

# Operating Instructions

Diesel engine  
8 V 2000 M70  
12 V 2000 M70  
16 V 2000 M70

MW15407/14E



*Power. Passion. Partnership.*

Printed in Germany

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This handbook is provided for use by maintenance and operating personnel in order to avoid malfunctions or damage during operation.

Subject to alterations and amendments.

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# 1 Safety

## 1.1 General conditions

### General

In addition to the instructions in this publication, the applicable country-specific legislation and other compulsory regulations regarding accident prevention and environmental protection must be observed. This state-of-the-art engine has been designed to meet all applicable laws and regulations. The engine may nevertheless present a risk of injury or damage in the following cases:

- Incorrect use
- Operation, maintenance and repair by unqualified personnel
- Modifications or conversions
- Noncompliance with the Safety Instructions

### Correct use

The engine is intended solely for use in accordance with contractual agreements and the purpose envisaged for it on delivery. Any other use is considered improper use. The engine manufacturer accepts no liability whatsoever for resultant damage or injury in such case. The responsibility is borne by the user alone.

Correct use also includes observation of and compliance with the maintenance specifications.

### Modifications or conversions

Unauthorized modifications to the engine represent a safety risk.

MTU will accept no liability or warranty claims for any damage caused by unauthorized modifications or conversions.

### Spare parts

Only genuine MTU spare parts must be used to replace components or assemblies. MTU accepts no liability whatsoever for damage or injury resulting from the use of other spare parts and the warranty shall be voided in such case.

### Reworking components

Repair or engine overhaul must be carried out in workshops authorized by MTU.

## 1.2 Personnel and organizational requirements

### **Personnel requirements**

Work on the engine must only be carried out by appropriately qualified and instructed personnel.

Observe the minimum legal age.

Responsibilities of the operating, maintenance and repair personnel must be specified by the operating company.

### **Organizational measures**

This publication must be issued to all personnel involved in operation, maintenance, repair or transportation.

Keep it handy in the vicinity of the engine such that it is accessible to operating, maintenance, repair and transport personnel at all times.

Use the manual as a basis for instructing personnel on engine operation and repair. In particular, personnel must have read and understood the safety-relevant instructions.

This is especially important for personnel who work on the engine only on an occasional basis. These persons shall receive repeated instruction.

Use the Spare Parts Catalog to identify spare parts during maintenance and repair work.

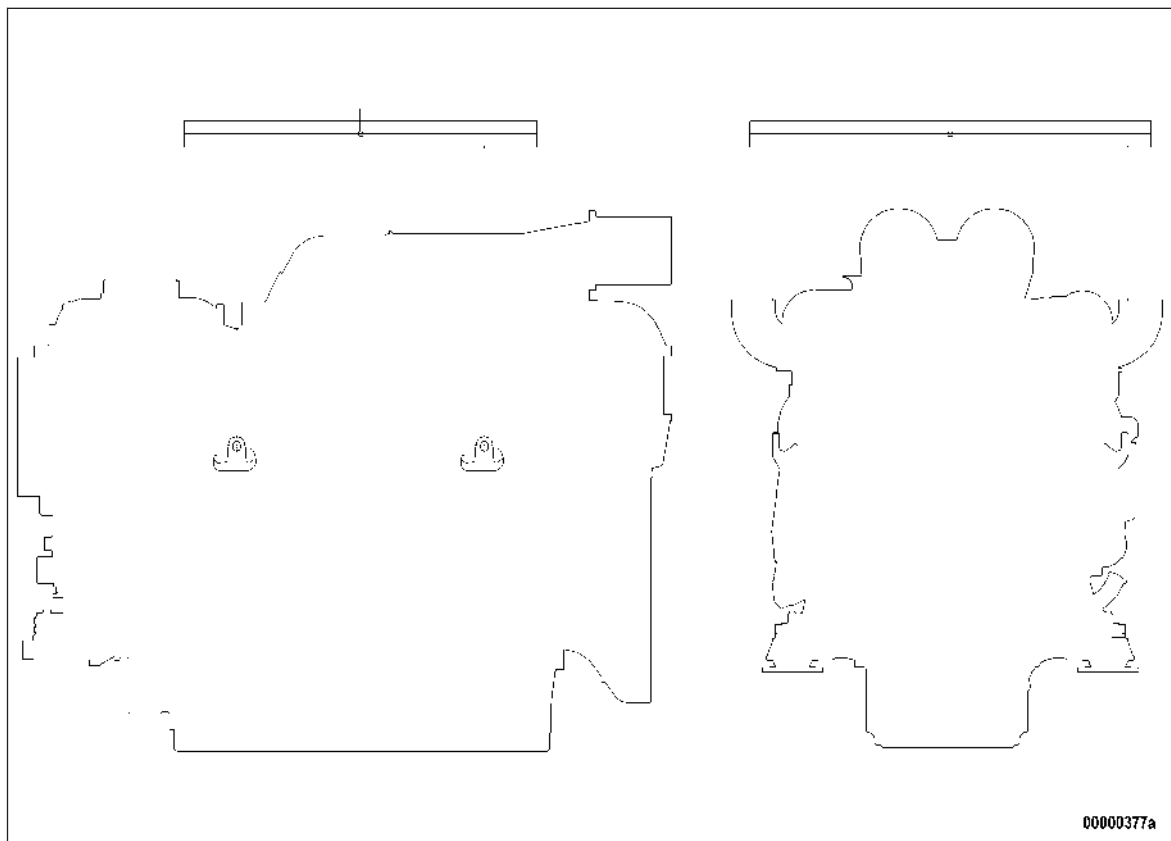
### **Working clothes and protective equipment**

Wear proper protective clothing for all work.

Depending on the kind of work, use the necessary personal protective equipment.

## 1.3 Transport

### Transport



Lift the engine only with the lifting eyes provided.

The lifting eyes are designed for engine transport only.

Use only the transport and lifting equipment approved by MTU.

The engine must only be transported in installation position, max. permissible diagonal pull 10°.

Take note of the engine center of gravity.

In the case of special packaging with aluminum foil, suspend the engine on the lifting eyes of the transport pallet or transport with equipment for heavy loads (forklift truck).

Prior to transporting the engine, it is imperative to install transportation locking devices for crankshaft and engine mounts.

Secure the engine against tilting during transportation. The engine must be especially secured against slipping or tilting when going up or down inclines and ramps.

#### Setting the engine down after transport

Place the engine only on an even, firm surface.

Ensure appropriate consistency and load-bearing capacity of the ground or support surface.

Never place an engine on the oil pan, unless expressly authorized by MTU on a case-to-case basis to do so.

## 1.4 Crankshaft transport locking device

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 10-60 Nm	F30510423	1
Torque wrench, 60-320 Nm	F30047446	1
Engine oil		

### Transport locking device

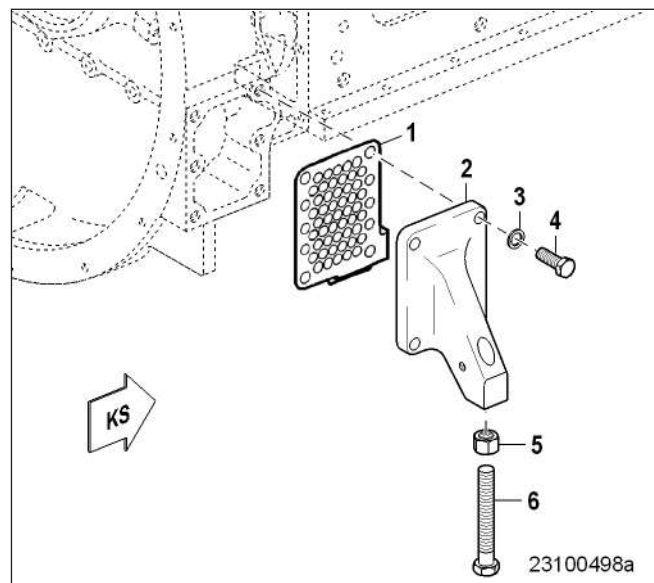
Note: The locking device protects the crankshaft bearings from shocks and vibration damage during engine transport.

#### For installation and removal of the transport locking device, follow the instructions below:

1. The transport locking device must remain installed as long as possible during engine installation in order to avoid damage.
2. Prior to every engine transport, the transport locking device must be reinstalled on both sides according to the instructions.
3. If the engine is to be moved together with the generator, the transport locking device for the generator must also be installed.
4. Always use the screws supplied with or installed in the transport locking device to secure it on the engine.
5. Starting or barring the engine is allowed only with the transport locking device removed. If the generator is already mounted on the engine, ensure that the transport locking device of the generator is also removed.
6. Attach these instructions, clearly visible, to the engine.

#### Removing guard plates and engine mounting brackets (if applicable) on driving end (KS)

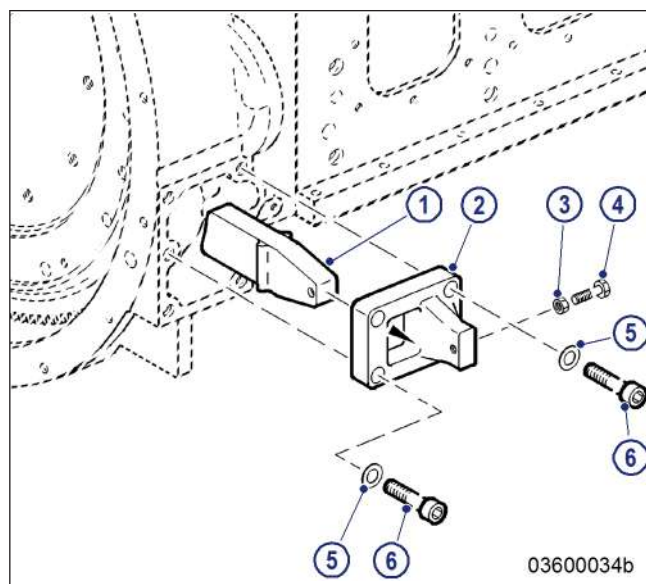
1. Remove screws (4) on both sides and take off with washers (3), guard plates (1) and engine mounting brackets (2).
2. Store the removed parts of the transport locking device carefully for possible reuse.



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## Fitting the transport locking device on driving end (KS)



Note: Attach plates (2) only to the upper part of the openings.

1. Secure the two plates (2) with screws (6) and washers (5) at the bores on both sides of the flywheel housing and tighten to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw	M16	Tightening torque	(Engine oil)	250 Nm +25 Nm

2. Screw nut (3) onto screws (4) up to the end of the thread.
3. The long end of retainers (1) must face downwards. Push retainers (1) with the round front face through the plate openings (2).

Note: The retainers (1) must lock the flywheel only, not the ring gear.

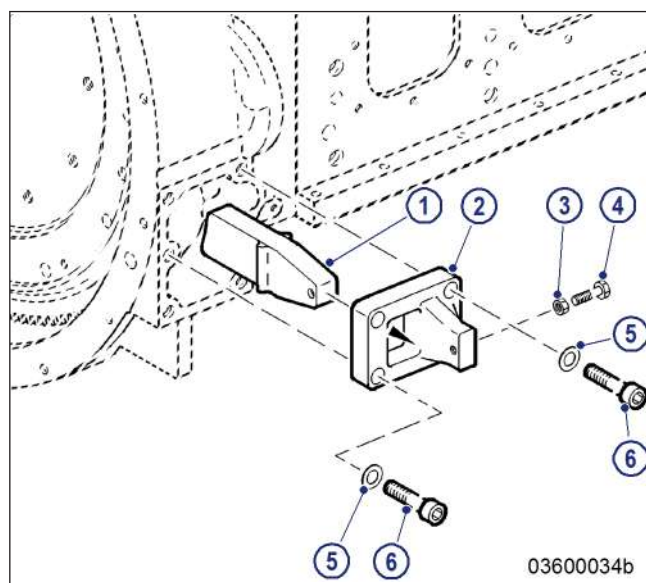
4. Install screws (4) into the bores of retainers (1) until the retainers (1) are locked in position.
5. Tighten screws (4) alternately with torque wrench to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw	M10	Tightening torque	(Engine oil)	30 Nm +3 Nm

6. Screw on nuts (3) of both screws (4) at plates (2) and secure.

## Removing the transport locking device from driving end (KS)

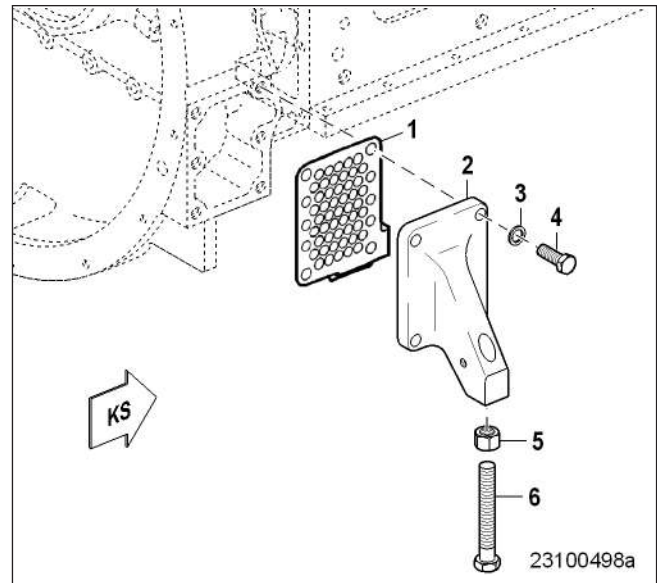
1. Release the locknuts (3) on both sides of the flywheel housing, remove screws (4) and take off the two locks (1).
2. Unscrew screws (6) and remove together with washers (5) and plates (2).
3. Store the removed parts of the transport locking device together with this documentation carefully for possible reuse.



## Installing guard plates and engine mounting brackets (if applicable) on driving end (KS)

Note: Always use the screws supplied with the or removed from the guard plates and engine mounting brackets to secure them on the engine.

1. Install engine mounting brackets (2) on both sides with guard plates (1) washers (3), and screws (4).
2. Tighten screws (4).



## 1.5 Safety regulations for startup and operation

### Safety requirements for initial operation

Prior to initial operation of the unit, install the assembly or unit according to the specifications and check the installation according to the MTU specifications.

Before putting the device or plant into operation, always ensure:

- that all maintenance and repair work is completed,
- that all loose parts have been removed from rotating machine components,
- that nobody is in the danger area of moving machine parts.

Immediately after putting the device or plant into operation, make sure that all control and display instruments as well as the signaling and alarm systems work properly.

### Safety requirements for operators

The procedures for cases of emergency must be practiced regularly.

The operator must be familiar with the control and display elements.

The operator must be familiar with the consequences of any operations performed.

During operation, the display instruments and monitoring units must be permanently observed with regard to present operating status, violation of limit values and warning or alarm messages.

The following steps must be taken if a malfunction of the system is recognized or reported by the system:

- inform supervisor(s) in charge,
- analyze the message,
- if required, carry out emergency operations e.g. emergency engine stop.

### Engine operation

The following conditions must be fulfilled before starting the engine:

- Wear ear protection.
- Ensure that the engine room is well ventilated.
- Do not inhale engine exhaust gases.
- Ensure that the exhaust system is free of leaks and that the gases are discharged to atmosphere.
- Mop up any leaked or spilt fluids and lubricants immediately or soak up with a suitable binding agent.
- Protect battery terminals, battery-charger terminals and cables against accidental contact.
- When the engine is running, never release coolant, oil, fuel, compressed-air or hydraulic lines.

### Operation of electrical equipment

When electrical equipment is in operation, certain components of these appliances are electrically live.

Observe the safety instructions for these devices.

## 1.6 Explosion hazard when removing inspection port cover on engine

DANGER



Explosion hazard due to oil vapors.

**Risk of serious injury – danger to life!**

- Allow the engine to cool down before opening the crankcase!
- Avoid open flames, electrical sparks and ignition sources.

### Safety instructions

- Before starting maintenance work, allow the engine to cool down for at least 10 min. (danger of explosion due to oil vapors).

## 1.7 Safety regulations for maintenance and repair work

### **Safety regulations for maintenance and repair work**

Have maintenance and repair work carried out by qualified and authorized personnel only.

Allow the engine to cool down before starting maintenance work (risk of explosion of oil vapors).

Before starting work, relieve pressure in systems and compressed-air lines which are to be opened.

Take special care when removing ventilation or plug screws from the engine. Cover the screw or plug with a rag to prevent fluids escaping under pressure.

Take special care when draining hot fluids ⇒ Risk of injury.

When changing the engine oil or working on the fuel system, ensure that the engine room is adequately ventilated.

Allow the engine / system to cool down before starting to work.

Observe the maintenance and repair instructions.

Never carry out maintenance and repair work with the engine running unless expressly instructed to do so.

Secure the engine against accidental starting.

Disconnect the battery when electrical starters are fitted.

Close the main valve on the compressed-air system and vent the compressed-air line when pneumatic starters are fitted.

Disconnect the control equipment from the assembly or system.

Use only proper, calibrated tools. Observe the specified tightening torques during assembly/disassembly.

Carry out work only on assemblies and/or units which are properly secured.

Never use lines for climbing.

Keep fuel injection lines and connections clean.

Always seal connections with caps or covers if a line is removed or opened.

Take care not to damage lines, in particular fuel lines, during maintenance and repair work.

Ensure that all retainers and dampers are installed correctly.

Ensure that all fuel injection and pressurized oil lines are installed with enough clearance to prevent contact with other components. Do not place fuel or oil lines near hot components.

Do not touch elastomeric seals if they have carbonized or resinous appearance unless hands are properly protected.

Note cooling time for components which are heated for installation or removal ⇒ Risk of burning.

When working high on the engine, always use suitable ladders and work platforms. Make sure components are placed on stable surfaces.

Observe special cleanness when conducting maintenance and repair work on the assembly or system. After completion of maintenance and repair work, make sure that no loose objects are in/on the assembly or system.

Before barring the engine, make sure that nobody is standing in the danger zone. Check that all guards have been reinstalled and that all tools and loose parts have been removed after working on the engine.

The following additional instructions apply to starters with beryllium copper pinion:

- Breathing protection of filter class P2 must be applied during maintenance work to avoid health hazards caused by the beryllium-containing pinion. Do not blow out the interior of the flywheel housing or the starter with compressed air. Clean the flywheel housing inside with a class H dust extraction device as an additional measure.

## **Welding work**

Never carry out welding work on the assembly, system, or engine-mounted units. Cover the engine when welding in its vicinity.

Do not use the assembly or system as ground terminal.

Do not route the welding lead over or near the wiring harnesses of MTU systems. The welding current may otherwise induce an interference voltage in the wiring harnesses which could conceivably damage the electrical system.

Remove parts (e.g. exhaust pipes) which are to be welded from the engine beforehand.

## **Hydraulic installation and removal**

Check the function and safe operating condition of tools and fixtures to be used. Use only the specified devices for hydraulic removal/installation procedures.

Observe the max. permissible push-on pressure specified for the equipment.

Do not attempt to bend or apply force to lines.

Before starting work, pay attention to the following:

- Vent the hydraulic installation/removal tool, the pumps and the lines at the relevant points for the equipment to be used (e.g. open vent plugs, pump until bubble-free air emerges, close vent plugs).
- For hydraulic installation, screw on the tool with the piston retracted.
- For hydraulic removal, screw on the tool with the piston extended.

For a hydraulic installation/removal tool with central expansion pressure supply, screw spindle into shaft end until correct sealing is established.

During hydraulic installation and removal, ensure that nobody is standing in the immediate vicinity of the component to be installed/removed.

## **Working on electrical/electronic assemblies**

Always obtain the permission of the person in charge before commencing maintenance and repair work or switching off any part of the electronic system required to do so.

De-energize the appropriate areas prior to working on assemblies.

Do not damage cabling during removal work. When reinstalling ensure that wiring is not damaged during operation by contact with sharp objects, by rubbing against other components or by a hot surface.

Do not secure cables on lines carrying fluids.

Do not use cable binders to secure cables.

Always use connector pliers to tighten connectors.

Subject the device or system to a function check on completion of all repair work.

Store spare parts properly prior to replacement, i.e. protect them against moisture in particular. Pack defective electronic components and assemblies in a suitable manner when dispatched for repair, i.e. particularly protected against moisture and impact and wrapped in antistatic foil if necessary.

## **Working with laser equipment**

When working with laser equipment, always wear special laser-protection goggles ⇒ Heavily focused radiation.

Laser equipment must be fitted with the protective devices necessary for safe operation according to type and application.

For conducting light-beam procedures and measurement work, only the following laser devices must be used:

- Laser devices of classes 1, 2 or 3A.
- Laser devices of class 3B, which have maximum output in the visible wavelength range (400 to 700 nm), a maximum output of 5 mW, and in which the beam axis and surface are designed to prevent any risk to the eyes.

## 1.8 Auxiliary materials, fire prevention and environmental protection

### Fire prevention

Rectify any fuel or oil leaks immediately; even splashes of oil or fuel on hot components can cause fires - therefore always keep the engine in a clean condition. Do not leave cloths soaked with fluids and lubricants lying on or near the assembly or unit. Do not store inflammable material near the assembly or unit.

Do not weld pipes and components carrying oil or fuel! Before welding, clean with a nonflammable fluid.

When starting the engine with an external power source, connect the ground lead last and remove it first. To avoid sparks in the vicinity of the battery, connect the ground lead from the external power source to the ground lead of the engine or to the ground terminal of the starter.

Always keep suitable firefighting equipment (fire extinguishers) at hand and familiarize yourself with their use.

### Noise

Noise can lead to an increased risk of accident if acoustic signals, warning shouts or noises indicating danger are drowned.

Wear ear protectors in work areas with a sound pressure level in excess of 85 dB (A).

### Environmental protection and disposal

Modification or removal of mechanical or electronic components or the installation of additional components as well as the execution of calibration processes that might affect the emission characteristics of the engine are prohibited by emission regulations. Emission control units/systems may only be maintained, exchanged or repaired if the components used for this purpose are approved by MTU or equivalent components. Noncompliance with these guidelines might represent a violation of the Clean Air Act and involves the termination of the operating license by the emission authorities. MTU does not accept any liability for violations of the emission regulations. MTU will provide assistance and advice if emission-relevant components are intended to be modified. The MTU Maintenance Schedules ensure the reliability and performance of MTU engines and must be complied with over the entire life cycle of the engine.

Use only fuel of prescribed quality to comply with emission limit values.

Dispose of used fluids, lubricants and filters in accordance with local regulations.

Within the EU, batteries can be returned free of charge to MTU FN / MTU Onsite Energy where they are subjected to proper recycling procedures.

### Auxiliary materials, fluids and lubricants

Use only fluids and lubricants that have been tested and approved by MTU.

Keep fluids and lubricants in suitable, properly designated containers. When using fluids, lubricants and other chemical substances, follow the safety instructions that apply to the product. Take special care when using hot, chilled or caustic materials. When using flammable materials, avoid all sparks and do not smoke.

### Used oil

Used oil contains harmful combustion residues.

Rub barrier cream into hands.

Wash hands after contact with used oil.



## Lead

- When working with lead or lead-containing compounds, avoid direct contact to the skin and do not inhale lead vapors.
- Adopt suitable measures to avoid the formation of lead dust.
- Switch on extraction system.
- Wash hands after contact with lead or lead-containing substances.

## Compressed air

Observe special safety precautions when working with compressed air:

- Pay special attention to the pressure level in the compressed air network and pressure vessel.
- Assemblies and equipment to be connected must either be designed for this pressure, or, if the permitted pressure for the connecting elements is lower than the pressure required, a pressure reducing valve and safety valve (set to permitted pressure) must form an intermediate connection.
- Hose couplings and connections must be securely attached.
- Wear goggles when blowing off components or blowing away chips.
- Provide the snout of the air nozzle with a protective disk (e.g. rubber disk).
- First shut off compressed air lines before compressed air equipment is disconnected from the supply line, or before equipment or tool is to be replaced.
- Unauthorized use of compressed air, e.g. forcing flammable liquids (danger class A1, A11 and B) out of containers, results in a risk of explosion.
- Forcing compressed air into thin-walled containers (e.g. containers made of tin, plastic and glass) for drying purposes or to check for leaks, results in a risk of bursting.
- Carry out leak test in accordance with the specifications.

## Painting

- When painting in other than spray booths equipped with extractors, ensure good ventilation. Make sure that neighboring work areas are not impaired.
- No open flames.
- No smoking.
- Observe fire prevention regulations.
- Always wear a mask providing protection against paint and solvent vapors.




## Liquid nitrogen

- Store liquid nitrogen only in small quantities and always in regulation containers without fixed covers.
- Avoid body contact (eyes, hands).
- Wear protective clothing, protective gloves, closed shoes and protective goggles / safety mask.
- Make sure that working area is well ventilated.
- Avoid all knocks and jars to the containers, fixtures or workpieces.

## Acids and alkaline solutions

- When working with acids and alkaline solutions, wear protective goggles or face mask, gloves and protective clothing.
- If such solutions are spilled onto clothing, remove the affected clothing immediately.
- Rinse injured parts of the body thoroughly with clean water.
- Rinse eyes immediately with eyedrops or clean tap water.

## 1.9 Conventions for safety instructions in the text

<b>DANGER</b> 	In the event of immediate danger. <b>Consequences: Death or serious injury</b> <ul style="list-style-type: none"><li>• Remedial action</li></ul>
<b>WARNING</b> 	In the event of potentially dangerous situations. <b>Consequences: Death or serious injury</b> <ul style="list-style-type: none"><li>• Remedial action</li></ul>
<b>CAUTION</b> 	In the event of dangerous situations. <b>Consequences: Minor injury or material damage</b> <ul style="list-style-type: none"><li>• Remedial action</li></ul>

Note: This manual contains highlighted safety warnings in accordance with the US ANSI Z535 standard which begin with one of the signal words listed above depending on the severity of the hazard.

### Safety instructions

1. Read and familiarize yourself with all safety notices before starting up or repairing the product.
2. Pass on all safety instructions to your operating, maintenance, repair and transport personnel.

## 2 General Information

### 2.1 Product description

#### Description of the engine

##### Engine

The engine is a liquid-cooled four-stroke diesel engine, rotating counterclockwise (seen from driving end), with direct injection, exhaust turbocharging and intercooling.

The engine is monitored by an engine control and monitoring system.

Monitoring in the engine room is carried out by the engine control and monitoring unit.

##### Fuel system

Electronically controlled unit injection pumps with jacketed HP lines.

The electronic control unit controls

- Injection start
- Injection quantity

##### Exhaust system

The exhaust system is equipped with triple-walled, water-cooled exhaust lines.

The triple-walled design permits

- Low surface temperature,
- Reduced amount of heat to be dissipated by the coolant
- Absolute gas-tightness.

##### Turbocharging

Sequential turbocharging with intercooling (turbochargers can be cut in/out during operation).

##### Cooling system

Engine cooled by split-circuit cooling system with plate-core heat exchanger.

##### Service block

The service components are mounted at the auxiliary PTO end.

The arrangement facilitates easy access for maintenance operations.

Service-components:

- Raw water pump, coolant pump
- Fuel duplex filter, switchable
- Lube-oil multiple filter, switchable
- Centrifugal lube oil filter
- Coolant expansion tank

##### Electronic system

Electronic control and monitoring system with integrated safety and test system, providing interfaces to Remote Control System (RCS) and Monitoring and Control System (MCS).

### **Electronic Engine Control Unit (ECU)**

Functions:

- Engine speed control with fuel and speed limitation dependent on engine state and operating conditions;
- Control of sequential turbocharging;
- Data processing logistics for analog and binary signals;
- Interface for data transfer to CAN field bus for remote control and ship-side monitoring;
- RS 232 interface for connection of MTU dialog unit.

### **Electronic Engine Monitoring Unit (EMU), optional**

Functions:

- Data processing logistics for analog and binary signals;
- Interface for data transfer to CAN field bus for remote control and ship-side monitoring.

### **Electronic Gear Control Unit (GCU), ship-side wall-mounting**

Functions:

- Data processing logistics for gear coupling control;
- Input/output signals as well as data transfer to CAN field bus for remote control and ship-side monitoring.

### **Monitoring in engine room**

Engine control and monitoring unit (LOP)

Functions:

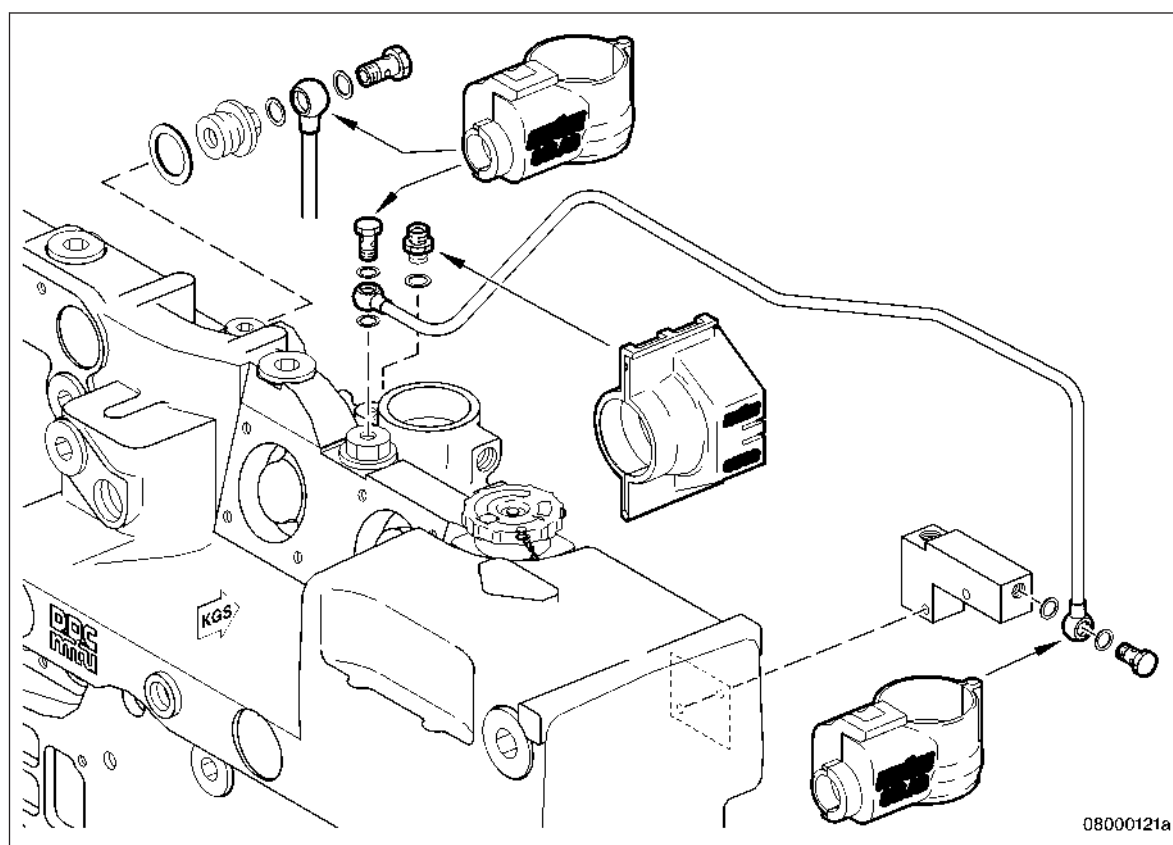
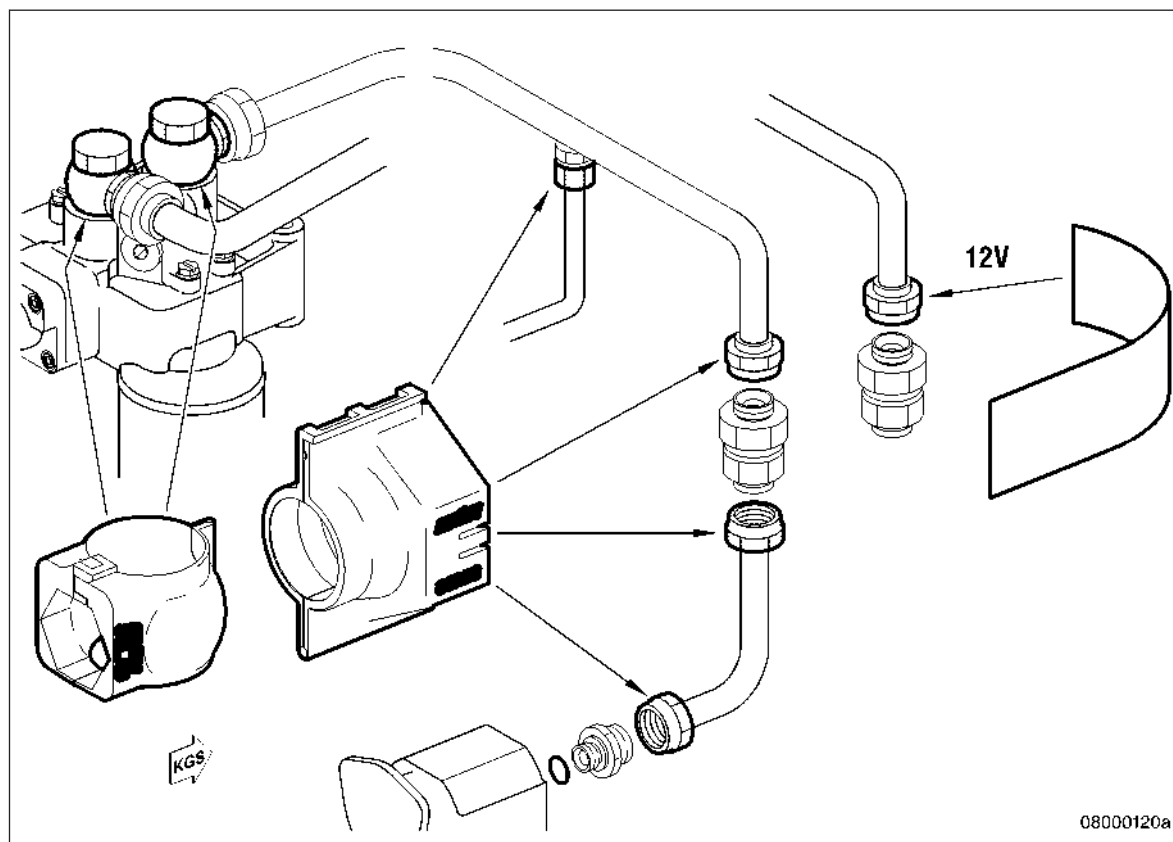
- Alphanumeric, monochrome LCD display for monitoring of measured values as well as alarms when limits are violated;
- Pushbuttons for menu control and dimming unit;
- Combined control and display elements for local engine/gear control;
- Flashing light and horn for summary alarm in engine room;
- Interface to CAN field bus for connected, communicating monitoring system components.

