. Check proper condition of breather valve and clean sealing faces if required.
8. Fit breather valve and close it.
9. Start engine (→ Page 39).
10. After 10 seconds of running the engine without load, shut down the engine (→ Page 42).
11. Turn breather valve of coolant expansion tank counterclockwise until the first stop and allow pressure to escape.
12. Continue to turn breather valve counterclockwise and remove.
13. Check coolant level (→ Page 105) and top up engine coolant as required:
 - a) Add coolant via filler neck on expansion tank until the coolant level at bottom edge of filler neck remains constant.
 - b) Check proper condition of breather valve and clean sealing faces if required.
 - c) Fit breather valve and close it.
14. Repeat the steps from "Start engine" (→ Step 8) until coolant is no longer needed to be topped up.
15. Disconnect pump and hose.



Alternatively: Filling with coolant through filler neck

1. Undo screw connection (arrowed) of the vent line on the distributor.
2. Fill in coolant via filler neck on expansion tank until the coolant level at bottom edge of filler neck remains constant.
3. Tighten connection (arrowed).
4. Check proper condition of breather valve and clean sealing faces if required.
5. Fit breather valve and close it.
6. Start engine (→ Page 39).
7. After 10 seconds of running the engine without load, shut down the engine (→ Page 42).
8. Turn breather valve of coolant expansion tank counterclockwise until the first stop and allow pressure to escape.
9. Turn breather valve counterclockwise and remove.
10. Check coolant level (→ Page 105) and top up with coolant through the filler neck if required:
 - a) Add coolant via filler neck on expansion tank until the coolant level at bottom edge of filler neck remains constant.
 - b) Check proper condition of breather valve and clean sealing faces if required.
 - c) Fit breather valve and close it.
11. Repeat the steps from "Start engine" (→ Step 6) until coolant is no longer needed to be topped up.



Final steps

1. Start the engine and run it without load for some minutes.
2. Check coolant level (→ Page 105) and top up engine coolant as required.

7.15.5 Engine coolant pump – Relief bore check

DANGER



Unguarded rotating and moving engine components.
Risk of serious injury – danger to life!

- Take special care when working on a running engine.

WARNING

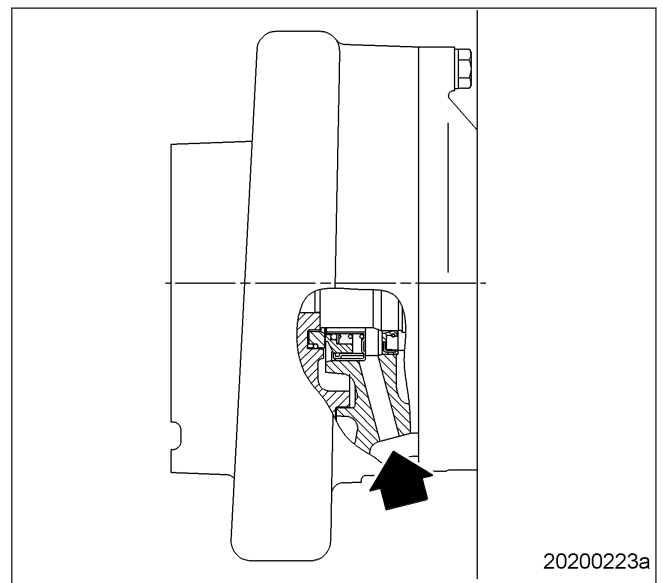


Engine noise above 85 dB (A).
Risk of damage to hearing!

- Wear ear protectors.

Checking relief bore on engine coolant pump

1. Checking relief bore for oil and coolant discharge.
2. Stop engine (→ Page 42) and disable engine start, observe general safety instructions for maintenance and repair.
3. Clean the relief bore with a wire if it is dirty.
 - Permissible coolant discharge: up to 10 drops per hour.
 - Permissible oil discharge: up to 5 drops per hour.
4. If discharge exceeds the specified limits: Contact Service.



7.15.6 Coolant – Sample extraction and analysis

Preconditions

- ☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
MTU test kit	5605892099/00	1

DANGER



Unguarded rotating and moving engine components.
Risk of serious injury – danger to life!

- Take special care when working on a running engine.

WARNING



Coolant is hot and under pressure.
Risk of injury and scalding!

- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

WARNING

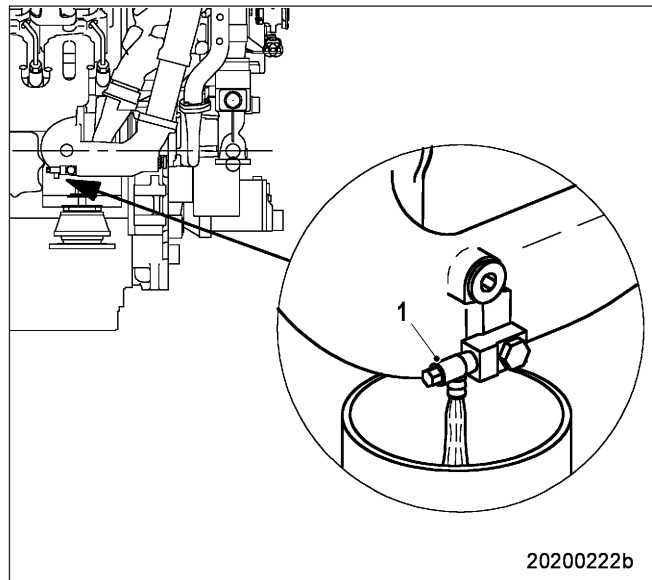


Engine noise above 85 dB (A).
Risk of damage to hearing!

- Wear ear protectors.

Coolant sample extraction and analysis

1. With the engine running, open drain valve (1).
2. Flush sample-extraction point by draining approx. 1 liter coolant.
3. Drain approx. 1 liter coolant into a clean container.
4. Close drain valve (1).
5. Using the equipment and chemicals of the MTU test kit, check the coolant for:
 - Antifreeze concentration
 - Corrosion inhibitor concentration
 - pH value.
6. For coolant change intervals, see (→ MTU Fluids and Lubricants Specifications.)



