Operating Instructions

Diesel engine
8 V 2000 M60/M61
12V 2000 M60/M61
16V 2000 M60/M61

MW15406/17E

Power. Passion. Partnership.

Commissioning Note

Important

Please complete and return the “Commissioning Note” card below to MTU Friedrichshafen GmbH.

The Commissioning Note information serves as a basis for the contractually agreed logistic support (warranty, spare parts, etc.).

Postcard

MTU Friedrichshafen GmbH

Technical Information Management

Dept. VOT

88040 Friedrichshafen

GERMANY

Engine No.:	MTU works order no.:
Engine model:	Date put into operation:
Application: * ☐ Marine ☐ Rail ☐ Genset ☐	Type: Manufacturer:
End user`s address:	
Remarks:	

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1 Safety

1.1 Important requirements for all products

Nameplate

The product is identified by a nameplate, model designation or serial number which must match the information on the title page of this manual.

Nameplate, model designation or serial number can be found on the product.

General information

This product may pose a risk of injury or damage in the following cases:
- Improper use
- Operation, maintenance and repair by unqualified personnel
- Changes or modifications
- Noncompliance with the safety instructions and warning notices

Intended use

The product is intended for use in accordance with its contractually-defined purpose as described in the relevant technical documents only.

Intended use entails operation:
- Within the permissible operating parameters in accordance with the (→ Technical data)
- With fluids and lubricants approved by the manufacturer in accordance with the (→ Fluids and Lubricants Specifications of the manufacturer)
- With spare parts approved by the manufacturer in accordance with the (→ Spare Parts Catalog/MTU contact/Service partner)
- In the original as-delivered configuration or in a configuration approved by the manufacturer in writing (including engine management/parameters)
- In compliance with all safety regulations and in accordance with all warning notices in this manual
- With maintenance work performed in accordance with the (→ Maintenance Schedule) throughout the useful life of the product
- In compliance with the maintenance and repair instructions contained in this manual, in particular with regard to the specified tightening torques
- With the exclusive use of technical personnel trained in commissioning, operation, maintenance and repair
- By contracting only workshops authorized by the manufacturer to carry out repair and overhaul

Any other use shall be considered non-intended. Such improper use increases the risk of injury and damage when working with the product. The manufacturer shall not be held liable for any damage resulting from improper, non-intended use.

Changes or modifications

Unauthorized changes to the product represent a contravention of its intended use and compromise safety.

Changes or modifications shall only be considered to comply with the intended use when expressly authorized by the manufacturer. The manufacturer shall not be held liable for any damage resulting from unauthorized changes or modifications.

1.2 Personnel and organizational requirements

Organizational measures of the operator

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

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

Use this manual as a basis for instructing personnel on product operation and repair, whereby the safety-relevant instructions, in particular, must be read and understood.

This is particularly important in the case of personnel who only occasionally perform work on or around the product. This personnel must be instructed repeatedly.

Personnel requirements

All work on the product shall be carried out by trained and qualified personnel only.
- Training at the Training Center of the manufacturer
- Qualified personnel specialized in mechanical and plant engineering

The operator must define the responsibilities of the personnel involved in operation, maintenance, repair and transport.

Working clothes and personal protective equipment

Wear proper protective clothing for all work.

When working, always wear the necessary personal protective equipment (e.g. ear protectors, protective gloves, goggles, breathing protection). Observe the information on personal protective equipment in the respective activity description.

1.3 Transport

Transport

Only use the lifting eyes provided to lift the engine.

Only use transport and lifting devices approved by MTU.

Take the engine's center of gravity into account.

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

If the engine is supplied with special aluminum foil packing, lift the engine at the lifting eyes of the bearing pedestal or use a means of transportation which is appropriate for the given weight (forklift truck).

Install the crankshaft locking device and the locking screws for the engine mounts prior to engine transportation.

Secure the engine against tilting during transport. In particular when going down inclines or ramps, the engine must be secured against moving and tilting.

Setting the engine down after transport

Only set down engine on a firm, level surface.

Make sure that the consistency and load-bearing capacity of the ground or support surface is adequate.

Never set an engine down on the oil pan unless expressively authorized to do so by MTU on a case-to-case basis.

1.4 Safety requirements for startup and operation

Safety requirements for startup

The product must be installed and accepted in accordance with manufacturers' specifications prior to initial startup.

All the requisite regulatory approvals must have been granted and all startup requirements fulfilled prior to initial startup.

Whenever the product is started, always ensure that:
- All maintenance and repair work has been completed.
- All loose parts have been removed from rotating machine components.
- Wearers of cardiac pacemakers or other active medical implants are well clear.
- The operating room is adequately ventilated.
- Exhaust pipework is leak-tight and routed to atmosphere.
- Battery terminals, generator terminals and cables are guarded to preclude accidental contact.
- All personnel is clear of the danger zone represented by moving parts.

Immediately after putting the product into operation, make sure that all control and display instruments as well as the monitoring, signaling and alarm systems are working properly.

Safety requirements for operation

The operator must be familiar with the controls and displays.

The operator must be aware of the consequences of any operations he/she performs.

During operation, the display instruments and monitoring units must be constantly observed in regard of present operating status, limit value violation and warning or alarm messages.

Malfunctions and emergency stop

Emergency procedures, in particular emergency stop, must be practiced on a regular basis.

Take the following steps if a system malfunction is detected or signaled by the system:
- Inform the duty supervisor(s).
- Evaluate the message.
- Respond to the emergency appropriately, e.g. execute an emergency stop.

Operation

Do not stay in the operating room when the product is running unless absolutely necessary and then as briefly as possible.

Keep a safe distance away from the product whenever possible. Do not touch the product unless expressly instructed to do so.

Do not inhale exhaust gases emitted by the product.

Ensure that the following requirements have been fulfilled before starting the product:
- Ear protectors are worn.
- Mop up any leaked or spilled fluids and lubricants immediately or soak up with a suitable binding agent.

Operation of electrical equipment

Some components are live (high voltage) when electrical equipment is in operation.

Observe the safety instructions for these appliances.

1.5 Safety requirements for maintenance and repair work

Safety requirements before commencing maintenance and repair work

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

Allow the product to cool down to less than 50°C (risk of explosion for oil vapors, fluids and lubricants, risk of burning).

Relieve pressure in fluid and lubricant systems and compressed-air lines which are to be opened. Use suitable collection vessels with a sufficient filling volume.

Ensure that the operating room is adequately ventilated when changing the oil or working on the fuel system.

Do not perform maintenance or repair work when the product is running unless:
- expressly instructed to do so.
- the product is running in the low load range and only for as long as necessary to complete the task.

Lock-out the product to preclude undesired starting, e.g. start interlock.

Tag-out the product with a “Do Not Start” sign in the operation room or on the control facility.

Disconnect the battery. Lock the contactor.

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

Disconnect the control facility from the product.

For starters with pinions made of copper-beryllium alloy:
- Wear a respirator mask (filter class P3). Do not blow out the interior of the flywheel housing or the starter with compressed air. Clean the interior of the flywheel housing with a class H dust extractor.
- Observe the safety data sheet.

Safety requirements during maintenance and repair work

Take special care when removing vent plugs or plug screws from the product. Hold a cloth over the screw or plug to prevent discharge of highly pressurized liquids.

Take care when draining hot fluids and lubricants (risk of burning).

Use suitable and calibrated tools only. Observe the specified tightening torques during assembly or disassembly.

Carry out work only on assembles and/or installations which are properly secured.

Never climb up on the lines.

Keep fuel injection lines and connections clean.

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

Fit new seals when re-installing lines.

Avoid damaging lines, particularly the fuel lines.

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. Never route fuel or oil lines in the vicinity of hot components.

Do not touch elastomeric seals (e.g. Viton sealing rings) with your bare hands if they have a carbonized or resinous appearance.

Observe the cooling time for components which have been heated for installation or removal (risk of burning!).

Always use suitable ladders and work platforms when working above head-height. Ensure that components or assemblies are placed on stable surfaces.

Pay particular attention to cleanliness at all times.

Safety requirements after completing maintenance and repair work

Ensure that all personnel is clear of danger zones before cranking.

Check that all access ports/apertures which have been opened to facilitate working are closed again.

Check that all safety equipment has been installed and that all tools and loose parts have been removed (especially the barring gear).

Ensure that no unattached parts have been left in/on the product (e.g. including rags and cable straps).

Welding work

Do not perform welding on the product or its attachments. Cover the product when performing welding work in the vicinity.

Before commencing welding work:
- Switch off the master power supply switch.
- Disconnect the battery.
- Disconnect electronic and genset grounds.

Do not perform maintenance or repair work on the product when welding is in progress in its vicinity. Risk of explosion or fire due to oil vapors and highly flammable process materials.

Do not use the product as a grounding terminal.

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

Remove components (e.g. exhaust pipe) from the product before performing necessary welding work .

Hydraulic installation and removal

Check function and satisfactory condition of the jigs and fixtures to be used. Use only the specified jigs and fixtures for hydraulic removal/installation.

Observe the max. permissible force-on pressure specified for the installation/removal jig.

Do not attempt to bend or exert force on HP lines.

Before starting work, pay attention to the following:
- Vent the installation/removal jig, the pumps and the pipework at the relevant designated points.
- For hydraulic installation, screw on the jig with the piston retracted.
- For hydraulic removal, screw on the jig with the piston extended.

For hydraulic installation/removal jigs with central expansion pressure supply, screw the spindle into the shaft end until correct sealing has been established.

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

Working with batteries

Observe the safety requirements of the battery manufacturer when working with batteries.

Gases released from the battery are explosive. Avoid sparks and naked flames.

Do not allow electrolyte (battery acid) to come into contact with skin or clothing.

Wear goggles and protective gloves.

Do not place tools on the battery.

Check polarity before connecting the cable to the battery. Battery polarity reversal may lead to injury by the sudden discharge of acid or bursting of the battery unit.

Working on electrical/electronic assemblies

Always obtain the permission of the duty supervisor before commencing maintenance or 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.

Avoid damaging cabling during removal. When reconnecting, ensure that cabling cannot be damaged during operation by:
- Contact with sharp edges
- Chafing on components
- Contact with hot surfaces.

Do not secure cabling to lines bearing fluids.

Do not use cable ties to secure cabling.

Always use connector pliers to tighten union nuts on connectors.

Subject the device and also the product to appropriate function testing whenever repair work has been completed. In particular, check the function of the emergency stop feature.

Store spare parts properly prior to replacement, i.e. protect them against moisture in particular. Package faulty electronic components or assemblies properly before dispatching for repair:
- Moisture-proof
- Shock-proof
- Wrapped in antistatic foil if necessary.

Working with laser equipment

Always wear special laser-protection goggles when working with laser equipment (danger due to intensely 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 nm 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.

Measuring component deviations

Workpieces, components and measuring instruments are within specified tolerances at a reference temperature of 20°C.

1.6 Fire prevention and environmental protection, fluids and lubricants, auxiliary materials

Fire prevention

Rectify any fuel or oil leaks immediately. Oil or fuel on hot components can cause fires – therefore always keep the product in a clean condition. Do not leave rags saturated with fluids and lubricants on the product. Do not store combustible materials near the product.

Do not carry out welding work on 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 accidents if it makes it more difficult to hear audible signals, warning calls or noises indicating danger.

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

Environmental protection and disposal

Modification or removal of any mechanical/electronic components or the installation of additional components including the execution of calibration processes that might affect the emission characteristics of the product 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 the manufacturer. Noncompliance with these guidelines will invalidate the design type approval issued by the emissions regulation authorities. The manufacturer does not accept any liability for violations of the emission regulations. The maintenance schedules of the manufacturer must be observed over the entire life cycle of the product.

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

Within the EU, batteries can be returned free of charge to the manufacturer where they will be properly recycled.

Fluids and lubricants and auxiliary materials

The Fluids and Lubricants Specifications will be amended or supplemented as necessary. Prior to operation, make sure that the latest version is used. The latest version can be found on the website on the "Technical Info" or "Spare Parts and Service" tabs at http://www.mtu-online.com.

Consumable fluids and materials may also be hazardous or toxic. When using fluids, lubricants, consumables and other chemical substances, follow the safety regulations that apply to the product. Take special care when using hot, chilled or caustic substances. When using flammable materials, prevent them coming into contact with ignition sources and do not smoke.

Used oil

Used oil contains combustion residues that are harmful to health.

Rub barrier cream into hands.

Wash hands after contact with used oil.

Lead

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

Compressed air

Observe special safety precautions when working with compressed air:

- Unauthorized use of compressed air, e.g. forcing flammable liquids (hazard class AI, AII and B) out of containers, risks causing an explosion.
- Wear goggles when blowing dirt off workpieces or blowing away swarf.
- Blowing compressed air into thin-walled containers (e.g. containers made of sheet metal, plastic or glass) for drying purposes or to check for leaks risks bursting them.
- Pay special attention to the pressure in the compressed air system or pressure vessel.
- Assemblies or products to be connected must either be designed for that pressure, or, if the permissible pressure is lower than the system pressure, a pressure reducing valve and safety valve (set to the permissible pressure) must be connected between the assemblies/products and the system.
- Hose couplings and connections must be securely attached.
- Provide the snout of the air nozzle with a protective disk (e.g. rubber disk).
- First shut off compressed air lines before compressed air device is disconnected from the supply line, or before device or tool is to be replaced.
- Carry out leak test in accordance with the specifications.

Paints and varnishes

- Observe the relevant safety data sheet for all materials.
- When painting in areas other than spray booths equipped with extractors, ensure good ventilation. Make sure that neighboring work areas are not adversely affected.
- There must be no naked flames in the vicinity.
- No smoking.
- Observe fire prevention regulations.
- Always wear a mask providing protection against paint and solvent vapors.

Liquid nitrogen

- Observe the relevant safety data sheet for all materials.
- Work with liquid nitrogen may be carried out only by qualified personnel.
- Store liquid nitrogen only in small quantities and always in regulation containers (without gas-tight caps).
- Avoid body contact (eyes, hands).
- Wear protective clothing, protective gloves, closed shoes and safety goggles.
- Make sure that working area is well ventilated.
- Avoid knocking or jolting the containers, valves and fittings or workpieces in any way.

Acids/alkaline solutions/urea (AdBlue®, DEF)

- Observe the relevant safety data sheet for all materials.
- When working with acids and alkaline solutions, wear goggles or face mask, gloves and protective clothing.
- Do not inhale vapors.
- If urea solution is swallowed, rinse out mouth and drink plenty of water.
- If spilled onto clothing, remove the affected clothing immediately.
- After contact with skin, rinse affected parts of the body with plenty of water.
- Rinse eyes immediately with eye drops or clean tap water. Seek medical attention as soon as possible.

1.7 Standards for safety notices in the text

DANGER 	In the event of immediate danger. **Consequences: Death, serious or permanent injury!** • Remedial action.
WARNING 	In the event of a situation involving potential danger. **Consequences: Death, serious or permanent injury!** • Remedial action.
CAUTION 	In the event of a situation involving potential danger. **Consequences: Minor or moderate injuries!** • Remedial action.
NOTICE 	In the event of a situation involving potentially adverse effects on the product. **Consequences: Material damage!** • Remedial action. • Additional product information.

Safety notices

1. This manual with all safety instructions and safety notices must be issued to all personnel involved in operation, maintenance, repair or transportation.
2. The higher level warning notice is used if several hazards apply at the same time. Warnings related to personal injury shall be considered to include a warning of potential damage.

2 General Information

2.1 Product description

Description of the engine

Engine

The engine is a liquid-cooled, four-stroke cycle diesel engine, rotating counter-clockwise (seen from driving end), with direct injection, sequential turbocharging and charge-air cooling.

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
- Beginning of injection
- 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 charge-air cooling (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:
- Date 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)

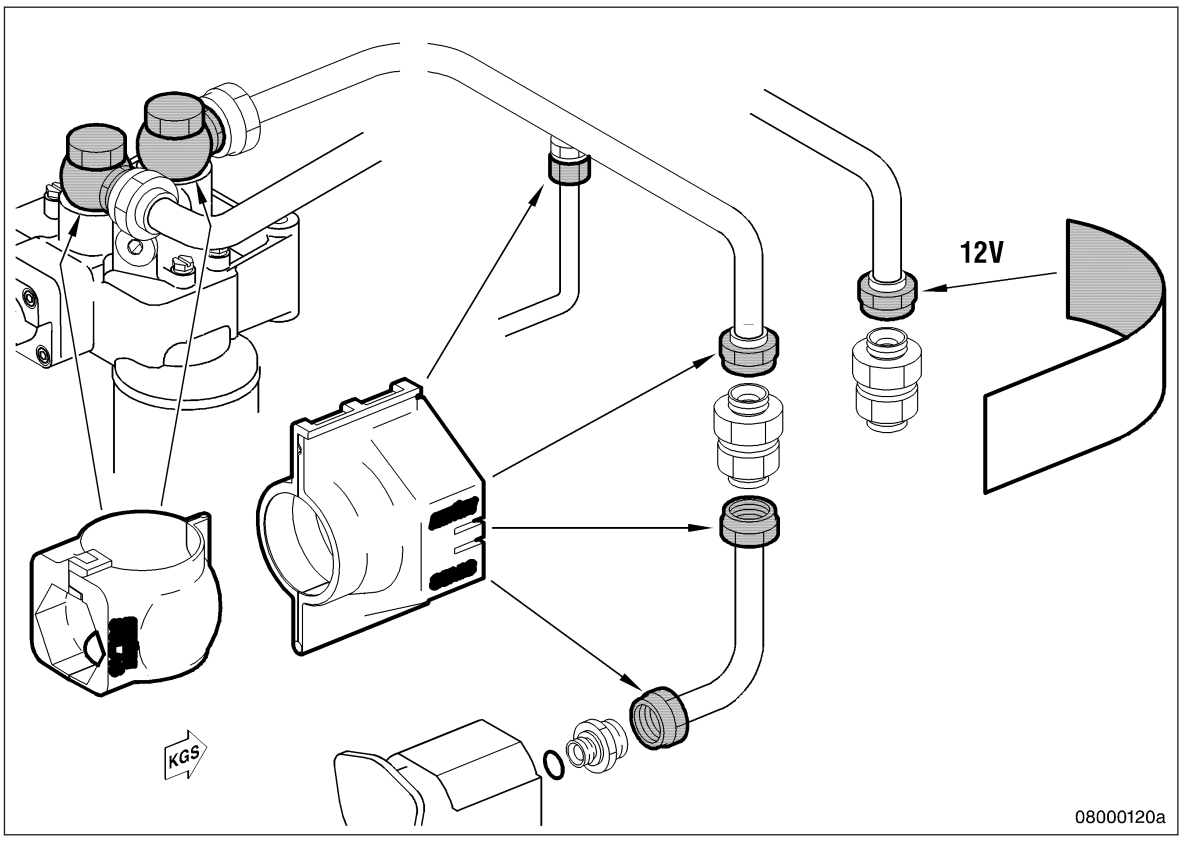
Functions:
- Alphanumeric, monochrome LCD display for monitoring of measured values as well as alarms when limits are violated;
- Pushbuttons for menu control and dimming unit;
- Combined control and display elements for local engine/gear control;
- Flashing light and horn for summary alarm in engine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

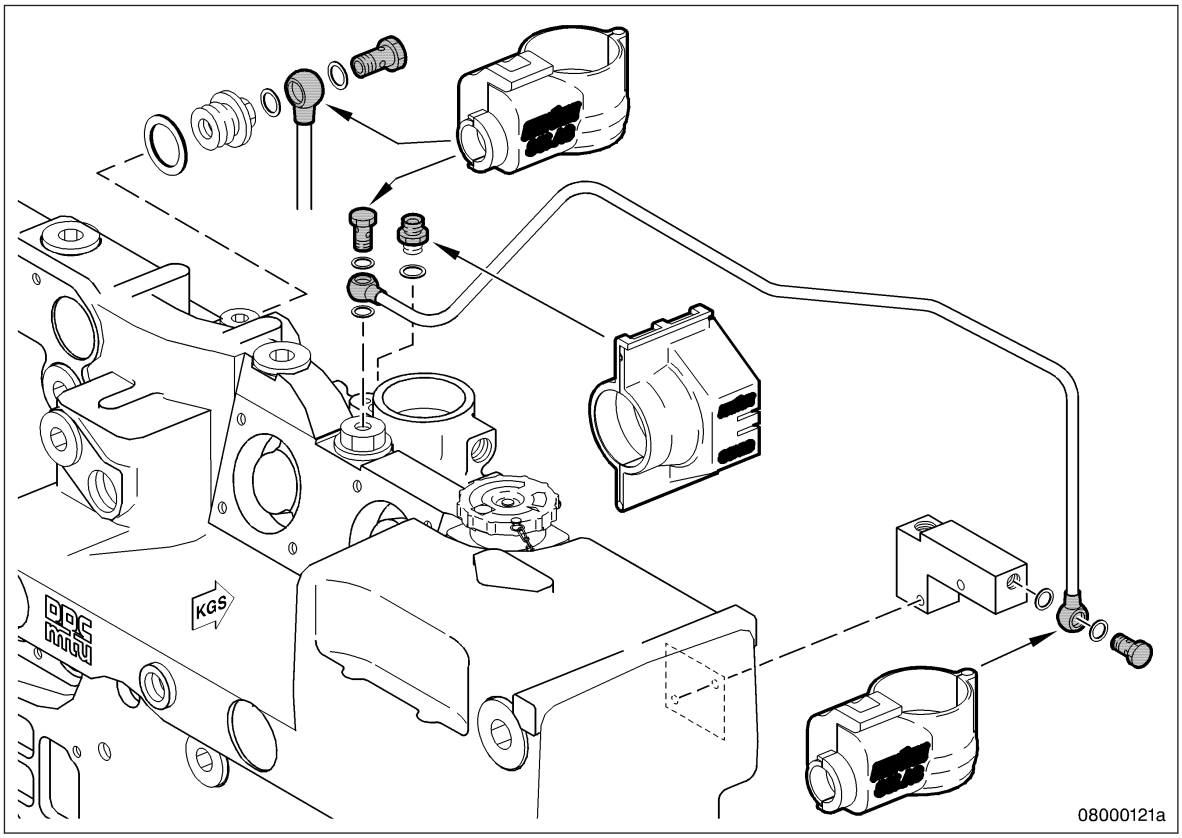
SOLAS – Fire protection specifications

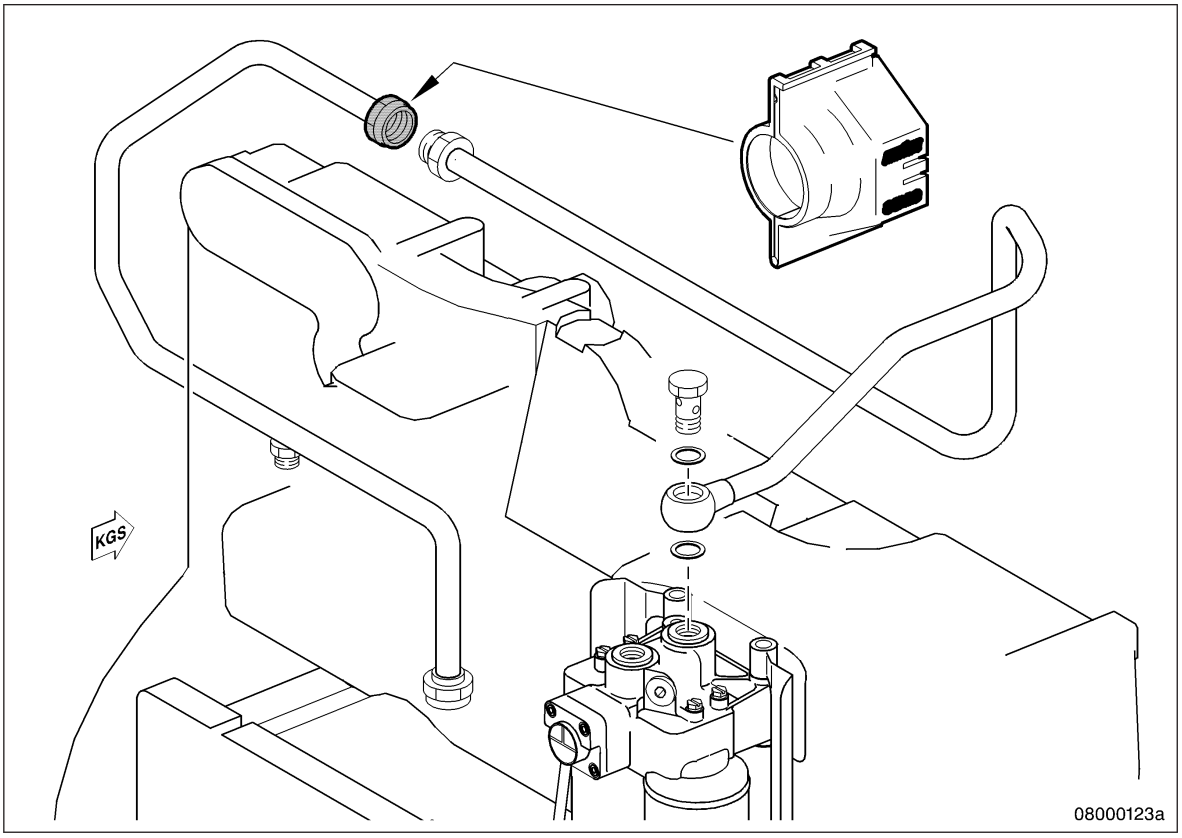
All fuel lines with fuel pressure >1.8 bar are fitted with SOLAS-compliant covers as per MTU standard MTN5233.