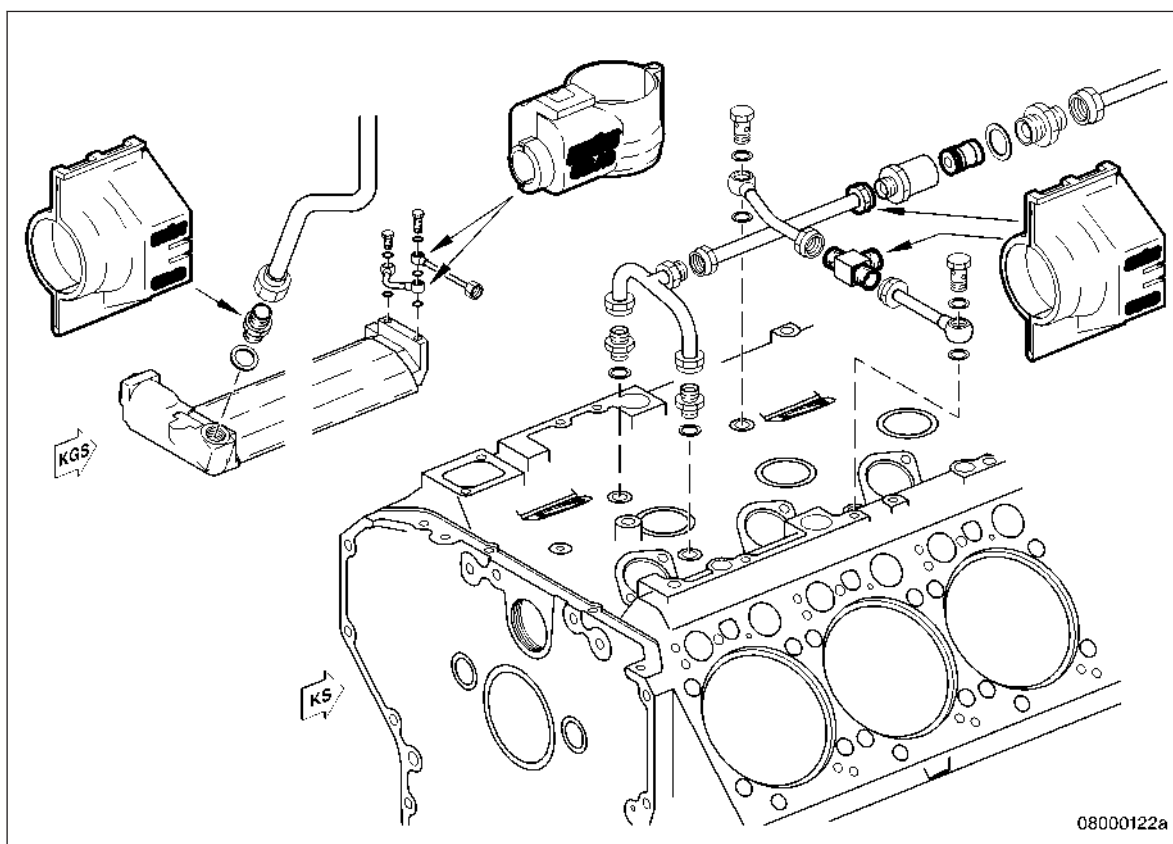
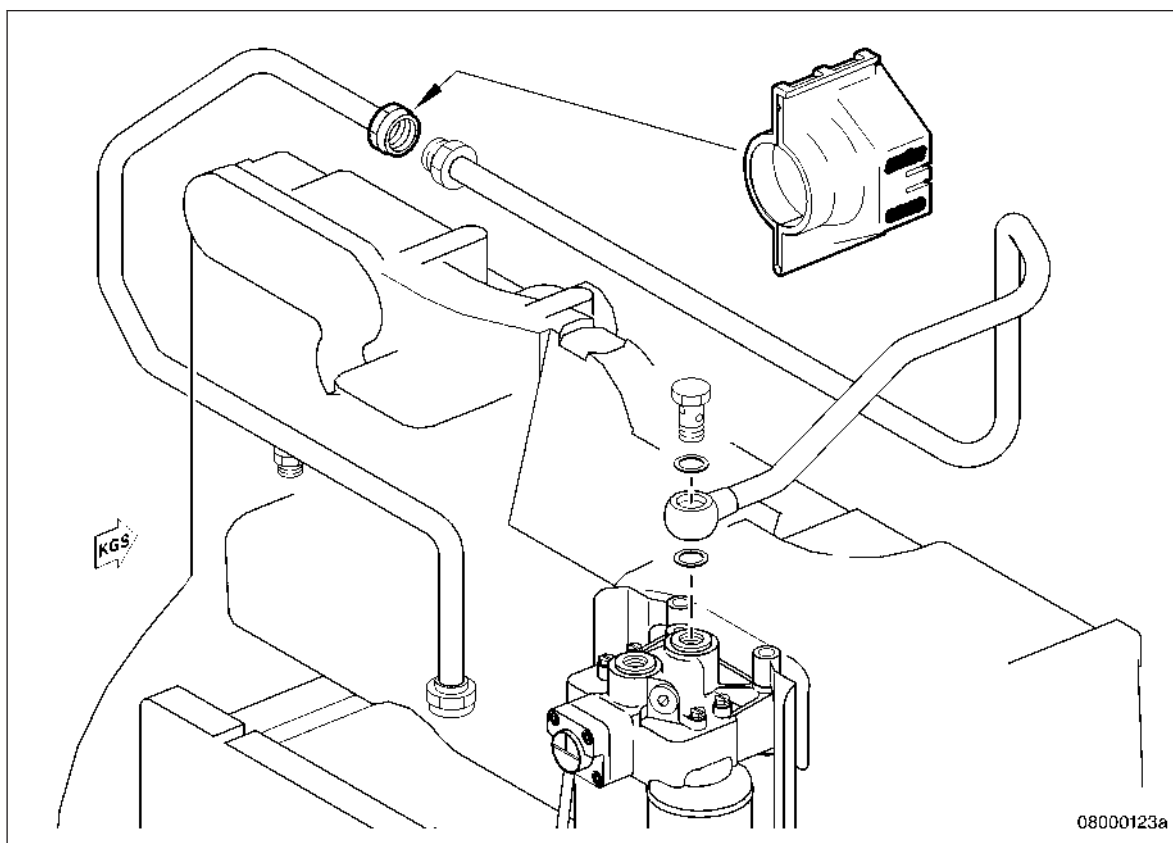
### **SOLAS – Fire protection specifications**

All fuel lines with fuel pressure >1.8 bar are fitted with SOLAS-compliant covers acc. to MTU standard MTN5233.

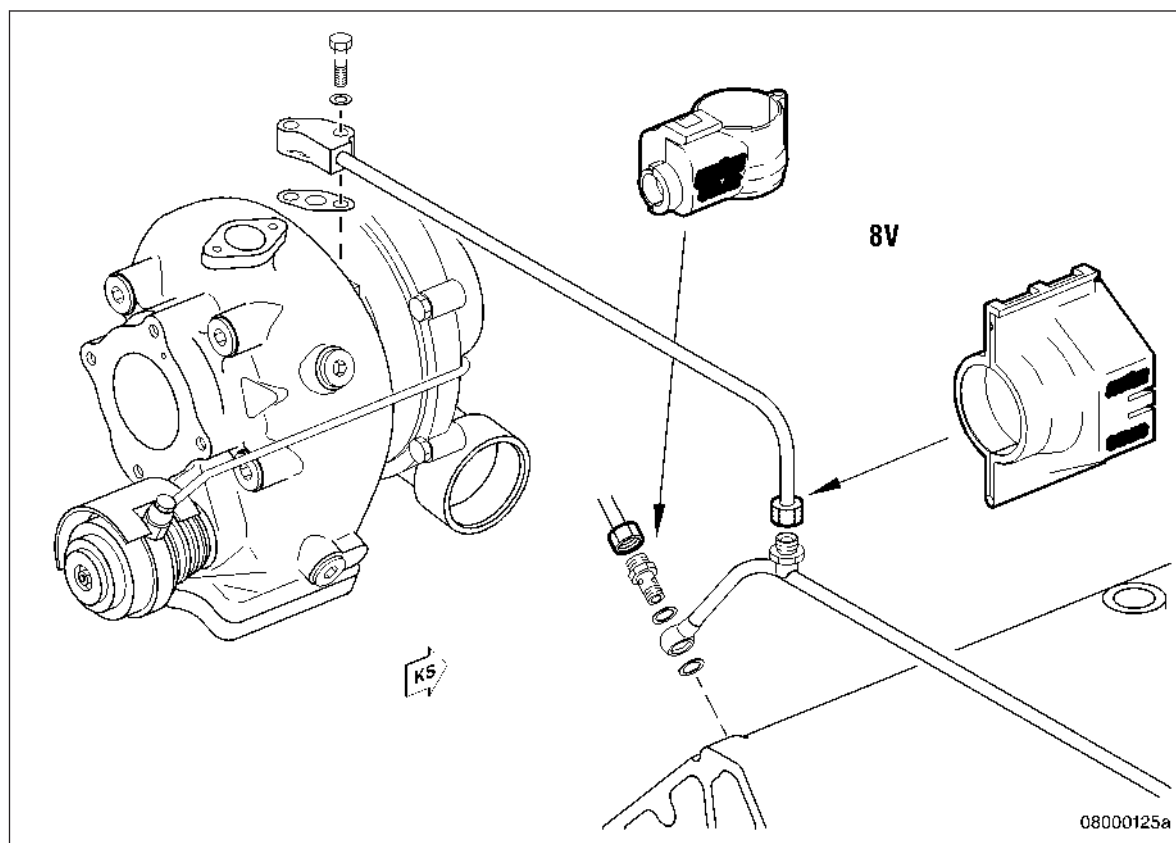
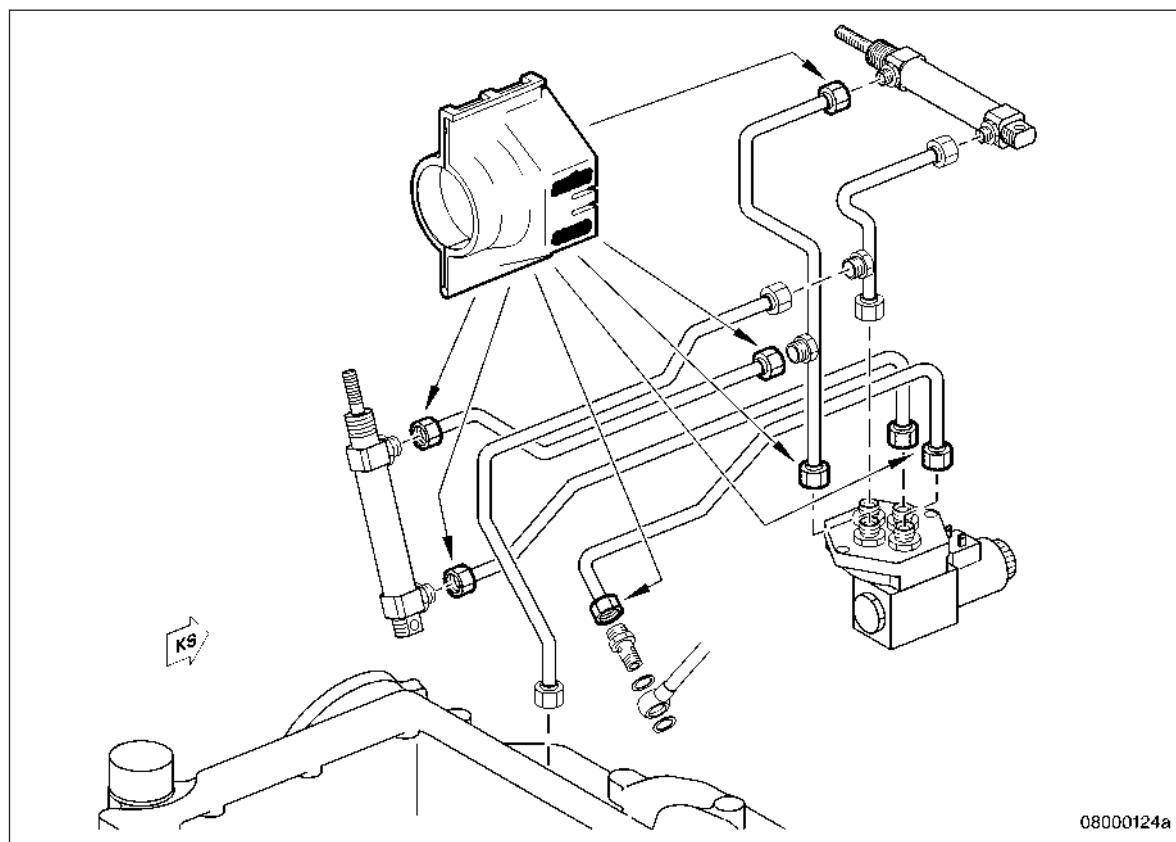
All oil lines with oil pressure >1.8 bar are fitted with SOLAS-compliant covers acc. to MTU standard MTN5233.

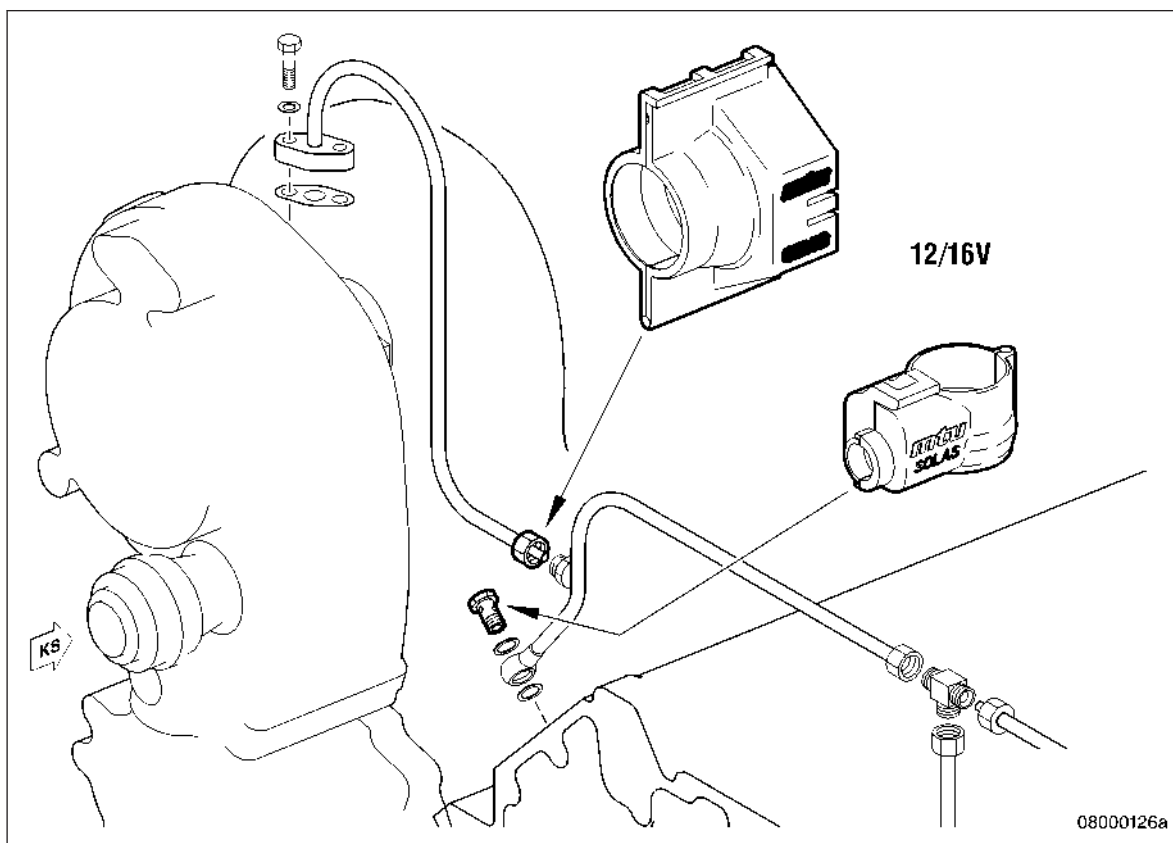
## Fuel system covers





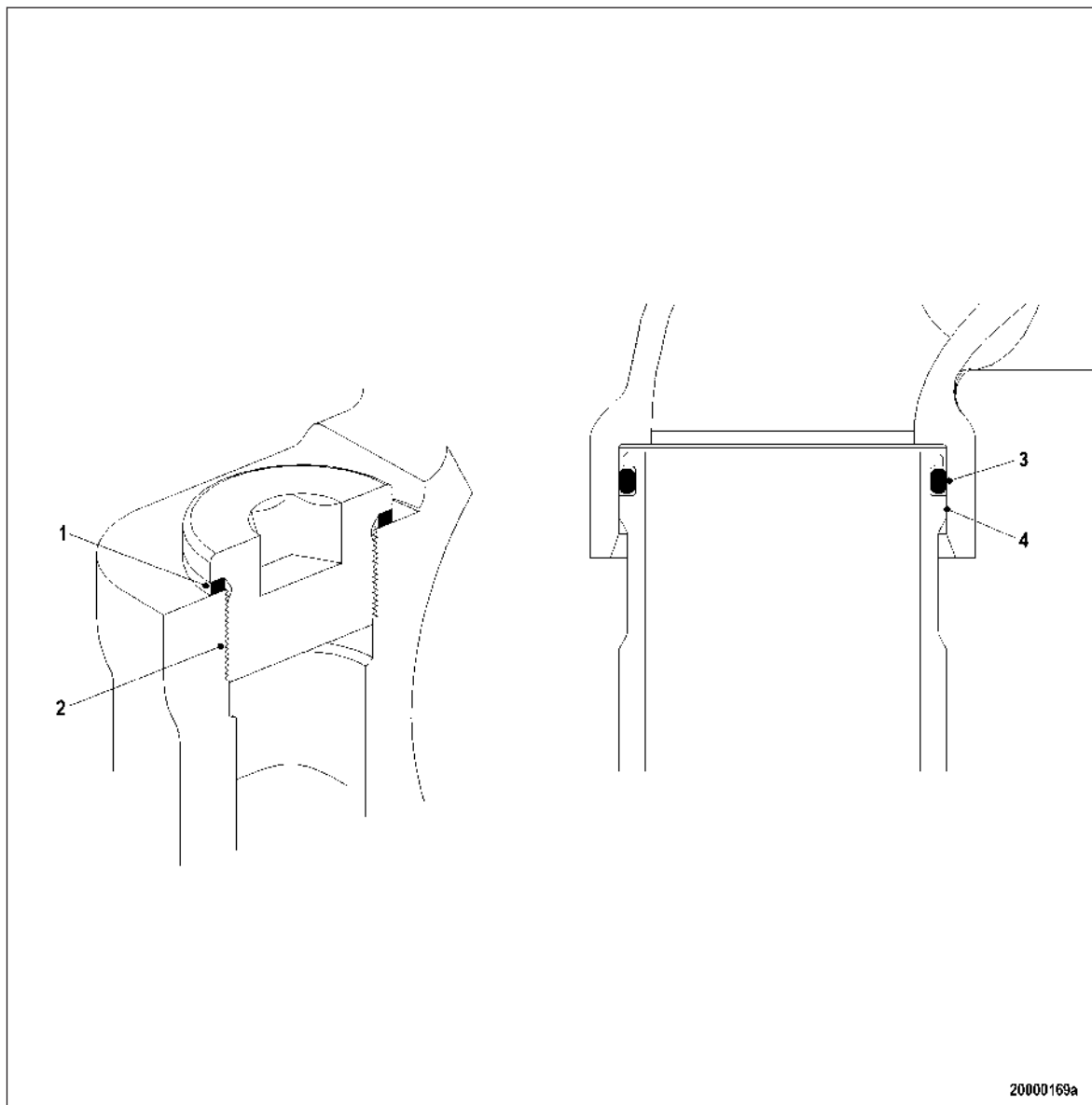
## Lube oil system covers







## Special unions



The following types of union are spray-proof in case of leakage even without covers and have been confirmed as being SOLAS-compliant by GL and DNV.

### Plug-in pipe union

Design precludes lateral spray as the parting line is shielded by the sleeve (4).

Only seepage along the pipeline is possible whereby the pressure is greatly reduced by a faulty O-ring (3).

The union is confirmed as being SOLAS-compliant by DNV and GL.

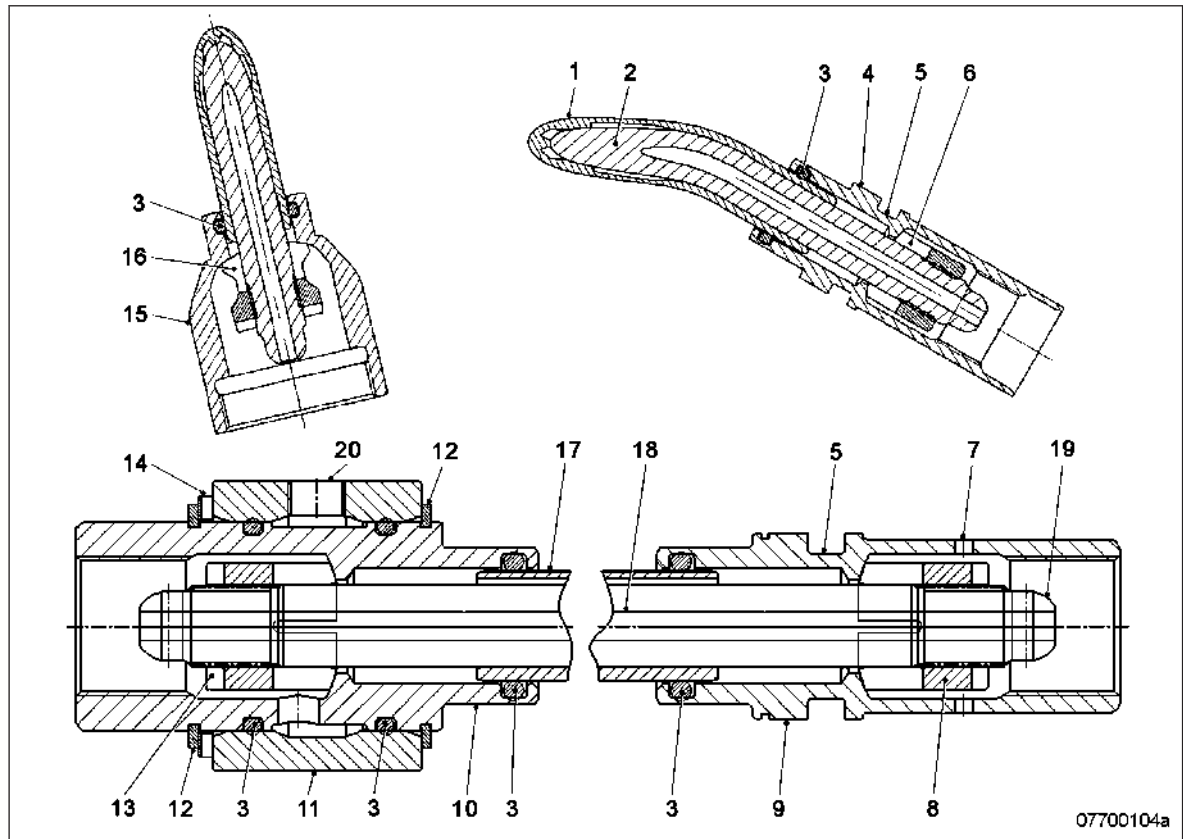
### Plugs and sensors

Screw-in plugs (2) are sealed toward the outside either with a copper sealing ring (1), according to DIN, or an O-ring (ISO).

The fluid must first pass the thread in case of a loose threaded union or faulty sealing ring (2).

The pressure is so greatly reduced by this and the faulty sealing ring (2) that any leakage is not under pressure.

## High-pressure unions



07700104a

- |                         |                     |                             |
|-------------------------|---------------------|-----------------------------|
| 1 Jacketed pipe         | 8 Thrust ring       | 15 Union nut                |
| 2 HP line               | 9 Union nut         | 16 Thrust ring              |
| 3 O-ring                | 10 Union nut        | 17 External pipe of HP line |
| 4 Union nut             | 11 Connecting piece | 18 Internal pipe of HP line |
| 5 Recess for O-ring     | 12 Snap ring        | 19 Spherical sealing area   |
| 6 Thrust ring           | 13 Thrust ring      | 20 Leak fuel connection     |
| 7 Leakage overflow bore | 14 Shims            |                             |

The HP fuel line is sealed by the thrust ring (8).

If leakage in the area of the thrust ring (8) or the HP line (5) occurs, the emerging fuel is routed to the leakage chamber.

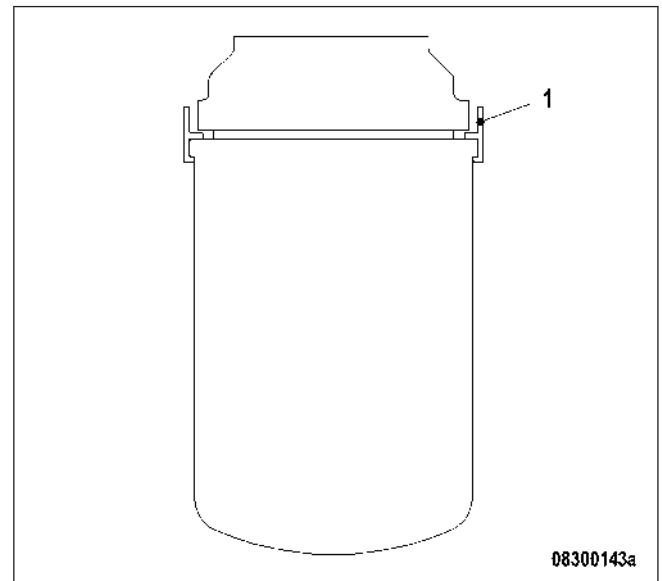
Leak fuel is allowed to escape without pressure via the leakage overflow bore (7). The leakage chamber is sealed toward the outside by the O-rings (3).

This prevents leaking fuel from escaping.

The union is confirmed as being SOLAS-compliant by DNV and GL.

## Shielding of fuel filters and lube-oil filters

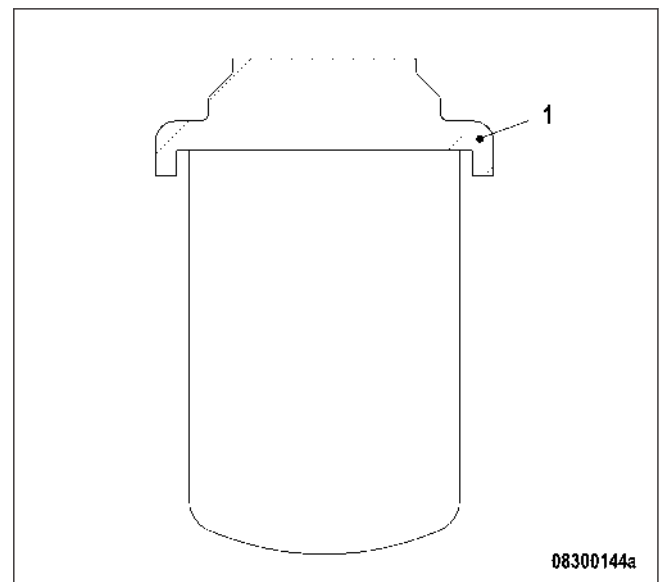
### Shielding with plastic ring



The plastic ring (1) precludes lateral spray.

The fluid is diverted to the catch basin whereby the pressure is greatly reduced.

### Shielding by structural overhang

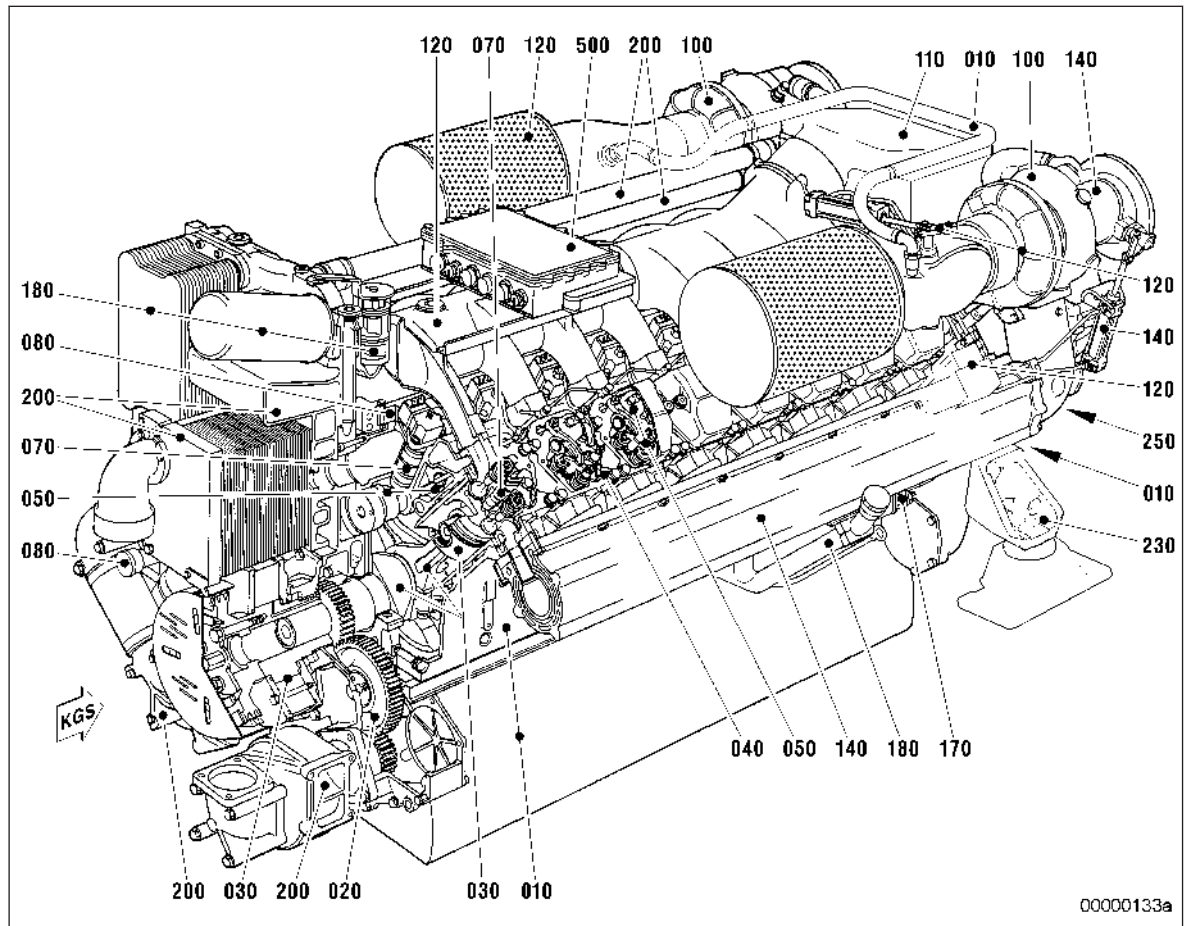


The overhang (1) prevents lateral spray.

The fluid is diverted to the catch basin whereby the pressure is greatly reduced.

## 2.2 2000 M70 engines

### Engine layout - functional grouping



010 Crankcase and externally mounted components	080 LP fuel system	230 Mounting / support
020 Gear train	100 Exhaust turbocharger	250 PTO systems, driving end and free end
030 Running gear	110 Intercooler	500 Monitoring, control and regulation system
040 Cylinder head	120 Air intake / air supply	
050 Valve gear	140 Exhaust system	
070 Fuel system (high pressure)	170 Starting system	
	180 Lube oil system	
	200 Cooling system	

### Engine model designation

Key to the engine model designations 8/12/16V 2000 M70

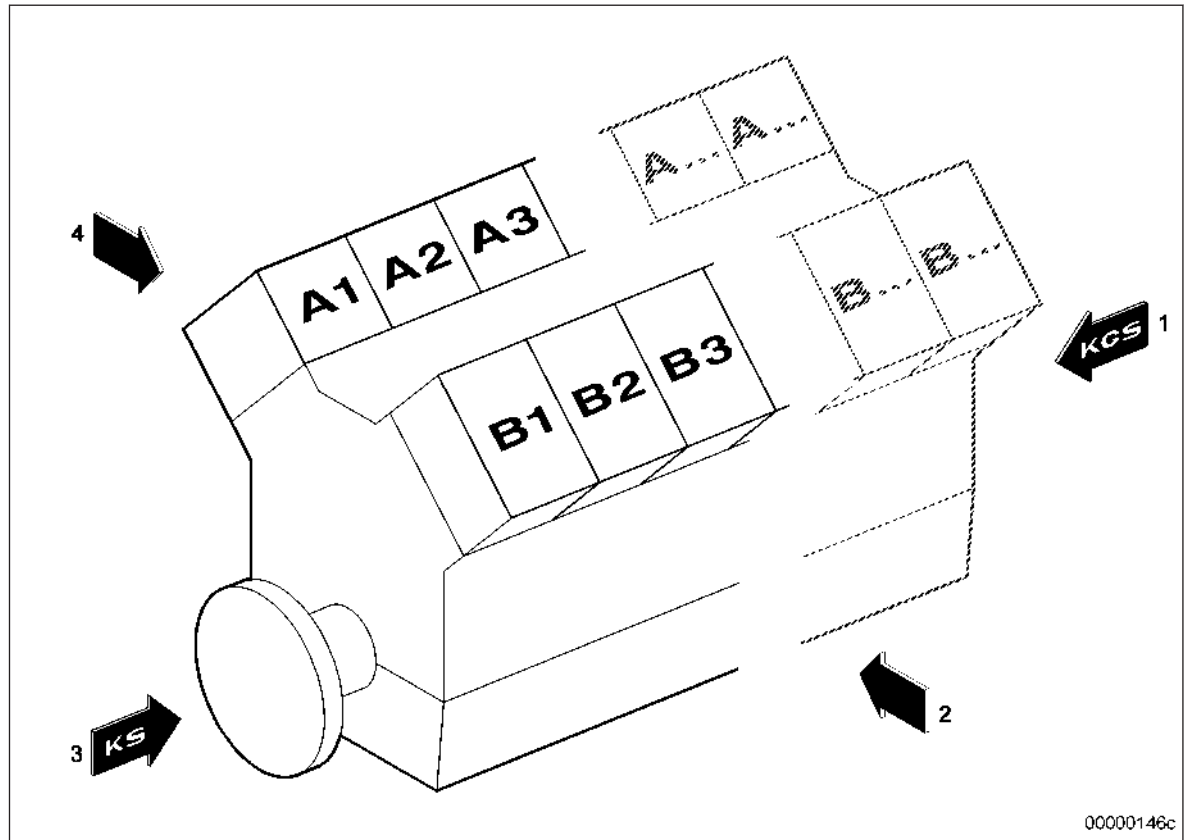
- 8/12/16 = Number of cylinders
- V = Cylinder configuration
- 2000 = Series
- M7 = Application segment
- 0 = Design index

## 2.3 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

00000146c

## 3 Technical Data

### 3.1 8V 2000 M70 engine data: Engine-mounted heat exchanger

#### Explanation

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

#### REFERENCE CONDITIONS

Engine model			8V 2000 M70
Application group			1B
Intake air temperature		°C	25
Raw water inlet temperature		°C	25
Barometric pressure		mbar	1000
Site altitude above sea level		m	100

#### POWER-RELATED DATA (power ratings are net brake power to ISO 3046)

Number of cylinders			8
Engine rated speed	A	rpm	2100
Fuel stop power ISO 3046	A	kW	525

#### GENERAL CONDITIONS (for maximum power)

Number of cylinders			8
Intake air depression (new filter)	A	mbar	15
Intake air depression, max.	L	mbar	50

#### MODEL-RELATED DATA (basic design)

Number of cylinders			8
Cylinder configuration: V angle		degree	90
Bore		mm	130
Stroke		mm	150

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Number of cylinders			8
Cylinder displacement		liter	1.99
Total displacement		liter	15.92
Number of inlet valves, per cylinder			2
Number of exhaust valves, per cylinder			2

### RAW WATER CIRCUIT (open circuit)

Number of cylinders			8
Raw water pump: inlet pressure, min.	L	bar	-0.5
Raw water pump: inlet pressure, max.	L	bar	+0.5
Pressure loss in the external raw water system, max.	L	bar	0.7

### LUBE OIL SYSTEM

Number of cylinders			8
Lube oil operating temperature before engine, from	R	°C	77
Lube oil operating temperature before engine, to	R	°C	82
Lube oil operating pressure before engine, from	R	bar	6.2
Lube oil operating pressure before engine, to	R	bar	6.7
Lube oil operating pressure, low idle (meas. point: before engine)	R	bar	2.6

### FUEL SYSTEM

Number of cylinders			8
Fuel pressure at supply connection to engine (when engine is starting), min.	L	bar	-0.3
Fuel pressure at supply connection to engine (when engine is running), min.	L	bar	-0.3
Fuel pressure at supply connection to engine (when engine is starting), max.	L	bar	+0.5
Fuel supply flow, max.	R	liter/min	2.3

### GENERAL OPERATING DATA

Number of cylinders			8
Firing speed, from	R	rpm	100
Firing speed, to	R	rpm	120

### STARTING (electric)

Number of cylinders			8
Rated starter voltage (standard design)	R	V=	24

### STARTING (pneumatic starter)

Number of cylinders			8
Starting air pressure before starter motor, min.	R	bar	18
Starting air pressure before starter motor, max.	R	bar	30

## INCLINATIONS – STANDARD OIL SYSTEM (ref.: water line)

Number of cylinders			8
Longitudinal inclination, continuous max., driving end down (option: max. operating inclinations)	L	degree	15
Longitudinal inclination, temporary max., driving end down (option: max. operating inclinations)	L	degree	22.5
Longitudinal inclination, continuous max., driving end up (option: max. operating inclinations)	L	degree	0
Longitudinal inclination, temporary max., driving end up (option: max. operating inclinations)	L	degree	10
Transverse inclination, continuous max. (option: max. operating inclinations)	L	degree	22.5
Transverse inclination, temporary max. (option: max. operating inclinations)	L	degree	40

## CAPACITIES

Number of cylinders			8
Engine coolant capacity (with cooling equipment)	R	liter	70
Engine oil capacity, initial filling (standard oil system) (option: max. operating inclinations)	R	liter	65
Oil change quantity, max. (standard oil system) (option: max. operating inclinations)	R	liter	60
Oil pan capacity, dipstick mark min. (standard oil system) (option: max. operating inclinations)	L	liter	45
Oil pan capacity, dipstick mark max. (standard oil system) (option: max. operating inclinations)	L	liter	55

## WEIGHTS / MAIN DIMENSIONS

Number of cylinders			8
Engine dry weight (with attached standard accessories, without coupling)	R	kg	1790

## ACOUSTICS

Number of cylinders			8
Exhaust noise, unsilenced, BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	106
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	100



## 3.2 8V 2000 M70 engine data: Separate heat exchanger

### Explanation

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

### REFERENCE CONDITIONS

Engine model			8V 2000 M70
Application group			1B
Intake air temperature		°C	25
Raw water intake temperature		°C	25
Barometric pressure		mbar	1000
Site altitude above sea level		m	100

### POWER-RELATED DATA (power ratings are net brake power to ISO 3046)

Number of cylinders			8
Engine rated speed	A	rpm	2100
Fuel stop power ISO 3046	A	kW	525

### GENERAL CONDITIONS (for maximum power)

Number of cylinders			8
Intake air depression (new filter)	A	mbar	15
Intake air depression, max.	L	mbar	50

### MODEL-RELATED DATA (basic design)

Number of cylinders			8
Cylinder configuration: V angle		degree	90
Bore		mm	130
Stroke		mm	150
Cylinder displacement		liter	1.99
Total displacement		liter	15.92

Number of cylinders			8
Number of inlet valves, per cylinder			2
Number of exhaust valves, per cylinder			2