20200222b

7.16 Low-Temperature Circuit

7.16.1 Charge-air coolant – Level check

Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

WARNING



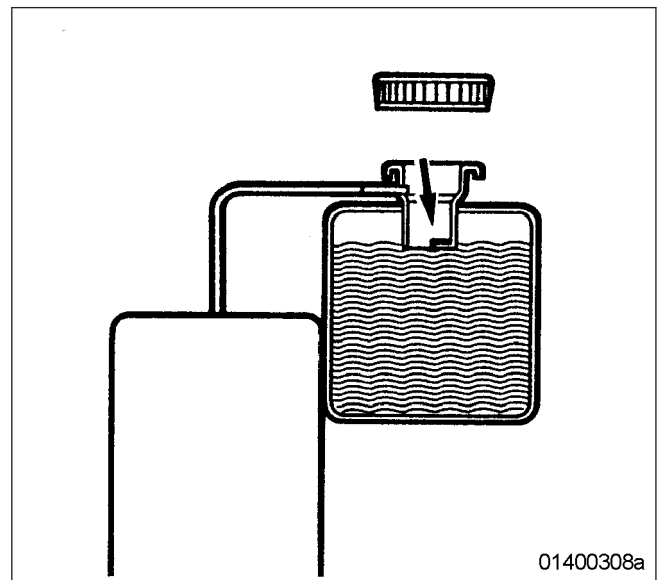
Coolant is hot and under pressure.

Risk of injury and scalding!

- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Checking charge-air coolant level at filler neck:

1. Turn breather valve on coolant expansion tank counterclockwise to the first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.
3. Check coolant level (coolant must be visible at marking plate).
4. Top up coolant if necessary (→ Page 116).
5. Check proper condition of breather valve, clean sealing faces if required.
6. Fit breather valve and close it.



Checking charge-air coolant level by means of level sensor:

1. Switch on engine control system and check display (coolant level is automatically monitored by engine control system).
2. Top up coolant if necessary (→ Page 116).

7.16.2 Charge-air coolant – Change

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Charge-air coolant		

Charge-air coolant – Change

1. Drain charge-air coolant (→ Page 115).
2. Fill with charge-air coolant (→ Page 116).

7.16.3 Charge-air coolant – Draining

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Sealing ring	(→ Spare Parts Catalog)	

WARNING



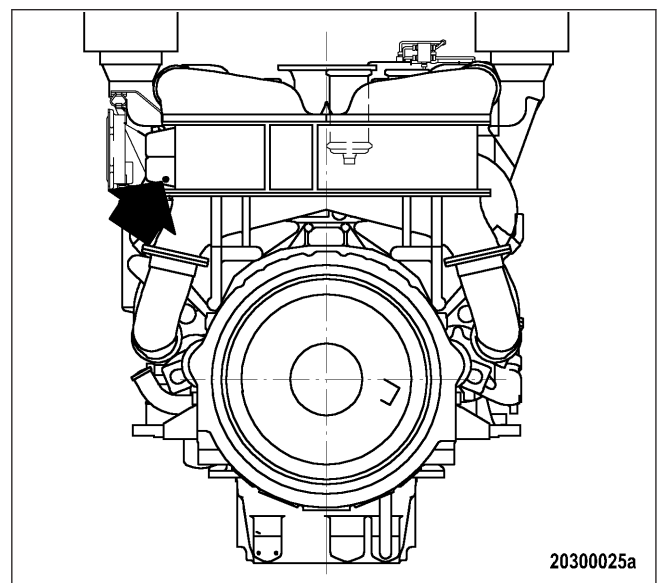
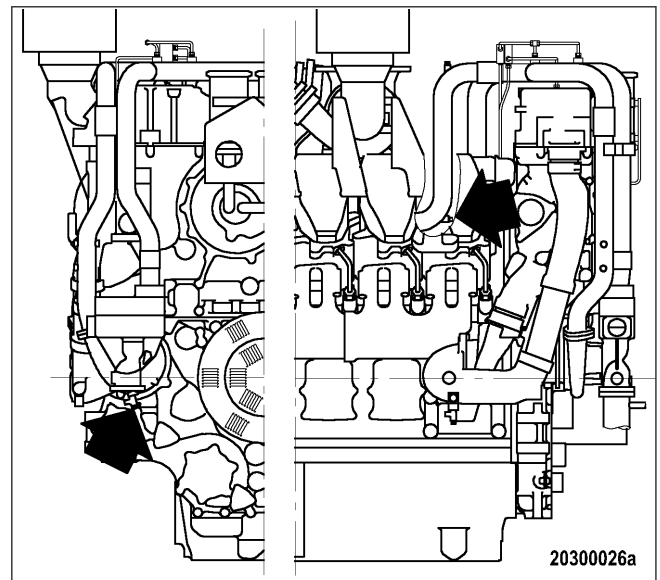
Coolant is hot and under pressure.

Risk of injury and scalding!

- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Charge-air coolant – Draining

1. Provide an appropriate container to drain the coolant into.
2. Turn breather valve of coolant expansion tank counterclockwise until the first stop and allow pressure to escape.
3. Continue to turn breather valve counterclockwise and remove.
4. Draw off precipitated corrosion inhibitor oil from the expansion tank through filler neck.
5. Open drain cocks and drain plugs and drain coolant at the following points:
 - at the LT cooling pump
 - at the coolant lines to and from the inter-cooler
6. Draining of residual coolant:
 - at the intercooler
7. Close all drain valves and install drain plugs with new sealing rings.
8. Set breather valve onto filler neck and close it.



7.16.4 Charge-air coolant – Filling

Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Charge-air coolant		

WARNING



Coolant is hot and under pressure.

Risk of injury and scalding!

- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

CAUTION



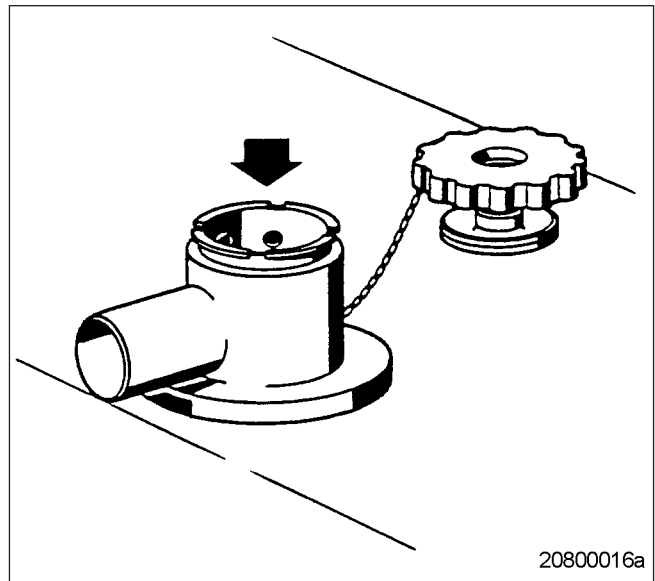
Cold coolant in hot engine can cause thermal stress.

Formation of cracks in components!

- Fill / top up coolant only into cold engine.

Preparatory steps

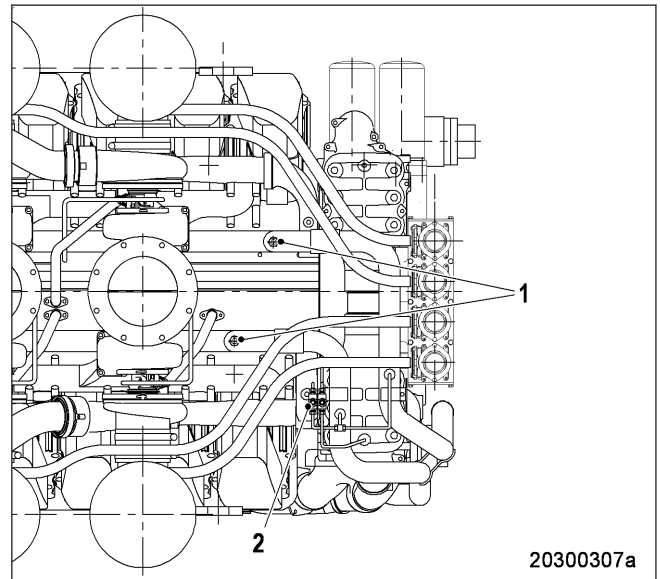
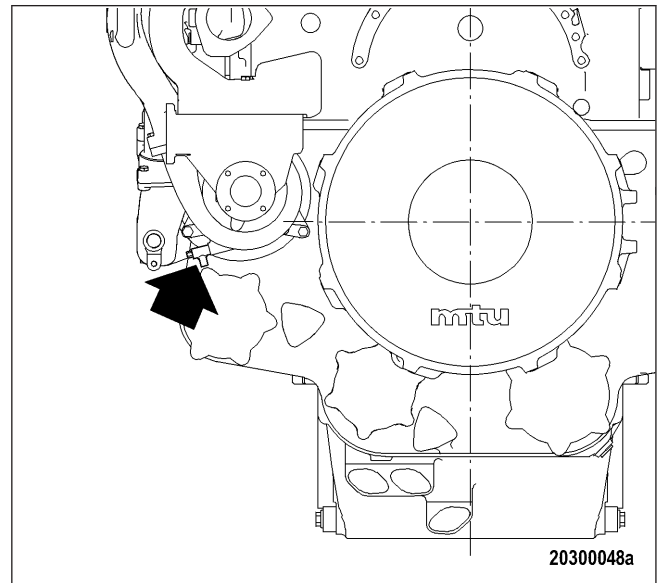
1. Turn breather valve of coolant expansion tank counterclockwise until the first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.



Filling with charge-air coolant using a pump

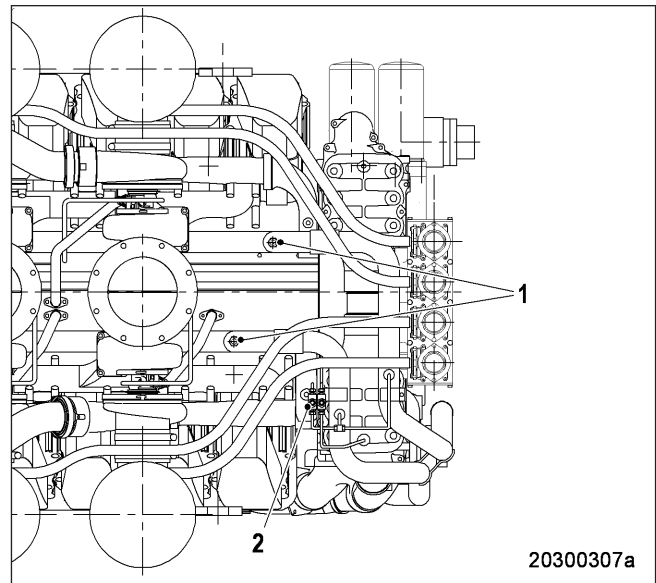
1. Connect suitable pump and hose to charge-air coolant pump drain valve (arrowed) or drain and filling line between engine and radiator.

2. Undo plug screws (1) on coolant lines to and from intercooler and connection (2) of the vent line on the distributor.
3. Open drain valve and pump coolant into engine with a pressure of at least 0.5 bar until coolant escapes from the open connections.
4. Tighten plug screws (1) and connection (2) in sequence from top to bottom.
5. Fill coolant expansion tank until coolant level reaches the bottom edge of the filler neck.
6. Close drain valve.
7. Check proper condition of breather valve and clean sealing faces if required.
8. Install and close breather valve.
9. Start engine (→ Page 39).
10. After the engine has run at unloaded condition for 10 seconds, stop engine (→ Page 42).
11. Turn breather valve of coolant expansion tank counterclockwise until the first stop and allow pressure to escape.
12. Continue to turn breather valve counterclockwise and remove.
13. Check coolant level (→ Page 113) and top up if required:
 - a) Add coolant via filler neck on expansion tank until the coolant level at bottom edge of filler neck remains constant.
 - b) Check proper condition of breather valve and clean sealing faces if required.
 - c) Install and close breather valve.
14. Repeat the steps from "Start engine" (→ Step 8) until coolant no longer needs to be topped up.
15. Disconnect pump and hose.