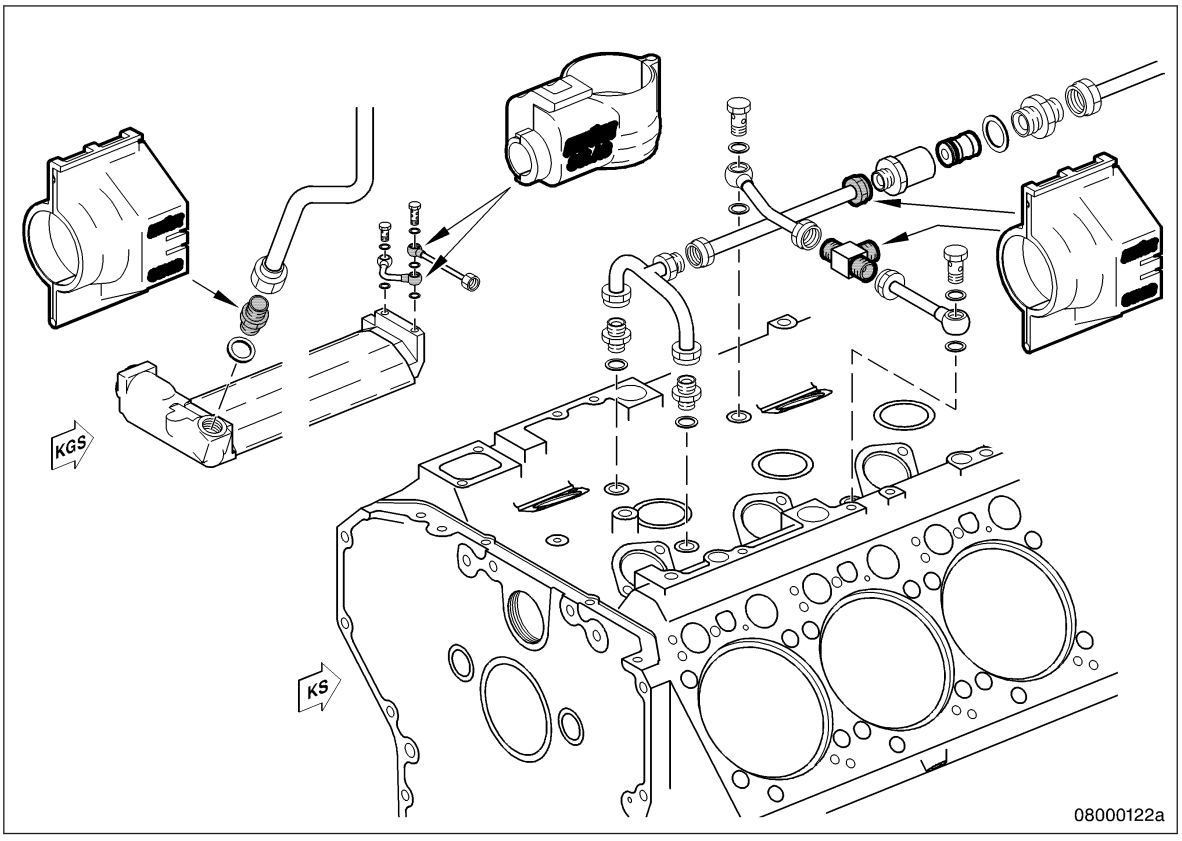
All oil lines with oil pressure >1.8 bar are fitted with SOLAS-compliant covers as per MTU standard MTN5233.

Fuel system covers

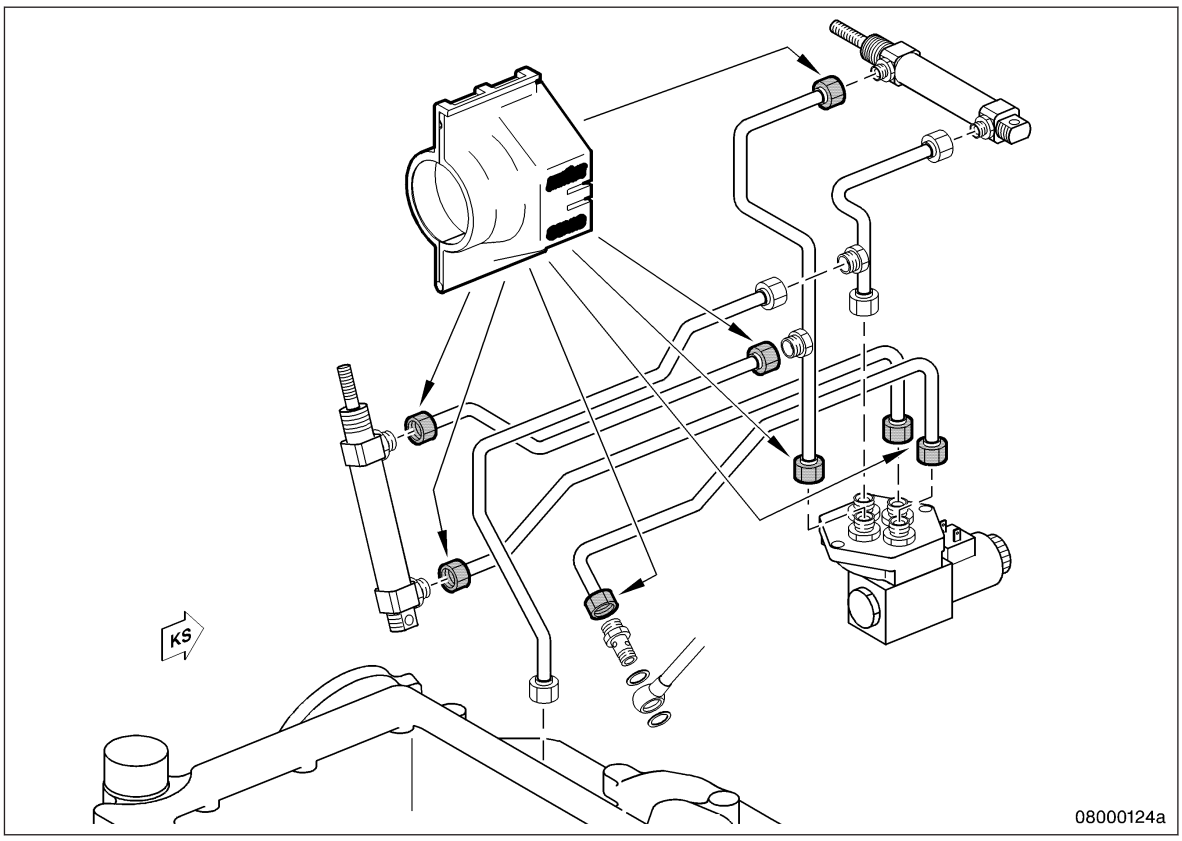


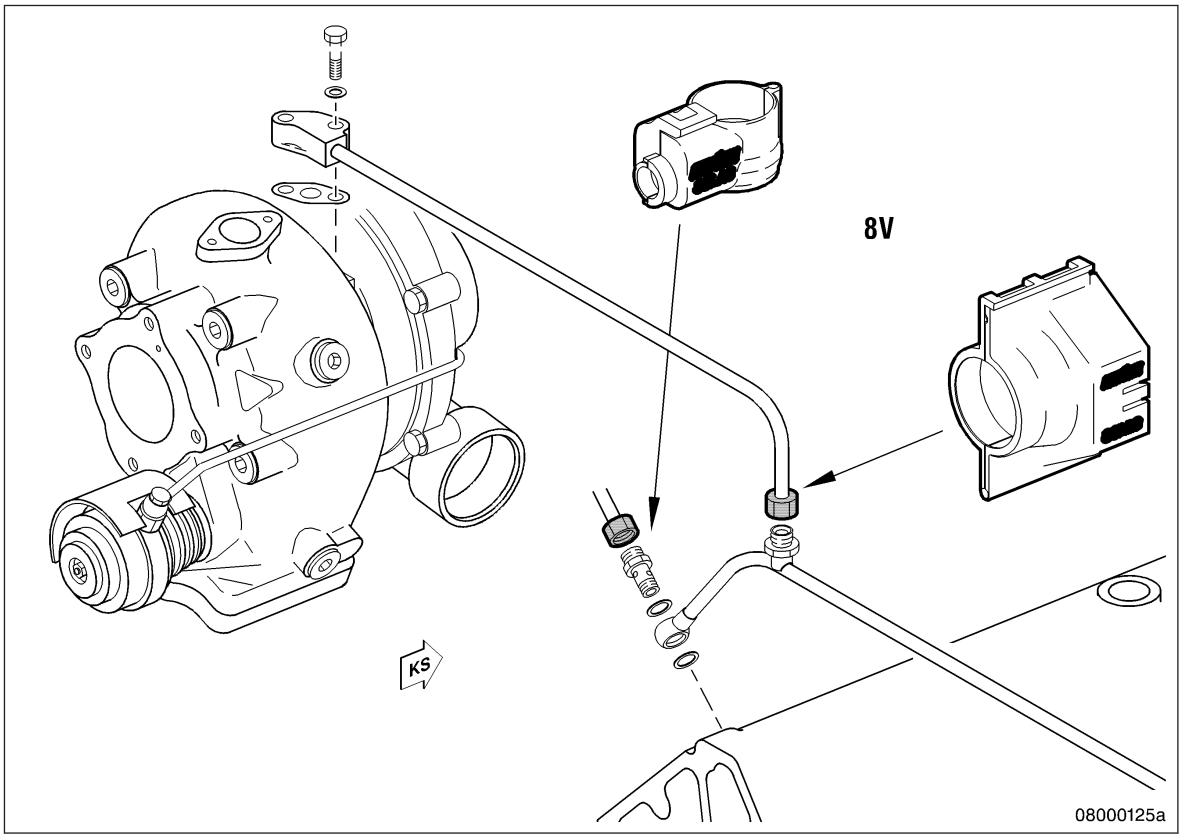




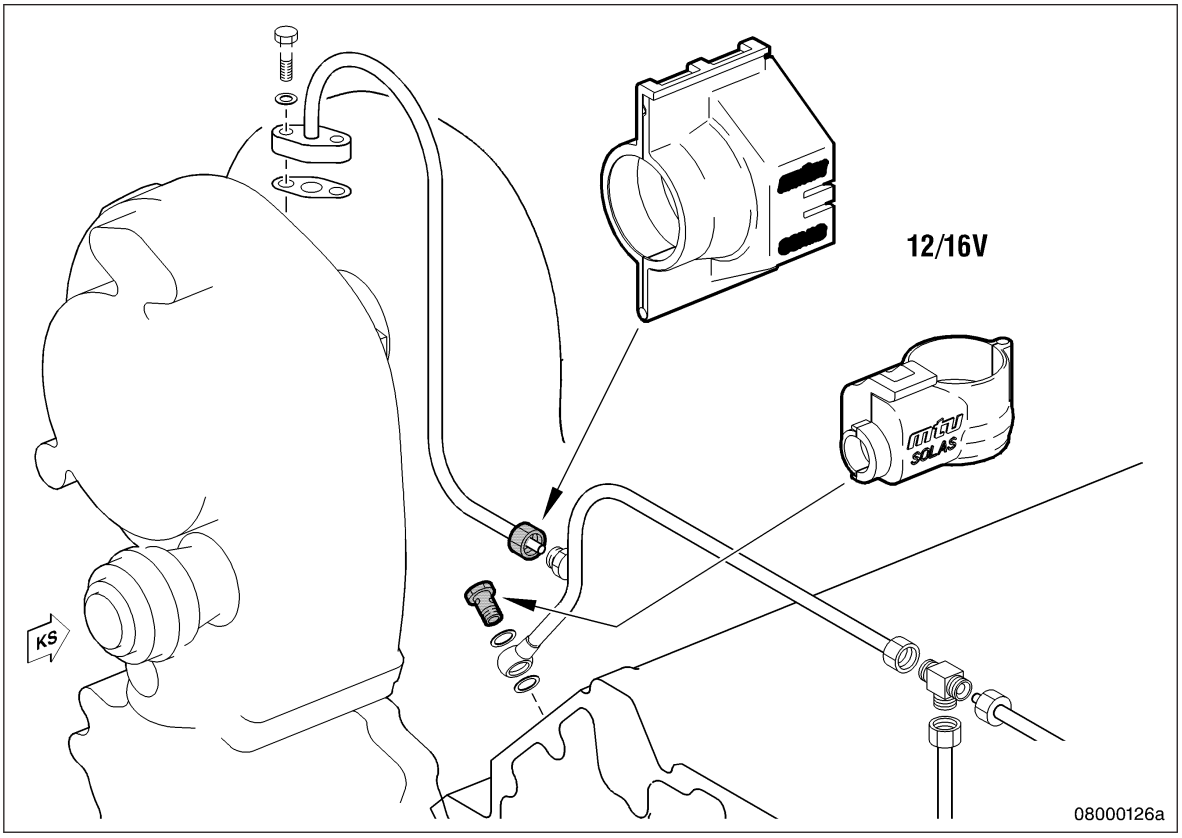


Lube oil system covers

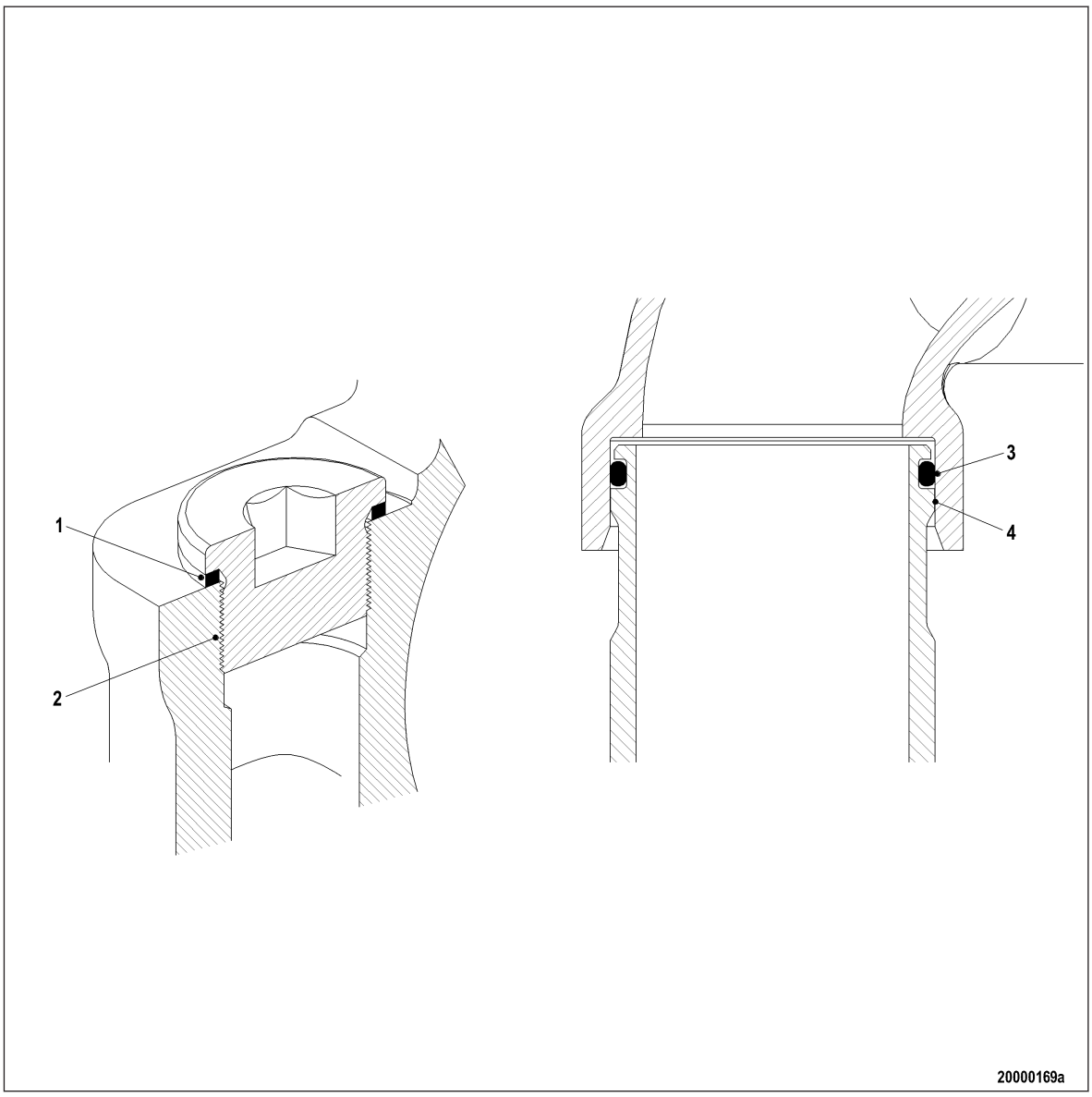




TIM-ID: 0000002178 - 006



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 point of separation 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.

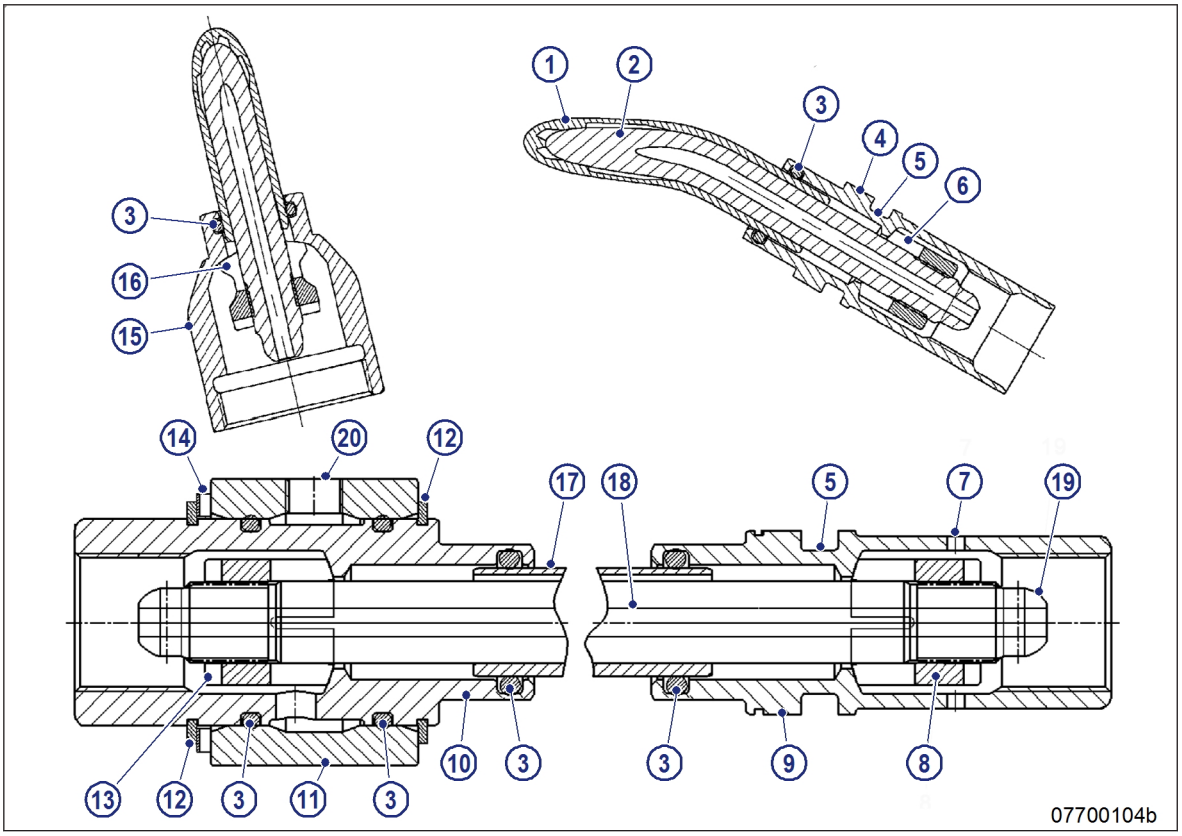
Plugs and sensors

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

High-pressure unions



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

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

In case of leakage around the thrust ring (8) or the HP line (5) fuel escapes into the leakage chamber.

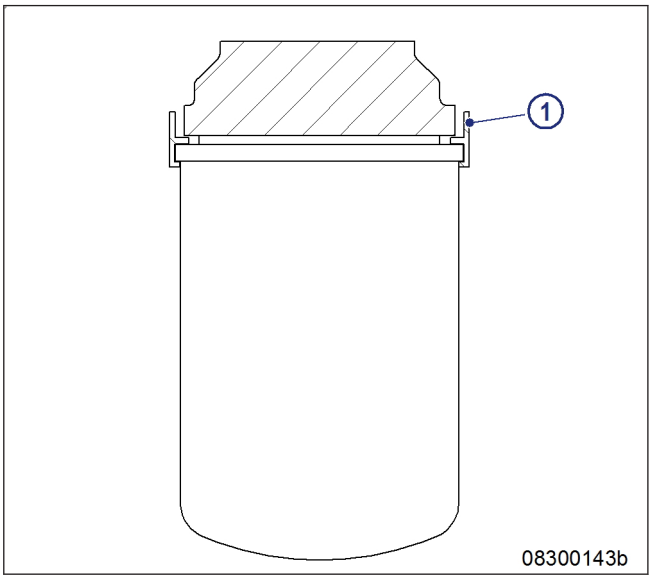
Leak fuel is allowed to escape without pressure via the leakage overflow bore (7). The leakage chamber is sealed toward the outside by the O-rings (3).

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

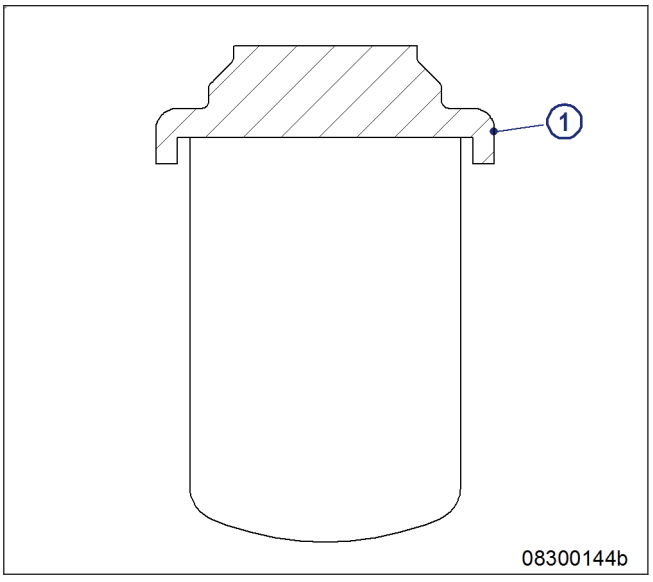
Shielding with plastic ring



The plastic ring (1) precludes lateral spray.

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

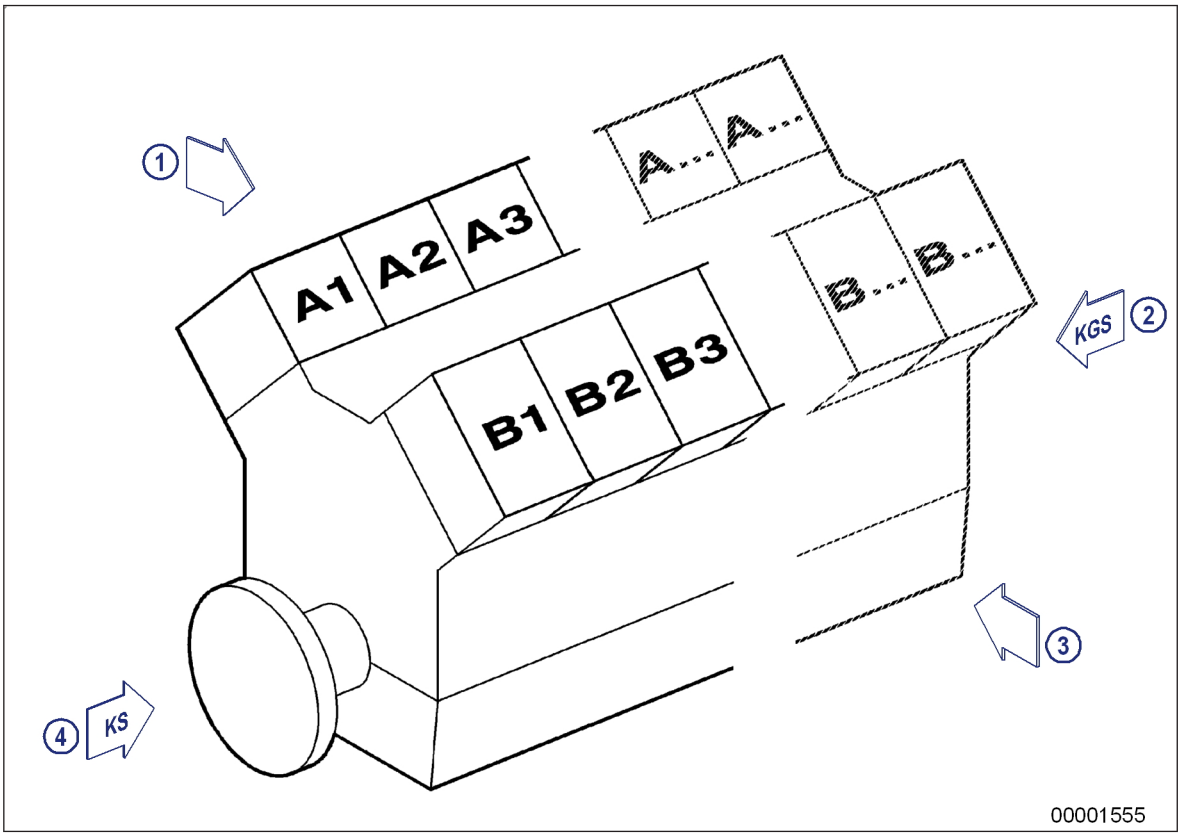
Shielding by overlapping design



The overlap (1) precludes lateral spray.