## LUBE OIL SYSTEM

Number of cylinders			8
Lube oil operating temperature before engine, from	R	°C	77
Lube oil operating temperature before engine, to	R	°C	82
Lube oil operating pressure before engine, from	R	bar	6.2
Lube oil operating pressure before engine, to	R	bar	6.7
Lube oil operating pressure, low idle (meas. point: before engine)	R	bar	2.6

## FUEL SYSTEM

Number of cylinders			8
Fuel pressure at supply connection to engine (when engine is starting), min.	L	bar	-0.3
Fuel pressure at supply connection to engine (when engine is running), min.	L	bar	-0.3
Fuel pressure at supply connection to engine (when engine is starting), max.	L	bar	+0.5
Fuel supply flow, max.	R	liter/min	13.9

## GENERAL OPERATING DATA

Number of cylinders			8
Firing speed, from	R	rpm	100
Firing speed, to	R	rpm	120

## STARTING (electric)

Number of cylinders			8
Rated starter voltage (standard design)	R	V=	24

## INCLINATIONS – STANDARD OIL SYSTEM (ref.: water line)

Number of cylinders			8
Longitudinal inclination, continuous max., driving end down (option: max. operating inclinations)	L	degree	15
Longitudinal inclination, temporary max., driving end down (option: max. operating inclinations)	L	degree	22.5
Longitudinal inclination, continuous max., driving end up (option: max. operating inclinations)	L	degree	0
Longitudinal inclination, temporary max., driving end up (option: max. operating inclinations)	L	degree	10
Transverse inclination, continuous max. (option: max. operating inclinations)	L	degree	22.5
Transverse inclination, temporary max. (option: max. operating inclinations)	L	degree	40

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## CAPACITIES

Number of cylinders			8
Engine oil capacity, initial filling (standard oil system) (option: max. operating inclinations)	R	liter	65
Oil change quantity, max. (standard oil system) (option: max. operating inclinations)	R	liter	60
Oil pan capacity, dipstick mark min. (standard oil system) (option: max. operating inclinations)	L	liter	45
Oil pan capacity, dipstick mark max. (standard oil system) (option: max. operating inclinations)	L	liter	55

## WEIGHTS / MAIN DIMENSIONS

Number of cylinders			8
Engine dry weight (with attached standard accessories, without coupling)	R	kg	1790

## ACOUSTICS

Number of cylinders			8
Exhaust noise, unsilenced, BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	106
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	100

### 3.3 12V 2000 M70 engine data: Engine-mounted heat exchanger

#### Explanation

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

#### REFERENCE CONDITIONS

Engine model			12 V 2000 M70
Application group			1B
Intake air temperature		°C	25
Raw water inlet temperature		°C	25
Barometric pressure		mbar	1000
Site altitude above sea level		m	100

#### POWER-RELATED DATA (power ratings are net brake power to ISO 3046)

Number of cylinders			12
Engine rated speed	A	rpm	2100
Fuel stop power ISO 3046	A	kW	788

#### GENERAL CONDITIONS (for maximum power)

Number of cylinders			12
Intake air depression (new filter)	A	mbar	15
Intake air depression, max.	L	mbar	50

#### MODEL-RELATED DATA (basic design)

Number of cylinders			12
Cylinder configuration: V angle		degree	90
Bore		mm	130
Stroke		mm	150
Cylinder displacement		liter	1.99
Total displacement		liter	23.88

T1M-ID: 0000002967 - 002

Number of cylinders			12
Number of inlet valves, per cylinder			2
Number of exhaust valves, per cylinder			2

### RAW WATER CIRCUIT (open circuit)

Number of cylinders			12
Raw water pump: inlet pressure, min.	L	bar	-0.4
Raw water pump: inlet pressure, max.	L	bar	+0.5
Pressure loss in the external raw water system, max.	L	bar	0.7

### LUBE OIL SYSTEM

Number of cylinders			12
Lube oil operating temperature before engine, from	R	°C	79
Lube oil operating temperature before engine, to	R	°C	84
Lube oil operating pressure before engine, from	R	bar	7.5
Lube oil operating pressure before engine, to	R	bar	8.5
Lube oil operating pressure, low idle (meas. point: before engine)	R	bar	3.5

### FUEL SYSTEM

Number of cylinders			12
Fuel pressure at supply connection to engine (when engine is starting), min.	L	bar	-0.3
Fuel pressure at supply connection to engine (when engine is running), min.	L	bar	-0.3
Fuel pressure at supply connection to engine (when engine is starting), max.	L	bar	+0.5
Fuel supply flow, max.	R	liter/min	3.5

### GENERAL OPERATING DATA

Number of cylinders			12
Firing speed, from	R	rpm	100
Firing speed, to	R	rpm	120

### STARTING (electric)

Number of cylinders			12
Rated starter voltage (standard design)	R	V=	24

### STARTING (pneumatic starter)

Number of cylinders			12
Starting air pressure before starter motor, min.	R	bar	21
Starting air pressure before starter motor, max.	R	bar	30

## INCLINATIONS – STANDARD OIL SYSTEM (ref.: water line)

Number of cylinders			12
Longitudinal inclination, continuous max., driving end down (Option: max. operating inclinations)	L	degree	15
Longitudinal inclination, temporary max., driving end down (Option: max. operating inclinations)	L	degree	22.5
Longitudinal inclination, continuous max., driving end up (Option: max. operating inclinations)	L	degree	5
Longitudinal inclination, temporary max., driving end up (Option: max. operating inclinations)	L	degree	10
Transverse inclination, continuous max. (Option: max. operating inclinations)	L	degree	22.5
Transverse inclination, temporary max. (Option: max. operating inclinations)	L	degree	40

## CAPACITIES

Number of cylinders			12
Engine coolant capacity (with cooling equipment)	R	liter	110
Engine oil capacity, initial filling (standard oil system) (Option: max. operating inclinations)	R	liter	105
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	liter	98
Oil pan capacity, dipstick mark min. (standard oil system) (Option: max. operating inclinations)	L	liter	73
Oil pan capacity, dipstick mark max. (standard oil system) (Option: max. operating inclinations)	L	liter	88

## WEIGHTS / MAIN DIMENSIONS

Number of cylinders			12
Engine dry weight (with attached standard accessories, without coupling)	R	kg	2600

## ACOUSTICS

Number of cylinders			12
Exhaust noise, unsilenced, BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	102
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	103

### 3.4 12V 2000 M70 engine data: Separate heat exchanger

#### Explanation

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

#### REFERENCE CONDITIONS

Engine model			12 V 2000 M70
Application group			1B
Intake air temperature		°C	25
Raw water intake temperature		°C	25
Barometric pressure		mbar	1000
Site altitude above sea level		m	100

#### POWER-RELATED DATA (power ratings are net brake power to ISO 3046)

Number of cylinders			12
Engine rated speed	A	rpm	2100
Fuel stop power ISO 3046	A	kW	788

#### GENERAL CONDITIONS (for maximum power)

Number of cylinders			12
Intake air depression (new filter)	A	mbar	15
Intake air depression, max.	L	mbar	50

#### MODEL-RELATED DATA (basic design)

Number of cylinders			12
Cylinder configuration: V angle		degree	90
Bore		mm	130
Stroke		mm	150
Cylinder displacement		liter	1.99
Total displacement		liter	23.88

Number of cylinders			12
Number of inlet valves, per cylinder			2
Number of exhaust valves, per cylinder			2

## LUBE OIL SYSTEM

Number of cylinders			12
Lube oil operating temperature before engine, from	R	°C	79
Lube oil operating temperature before engine, to	R	°C	84
Lube oil operating pressure before engine, from	R	bar	7.5
Lube oil operating pressure before engine, to	R	bar	8.5
Lube oil operating pressure, low idle (meas. point: before engine)	R	bar	3.5

## FUEL SYSTEM

Number of cylinders			12
Fuel pressure at supply connection to engine (when engine is starting), min.	L	bar	-0.3
Fuel pressure at supply connection to engine (when engine is running), min.	L	bar	-0.3
Fuel pressure at supply connection to engine (when engine is starting), max.	L	bar	+0.5
Fuel supply flow, max.	R	liter/min	29

## GENERAL OPERATING DATA

Number of cylinders			12
Firing speed, from	R	rpm	100
Firing speed, to	R	rpm	120

## STARTING (electric)

Number of cylinders			12
Rated starter voltage (standard design)	R	V=	24

## STARTING (pneumatic starter)

Number of cylinders			12
Starting air pressure before starter motor, min.	R	bar	21
Starting air pressure before starter motor, max.	R	bar	30

## INCLINATIONS – STANDARD OIL SYSTEM (ref.: water line)

Number of cylinders			12
Longitudinal inclination, continuous max., driving end down (Option: max. operating inclinations)	L	degree	15
Longitudinal inclination, temporary max., driving end down (Option: max. operating inclinations)	L	degree	22.5
Longitudinal inclination, continuous max., driving end up (Option: max. operating inclinations)	L	degree	5

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Number of cylinders			12
Longitudinal inclination, temporary max., driving end up (Option: max. operating inclinations)	L	degree	10
Transverse inclination, continuous max. (Option: max. operating inclinations)	L	degree	22.5
Transverse inclination, temporary max. (Option: max. operating inclinations)	L	degree	40

## CAPACITIES

Number of cylinders			12
Engine oil capacity, initial filling (standard oil system) (Option: max. operating inclinations)	R	liter	105
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	liter	98
Oil pan capacity, dipstick mark min. (standard oil system) (Option: max. operating inclinations)	L	liter	73
Oil pan capacity, dipstick mark max. (standard oil system) (Option: max. operating inclinations)	L	liter	88

## WEIGHTS / MAIN DIMENSIONS

Number of cylinders			12
Engine dry weight (with attached standard accessories, without coupling)	R	kg	2600

## ACOUSTICS

Number of cylinders			12
Exhaust noise, unsilenced, BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	102
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	103

### 3.5 16V 2000 M70 engine data: Engine-mounted heat exchanger

#### Explanation

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

#### REFERENCE CONDITIONS

Engine model			16 V 2000 M70
Application group			1B
Intake air temperature		°C	25
Raw water inlet temperature		°C	25
Barometric pressure		mbar	1000
Site altitude above sea level		m	100

#### POWER-RELATED DATA (power ratings are net brake power to ISO 3046)

Number of cylinders			16
Engine rated speed	A	rpm	2100
Fuel stop power ISO 3046	A	kW	1050

#### GENERAL CONDITIONS (for maximum power)

Number of cylinders			16
Intake air depression (new filter)	A	mbar	15
Intake air depression, max.	L	mbar	50

#### MODEL-RELATED DATA (basic design)

Number of cylinders			16
Cylinder configuration: V angle		degree	90
Bore		mm	130
Stroke		mm	150
Cylinder displacement		liter	1.99
Total displacement		liter	31.84

T1M-ID: 0000003010 - 002

Number of cylinders			16
Number of inlet valves, per cylinder			2
Number of exhaust valves, per cylinder			2

### RAW WATER CIRCUIT (open circuit)

Number of cylinders			16
Raw water pump: inlet pressure, min.	L	bar	-0.3
Raw water pump: inlet pressure, max.	L	bar	+0.5
Pressure loss in the external raw water system, max.	L	bar	0.7

### LUBE OIL SYSTEM

Number of cylinders			16
Lube oil operating temperature before engine, from	R	°C	84
Lube oil operating temperature before engine, to	R	°C	89
Lube oil operating pressure before engine, from	R	bar	6.4
Lube oil operating pressure before engine, to	R	bar	7.4
Lube oil operating pressure, low idle (meas. point: before engine)	R	bar	3.0

### FUEL SYSTEM

Number of cylinders			16
Fuel pressure at supply connection to engine (when engine is starting), min.	L	bar	-0.3
Fuel pressure at supply connection to engine (when engine is running), min.	L	bar	-0.3
Fuel pressure at supply connection to engine (when engine is starting), max.	L	bar	+0.5
Fuel supply flow, max.	R	liter/min	4.5

### GENERAL OPERATING DATA

Number of cylinders			16
Firing speed, from	R	rpm	100
Firing speed, to	R	rpm	120

### STARTING (electric)

Number of cylinders			16
Rated starter voltage (standard design)	R	V=	24

### STARTING (pneumatic starter)

Number of cylinders			16
Starting air pressure before starter motor, min.	R	bar	24
Starting air pressure before starter motor, max.	R	bar	30

## INCLINATIONS – STANDARD OIL SYSTEM (ref.: water line)

Number of cylinders			16
Longitudinal inclination, continuous max., driving end down (Option: max. operating inclinations)	L	degree	15
Longitudinal inclination, temporary max., driving end down (Option: max. operating inclinations)	L	degree	22.5
Longitudinal inclination, continuous max., driving end up (Option: max. operating inclinations)	L	degree	0
Longitudinal inclination, temporary max., driving end up (Option: max. operating inclinations)	L	degree	6
Transverse inclination, continuous max. (Option: max. operating inclinations)	L	degree	22.5
Transverse inclination, temporary max. (Option: max. operating inclinations)	L	degree	35

## CAPACITIES

Number of cylinders			16
Engine coolant capacity (with cooling equipment)	R	liter	160
Engine oil capacity, initial filling (standard oil system) (Option: max. operating inclinations)	R	liter	134
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	liter	127
Oil pan capacity, dipstick mark min. (standard oil system) (Option: max. operating inclinations)	L	liter	97
Oil pan capacity, dipstick mark max. (standard oil system) (Option: max. operating inclinations)	L	liter	117

## WEIGHTS / MAIN DIMENSIONS

Number of cylinders			16
Engine dry weight (with attached standard accessories, without coupling)	R	kg	3200

## ACOUSTICS

Number of cylinders			16
Exhaust noise, unsilenced, BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	105
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	107

## 3.6 16V 2000 M70 engine data: Separate heat exchanger

### Explanation

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

### REFERENCE CONDITIONS

Engine model			16 V 2000 M70
Application group			1B
Intake air temperature		°C	25
Raw water intake temperature		°C	25
Barometric pressure		mbar	1000
Site altitude above sea level		m	100

### POWER-RELATED DATA (power ratings are net brake power to ISO 3046)

Number of cylinders			16
Engine rated speed	A	rpm	2100
Fuel stop power ISO 3046	A	kW	1050

### GENERAL CONDITIONS (for maximum power)

Number of cylinders			16
Intake air depression (new filter)	A	mbar	15
Intake air depression, max.	L	mbar	50

### MODEL-RELATED DATA (basic design)

Number of cylinders			16
Cylinder configuration: V angle		degree	90
Bore		mm	130
Stroke		mm	150
Cylinder displacement		liter	1.99
Total displacement		liter	31.84

Number of cylinders			16
Number of inlet valves, per cylinder			2
Number of exhaust valves, per cylinder			2

## LUBE OIL SYSTEM

Number of cylinders			16
Lube oil operating temperature before engine, from	R	°C	86
Lube oil operating temperature before engine, to	R	°C	91
Lube oil operating pressure before engine, from	R	bar	6.4
Lube oil operating pressure before engine, to	R	bar	7.4
Lube oil operating pressure, low idle (meas. point: before engine)	R	bar	3.0

## FUEL SYSTEM

Number of cylinders			16
Fuel pressure at supply connection to engine (when engine is starting), min.	L	bar	-0.3
Fuel pressure at supply connection to engine (when engine is running), min.	L	bar	-0.3
Fuel pressure at supply connection to engine (when engine is starting), max.	L	bar	+0.5
Fuel supply flow, max.	R	liter/min	29

## GENERAL OPERATING DATA

Number of cylinders			16
Firing speed, from	R	rpm	100
Firing speed, to	R	rpm	120

## STARTING (electric)

Number of cylinders			16
Rated starter voltage (standard design)	R	V=	24

## INCLINATIONS – STANDARD OIL SYSTEM (ref.: water line)

Number of cylinders			16
Longitudinal inclination, continuous max., driving end down (Option: max. operating inclinations)	L	degree	15
Longitudinal inclination, temporary max., driving end down (Option: max. operating inclinations)	L	degree	22.5
Longitudinal inclination, continuous max., driving end up (Option: max. operating inclinations)	L	degree	0
Longitudinal inclination, temporary max., driving end up (Option: max. operating inclinations)	L	degree	6
Transverse inclination, continuous max. (Option: max. operating inclinations)	L	degree	22.5
Transverse inclination, temporary max. (Option: max. operating inclinations)	L	degree	35

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## CAPACITIES

Number of cylinders			16
Engine oil capacity, initial filling (standard oil system) (Option: max. operating inclinations)	R	liter	134
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	liter	127
Oil pan capacity, dipstick mark min. (standard oil system) (Option: max. operating inclinations)	L	liter	97
Oil pan capacity, dipstick mark max. (standard oil system) (Option: max. operating inclinations)	L	liter	117

## WEIGHTS / MAIN DIMENSIONS

Number of cylinders			16
Engine dry weight (with attached standard accessories, without coupling)	R	kg	3200

## ACOUSTICS

Number of cylinders			16
Exhaust noise, unsilenced, BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	105
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	107

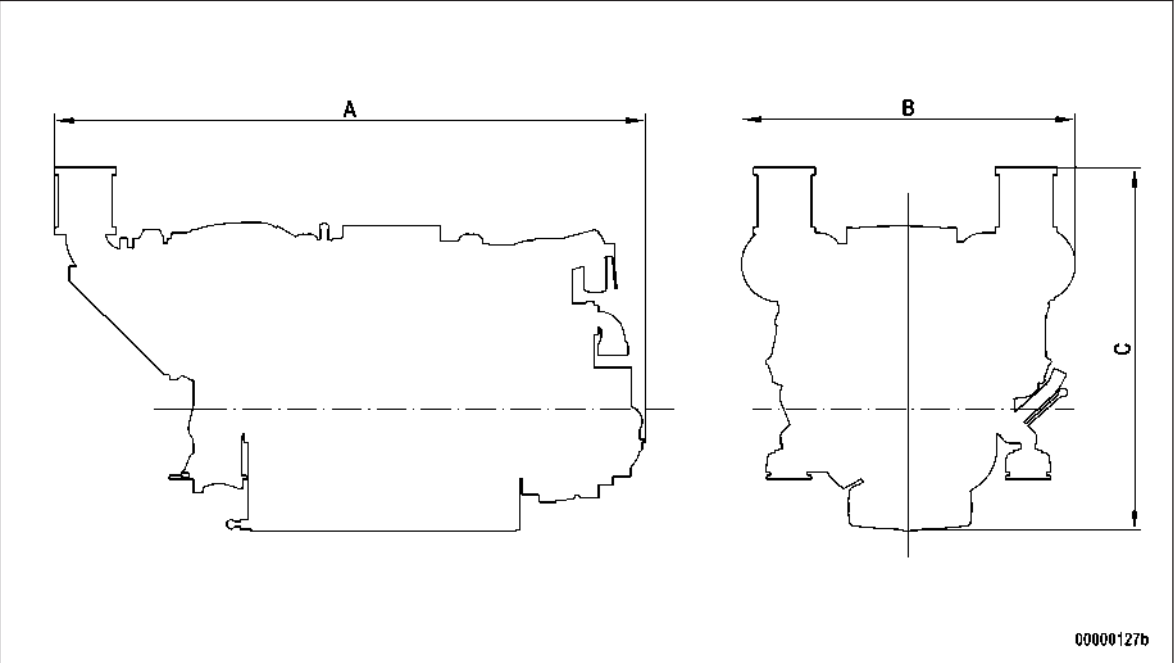
## 3.7 Firing order

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



# 3.8 Main engine dimensions

## Main engine dimensions

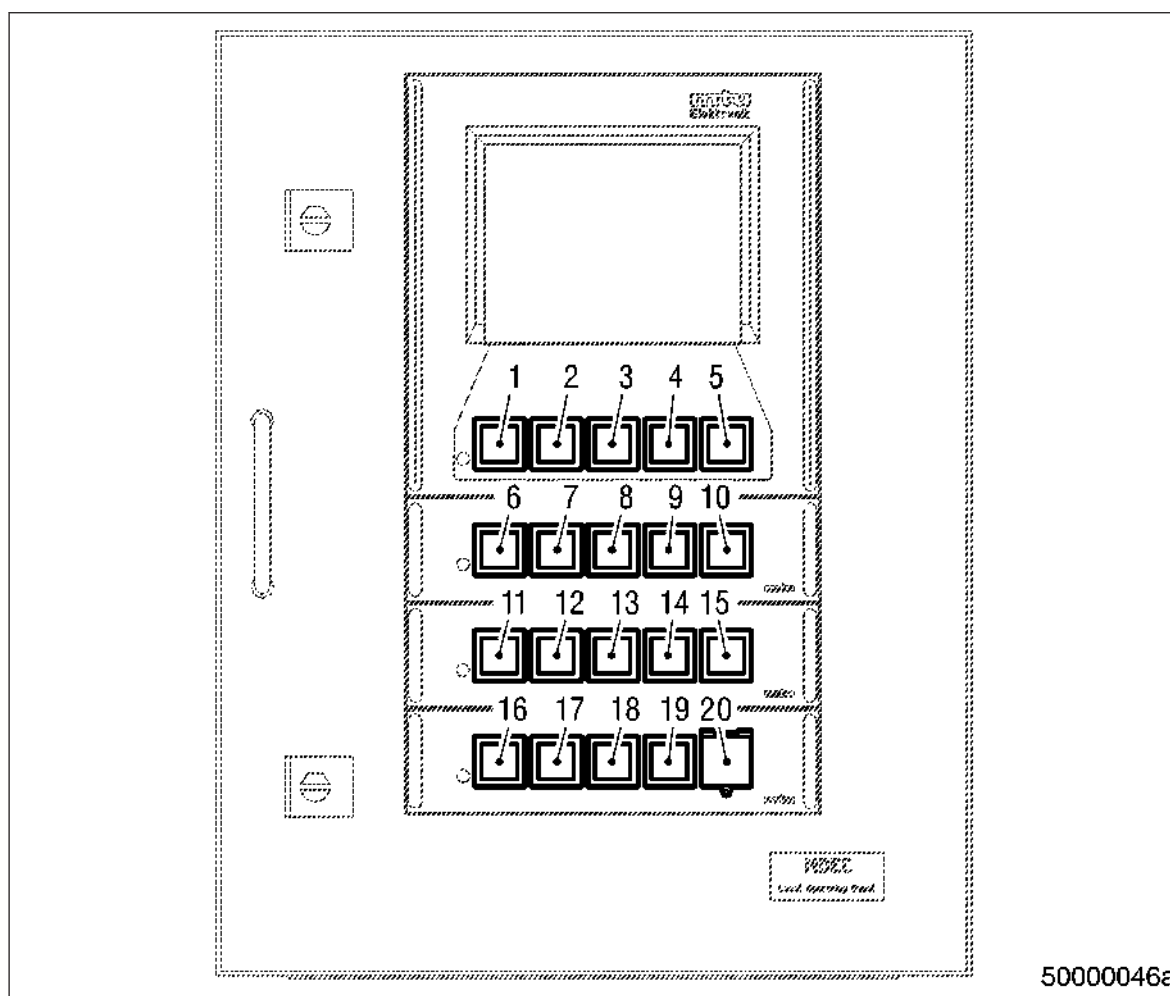


Engine model	Length (A)	Width (B)	Height (C)
8 V 2000 M70	approx. 2005 mm	approx. 1280 mm	approx. 1315 mm
12 V 2000 M70	approx. 2470 mm	approx. 1400 mm	approx. 1460 mm
16 V 2000 M70	approx. 2815 mm	approx. 1400 mm	approx. 1520 mm

## 4 Operation

### 4.1 LOP controls (without Blue Line automation system)

#### LOP – Controls



Item	Color	Inscription	Meaning / Function
1	White	F1	Function keys to control the man-machine interface. Functions vary and are displayed on the LCD screen.
2	White	F2	
3	White	F3	
4	White	F4	
5	White	F5	
6	White	ALARM ACKNOWL	Pressing the button the first time stops alarm signalization.  Pressing the button a second time acknowledges an active alarm.  LED (spot) lights up when an alarm is active.
7	White	DIM ↑	Holding down the button increases LCD background illumination.

Item	Color	Inscription	Meaning / Function
8	White	DIM ↓	Holding down the button decreases LCD background illumination.
9	White	LAMP TEST	Pressing the button initiates lamp test.
10	Red	TEST OVERSPEED	Pressing the button initiates overspeed test. LED (spot) lights up as long as the overspeed test is running.
11	Green	(depending on type of gearbox and propulsion)	FPP: Pressing the button engages gear ahead. CPP, WJ, VS: Pressing the button engages clutch. LED (spot) lights up when GCU feedback is active.
12	Green		FPP, CPP, WJ, VS: Pressing the button disengages clutch. LED (spot) lights up when GCU feedback is active.
13	Green		FPP: Pressing the button engages gear astern. CPP, VS: No function assigned. WJ: Holding down the button provides flushing of water jet intake channel (water-jet reverse) . LED (spot) lights up when GCU feedback is active.
14	White	ENGINE SPEED INCREASE	Engine speed is increased as long as the button is held down.
15	White	ENGINE SPEED DECREASE	Engine speed is decreased as long as the button is held down.
16	Green	READY FOR OPERATION	Pressing the button causes changeover between "Not ready for operation" and "Ready for operation" status. LED (spot) lights up at "Ready for operation" position.
17	Green	LOCAL OPERATION	Pressing the button activates changeover between local and remote control mode. LED (spot) lights up when local mode is active.
18	White	START	Pressing the button initiates the automatic engine start sequence. LED (spot) lights up as long as the starting procedure is running.
19	White	STOP	Pressing the button initiates automatic engine stopping procedure. LED (spot) lights up as long as the STOP signal is available (also if transmitted from RCS).
20	Red	EMERGENCY STOP	Pressing the button initiates an immediate emergency engine stop. LED (spot) flashes once the emergency stop has been tripped and until the alarm has been acknowledged.

## 4.2 Putting the engine into operation (out-of-service-period > 3 months)

### Preconditions

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

### Putting the engine into operation ( > 3 months)

Item	Task
Engine	Depreserve (→ MTU Fluids and Lubricants Specification A001061/..).
Universal shaft	Grease (→ Page 144).
Lube oil system	Check oil level (→ Page 119).
Fuel prefilter	Prime (→ Page 110).
Fuel prefilter, pressure gauge	Align adjustable pointer with position of pressure indicator (→ Page 106).
Fuel system	Vent (→ Page 102).
Raw-water pump (if located above waterline)	Prime (approx. 3 to 4 liters).
Cooling system	If engine is out of service for more than one year, change coolant (→ Page 133).
Cooling system	Check coolant level (→ Page 132).
Cooling system	Preheat coolant with preheating unit.
ECU	Check plug-in connections (→ Page 149).
Engine control system	Switch ON. Press READY FOR OPERATION button (→ Page 50).
LOP	Press LAMP TEST button (→ Page 50).

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

### Preconditions

- ☑ Engine is stopped and starting disabled.

### Putting into operation

Item	Task
Lube oil system	Check oil level (→ Page 119).
Cooling system	Check coolant level (→ Page 132).
Cooling system	Preheat coolant with preheating unit.
Fuel prefilter	Drain (→ Page 107).
Battery-charging generator drive	Check condition of drive belt (→ Page 139).
Engine control system	Switch ON. Press READY FOR OPERATION button (→ Page 50).
LOP	Press LAMP TEST button (→ Page 50).

## 4.4 Starting the engine from LOP (without Blue Line automation system)

### Preconditions

- ☑ Gearbox is disengaged.
- ☑ External start interlock is not activated.
- ☑ Emergency air-shut-off flaps (if provided) are open.

#### 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.

### Barring the engine (out-of-service period > 1 month)

Item	Task
Engine	Bar with starting system (→ Page 78).

### Starting the engine from LOP

Item	Task
Engine	Make sure that engine is in unloaded condition.
Engine control system	Switch ON. LOP: <ul style="list-style-type: none"><li>• LOCAL OPERATION button is illuminated brightly (local operating mode is active) (→ Page 50);</li><li>• CLUTCH NEUTRAL button is illuminated brightly (gearbox is disengaged) (→ Page 50).</li></ul>
LOP	Press READY FOR OPERATION button briefly (→ Page 50). <ul style="list-style-type: none"><li>• READY FOR OPERATION button is illuminated brightly.</li></ul>
LOP	Press START button briefly (→ Page 50). <ul style="list-style-type: none"><li>• START button of the engine concerned is illuminated brightly;</li><li>• Automatic starting procedure is performed;</li><li>• Tachometer indicates increasing crankshaft speed;</li><li>• After the starting procedure is completed, engine is running at idle speed and START button is reset to basic illumination.</li></ul>

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## 4.5 Engine starting from the BlueLine automation system (control stand)

### 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.

### Cranking the engine (out-of-service period > 1 month)

Item	Action
Engine	Crank on starter (→ Page 78).

### Engine starting from the BlueLine automation system (control stand)

Item	Action
Engine	Start from the BlueLine automation system (control stand) (→ BlueLine documentation).

## 4.6 Engine emergency stop at BlueLine automation system (control stand)

CAUTION



An emergency stop causes extreme stress to the engine.  
**Risk of overheating, damage to components!**

- Initiate emergency stop only in emergency situations.

### Engine emergency stop at BlueLine automation system

Item	Action
Engine	Emergency stop at BlueLine automation system (→ BlueLine Operating Instructions).



## 4.7 Operational checks

### 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.

### Operational checks

Item	Measure
Engine under load	Visually inspect engine for leaks and general condition;
Engine at nominal speed	Check for abnormal running noises and vibration; Check exhaust color (→ Page 67).
Fuel prefilter	Check fuel prefilter contamination indicator for max. admissible value (→ Page 106). Drain water and contaminants (→ Page 107).
Air filter	Check signal ring position of contamination indicator (→ Page 115).
HT coolant pump	Check relief bore for oil and coolant discharge and contamination (→ Page 136).
Raw water pump	Check relief bore for oil and water discharge and contamination (→ Page 138).
Intercooler	Check condensate drain (if applicable) (→ Page 112).
Engine oil	Check engine oil level (→ Page 119).

## 4.8 Clutch – Engaging from LOP

### Preconditions

- ☑ LOCAL OPERATION button is illuminated brightly (local operating mode is active).
- ☑ Engine speed is within range for clutch engagement.
- ☑ No external clutch engagement interlock is activated.

DANGER



Vessel is sailing blind.

In Local Operation mode, the propulsion plant is controlled from the engine room.

#### **Risk of accidents!**

- Only execute vessel movements on the instructions of a person who has visual contact with the area outside the vessel.

### Engaging clutch without reversing gearbox (CPP, WJ, VS)

Item	Action
LOP	Press CLUTCH IN button (→ Page 50). <ul style="list-style-type: none"><li>• CLUTCH IN button flashes.</li><li>• Clutch is engaged.</li><li>• After receiving the feedback signal from clutch, the CLUTCH IN button is illuminated brightly.</li></ul>

### Engaging clutch in ahead direction with reversing gearbox (FPP, WJ)

Item	Action
LOP	Press CLUTCH AHEAD button (→ Page 50). <ul style="list-style-type: none"><li>• CLUTCH AHEAD button flashes.</li><li>• Gearbox is engaged in AHEAD direction.</li><li>• After receiving the feedback signal from clutch, the CLUTCH AHEAD button is illuminated brightly.</li></ul>

### Engaging clutch in astern direction with reversing gearbox (FPP)

Item	Action
LOP	Press CLUTCH ASTERN button (→ Page 50). <ul style="list-style-type: none"><li>• CLUTCH ASTERN button flashes.</li><li>• Gearbox is engaged astern.</li><li>• After receiving the feedback signal from clutch, the CLUTCH ASTERN button is illuminated brightly.</li></ul>

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## 4.9 Clutch – Disengaging from LOP

### Preconditions

- ☑ LOCAL OPERATION button is illuminated brightly (local operating mode is active).
- ☑ Engine speed in disengagement window.

### Disengaging clutch without reversing gearbox (CPP, WJ, VS)

Item	Action
LOP	<p>Press CLUTCH OUT button (→ Page 50).</p> <ul style="list-style-type: none"><li>• CLUTCH OUT button flashes.</li><li>• Clutch is disengaged.</li><li>• After receiving the feedback signal from clutch, the CLUTCH OUT button is illuminated brightly.</li></ul>

### Disengaging clutch with reversing gearbox (FPP, WJ)

Item	Action
LOP	<p>Press CLUTCH NEUTRAL button (→ Page 50).</p> <ul style="list-style-type: none"><li>• CLUTCH NEUTRAL button flashes.</li><li>• Gearbox is disengaged (neutral position).</li><li>• After receiving the feedback signal from clutch, the CLUTCH NEUTRAL button is illuminated brightly.</li></ul>

# 4.10 Waterjet – Flushing from LOP (optional)

## Preconditions

- ☑ LOCAL OPERATION button is illuminated brightly (local operating mode is active).
- ☑ Vessel at a standstill and Waterjet bucket below the waterline.
- ☑ Engine speed is within range for clutch engagement.
- ☑ No external clutch engagement interlock is activated.

### CAUTION



Waterjet flushing puts excessive strain on the bearings.

#### **Bearing damage!**

- Do not flush waterjet for too long.
- Follow instructions of the waterjet manufacturer.

## Flushing with reversing gearbox and flushing mode

Item	Action
LOP	Press FLUSH button and keep pressed (→ Page 50). <ul style="list-style-type: none"><li>• FLUSH button flashes.</li><li>• Gearbox is engaged astern.</li><li>• After receiving the feedback signal from clutch, the FLUSH button is illuminated brightly.</li></ul>
LOP	Release FLUSH button. <ul style="list-style-type: none"><li>• FLUSH button flashes.</li><li>• Gearbox is disengaged (neutral position).</li><li>• Illumination of FLUSH button is switched off as soon as the feedback signal from clutch is received.</li></ul>

## 4.11 Stopping the engine from LOP (without Blue Line automation system)

### Preconditions

- ☑ Engine is running in local 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 shutting down, disengage gear and run the engine at idle speed for at least 10 mins. until engine temperatures have dropped and constant values are displayed.

### Stopping the engine from LOP

Item	Task
LOP	Disengage clutch (→ Page 50).
LOP	Operate engine at idle speed (→ Page 50).
Temperature readings	Wait until engine temperatures do not sink any further.
LOP	Press STOP button (→ Page 50). <ul style="list-style-type: none"><li>• STOP button is illuminated;</li><li>• Engine is stopped.</li></ul>

# 4.12 Stopping the engine at the BlueLine automation system (control stand)

CAUTION



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

**Risk of overheating, damage to components!**

- Before shutting down, disengage gear and run the engine at idle speed for at least 10 mins. until engine temperatures have dropped and constant values are displayed.

## Stopping the engine at the BlueLine automation system (control stand)

Item	Measure
Engine	Stop the engine at the BlueLine automation system (control stand) (→ BlueLine Operating Instructions).

## 4.13 Emergency stop from LOP (without Blue Line automation system)

### 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
LOP	Open cap of EMERGENCY STOP button (→ Page 50).
LOP	Press EMERGENCY STOP button. <ul style="list-style-type: none"><li>• Engine is stopped by switching power supply to ECU off;</li><li>• Engines with emergency air-shut-off flaps: Flaps close;</li><li>• EMERGENCY STOP button flashes, signalization by horn, flash lamp etc. is released.</li></ul>

### After emergency stop from LOP

Item	Task
LOP	Press ALARM ACKNOWLEDGE button (→ Page 50). <ul style="list-style-type: none"><li>• Audible and visual signalization stops.</li></ul>
LOP	Press ALARM ACKNOWLEDGE button again. <ul style="list-style-type: none"><li>• Power supply to ECU is provided;</li><li>• Alarm is acknowledged.</li></ul>
Engine	Engines with emergency air-shut-off flaps: Open flaps. <ul style="list-style-type: none"><li>• Engine is ready for operation.</li></ul>

## 4.14 After stopping the engine

### Preconditions

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

### After stopping the engine

Item	Action
Coolant circuit	Drain coolant (→ Page 134) if: <ul style="list-style-type: none"><li>• freezing temperatures are expected and the engine is to remain out of service for an extended period, but engine coolant has no antifreeze additive;</li><li>• the engine room is not heated;</li><li>• the coolant is not kept at a suitable temperature;</li><li>• the antifreeze concentration is insufficient for the engine-room temperature;</li><li>• antifreeze concentration is 50 % and engine-room temperature is below -40 °C.</li></ul>
Raw water	Drain <ul style="list-style-type: none"><li>• If freezing temperatures are to be expected and the engine is to remain out of service for an extended period.</li></ul>
Engine control system	Switch off.
Air intake and exhaust system	Out-of-service-period > 1 week <ul style="list-style-type: none"><li>• Seal engine's air and exhaust sides.</li></ul>
Engine	Out-of-service-period > 1 month <ul style="list-style-type: none"><li>• Preserve engine (→ MTU Fluids and Lubricants Specifications A001061/.. )</li></ul>



## 4.15 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



Compressed air

#### **Risk of injury!**

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

#### WARNING



Water jet.

#### **Risk of injury and scalding!**

- Do not direct water jet at persons.
- Wear protective clothing, gloves, and goggles / safety mask.

#### CAUTION



Excessive reaction time of cleaning agents on components.