Alternatively: Filling with coolant through filler neck

1. Undo plug screws (1) on coolant lines to and from intercooler and connection (2) of the vent line on the distributor.
2. Fill in coolant via filler neck on expansion tank until the coolant level at bottom edge of filler neck remains constant.
3. Tighten plug screws (1) and connection (2) in sequence from top to bottom.
4. Check proper condition of breather valve and clean sealing faces if required.
5. Install and close breather valve.
6. Start engine (→ Page 39).
7. After the engine has run at unloaded condition for 10 seconds, stop engine (→ Page 42).
8. Turn breather valve of coolant expansion tank counterclockwise until the first stop and allow pressure to escape.
9. Turn breather valve counterclockwise and remove.
10. Check coolant level (→ Page 113) and top up if required:
 - a) Add coolant via filler neck on expansion tank until the coolant level at bottom edge of filler neck remains constant.
 - b) Check proper condition of breather valve and clean sealing faces if required.
 - c) Install and close breather valve.
11. Repeat the steps from "Start engine" (→ Step 6) until coolant no longer needs to be topped up.



20300307a

Final steps

1. Start the engine and operate it at unloaded condition for some minutes.
2. Check coolant level (→ Page 113) and top up if required.




7.16.5 Charge-air coolant – Sample extraction and analysis

Preconditions

- ☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

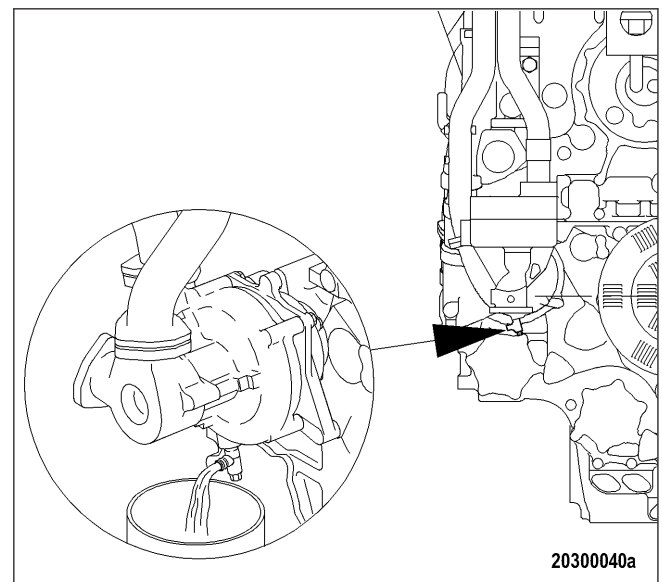
Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
MTU test kit	(→ Tools Catalog)	

DANGER 	Unguarded rotating and moving engine components. Risk of serious injury – danger to life! <ul style="list-style-type: none">• Take special care when working on a running engine.
WARNING 	Coolant is hot and under pressure. Risk of injury and scalding! <ul style="list-style-type: none">• Let the engine cool down.• Wear protective clothing, gloves, and goggles / safety mask.
WARNING 	Engine noise above 85 dB (A). Risk of damage to hearing! <ul style="list-style-type: none">• Wear ear protectors.

Charge-air coolant – Sample extraction and analysis

1. With the engine running, open drain valve.
2. Flush sample-extraction point by draining approx. 1 liter coolant.
3. Drain approx. 1 liter coolant into a clean container.
4. Close drain valve.
5. Using the equipment and chemicals of the MTU test kit, examine coolant for:
 - antifreeze concentration;
 - corrosion inhibitor concentration;
 - pH value.
6. Change charge-air coolant according to the intervals specified in the MTU Fluids and Lubricants Specifications (→ Page 114).



7.16.6 Charge-air coolant pump – Relief bore check

DANGER



Unguarded rotating and moving engine components.
Risk of serious injury – danger to life!

- Take special care when working on a running engine.

WARNING

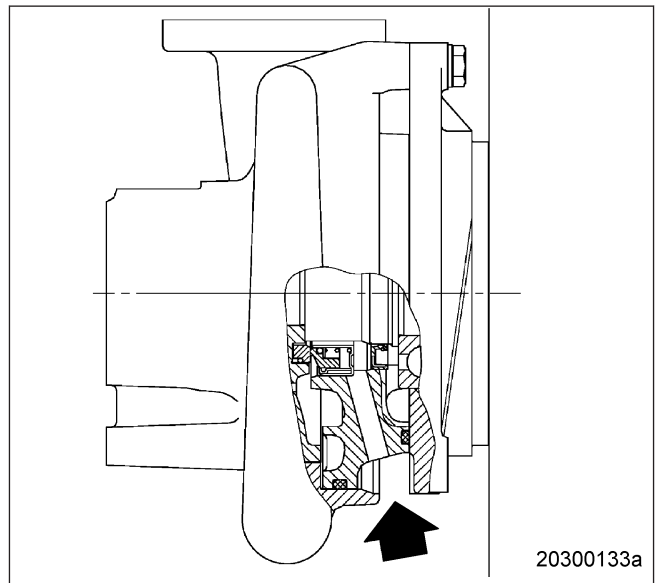


Engine noise above 85 dB (A).
Risk of damage to hearing!

- Wear ear protectors.

Charge-air coolant pump – Relief bore check

1. Check relief bore for oil and coolant discharge.
2. Stop engine (→ Page 42) and disable engine start, observe general safety instructions for maintenance and repair.
3. Clean the relief bore with a wire if it is dirty.
 - Permissible coolant discharge: up to 10 drops per hour.
 - Permissible oil discharge: up to 5 drops per hour.
4. If discharge exceeds the specified limits: Contact Service.