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

2.2 Engine side and cylinder designations



1 Left engine side (A-side)
2 Engine free end in accordance with DIN ISO 1204 (KGS = Kupplungsgegenseite)
3 Right engine side (B-side)
4 Engine driving end in accordance with DIN ISO 1204 (KS = Kupplungsseite)

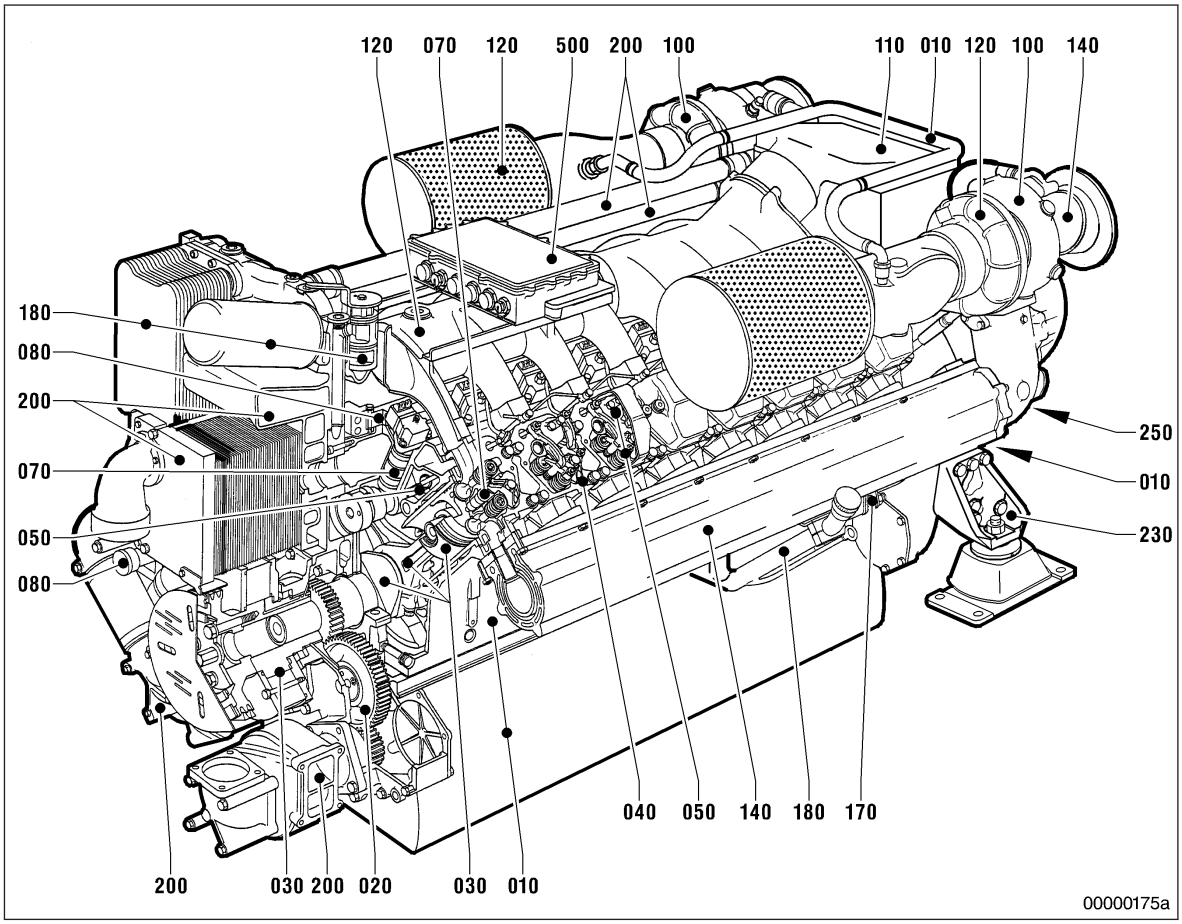
Engine sides are always designated (in accordance with DIN ISO 1204) as viewed from driving end (4).

For cylinder designation (in accordance with DIN ISO 1204), the letter "Ax" refers to the cylinders on the left-hand side of the engine (1) and letter "Bx" refers to the cylinders on the right-hand side (3). The cylinders of each bank are numbered consecutively, starting with x=1 at driving end (4).

The numbering of other engine components also starts with 1 at driving end (4).

2.3 2000 M40-M91A/B engines – Overview

Engine – Overview of functional groups



010 Crankcase and externally mounted components
020 Gear train
030 Crank drive
040 Cylinder head
050 Valve gear
070 Injection system (high pressure)
080 Fuel system (low pressure)
100 Exhaust turbocharger
110 Charge-air cooling
120 Air intake/air supply
140 Exhaust system
170 Starting equipment
180 Lube oil system/lube oil circuit
200 Coolant circuit
230 Mounting/support
250 PTO systems, driving end and free end
500 Monitoring, control and regulation system

Engine model designation

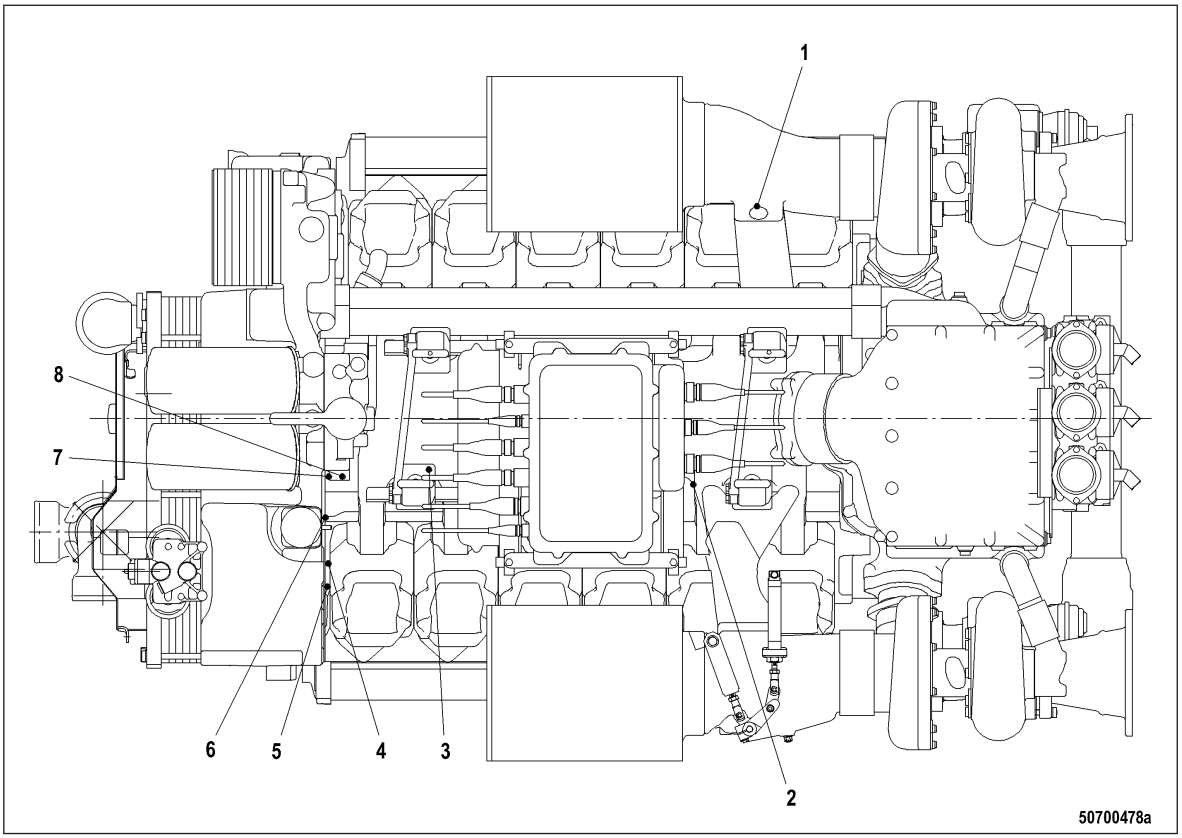
Key to the engine model designations 8/12/16V 2000 M40-M91A/B

8,12,16	Number of cylinders
V	Cylinder arrangement: V engine
2000	Series
M	Application: M = Marine
4, ...,9	Application segment
0, 1	Design index (0, ..., 9)
A/B	Special feature: A = 50 Hz, B = 60 Hz

Table 1: Engine model designation

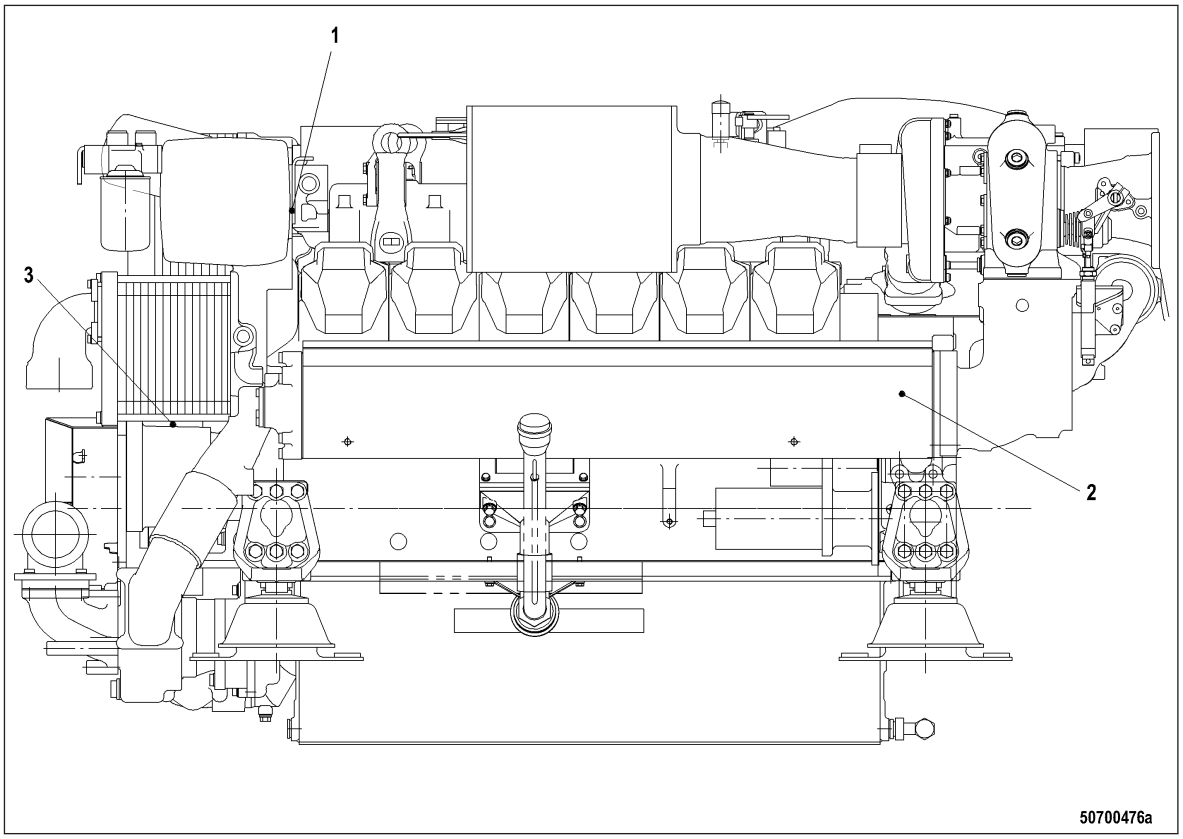
2.4 Sensors and actuators – Overview

Top view 12V 2000 M



1 B03 (intake air temperature)
2 B10 (charge-air pressure)
3 B09 (charge-air temperature)
4 B5.2 (lube oil pressure)
5 F25 (lube-oil pressure difference over filter)
6 B34 (fuel pressure after filter)
7 B07 (lube oil temperature)
8 B05 (lube oil pressure)

Left engine side 12V 2000 M

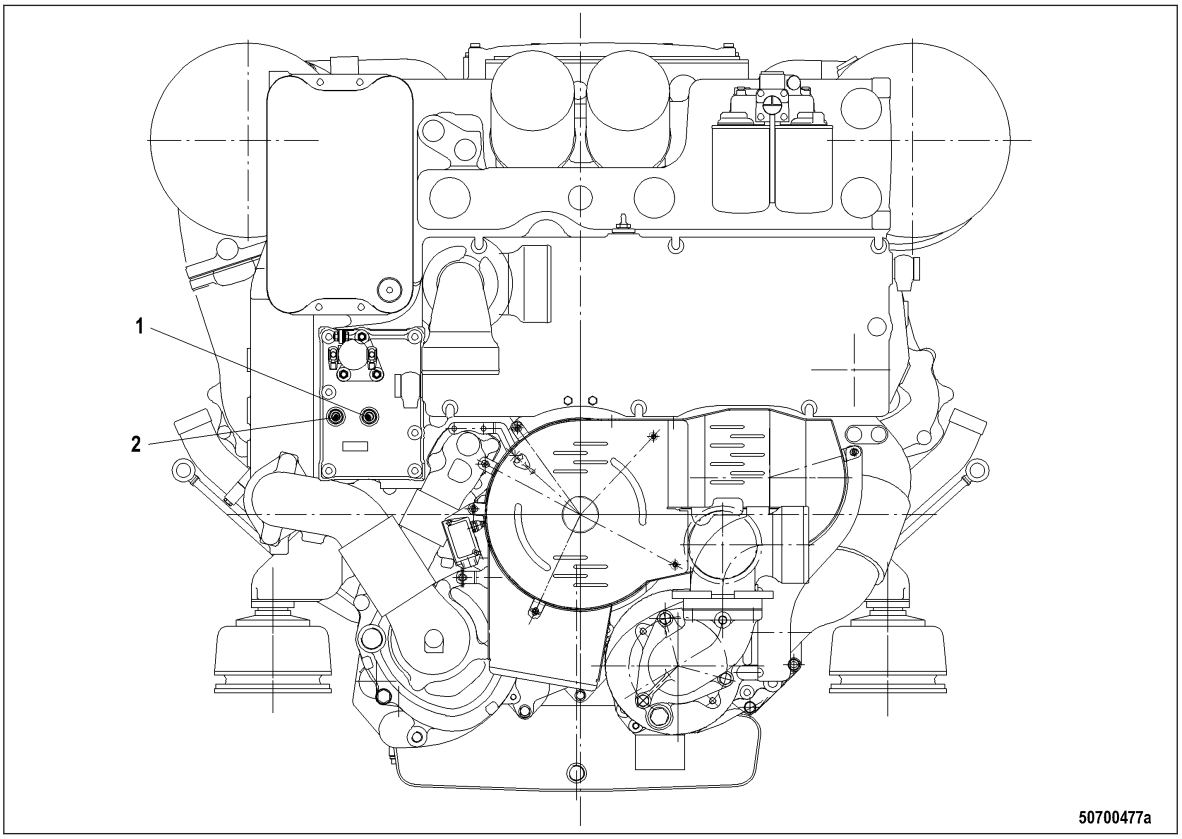


1 F33 (coolant level)

2 Y27 (turbocharger control valve)

3 B21 (raw water pressure)

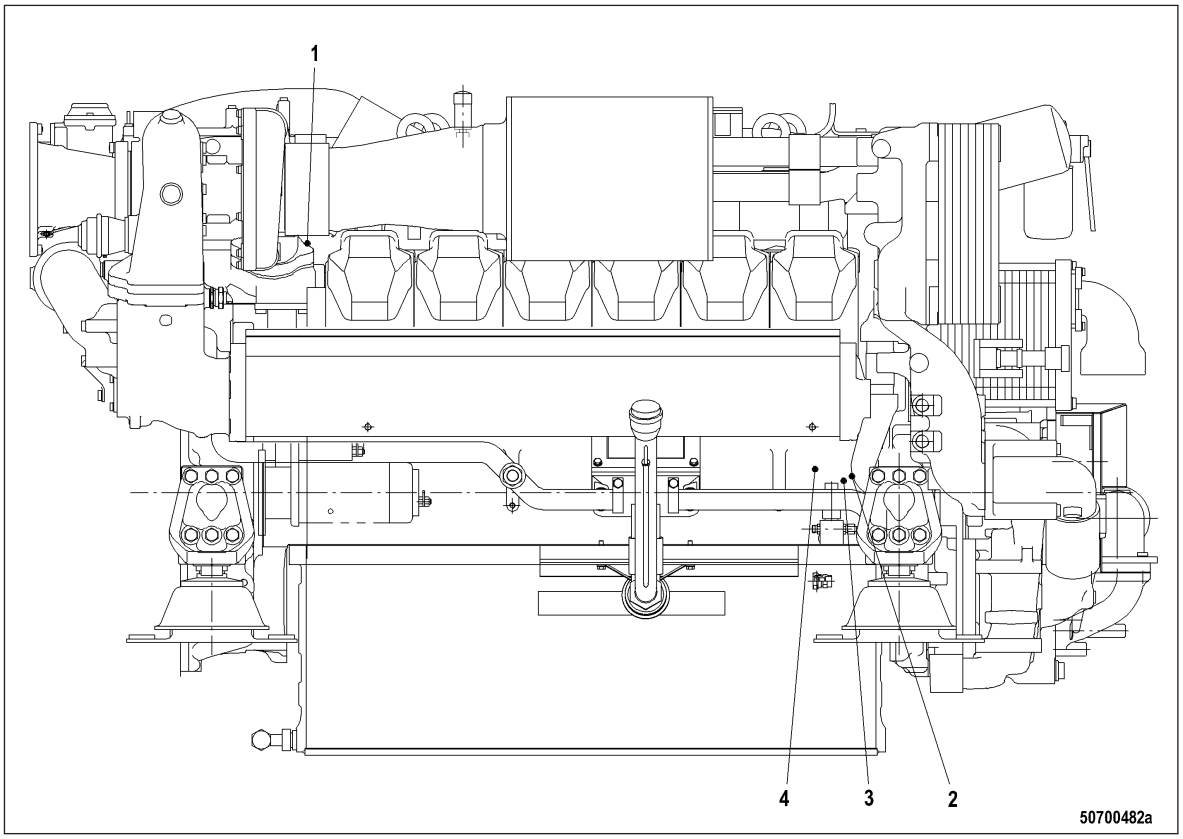
Engine free end 12V 2000 M



1 B06 (coolant temperature)

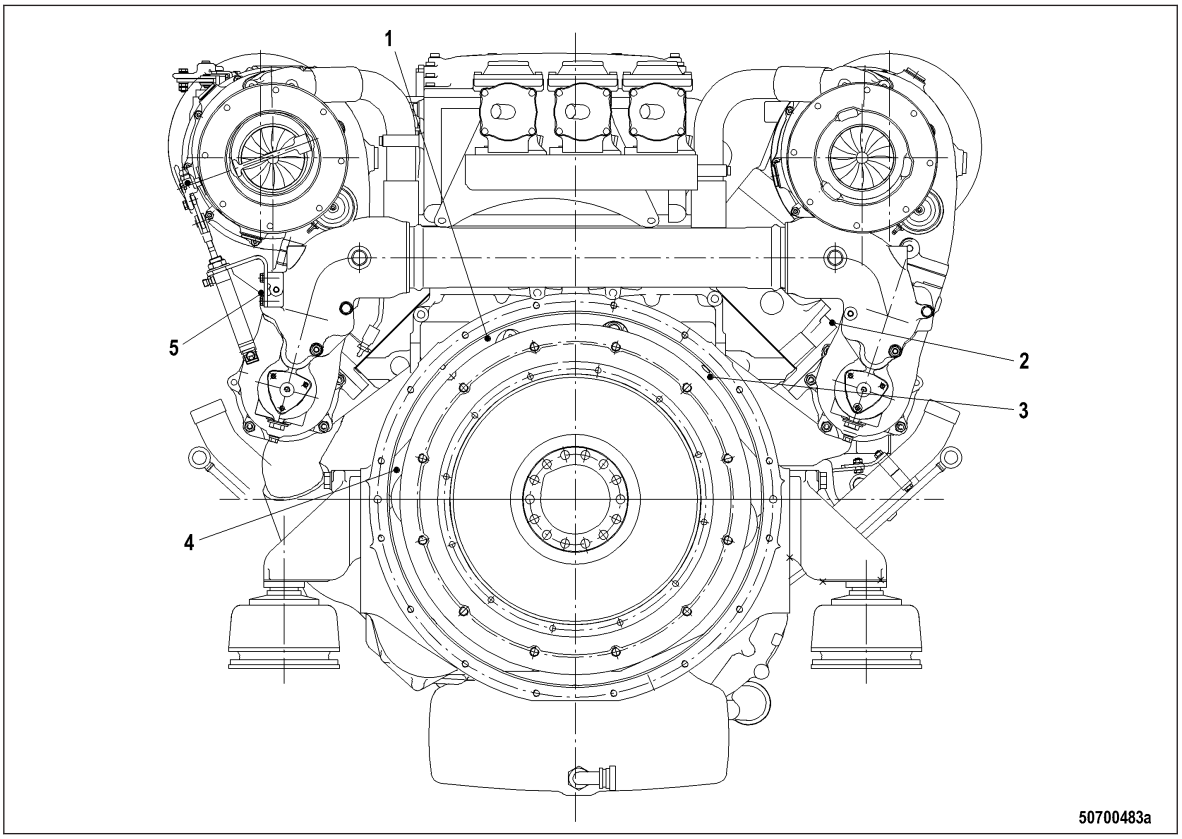
2 B6.2 (coolant temperature)

Right engine side 12V 2000 M



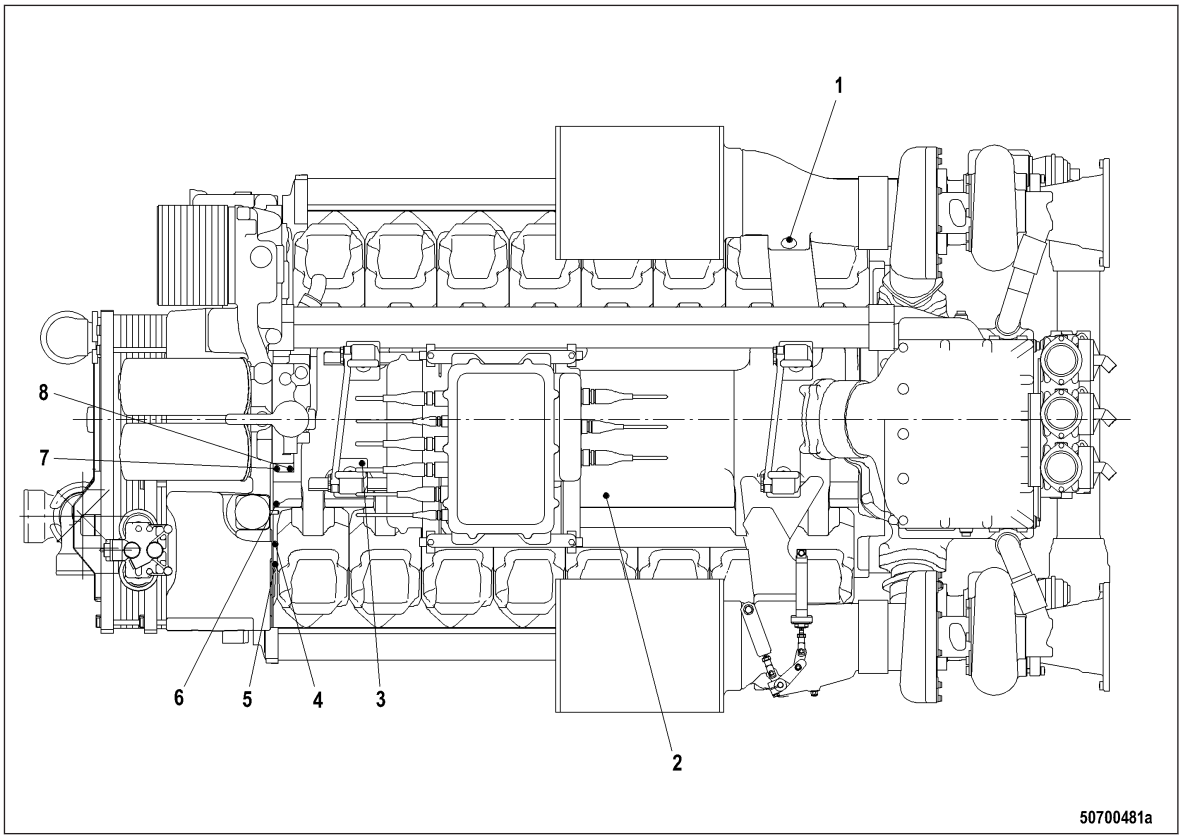
1 B44 (turbocharger speed)
2 B16 (coolant pressure)
3 F46 (leak-off fuel level)
4 B33 (fuel temperature)

Driving end 12V 2000 M



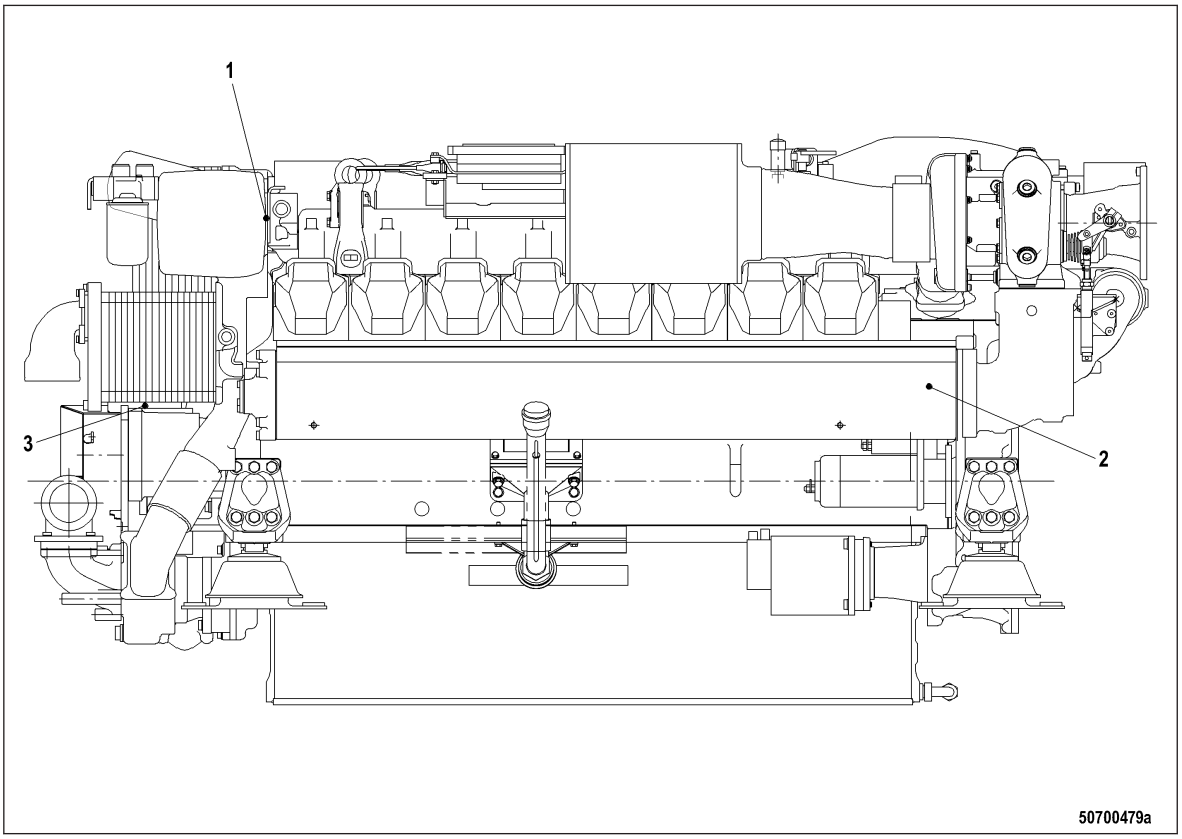
1 B01 (camshaft speed)
2 B4.22 (exhaust bulk temperature, B side)
3 B13 (crankshaft speed)
4 B13.2 (crankshaft speed)
5 B4.21 (exhaust bulk temperature, A side)