#### **Damage to component!**

- 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 119)
W0501	Visually inspect engine for leaks and general condition	(→ Page 57)
W0502	Check intercooler drain (if fitted)	(→ Page 57)
W0503	Check signal ring position of service indicator on air filter	(→ Page 57)
W0505	Check relief bores of coolant pump(s)	(→ Page 57)
W0506	Check engine for abnormal running noises, exhaust color and vibrations	(→ Page 57)
W0507	Drain water and contaminants from fuel prefilter (if fitted)	(→ Page 57)
W0508	Check reading on differential pressure gauge of fuel prefilter (if fitted)	(→ Page 57)
W1001	Replace fuel filter or fuel filter element	(→ Page 104)
W1002	Check valve clearance	(→ Page 86)
W1003	Check belt condition and tension, replace if necessary	(→ Page 139)
W1005	Replace air filter	(→ Page 113)
W1006	Replace fuel injectors	(→ Page 94)
W1007	Replace fuel injection pump(s)	(→ Page 90)
W1008	Replace engine oil filter at each oil change or when the time limit (years) is reached, at the latest	(→ Page 122)
W1009	Check layer thickness of oil residue, clean and replace filter sleeve (if fitted) at each oil change or when the time limit (years) is reached, at the latest	(→ Page 124)
W1011	Perform endoscopic inspection of combustion chambers	(→ Page 79)
W1140	Clean wire meshes of crankcase breather	(→ Page 83)
W1178	Replace pressure pipe neck in cylinder head	(→ Page 99)

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	Engine wiring or starter defective	Check if cable connections are properly secured, contact Service.
Engine wiring	Defective	Check (→ Page 145).
LOP	Secure seating of assemblies or connectors not provided	Perform visual inspection (→ Page 154).
ECU	Plug-in connections are loose	Check plug-in connections (→ Page 149).
Engine	Running gear blocked (engine cannot be barred manually)	Contact Service.
Start-interlock limit switch	Limit switch not installed	Check limit switch (→ Page 148).
	Limit switch defective	
	Wiring defective	Check wiring (→ Page 145).

### Engine turns but does not fire

Component	Probable Cause	Task
Starter	Poor rotation by starter: Battery low or defective	Charge or replace battery (see manufacturer's documentation).
Engine wiring	Defective	Check (→ Page 145).
Fuel system	Not vented	Vent fuel system (→ Page 102).
ECU	Defective	Contact Service.

### Engine fires unevenly

Component	Probable Cause	Task
Fuel injection equipment	Injector defective	Replace (→ Page 94).
	Injection pump defective	Replace (→ Page 91).
Engine wiring	Defective	Check (→ Page 145).
Fuel system	Not vented	Vent fuel system (→ Page 102).
ECU	Defective	Contact Service.

## Engine does not reach full-load speed

Component	Probable Cause	Task
Fuel supply	Shut off	Open shut-off valve before fuel prefilter completely.
	Fuel prefilter clogged	Replace (→ Page 110).
	Fuel filter clogged	Replace (→ Page 104).
Air supply	Air filter clogged	Check signal ring position of service indicator (→ Page 115).
Fuel injection equipment	Injector defective	Replace (→ Page 94).
	Injection pump defective	Replace (→ Page 91).
Engine wiring	Defective	Check (→ Page 145).
Vessel	Overloaded	Contact Service.
	Exceeding weight	Check vessel's loading condition; Reduce load.
	Vessel's trim position	Trim vessel.
	Marine growths on hull, propeller shaft, propeller, rudder	Clean.
Rudder	Rudder position	Align rudder.
Propeller	After propeller replacement: Propeller is too big.	Replace.

## Engine speed not steady

Component	Probable Cause	Task
Fuel injection equipment	Injector defective	Replace (→ Page 94).
	Injection pump defective	Replace (→ Page 90).
Speed sensor	Defective	Contact Service.
Fuel system	Not vented	Vent fuel system (→ Page 102).
ECU	Defective	Contact Service.

## Charge-air temperature too high

Component	Probable Cause	Task
Coolant	Incorrect coolant concentration	Check (MTU test kit).
Intercooler	Contaminated	Contact Service.
Engine room	Air-intake temperature too high	Check fans; Check 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 115).
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 115).
Fuel injection equipment	Injector defective	Replace (→ Page 94).
	Injection pump defective	Replace (→ Page 90).
Vessel	Overloaded	Contact Service.

## Exhaust gas blue

Component	Probable Cause	Task
Lube oil system	Too much oil in engine	Drain engine oil (→ Page 120).
	Oil separator or oil-preseparator of crankcase breather clogged	Replace (→ Page 84).
Exhaust turbocharger	Defective	Contact Service.
Cylinder head		
Piston rings		
Cylinder liner		

## 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 107).
Intercooler	Leaking	Contact Service.

## 6.2 LOP alarms

### LOP

At the LOP, alarm texts and measuring-point messages are indicated on the DIS. Explanation of the displayed texts can be gathered by pressing the help key on the touch screen. Alarms can also be caused by defective sensors / actuators. Contact Service to have sensors/actuators tested and replaced as necessary if troubleshooting as described in the table below proves unsuccessful.

Display text	Meaning	Task
AL RCS Speed Demand Defect	No speed demand signal	<ol style="list-style-type: none"> <li>1. Check remote control system;</li> <li>2. Check LOP visually (→ Page 154).</li> <li>3. Perform LOP test procedures (→ Page 156).</li> <li>4. Check ECU plug-in connections (→ Page 149).</li> <li>5. Check engine wiring (→ Page 145).</li> </ol>
AL Battery Charger Fail	No battery charging	<ol style="list-style-type: none"> <li>1. Check power circuit breakers and fuses;</li> <li>2. Check transistor controllers.</li> </ol>
AL Press Monitoring Fail (EMU)	EMU pressure monitoring failure	Contact Service <ul style="list-style-type: none"> <li>• Have EMU replaced.</li> </ul>
AL ECU Defect	ECU 4 is defective	<ol style="list-style-type: none"> <li>1. Check LOP visually (→ Page 154).</li> <li>2. Perform LOP test procedures (→ Page 156).</li> <li>3. Check ECU plug-in connections (→ Page 149).</li> <li>4. Check engine wiring (→ Page 145).</li> <li>5. Contact Service               <ul style="list-style-type: none"> <li>• Have ECU checked and replaced, if required.</li> </ul> </li> </ol>
AL Power Amplifier 1 Fail	Power amplifier cylinder side A failure	<ol style="list-style-type: none"> <li>1. Check LOP visually (→ Page 154).</li> <li>2. Perform LOP test procedures (→ Page 156).</li> <li>3. Check ECU plug-in connections (→ Page 149).</li> <li>4. Check engine wiring (→ Page 145).</li> <li>5. Contact Service               <ul style="list-style-type: none"> <li>• Have ECU checked and replaced, if required.</li> </ul> </li> </ol>
AL Power Amplifier 2 Fail	Power amplifier cylinder side B failure	<ol style="list-style-type: none"> <li>1. Check LOP visually (→ Page 154).</li> <li>2. Perform LOP test procedures (→ Page 156).</li> <li>3. Check ECU plug-in connections (→ Page 149).</li> <li>4. Check engine wiring (→ Page 145).</li> <li>5. Contact Service               <ul style="list-style-type: none"> <li>• Have ECU checked and replaced, if required.</li> </ul> </li> </ol>
AL Gear Control Fail (GCU)	GCU failure	Contact Service <ul style="list-style-type: none"> <li>• Have GCU solenoid valve checked and replaced, if required;</li> <li>• Have GCU wiring checked and replaced, if required.</li> </ul>

Display text	Meaning	Task
AL Gear Oil Filter Clogged	Gear-Oil Filter Clogged	Clean gear-oil filter and replace, if required (see gearbox documentation).
AL Override Activated	Engine safety system not active	Status message: • Override activated.
AL Power Fail Control	Power failure of control system	Check power circuit breakers and fuses.
AL Power Fail Monitoring	Power failure	Check power circuit breakers and fuses.
AL Transistor Output 1/2 Fail	One of the ECU transistor outputs (TAA1 or TAA2) is defective	Contact Service • Have ECU checked and replaced, if required.
AL Transistor Output 3/4 Fail	One of the ECU transistor outputs (TAA3 or TAA4) is defective	Contact Service • Have ECU checked and replaced, if required.
AL Water in Fuel Pre-filter	Water in fuel prefilter	Drain fuel prefilter (→ Page 107).
DL 211+A001-A001	Display panel DIS not detected on default bus	1. Check LOP visually (→ Page 154). 2. Perform LOP test procedures (→ Page 156). 3. Check ECU plug-in connections (→ Page 149). 4. Check engine wiring (→ Page 145). 5. Contact Service • Have DIS checked and replaced, if required.
DL 211+A001-A010	LCU of LOP 1 (PIM No. 21.X+A001-A010) not detected on default bus	1. Check LOP visually (→ Page 154). 2. Perform LOP test procedures (→ Page 156). 3. Check ECU plug-in connections (→ Page 149). 4. Check engine wiring (→ Page 145). 5. Contact Service • Have MPU 23 of PIM No. 21.X+A001-A010 checked and replaced, if required.
DL 211+A001-A020	LMU of LOP 1 (PIM No. 21.X+A001-A020) not detected on default bus	1. Check LOP visually (→ Page 154). 2. Perform LOP test procedures (→ Page 156). 3. Check ECU plug-in connections (→ Page 149). 4. Check engine wiring (→ Page 145). 5. Contact Service • Have MPU 23 of PIM No. 21.X+A001-A020 checked and replaced, if required.
DL 211+A002-A030	GCU 1 (PIM No. 21.X+A002-A030) not detected on default bus	1. Check LOP visually (→ Page 154). 2. Perform LOP test procedures (→ Page 156). 3. Check ECU plug-in connections (→ Page 149). 4. Check engine wiring (→ Page 145). 5. Contact Service • Have GCU/GMU checked and replaced, if required.

Display text	Meaning	Task
DL 211+A002-A040	GCU 1 (PIM No. 21.X+A002-A040) not detected on default bus	<ol style="list-style-type: none"> <li>1. Check LOP visually (→ Page 154).</li> <li>2. Perform LOP test procedures (→ Page 156).</li> <li>3. Check ECU plug-in connections (→ Page 149).</li> <li>4. Check engine wiring (→ Page 145).</li> <li>5. Contact Service <ul style="list-style-type: none"> <li>• Have GCU/GMU checked and replaced, if required.</li> </ul> </li> </ol>
DL 211+A003-ECU	ECU 4 not detected on default bus	<ol style="list-style-type: none"> <li>1. Check LOP visually (→ Page 154).</li> <li>2. Perform LOP test procedures (→ Page 156).</li> <li>3. Check ECU plug-in connections (→ Page 149).</li> <li>4. Check engine wiring (→ Page 145).</li> <li>5. Contact Service <ul style="list-style-type: none"> <li>• Have ECU checked and replaced, if required.</li> </ul> </li> </ol>
DL 211+A004-EMU	EMU 1 not detected on default bus	<ol style="list-style-type: none"> <li>1. Check LOP visually (→ Page 154).</li> <li>2. Perform LOP test procedures (→ Page 156).</li> <li>3. Check ECU plug-in connections (→ Page 149).</li> <li>4. Check engine wiring (→ Page 145).</li> <li>5. Contact Service <ul style="list-style-type: none"> <li>• Have EMU checked and replaced, if required.</li> </ul> </li> </ol>
DL 211+A300-A500	RCS with PIM No. 21.X+A300-A500 not detected on default bus	<ol style="list-style-type: none"> <li>1. Check LOP visually (→ Page 154).</li> <li>2. Perform LOP test procedures (→ Page 156).</li> <li>3. Check ECU plug-in connections (→ Page 149).</li> <li>4. Check engine wiring (→ Page 145).</li> <li>5. Contact Service <ul style="list-style-type: none"> <li>• Have RCS checked and replaced, if required.</li> </ul> </li> </ol>
DL 211+A300-A501	PCU (PIM No. 21.X+A300-A501) not detected on default bus	<ol style="list-style-type: none"> <li>1. Check LOP visually (→ Page 154).</li> <li>2. Perform LOP test procedures (→ Page 156).</li> <li>3. Check ECU plug-in connections (→ Page 149).</li> <li>4. Check engine wiring (→ Page 145).</li> <li>5. Contact Service <ul style="list-style-type: none"> <li>• Have PCU checked and replaced, if required.</li> </ul> </li> </ol>
HI P-Oil Filter Difference	Excessive oil-pressure difference between oil-filter inlet and outlet	Replace engine oil filter (→ Page 122).
MG Disengage Error	Message from RCS	Contact Service <ul style="list-style-type: none"> <li>• Have GCU solenoid valve checked and replaced, if required;</li> <li>• Have GCU wiring checked and replaced, if required.</li> </ul>
MG Eng Speed High/Low (Clutch)	Message from RCS	Reduce speed.



Display text	Meaning	Task
MG Engage Error	Message from RCS	Contact Service <ul style="list-style-type: none"> <li>Have GCU solenoid valve checked and replaced, if required;</li> <li>Have GCU wiring checked and replaced, if required.</li> </ul>
MG Check Start Interlocks	Start conditions not fulfilled	Check start conditions and fulfill if necessary.
RL 211+A001-A001	DIS not detected on redundant bus	<ol style="list-style-type: none"> <li>1. Check LOP visually (→ Page 154).</li> <li>2. Perform LOP test procedures (→ Page 156).</li> <li>3. Contact Service <ul style="list-style-type: none"> <li>Have DIS checked and replaced, if required.</li> </ul> </li> </ol>
RL 211+A001-A010	LCU of LOP 1 (PIM No. 21.X+A001-A010) not detected on redundant bus	<ol style="list-style-type: none"> <li>1. Check LOP visually (→ Page 154).</li> <li>2. Perform LOP test procedures (→ Page 156).</li> <li>3. Contact Service <ul style="list-style-type: none"> <li>Have MPU 23 of PIM No. 21.X+A001-A010 checked and replaced, if required.</li> </ul> </li> </ol>
RL 211+A001-A020	LMU of LOP 1 (PIM No. 21.X+A001-A020) not detected on redundant bus	<ol style="list-style-type: none"> <li>1. Check LOP visually (→ Page 154).</li> <li>2. Perform LOP test procedures (→ Page 156).</li> <li>3. Contact Service <ul style="list-style-type: none"> <li>Have MPU 23 of PIM No. 21.X+A001-A020 checked and replaced, if required.</li> </ul> </li> </ol>
RL 211+A002-A030	GCU 1 (PIM No. 21.X+A002-A030) not detected on redundant bus	<ol style="list-style-type: none"> <li>1. Check LOP visually (→ Page 154).</li> <li>2. Perform LOP test procedures (→ Page 156).</li> <li>3. Contact Service <ul style="list-style-type: none"> <li>Have GCU/GMU checked and replaced, if required.</li> </ul> </li> </ol>
RL 211+A002-A040	GCU 1 (PIM No. 21.X+A002-A040) not detected on redundant bus	<ol style="list-style-type: none"> <li>1. Check LOP visually (→ Page 154).</li> <li>2. Perform LOP test procedures (→ Page 156).</li> <li>3. Contact Service <ul style="list-style-type: none"> <li>Have GCU/GMU checked and replaced, if required.</li> </ul> </li> </ol>
RL 211+A003-ECU	ECU 4 not detected on redundant bus	<ol style="list-style-type: none"> <li>1. Check LOP visually (→ Page 154).</li> <li>2. Perform LOP test procedures (→ Page 156).</li> <li>3. Check ECU plug-in connections (→ Page 149).</li> <li>4. Contact Service <ul style="list-style-type: none"> <li>Have ECU checked and replaced, if required.</li> </ul> </li> </ol>
RL 211+A004-EMU	EMU 1 not detected on redundant bus	<ol style="list-style-type: none"> <li>1. Check LOP visually (→ Page 154).</li> <li>2. Perform LOP test procedures (→ Page 156).</li> <li>3. Contact Service <ul style="list-style-type: none"> <li>Have EMU checked and replaced, if required.</li> </ul> </li> </ol>

Display text	Meaning	Task
RL 211+A300-A500	RCS with PIM No. 21.X+A300-A500 not detected on redundant bus	<ol style="list-style-type: none"> <li>1. Check LOP visually (→ Page 154).</li> <li>2. Perform LOP test procedures (→ Page 156).</li> <li>3. Contact Service <ul style="list-style-type: none"> <li>• Have RCS checked and replaced, if required.</li> </ul> </li> </ol>
RL 211+A300-A501	PCU (PIM No. 21.X+A300-A501) not detected on redundant bus	<ol style="list-style-type: none"> <li>1. Check LOP visually (→ Page 154).</li> <li>2. Perform LOP test procedures (→ Page 156).</li> <li>3. Contact Service <ul style="list-style-type: none"> <li>• Have PCU checked and replaced, if required.</li> </ul> </li> </ol>
SS Safety System Fail (EMU)	Safety system has detected EMU failure	Contact Service.
SS Power Reduction Active	Safety system has requested power reduction	<ol style="list-style-type: none"> <li>1. Determine cause of automatic power reduction;</li> <li>2. Note further alarms / indications on display;</li> <li>3. Contact Service.</li> </ol>
SS Emergency Stop	Safety system has tripped an emergency stop	<ol style="list-style-type: none"> <li>1. Determine cause of shutdown and rectify;</li> <li>2. Note further alarms / indications on display.</li> </ol>
SS Emergency Stop Ext.	Safety system has executed an externally tripped emergency stop	<ol style="list-style-type: none"> <li>1. Determine cause of shutdown and rectify;</li> <li>2. Note further alarms / indications on display.</li> </ol>
SS P-Gear Lube Oil (GCU)	Safety system detects that control-oil pressure in gearbox is too low	Check gearbox lube-oil level and top up, if required (see gearbox documentation).
SS P-Gear Lube Oil (GMU)	Safety system detects that lube-oil pressure in gearbox is too low	Check gearbox lube-oil level and top up, if required (see gearbox documentation).
SS P-Gear Control Oil (GCU)	Safety system detects that control-oil pressure in gearbox is too low	Check gearbox control-oil level and top up, if required (see gearbox documentation).
SS P-Gear Control Oil (GMU)	Safety system detects that control-oil pressure in gearbox is too low	Check gearbox control-oil level and top up, if required (see gearbox documentation).
SS P-Coolant	Safety system detects that coolant pressure is too low	Check engine coolant level, top up as necessary (→ Page 132).
SS P-Lube Oil (ECU)	Safety system detects that engine-oil pressure is too low	<ol style="list-style-type: none"> <li>1. Check lube oil level, top up as necessary (→ Page 119).</li> <li>2. Contact Service.</li> </ol>
SS P-Lube Oil (EMU)	Safety system detects that engine-oil pressure is too low	<ol style="list-style-type: none"> <li>1. Check lube oil level, top up as necessary (→ Page 119).</li> <li>2. Contact Service.</li> </ol>
SS Security Channel Def EMU	Fault message of safety system	Contact Service <ul style="list-style-type: none"> <li>• Have EMU checked and replaced, if required.</li> </ul>
SS SDAF Closed	Safety system reports closed emergency air-shutoff flaps	Open emergency air-shutoff flaps (→ Page 116).

Display text	Meaning	Task
SS Security Shut-down	Safety system has tripped a shutdown	Determine cause of shutdown and rectify.
SS T-Coolant (ECU)	Safety system detects excessive coolant temperature	Reduce power.
SS T-Coolant (EMU)	Safety system detects excessive coolant temperature	Reduce power.
SS T-Lube Oil	Safety system detects excessive lube-oil temperature	Reduce power.
Stop Activated (EMU)	EMU has tripped automatic stop command due to limit value violation	<ol style="list-style-type: none"> <li>1. Determine cause of shutdown and rectify;</li> <li>2. Note further alarms / indications on display.</li> </ol>
TD P-Lube Oil	Different measurement values transmitted by the two sensors for lube-oil pressure measurement	<ol style="list-style-type: none"> <li>1. Check LOP visually (→ Page 154).</li> <li>2. Perform LOP test procedures (→ Page 156).</li> <li>3. Check ECU plug-in connections (→ Page 149).</li> <li>4. Check engine wiring (→ Page 145).</li> <li>5. Contact Service <ul style="list-style-type: none"> <li>• Have sensors checked and replaced, if required.</li> </ul> </li> </ol>
TD T-Coolant	Different measurement values transmitted by the two sensors for coolant temperature measurement	<ol style="list-style-type: none"> <li>1. Check LOP visually (→ Page 154).</li> <li>2. Perform LOP test procedures (→ Page 156).</li> <li>3. Check ECU plug-in connections (→ Page 149).</li> <li>4. Check engine wiring (→ Page 145).</li> <li>5. Contact Service <ul style="list-style-type: none"> <li>• Have sensors checked and replaced, if required.</li> </ul> </li> </ol>
Trolling Active	RCS measuring point	Status message (signal lamp 'Trolling Active' is ON)
Cylinder Cutout	Measuring point "Cylinder Cutout"	Status message of 'Cylinder cutout / half of cylinders running' mode in idle operation.

## 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.
Ratchet	F30006212	1
Socket	F30005655	1

##### DANGER



Unguarded rotating and moving engine components.

##### **Risk of serious injury – danger to life!**

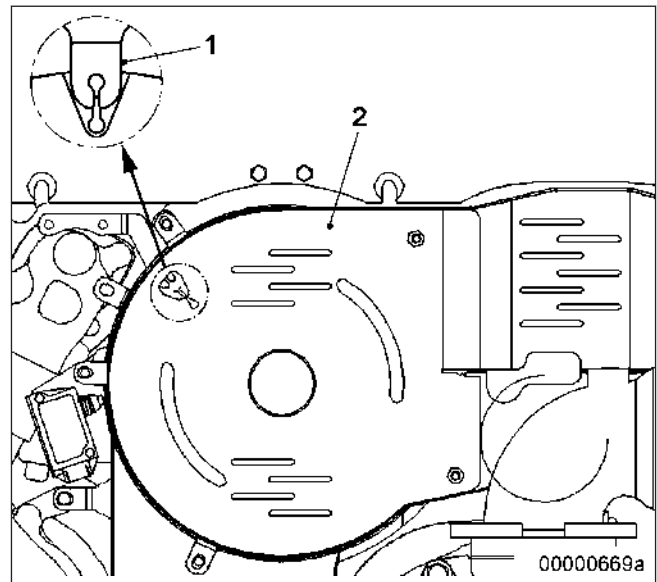
- before barring or starting the engine, ensure that nobody is in the danger zone.
- After working on the engine, check that all protective devices have been reinstalled and all tools removed from the engine.

##### Engine – Barring manually

1. Remove cover plate (2).
2. Attach ratchet with socket to barring tool.
3. Rotate crankshaft in engine direction of rotation. Apart from the normal compression resistance, there should be no abnormal resistance.

Result: If the resistance exceeds compression resistance, contact Service.

4. For barring-tool removal follow reverse sequence of working steps.



## 7.1.2 Engine cranking on starter

### Special tools, Material, Spare parts

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

#### DANGER



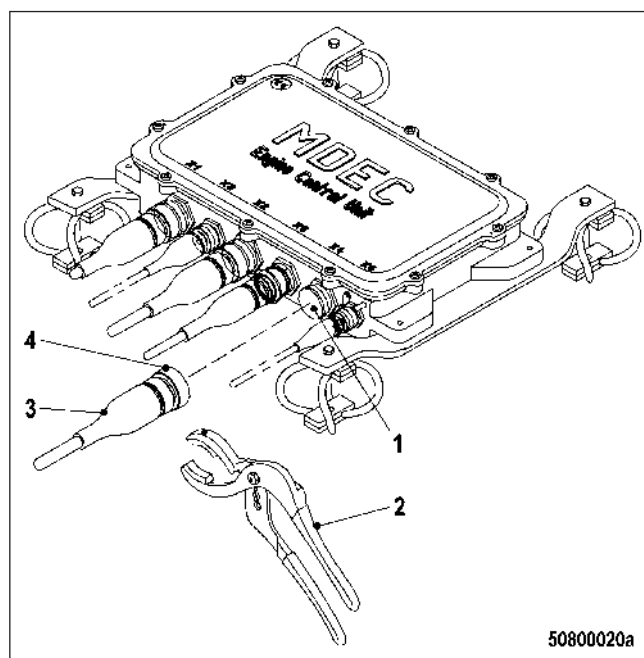
Unguarded rotating and moving engine components.

#### **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 cranking on starter

1. Disengage the bayonet union nut (4) of connector X4 with connector pliers (2) and withdraw connector (3) from Engine Control Unit.
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 max. admissible starting period has expired. Re-start engine after approx. 20 seconds if necessary.
5. Plug connector X4 (3) and use connector pliers (2) to secure the bayonet union nut (4) by turning it clockwise until it latches into place.



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## 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 89).
2. Remove injector (→ Page 95).

#### Positioning crankshaft at BDC

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

#### Endoscopic examination of cylinder liner

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

1. Compile endoscopy report using the table.
2. Use technical terms for description of the liner surface (→ Page 81).
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 95).
2. Install cylinder head cover (→ Page 89).

## 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	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. Findings not critical.
Single scores	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. Findings not critical.
Scored area	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. Findings not critical.
Smoothened area	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. Findings not critical.
Bright area	Bright areas are on the running surface and show local removal of the honing pattern. Grooves from honing process are not visible any more.
Discoloration	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. Findings not critical.
Corrosion fields / spots	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. This corrosion is not critical unless there is corrosion pitting.
Black lines	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. Cylinder liners with a large number of black lines around the running surface have limited service life and should be replaced.

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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 – Cleaning oil separator element

#### Preconditions

- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
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.

#### WARNING



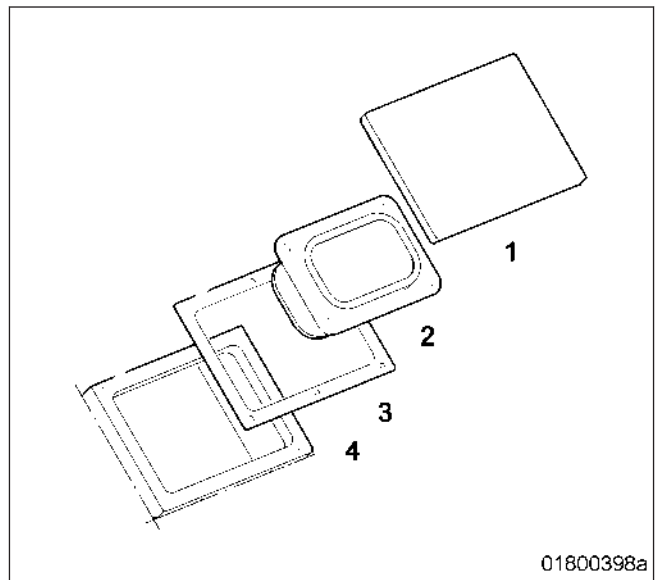
Compressed air

#### Risk of injury!

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

#### Crankcase breather – Cleaning oil separator element

1. Remove cover (1) from housing (4).
2. Remove oil separator (2) and gasket (3).
3. Clean oil separator (2) in fuel and blow dry with compressed air.
4. Moisten oil separator (2) with engine oil.
5. Place oil separator (2) with new gasket (3) onto housing (4) and install cover (1).
6. Clean further oil separator element in the same way.



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## 7.3.2 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
Filter element	(→ Spare Parts Catalog)	
Diaphragm	(→ Spare Parts Catalog)	
O-ring	(→ Spare Parts Catalog)	

#### WARNING



Hot oil.

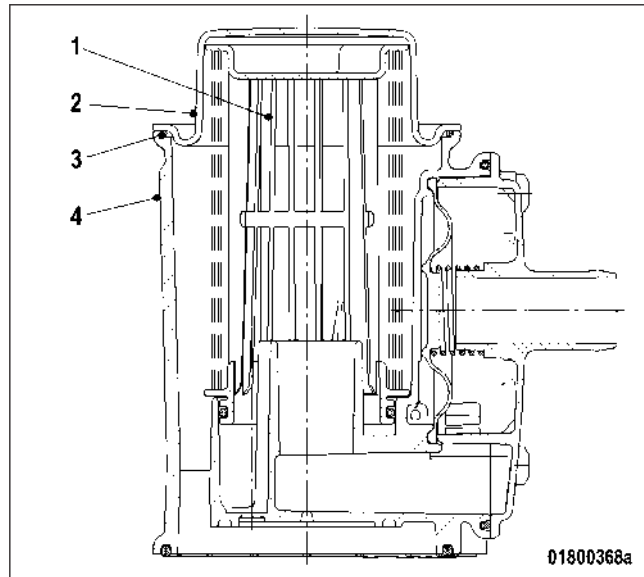
Oil can contain combustion residues which are harmful to health.

#### Risk of injury and poisoning!

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

### Replacing filter element of oil separator

1. Remove cover (2) with O-ring (3).
2. Remove filter element (1) from housing (4).
3. Insert new filter element into housing (4) ensuring correct installation position, and fit cover (2) with new O-ring.



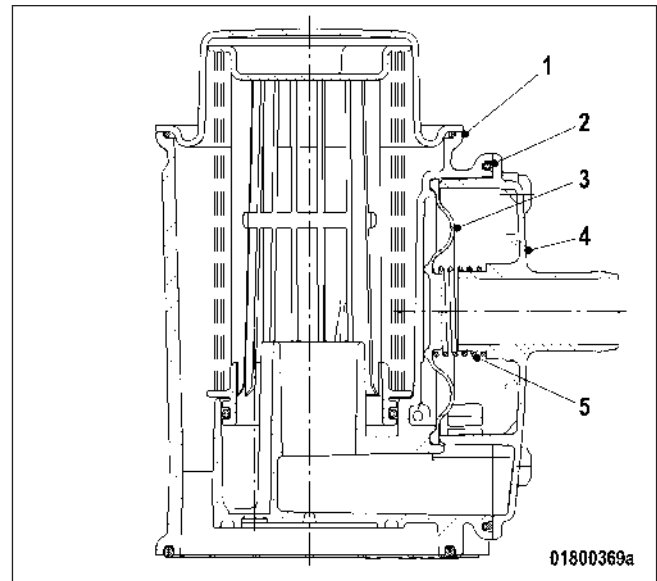
4. Tighten screws of cover (2) to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque		6 Nm + 2 Nm

5. Replace filter elements of further oil separators in the same way.

## Checking diaphragm

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



7. Tighten screws of cover (4) to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque		6 Nm + 2 Nm

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

## 7.4 Valve Drive

### 7.4.1 Valve clearance – Check and adjustment

#### Preconditions

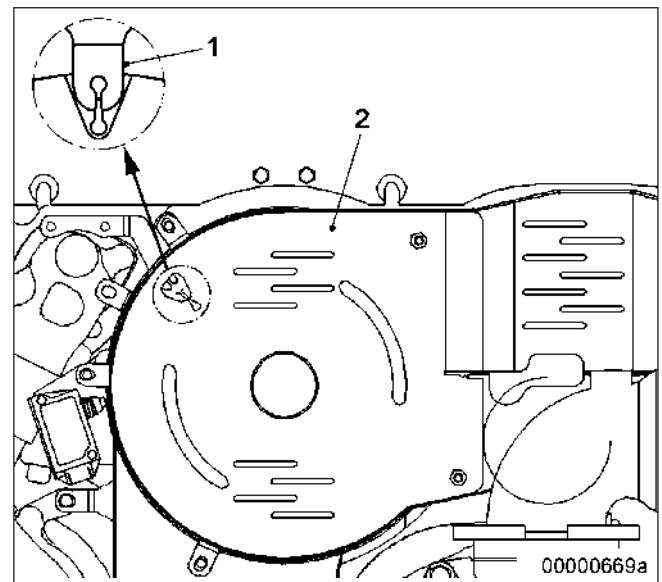
- ☑ Engine is stopped and starting disabled.
- ☑ Engine coolant temperature is max. 40 °C.
- ☑ Valves are closed.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 20-100 Nm	F30026582	1
Ratchet adapter	F30062582	1
Feeler gauge	Y4342013	1

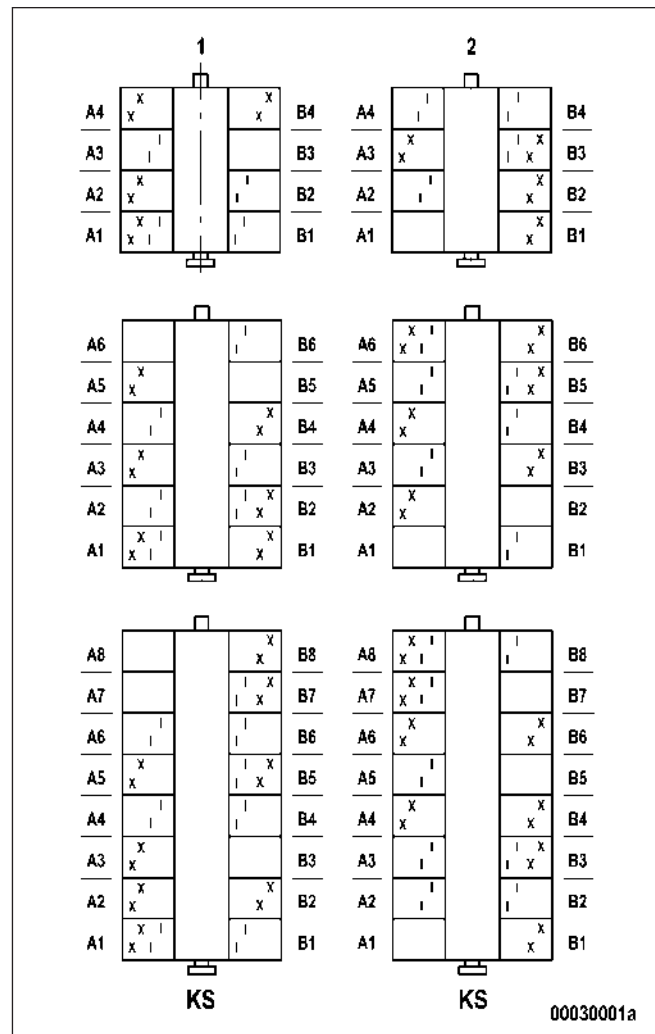
#### Preparatory steps

1. Remove cover plate (2).
2. Remove cylinder head cover (→ Page 89).
3. Bar engine manually in engine direction of rotation until the markings (1) are aligned.



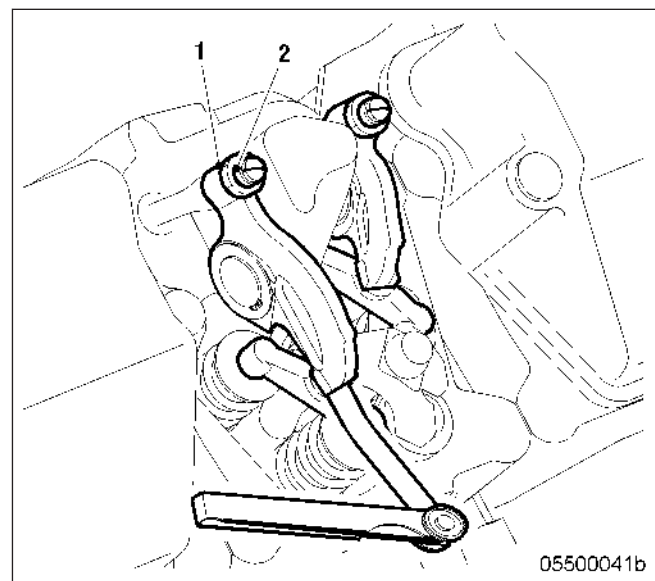
## Checking valve clearance at two crankshaft positions

1. Check TDC position of piston in cylinder A1:
  - If the rocker arms are not under load 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.
2. Check valve clearance with the engine cold:
  - Inlet = 0.4 mm;
  - Exhaust = 0.6 mm;.
3. Check all valve clearances in two crankshaft positions (firing TDC and overlap TDC of cylinder A1) as per diagram:
  - 1 Cylinder A1 is in firing TDC
  - 2 Cylinder A1 is in overlap TDC
  - I Inlet valve
  - X Exhaust valve
4. Use feeler gauge to determine the distance between valve bridge and rocker arm.
5. If the deviation from the set value exceeds 0.1 mm, adjust valve clearance.



## Adjusting valve clearance

1. Loosen locknut (1) and unscrew adjusting screw (2) slightly.
2. Insert feeler gauge between valve bridge and rocker arm.
3. Readjust adjusting screw (2) so that the feeler gauge just passes through the gap.



4. Tighten locknut (1) applying the specified tightening torque, holding adjusting screw (2) firmly with screwdriver.

Name	Size	Type	Lubricant	Value/Standard
Locknut		Tightening torque		50 Nm

5. Insert feeler gauge between valve bridge and rocker arm to verify that the gauge just passes through the gap.

Result: If not, adjust valve clearance.

### **Final steps**

1. Remove barring device.
2. For installation of removed parts, follow reverse sequence of working steps.

## 7.4.2 Cylinder head cover – Removal and installation

### Preconditions

- ☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

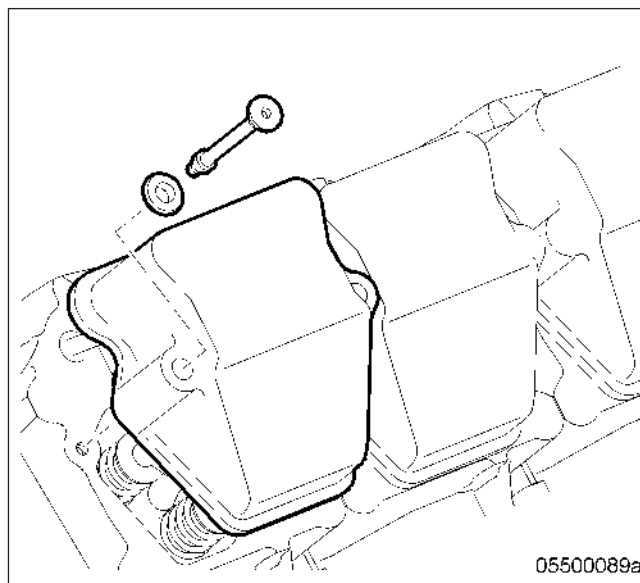
Designation / Use	Part No.	Qty.
Torque wrench, 6-50 Nm	F30027336	1
Ratchet adapter	F30027340	1
Gasket	(→ Spare Parts Catalog)	

### Preparatory steps

1. Remove air filter (→ Page 113).
2. Remove mounting bracket with control valves for exhaust turbocharger and air flap switching.