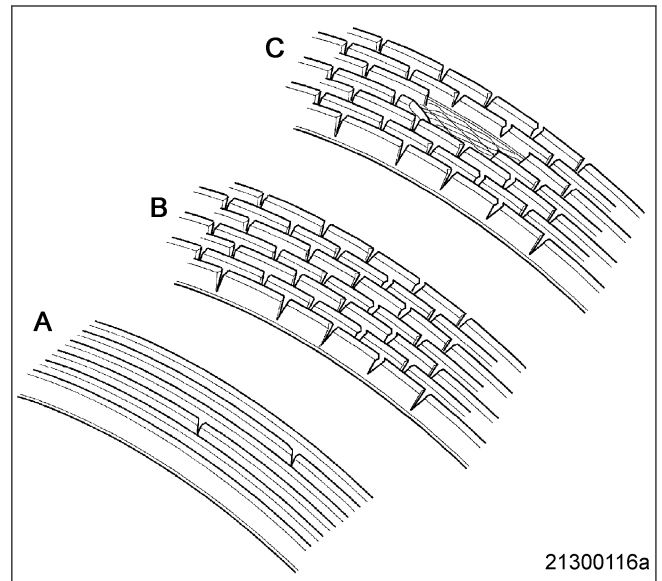
7.17 Belt Drive

7.17.1 Drive belt – Condition check

Preconditions

- Engine is stopped and starting disabled.
- Guard is removed.

Drive belt – Condition check



Item	Findings	Action
Drive belt A	Singular cracks	None
Drive belt	Belt is oily, shows signs of overheating	Replace(→ Page 124)
Drive belt B	Cracks on entire circumference	
Drive belt C	Chunking	

7.18 Battery-Charging Generator

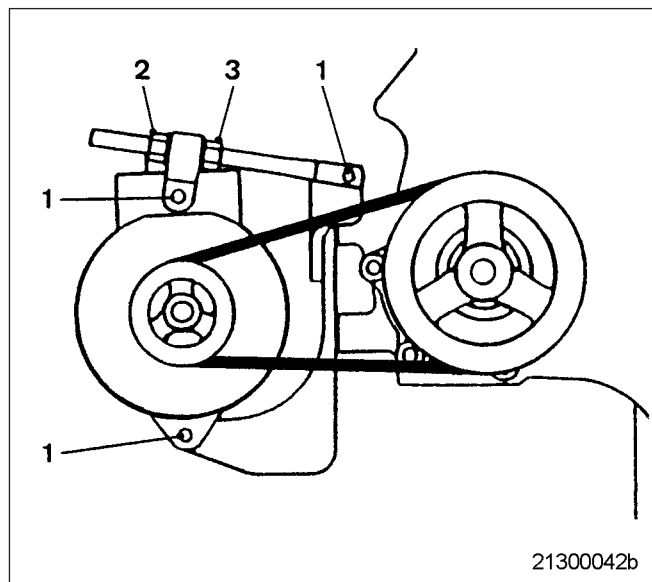
7.18.1 Battery-charging generator drive – Drive belt tension adjustment

Preconditions

- Engine is stopped and starting disabled.

Adjusting belt tension

1. Loosen locknut (2) and screws (1).
2. Tension drive belt with tensioning nut (3) and check belt tension (→ Page 123).
3. Tighten locknut (2).
4. Tighten screws (1).
5. Install guard cover.



7.18.2 Battery-charging generator drive – Drive belt tension check

Preconditions

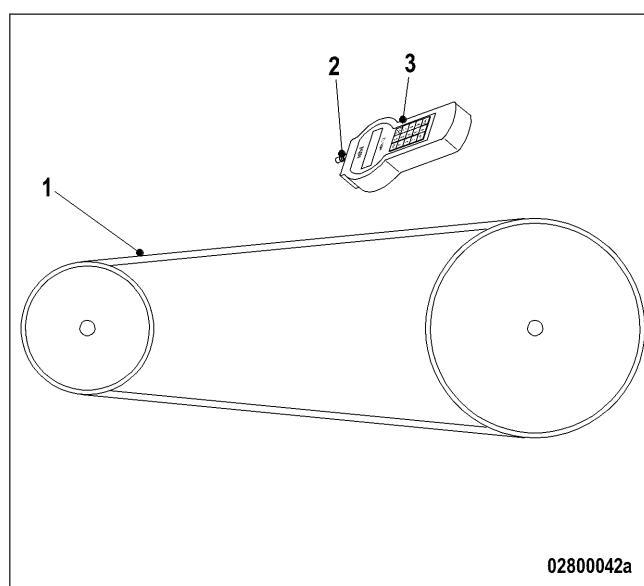
- Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Belt tension tester	Y4345711	1

Preparatory steps

1. Remove guard cover.
2. Check belt condition visually (→ Page 121).



Checking drive belt tension

1. Fit measuring head (2) on belt-tension tester (3) and hit drive belt (1) with a suitable tool.
2. Hold belt tension tester over belt drive until the measured value is displayed. For specifications, refer to table below.

Application	Value for new drive belt	Value for used drive belt
Series 4000	92 Hz to 96 Hz	80 Hz to 84 Hz

3. If the measured values deviate from the specifications above, adjust drive belt tension (→ Page 122).

7.18.3 Battery-charging generator drive – Drive belt replacement

Preconditions

- ☑ Engine is stopped and starting disabled.