Top view 16V 2000 M



1 B03 (intake air temperature)
2 B10 (charge-air pressure)
3 B09 (charge-air temperature)
4 B5.2 (lube oil pressure)
5 F25 (lube-oil pressure difference over filter)
6 B34 (fuel pressure after filter)
7 B07 (lube oil temperature)
8 B05 (lube oil pressure)

Left engine side 16V 2000 M

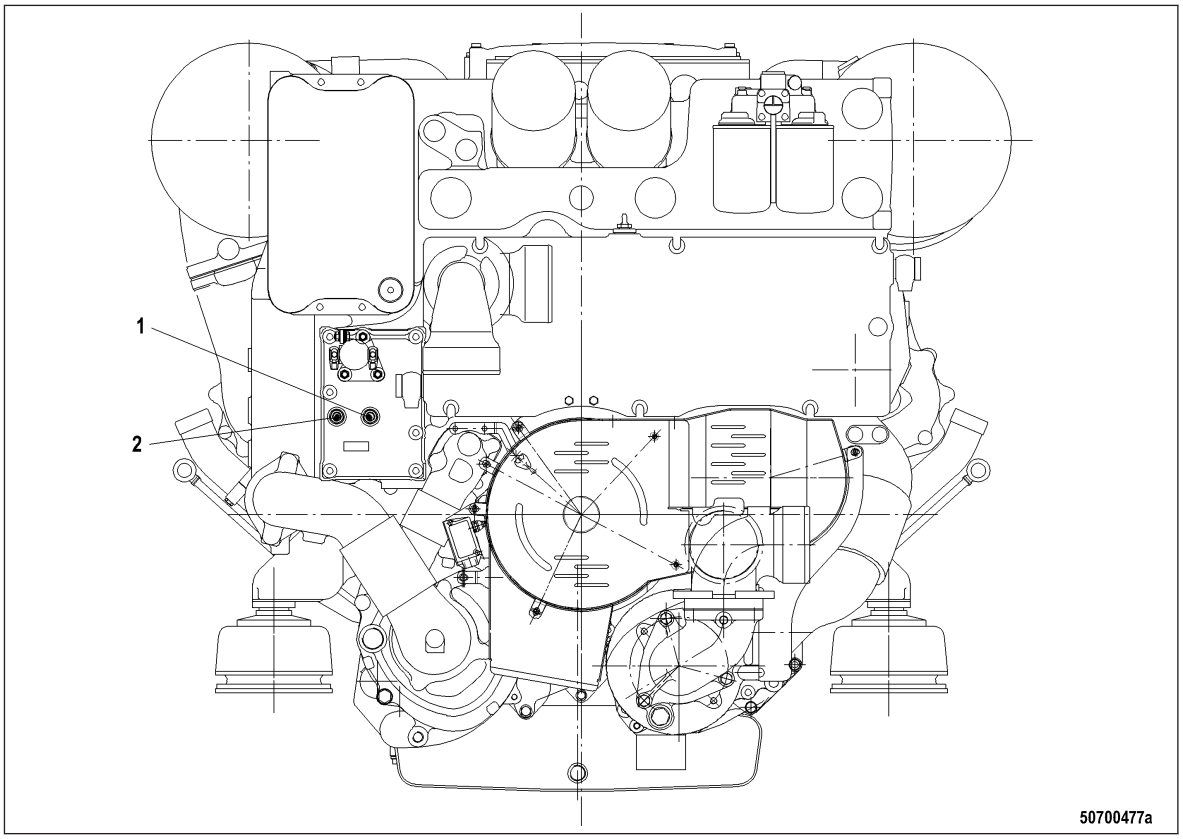


1 F33 (coolant level)

2 Y27 (turbocharger control valve)

3 B21 (raw water pressure)

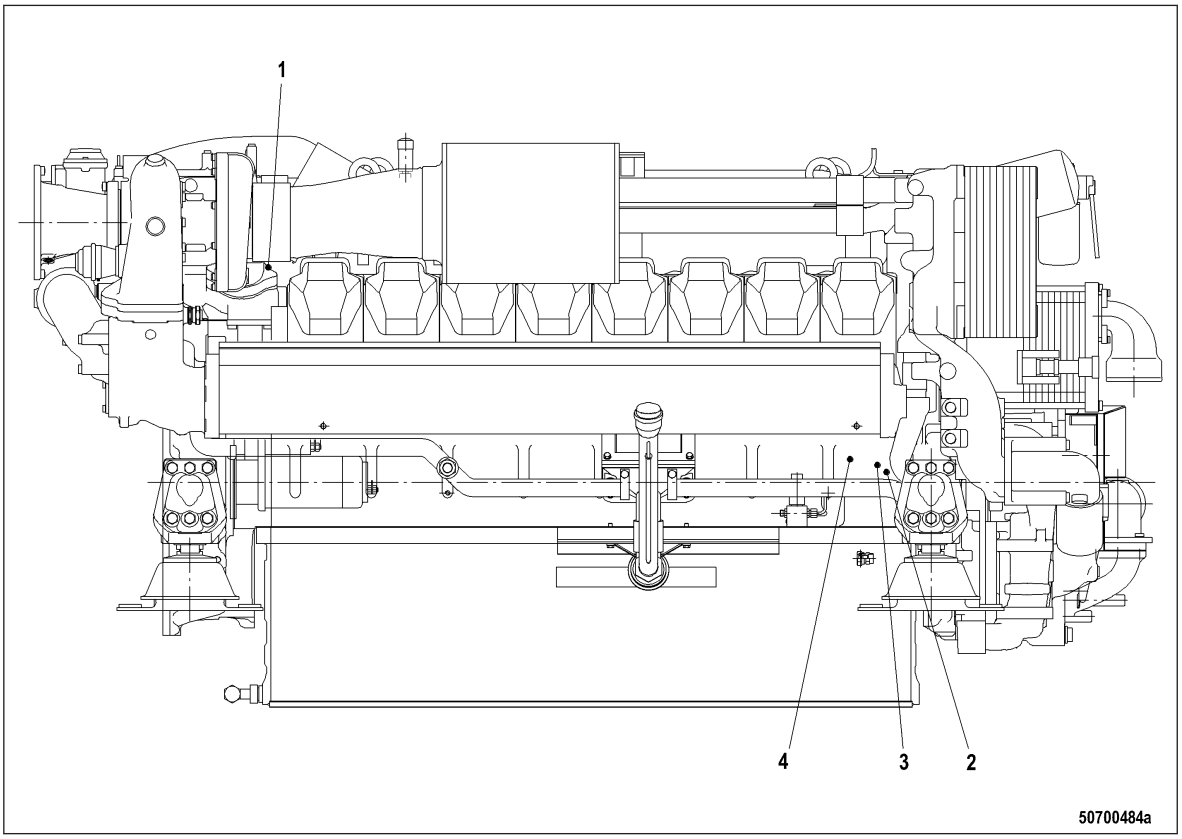
Free end 16V 2000 M



1 B06 (coolant temperature)

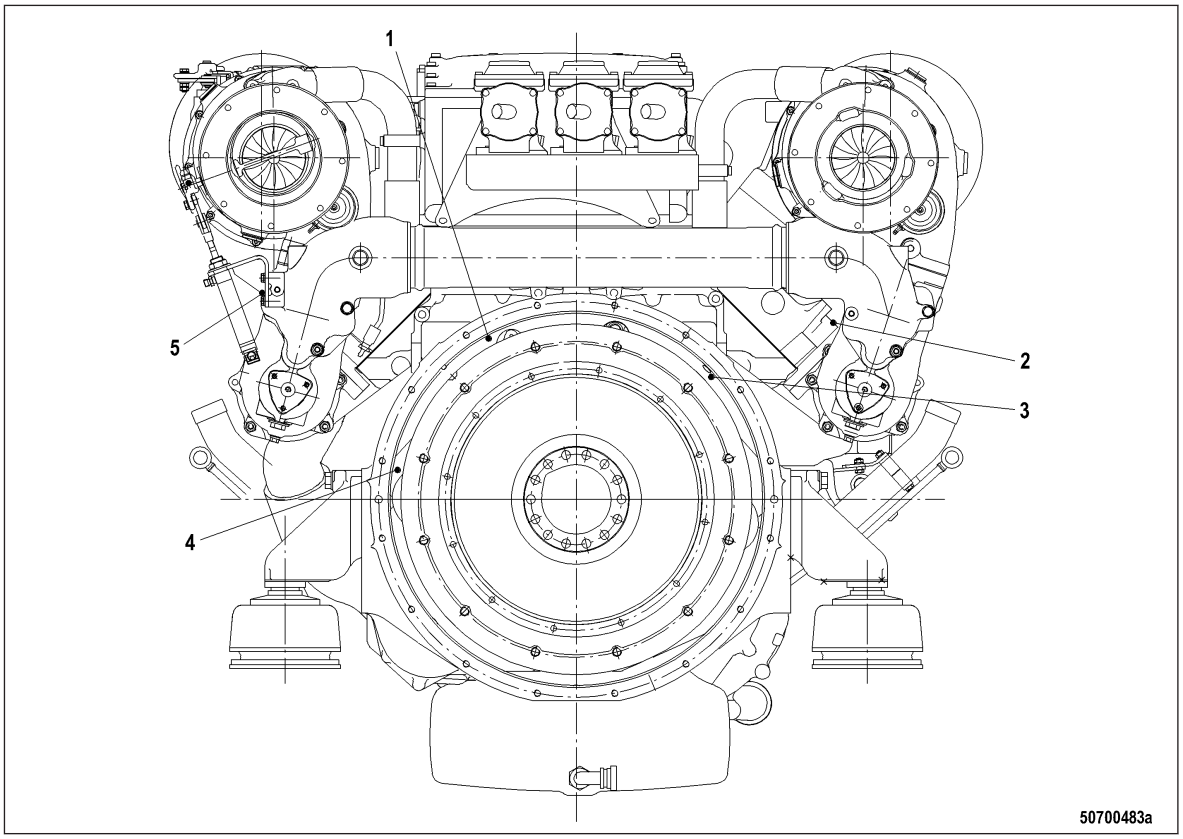
2 B6.2 (coolant temperature)

Right engine side 16V 2000 M



1 B44 (turbocharger speed)
2 B16 (coolant pressure)
3 F46 (leak-off fuel level)
4 B33 (fuel temperature)

Driving end 16V 2000 M



1 B01 (camshaft speed)
2 B4.22 (exhaust bulk temperature, B side)
3 B13 (crankshaft speed)
4 B13.2 (crankshaft speed)
5 B4.21 (exhaust bulk temperature, A side)

3 Technical Data

3.1 8V 2000 M60 engine data: Engine-mounted heat exchanger, reference condition: 25 °C intake air temperature

Explanation:

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 M60
Application group			1A
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	1800
Fuel stop power ISO 3046	A	kW	400

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 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. permissible	L	bar	0.7

LUBE OIL SYSTEM

Number of cylinders			8
Lube oil operating temperature before engine, from	R	°C	75
Lube oil operating temperature before engine, to	R	°C	80
Lube oil operating pressure before engine, from	R	bar	5.6
Lube oil operating pressure before engine, to	R	bar	6.1
Lube oil operating pressure, low idle (meas. point: before engine)	R	bar	2.0

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	1.4

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 (relative to: waterline)

Number of cylinders			8
Longitudinal inclination continuous max. drive side down (Design: max. operating inclinations)	L	degree	15
Longitudinal inclination temporary max. drive side down (Design: max. operating inclinations)	L	degree	22.5
Longitudinal inclination continuous max. drive side up (Design: max. operating inclinations)	L	degree	0

Number of cylinders			8
Longitudinal inclination temporary max. drive side up (Design: max. operating inclinations)	L	degree	10
Transverse inclination continuous max. (Design: max. operating inclinations)	L	degree	22.5
Transverse inclination temporary max. (Design: 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)	104
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	99

3.2 8V 2000 M60 engine data: Engine-mounted heat exchanger, reference condition: 45 °C intake air temperature

Explanation:

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 M60
Application group			1A
Intake air temperature		°C	45
Raw water inlet temperature		°C	32
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	1800
Fuel stop power ISO 3046	A	kW	400

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 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. permissible	L	bar	0.7

LUBE OIL SYSTEM

Number of cylinders			8
Lube oil operating temperature before engine, from	R	°C	75
Lube oil operating temperature before engine, to	R	°C	80
Lube oil operating pressure before engine, from	R	bar	5.6
Lube oil operating pressure before engine, to	R	bar	6.1
Lube oil operating pressure, low idle (meas. point: before engine)	R	bar	2.0

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	1.4

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 (relative to: waterline)

Number of cylinders			8
Longitudinal inclination continuous max. drive side down (Design: max. operating inclinations)	L	degree	15
Longitudinal inclination temporary max. drive side down (Design: max. operating inclinations)	L	degree	22.5
Longitudinal inclination continuous max. drive side up (Design: max. operating inclinations)	L	degree	0
Longitudinal inclination temporary max. drive side up (Design: max. operating inclinations)	L	degree	10
Transverse inclination continuous max. (Design: max. operating inclinations)	L	degree	22.5
Transverse inclination temporary max. (Design: 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)	104
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	99

3.3 8V 2000 M60 engine data: Separate heat exchanger, reference condition: 25 °C intake air temperature

Explanation:

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 M60
Application group			1A
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	1800
Fuel stop power ISO 3046	A	kW	400

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 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	75
Lube oil operating temperature before engine, to	R	°C	80
Lube oil operating pressure before engine, from	R	bar	5.6
Lube oil operating pressure before engine, to	R	bar	6.1
Lube oil operating pressure, low idle (meas. point: before engine)	R	bar	2.0

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	11.9

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

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 (relative to: waterline)

Number of cylinders			8
Longitudinal inclination continuous max. drive side down (Design: max. operating inclinations)	L	degree	15
Longitudinal inclination temporary max. drive side down (Design: max. operating inclinations)	L	degree	22.5
Longitudinal inclination continuous max. drive side up (Design: max. operating inclinations)	L	degree	0
Longitudinal inclination temporary max. drive side up (Design: max. operating inclinations)	L	degree	10
Transverse inclination continuous max. (Design: max. operating inclinations)	L	degree	22.5
Transverse inclination temporary max. (Design: max. operating inclinations)	L	degree	40

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	1750

ACOUSTICS

Number of cylinders			8
Exhaust noise, unsilenced, BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	104
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	99

3.4 8V 2000 M60 engine data: Separate heat exchanger, reference condition: 45 °C intake air temperature

Explanation:

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 M60
Application group			1A
Intake air temperature		°C	45
Raw water inlet temperature		°C	32
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	1800
Fuel stop power ISO 3046	A	kW	400

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 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	75
Lube oil operating temperature before engine, to	R	°C	80
Lube oil operating pressure before engine, from	R	bar	5.6
Lube oil operating pressure before engine, to	R	bar	6.1
Lube oil operating pressure, low idle (meas. point: before engine)	R	bar	2.0

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	11.9

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 (relative to: waterline)

Number of cylinders			8
Longitudinal inclination continuous max. drive side down (Design: max. operating inclinations)	L	degree	15
Longitudinal inclination temporary max. drive side down (Design: max. operating inclinations)	L	degree	22.5
Longitudinal inclination continuous max. drive side up (Design: max. operating inclinations)	L	degree	0
Longitudinal inclination temporary max. drive side up (Design: max. operating inclinations)	L	degree	10
Transverse inclination continuous max. (Design: max. operating inclinations)	L	degree	22.5
Transverse inclination temporary max. (Design: max. operating inclinations)	L	degree	40

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

Number of cylinders			8
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	1750

ACOUSTICS

Number of cylinders			8
Exhaust noise, unsilenced, BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	104
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	99

3.5 8V 2000M61 engina data

Explanation:

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

Reference conditions

Engine model			8V2000M 61	8V2000M 61	8V2000M 61	8V2000M 61
Application group			1A	1A	1A	1A
Intake air temperature		°C	25	25	25	25
Charge air coolant temperature		°C	-	-	-	-
Raw water inlet temperature		°C	25	25	25	25
Barometric pressure		mbar	1000	1000	1000	1000
Site altitude above sea level		m	100	100	100	100

Power-related data (power ratings are net brake power as per ISO 3046)

Number of cylinders			8	8	8	8
Rated engine speed	A	rpm	1800	1800	1800	1800
Fuel stop power ISO 3046	A	kW	400	400	400	400

General conditions (for maximum power)

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

Model related data (basic design)

Number of cylinders			8	8	8	8
Cylinder arrangement: V-angle		Degrees (°)	90	90	90	90
Bore		mm	130	130	130	130
Stroke		mm	150	150	150	150
Displacement, cylinder		Liters	1.99	1.99	1.99	1.99
Displacement, total		Liters	15.92	15.92	15.92	15.92
Number of inlet valves per cylinder			2	2	2	2
Number of exhaust valves per cylinder			2	2	2	2

Raw water circuit (open circuit)

Number of cylinders			8	8	8	8
Raw water pump: Inlet pressure, min.	L	bar	-	-0.4	-0.4	-0.4
Raw water pump: Inlet pressure, max.	L	bar	-	0.5	0.5	0.5
Pressure loss in off-engine raw water system, max.	L	bar	-	0.7	0.7	0.7

Lube oil system

Number of cylinders			8	8	8	8
Lube oil operating temperature before engine, from	R	°C	75	75	75	75
Lube oil operating temperature before engine, to	R	°C	80	80	80	80
Lube oil operating pressure before engine, from	R	bar	5.6	5.6	5.6	5.6
Lube oil operating pressure before engine, to	R	bar	6.1	6.1	6.1	6.1
Lube oil operating pressure (low idle) (meas. point: before engine)	R	bar	2.0	2.0	2.0	2.0

Fuel system

Number of cylinders			8	8	8	8
Fuel pressure at engine inlet connection, min. (when engine is starting)	L	bar	-0.3	-0.3	-0.3	-0.3
Fuel pressure at engine inlet connection, min. (when engine is running)	L	bar	-0.3	-0.3	-0.3	-0.3
Fuel pressure at engine inlet connection, max. (when engine is starting)	L	bar	0.5	0.5	0.5	0.5
Fuel supply flow, max.	A	Liter/min	12	1.8	12	1.8

General operating data

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

Starting (electric)

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

Starting (with compressed air/hydraulic starter)

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

Inclinations - standard oil system (Reference: waterline)

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

Capacities

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

Weights / main dimensions

Number of cylinders			8	8	8	8
Engine dry weight (with standard accessories installed, w/o coupling)	R	kg	1790	1790	1790	1790

Acoustics

Number of cylinders			8	8	8	8
Exhaust noise, unsilenced - BL (free-field sound pressure level Lp, 1m distance, ISO 6798, +3dB(A) tolerance)	R	dB(A)	104	104	104	104
Engine surface noise with attenuated intake noise (filter) - BL (free-field sound power level Lp, 1 m distance, ISO 6798, +2dB(A) tolerance)	R	dB(A)	99	99	99	99

3.6 12V 2000 M60 engine data: Engine-mounted heat exchanger, reference condition: 25 °C intake air temperature

Explanation:

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			12V 2000 M60
Application group			1A
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	1800
Fuel stop power ISO 3046	A	kW	600

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 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. permissible	L	bar	0.7

LUBE OIL SYSTEM

Number of cylinders			12
Lube oil operating temperature before engine, from	R	°C	75
Lube oil operating temperature before engine, to	R	°C	80
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	2.5

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 (relative to: waterline)

Number of cylinders			12
Longitudinal inclination continuous max. drive side down (Design: max. operating inclinations)	L	degree	15
Longitudinal inclination temporary max. drive side down (Design: max. operating inclinations)	L	degree	22.5
Longitudinal inclination continuous max. drive side up (Design: max. operating inclinations)	L	degree	5

Number of cylinders			12
Longitudinal inclination temporary max. drive side up (Design: max. operating inclinations)	L	degree	10
Transverse inclination continuous max. (Design: max. operating inclinations)	L	degree	22.5
Transverse inclination temporary max. (Design: 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)	104
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	100

3.7 12V 2000 M60 engine data: Engine-mounted heat exchanger, reference condition: 45 °C intake air temperature

Explanation:

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			12V 2000 M60
Application group			1A
Intake air temperature		°C	45
Raw water inlet temperature		°C	32
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	1800
Fuel stop power ISO 3046	A	kW	600

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 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. permissible	L	bar	0.7

LUBE OIL SYSTEM

Number of cylinders			12
Lube oil operating temperature before engine, from	R	°C	78
Lube oil operating temperature before engine, to	R	°C	83
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	2.5

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

INCLINATIONS, STANDARD OIL SYSTEM (relative to: waterline)

Number of cylinders			12
Longitudinal inclination continuous max. drive side down (Design: max. operating inclinations)	L	degree	15
Longitudinal inclination temporary max. drive side down (Design: max. operating inclinations)	L	degree	22.5
Longitudinal inclination continuous max. drive side up (Design: max. operating inclinations)	L	degree	5
Longitudinal inclination temporary max. drive side up (Design: max. operating inclinations)	L	degree	10
Transverse inclination continuous max. (Design: max. operating inclinations)	L	degree	22.5
Transverse inclination temporary max. (Design: 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)	104
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	100

3.8 12V 2000 M60 engine data: Separate heat exchanger, reference condition: 25 °C intake air temperature

Explanation:

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			12V 2000 M60
Application group			1A
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	1800
Fuel stop power ISO 3046	A	kW	600

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 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	75
Lube oil operating temperature before engine, to	R	°C	85
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	25

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 (relative to: waterline)

Number of cylinders			12
Longitudinal inclination continuous max. drive side down (Design: max. operating inclinations)	L	degree	15
Longitudinal inclination temporary max. drive side down (Design: max. operating inclinations)	L	degree	22.5
Longitudinal inclination continuous max. drive side up (Design: max. operating inclinations)	L	degree	5
Longitudinal inclination temporary max. drive side up (Design: max. operating inclinations)	L	degree	10
Transverse inclination continuous max. (Design: max. operating inclinations)	L	degree	22.5
Transverse inclination temporary max. (Design: max. operating inclinations)	L	degree	40

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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)	104
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	100

3.9 12V 2000 M60 engine data: Separate heat exchanger, reference condition: 45 °C intake air temperature

Explanation:

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			12V 2000 M60
Application group			1A
Intake air temperature		°C	45
Raw water inlet temperature		°C	32
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	1800
Fuel stop power ISO 3046	A	kW	600

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 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	75
Lube oil operating temperature before engine, to	R	°C	85
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	25

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

INCLINATIONS, STANDARD OIL SYSTEM (relative to: waterline)

Number of cylinders			12
Longitudinal inclination continuous max. drive side down (Design: max. operating inclinations)	L	degree	15
Longitudinal inclination temporary max. drive side down (Design: max. operating inclinations)	L	degree	22.5
Longitudinal inclination continuous max. drive side up (Design: max. operating inclinations)	L	degree	5
Longitudinal inclination temporary max. drive side up (Design: max. operating inclinations)	L	degree	10
Transverse inclination continuous max. (Design: max. operating inclinations)	L	degree	22.5
Transverse inclination temporary max. (Design: 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

Number of cylinders			12
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)	104
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	100

3.10 12V 2000 M61 engine data

Explanation:

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

REFERENCE CONDITIONS

Engine model			12V 2000 M61
Application group			1A
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 as per ISO 3046)

Number of cylinders			12
Rated engine speed	A	rpm	1800
Fuel stop power ISO 3046	A	kW	600

GENERAL CONDITIONS (for maximum power)

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

MODEL RELATED DATA (basic design)

Number of cylinders			12
Cylinder arrangement: V angle		Degrees (°)	90
Bore		mm	130
Stroke		mm	150
Displacement per cylinder		Liters	1.99
Total displacement		Liters	23.88
Inlet valves per cylinder			2
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 off-engine raw water system, max.	L	bar	0.7

LUBE-OIL SYSTEM

Number of cylinders			12
Lube oil operating temperature before engine, from	R	°C	75
Lube-oil operating temperature before engine, to	R	°C	80
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 engine inlet connection, min. (when engine is starting)	L	bar	-0.3
Fuel pressure at supply connection to engine, min. (when engine is running),	L	bar	-0.3
Fuel pressure at engine inlet connection, max. (when engine is starting)	L	bar	+0.5
Fuel supply flow, max.	R	liter/min	2.5

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 (with compressed air/hydraulic 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 (reference: waterline)

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

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

CAPACITIES

Number of cylinders			12
Engine coolant, engine side (with cooling system)	R	Liters	110
Total engine oil capacity at initial filling (standard oil system) (Option: max. operating inclinations)	R	Liters	105
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	Liters	98
Oil pan capacity at dipstick mark “min.” (standard oil system) (Option: max. operating inclinations)	L	Liters	73
Oil pan capacity at dipstick mark “max.” (standard oil system) (Option: max. operating inclinations)	L	Liters	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, +3dB(A) tolerance)	R	dB(A)	104
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798+2dB(A) tolerance)	R	dB(A)	100

3.11 12V 2000 M61 engine data

Explanation:

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

REFERENCE CONDITIONS

Engine model			12V 2000 M61
Application group			1A
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 as per ISO 3046)

Number of cylinders			12
Rated engine speed	A	rpm	1800
Fuel stop power ISO 3046	A	kW	600

GENERAL CONDITIONS (for maximum power)

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

MODEL RELATED DATA (basic design)

Number of cylinders			12
Cylinder arrangement: V angle		Degrees (°)	90
Bore		mm	130
Stroke		mm	150
Displacement per cylinder		Liters	1.99
Total displacement		Liters	23.88
Inlet valves per cylinder			2
Exhaust valves per cylinder			2