### Cylinder head cover – Removal and installation

1. Remove screws.
2. Remove cylinder head cover with gasket from cylinder head.
3. Clean installation surface.
4. Check condition of profile gasket in cylinder head cover.
5. Replace damaged gaskets.



6. Place cylinder head covers onto crankcase and tighten screws to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque		20 Nm

### Final steps

1. Install mounting bracket with control valves for exhaust turbocharger and air flap control.
2. Install air filter (→ Page 113).



## 7.5 Injection Pump / HP Pump

### 7.5.1 Injection pump – Replacement

#### Special tools, Material, Spare parts

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

#### Injection pump – Replacement

- ▶ Remove injection pump and install new one (→ Page 91).

## 7.5.2 Injection pump – Removal and installation

### Preconditions

- ☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 20-100 Nm	F30026582	1
Ratchet adapter	F30027340	1
Crow-foot box wrench	F30027424	1
Crow-foot box wrench	F30027425	1
Torque wrench, 0.5-5 Nm	0015384230	1
Grease (Kluth Hakuform 30-10/Emulgier)	X00029933	
Sealing ring	(→ Spare Parts Catalog)	
Sealing ring	(→ Spare Parts Catalog)	

#### 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.

#### WARNING



Fuels are combustible.

#### **Risk of fire and explosion!**

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

### Preparatory steps

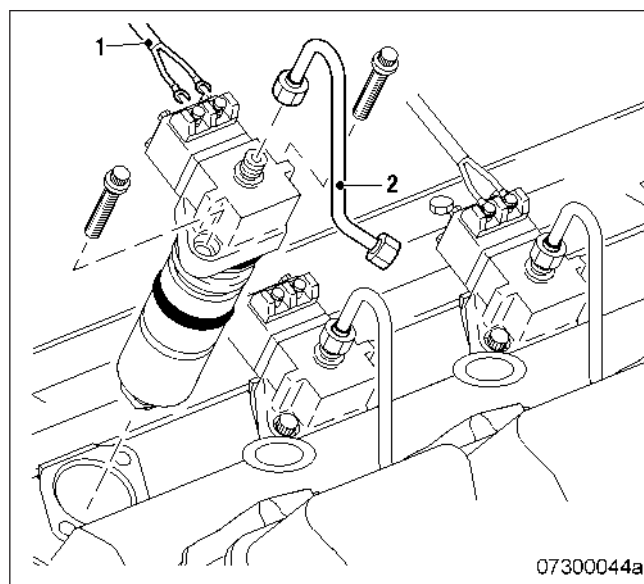
1. Shut off fuel supply line before fuel filter.
2. Remove engine control system (→ Page 151).
3. Drain fuel (→ Page 101).
4. Remove charge-air pipes and all seals.

## Removing injection pump

1. Mark installation position of injection pump.
2. Disconnect cabling (1) from injection pump.
3. Remove fuel line (2).
4. Unscrew securing screws of injection pump by approx. 6 mm.

**Result:** The pretensioned compression spring presses the injection pump out of the crankcase; If not:

- Turn crankshaft with barring tool (→ Page 76).  
The pump cam on the camshaft spring presses the injection pump out of the crankcase; If not:
  - Carefully force out injection pump at the recess in the injection pump head.
5. Remove injection pump securing screws.
  6. Remove injection pump.
  7. Remove sealing rings from injection pump.
  8. After removal, seal all openings with suitable covers.



## Installing injection pump

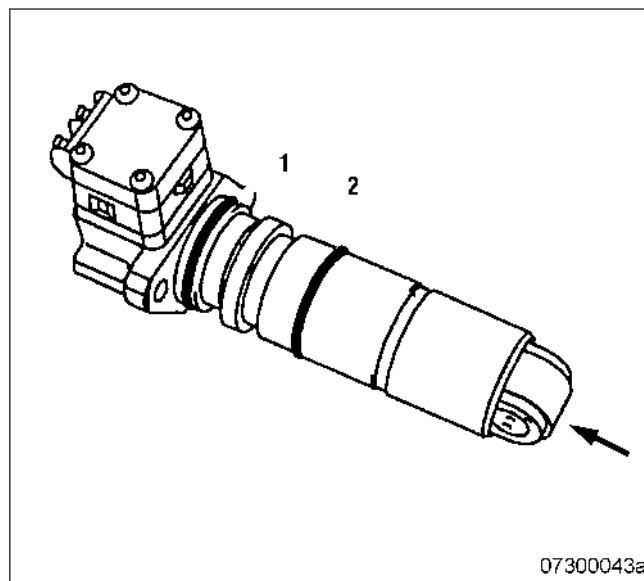
1. Remove all blanking plugs and covers.
2. Clean mating face of injection pump and roller.

**Note:** Sealing ring (1) Ø47 mm

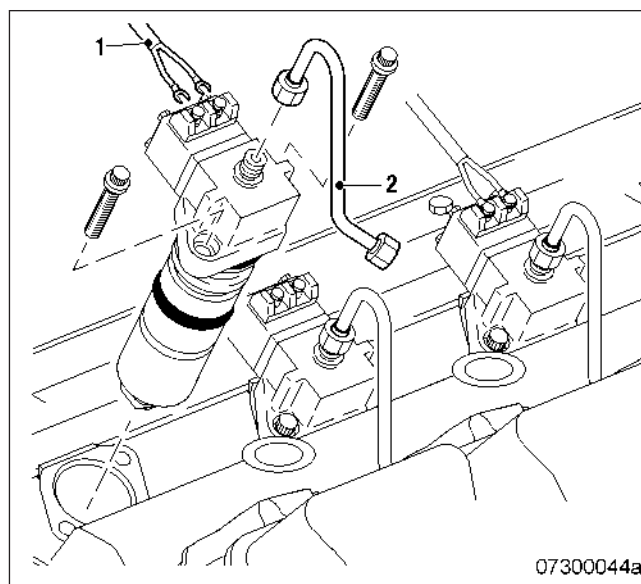
3. Coat sealing ring (1) with grease (Kluthe Hakuform 30-10/Emulgier) and fit on to injection pump.

**Note:** Sealing ring (2) Ø45 mm

4. Coat sealing ring (2) with grease (Kluthe Hakuform 30-10/Emulgier) and fit on to injection pump.
5. Coat roller (arrowed) with engine oil.
6. Clean sealing surface and fuel bores in crankcase.
7. Use barring tool (→ Page 76) to position the pump cams on the camshaft at base circle.



8. Install injection pump in the installation position marked prior to removal.



9. Install securing screws of injection pump and tighten with torque wrench to the specified torque.

Name	Size	Type	Lubricant	Value/Standard
Securing screw		Tightening torque		60 Nm + 12 Nm

10. Install fuel line (2).

11. Tighten union nut on the injection pump to the specified tightening torque using a torque wrench.
  - Maximum permissible tightening torque: 35 Nm

Name	Size	Type	Lubricant	Value/Standard
Union nut		Tightening torque		20 Nm + 5 Nm

12. Tighten union nut on the pressure pipe neck to the specified tightening torque using a torque wrench.
  - Maximum permissible tightening torque: 35 Nm

Name	Size	Type	Lubricant	Value/Standard
Union nut		Tightening torque		20 Nm + 5 Nm

13. Install injection pump cabling (1).

14. Use torque wrench to tighten screws to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque		1.0 Nm ± 0.2 Nm

## Final steps

1. Remove barring device (→ Page 76).
2. Clean mating faces on cylinder head and charge-air pipe.
3. Check seals for damage and replace them, if required.
4. Coat seals with grease (Kluthe Hakuform 30-10/Emulgier) and place onto cylinder head.
5. Install charge-air pipes.
6. Install engine control system (→ Page 151).
7. Open fuel supply line before fuel filter.
8. Vent fuel system (→ Page 102).

## 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 95).

## 7.6.2 Injector – Removal and installation

### Preconditions

- ☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Puller	3555890163/00	
Fuel suction device	F30378207	1
Torque wrench, 20-100 Nm	F30026582	1
Open end socket wrench	F30025897	1
Crowfoot box wrench	F30027425	1
Crowfoot box wrench	F30027424	1
Double-head box wrench	F30011450	1
Ratchet adapter	F30027340	1
Grease (Kluthe Hakuform 30-10/emulsifier)	X00029933	1
Sealing ring	(→ Spare Parts Catalog)	
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.

#### WARNING



Compressed air

#### **Risk of injury!**

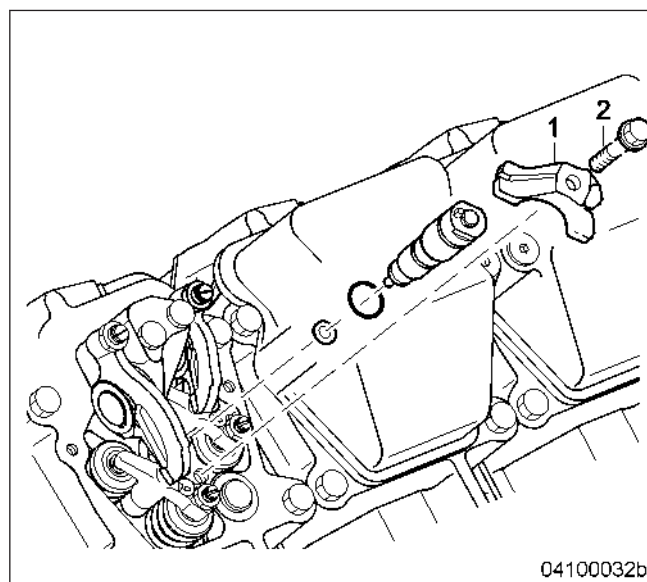
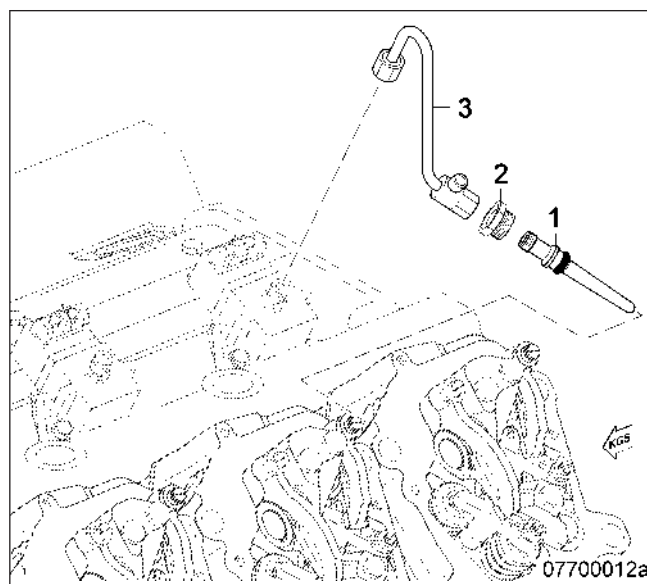
- Do not direct compressed-air jet at persons.
- Wear protective goggles / safety mask and ear protectors.

### Preparatory steps

1. Remove cylinder head cover (→ Page 88).
2. Drain fuel (→ Page 101).

## Removing injector

1. Remove leak-off-fuel lines.
  2. Remove fuel line (3).
  3. Remove thrust screw (2).
  4. Withdraw pressure pipe neck (1).
  5. Extract fuel from the exposed bores using the suction device.
- 
6. Remove screw (2).
  7. Take off clamp (1).
  8. Screw puller into injector.
  9. Remove injector with puller.
  10. Remove injector sealing ring using a self-made hook.
  11. After removal, seal all openings with suitable covers.



## Installing injector

1. Remove all covers before installation.
2. Clean sealing surface on cylinder head and protective sleeve.
3. Coat sealing ring (1) with grease and fit on-to injector.
4. Coat sealing ring (2) with grease and fit on-to injector.
5. Press injector into cylinder head by hand.

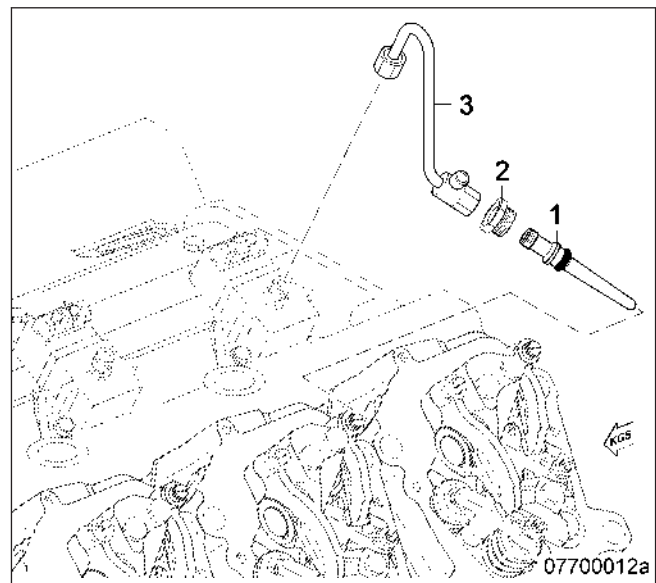
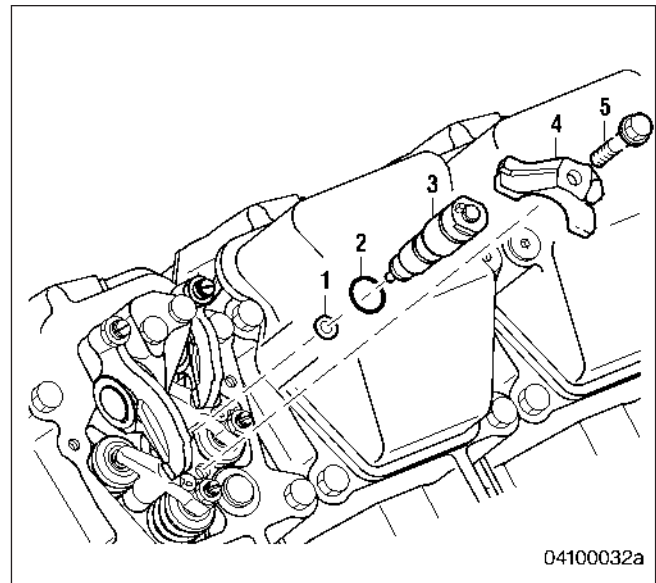
- Result:
- The pin is at 11-o'clock position to the transversal axis of the engine.
  - The pin is engaged in the recess of the clamp (4).
6. Install clamp (4) with screw (5), positioning it correctly.

- Result:
- Pin on injector is in the recess in the clamp.
  - Forked clamp end is engaged in the cover recess.

7. Tighten screw (5) of the clamp by hand.

- Result: Injector can still be turned.

8. Blow out fuel line (3) and pressure pipe neck (1) with compressed air.
9. Coat sealing ring with grease and fit onto pressure pipe neck (1).
10. Coat taper on pressure pipe neck with engine oil.
11. Insert pressure pipe neck into cylinder head until it is in contact with the sealing ring.
12. Fully press in pressure pipe neck (1) by hand.



13. Tighten thrust screw (2) with torque wrench to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Thrust screw		Tightening torque		40 Nm $\pm$ 5 Nm

14. Use torque wrench to tighten screw for clamp at injector to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque		50 Nm

15. Install fuel line (3).

16. Tighten union nut on the injection pump to the specified tightening torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Union nut		Tightening torque		20 Nm +5 Nm



17. Tighten union nut on the pressure pipe neck to the specified tightening torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Union nut		Tightening torque		20 Nm +5 Nm

18. Install leak-off-fuel lines.

### Final steps

1. Install cylinder head cover (→ Page 88).
2. Vent fuel system (→ Page 102).

## 7.7 Fuel System

### 7.7.1 HP fuel line – Pressure pipe neck replacement

#### Preconditions

- ☒ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 20-100 Nm	F30026582	1
Open end socket wrench	F30025897	1
Crowfoot box wrench	F30027425	1
Crowfoot box wrench	F30027424	1
Double-head box wrench	F30011450	1
Ratchet adapter	F30027340	1
Grease (Kluth Hakuform 30-10/emulsifier)	X00029933	
Engine oil		
Pressure pipe neck	(→ Spare Parts Catalog)	

#### WARNING



Fuels are combustible.

#### **Risk of fire and explosion!**

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

#### WARNING



Compressed air

#### **Risk of injury!**

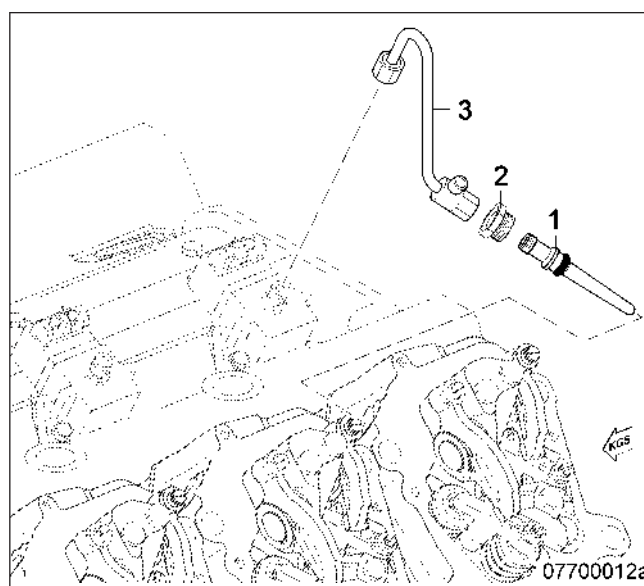
- Do not direct compressed-air jet at persons.
- Wear protective goggles / safety mask and ear protectors.

#### Preparatory steps

1. Remove cylinder head cover (→ Page 88).
2. Drain fuel (→ Page 101).

## Replacing pressure pipe neck

1. Remove fuel line (3).
2. Remove thrust screw (2).
3. Withdraw pressure pipe neck (1).
4. Coat sealing ring with grease (Kluthe Hakuform 30-10/emulsifier) and fit on to new pressure pipe neck (1).
5. Blow out fuel line (3) with compressed air.
6. Coat sealing cone of pressure pipe neck with engine oil.
7. Insert pressure pipe neck into cylinder head until it is in contact with the sealing ring.
8. Fully press in pressure pipe neck (1) by hand.



9. Tighten thrust screw (2) with torque wrench to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Thrust screw		Tightening torque		40 Nm $\pm$ 5 Nm

10. Install fuel line (3).

11. Tighten union nut on the injection pump to the specified tightening torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Union nut		Tightening torque		20 Nm + 5 Nm

12. Tighten union nut on the pressure pipe neck to the specified tightening torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Union nut		Tightening torque		20 Nm + 5 Nm

## Final steps

1. Install cylinder head cover ( $\rightarrow$  Page 88).
2. Vent fuel system ( $\rightarrow$  Page 102).

## 7.7.2 Fuel – Draining

### Preconditions

- ☑ Engine is stopped and starting disabled.

#### WARNING



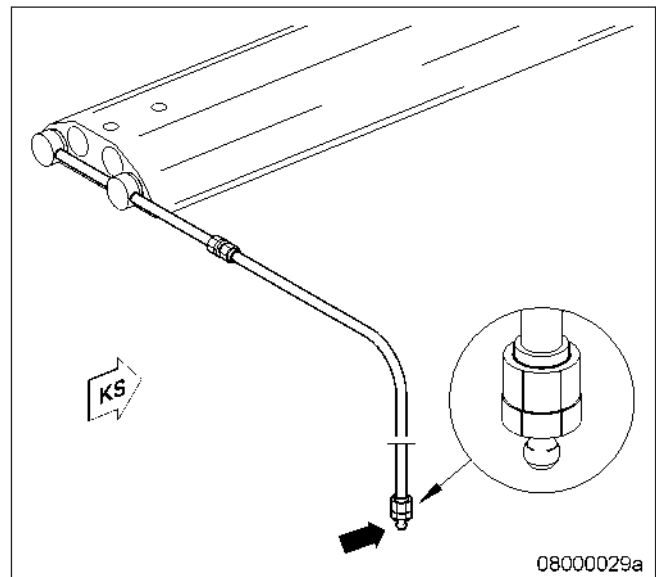
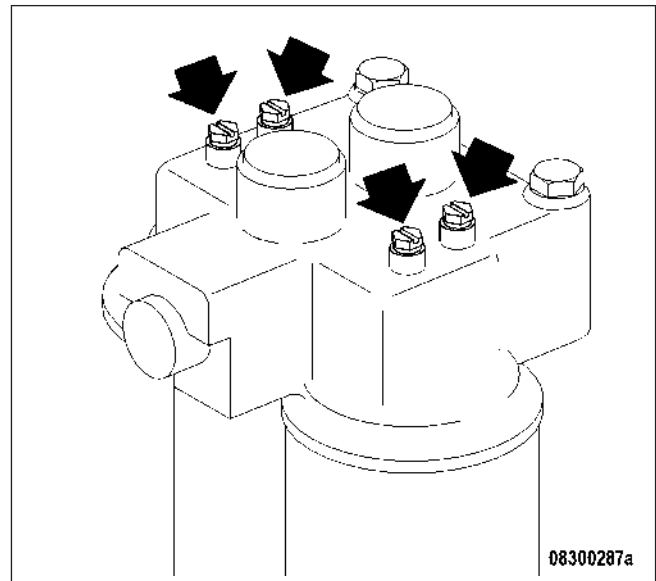
Fuels are combustible.

#### Risk of fire and explosion!

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

### Fuel – Draining

1. Release threaded vent plugs on filter head.
2. Open nipple on fuel line and drain fuel into appropriate container.
3. When fuel stops emerging from system, close nipple on fuel line.
4. Close vent plugs on filter head.



### 7.7.3 Fuel system – Venting

#### Preconditions

- ☑ Engine is stopped and starting disabled.

#### WARNING



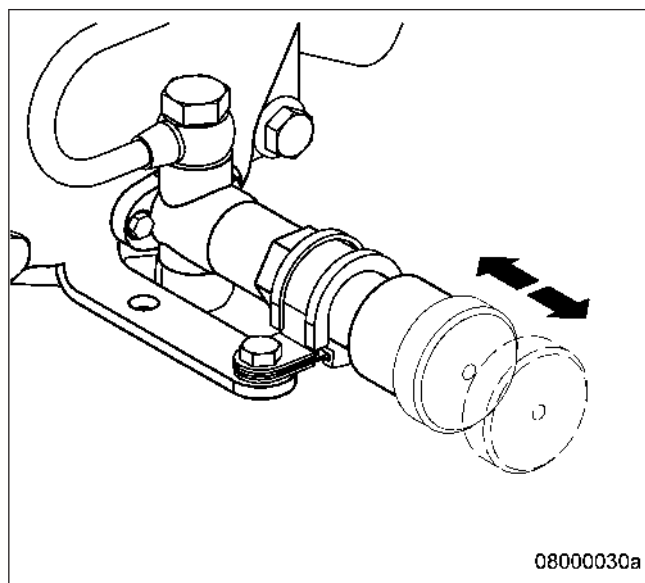
Fuels are combustible.

#### Risk of fire and explosion!

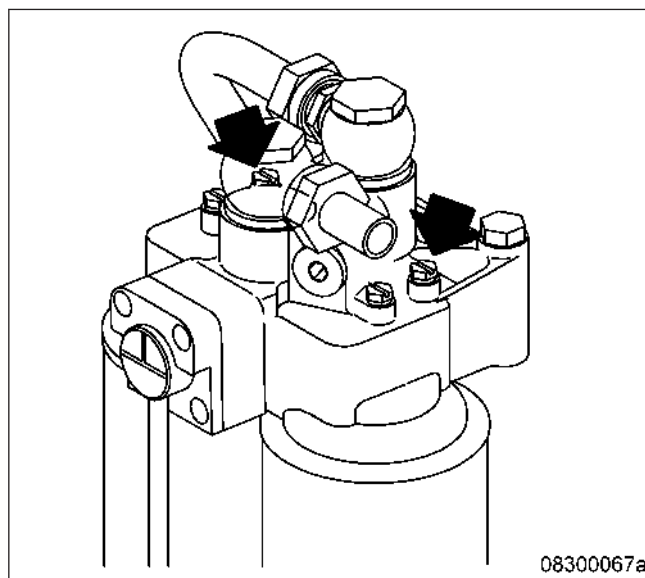
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

#### Venting fuel system

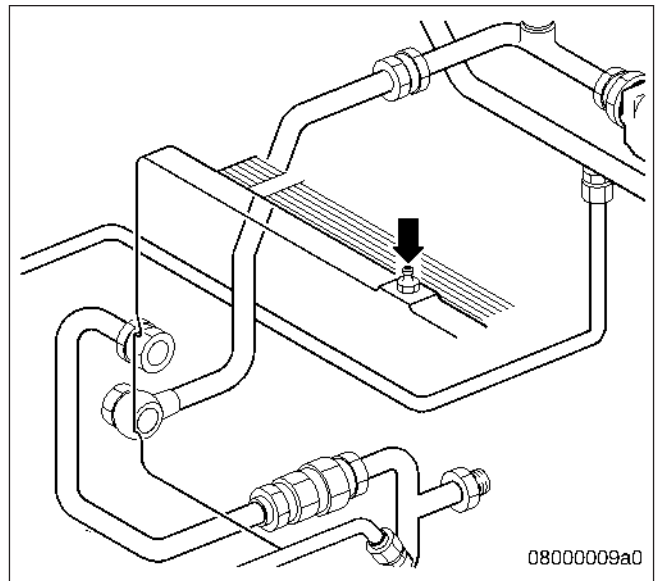
1. Unlock fuel priming pump, unscrew handle.



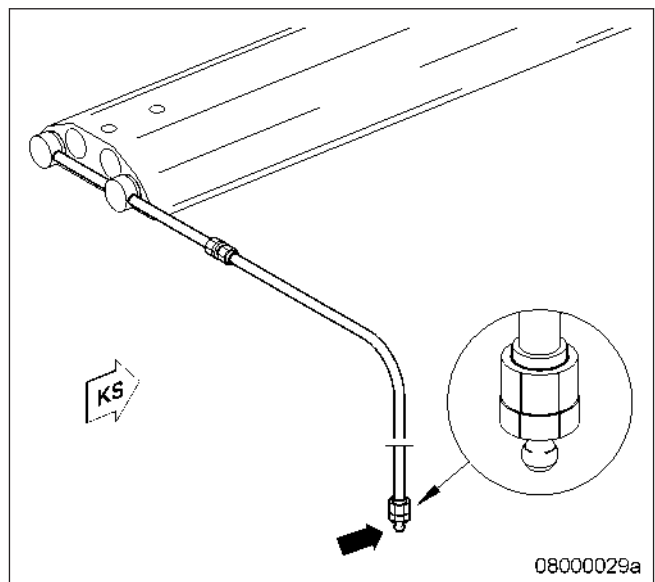
2. Open vent plugs on filter head.
3. Operate the pump with the handle until bubble-free fuel emerges at the vent plugs.
4. Close vent plugs on filter head.



5. Open nipple at fuel heat exchanger.
6. Operate the pump with the handle until bubble-free fuel emerges at the nipple.
7. Close nipple at fuel heat exchanger.



8. Open nipple at fuel line.
9. Operate the pump with the handle until bubble-free fuel emerges at the nipple.
10. Close nipple at fuel line.
11. Lock fuel priming pump, screw in handle.



## 7.8 Fuel Filter

### 7.8.1 Fuel filter – Replacement

#### Preconditions

- ☑ Engine shut down and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Oil filter wrench	F30379104	1
Diesel fuel		
Easy-change filter	(→ Spare Parts Catalog)	
Plastic ring	(→ Spare Parts Catalog)	

#### DANGER



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

- Take special care when working on a running engine.

#### WARNING



Fuels are combustible.  
**Risk of fire and explosion!**

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

#### WARNING



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

- Wear ear protectors.

#### CAUTION

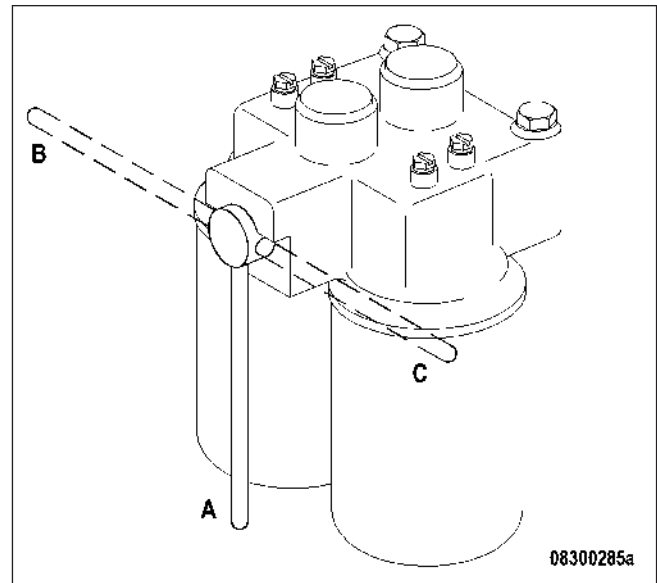


Damage to component.  
**Serious damage to plant!**

- For filter replacement with the engine running, operate the engine at low engine load.
- The filter which is to be exchanged must be cut out for a brief period only.

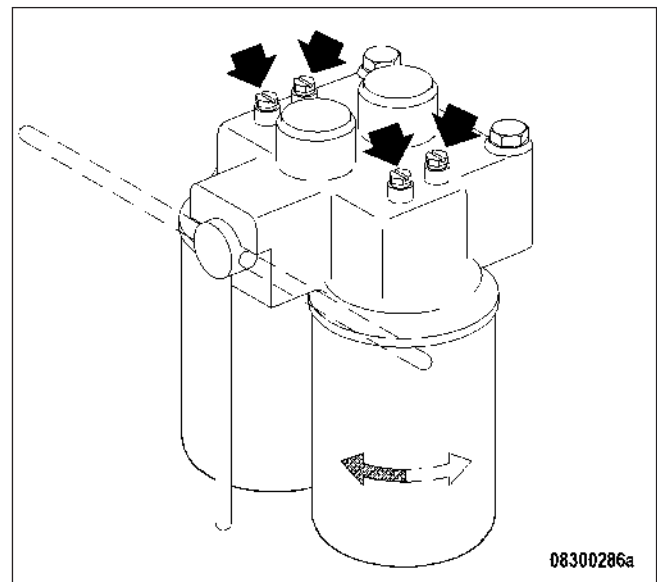
## Replacing fuel filter with the engine stopped

1. Cut out the filter to be replaced.
  - A Both filters cut in (operating position)
  - B Left filter cut out
  - C Right filter cut out
2. Unscrew cut-out easy-change filter with oil filter wrench.
3. Clean sealing face on filter head.
4. Check sealing ring on new easy-change filter and moisten with fuel.
5. Fit SOLAS shield (→ Page 19).
6. Screw on easy-change filter and tighten by hand.
7. Set three-way cock to operating position for both filters (normal position).
8. Replace other fuel filters in the same way.
9. Vent fuel system (→ Page 101).



## Replacing fuel filter with the engine running

1. Cut out the filter to be replaced.
2. Open threaded vent plugs at filter head of cut-out filter and ensure that fuel filter is not under pressure.
3. Close threaded vent plugs.
4. Unscrew cut-out easy-change filter with oil filter wrench.
5. Clean sealing face on filter head.
6. Check sealing ring on new easy-change filter and moisten with fuel.
7. Fit SOLAS shield (→ Page 19).
8. Screw on easy-change filter and tighten by hand.
9. Set three-way cock to operating position for both filters (normal position).
10. Replace other fuel filters in the same way.





## 7.8.2 Fuel prefilter – Differential pressure check and adjustment of gauge

### DANGER



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

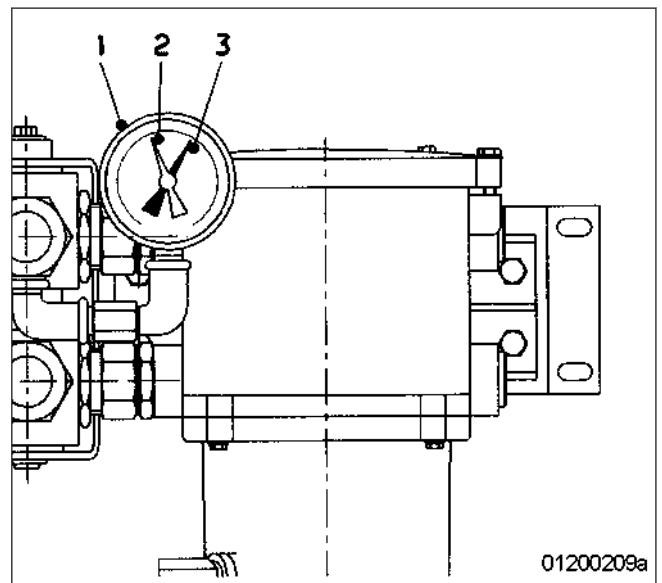
### WARNING



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

### Differential pressure gauge adjustment

1. When installing the new filter element: align adjustable pointer (2) with pressure-indicating pointer (3) of pressure gauge (1).
2. Verify that differential pressure is within the limit.



### Fuel prefilter – Checking differential pressure

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 indicator of pressure gauge (3) is  $\geq 0.3$  bar, flush filter element of the cut-in filter (→ Page 108).

## 7.8.3 Fuel prefilter – Draining

### Preconditions

- ☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

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

#### WARNING



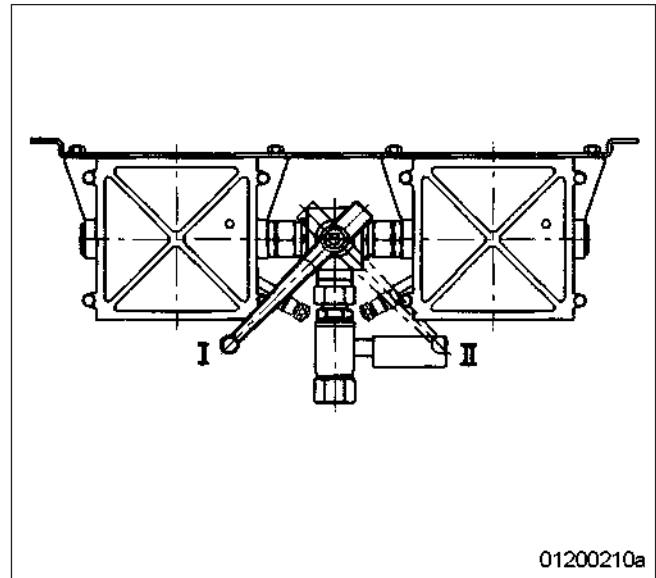
Fuels are combustible.

#### Risk of fire and explosion!

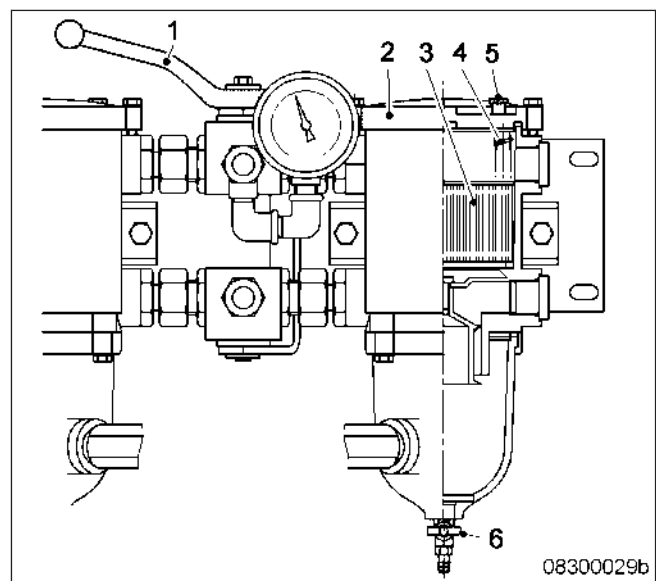
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

### Fuel prefilter – Draining

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



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## 7.8.4 Fuel prefilter – Flushing

### Special tools, Material, Spare parts

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

#### DANGER



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

#### WARNING



Fuels are combustible.  
**Risk of fire and explosion!**  
• Avoid open flames, electrical sparks and ignition sources.  
• Do not smoke.