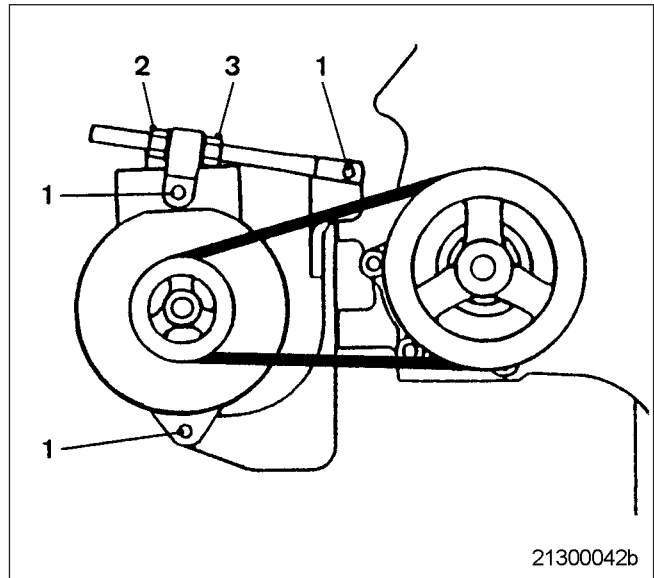
Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Drive belt	(→ Spare Parts Catalog)	

Note: In the event of drive belt failure during engine operation fit a new drive belt as quickly as possible. Non-compliance with these instructions may lead to severe consequential damage to drive unit and gear train, since pretension by the drive belt is no longer provided. Therefore, engine operation without drive-belt connection is not allowed.

Battery-charging generator drive – Drive belt replacement

1. Remove guard cover.
2. Loosen locknut (2) and screws (1).
3. Release drive belt with tensioning nut (3) and take off belt.
4. Clean belt pulleys.
5. Fit new drive belt.
6. Tension drive belt with tensioning nut (3) and check belt tension (→ Page 122).
7. Tighten locknut (2).
8. Tighten screws (1).
9. Install guard cover.
10. Check belt tension after 30 minutes and again after 8 hours engine runtime.



7.19 Wiring (General) for Engine/Gearbox/Unit

7.19.1 Engine wiring – Check

Preconditions

- Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Isopropyl alcohol	X00058037	1

Engine wiring – Check

1. Check securing screws of cable clamps on engine and tighten loose threaded connections.
 2. Ensure that cables are fixed in their clamps and cannot swing freely.
 3. Check that cable ties are firm, tighten loose cable ties.
 4. Replace faulty cable ties.
 5. Visually inspect the following electrical line components for damage:
 - connector housings;
 - contacts;
 - sockets;
 - cables and terminals;
 - plug-in contacts.
 6. (→ Contact Service) if cable conductors are damaged.
- Note: Close male connectors that are not plugged in with the protective cap supplied.
7. Clean dirty connector housings, sockets and contacts with isopropyl alcohol.
 8. Ensure that all sensor connectors are securely engaged.

7.20 Accessories for (Electronic) Engine Governor / Control System

7.20.1 Engine control unit and connectors – Cleaning

Preconditions

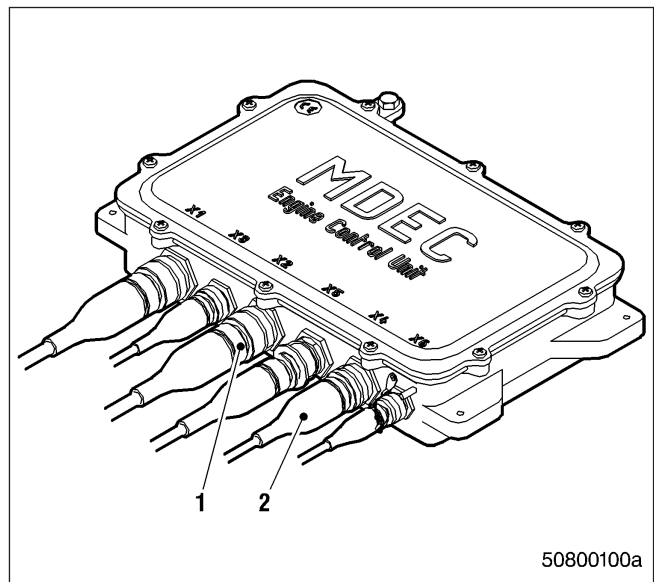
- ☑ Engine shut down and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Connector pliers	0135315483	1
Isopropyl alcohol	46181	1

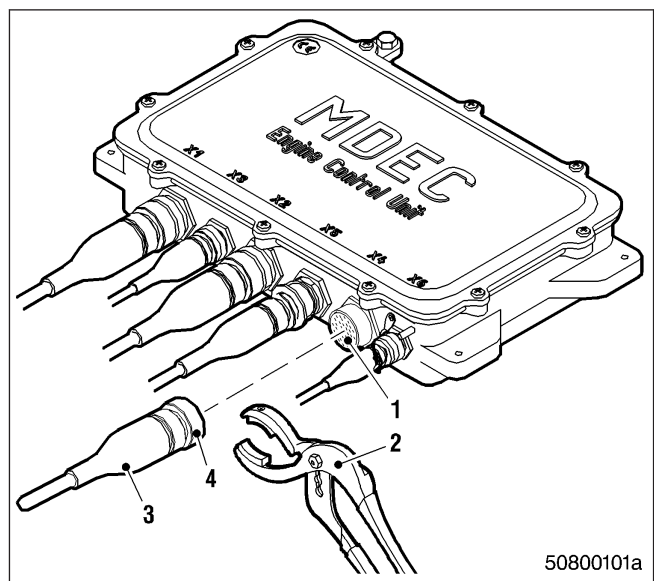
Cleaning engine control unit and connectors

1. Remove heavy soiling from housing surface with isopropyl alcohol.
2. Remove dirt from surface of connectors (1), connector sockets and shrink-formed components (2) using a cloth moistened with isopropyl alcohol.
3. Check legibility of cable labels. Clean or replace illegible labels.



Cleaning heavily soiled connectors on engine control unit

1. Use connector pliers (2) to disengage bayonet union nut (4) and withdraw connector (3).
2. Clean connector housings, connector socket housings (1) and all contacts with isopropyl alcohol.
3. When connectors, sockets and all contacts are dry: Fit connectors and check engine control unit plug connections (→ Page 127).