LUBE-OIL SYSTEM

Number of cylinders			12
Lube oil operating temperature before engine, from	R	°C	75
Lube-oil operating temperature before engine, to	R	°C	85
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 engine inlet connection, min. (when engine is starting)	L	bar	-0.3
Fuel pressure at supply connection to engine, min. (when engine is running),	L	bar	-0.3
Fuel pressure at engine inlet connection, max. (when engine is starting)	L	bar	+0.5
Fuel supply flow, max.	R	liter/min	25

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 (with compressed air/hydraulic 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 (reference: waterline)

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

CAPACITIES

Number of cylinders			12
Total engine oil capacity at initial filling (standard oil system) (Option: max. operating inclinations)	R	Liters	105
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	Liters	98
Oil pan capacity at dipstick mark “min.” (standard oil system) (Option: max. operating inclinations)	L	Liters	73
Oil pan capacity at dipstick mark “max.” (standard oil system) (Option: max. operating inclinations)	L	Liters	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, +3dB(A) tolerance)	R	dB(A)	104
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798+2dB(A) tolerance)	R	dB(A)	100

3.12 12V 2000 M61 engine data

Explanation:

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

REFERENCE CONDITIONS

Engine model			12V 2000 M61
Application group			1A
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 as per ISO 3046)

Number of cylinders			12
Rated engine speed	A	rpm	1800
Fuel stop power ISO 3046	A	kW	600

GENERAL CONDITIONS (for maximum power)

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

MODEL RELATED DATA (basic design)

Number of cylinders			12
Cylinder arrangement: V angle		Degrees (°)	90
Bore		mm	130
Stroke		mm	150
Displacement per cylinder		Liters	1.99
Total displacement		Liters	23.88
Inlet valves per cylinder			2
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 off-engine raw water system, max.	L	bar	0.7

LUBE-OIL SYSTEM

Number of cylinders			12
Lube oil operating temperature before engine, from	R	°C	75
Lube-oil operating temperature before engine, to	R	°C	80
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 engine inlet connection, min. (when engine is starting)	L	bar	-0.3
Fuel pressure at supply connection to engine, min. (when engine is running),	L	bar	-0.3
Fuel pressure at engine inlet connection, max. (when engine is starting)	L	bar	+0.5
Fuel supply flow, max.	R	liter/min	2.5

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 (with compressed air/hydraulic 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 (reference: waterline)

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

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

CAPACITIES

Number of cylinders			12
Engine coolant, engine side (with cooling system)	R	Liters	110
Total engine oil capacity at initial filling (standard oil system) (Option: max. operating inclinations)	R	Liters	105
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	Liters	98
Oil pan capacity at dipstick mark “min.” (standard oil system) (Option: max. operating inclinations)	L	Liters	73
Oil pan capacity at dipstick mark “max.” (standard oil system) (Option: max. operating inclinations)	L	Liters	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, +3dB(A) tolerance)	R	dB(A)	104
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798+2dB(A) tolerance)	R	dB(A)	100

3.13 12V 2000 M61 engine data

Explanation:

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

REFERENCE CONDITIONS

Engine model			12V 2000 M61
Application group			1A
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 as per ISO 3046)

Number of cylinders			12
Rated engine speed	A	rpm	1800
Fuel stop power ISO 3046	A	kW	600

GENERAL CONDITIONS (for maximum power)

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

MODEL RELATED DATA (basic design)

Number of cylinders			12
Cylinder arrangement: V angle		Degrees (°)	90
Bore		mm	130
Stroke		mm	150
Displacement per cylinder		Liters	1.99
Total displacement		Liters	23.88
Inlet valves per cylinder			2
Exhaust valves per cylinder			2

LUBE-OIL SYSTEM

Number of cylinders			12
Lube oil operating temperature before engine, from	R	°C	75
Lube-oil operating temperature before engine, to	R	°C	85
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 engine inlet connection, min. (when engine is starting)	L	bar	-0.3
Fuel pressure at supply connection to engine, min. (when engine is running),	L	bar	-0.3
Fuel pressure at engine inlet connection, max. (when engine is starting)	L	bar	+0.5
Fuel supply flow, max.	R	liter/min	25

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 (with compressed air/hydraulic 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 (reference: waterline)

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

CAPACITIES

Number of cylinders			12
Total engine oil capacity at initial filling (standard oil system) (Option: max. operating inclinations)	R	Liters	105
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	Liters	98
Oil pan capacity at dipstick mark “min.” (standard oil system) (Option: max. operating inclinations)	L	Liters	73
Oil pan capacity at dipstick mark “max.” (standard oil system) (Option: max. operating inclinations)	L	Liters	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, +3dB(A) tolerance)	R	dB(A)	104
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798+2dB(A) tolerance)	R	dB(A)	100

3.14 16V 2000 M60 engine data: Engine-mounted heat exchanger, reference condition: 25 °C intake air temperature

Explanation:

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			16V 2000 M60
Application group			1A
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	1800
Fuel stop power ISO 3046	A	kW	800

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 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. permissible	L	bar	0.7

LUBE OIL SYSTEM

Number of cylinders			16
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	6.0
Lube oil operating pressure before engine, to	R	bar	7.0
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	3.2

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 (relative to: waterline)

Number of cylinders			16
Longitudinal inclination continuous max. drive side down (Design: max. operating inclinations)	L	degree	15
Longitudinal inclination temporary max. drive side down (Design: max. operating inclinations)	L	degree	22.5
Longitudinal inclination continuous max. drive side up (Design: max. operating inclinations)	L	degree	0

Number of cylinders			16
Longitudinal inclination temporary max. drive side up (Design: max. operating inclinations)	L	degree	6
Transverse inclination continuous max. (Design: max. operating inclinations)	L	degree	22.5
Transverse inclination temporary max. (Design: 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)	104
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	106

3.15 16V 2000 M60 engine data: Engine-mounted heat exchanger, reference condition: 45 °C intake air temperature

Explanation:

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			16V 2000 M60
Application group			1A
Intake air temperature		°C	45
Raw water inlet temperature		°C	32
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	1800
Fuel stop power ISO 3046	A	kW	800

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

TIM-ID: 0000003061 - 001

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. permissible	L	bar	0.7

LUBE OIL SYSTEM

Number of cylinders			16
Lube oil operating temperature before engine, from	R	°C	80
Lube oil operating temperature before engine, to	R	°C	85
Lube oil operating pressure before engine, from	R	bar	6.0
Lube oil operating pressure before engine, to	R	bar	7.0
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	3.3

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 (relative to: Water level)

Number of cylinders			16
Longitudinal inclination continuous max. drive side down (Design: max. operating inclinations)	L	degree	15
Longitudinal inclination temporary max. drive side down (Design: max. operating inclinations)	L	degree	22.5
Longitudinal inclination continuous max. drive side up (Design: max. operating inclinations)	L	degree	0
Longitudinal inclination temporary max. drive side up (Design: max. operating inclinations)	L	degree	6
Transverse inclination continuous max. (Design: max. operating inclinations)	L	degree	22.5
Transverse inclination temporary max. (Design: 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)	104
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	106

3.16 16V 2000 M60 engine data: Separate heat exchanger, reference condition: 25 °C intake air temperature

Explanation:

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			16V 2000 M60
Application group			1A
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	1800
Fuel stop power ISO 3046	A	kW	800

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 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	79
Lube oil operating temperature before engine, to	R	°C	84
Lube oil operating pressure before engine, from	R	bar	6.0
Lube oil operating pressure before engine, to	R	bar	7.0
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	24

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 (relative to: waterline)

Number of cylinders			16
Longitudinal inclination continuous max. drive side down (Design: max. operating inclinations)	L	degree	15
Longitudinal inclination temporary max. drive side down (Design: max. operating inclinations)	L	degree	22.5
Longitudinal inclination continuous max. drive side up (Design: max. operating inclinations)	L	degree	0
Longitudinal inclination temporary max. drive side up (Design: max. operating inclinations)	L	degree	6
Transverse inclination continuous max. (Design: max. operating inclinations)	L	degree	22.5
Transverse inclination temporary max. (Design: max. operating inclinations)	L	degree	35

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

Number of cylinders			16
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)	104
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	106

3.17 16V 2000 M60 engine data: Separate heat exchanger, reference condition: 45 °C intake air temperature

Explanation:

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			16V 2000 M60
Application group			1A
Intake air temperature		°C	45
Raw water inlet temperature		°C	32
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	1800
Fuel stop power ISO 3046	A	kW	800

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 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	80
Lube oil operating temperature before engine, to	R	°C	85
Lube oil operating pressure before engine, from	R	bar	6.0
Lube oil operating pressure before engine, to	R	bar	7.0
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	24

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 (relative to: waterline)

Number of cylinders			16
Longitudinal inclination continuous max. drive side down (Design: max. operating inclinations)	L	degree	15
Longitudinal inclination temporary max. drive side down (Design: max. operating inclinations)	L	degree	22.5
Longitudinal inclination continuous max. drive side up (Design: max. operating inclinations)	L	degree	0
Longitudinal inclination temporary max. drive side up (Design: max. operating inclinations)	L	degree	6
Transverse inclination continuous max. (Design: max. operating inclinations)	L	degree	22.5
Transverse inclination temporary max. (Design: max. operating inclinations)	L	degree	35

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

Number of cylinders			16
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)	104
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	106

3.18 16V 2000 M61 engine data

Explanation:

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

REFERENCE CONDITIONS

Engine model			16V 2000 M61
Application group			1A
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 as per ISO 3046)

Number of cylinders			16
Rated engine speed	A	rpm	1800
Fuel stop power ISO 3046	A	kW	800

GENERAL CONDITIONS (for maximum power)

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

MODEL RELATED DATA (basic design)

Number of cylinders			16
Cylinder arrangement: V angle		Degrees (°)	90
Bore		mm	130
Stroke		mm	150
Displacement per cylinder		Liters	1.99
Total displacement		Liters	31.84
Inlet valves per cylinder			2
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 off-engine raw water system, max.	L	bar	0.7

LUBE-OIL SYSTEM

Number of cylinders			16
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	6.0
Lube-oil operating pressure before engine, to	R	bar	7.0
Lube oil operating pressure (low idle) (meas. point: before engine)	R	bar	3.0

FUEL SYSTEM

Number of cylinders			16
Fuel pressure at engine inlet connection, min. (when engine is starting)	L	bar	-0.3
Fuel pressure at supply connection to engine, min. (when engine is running),	L	bar	-0.3
Fuel pressure at engine inlet connection, max. (when engine is starting)	L	bar	+0.5
Fuel supply flow, max.	R	liter/min	3.2

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 (with compressed air/hydraulic 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 (reference: waterline)

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

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

CAPACITIES

Number of cylinders			16
Engine coolant, engine side (with cooling system)	R	Liters	160
Total engine oil capacity at initial filling (standard oil system) (Option: max. operating inclinations)	R	Liters	134
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	Liters	127
Oil pan capacity at dipstick mark “min.” (standard oil system) (Option: max. operating inclinations)	L	Liters	97
Oil pan capacity at dipstick mark “max.” (standard oil system) (Option: max. operating inclinations)	L	Liters	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, +3dB(A) tolerance)	R	dB(A)	104
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798+2dB(A) tolerance)	R	dB(A)	106

3.19 16V 2000 M61 engine data

Explanation:

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

REFERENCE CONDITIONS

Engine model			16V 2000 M61
Application group			1A
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 as per ISO 3046)

Number of cylinders			16
Rated engine speed	A	rpm	1800
Fuel stop power ISO 3046	A	kW	800

GENERAL CONDITIONS (for maximum power)

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

MODEL RELATED DATA (basic design)

Number of cylinders			16
Cylinder arrangement: V angle		Degrees (°)	90
Bore		mm	130
Stroke		mm	150
Displacement per cylinder		Liters	1.99
Total displacement		Liters	31.84
Inlet valves per cylinder			2
Exhaust valves per cylinder			2

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LUBE-OIL SYSTEM

Number of cylinders			16
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	6.0
Lube-oil operating pressure before engine, to	R	bar	7.0
Lube oil operating pressure (low idle) (meas. point: before engine)	R	bar	3.0

FUEL SYSTEM

Number of cylinders			16
Fuel pressure at engine inlet connection, min. (when engine is starting)	L	bar	-0.3
Fuel pressure at supply connection to engine, min. (when engine is running),	L	bar	-0.3
Fuel pressure at engine inlet connection, max. (when engine is starting)	L	bar	+0.5
Fuel supply flow, max.	R	liter/min	24

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 (with compressed air/hydraulic 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 (reference: waterline)

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

CAPACITIES

Number of cylinders			16
Total engine oil capacity at initial filling (standard oil system) (Option: max. operating inclinations)	R	Liters	134
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	Liters	127
Oil pan capacity at dipstick mark “min.” (standard oil system) (Option: max. operating inclinations)	L	Liters	97
Oil pan capacity at dipstick mark “max.” (standard oil system) (Option: max. operating inclinations)	L	Liters	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, +3dB(A) tolerance)	R	dB(A)	104
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798+2dB(A) tolerance)	R	dB(A)	106

3.20 16V 2000 M61 engine data

Explanation:

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

REFERENCE CONDITIONS

Engine model			16V 2000 M61
Application group			1A
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 as per ISO 3046)

Number of cylinders			16
Rated engine speed	A	rpm	1800
Fuel stop power ISO 3046	A	kW	800

GENERAL CONDITIONS (for maximum power)

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

MODEL RELATED DATA (basic design)

Number of cylinders			16
Cylinder arrangement: V angle		Degrees (°)	90
Bore		mm	130
Stroke		mm	150
Displacement per cylinder		Liters	1.99
Total displacement		Liters	31.84
Inlet valves per cylinder			2
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 off-engine raw water system, max.	L	bar	0.7

LUBE-OIL SYSTEM

Number of cylinders			16
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	6.0
Lube-oil operating pressure before engine, to	R	bar	7.0
Lube oil operating pressure (low idle) (meas. point: before engine)	R	bar	3.0

FUEL SYSTEM

Number of cylinders			16
Fuel pressure at engine inlet connection, min. (when engine is starting)	L	bar	-0.3
Fuel pressure at supply connection to engine, min. (when engine is running),	L	bar	-0.3
Fuel pressure at engine inlet connection, max. (when engine is starting)	L	bar	+0.5
Fuel supply flow, max.	R	liter/min	3.2

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 (with compressed air/hydraulic 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 (reference: waterline)

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

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

CAPACITIES

Number of cylinders			16
Engine coolant, engine side (with cooling system)	R	Liters	160
Total engine oil capacity at initial filling (standard oil system) (Option: max. operating inclinations)	R	Liters	134
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	Liters	127
Oil pan capacity at dipstick mark “min.” (standard oil system) (Option: max. operating inclinations)	L	Liters	97
Oil pan capacity at dipstick mark “max.” (standard oil system) (Option: max. operating inclinations)	L	Liters	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, +3dB(A) tolerance)	R	dB(A)	104
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798+2dB(A) tolerance)	R	dB(A)	106

3.21 16V 2000 M61 engine data

Explanation:

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

REFERENCE CONDITIONS

Engine model			16V 2000 M61
Application group			1A
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 as per ISO 3046)

Number of cylinders			16
Rated engine speed	A	rpm	1800
Fuel stop power ISO 3046	A	kW	800

GENERAL CONDITIONS (for maximum power)

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

MODEL RELATED DATA (basic design)

Number of cylinders			16
Cylinder arrangement: V angle		Degrees (°)	90
Bore		mm	130
Stroke		mm	150
Displacement per cylinder		Liters	1.99
Total displacement		Liters	31.84
Inlet valves per cylinder			2
Exhaust valves per cylinder			2

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LUBE-OIL SYSTEM

Number of cylinders			16
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	6.0
Lube-oil operating pressure before engine, to	R	bar	7.0
Lube oil operating pressure (low idle) (meas. point: before engine)	R	bar	3.0

FUEL SYSTEM

Number of cylinders			16
Fuel pressure at engine inlet connection, min. (when engine is starting)	L	bar	-0.3
Fuel pressure at supply connection to engine, min. (when engine is running),	L	bar	-0.3
Fuel pressure at engine inlet connection, max. (when engine is starting)	L	bar	+0.5
Fuel supply flow, max.	R	liter/min	24

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 (with compressed air/hydraulic 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 (reference: waterline)

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

CAPACITIES

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

WEIGHTS / MAIN DIMENSIONS

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

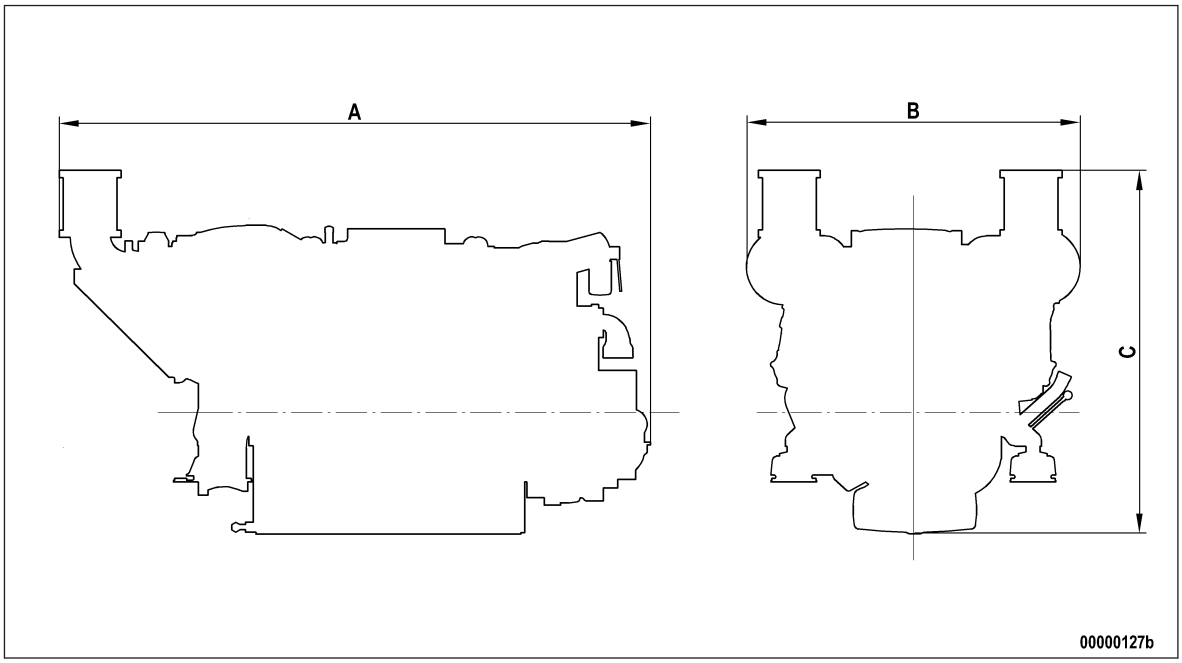
ACOUSTICS

Number of cylinders			16
Exhaust noise, unsilenced - BL (free-field sound pressure level Lp, 1m distance, ISO 6798, +3dB(A) tolerance)	R	dB(A)	104
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798+2dB(A) tolerance)	R	dB(A)	106

3.22 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

3.23 Engine – Main dimensions

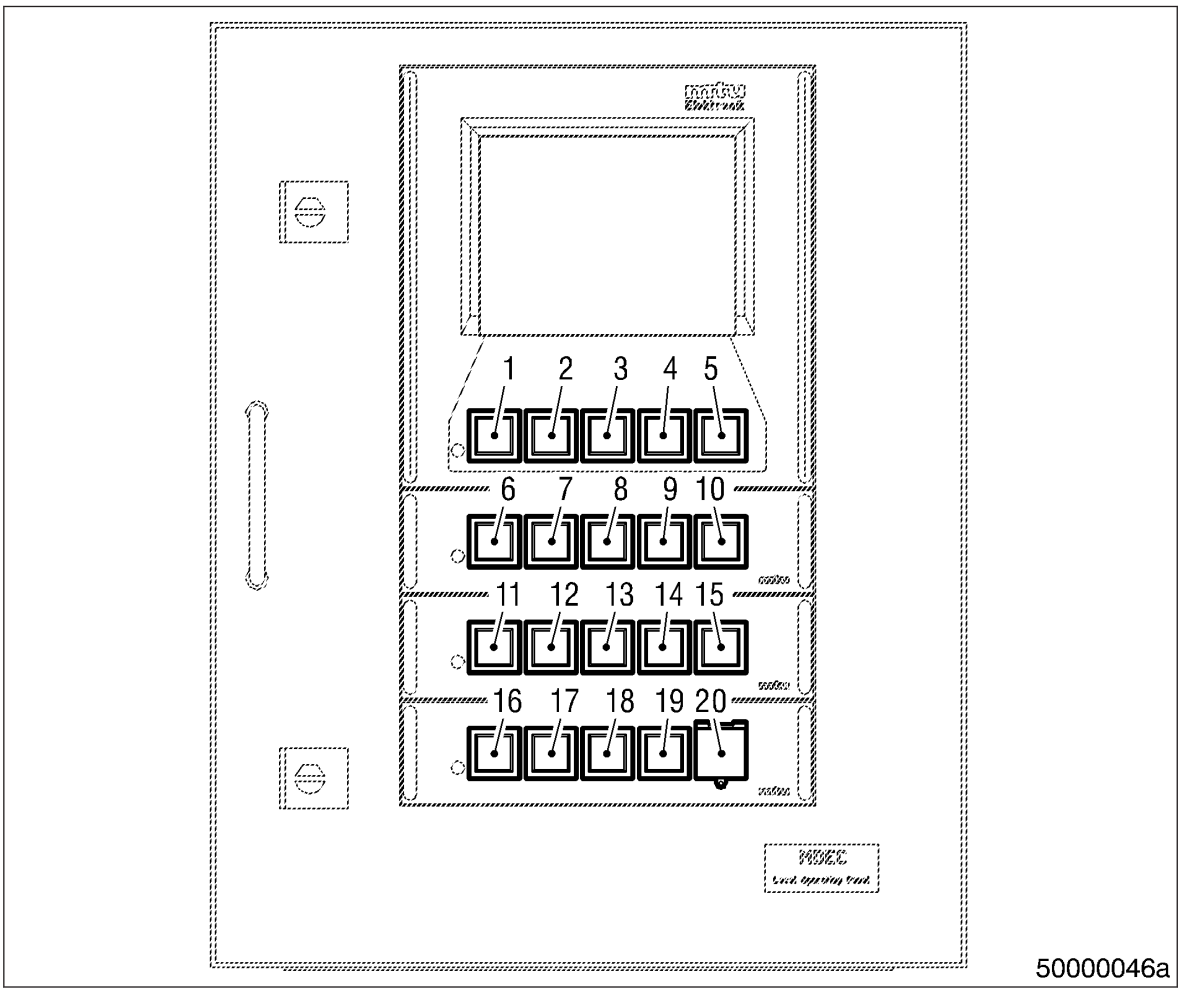


Engine model	Length (A)	Width (B)	Height (C)
8 V 2000 M50-M61	approx. 2005 mm	approx. 1280 mm	approx. 1315 mm
12 V 2000 M50-M61	approx. 2350 mm	approx. 1400 mm	approx. 1475 mm
16 V 2000 M50-M61	approx. 2815 mm	approx. 1425 mm	approx. 1520 mm

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.
8	White	DIM ↓	Holding down the button decreases LCD background illumination.

Item	Color	Inscription	Meaning / Function
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 after extended out-of-service periods (>3 months)

Preconditions

☑ Engine is stopped and starting disabled.

☑ MTU Preservation and Represervation Specifications (A001070/..) are available.

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

Item	Measure
Engine	Depreserve (→ MTU Preservation and Represervation Specifications A001070/..).
Universal shaft	Lubricate (→ Page 213).
Lube oil system	Check engine oil level (→ Page 187).
Fuel prefilter	Fill with fuel (→ Page 179).
Fuel prefilter, pressure gauge	Align adjustable pointer with position of pressure indicator (→ Page 175).
Fuel system	Vent (→ Page 171).
Raw-water pump (if located above waterline)	Prime with water (approx. 3 4 l) (→ Page 206).
Coolant circuit	If engine is out of service for more than one year, change engine coolant (→ Page 201).
Coolant circuit	Check coolant level (→ Page 200).
Coolant circuit	Heat engine coolant with coolant preheating unit.
Engine governor ECU	Check plug-in connections (→ Page 218).
Engine control system	Switch master switch to ON; Press illuminated pushbutton READY FOR OPERATION (→ Page 105).
LOP	Press illuminated pushbutton LAMP TEST (→ Page 105).

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 187).
Cooling system	Check coolant level (→ Page 200).
Cooling system	Preheat coolant with preheating unit.
Fuel prefilter	Drain (→ Page 176).
Battery-charging generator drive	Check condition of drive belt (→ Page 208).
Engine control system	Switch ON. Press READY FOR OPERATION button (→ Page 105).
LOP	Press LAMP TEST button (→ Page 105).

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

Preconditions

☑ Gearbox is in neutral position.

☑ External start interlock is not activated.

☑ Emergency air shut-off flaps (if fitted) are open.

DANGER

Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Before cranking the engine with starter system, make sure that there are no persons in the engine's danger zone.

WARNING

High level of engine noise when the engine is running.
Risk of damage to hearing!
- Wear ear protectors.

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

Item	Measure
Engine	Crank on starter (→ Page 147).

Starting the engine from LOP

Item	Measure
Engine	Start in unloaded condition.
System	Switch on. LOP: • Illuminated push button LOCAL OPERATION lights up brightly (local control mode is active) (→ Page 105); • Illuminated push button GEARBOX NEUTRAL lights up brightly (gearbox is disengaged) (→ Page 105).
LOP	Press illuminated pushbutton READY FOR OPERATION briefly (→ Page 105). • Illuminated pushbutton READY FOR OPERATION lights up brightly.
LOP	Press illuminated pushbutton START briefly (→ Page 105). • Illuminated pushbutton START of the relevant engine lights up brightly; • Automatic starting sequence is performed; • Engine speed display instrument indicates increasing speed; • After completion of the starting sequence, the engine runs at idle speed, and the illuminated pushbutton START changes to basic brightness.

4.5 Starting the engine with the BlueLine automation system (control stand)

DANGER

Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Before cranking the engine with starter system, make sure that there are no persons in the engine's danger zone.