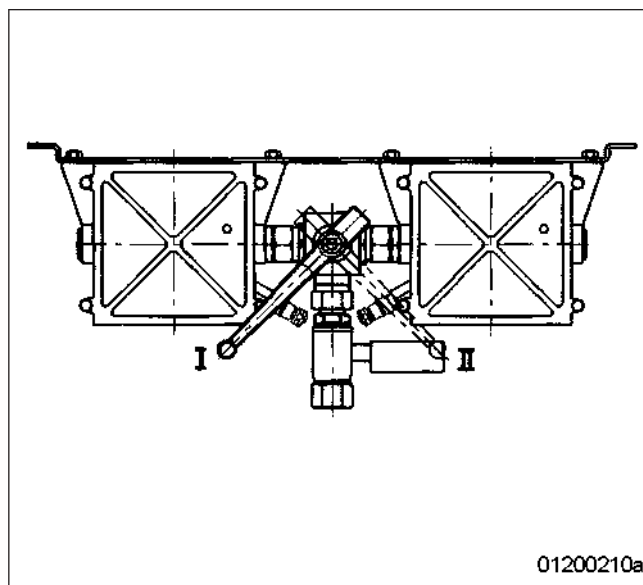
#### WARNING



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

### Flushing fuel prefilter

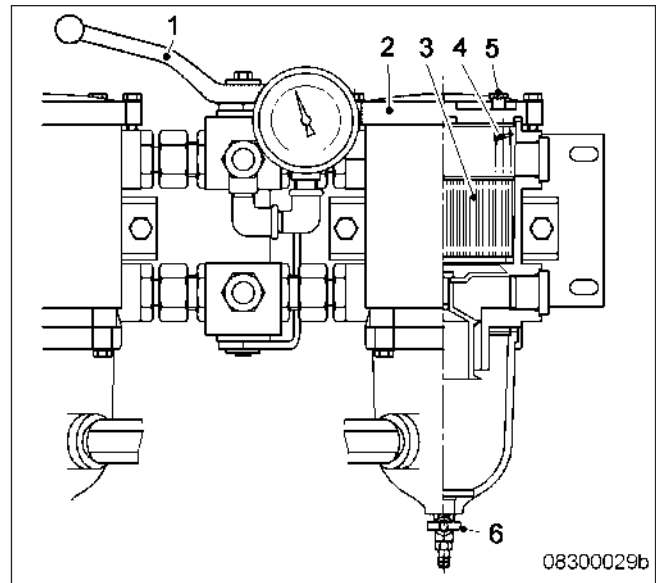
1. Cut out clogged filter.  
I Left filter cut in  
II Right filter cut in



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 61) 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 105).

Result: If flushing did not lead to an improvement of the differential pressure, replace filter element of fuel prefilter (→ Page 110).

## 7.8.5 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)	
Seal	(→ Spare Parts Catalog)	

#### WARNING



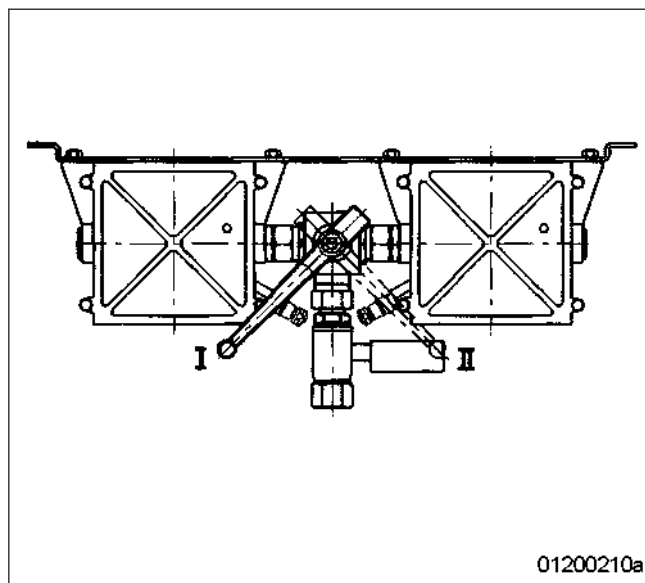
Fuels are combustible.

#### **Risk of fire and explosion!**

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

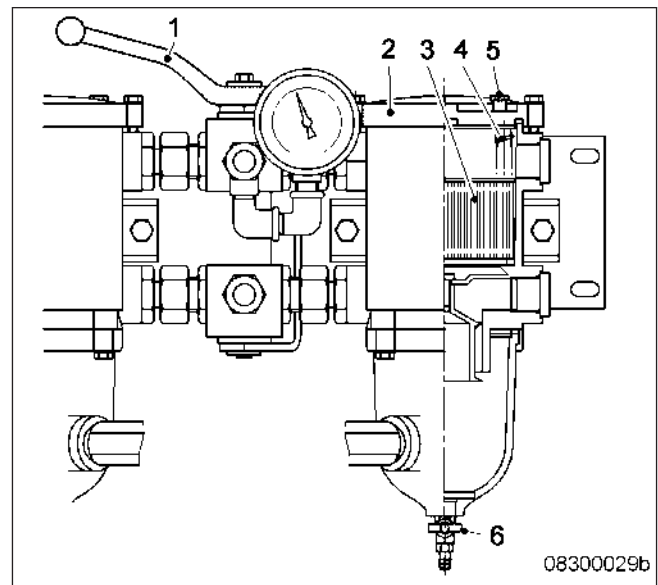
### Replacing filter element

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



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2. Open threaded vent plug (5) of contaminated filter.
3. Unlock drain valve (6) by pressing toggle and open it.
4. Drain water and contaminants from the 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 seal 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. Set adjustable pointer of differential pressure gauge (→ Page 105).



## 7.9 Charge-Air Cooling

### 7.9.1 Intercooler – Checking condensate drain line for coolant discharge 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.

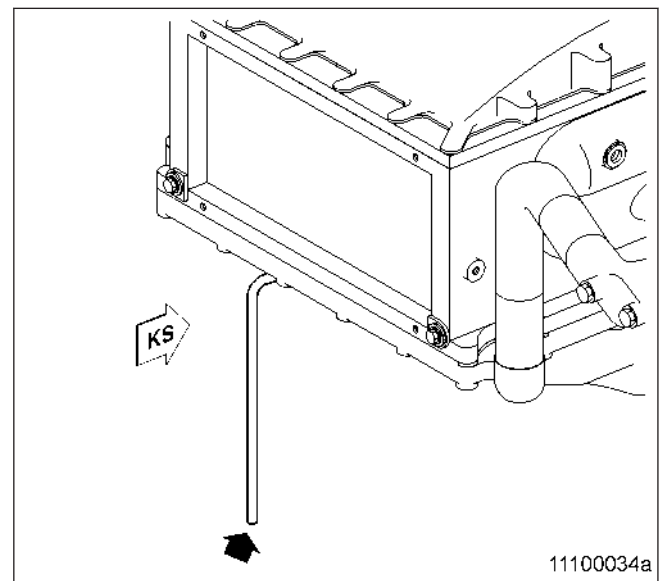
#### WARNING



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

#### Checking intercooler condensate drain line for coolant discharge and obstruction

1. With the engine running, check the condensate drain line on engine driving end for air discharge.
2. If no air emerges, remove condensate drain line and blow out with compressed air.
3. Replace obstructed drain line by new one.
4. Install condensate drain line.
5. If a large amount of coolant is continuously discharged, the intercooler is leaking. Contact Service.



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#### Emergency measures prior to engine start with a leaking intercooler

1. Remove injectors (→ Page 93).
2. Bar engine manually (→ Page 76).
3. Bar engine with starting system to blow out cylinder chambers (→ Page 77).
4. Install injectors (→ Page 94).

## 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)	

#### Replacing the air filter

1. Remove old air filter and install new air filter (→ Page 114).
2. Reset signal ring of contamination indicator (→ Page 115).



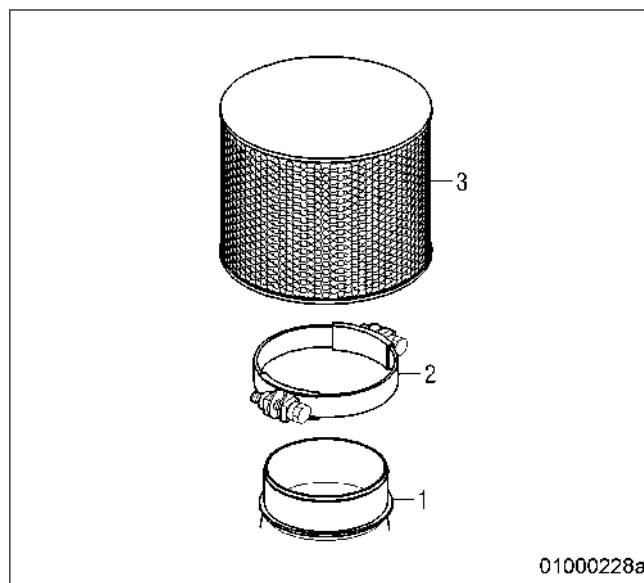
## 7.10.2 Air filter – Removal and installation

### 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

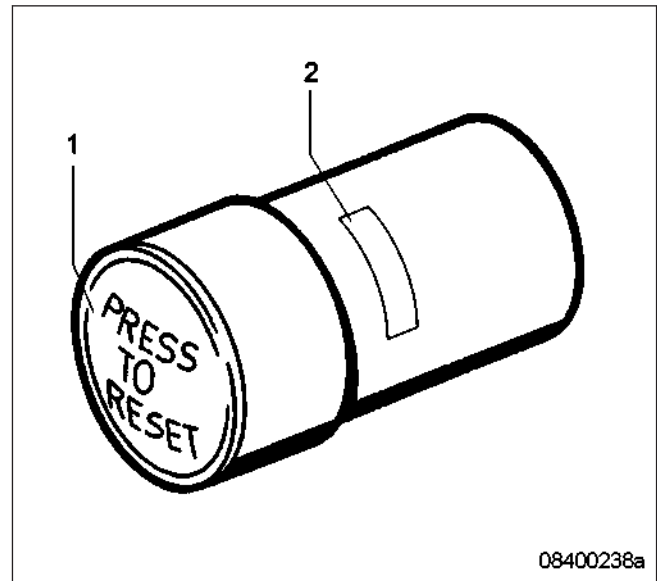
#### Preconditions

- ☑ 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 112).
2. After installation of new filter, press reset button (1).

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



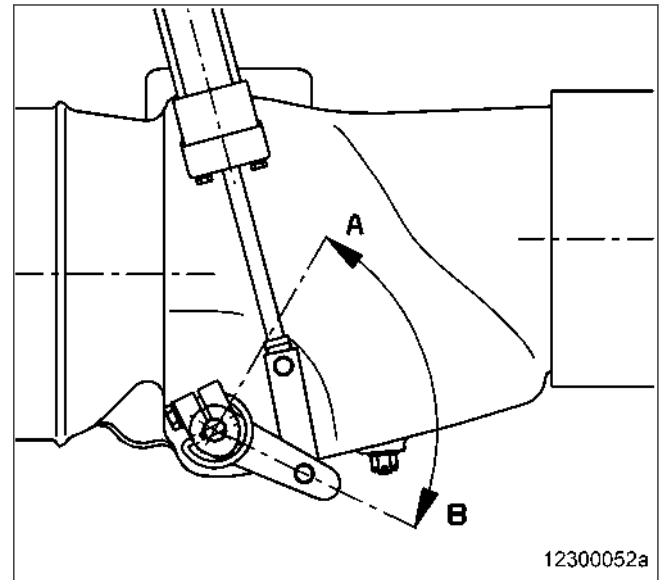
## 7.11.2 Air-flow control flap – Ease of movement check

### Preconditions

- ☑ Engine is stopped and starting disabled.

### Air-flow control flap – Check for ease of movement

1. Actuate lever several times by hand, moving it between positions “A” and “B” to check for ease of movement.
2. If the lever does not move freely, contact Service.



## 7.12 Exhaust Flap with Actuator

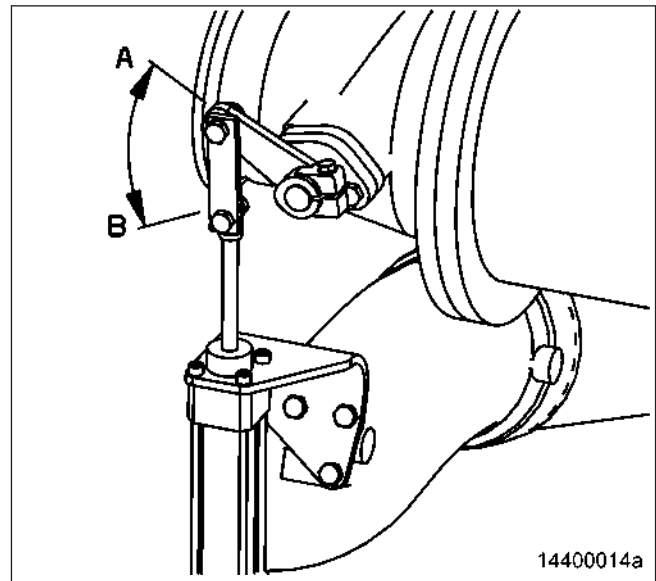
### 7.12.1 Exhaust flow control flap – Ease of movement check

#### Preconditions

- ☑ Engine is stopped and starting disabled.

#### Exhaust flow control flap – Check for ease of movement

1. Actuate control linkage and cylinder several times by hand, moving it between positions “A” and “B” to check for ease of movement.
2. If it does not move freely, contact Service.



## 7.13 Starting Equipment

### 7.13.1 Starter – Condition check

#### **Preconditions**

- ☒ Engine is stopped and starting disabled.

#### **Starter – Condition check**

1. Check securing screws of starter for secure seating and tighten if required.
2. Check wiring (→ Page 145).

## 7.14 Lube Oil System, Lube Oil Circuit

### 7.14.1 Engine oil – Level check

#### Preconditions

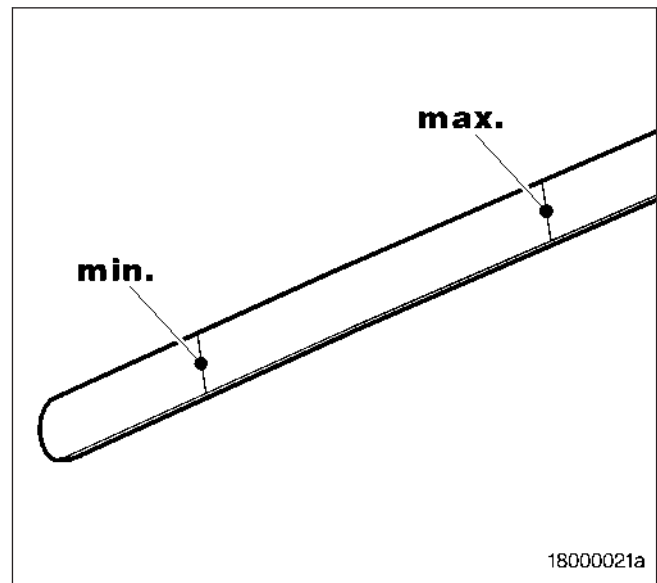
- ☑ Engine is stopped and starting disabled.

#### 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 the stop, withdraw after approx. 10 seconds and check oil level.
3. Oil level must be between "min." and "max." marks.

Result: If there is no mark, mark the oil dipstick (→ Page 121).

4. If necessary, top up to "max." mark (→ Page 120).
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 the stop, withdraw after approx. 10 seconds and check oil level.
  3. Oil level must be between "min." and "max." marks.
- Result: If there is no mark, mark the oil dipstick (→ Page 121).
4. If necessary, top up to "max." mark (→ Page 120).
  5. Insert oil dipstick into guide tube up to the stop.

## 7.14.2 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.
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 oil at drain plug on oil pan

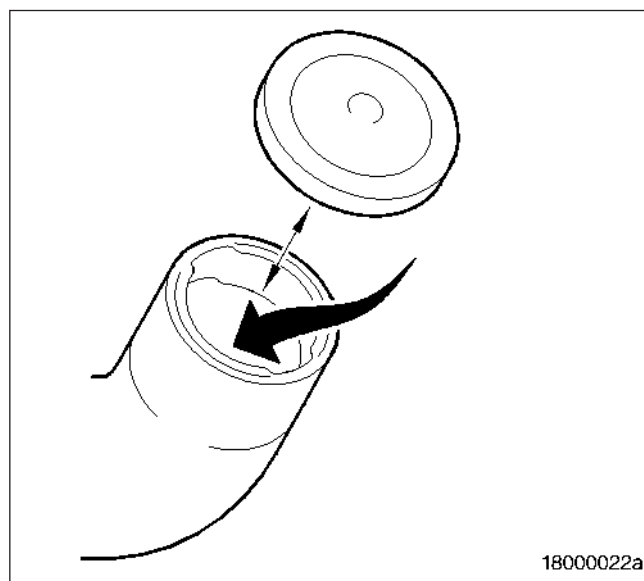
1. Provide a suitable container to collect the oil.
2. Remove drain plug and drain oil.
3. Install drain plug with new sealing ring.
4. Replace engine oil filter (→ Page 122).

### Oil change using semirotary hand pump: Oil extraction

1. Provide a suitable container to collect the oil.
2. Extract all oil from oil pan using the semirotary hand pump.
3. Replace engine oil filter (→ Page 122).

### Filling with new oil

1. Open cap on filler neck.
2. Pour oil in at filler neck up to "max." mark at oil dipstick.
3. Close cap on filler neck.
4. Check engine oil level (→ Page 118).
5. After oil change and filter replacement, bar engine with starting system (→ Page 77).



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## 7.15 Oil Filtration / Cooling

### 7.15.1 Oil dipstick – Marking

#### Preconditions

- ☒ Engine is stopped and starting disabled.

#### 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.

Note: In the case of new engines and spare parts, oil dipsticks are delivered without marks.

#### Oil dipstick — Marking

1. Extract or drain off all oil from oil pan.
2. Pull out oil dipstick.
3. Fill in minimum oil quantity.
4. Insert oil dipstick and pull out again.
5. Mark a "Min." notch on the oil dipstick. Max. notch depth 1 mm.
6. Shorten oil dipstick.
7. Fill in maximum oil quantity.
8. Insert oil dipstick and pull out again.
9. Mark a "Max." notch on the oil dipstick. Max. notch depth 1 mm.



## 7.15.2 Engine oil filter – Replacement

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Oil filter wrench	F30379104	1
Engine oil		
Oil filter	(→ Spare Parts Catalog)	
Synthetic ring	(→ Spare Parts Catalog)	

#### 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



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.

#### CAUTION



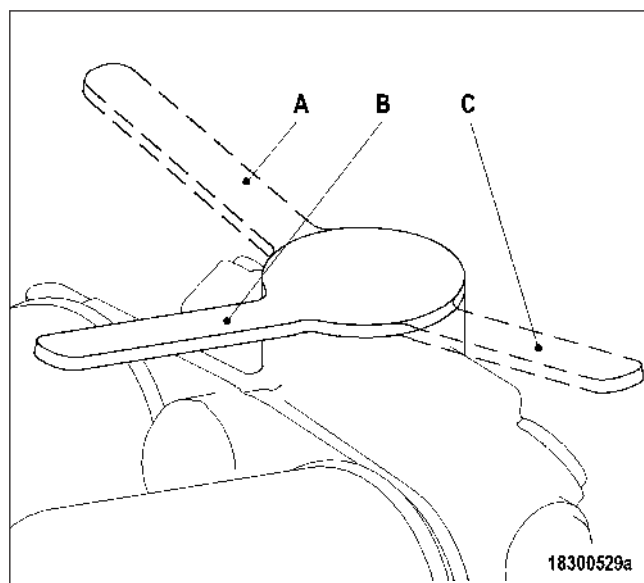
Damage to component.

**Serious damage to plant!**

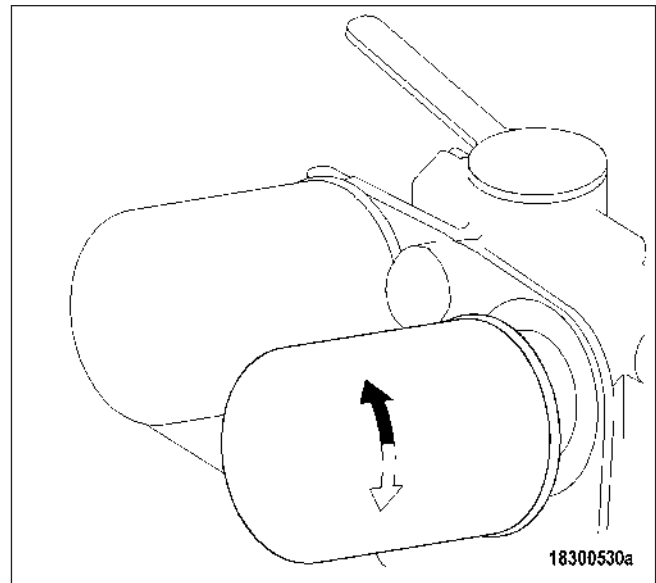
- For filter replacement with the engine running, operate the engine at low engine load.
- The filter which is to be exchanged must be cut out for a brief period only.

### Oil filter replacement with the engine stopped

1. Stop engine (→ Page 61) and disable engine start.
2. Cut out the filter to be replaced.
  - A Right filter cut out
  - B Both filters cut in (operating position)
  - C Left filter cut out



3. Remove cut-out oil filter using the oil filter wrench.
4. Clean the sealing face on the adapter.
5. Check condition of the new sealing ring and coat it with oil.
6. Fit SOLAS shield (→ Page 19).
7. Screw on and tighten new engine oil filter by hand.
8. Replace other oil filters in the same way.
9. Switch filter to normal position.
10. After each oil change and filter replacement, bar engine with starting system (→ Page 77).
11. Check oil level (→ Page 118).



### Oil filter replacement with the engine running

1. Reduce engine speed to <1100 rpm.
2. Remove cut-out oil filter using the oil filter wrench.
3. Clean the sealing face on the adapter.
4. Check condition of the new sealing ring and coat it with oil.
5. Fit SOLAS shield (→ Page 19).
6. Screw on and tighten new engine oil filter by hand.
7. Replace other oil filters in the same way.
8. Switch filter to normal position.
9. Check oil level (→ Page 118).

### 7.15.3 Centrifugal oil filter – Cleaning and filter-sleeve replacement

#### Preconditions

- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Strap wrench	F30379104	1
Cold cleaner (Hakutex 50)	50622	1
Filter sleeve	(→ Spare Parts Catalog)	
O-ring	(→ Spare Parts Catalog)	
O-ring	(→ Spare Parts Catalog)	

#### WARNING



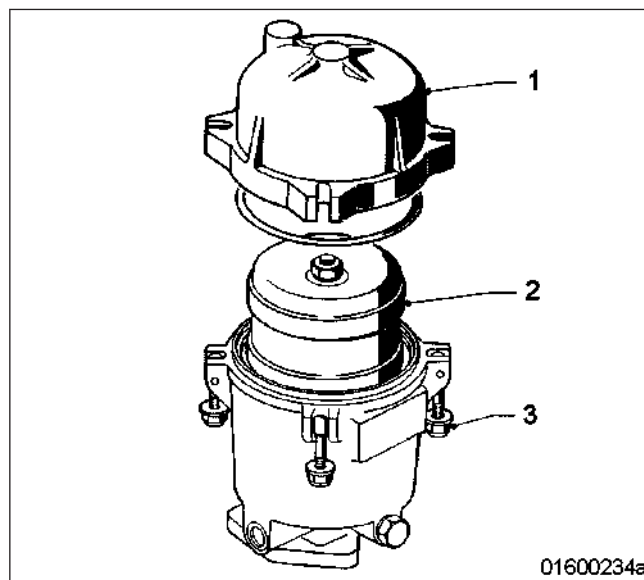
Compressed air

#### Risk of injury!

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

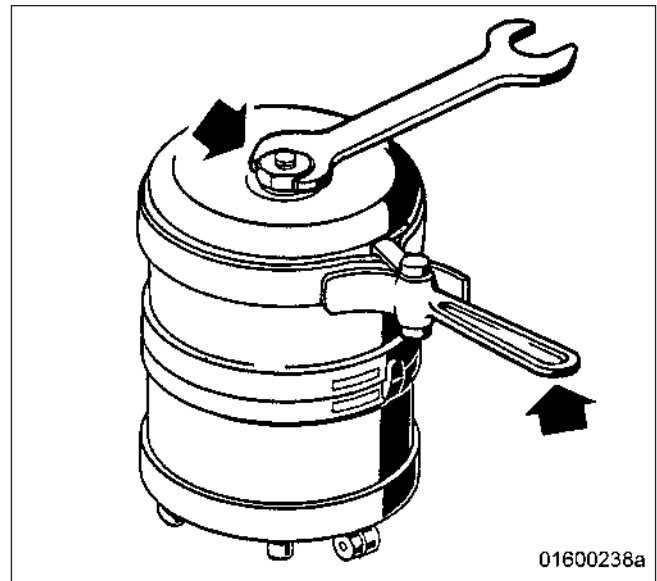
#### Removing rotor of centrifugal oil filter

1. Release nuts (3).
2. Remove housing cover (1).
3. Remove complete rotor (2) from housing.

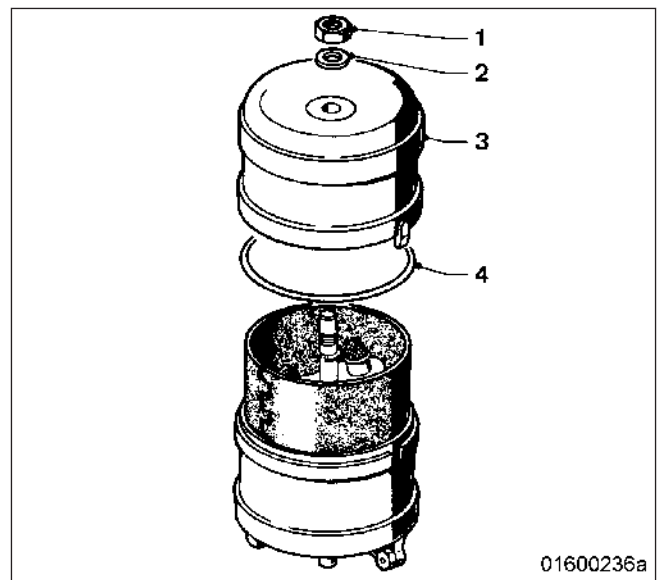


## Cleaning centrifugal oil filter and replacing filter sleeve

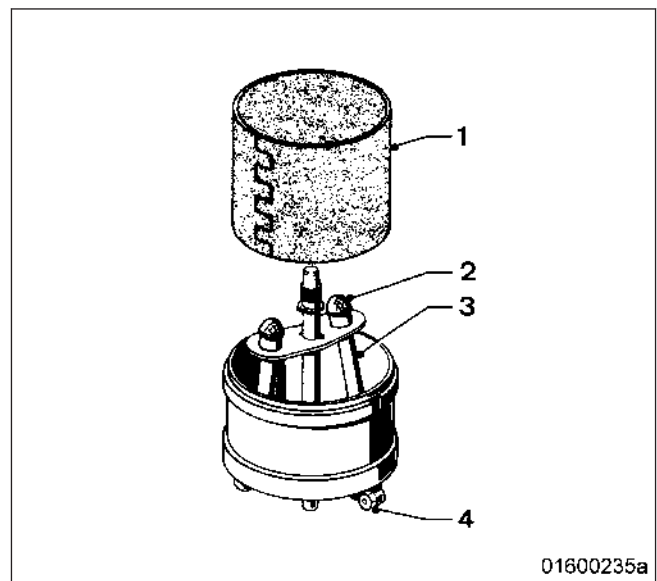
1. Remove nut, holding the rotor with a strap wrench.



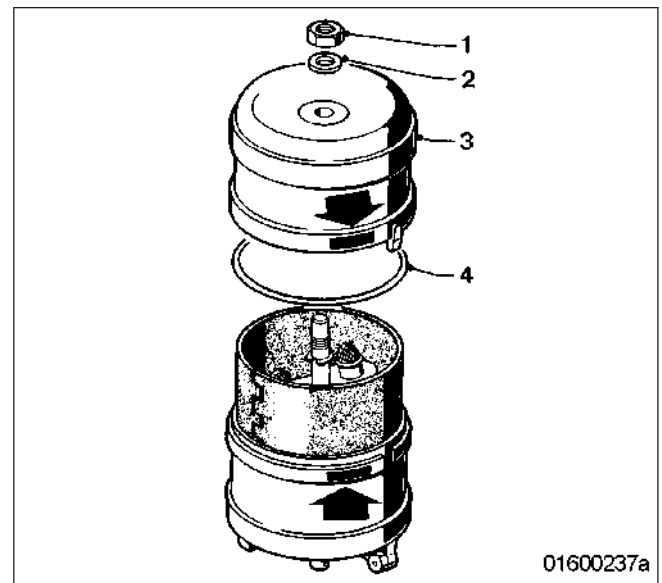
2. Remove nut (1), washer (2), rotor cap (3) and sealing ring (4).



3. Remove sleeve (1).
4. Measure the layer thickness of the oil residue.
5. If maximum layer thickness (25 mm) is exceeded, shorten maintenance interval.
6. Clean rotor components and remove strainers (2).
7. Wash standpipes (3) and nozzles (4) with cleaner, blow out with compressed air.
8. Insert the new filter sleeve with the smooth surface facing the rotor cap.



9. Fit new sealing ring (4).
10. Set on rotor cap (3), observe marks.
11. Fit washer (2).



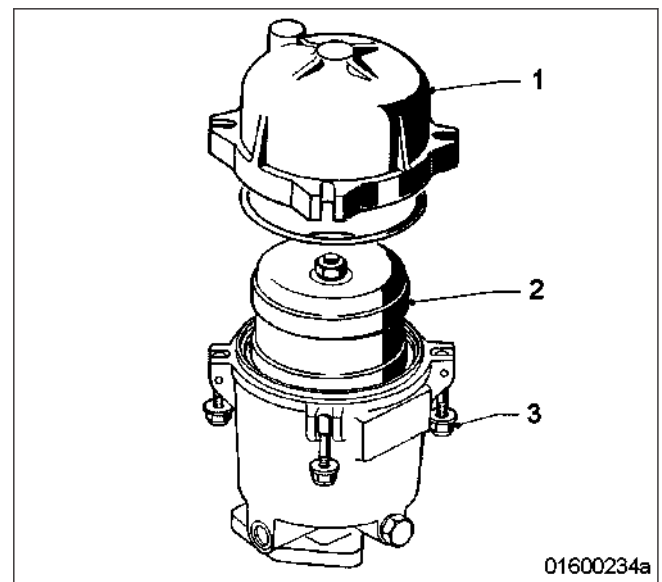
12. Hold rotor (new design) with strap wrench and tighten nut (1) with torque wrench to the specified torque.

Name	Size	Type	Lubricant	Value/Standard
Nut	M18 x 1.5	Tightening torque		10 Nm

13. Hold rotor (old design) with strap wrench and tighten nut (1) with torque wrench to the specified torque.

Name	Size	Type	Lubricant	Value/Standard
Nut	M16 x 1.5	Tightening torque		40 Nm to 50 Nm

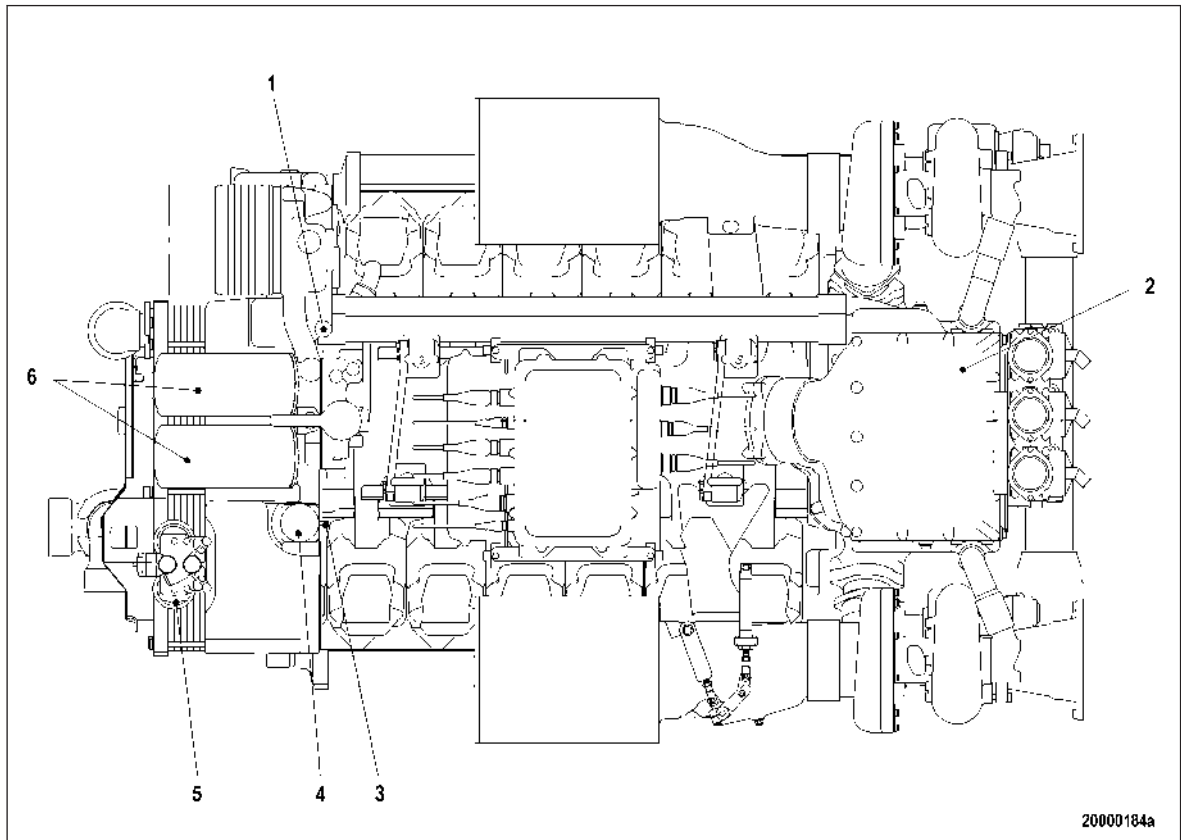
14. Insert complete rotor (2) into the housing and check for ease-of-movement.
15. Set housing cover (1) with new sealing ring onto lower section, observe marks.
16. Tighten nuts (3) crosswise and evenly.