7.20.2 Engine control unit plug connections – Check

Preconditions

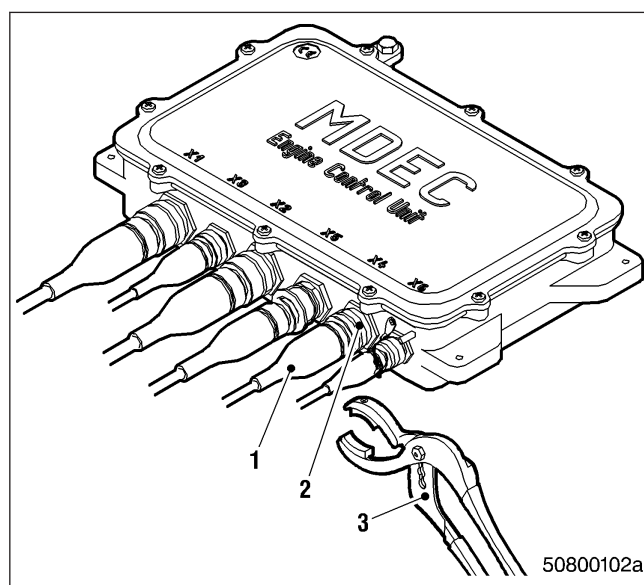
- ☑ Engine shut down and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Connector pliers	0135315483	1

Checking engine control unit plug connections

1. Use connector pliers (3) to make certain that all plug connections on engine control unit are securely seated.
2. Tighten loose bayonet union nuts (2) with connector pliers (3) by turning them clockwise until they latch into place.
3. Make sure that unassigned sockets are closed off with cover caps.
4. If bayonet union nuts are defective, contact Service.



8 Appendix A

8.1 Abbreviations

Abbreviation	Meaning	Explanation
A/D	Analog/Digital	Transformer: transforms sensor voltages into numeric values
ADEC	Advanced Diesel Engine Controller	Engine management system
AFRS	Air Filter Restriction Sensor	
ANSI	American National Standards Institute	Association of American standardization organizations
ATL	Abgasturbolader	Exhaust turbocharger (ETC)
ATS	Air Temperature Sensor	
BR	Baureihe	Series
BV	Betriebsstoffvorschrift	MTU Fluids and Lubricants Specifications, Publication No. A01061/..
CAN	Controller Area Network	Data bus system, bus standard
CDC	Calibration Drift Compensation	Setting of drift compensation in engine governor with DiaSys
CEL	Stop Engine Light	1st function: Warning lamp (rectify fault as soon as possible) 2nd function: Read out fault codes
CKT	Circuit	
CLS	Coolant Level Sensor	Monitors coolant level
CPS	Coolant Pressure Sensor	Monitors coolant pressure
CTS	Coolant Temperature Sensor	Monitors coolant temperature
DDEC	Detroit Diesel Electronic Controls	Engine control system made by Detroit Diesel
DDL	Diagnostic Data Link	Diagnostic lines
DDR	Diagnostic Data Reader	Diagnostic unit
DIN	Deutsches Institut für Normung e. V.	At the same time identifier of German standards (DIN = "Deutsche Industrie-Norm")
DL	Default Lost	Alarm: Default CAN bus failure
DOC	Diesel Oxidation Catalyst	Oxidation catalyst upstream of the diesel particulate filter
DPF	Diesel Particulate Filter	
DT	Diagnostic Tool	Diagnostic unit
ECM	Electronic Control Module	Electronic control unit of the DDEC system
ECU	Engine Control Unit	Engine governor
EDM	Engine Data Module	Memory module for engine data
EEPROM	Electrically Erasable Programmable Read Only Memory	
EFPA	Electronic Foot Pedal Assembly	

Abbreviation	Meaning	Explanation
EGR	Exhaust Gas Recirculation	
EMU	Engine Monitoring Unit	
ETK	Ersatzteilkatalog	Spare Parts Catalog (SPC)
EUI	Electronic Unit Injector	
FPS	Fuel Pressure Sensor	Monitors fuel pressure
FRS	Fuel - Differential Pressure Sensor	
FTS	Fuel Temperature Sensor	Monitors fuel temperature
FWCP	Fire Water Control Panel	Control cabinet
GND	Ground	
HD	Hochdruck	High Pressure (HP)
HI	High	Alarm: Measured value exceeds 1st maximum limit
HIHI	High High	Alarm: Measured value exceeds 2nd maximum limit value
HT	High Temperature	
IDM	Interface Data Module	Memory module for interface data
INJ	Injector	
ISO	International Organization for Standardization	International umbrella organization for all national standardization institutes
KGS	Kraftgegenseite	Engine free end in accordance with DIN ISO 1204
KS	Kraftseite	Engine driving end in accordance with DIN ISO 1204
LED	Light Emitting Diode	
LO	Low	Alarm: Measured value lower than 1st minimum limit value
LOLO	Low Low	Alarm: Measured value lower than 2nd minimum limit value
LSG	Limiting Speed Governor	
N/A	Not Applicable	
LP	Low Pressure	
OEM	Original Equipment Manufacturer	
OI	Optimized Idle	
OLS	Oil Level Sensor	Monitors oil level
OPS	Oil Pressure Sensor	Monitors oil pressure
OTS	Oil Temperature Sensor	Monitors oil temperature
OT	Oberer Totpunkt	Top Dead Center (TDC)
PAN	Panel	Control panel
PIM	Peripheral Interface Module	
PWM	Modulated signal	
P-xyz	Pressure-xyz	Pressure measuring point, xyz specifies the measuring point designation
RL	Redundancy Lost	Alarm: Redundant CAN bus failure

Abbreviation	Meaning	Explanation
SAE	Society of Automotive Engineers	U.S. standardization organization
SD	Sensor Defect	Alarm: Sensor failure
SEL	Stop Engine Light	1st function: Warning lamp (stop engine and rectify fault) 2nd function: Read out fault codes
SID	System Identifier	
SRS	Synchronous Reference Sensor	TDC cylinder 1
SS	Safety System	Safety system alarm
TBS	Turbocharger Boost Sensor	Monitors charge-air pressure
TCI	Turbo Compressor Inlet	
TCO	Turbo Compressor Outlet	
TD	Transmitter Deviation	Alarm: Deviation in transmitter values
TPS	Throttle Position Sensor	
TRS	Timing Reference Sensor	
T-xyz	Temperature-xyz	Temperature measuring point, xyz specifies the measuring point designation
UT	Unterer Totpunkt	Bottom Dead Center (BDC)
VNT	Variable Nozzle Turbine	
VSG	Variable-Speed Governor	
VSS	Vehicle Speed Sensor	
WZK	Werkzeugkatalog	Tool Catalog (TC)

8.2 MTU contacts/service partners

Service

Our worldwide sales network with its subsidiaries, sales offices, representatives and customer service centers ensures fast and direct support on site and the high availability of our products.