WARNING

High level of engine noise when the engine is running.
Risk of damage to hearing!
- Wear ear protectors.

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

Item	Measure
Engine	Bar with starting system (→ Page 147).

Starting the engine at the BlueLine automation system (control stand)

Item	Measure
Engine	Start the engine at the BlueLine automation system (control stand) (→ BlueLine documentation).

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

NOTICE

An emergency stop causes extreme stress to the engine plant.
Risk of overheating, damage to components!
- Initiate emergency stop only in emergency situations.

Engine emergency stop at BlueLine automation system

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

4.7 Operational checks

DANGER

Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING

High level of engine noise when the engine is running.
Risk of damage to hearing!
- Wear ear protectors.

Operational checks

Item	Measure
Engine under load Engine at nominal speed	Visually inspect engine for leaks and general condition Check for abnormal running noises and vibration Check exhaust color (→ Page 121).
Fuel prefilter	Check that contamination indicator position at the fuel prefilter is within the permissible limit (→ Page 175). Drain water and contaminants (→ Page 176).
Intercooler	Check drain line for water discharge and obstruction (→ Page 181).
Air filter	Check signal ring position of service indicator (→ Page 184). Replace air filter (→ Page 182) if the signal ring is completely visible in the contamination indicator control window.
HT coolant pump	Check relief bore for oil and coolant discharge and contamination (→ Page 204).
Raw-water pump	Check relief bore for escaping oil and water, check for contamination (→ Page 207).

4.8 Coupling - Disengaging from LOP

Preconditions

☑ LOCAL OPERATION illuminated pushbutton lights up brightly (local operating mode is active).

☑ Engine speed in disengagement window.

Disengaging coupling without reversing gearbox (CPP, WJ, VS)

Item	Measure
LOP	Press COUPLING OUT illuminated pushbutton (→ Page 105). • COUPLING OUT button flashes. • Coupling is disengaged. • After receiving the feedback signal from coupling, the COUPLING OUT button is illuminated brightly.

Disengaging coupling with reversing gearbox (FPP, WJ)

Item	Measure
LOP	Press COUPLING NEUTRAL illuminated pushbutton (→ Page 105). • COUPLING NEUTRAL button flashes. • Gearbox is disengaged (neutral position). • After receiving the feedback signal from coupling, the COUPLING NEUTRAL button is illuminated brightly.

4.9 Waterjet – Flushing from LOP (optional)

Preconditions

☑ LOCAL OPERATION illuminated pushbutton is lit brightly (local operating mode is active).

☑ Vessel is at a standstill and waterjet bucket is below the waterline.

☑ Engine speed is in engagement window.

☑ No external engagement interlock is active.

NOTICE

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	Measure
LOP	Press FLUSH illuminated pushbutton and keep pressed (→ Page 105). • FLUSH pushbutton flashes. • Gearbox is engaged astern. • After receiving the feedback signal from coupling, the FLUSH pushbutton is illuminated brightly.
LOP	Release FLUSH illuminated pushbutton. • FLUSH pushbutton flashes. • Gearbox is disengaged (neutral position). • Illumination of FLUSH pushbutton is switched off as soon as the feedback signal from coupling is received.

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

Preconditions

☑ Engine is running in Local mode.

NOTICE

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 minutes until engine temperatures have dropped and constant values are displayed.

Stopping the engine from LOP

Item	Measure
LOP	Disengage gearbox (→ Page 105).
LOP	Operate engine at idle speed (→ Page 105).
Temperature indications	Wait until engine temperatures do not fall any further.
LOP	Press illuminated pushbutton STOP (→ Page 105). • STOP pushbutton is illuminated; • Engine at a standstill.

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

NOTICE

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 minutes 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).

4.12 Emergency stop from LOP (without Blue Line automation system)

NOTICE

An emergency stop causes extreme stress to the engine plant.
Risk of overheating, damage to components!
- Initiate emergency stop only in emergency situations.

Emergency stop from LOP

Item	Measure
LOP	Open cap of illuminated pushbutton EMERGENCY STOP (→ Page 105).
LOP	Press illuminated pushbutton EMERGENCY STOP. • Engine is stopped by disconnecting the power supply to the ECU; • On engines with emergency air-shutoff flaps: flaps close; • Illuminated pushbutton EMERGENCY STOP flashes, Horn, flashing lamp etc. are tripped.

After emergency stop from LOP

Item	Measure
LOP	Press illuminated pushbutton ALARM ACKNOWLEDGE (→ Page 105). • Audible and visual alarm signaling stops.
LOP	Press ALARM ACKNOWLEDGE button again. • Power supply to ECU is provided; • Alarm has been acknowledged.
Engine	On engines with emergency air-shutoff flaps: open flaps. • Engine is ready for starting.

4.13 After stopping the engine

Preconditions

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

After stopping the engine

Item	Measure
Coolant circuit	Drain coolant (→ Page 202) if: • freezing temperatures are expected and the engine is to remain out of service for an extended period, but engine coolant has no antifreeze additive; • the engine room is not heated; • the coolant is not kept at a suitable temperature; • the antifreeze concentration is insufficient for the engine-room temperature; • antifreeze concentration is 50 % and engine-room temperature is below -40°C.
Raw water	Drain • if freezing temperatures are to be expected and the engine is to remain out of service for an extended period.
Engine control system	Switch off.
Air intake and exhaust system	Out-of-service-period > 1 week • Seal engine's air and exhaust sides.
Engine	Out-of-service-period > 1 month • Depreserve engine (→ MTU Preservation and Represervation Specifications A001070/..)

4.14 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 gun ejects a jet of pressurized air.
Risk of injury to eyes and damage to hearing, risk of rupturing internal organs!
- Never direct air jet at people.
- Always wear safety goggles/face mask and ear defenders.

WARNING

Steam jet cleaner ejects jet of pressurized water.
Risk of injury to eyes and scalding!
- Never direct water jet at people.
- Wear protective clothing, protective gloves and safety goggles/face mask.

NOTICE

Cleaning agents should not be left to take effect for too long.
Damage to components is possible!
- Observe manufacturer's instructions.

NOTICE

Blowing down product with compressed air.
Entry of dirt and damage to components is possible!
- Do not aim compressed air gun directly at seals or electronic components such as connectors or ECUs.

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 of the plant with water or steam-jet cleaners:
   - 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.
4. For external cleaning with high-pressure jet, use a flat-mouth nozzle only.

Note: Never aim compressed air directly at electronic components.

5. Carry out external cleaning as follows:
   a) Seal all openings in a suitable way.
   b) Remove coarse dirt.
   c) Spray on cleaner sparingly and leave it for 1 to 5 minutes.
   d) Use the high-pressure jet to remove the loosened dirt.
   e) Dry engine with compressed air.

5 Maintenance

5.1 Maintenance schedule reference table [QL1]

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

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

Task	Maintenance activity	
W0500	Check engine oil level	(→ Page 187)
W0501	Visually inspect engine for leaks and general condition	(→ Page 112)
W0502	Check intercooler condensate drain (if applicable)	(→ Page 112)
W0503	Check service indicator of air filter	(→ Page 112)
W0505	Check relief bores on coolant pump(s)	(→ Page 112)
W0506	Check for abnormal running noise, exhaust gas color and vibrations	(→ Page 112)
W0507	Drain water and impurities from fuel prefilter (if applicable)	(→ Page 112)
W0508	Check vacuum gage reading on fuel prefilter (if applicable)	(→ Page 112)
W1001	Replace fuel filter or fuel filter element	(→ Page 173)
W1002	Check valve clearance	(→ Page 155)
W1003	Check condition and tension of drive belt, replace belt if required	(→ Page 208)
W1005	Replace air filter	(→ Page 182)
W1006	Replace fuel injectors	(→ Page 163)
W1007	Replace fuel injection pump(s)	(→ Page 159)
W1008	Replace engine oil filter when changing engine oil, or when the interval (years) is reached, at the latest	(→ Page 190)
W1009	Check layer thickness of oil residue, clean and replace filter sleeve (if applicable) when changing engine oil, at the latest	(→ Page 192)
W1011	Perform endoscopic inspection of combustion chambers	(→ Page 148)
W1140	Clean wire meshes of crankcase breather	(→ Page 154)
W1178	Replace pressure pipe neck in cylinder head	(→ Page 164)

Table 2: Maintenance schedule reference table [QL1]

6 Troubleshooting

6.1 LOP fault messages

AL RCS Speed Demand Defect

Cause	Corrective action
No speed demand signal.	1. Check remote control system. 2. Check LOP visually (→ Page 223). 3. Perform LOP test procedures (→ Page 225). 4. Check ECU plug-in connections (→ Page 218). 5. Check engine wiring (→ Page 214).

AL Battery Charger Failure

Cause	Corrective action
Battery not being charged.	1. Check power circuit breakers and fuses. 2. Check transistorized regulator. 3. Check drive belt (→ Page 209).

AL Press. Monitoring Fail (EMU)

Cause	Corrective action
EMU pressure monitoring failure.	▶ Contact Service. • Have EMU replaced.

AL ECU Defective

Cause	Corrective action
ECU 4 is defective.	1. Check LOP visually (→ Page 223). 2. Perform LOP test procedures (→ Page 225). 3. Check ECU plug-in connections (→ Page 218). 4. Check engine wiring (→ Page 214). 5. Contact Service. • have ECU checked and replaced, if required.

AL Output Stage Bank 1 Fault

Cause	Corrective action
Fault message of power output stage, cylinder bank A	1. Check LOP visually (→ Page 223). 2. Perform LOP test procedures (→ Page 225). 3. Check ECU plug-in connections (→ Page 218). 4. Check engine wiring (→ Page 214). 5. Contact Service. • have ECU checked and replaced, if required.

AL Output Stage Bank 2 Fault

Cause	Corrective action
Fault message of power output stage, cylinder bank B	1. Check LOP visually (→ Page 223). 2. Perform LOP test procedures (→ Page 225). 3. Check ECU plug-in connections (→ Page 218). 4. Check engine wiring (→ Page 214). 5. Contact Service. • have ECU checked and replaced, if required.

AL Gear Control Fail GCU

Cause	Corrective action
GCU fault.	▶ Contact Service. • Have GCU solenoid checked and replaced, if required. • Have GCU wiring checked and replaced, if required .

AL Gear Oil Filter Clogged

Cause	Corrective action
Gear oil filter clogged.	▶ Clean gear-oil filter and replace, if required (see gearbox documentation).

AL Override Activated

Cause	Corrective action
Safety system override is active.	▶ Status message: • Override activated.

AL Power Failure Control

Cause	Corrective action
Power failure of control system.	▶ Check power circuit breakers and fuses.

AL Power Failure Monitoring

Cause	Corrective action
Power failure.	▶ Check power circuit breakers and fuses.

AL Transistor Output 1/2 Fail

Cause	Corrective action
One of the ECU 4 transistor outputs (TAA1 or TAA2) defective.	▶ Contact Service. • have ECU checked and replaced, if required.

AL Transistor Output 3/4 Fail

Cause	Corrective action
One of the ECU 4 transistor outputs (TAA3 or TAA4) defective.	▶ Contact Service. • have ECU checked and replaced, if required.

AL Water in Fuel Prefilter

Cause	Corrective action
Water in fuel prefilter.	▶ Drain fuel prefilter (→ Page 176).

DL 211+A001-A001

Cause	Corrective action
DIS not detected on default CAN bus.	1. Check LOP visually (→ Page 223). 2. Perform LOP test procedures (→ Page 225). 3. Check ECU plug-in connections (→ Page 218). 4. Check engine wiring (→ Page 214). 5. Contact Service. • Have DIS checked and replaced, if required.

DL 211+A001-A010

Cause	Corrective action
LCU of LOP 1 (PIM No. 21.X +A001-A010) not detected on default CAN bus.	1. Check LOP visually (→ Page 223). 2. Perform LOP test procedures (→ Page 225). 3. Check ECU plug-in connections (→ Page 218). 4. Check engine wiring (→ Page 214). 5. Contact Service. • Have MPU 23 of PIM No. 21.X+A001-A010 checked and replaced, if required.

DL 211+A001-A020

Cause	Corrective action
LMU of LOP 1 (PIM No. 21.X +A001-A020) not detected on default CAN bus.	1. Check LOP visually (→ Page 223). 2. Perform LOP test procedures (→ Page 225). 3. Check ECU plug-in connections (→ Page 218). 4. Check engine wiring (→ Page 214). 5. Contact Service. • Have MPU 23 of PIM No. 21.X+A001-A020 checked and replaced, if required.

DL 211+A002-A030

Cause	Corrective action
GCU 1 (PIM No. 21.X+A002-A030) not detected on default CAN bus.	1. Check LOP visually (→ Page 223). 2. Perform LOP test procedures (→ Page 225). 3. Check ECU plug-in connections (→ Page 218). 4. Check engine wiring (→ Page 214). 5. Contact Service. • Have GCU/GMU checked and replaced if required.

DL 211+A002-A040

Cause	Corrective action
GMU 1 (PIM No. 21.X+A002-A040) not detected on default CAN bus.	1. Check LOP visually (→ Page 223). 2. Perform LOP test procedures (→ Page 225). 3. Check ECU plug-in connections (→ Page 218). 4. Check engine wiring (→ Page 214). 5. Contact Service. • Have GCU/GMU checked and replaced if required.

DL 211+A003-ECU

Cause	Corrective action
ECU 4 not detected on default CAN bus.	1. Check LOP visually (→ Page 223). 2. Perform LOP test procedures (→ Page 225). 3. Check ECU plug-in connections (→ Page 218). 4. Check engine wiring (→ Page 214). 5. Contact Service. • have ECU checked and replaced, if required.

DL 211+A004-EMU

Cause	Corrective action
EMU 1 not detected on default CAN bus.	1. Check LOP visually (→ Page 223). 2. Perform LOP test procedures (→ Page 225). 3. Check ECU plug-in connections (→ Page 218). 4. Check engine wiring (→ Page 214). 5. Contact Service. • have EMU checked and replaced, if required.

DL 211+A300-A500

Cause	Corrective action
RCS with PIM No. 21.X+A300-A500 not detected on default CAN bus.	1. Check LOP visually (→ Page 223). 2. Perform LOP test procedures (→ Page 225). 3. Check ECU plug-in connections (→ Page 218). 4. Check engine wiring (→ Page 214). 5. Contact Service. • Have RCS checked and replaced, if required.

DL 211+A300-A501

Cause	Corrective action
PCU (PIM No. 21.X+A300-A501) not detected on default CAN bus.	1. Check LOP visually (→ Page 223). 2. Perform LOP test procedures (→ Page 225). 3. Check ECU plug-in connections (→ Page 218). 4. Check engine wiring (→ Page 214). 5. Contact Service. • Have PCU checked and replaced, if required.

HI P-Oil Filter Fifference

Cause	Corrective action
Oil pressure difference between oil pressures before and after filter too high.	▶ Replace engine oil filter (→ Page 190).

MG Disengagement Fault

Cause	Corrective action
RCS message.	▶ Contact Service. • Have GCU solenoid checked and replaced, if required. • Have GCU wiring checked and replaced, if required .

MG Eng Speed High/Low (Clutch)

Cause	Corrective action
RCS message.	▶ Speed reduction

MG Engagement Fault

Cause	Corrective action
RCS message.	▶ Contact Service. • Have GCU solenoid checked and replaced, if required. • Have GCU wiring checked and replaced, if required .

MG Check Start Interlocks

Cause	Corrective action
Start conditions are not fulfiulled.	▶ Check start conditions and fulfill if necessary.

RL 211+A001-A001

Cause	Corrective action
DIS not detected on redundant bus	1. Check LOP visually (→ Page 223). 2. Perform LOP test procedures (→ Page 225). 3. Contact Service. • Have DIS checked and replaced, if required.

RL 211+A001-A010

Cause	Corrective action
LCU of LOP 1 (PIM No. 21.X +A001-A010) not detected on redundant CAN bus.	1. Check LOP visually (→ Page 223). 2. Perform LOP test procedures (→ Page 225). 3. Contact Service. • Have MPU 23 of PIM No. 21.X+A001-A010 checked and replaced, if required.

RL 211+A001-A020

Cause	Corrective action
LMU of LOP 1 (PIM No. 21.X +A001-A020) not detected on redundant CAN bus.	1. Check LOP visually (→ Page 223). 2. Perform LOP test procedures (→ Page 225). 3. Contact Service. • Have MPU 23 of PIM No. 21.X+A001-A020 checked and replaced, if required.

RL 211+A002-A030

Cause	Corrective action
GCU 1 (PIM No. 21.X+A002-A030) not detected on redundant CAN bus.	1. Check LOP visually (→ Page 223). 2. Perform LOP test procedures (→ Page 225). 3. Contact Service. • Have GCU/GMU checked and replaced if required.

RL 211+A002-A040

Cause	Corrective action
GMU 1 (PIM No. 21.X+A002-A040) not detected on redundant CAN bus.	1. Check LOP visually (→ Page 223). 2. Perform LOP test procedures (→ Page 225). 3. Contact Service. • Have GCU/GMU checked and replaced if required.

RL 211+A003-ECU

Cause	Corrective action
ECU 4 not detected on redundant CAN bus.	1. Check LOP visually (→ Page 223). 2. Perform LOP test procedures (→ Page 225). 3. Check ECU plug-in connections (→ Page 218). 4. Contact Service. • have ECU checked and replaced, if required.

RL 211+A004-EMU

Cause	Corrective action
EMU 1 not detected on redundant bus	1. Check LOP visually (→ Page 223). 2. Perform LOP test procedures (→ Page 225). 3. Contact Service. • have EMU checked and replaced, if required.

RL 211+A300-A500

Cause	Corrective action
RCS with PIM No. 21.X+A300-A500 not detected on redundant CAN bus.	1. Check LOP visually (→ Page 223). 2. Perform LOP test procedures (→ Page 225). 3. Contact Service. • Have RCS checked and replaced, if required.

RL 211+A300-A501

Cause	Corrective action
PCU (PIM No. 21.X+A30-A501) not detected on redundant CAN bus.	1. Check LOP visually (→ Page 223). 2. Perform LOP test procedures (→ Page 225). 3. Contact Service. • Have PCU checked and replaced, if required.

SS Safety System Failure (EMU)

Cause	Corrective action
Safety system has detected fault on Engine Monitoring Unit.	▶ Contact Service.

SS Power Reduction Active

Cause	Corrective action
Safety system has requested power reduction.	1. Determine cause of automatic power reduction. 2. Observe further display messages/alarms. 3. Contact Service.

SS Emergency Stop

Cause	Corrective action
Safety system has initiated an emergency stop	1. Determine cause for shutoff and rectify. 2. Observe further display messages/alarms.

SS Emergency Stop External

Cause	Corrective action
Safety system has carried out an externally triggered emergency stop.	1. Determine cause for shutoff and rectify. 2. Observe further display messages/alarms.

SS P-Gear Lube Oil (GCU)

Cause	Corrective action
Safety system detects that gear control oil pressure is too low.	▶ Check gearbox lube-oil level and top up, if required (see gearbox documentation).

SS P- Gear Lube Oil (GMU)

Cause	Corrective action
Safety system detects that gear lube oil pressure is too low.	▶ Check gearbox lube-oil level and top up, if required (see gearbox documentation).

SS P-Gear Control Oil (GCU)

Cause	Corrective action
Safety system detects that gear control oil pressure is too low.	▶ Check gearbox control-oil level and top up, if required (see gearbox documentation).

SS P- Gear Control Oil (GMU)

Cause	Corrective action
Safety system detects that gear control oil pressure is too low.	▶ Check gearbox control-oil level and top up, if required (see gearbox documentation).

SS P-Coolant

Cause	Corrective action
Safety system detects that coolant pressure is too low.	▶ Check coolant level and top up if required (→ Page 200).

SS P-Lube Oil (ECU)

Cause	Corrective action
Safety system detects that engine-oil pressure is too low.	1. Check lube-oil level and top up if required (→ Page 187). 2. Contact Service.

SS P-Lube Oil (EMU)

Cause	Corrective action
Safety system detects that engine-oil pressure is too low.	1. Check lube-oil level and top up if required (→ Page 187). 2. Contact Service.

SS Security Channel Def EMU

Cause	Corrective action
Safety system fault message.	▶ Contact Service. • have EMU checked and replaced, if required.

SS SDAF Closed

Cause	Corrective action
Safety system reports closed emergency-air shutoff flaps.	▶ Open emergency-air shutoff flaps (→ Page 185).

SS Security Shutdown

Cause	Corrective action
Safety system has triggered engine stop.	▶ Determine cause for shutoff and rectify.

SS T-Coolant (ECU)

Cause	Corrective action
Safety system detects that coolant temperature is too high.	▶ Reduce power.

SS T-Coolant (EMU)

Cause	Corrective action
Safety system detects that the engine coolant temperature is too high.	▶ Reduce power.

SS T-Lube Oil

Cause	Corrective action
Safety system detects that lube oil temperature is too high.	▶ Reduce power.

Stop Activated (EMU)

Cause	Corrective action
EMU has triggered automatic stop command due to limit value violation.	1. Determine cause for shutoff and rectify. 2. Observe further display messages/alarms.

TD P-Lube Oil

Cause	Corrective action
The two lube-oil pressure sensors provide different values.	1. Check LOP visually (→ Page 223). 2. Perform LOP test procedures (→ Page 225). 3. Check ECU plug-in connections (→ Page 218). 4. Check engine wiring (→ Page 214). 5. Contact Service. • Have sensors checked and replaced, if required.

TD T-Coolant

Cause	Corrective action
The two coolant temperature sensors provide different values.	1. Check LOP visually (→ Page 223). 2. Perform LOP test procedures (→ Page 225). 3. Check ECU plug-in connections (→ Page 218). 4. Check engine wiring (→ Page 214). 5. Contact Service. • Have sensors checked and replaced, if required.

Trolling Active

Cause	Corrective action
RCS measuring point.	▶ Status report ("Trolling Active" lamp on).

Cylinder cutout

Cause	Corrective action
Measuring point "Cylinder cutout active".	▶ Status report for "cylinder cutout/number of cylinders halved" during idling

6.2 Troubleshooting

Engine does not turn when starter is actuated

Cause	Corrective action
Battery flat or defective.	▶ Charge or replace battery (see manufacturer's documentation).
Cable connections on battery are defective.	▶ Check if cable connections are properly secured (see manufacturer's documentation).
Engine wiring or starter defective.	▶ Check if cable connections are properly secured, contact Service.
Engine wiring faulty.	▶ Check (→ Page 214).
Assemblies are not correctly connected in control panel LOP. Plug-in connections at LOP control panel are loose.	▶ Perform visual inspection (→ Page 223).
Plug connection are loose at engine control unit ECU.	▶ Check plug connections (→ Page 218).
Engine blocked (cannot be rotated by hand).	▶ Contact Service.
Start interlock limit switch is not installed.	▶ Check limit switch (→ Page 217).
Start interlock limit switch is defective.	▶ Check limit switch (→ Page 217).
Wiring of start interlock limit switch is faulty.	▶ Check wiring (→ Page 214).

Engine turns but does not fire

Cause	Corrective action
Poor rotation by starter: Battery flat or defective.	▶ Charge or replace battery (see manufacturer's documentation).
Engine wiring faulty.	▶ Check (→ Page 214).
Air in fuel system.	▶ Vent fuel system (→ Page 171).
Engine control unit ECU is defective.	▶ Contact Service.

Engine fires unevenly

Cause	Corrective action
Injector faulty.	▶ Replace (→ Page 163).
Injection pump faulty.	▶ Replace (→ Page 160).
Engine wiring faulty.	▶ Check (→ Page 214).
Air in fuel system.	▶ Vent fuel system (→ Page 171).
Engine control unit ECU is defective.	▶ Contact Service.

Engine does not reach full load speed

Cause	Corrective action
Fuel supply blocked.	▶ Completely open shutoff valve upstream of fuel prefilter.
Fuel prefilter clogged.	▶ Replace filter element (→ Page 179).
Easy-change fuel filter clogged.	▶ Replace (→ Page 173).
Air filter clogged.	▶ Check signal ring position of contamination indicator (→ Page 184).
Injector faulty.	▶ Replace (→ Page 163).
Injection pump faulty.	▶ Replace (→ Page 160).
Engine wiring faulty.	▶ Check (→ Page 214).
Overload.	▶ Contact Service.
Vessel too heavy.	▶ Check load. Reduce load.
Trim position incorrect.	▶ Trim vessel.
Marine growth on hull, propeller shaft, propeller, rudder.	▶ Clean components.
Rudder position incorrect.	▶ Align rudder.
Propeller too big after replacement.	▶ Install suitable propeller.

Engine speed not steady

Cause	Corrective action
Injector faulty.	▶ Replace (→ Page 163).
Injection pump faulty.	▶ Replace (→ Page 159).
Speed sensor is faulty.	▶ Contact Service.
Air in fuel system.	▶ Vent fuel system (→ Page 171).
Engine control unit ECU is defective.	▶ Contact Service.

Charge-air temperature too high

Cause	Corrective action
Incorrect engine coolant concentration.	▶ Check (MTU test kit).
Charge-air cooler is contaminated.	▶ Contact Service.
Air inlet temperature in engine room is too high.	▶ Check fan Check air inlet/outlet ducts.

Charge-air pressure too low

Cause	Corrective action
Air filter clogged.	▶ Check signal ring position of contamination indicator (→ Page 184).
Charge-air cooler is contaminated.	▶ Contact Service.
Exhaust turbocharger faulty.	▶ Contact Service.

Coolant leaks at intercooler

Cause	Corrective action
Major coolant discharge at charge-air cooler. Charge-air cooler leaky.	▶ Contact Service.

Black exhaust gas

Cause	Corrective action
Air filter clogged.	▶ Check signal ring position of contamination indicator (→ Page 184).
Injector faulty.	▶ Replace (→ Page 163).
Injection pump faulty.	▶ Replace (→ Page 159).
Overload.	▶ Contact Service.

Blue exhaust gas

Cause	Corrective action
Too much oil in engine.	▶ Drain engine oil (→ Page 188).
Oil separator or oil preseparator of crankcase breather clogged.	▶ Replace (→ Page 152).
Exhaust turbocharger faulty.	▶ Contact Service.
Cylinder head is faulty.	▶ Contact Service.
Piston rings are defective.	▶ Contact Service.
Cylinder liner defective.	▶ Contact Service.