## 7.16 Coolant Circuit, General, High-Temperature Circuit

### 7.16.1 Drain and venting points

#### Top side

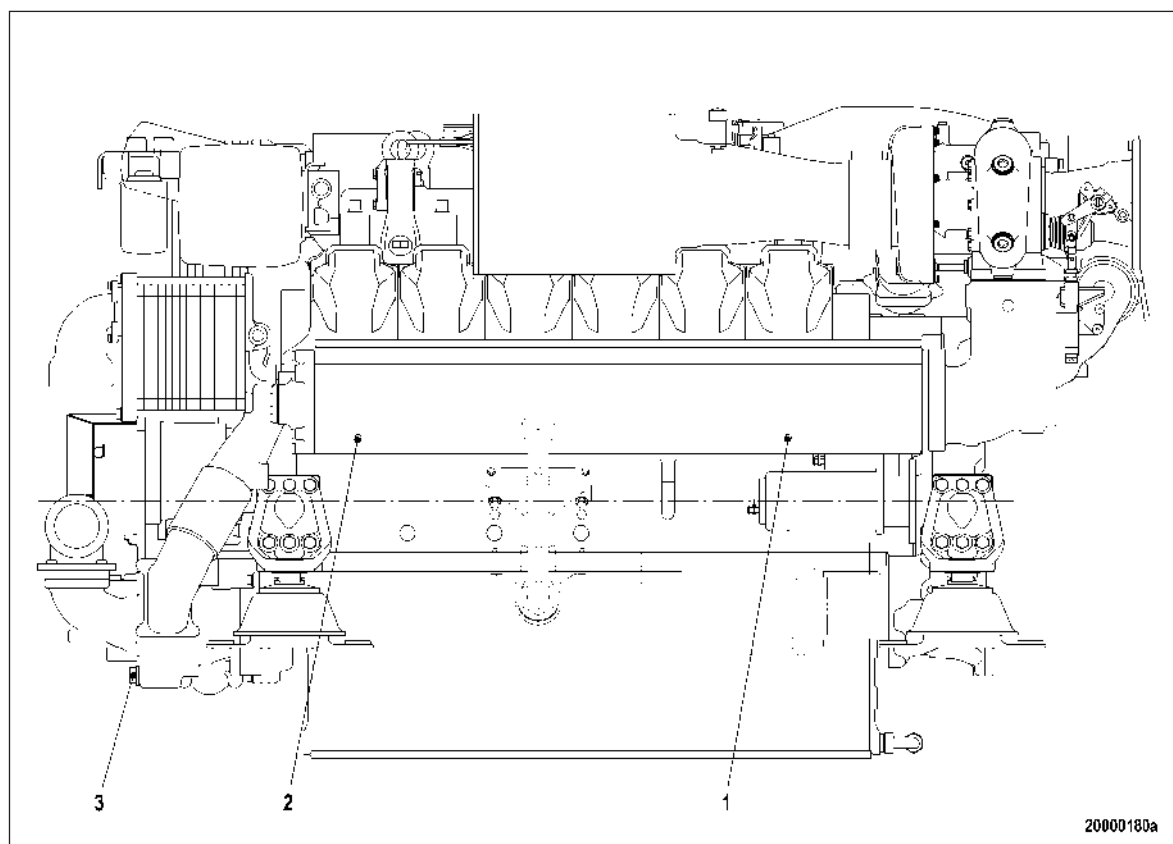


- 1 Engine coolant vent
- 2 Intercooler
- 3 Overflow line

- 4 Engine coolant expansion tank
- 5 Fuel filter

- 6 Engine oil filter

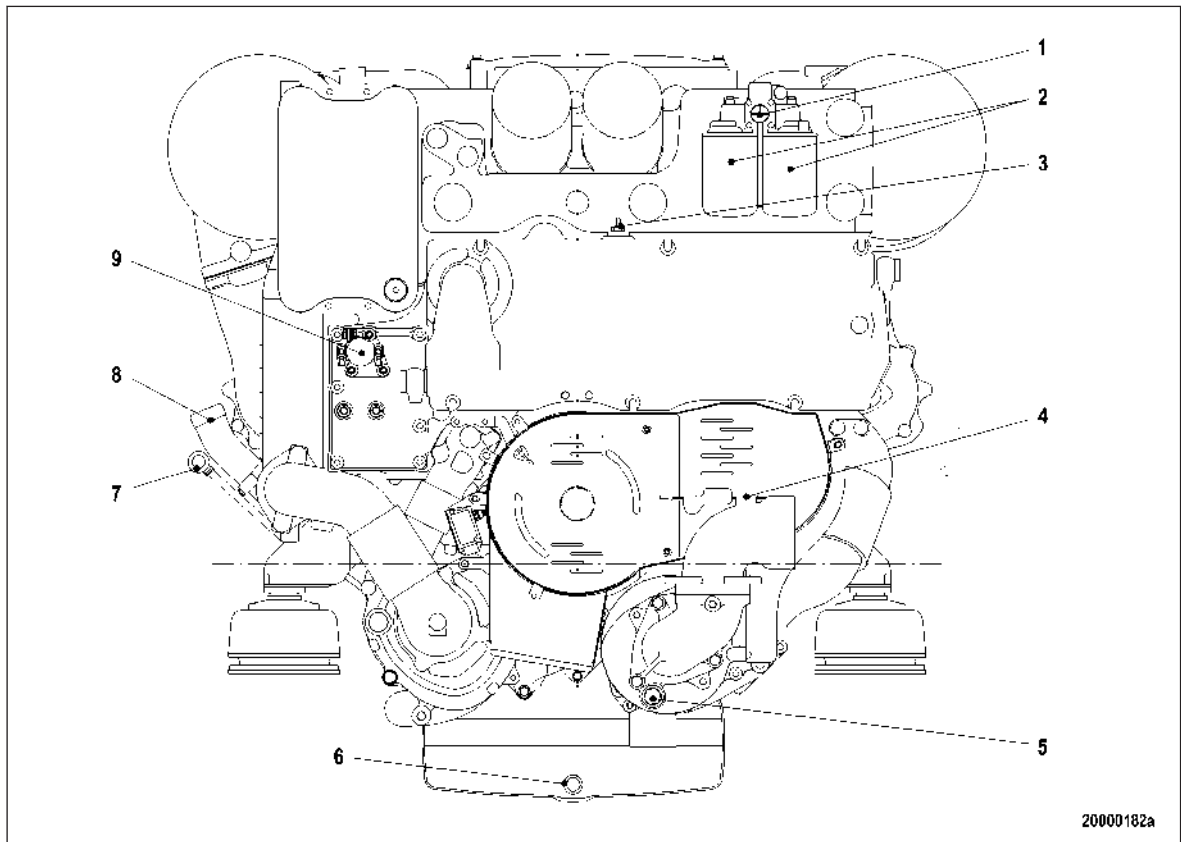
## Left side



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- |                             |                             |
|-----------------------------|-----------------------------|
| 1 Engine coolant drain plug | 3 Raw water pump drain plug |
| 2 Engine coolant drain plug |                             |

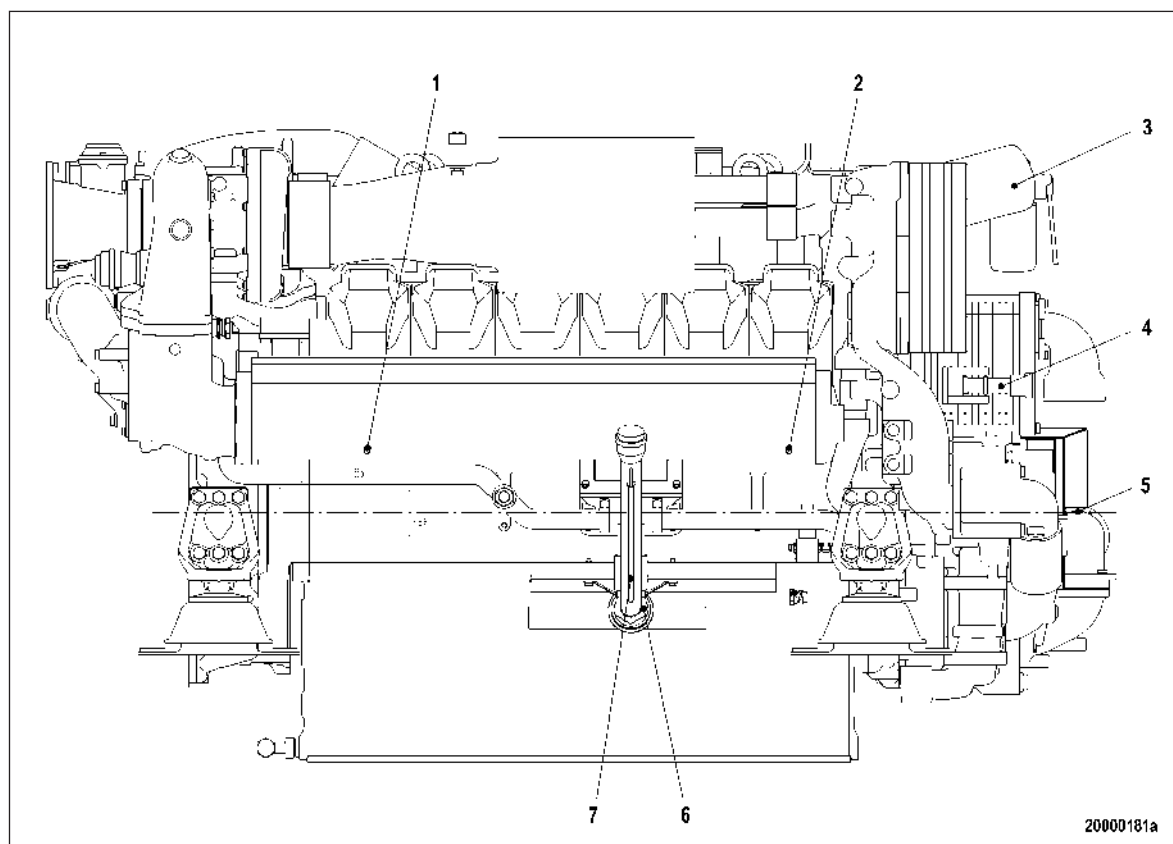
## Free end (KGS)



- |                          |                              |                               |
|--------------------------|------------------------------|-------------------------------|
| 1 Three-way cock         | 6 Connection for oil extrac- | 8 Oil filler neck (connection |
| 2 Fuel filter            | tion                         | left or right engine side     |
| 3 Fuel vent valve        | 7 Oil dipstick (connection   | optional)                     |
| 4 Raw water pump filling | left or right engine side    | 9 Fuel priming pump           |
| plug                     | optional)                    |                               |
| 5 Raw water pump drain   |                              |                               |
| plug                     |                              |                               |



## Right side



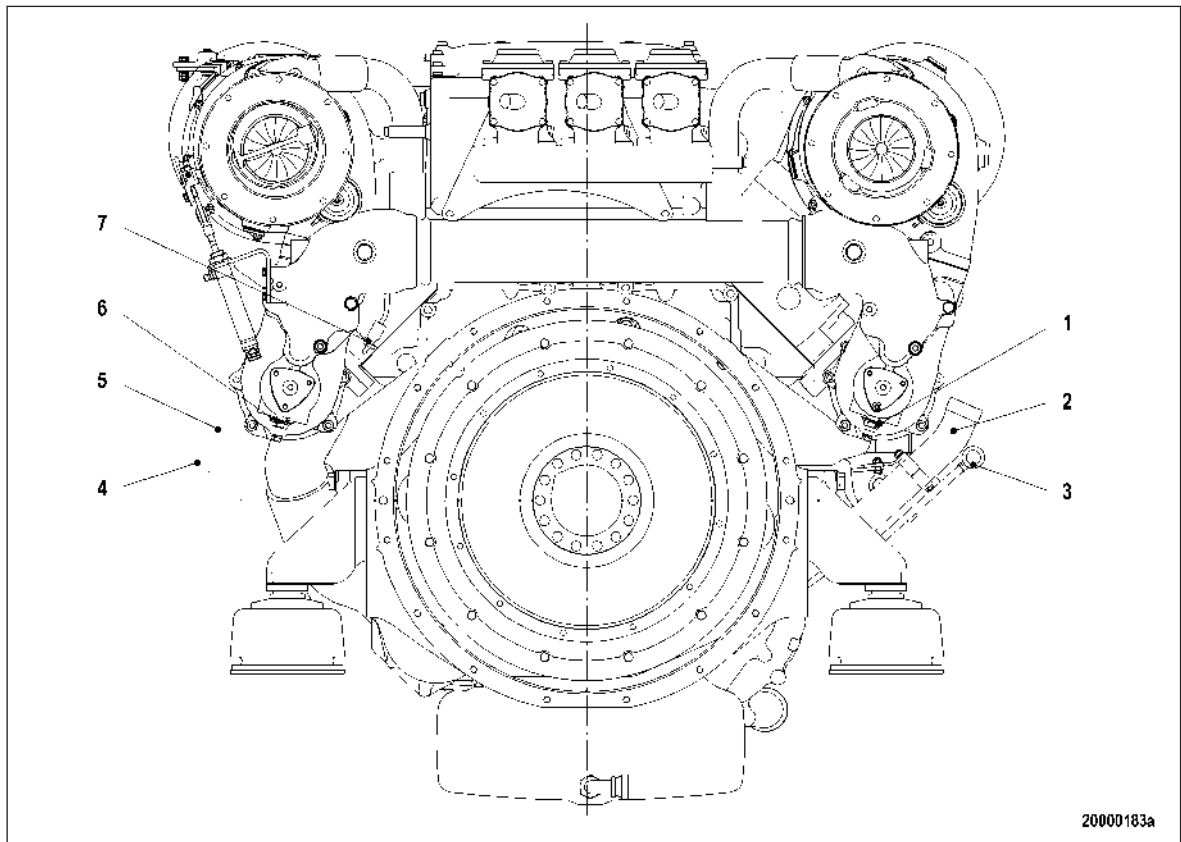
20000181a

- 1 Engine coolant drain plug
- 2 Engine coolant drain plug
- 3 Engine oil filter
- 4 Fuel priming pump
- 5 Raw water pump filling plug

- 6 Oil filler neck (connection left or right engine side optional)
- 7 Oil dipstick (connection left or right engine side optional)

- 4 Leak-off fuel tank

## Driving end (KS)



- |   |   |             |
|---|---|-------------|
| 1 Engine coolant drain plug                                       | 4 Oil dipstick (connection left or right engine side optional)    | 7 Fuel vent |
| 2 Oil filler neck (connection left or right engine side optional) | 5 Oil filler neck (connection left or right engine side optional) |             |
| 3 Oil dipstick (connection left or right engine side optional)    | 6 Engine coolant drain plug                                       |             |

## 7.16.2 Engine coolant – Level check

### Preconditions

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

#### WARNING



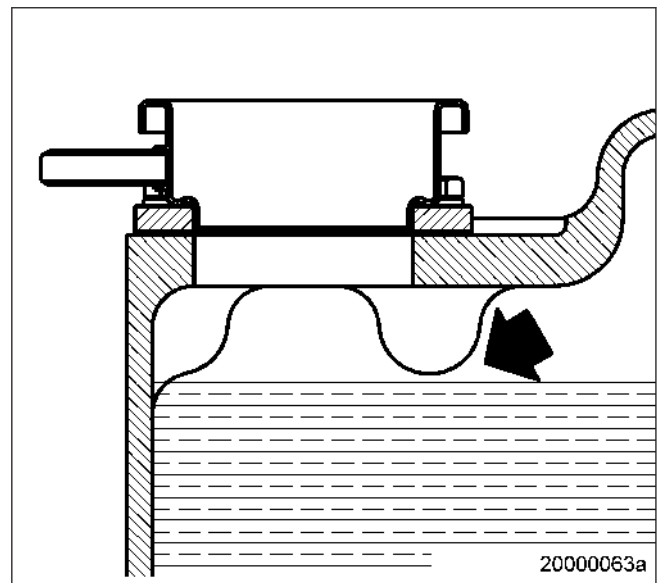
Coolant is hot and under pressure.

#### Risk of injury and scalding!

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

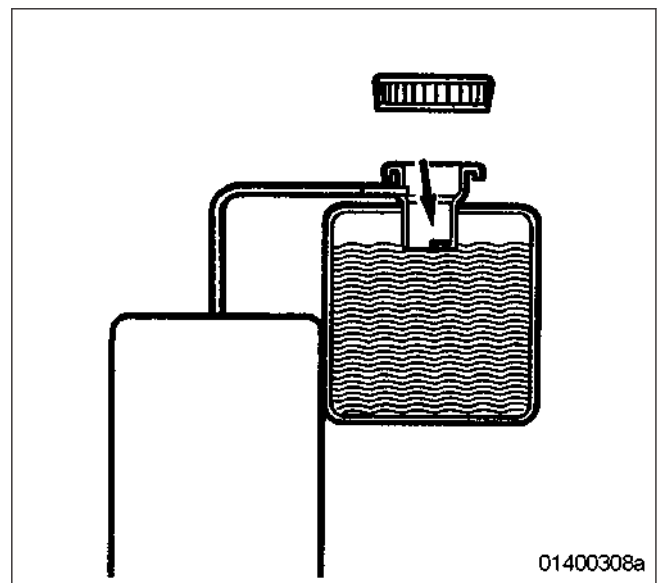
### Checking coolant level at filler neck

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. 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 with treated coolant as necessary (→ Page 135).
3. Check proper condition of breather valve and clean sealing faces.
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 display (coolant level is automatically monitored by engine control system).
2. Top up with treated coolant as necessary (→ Page 135).

7.16.3 Engine coolant – Change

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine coolant		

Changing engine coolant

- 1. Drain engine coolant (→ Page 134).
- 2. Fill with engine coolant (→ Page 135).

## 7.16.4 Engine coolant – Draining

### Preconditions

- ☑ Engine is stopped and starting disabled.

#### WARNING



Coolant is hot and under pressure.

#### **Risk of injury and scalding!**

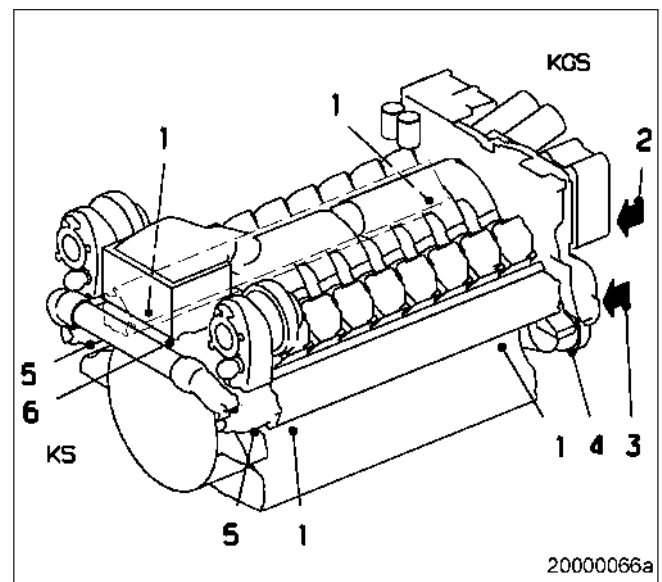
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

### Preparatory steps

1. Provide a suitable receptacle to catch the coolant.
2. Switch off preheating unit.

### Engine coolant draining

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.
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:
  - Drain plug (4)
  - Crankcase (1)
  - Intercooler (6)
  - Exhaust-pipe elbow (5)
  - Heating connection (3)
  - Engine oil heat exchanger (2)
5. Close all open drain points.
6. Place breather valve on filler neck and close.



## 7.16.5 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



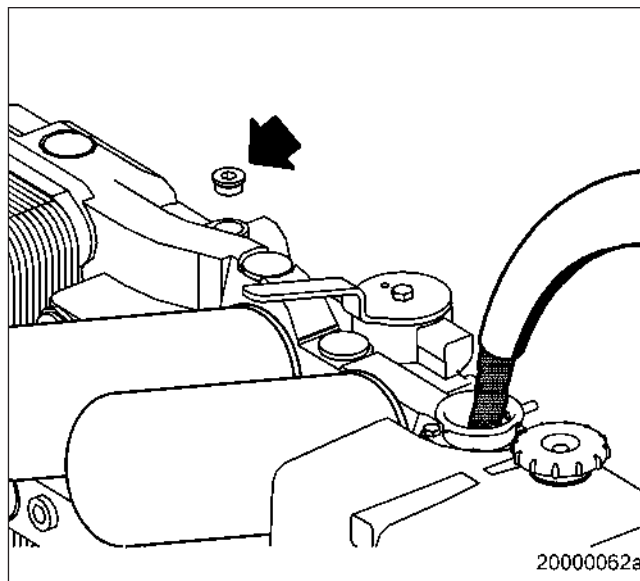
Cold coolant in hot engine can cause thermal stress.

#### **Formation of cracks in components!**

- Fill / top up coolant only into cold engine.

### Filling engine coolant

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. Remove plug (required only for first fill).
4. Pour coolant into engine until coolant level reaches lower edge of cast-in eye of filler neck.
5. Install plug screw.
6. Check proper condition of breather valve and clean sealing faces.
7. Place breather valve on filler neck and close.
8. Start the engine and operate it at idle speed for some minutes.
9. Check coolant level (→ Page 131).



### 7.16.6 HT 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



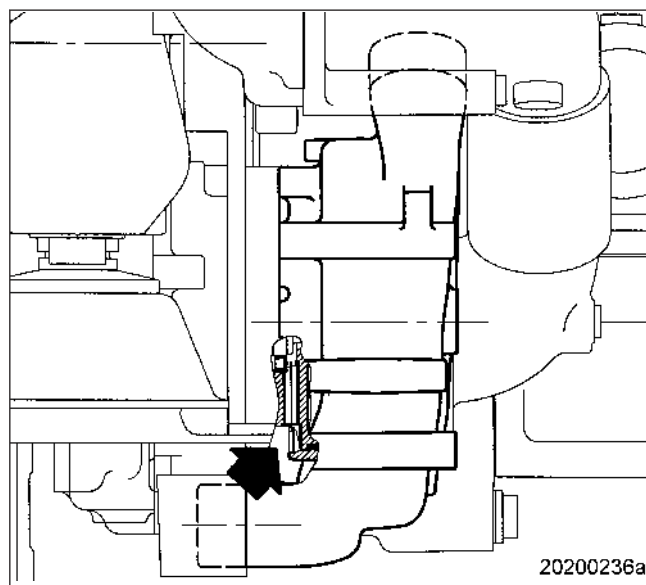
Engine noise above 85 dB (A).

**Risk of damage to hearing!**

- Wear ear protectors.

#### Checking relief bore on HT coolant pump

1. Check relief bore for oil and coolant discharge.
2. Stop engine (→ Page 61) and disable engine start.
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.



## 7.16.7 Engine coolant – Sample extraction and analysis

### 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.
MTU test kit	5605892099/00	1

#### WARNING



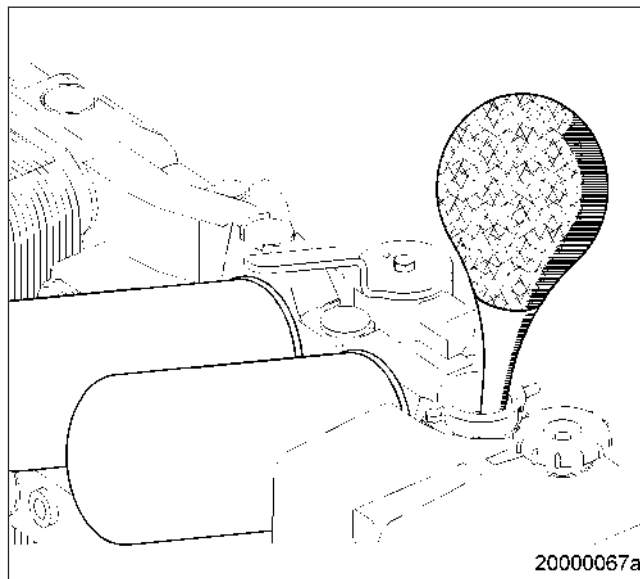
Coolant is hot and under pressure.

#### Risk of injury and scalding!

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

### Engine coolant sample extraction and analysis

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 precipitated corrosion inhibitor oil from expansion tank and dispose of oil.
4. Draw off approx. 1 liter coolant and drain into a clean container.
5. Using the equipment and chemicals from the MTU test kit, examine coolant for:
  - antifreeze concentration;
  - corrosion inhibitor concentration;
  - pH value.
6. Position breather valve on filler neck and close.
7. Change engine coolant according to the coolant operating times specified in (→ MTU Fluids and Lubricants Specifications A001061/..)(→ Page 133).



20000067a



## 7.17 Raw Water Pump with Connections

### 7.17.1 Raw water pump – Relief bore check

#### Preconditions

- ☑ Engine is stopped and starting disabled.

#### DANGER



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

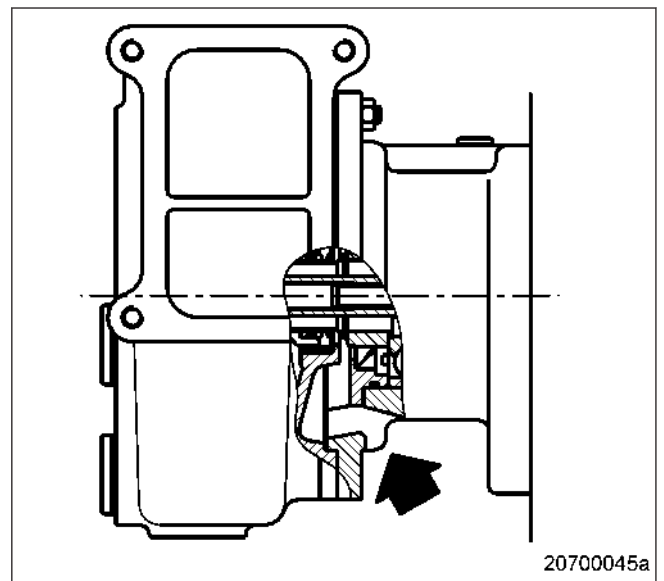
#### WARNING



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

#### Checking relief bore on raw water pump

1. Check relief bore for oil and coolant discharge.
2. 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.
3. If discharge exceeds the specified limits, contact Service.



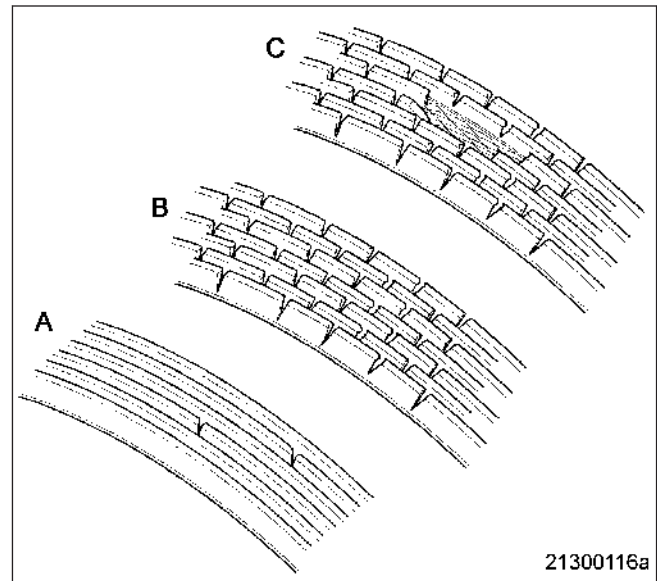
## 7.18 Belt Drive

### 7.18.1 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 over-heating	Replace (→ Page 142)
Drive belt B	Cracks on entire circumference	
Drive belt C	Chunking	

## 7.19 Battery-Charging Generator

### 7.19.1 Battery-charging generator drive – Drive belt check and adjustment

#### Preconditions

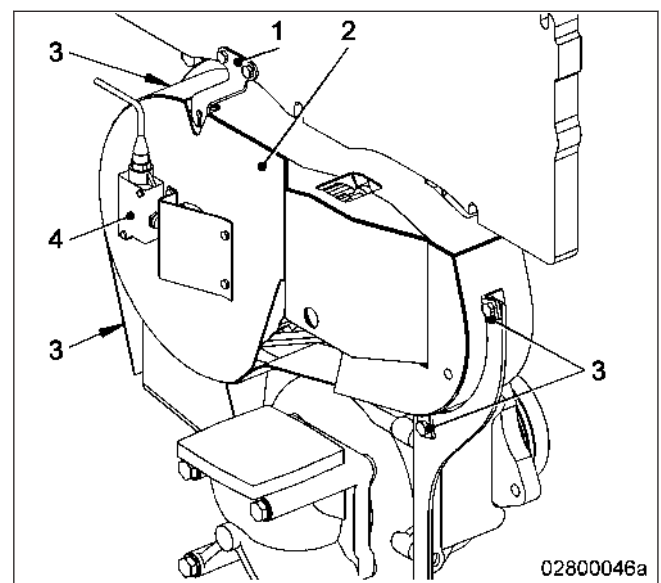
- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Assembly device	F6559691	1

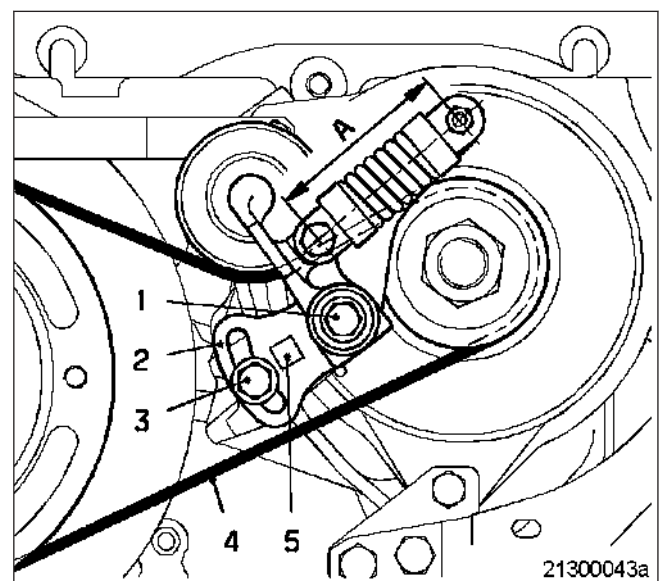
#### Preparatory steps

1. Remove limit switch (4).
2. Remove indicator (1).
3. Remove screws (3) of protective cover (2).
4. Remove protective cover.
5. Check drive belt condition (→ Page 138).



#### Belt drive – Checking distance

1. Measure distance (A) with assembly device.
2. If measured value of distance (A) is not within the tolerance of  $98 \text{ mm} \pm 1.5 \text{ mm}$ , re-adjust belt tension.

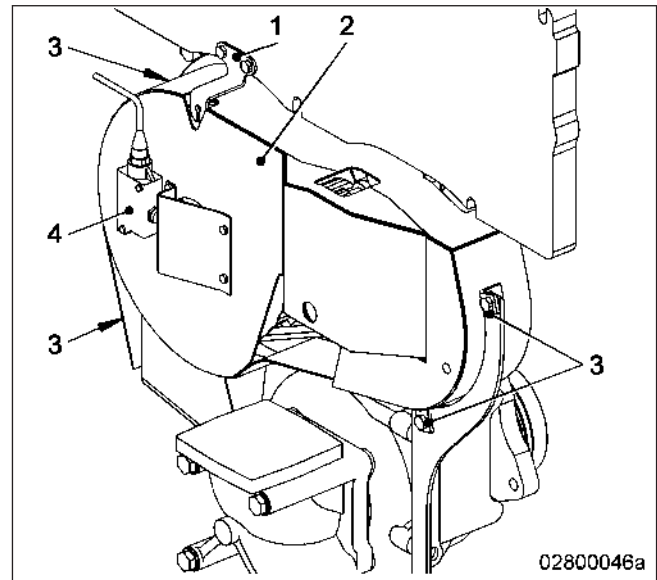


## Adjusting belt tension

1. Hold adjustment lever (2) at square (5).
2. Rotate adjusting lever until drive belt (4) is released.
3. Loosen screws (1) and (3).
4. Use assembly device to adjust distance (A) by turning adjustment lever (2).
5. Tighten screws (1) and (3).
6. Measure distance (A) with assembly device.

## Final steps

1. Install protective cover (2).
2. Install securing screws (3) of protective cover (2).
3. Install indicator (1).
4. Install limit switch (4).



## 7.19.2 Battery-charging generator drive – Drive belt replacement

### Preconditions

- ☒ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Mandrel	8205892861/08	1

### Preparatory steps

1. Remove safety equipment (if fitted).
2. Remove screws of protective cover (engine free end).
3. Remove protective cover.

### Drive belt – Replacement

1. Hold adjusting lever at square.
2. Rotate adjusting lever until drive belt is released.
3. Use mandrel to lock adjusting lever in position.
4. Remove drive belt.
5. Check cleanness of belt pulleys.
6. Fit new drive belt.
7. Remove mandrel.

### Final steps

1. Install protective cover.
2. Install screws of protective cover.
3. Install safety equipment (if fitted).
4. Check function of safety equipment (if fitted).

## 7.20 Engine Mounting / Support

### 7.20.1 Engine mounting – Checking condition of resilient mounts

#### Preconditions

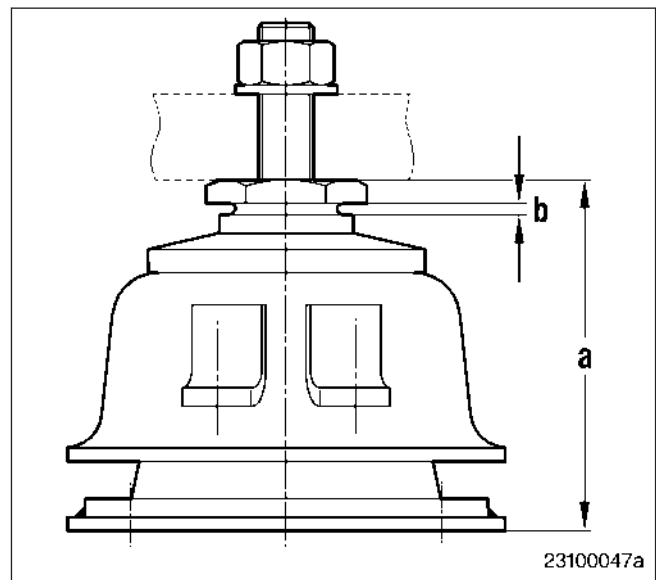
- ☑ Engine is stopped and starting disabled.
- ☑ Engine is filled with engine coolant and engine oil.
- ☑ Engine is under static load.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Feeler gauge	Y4342013	1
Vernier caliper	2000275	1

#### Engine mounting – Checking condition of resilient mounts

1. Measure height setting (b) with feeler gauge.
2. Measure dimension (a) with calipers.
3. Calculate permissible value of dimension (a), considering the measured value of height adjustment (b):
  - Reference values: The permissible value of dimension (a) is 144 mm when (b) = 5 mm.
  - When measured height setting (b) = 6 mm, the permissible value of (a) is 145 mm.
  - When measured height setting (b) = 4 mm, the permissible value of (a) is 143 mm.
4. Replace the resilient mount, if the measured value of dimension (a) is lower than the permissible value.



## 7.21 Universal Shaft

### 7.21.1 Universal shaft – Greasing

#### Preconditions

- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Lithium-soap greases according to DIN2-KP K-20		

#### CAUTION



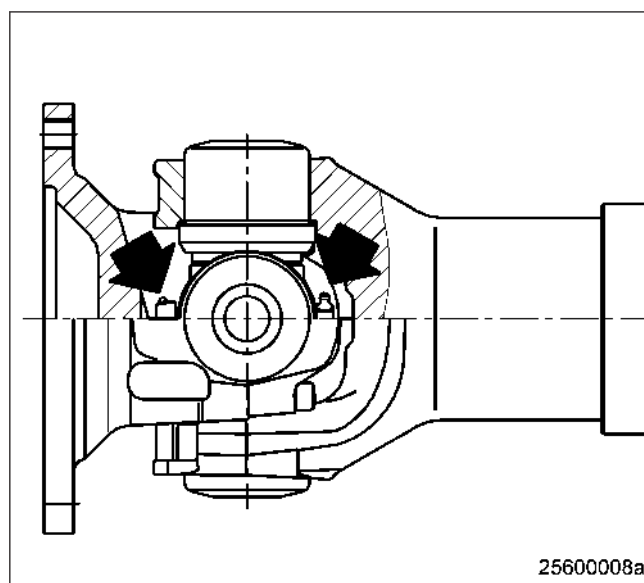
Damage to component.

#### Serious damage to plant!

- Never press grease in at high pressure or with short, sharp movements.
- Maximum admissible greasing pressure: 15 bar.

#### Universal shaft – Greasing

1. Remove guard from universal shaft.
2. Clean the two grease nipples on each joint half.
3. Press grease into all nipples until it emerges at the star seals and sealing rings.
4. Reinstall guard.



## 7.22 Wiring (General) for Engine/Gearbox/Unit

### 7.22.1 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.



## 7.23 Accessories for (Electronic) Engine Governor / Control System

### 7.23.1 Engine governor and connectors – Cleaning

#### Preconditions

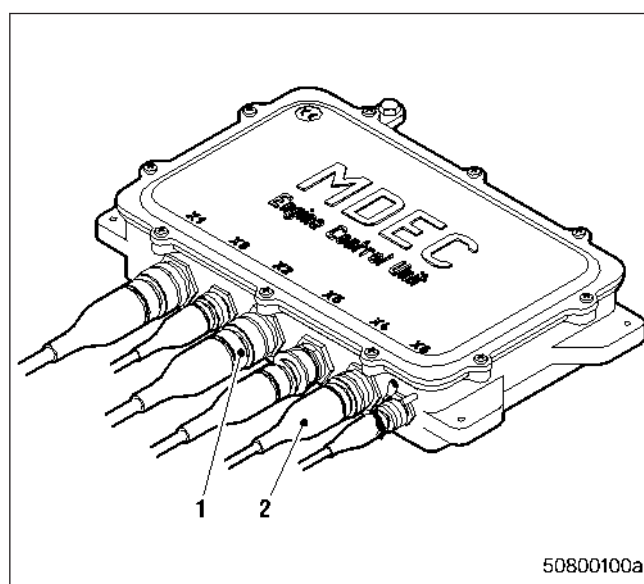
- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Connector pliers	0135315483	1
Isopropyl alcohol	X00058037	1

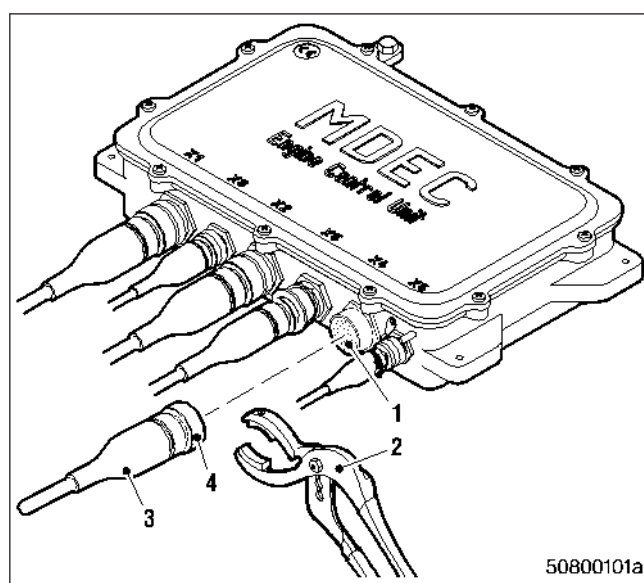
#### Cleaning engine governor and connectors

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 governor

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 governor plug connections (→ Page 149).