Local support

Experienced and qualified specialists place their knowledge and expertise at your disposal.

For locally available support, go to the MTU internet site: <http://www.mtu-online.com>

24h hotline

With our 24h hotline and the outstanding flexibility of our service staff, we are always ready to assist you - either during operation, for preventive maintenance, corrective work in case of malfunction or changed operating conditions, or for spare parts supply.

Your contact at Headquarters: Service-support@mtu-online.com

Spare parts service

Fast, simple and correct identification of spare parts for your drive system or vehicle fleet. The right spare part at the right time at the right place.

With this aim in mind, we can call on a globally networked spares logistics system

- a central depot at Headquarters, as well as decentralized depots among our subsidiaries, representatives and contractual workshops.

Your contact at Headquarters:

E-mail: spare.parts@mtu-online.com

Phone: +49 7541 908555

Fax: +49 7541 908121

9 Appendix B

9.1 Special Tools

Allen key	
Part No.:	F30002817
Qty.:	1
Used in:	7.4.2 Valve clearance – Check and adjustment (→ Page 73)

Barring device	
Part No.:	F6555766
Qty.:	1
Used in:	7.1.1 Engine – Barring manually (→ Page 63)

Belt tension tester	
Part No.:	Y4345711
Qty.:	1
Used in:	7.18.2 Battery-charging generator drive – Drive belt tension check (→ Page 123)

Connector pliers	
Part No.:	0135315483
Qty.:	1
Used in:	7.1.2 Engine – Barring with starting system (→ Page 64)
Qty.:	1
Used in:	7.20.1 Engine control unit and connectors – Cleaning (→ Page 126)
Qty.:	1
Used in:	7.20.2 Engine control unit plug connections – Check (→ Page 127)

Feeler gauge	
Part No.:	Y20010128
Qty.:	1
Used in:	7.4.2 Valve clearance – Check and adjustment (→ Page 73)

Filter wrench	
Part No.:	F30379104
Qty.:	1
Used in:	7.8.1 Fuel filter – Replacement (→ Page 84)
Qty.:	1
Used in:	7.14.1 Engine oil filter – Replacement (→ Page 102)
Qty.:	1
Used in:	7.14.2 Centrifugal oil filter – Cleaning and filter sleeve replacement (→ Page 103)

Installation and removal tool for injector	
Part No.:	F6790161
Qty.:	1
Used in:	7.6.2 Injector – Removal and installation (→ Page 78)

Milling cutter

Part No.: F30452739

Qty.: 1

Used in: 7.6.2 Injector – Removal and installation (→ Page 78)

MTU test kit

Part No.: 5605892099/00

Qty.: 1

Used in: 7.13.3 Engine oil – Sample extraction and analysis (→ Page 101)

Qty.: 1

Used in: 7.15.6 Coolant – Sample extraction and analysis (→ Page 112)

MTU test kit

Part No.:

Qty.:

Used in: 7.16.5 Charge-air coolant – Sample extraction and analysis (→ Page 119)

Ratchet adapter

Part No.: F30027340

Qty.: 1

Used in: 7.3.1 Crankcase breather – Oil separator replacement, diaphragm check and replacement (→ Page 70)

Ratchet adapter

Part No.: F30027341

Qty.: 1

Used in: 7.13.2 Engine oil – Change (→ Page 99)

Ratchet adapter

Part No.: F30027339

Qty.: 1

Used in: 7.14.2 Centrifugal oil filter – Cleaning and filter sleeve replacement (→ Page 103)

Ratchet with extension

Part No.: F30006212

Qty.: 1

Used in: 7.1.1 Engine – Barring manually (→ Page 63)

Rigid endoscope

Part No.: Y20097353

Qty.: 1

Used in: 7.2.1 Cylinder liner – Endoscopic examination (→ Page 66)

Slotted nut screwdriver

Part No.: F30452578

Qty.: 1

Used in: 7.6.2 Injector – Removal and installation (→ Page 78)

Socket wrench, 24 mm

Part No.: F30039526

Qty.: 1

Used in: 7.4.2 Valve clearance – Check and adjustment (→ Page 73)

Steam jet cleaner

Part No.: -

Qty.: 1

Used in: 4.10 Plant – Cleaning (→ Page 46)

Torque wrench, 0.5-5 Nm

Part No.: 0015384230

Qty.: 1

Used in: 7.6.2 Injector – Removal and installation (→ Page 78)

Torque wrench, 10-60 Nm

Part No.: F30510423

Qty.: 1

Used in: 1.4 Crankshaft transport locking device (→ Page 10)

Qty.: 1

Used in: 7.6.2 Injector – Removal and installation (→ Page 78)

Torque wrench, 40-200 Nm

Part No.: F30027337

Qty.: 1

Used in: 7.13.2 Engine oil – Change (→ Page 99)

Torque wrench, 6-50 Nm

Part No.: F30027336

Qty.: 1

Used in: 7.3.1 Crankcase breather – Oil separator replacement, diaphragm check and replacement (→ Page 70)

Torque wrench, 6-50 Nm

Part No.: F30027336

Qty.: 1

Used in: 7.14.2 Centrifugal oil filter – Cleaning and filter sleeve replacement (→ Page 103)

Torque wrench, 60-320 Nm

Part No.: F30047446

Qty.: 1

Used in: 1.4 Crankshaft transport locking device (→ Page 10)

Qty.: 1

Used in: 7.4.2 Valve clearance – Check and adjustment (→ Page 73)

Qty.: 1

Used in: 7.6.2 Injector – Removal and installation (→ Page 78)

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