White exhaust gas

Cause	Corrective action
Engine is not at operating temperature.	▶ Run engine to reach operating temperature.
Water in fuel.	▶ Check fuel system at fuel prefilter. Drain fuel prefilter (→ Page 176).
Charge-air cooler leaky.	▶ Contact Service.

7 Task Description

7.1 SOLAS

7.1.1 SOLAS shielding as per MTN 5233 - Installation

Preconditions

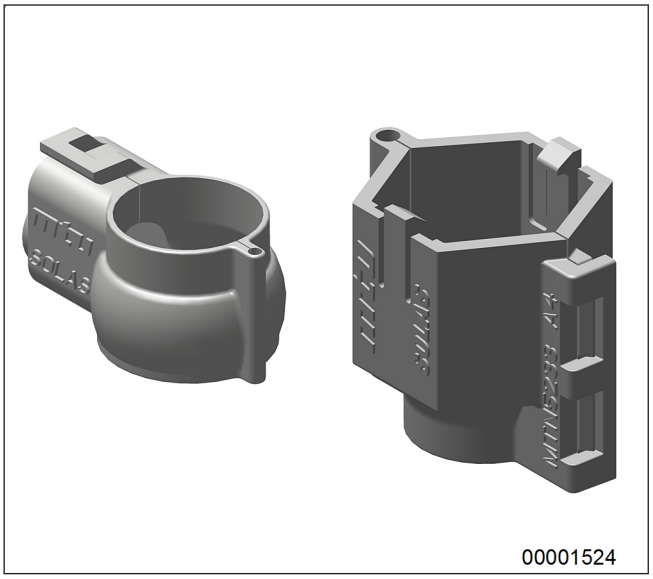
☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Shield A4	735233000100	10
Shield A5	735233000101	14
Shield A7	735233000103	6
Shield A8	735233000104	2

SOLAS shielding – Installation

1. Pinpoint installation location (→ Page 136).
2. Install suitable shielding.
3. Press shielding until locked.



00001524

TIM-ID: 0000010550 - 003

7.1.2 SOLAS shielding - Installation as per MTN 5233

Preconditions

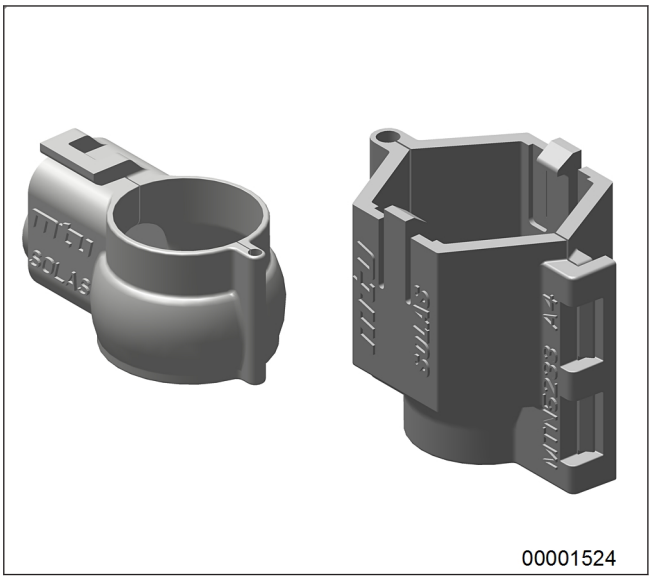
☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Shield A4	735233000100	5
Shield A5	735233000101	7
Shield A7	735233000103	6
Shield A8	735233000104	2

Installing SOLAS shielding

1. Pinpoint installation location (→ Page 136).
2. Install suitable shielding.
3. Press shielding until locked.



7.1.3 SOLAS shielding - Installation

Preconditions

☑ Engine is stopped and starting disabled.

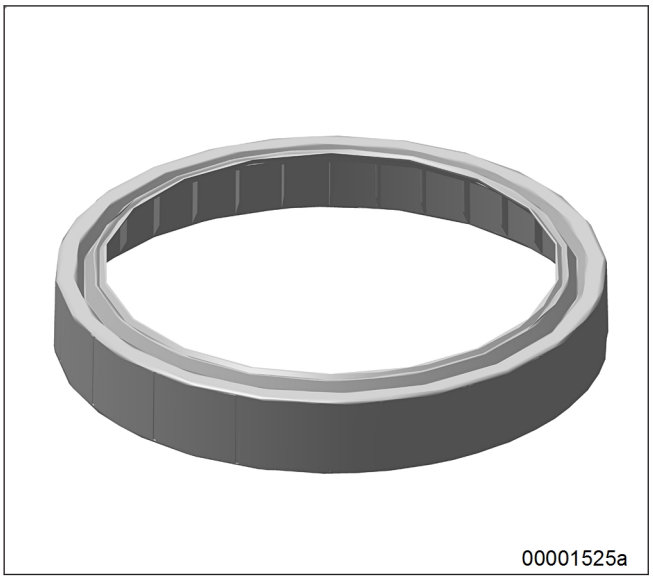
☑ Engine is cooled down to ambient temperature.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Oil filter shield	X00009628	
Fuel filter shield	X00009654	

Installing SOLAS shield on oil filter and fuel filter

1. Pinpoint installation location (→ Page 136).
2. Install suitable shielding.

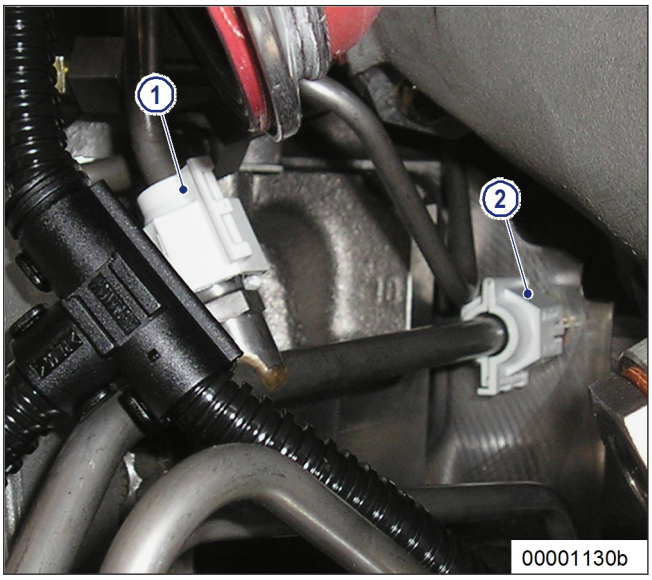


7.1.4 Installation locations for SOLAS shielding

General information

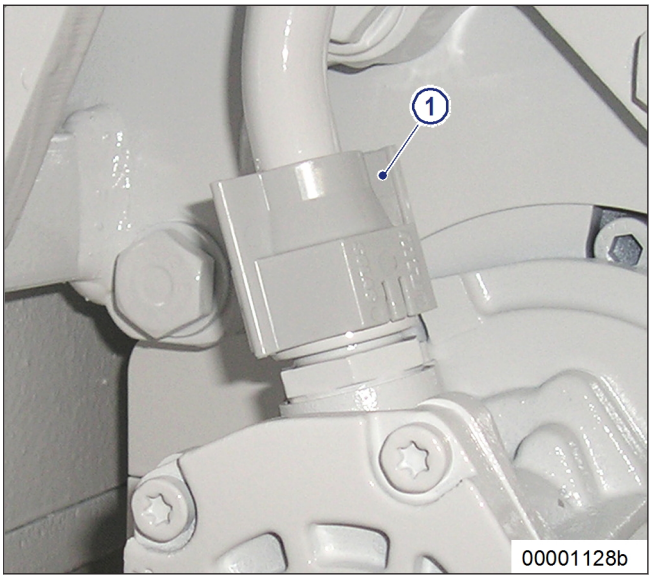
Primarily fit SOLAS shielding as per MTN 5233 (→ Page 133).

On crankcase



Item	Type of shielding	Remarks
1	Shield (A4)	On brazed-on union
2	Shield (A5)	On crankcase

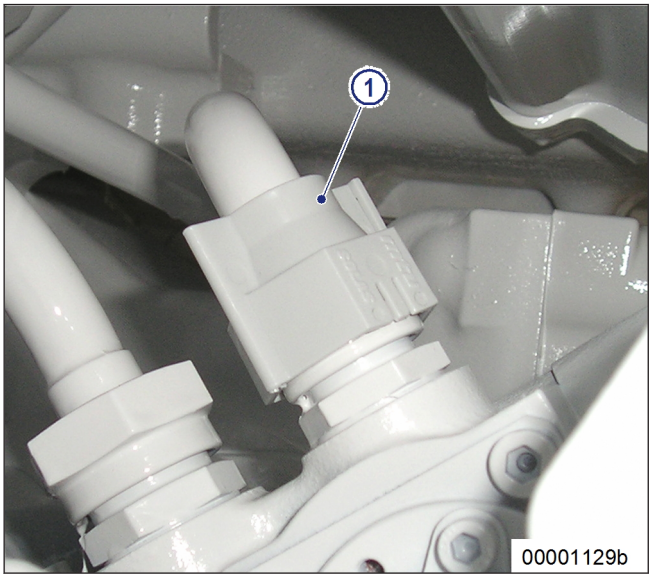
Free end B-side



TIM-ID: 0000010065 - 007

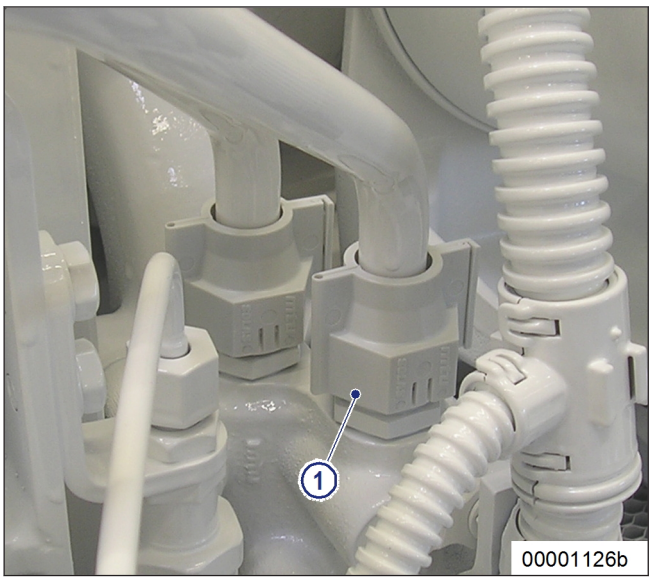
Item	Type of shielding	Remarks
1 Free end B-side	Shield (A7)	On fuel delivery pump

Free end B-side



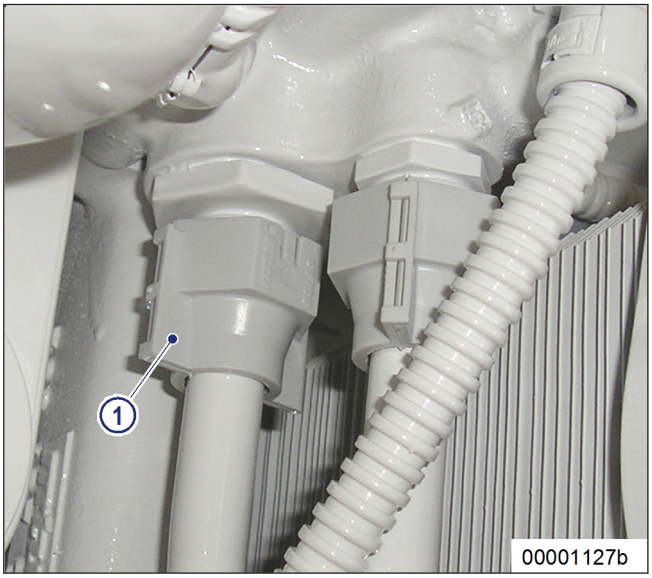
Item	Type of shielding	Remarks
1 Free end B-side	Shield (A7)	On HP fuel pump

Free end



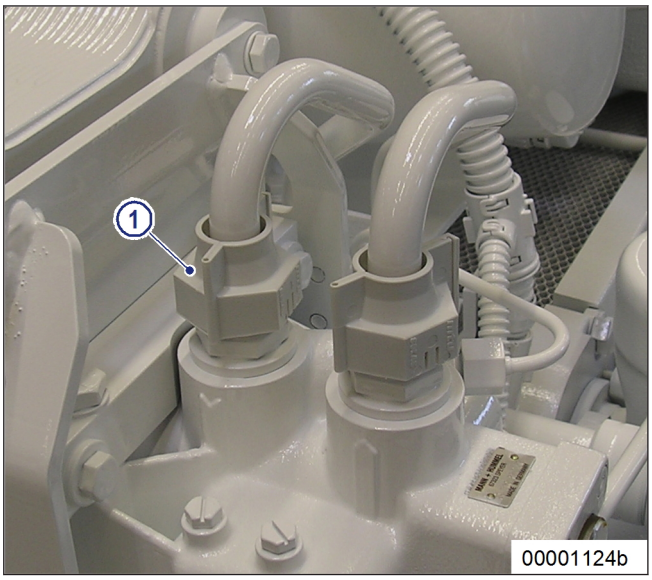
Item	Type of shielding	Remarks
1 Free end	Shield (A7)	Above fuel priming pump.

Free end



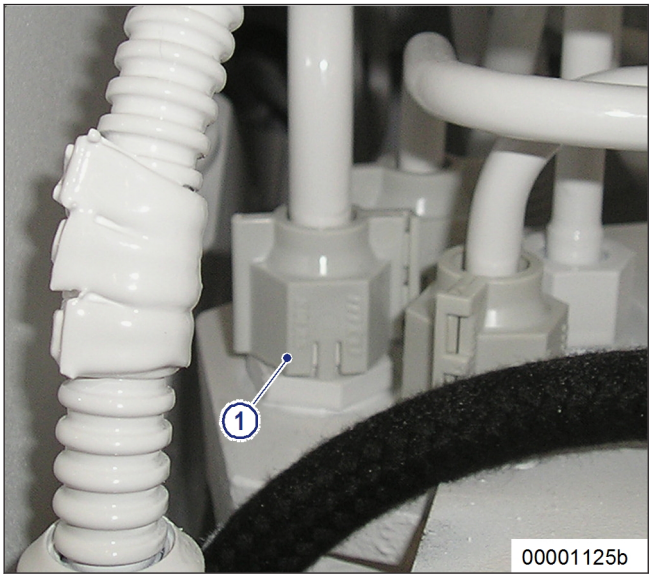
Item	Type of shielding	Remarks
1 Free end	Shield (A7)	Below fuel priming pump.

Free end



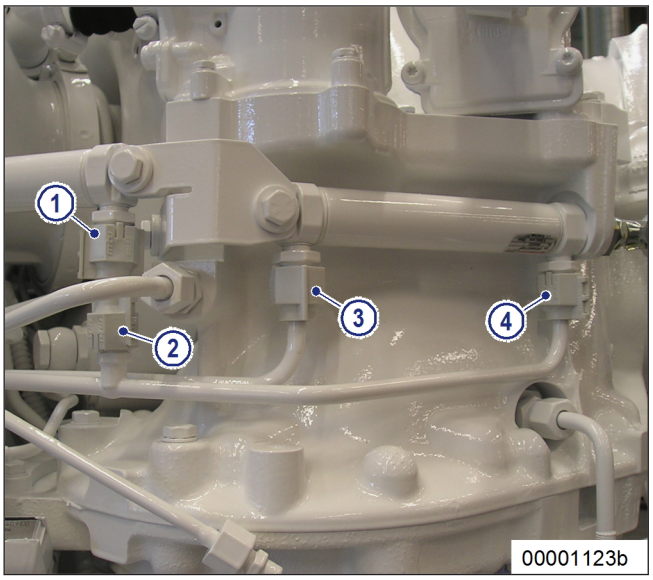
Item	Type of shielding	Remarks
1 Free end	Shield (A8)	On fuel filter housing

Driving end A-side



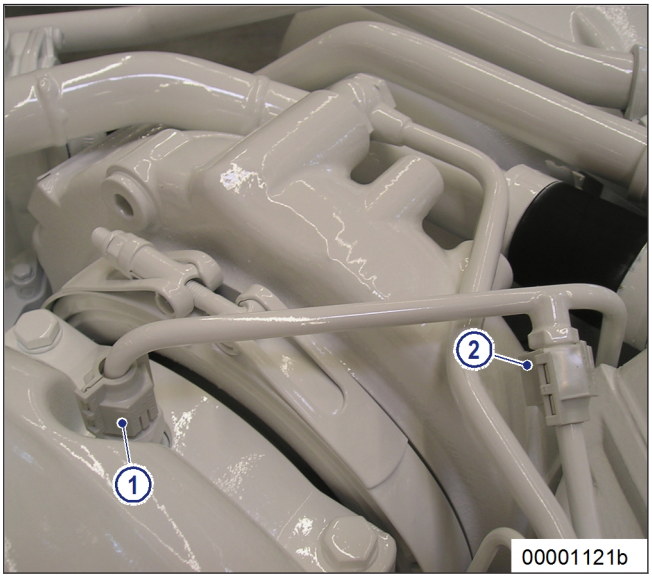
Item	Type of shielding	Remarks
1 Driving end	Shield (A5)	On valve plate

Driving end A-side



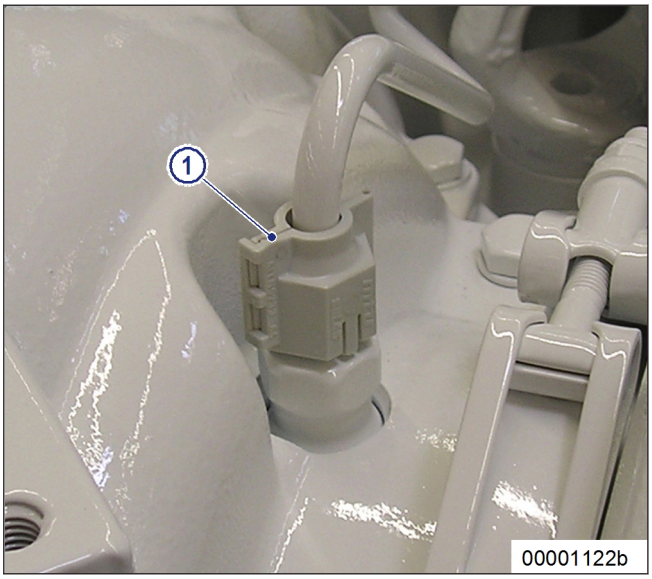
Item	Type of shielding	Remarks
1 Driving end	Shield (A5)	On air flap control
2 Driving end	Shield (A4)	On brazed-on union
3 Driving end	Shield (A5)	On exhaust turbocharger flap control.
4 Driving end	Shield (A5)	On exhaust turbocharger flap control.

Driving end



Item	Type of shielding	Remarks
1 Driving end	Shield (A4)	Exhaust turbocharger lubrication.
2 Driving end	Shield (A4)	On brazed-on union.

Driving end



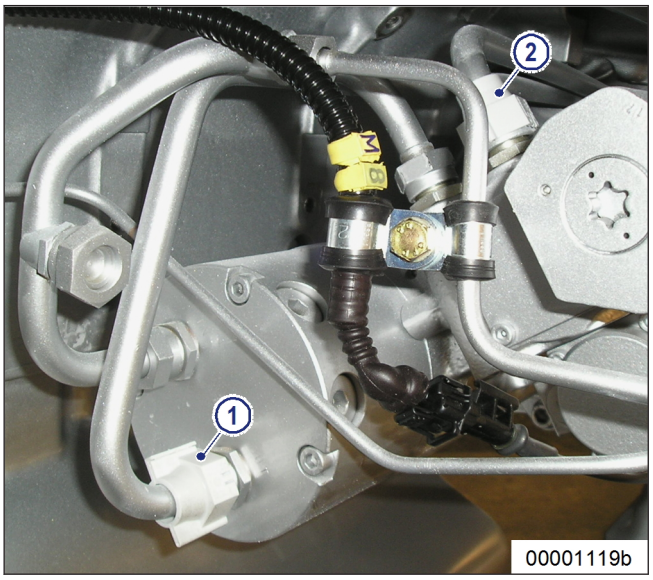
Item	Type of shielding	Remarks
1 Driving end	Shield (A4)	Exhaust turbocharger lubrication.

7.1.5 Installation locations for SOLAS shielding

General information

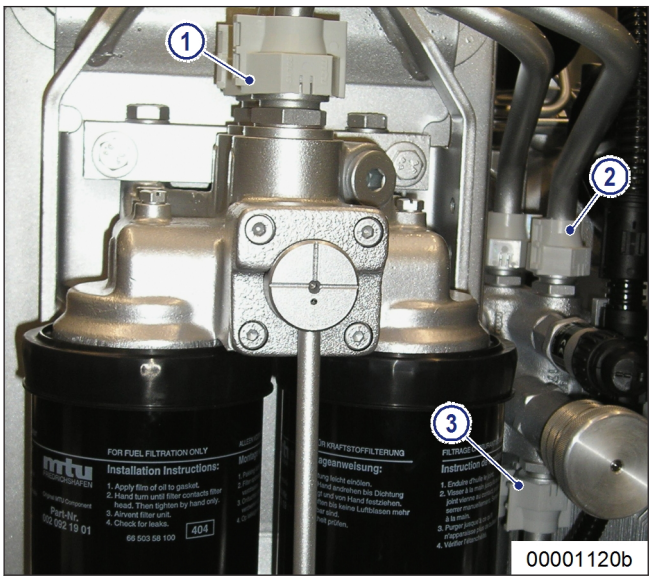
Primarily fit SOLAS shielding as per MTN 5233 (→ Page 133).

Free end B-side



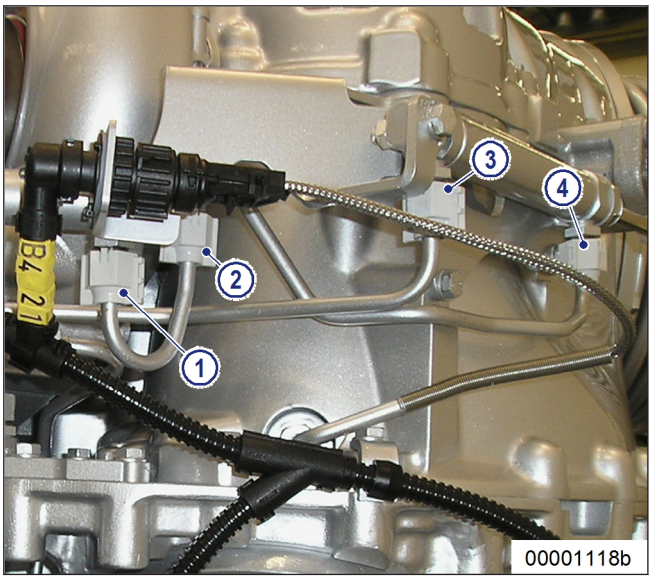
Item	Type of shielding	Comments
1 (free end, B-side)	Shield (A7)	On fuel delivery pump
2 (free end, B-side)	Shield (A7)	On HP fuel pump

Free end



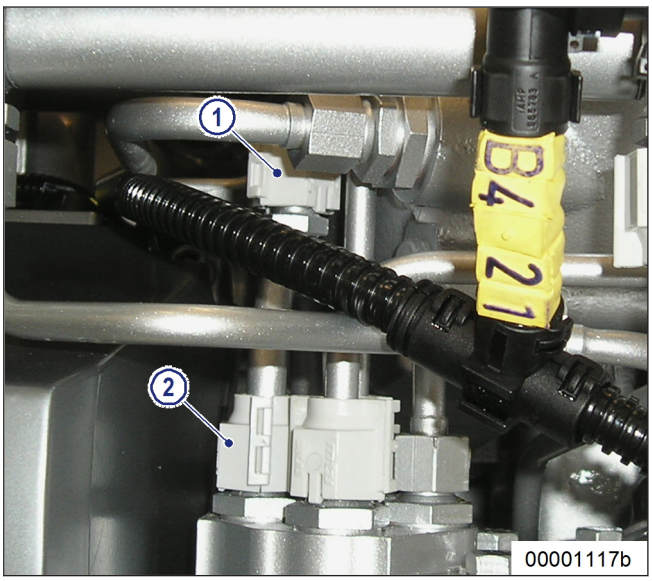
Item	Type of shielding	Comments
1 (free end)	Shield (A8)	On fuel filter
2 (free end)	Shield (A7)	Above fuel priming pump
3 (free end)	Shield (A7)	Below fuel priming pump

Driving end A-side



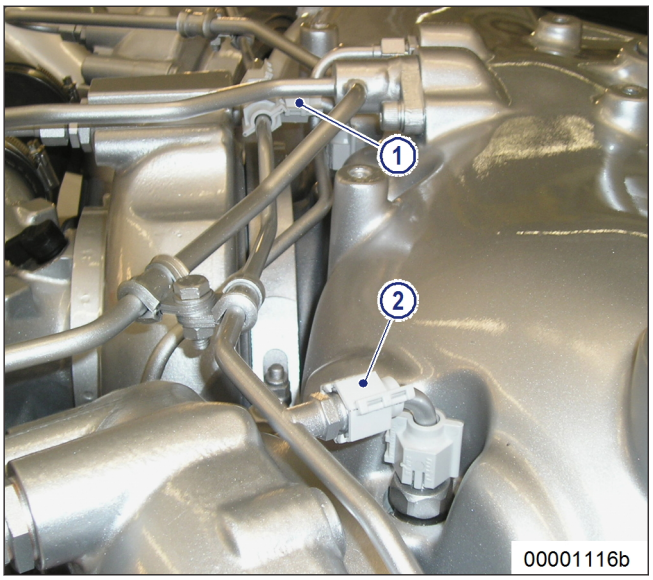
Item	Type of shielding	Comments
1 (Driving end, A-side)	Shield (A5)	On air flap
2 (driving end, A-side)	Shield (A4)	On brazed-on union
3 (driving end, A-side)	Shield (A5)	On turbocharger flap
4 (driving end, A-side)	Shield (A5)	On turbocharger flap