## 7.23.2 Engine monitoring unit and connectors – Cleaning

### Preconditions

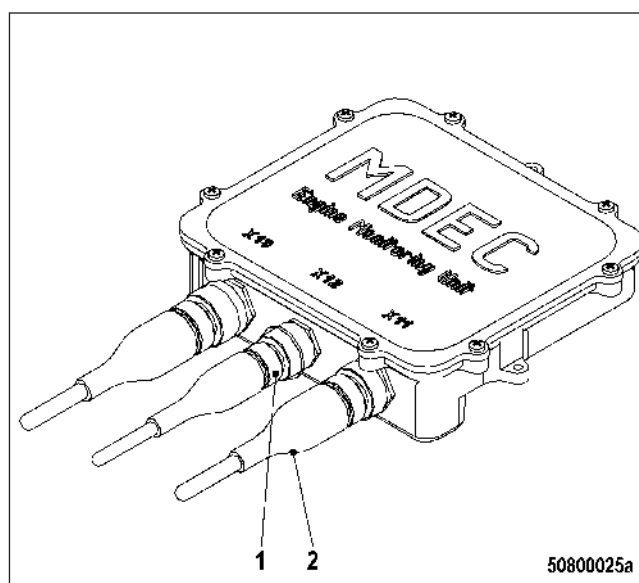
- ☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Connector pliers	0135315483	1
Isopropyl alcohol	X00058037	1

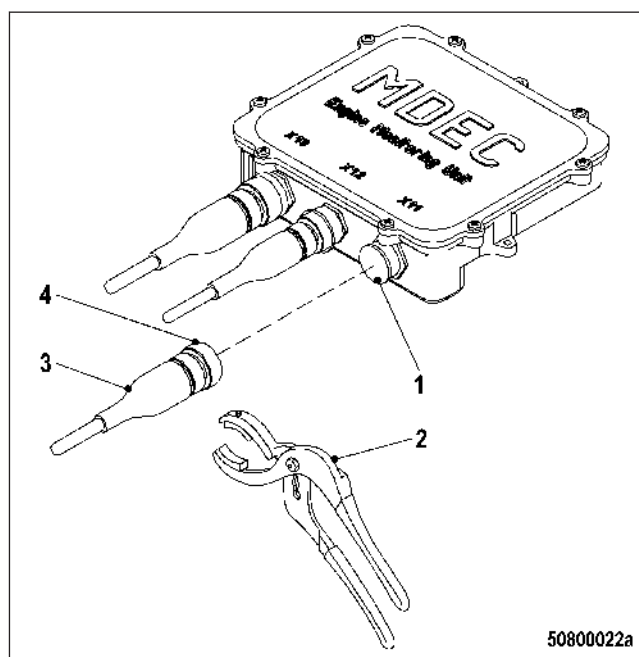
### Engine monitoring unit and connectors – Cleaning

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



### Cleaning severely contaminated EMU connectors

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 plug connections on EMU (→ Page 150).



### 7.23.3 Start interlock limit switch – Check

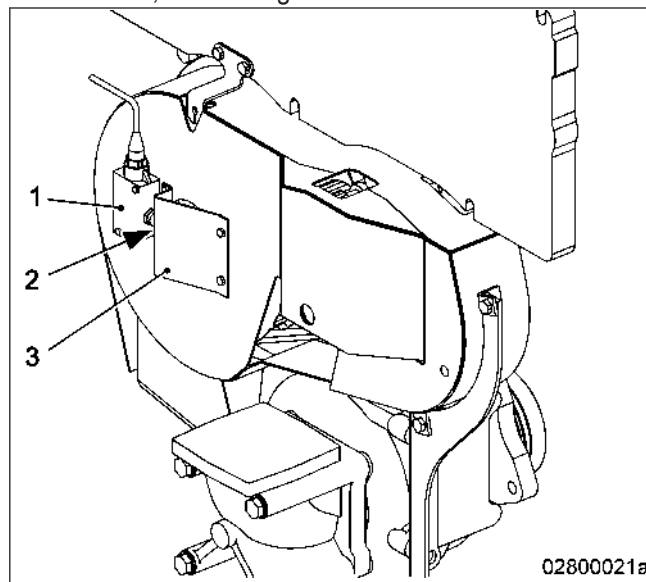
#### Preconditions

- ☑ Engine is stopped and starting disabled.

Note: Being in OFF-position, the limit switch initiates start interlock, i.e. the engine cannot be started.

#### Start interlock limit switch – Check

1. Check if switch housing (1) and cover plate (3) are mounted and the switch (2) is in ON-position.
2. If switch housing (1) and/or cover plate (3) is/are not mounted:
  - Secure cover plate (3) with screws.
  - Then install switch housing (1) with screws, ensuring that the switch (2) is actuated by the cover plate (3).
3. If switch housing (1) and cover plate (3) are mounted, but switch (2) is in OFF-position:
  - Make certain that the cover plate (3) at the side of the switch (2) is not distorted.
  - Loosen switch housing (1) and fit it with screws in a position providing that the switch (2) is ON.
  - If this is not feasible, contact Service.



7.23.4 Engine control unit plug connections – Check

Preconditions

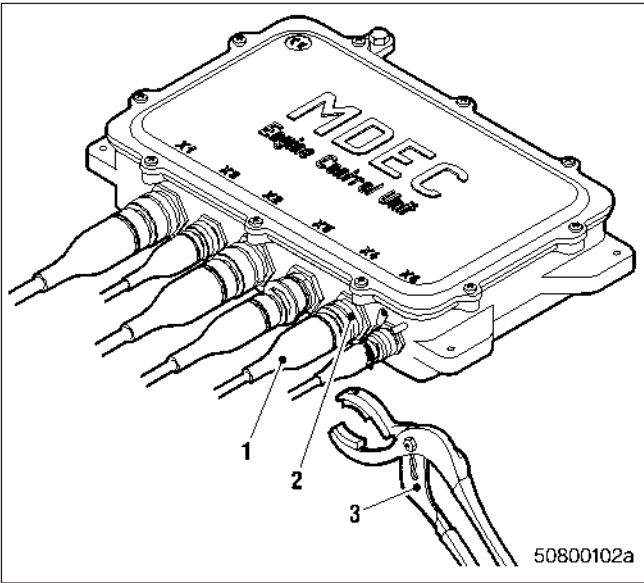
- ☑ Engine shut down and starting disabled.

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.



### 7.23.5 Engine monitoring unit – Plug connection check

#### Preconditions

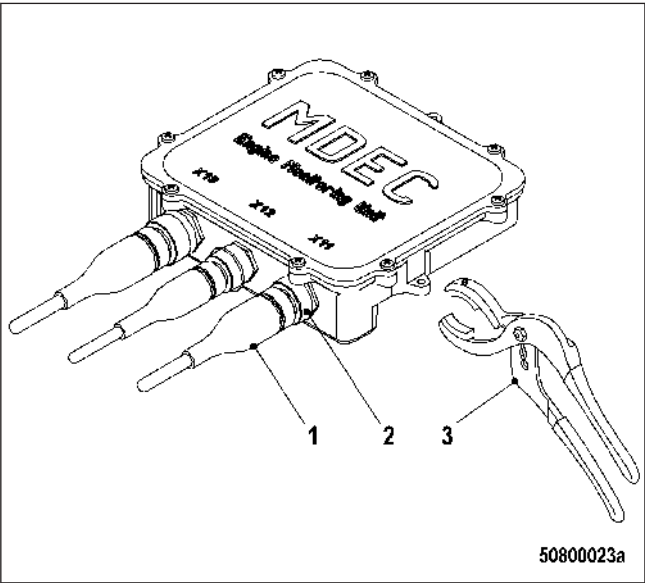
- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

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

#### Checking engine monitoring unit plug connections

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



### 7.23.6 Engine control unit – Removal and installation

#### Preconditions

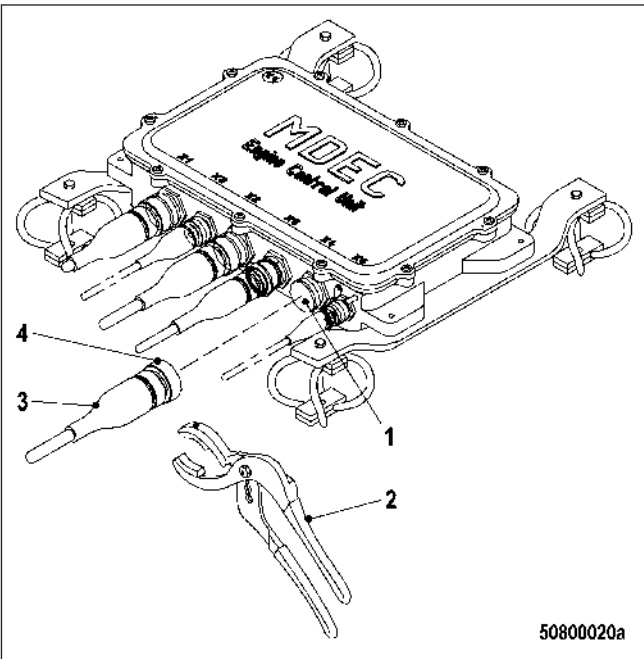
- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

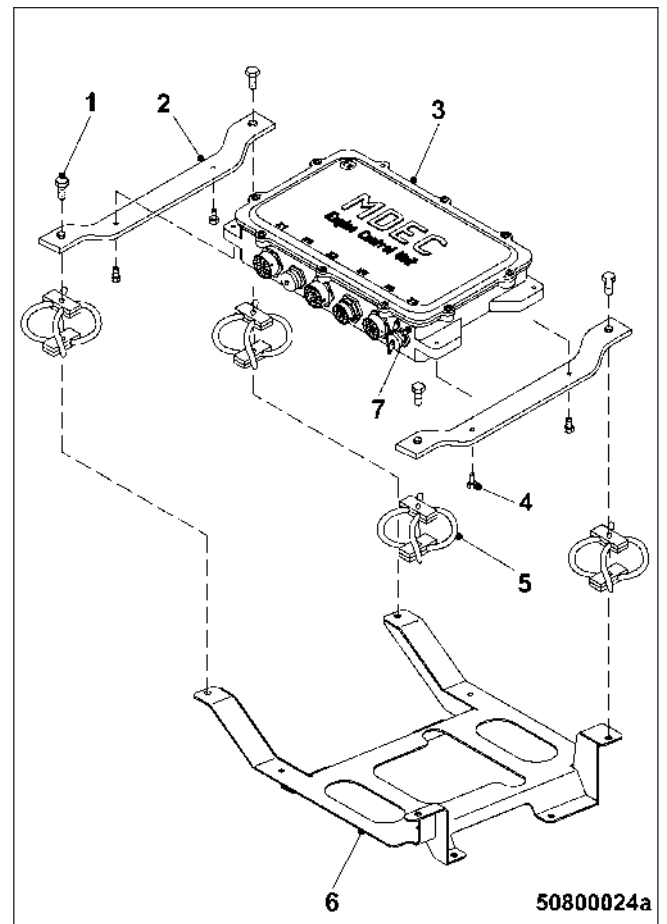
Designation / Use	Part No.	Qty.
Connector pliers	0135315483	1
Covering caps for Cannon sockets		

#### Removing control unit from engine

1. Note or mark assignment of cables to connector sockets.
2. Use connector pliers (2) to disengage the bayonet union nuts (4) of the connectors (3) by turning them counterclockwise.
3. Remove all connectors.
4. Close connector sockets with appropriate covering caps (1).



5. Disconnect ground strap from engine control unit grounding stud (7).
6. If the screws (4) are easily accessible:
  1. Remove screws (4).
  2. Remove engine control unit housing (3) from mounting plates (2).
  3. Unscrew mounting plates (2), cable shock absorbers (5) and further fastening parts (6) as one unit from engine.
7. If the screws (4) are not easily accessible:
  1. Unscrew screws (1).
  2. Remove engine control unit housing (3) together with mounting plates (2).
  3. Unscrew cable shock absorbers (5) and further fastening parts (6) as one unit from engine.



### Installing engine control unit on engine

1. Install in reverse order. Ensure correct assignment of plugs and sockets.
2. Use connector pliers to turn the bayonet union nuts of the connectors clockwise until they lock into place.

## 7.24 Emergency Instrumentation (Local Operating Panel)

### 7.24.1 LOP and connectors – Cleaning

#### Preconditions

- ☒ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

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

#### Cleaning LOP

1. Wipe LCD display with dry cloth, without applying excessive pressure.
2. Remove dirt from keys using isopropyl alcohol.
3. Remove heavy soiling from housing surface with isopropyl alcohol.

#### Cleaning connectors on LOP

1. Remove dirt from connector and socket surfaces using isopropyl alcohol.
2. Check legibility of cable labels. Clean or replace illegible labels.



## 7.24.2 LOP – Visual inspection

### Preconditions

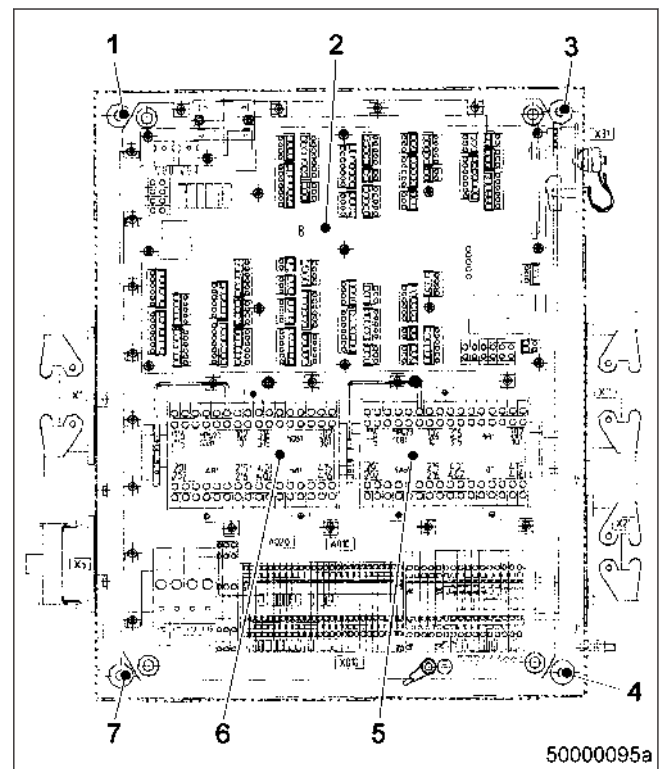
- ☑ Engine is stopped and starting disabled.

### Preparatory steps

1. If READY FOR OPERATION pushbutton is illuminated brightly, press switch briefly.  
Result: READY FOR OPERATION pushbutton returns to basic brightness.
2. Switch master power switch to OFF.
3. Disconnect battery in accordance with battery manufacturer's instructions.

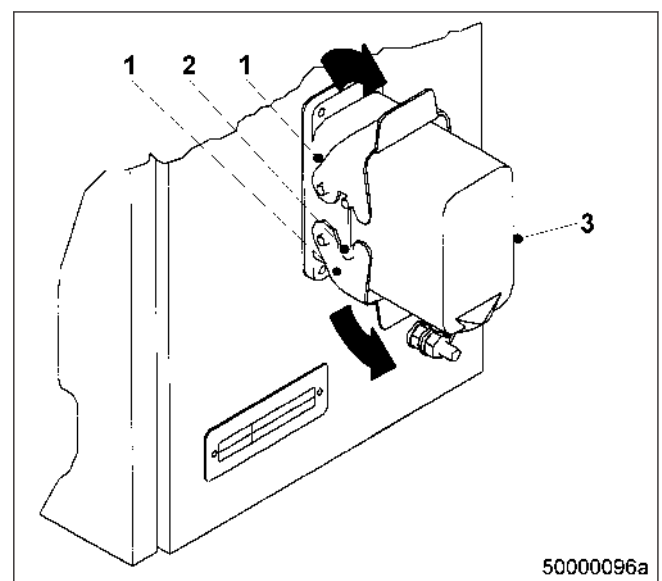
### Checking housing and internal assemblies for secure seating

1. Open LOP front door.
2. Check securing screws (1, 3, 4, 7) for firm seating. Tighten loose threaded connections.
3. Check internal assemblies for firm seating, this applies in particular to printed circuit board (2) and PIMs (5, 6). Tighten loose threaded connections.
4. Close LOP front door.



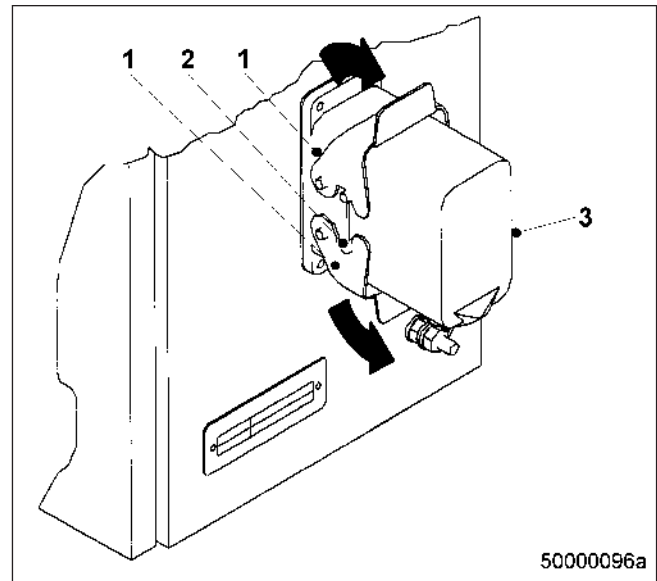
### Checking plug connections

1. Check all connected cables to verify that the two securing elements (1) are engaged on the lugs (2) so that the respective male connector (3) is held firmly in place in the socket.
2. If this is not the case, press the securing elements (1) concerned in the direction of the arrow until they engage noticeably.



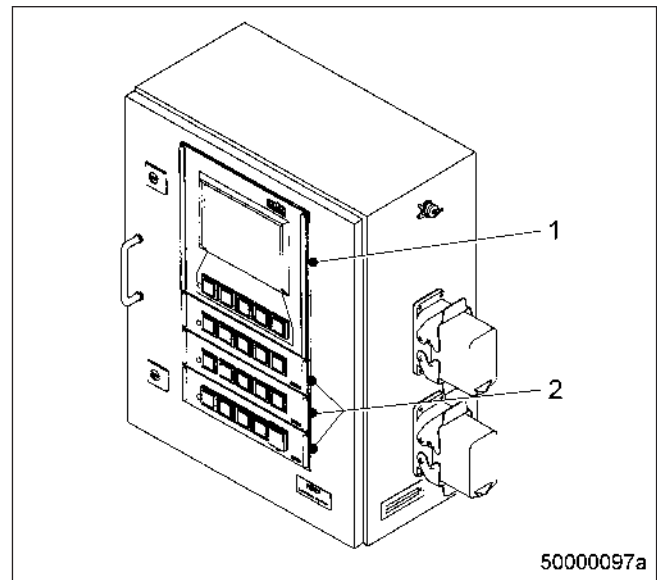
### Checking unassigned connector sockets

1. Ensure that non-assigned connector sockets are protected with covering caps.
2. Make certain that the two securing elements (1) are engaged in the lugs (2) so that the covering cap (3) is held firmly in place in the socket.
3. If this is not the case, press the securing elements (1) concerned in the direction of the arrow until they engage noticeably.



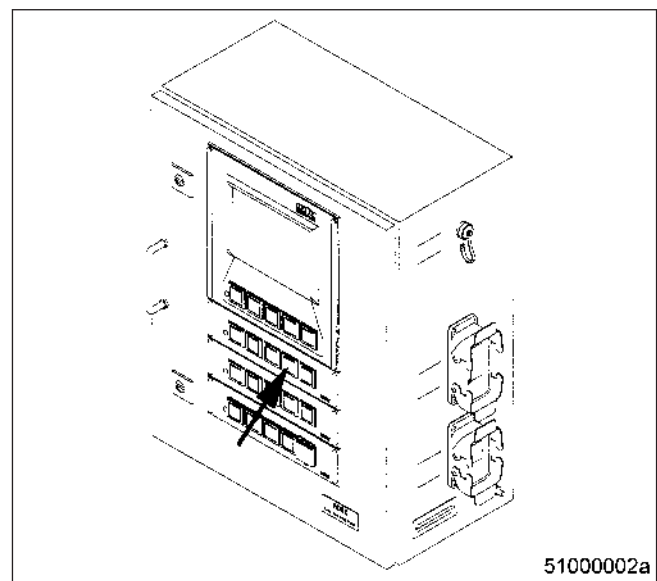
### Checking pushbuttons and display

1. Pushbuttons: Ensure that
  - Pushbutton caps are not damaged (cracks or similar damage)
  - Pushbuttons move easily
  - Pushbutton housings are seated securely
  - Seals (2) between PAN control panels and LOP housing are not damaged.
2. Display: Ensure that
  - Front glass is not damaged or pressed in
  - Seal (1) between display housing and LOP housing is not damaged.
3. Have damaged components replaced immediately by Service.



### Performing lamp test

1. Connect battery in accordance with battery manufacturer's instructions.
  2. Switch master power switch to ON.
  3. Switch on engine control system.
  4. Hold down LAMP TEST pushbutton:
- Result: Indicators and controls light up.
5. Have damaged lamps immediately replaced by Service.



### 7.24.3 LOP – Test procedures

#### Preconditions

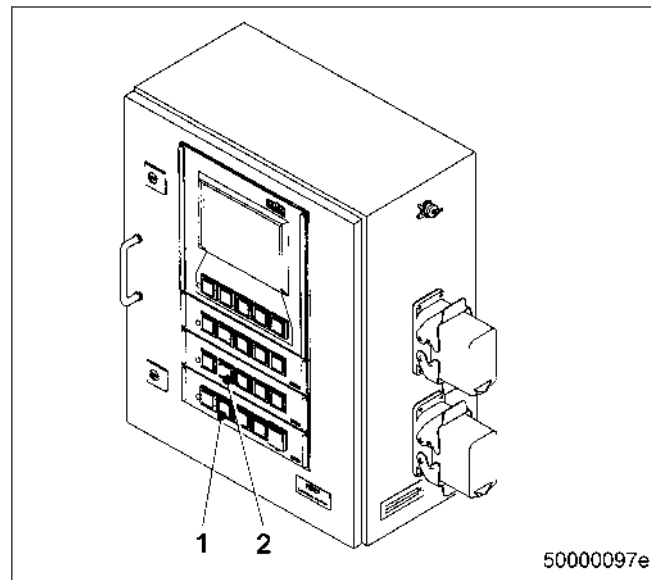
- ☑ Engine is stopped and starting disabled.

#### Preparatory steps

1. Connect battery in accordance with battery manufacturer's instructions.
2. Switch master power switch to ON.
3. Switch on engine management system ECS-5.

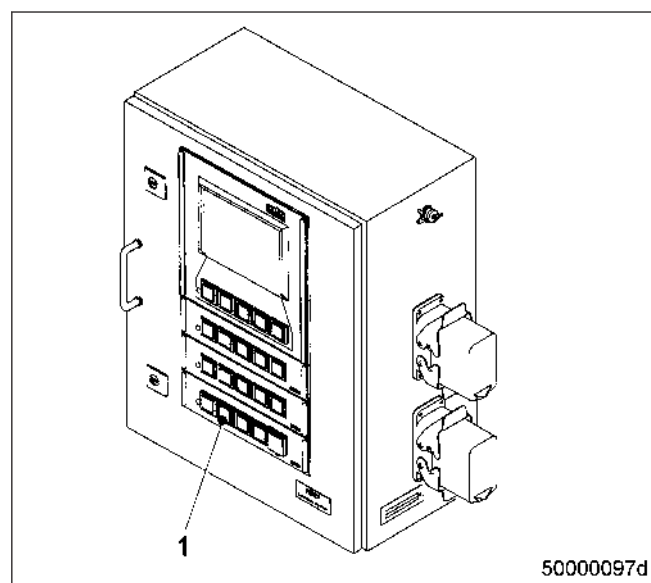
Result:

- LOCAL OPERATION button (1) is illuminated brightly (local control mode is active);
- CLUTCH NEUTRAL button (2) is illuminated brightly (gearbox disengaged).



#### Switching between local and remote control mode

1. Press LOCAL OPERATION button (1).
- Result:
- LOCAL OPERATION button (1) flashes: Setting does not correspond with feedback signal from ECU and GCU.
  - LOCAL OPERATION button (1) is illuminated at basic brightness: Remote control mode is active.
2. Press LOCAL OPERATION button (1) again.
- Result: LOCAL OPERATION button (1) is illuminated brightly (local control mode is active);



## Overspeed test with the engine at standstill

Note: Overspeed test with the engine at standstill can only be carried out if the engine is equipped with a monitoring unit.

1. Press TEST OVERSPEED button (3). Observe speed limit and speed simulated by the engine monitoring unit on display.

Result:

- Engine governor is deenergized by the safety system.
- On engines with emergency air-shutoff flaps: Flaps close.
- EMERGENCY STOP button (2) flashes; Signalization (horn, beacon etc.) is released; ALARM ACKNOWLEDGE button (1) is illuminated brightly.

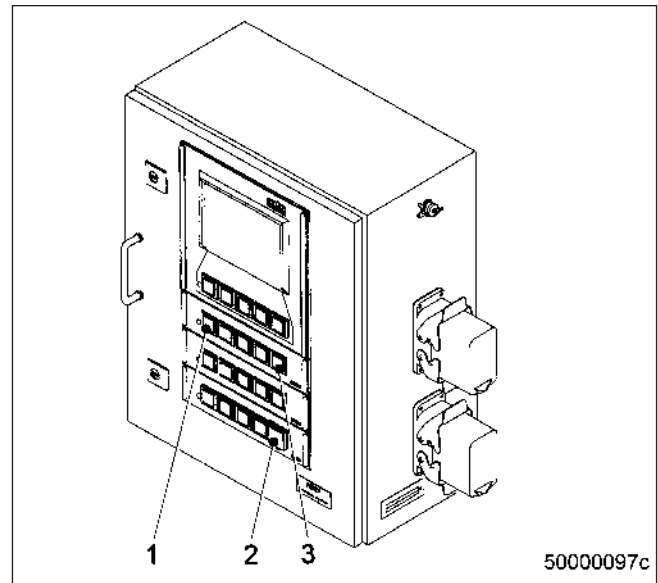
2. Press ALARM ACKNOWLEDGE button (1).

Result: Audible and visual signalization stops.

3. Press ALARM ACKNOWLEDGE button (1) again.

Result: Power supply to engine governor is re-established.

4. On engines with emergency air-shutoff flaps: open flaps.



## Emergency stop simulation with the engine at standstill

1. Open cap of EMERGENCY STOP button (2).

2. Press EMERGENCY STOP button (2).

Result:

- Engine governor is deenergized by the safety system.
- On engines with emergency air-shutoff flaps: Flaps close.
- EMERGENCY STOP button (2) flashes; Signalization (horn, beacon etc.) is released; ALARM ACKNOWLEDGE button (1) is illuminated brightly.

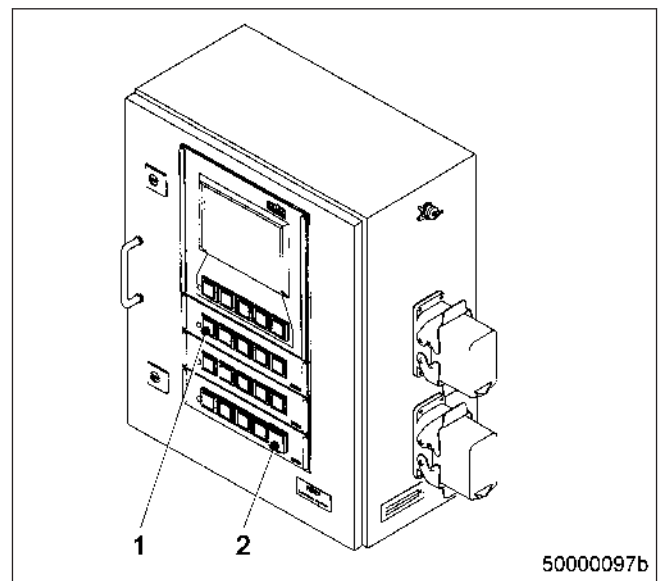
3. Press ALARM ACKNOWLEDGE button (1).

Result: Audible and visual signalization stops.

4. Press ALARM ACKNOWLEDGE button (1) again.

Result: Power supply to engine governor is re-established.

5. On engines with emergency air-shutoff flaps: open flaps.



## 8 Appendix A

### 8.1 Abbreviations

Abbrevia- tion	Meaning	Explanation
ADEC	Advanced Diesel Engine Control	Engine governor
AL	Alarm	Alarm (general)
ANSI	American National Standards Institute	Association of American standardization organiza- tions
ATL	Abgasturbolader	Exhaust turbocharger (ETC)
BR	Baureihe	Series
BV	Betriebsstoffvorschrift	MTU Fluids and Lubricants Specifications, Publica- tion No. A01061/..
CAN	Controller Area Network	Data bus system, bus standard
CCG	Cross Connection Gear	Transfer gearbox
CODAG	Combined Diesel (engine) And Gas (turbine propulsion)	
CPP	Controllable Pitch Propeller	
DAG	Diesel (engine) And Gas (turbine)	
DE	Diesel Engine	
DIN	Deutsches Institut für Normung e. V.	At the same time identifier of German standards (DIN = "Deutsche Industrie-Norm")
DIS	Display unit	
DL	Default Lost	Alarm: CAN bus missing
ECS	Engine Control System	
ECS-UNI	Engine Control System UNiversal	
ECU	Engine Control Unit	Engine governor
EDM	Engine Data Module	
EMU	Engine Monitoring Unit	
ETK	Ersatzteilkatalog	Spare Parts Catalog (SPC)
FPP	Fixed Pitch Propeller	
GCU	Gear Control Unit	
GMU	Gear Monitoring Unit	
GT	Gas Turbine	
HAT	Harbor Acceptance Test	
HI	High	Alarm: Measured value exceeds 1st maximum limit
HIHI	High High	Alarm: Measured value exceeds 2nd maximum lim- it value
HT	High Temperature	
ICFN	ISO – Continuous rating – Fuel stop power – Net	Power specification in accordance with DIN-ISO 3046-7

Abbrevia- tion	Meaning	Explanation
IDM	Interface Data Module	
IMO	International Maritime Organization	
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
LCD	Liquid Crystal Display, Liquid Crystal Device	
LCU	Local Control Unit	LOP subassembly
LED	Light Emitting Diode	
LMU	Local Monitoring Unit	LOP subassembly
LO	Low	Alarm: Measured value lower than 1st minimum limit value
LOLO	Low Low	Alarm: Measured value lower than 2nd minimum limit value
LOP	Local Operating Panel	Control console, control panel
LOS	Local Operating Station	
MCS	Monitoring and Control System	
MG	Message	
MPU	Microprocessor Unit, Microprocessing Unit	
MRG	Main Reduction Gear	
OT	Oberer Totpunkt	Top Dead Center (TDC)
P-xyz	Pressure-xyz	Pressure measuring point xyz
PAN	Panel	Control panel
PCU	Propeller Control Unit	
PIM	Peripheral Interface Module	
PT	Power Turbine	
RCS	Remote Control System	
RL	Redundancy Lost	Alarm: Redundant CAN bus missing
SAE	Society of Automotive Engineers	U.S. standardization organization
SAT	Sea Acceptance Test	
SD	Sensor Defect	Alarm: Sensor failure
SDAF	Shut Down Air Flaps	Emergency-air shutoff flap(s)
SOLAS	International Convention for the Safety of Life at Sea	
SS	Safety System	Safety system alarm
SSK	Schnellschlussklappe(n)	Emergency air shut-off flaps
SSS	Synchronized Self-Shifting (clutch)	
STBD	Starboard	
T-xyz	Temperature-xyz	Temperature measuring point xyz

Abbrevia- tion	Meaning	Explanation
TD	Transmitter Deviation	Alarm: Deviation in transmitter values
UT	Unterer Totpunkt	Bottom Dead Center (BDC)
VS	Voith Schneider	Voith Schneider drive
WJ	Water jet	Water jet drive
WZK	Werkzeugkatalog	Tool Catalog (TC)
ZKP	Zugehörigkeit-Kategorie-Parameter	Assignment category parameter; number scheme for signals from the ADEC engine governor

## 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](mailto:Service-support@mtu-online.com)

### **Spare parts service**

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## 9 Appendix B

### 9.1 Special Tools

#### Assembly device

Part No.: F6559691

Qty.: 1

Used in: 7.19.1 Battery-charging generator drive – Drive belt check and adjustment (→ Page 139)

#### Connector pliers

Part No.: 0135315483

Qty.: 1

Used in: 7.1.2 Engine cranking on starter (→ Page 77)

Qty.: 1

Used in: 7.23.1 Engine governor and connectors – Cleaning (→ Page 145)

Qty.: 1

Used in: 7.23.2 Engine monitoring unit and connectors – Cleaning (→ Page 146)

Qty.: 1

Used in: 7.23.4 Engine control unit plug connections – Check (→ Page 148)

Qty.: 1

Used in: 7.23.5 Engine monitoring unit – Plug connection check (→ Page 149)

Qty.: 1

Used in: 7.23.6 Engine control unit – Removal and installation (→ Page 150)

#### Crow-foot box wrench

Part No.: F30027424

Qty.: 1

Used in: 7.5.2 Injection pump – Removal and installation (→ Page 90)

#### Crow-foot box wrench

Part No.: F30027425

Qty.: 1

Used in: 7.5.2 Injection pump – Removal and installation (→ Page 90)

#### Crowfoot box wrench

Part No.: F30027425

Qty.: 1

Used in: 7.6.2 Injector – Removal and installation (→ Page 94)

Qty.: 1

Used in: 7.7.1 HP fuel line – Pressure pipe neck replacement (→ Page 98)

Double-head box wrench	
Part No.:	F30011450
Qty.:	1
Used in:	7.6.2 Injector – Removal and installation (→ Page 94)
Qty.:	1
Used in:	7.7.1 HP fuel line – Pressure pipe neck replacement (→ Page 98)
Feeler gauge	
Part No.:	Y4342013
Qty.:	1
Used in:	7.4.1 Valve clearance – Check and adjustment (→ Page 85)
Qty.:	1
Used in:	7.20.1 Engine mounting – Checking condition of resilient mounts (→ Page 142)
Fuel suction device	
Part No.:	F30378207
Qty.:	1
Used in:	7.6.2 Injector – Removal and installation (→ Page 94)
Mandrel	
Part No.:	8205892861/08
Qty.:	1
Used in:	7.19.2 Battery-charging generator drive – Drive belt replacement (→ Page 141)
MTU test kit	
Part No.:	5605892099/00
Qty.:	1
Used in:	7.16.7 Engine coolant – Sample extraction and analysis (→ Page 136)
Oil filter wrench	
Part No.:	F30379104
Qty.:	1
Used in:	7.8.1 Fuel filter – Replacement (→ Page 103)
Qty.:	1
Used in:	7.15.2 Engine oil filter – Replacement (→ Page 121)
Open end socket wrench	
Part No.:	F30025897
Qty.:	1
Used in:	7.6.2 Injector – Removal and installation (→ Page 94)
Qty.:	1
Used in:	7.7.1 HP fuel line – Pressure pipe neck replacement (→ Page 98)
Puller	
Part No.:	3555890163/00
Qty.:	1
Used in:	7.6.2 Injector – Removal and installation (→ Page 94)

### Ratchet

Part No.: F30006212

Qty.: 1

Used in: 7.1.1 Engine – Barring manually (→ Page 76)

### Ratchet adapter

Part No.: F30027340

Qty.: 1

Used in: 7.3.2 Crankcase breather – Oil separator replacement, diaphragm check and replacement (→ Page 83)

Qty.: 1

Used in: 7.4.2 Cylinder head cover – Removal and installation (→ Page 88)

Qty.: 1

Used in: 7.5.2 Injection pump – Removal and installation (→ Page 90)

Qty.: 1

Used in: 7.6.2 Injector – Removal and installation (→ Page 94)

Qty.: 1

Used in: 7.7.1 HP fuel line – Pressure pipe neck replacement (→ Page 98)

### Ratchet adapter

Part No.: F30062582

Qty.: 1

Used in: 7.4.1 Valve clearance – Check and adjustment (→ Page 85)

### Rigid endoscope

Part No.: Y20097353

Qty.: 1

Used in: 7.2.1 Cylinder liner – Endoscopic examination (→ Page 78)

### Socket

Part No.: F30005655

Qty.: 1

Used in: 7.1.1 Engine – Barring manually (→ Page 76)

### Steam jet cleaner

Part No.: -

Qty.: 1

Used in: 4.15 Plant – Cleaning (→ Page 65)

### Strap wrench

Part No.: F30379104

Qty.: 1

Used in: 7.15.3 Centrifugal oil filter – Cleaning and filter-sleeve replacement (→ Page 123)

Torque wrench, 0.5-5 Nm	
Part No.:	0015384230
Qty.:	1
Used in:	7.5.2 Injection pump – Removal and installation (→ Page 90)
Torque wrench, 10-60 Nm	
Part No.:	F30510423
Qty.:	1
Used in:	1.4 Crankshaft transport locking device (→ Page 8)
Torque wrench, 20-100 Nm	
Part No.:	F30026582
Qty.:	1
Used in:	7.4.1 Valve clearance – Check and adjustment (→ Page 85)
Qty.:	1
Used in:	7.6.2 Injector – Removal and installation (→ Page 94)
Qty.:	1
Used in:	7.7.1 HP fuel line – Pressure pipe neck replacement (→ Page 98)
Torque wrench, 20-100 Nm	
Part No.:	F30026582
Qty.:	1
Used in:	7.5.2 Injection pump – Removal and installation (→ Page 90)
Torque wrench, 6-50 Nm	
Part No.:	F30027336
Qty.:	1
Used in:	7.3.2 Crankcase breather – Oil separator replacement, diaphragm check and replacement (→ Page 83)
Qty.:	1
Used in:	7.4.2 Cylinder head cover – Removal and installation (→ Page 88)
Torque wrench, 60-320 Nm	
Part No.:	F30047446
Qty.:	1
Used in:	1.4 Crankshaft transport locking device (→ Page 8)
Vernier caliper	
Part No.:	2000275
Qty.:	1
Used in:	7.20.1 Engine mounting – Checking condition of resilient mounts (→ Page 142)

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