Driving end A-side



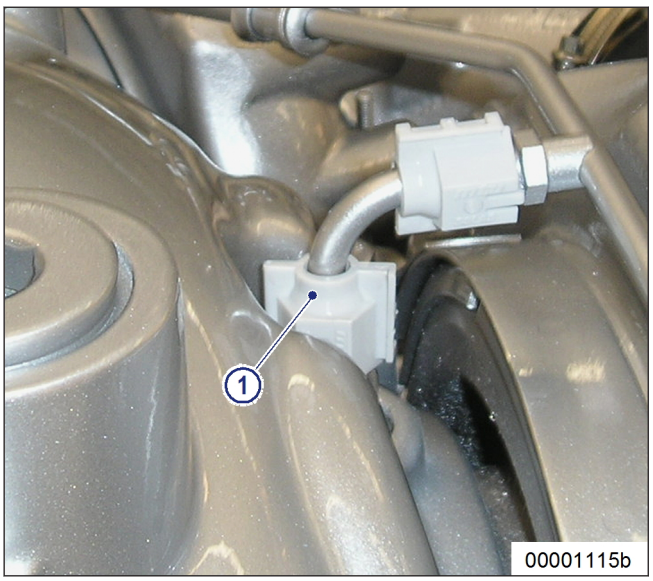
Item	Type of shielding	Comments
1 (Driving end, A-side)	Shield (A5)	To turbocharger lubrication
2 (driving end, A-side)	Shield (A5)	On valve plate

Driving end



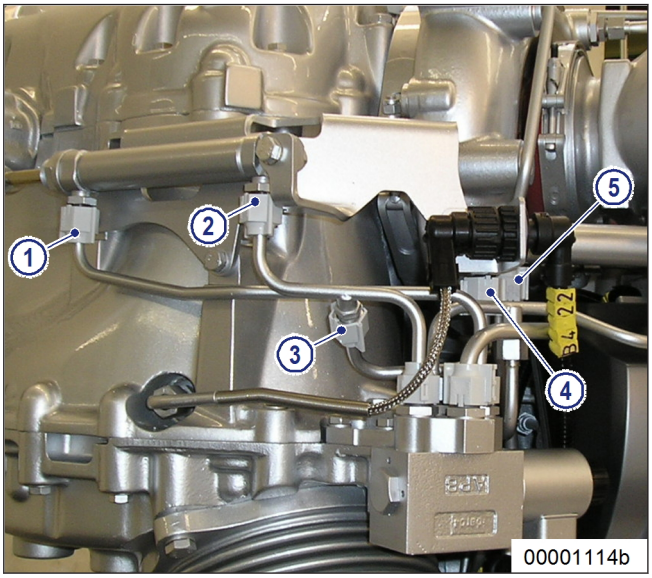
Item	Type of shielding	Comments
1 (driving end)	Shield (A4)	Turbocharger lubrication, left side
2 (driving end)	Shield (A4)	Turbocharger lubrication, center

Driving end



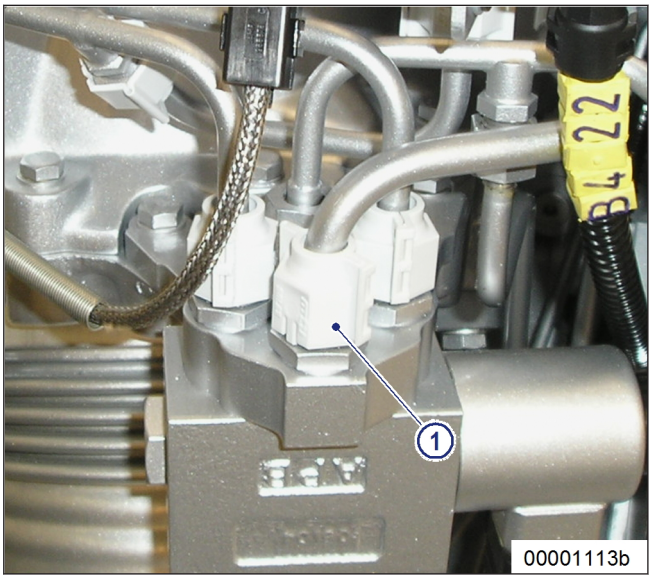
Item	Type of shielding	Comments
1 (driving end)	Shield (A4)	Turbocharger lubrication, right side

Driving end B-side



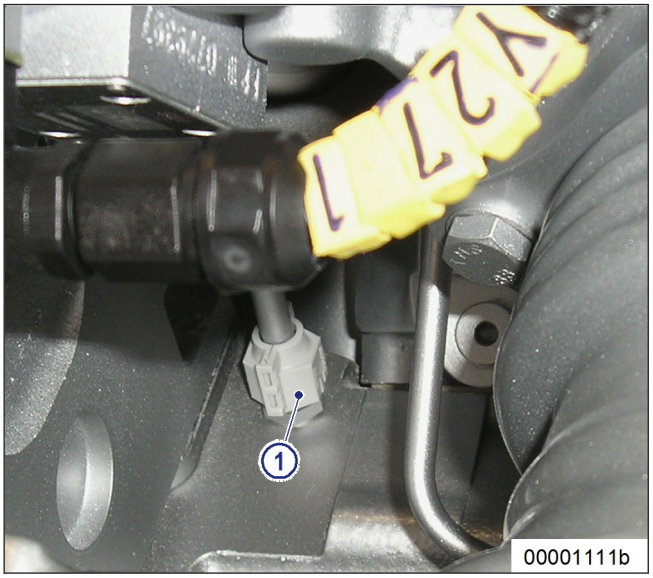
Item	Type of shielding	Comments
1 (driving end, B-side)	Shield (A5)	Turbocharger flap
2 (driving end, B-side)	Shield (A5)	Turbocharger flap
3 (driving end, B-side)	Shield (A4)	On brazed-on union
4 (driving end, B-side)	Shield (A5)	On air flap
5 (driving end, B-side)	Shield (A4)	To turbocharger lubrication

Driving end B-side



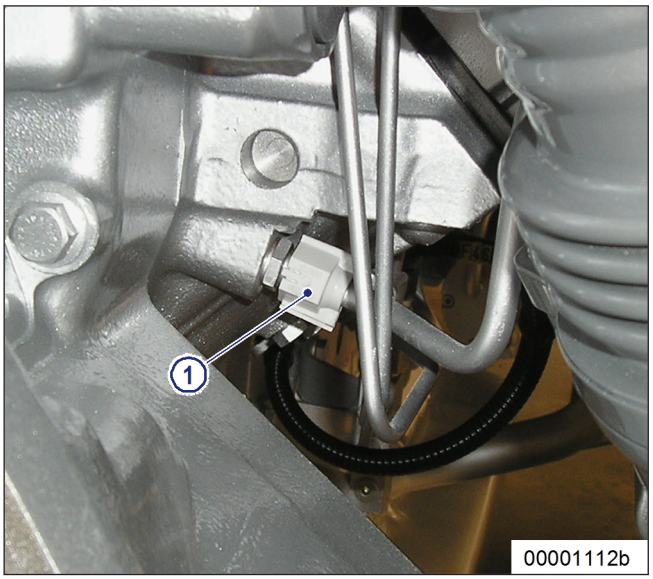
Item	Type of shielding	Comments
1 (driving end, B-side)	Shield (A5)	On valve plate

Driving end A-side



Item	Type of shielding	Comments
1 (Driving end, A-side)	Shield (A5)	To flap control

Driving end B-side



Item	Type of shielding	Comments
1 (driving end, B-side)	Shield (A5)	To flap control

7.2 Engine

7.2.1 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

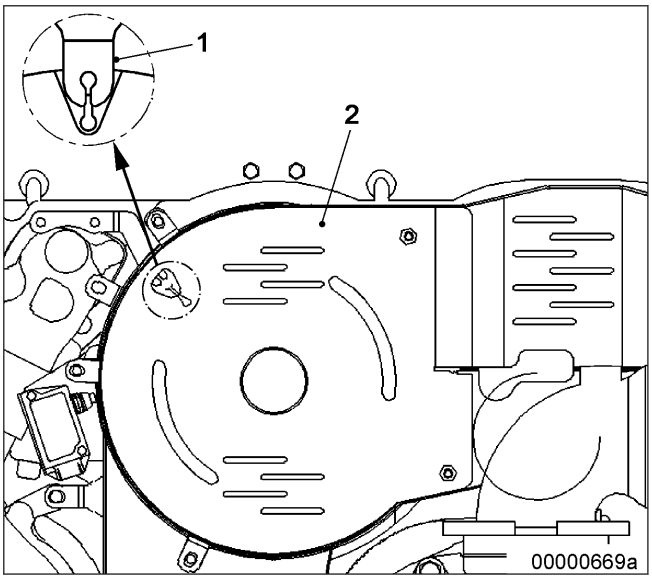
Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Before barring the engine, make sure that there are no persons in the engine's danger zone.
- After finishing work on the engine, make sure that all safety devices are put back in place and all tools are removed from the engine.

Engine – Barring manually

1. Remove cover plate (2).
2. Attach ratchet with socket to barring device.
3. Rotate crankshaft in engine direction of rotation. No resistance other than compression resistance may be encountered.

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

4. For barring device removal, follow reverse sequence of working steps.



7.2.2 Engine - Barring with starting system

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Connector pliers	F30017884	1

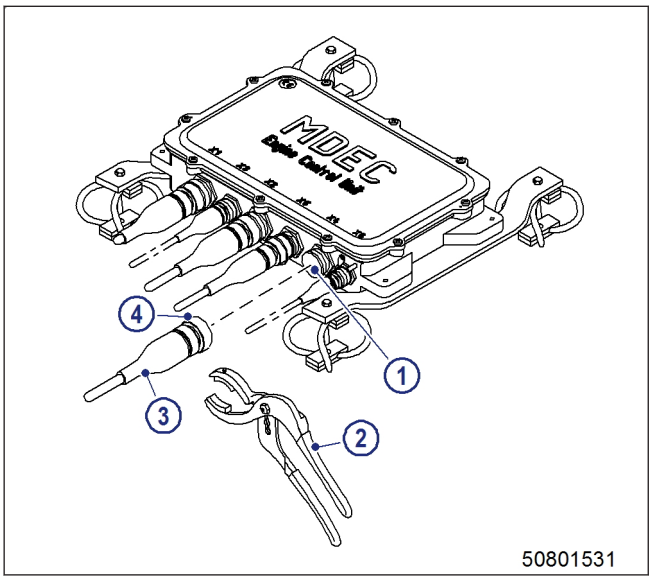
DANGER

Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!

- Before barring the engine, make sure that there are no persons in the engine's danger zone.
- After finishing work on the engine, make sure that all safety devices are put back in place and all tools are removed from the engine.

Engine – Barring with starting system

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



7.3 Cylinder Liner

7.3.1 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 158).
2. Remove injector (→ Page 166).

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.

Cylinder liner – Endoscopic examination

Findings	Task
• Thin carbon coating around circumference of carbon scraper ring • Slight localized additive deposits at top edge • Localized smooth areas at bottom edge • Carbon deposits around circumference between top piston ring and bottom edge of carbon scraper ring • First signs of marks left by top piston ring • Bright mark around circumference • Faultless, even honing pattern • First signs of marks left by lower cooling bores • Running pattern seems darker	No action required.
• Darker areas of even or varying color intensity • Beginning and end of the discoloration are not sharply defined and do not cover the entire stroke area • Dark areas in the upper section of the cooling bore, remaining circumference cannot be faulted • Piston rings faultless	Further endoscopic examination required as part of maintenance work.
• On the entire circumference not only bright discoloration (not critical for operation) clearly visible darker stripes that begin at the top piston ring • Heat discoloration in the direction of stroke and honing pattern damage • Heat discoloration of piston rings	Cylinder liner must be replaced, contact Service.

1. Compile endoscopy report using the table.
2. Use technical terms for description of the liner surface (→ Page 150).
3. Depending on findings:
   - Do not take any action or
   - Carry out further endoscopic examination as part of maintenance work or
   - Contact Service; cylinder liner must be replaced.

Final steps

1. Install injector (→ Page 166).
2. Install cylinder head cover (→ Page 158).

7.3.2 Instructions and comments on endoscopic and visual examination of cylinder liners

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	Explanations/Action
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.
Burn mark	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. Liners with burn marks, or heat discoloration, starting in TDC-ring 1 have to be replaced.
Seizure marks, scuffing	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. Replace liner.

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.

7.4 Crankcase Breather

7.4.1 Crankcase ventilation – Oil separator element replacement, diaphragm check and replacement

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

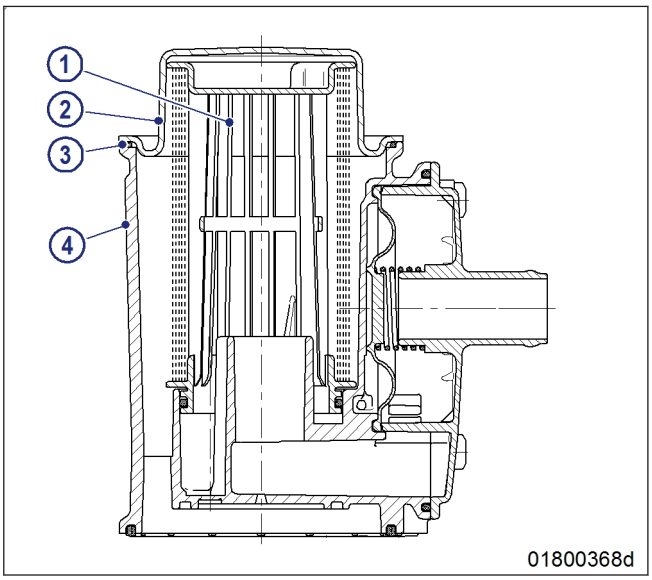
Designation / Use	Part No.	Qty.
Torque wrench, 6-50 Nm	F30027336	1
Ratchet adapter	F30027340	1
Filter element	(→ Spare Parts Catalog)	
Diaphragms	(→ Spare Parts Catalog)	
O-ring	(→ Spare Parts Catalog)	

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 position, and fit end cover (2) with new O-ring.



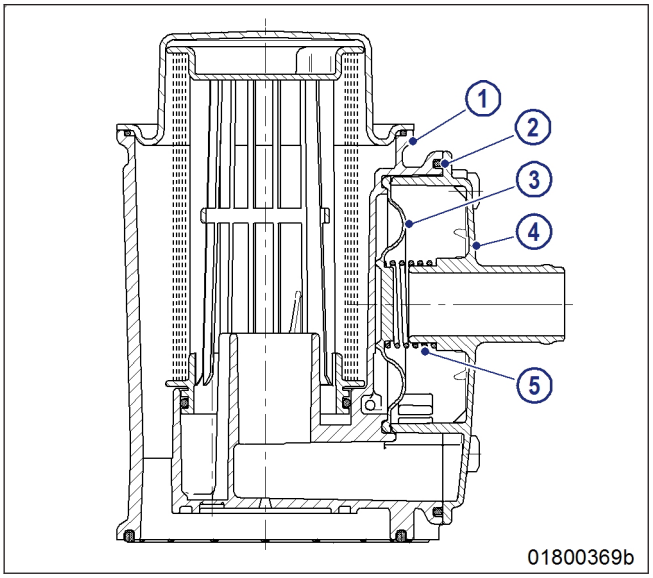
4. Tighten screws of cover (2) to specified tightening torque.

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

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

Checking diaphragms

1. Remove cover (4).
2. Take off spring (5), gasket (2) and diaphragm (3).
3. Check diaphragm (3) for damage.
4. Replace diaphragm if damaged.
5. Install diaphragm (3) on housing (1).
6. Install new gasket (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.

7.4.2 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

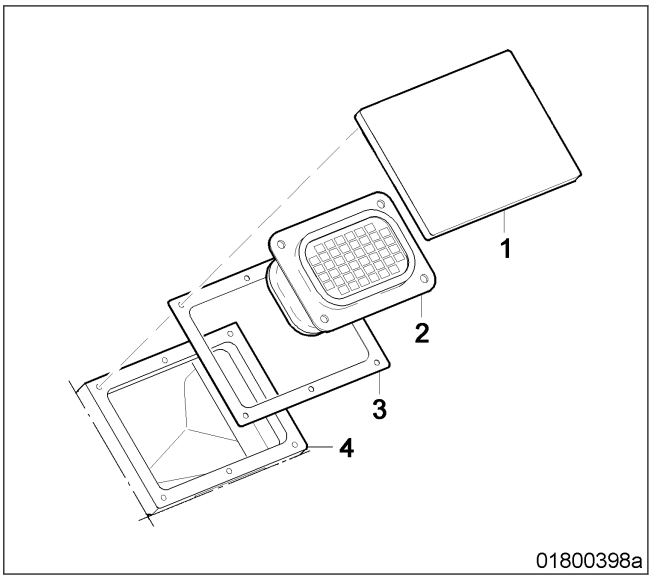
Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

WARNING

Compressed air gun ejects a jet of pressurized air.
Risk of injury to eyes and damage to hearing, risk of rupturing internal organs!
- Never direct air jet at people.
- Always wear safety goggles/face mask and ear defenders.

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 other oil separator element in the same way.



7.5 Valve Drive

7.5.1 Valve clearance - Check and adjustment

Preconditions

☑ Engine is stopped and starting disabled.

☑ Engine coolant temperature is max. 40 °C.

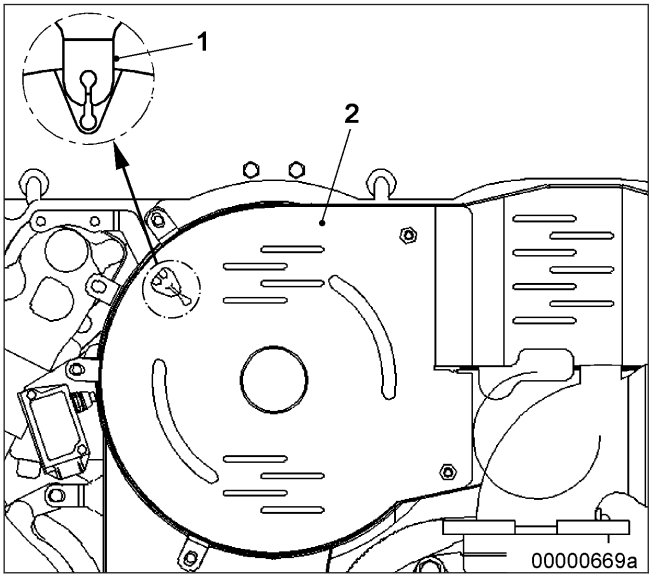
☑ Valves are closed.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 20-100 Nm	F30026582	1
Box wrench bit, 17 mm	F30030450	1
Feeler gauge	Y4342013	1

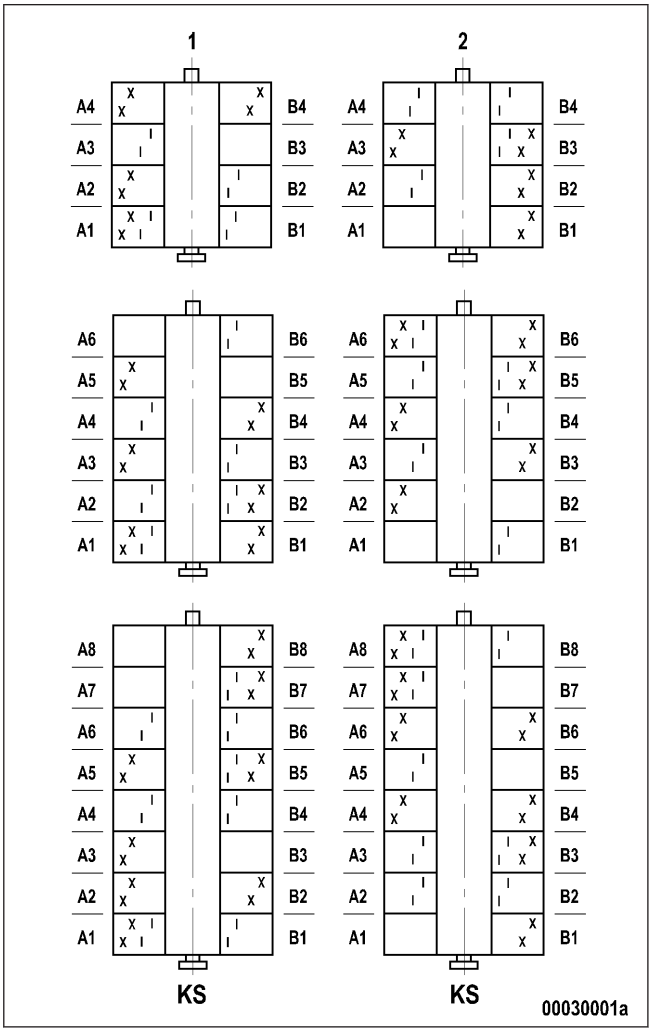
Preparatory steps

1. Remove cover plate (2).
2. Remove cylinder head cover (→ Page 158).
3. Bar engine manually in engine direction of rotation until the markings (1) are aligned.



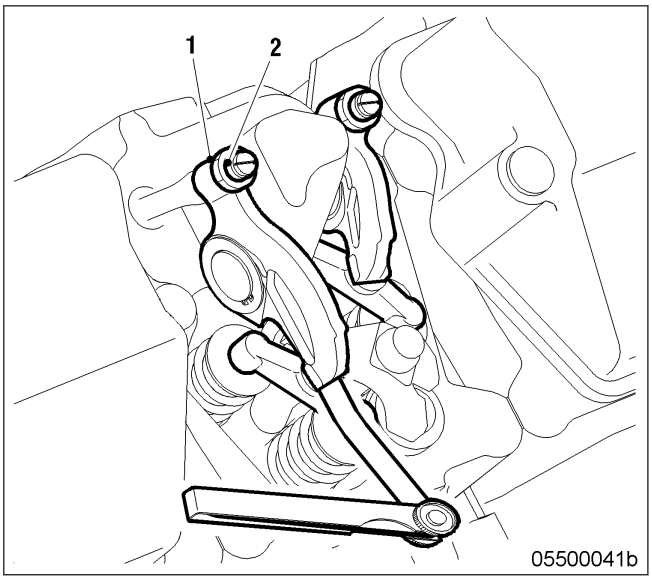
Checking valve clearance at two crankshaft positions

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.



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

Name	Size	Type	Lubricant	Value/Standard
Locknut	M12x1	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.

7.5.2 Cylinder head cover - Removal and installation

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Centering jig	F6783025	1
Sealing	(→ Spare Parts Catalog)	

Preparatory steps

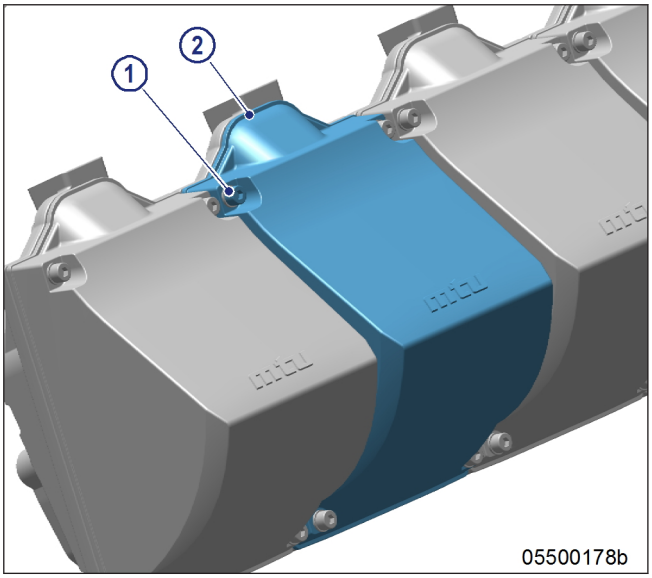
1. Remove air filter (→ Page 183).
2. Remove air guide housing.

Removing and installing cylinder head cover

1. Remove screws (1).
2. Remove cylinder head cover (2) with gasket from cylinder head.
3. Clean installation surface.
4. Check condition of gasket of cylinder head cover.

Result: Replace damaged seals.

5. Align cylinder head cover (2) with centering jig.
6. Tighten screws (1) to specified torque 20 Nm using a torque wrench.



Final steps

1. Install air filter (→ Page 183).
2. Install air guide housing.
3. Check cylinder head covers for leaks.

7.6 Injection Pump / HP Pump

7.6.1 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 160).

7.6.2 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
Box wrench	F30038493	1
Spider patch spanner, AF19	F30027424	1
Spider patch spanner, AF22	F30027425	1
Torque wrench, 0.5-5 Nm	0015384230	1
Grease (Kluthe Hakuform 30-10/Emulgier)	X00029933	
Sealing ring	(→ Spare Parts Catalog)	
Sealing ring	(→ Spare Parts Catalog)	

DANGER

Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Before cranking the engine with starter system, make sure that there are no persons in the engine's 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. Close fuel supply line upstream of fuel filter.
2. Remove engine control system (→ Page 220).
3. Drain fuel (→ Page 170).
4. Remove charge-air pipes and all seals.

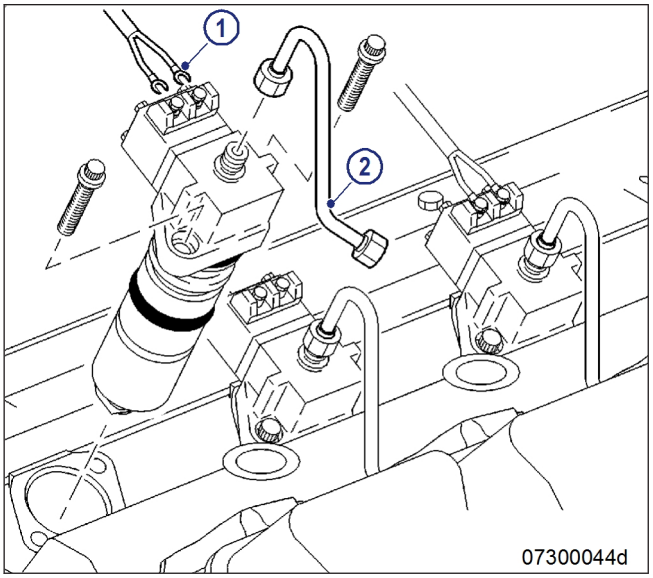
Removing injection pump

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

Result: The preloaded compression spring presses the injection pump out of the crankcase; if not:

- Turn crankshaft with barring gear (→ Page 146).
  The pump cam on the camshaft presses the injection pump out of the crankcase; if not:
- Carefully press 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

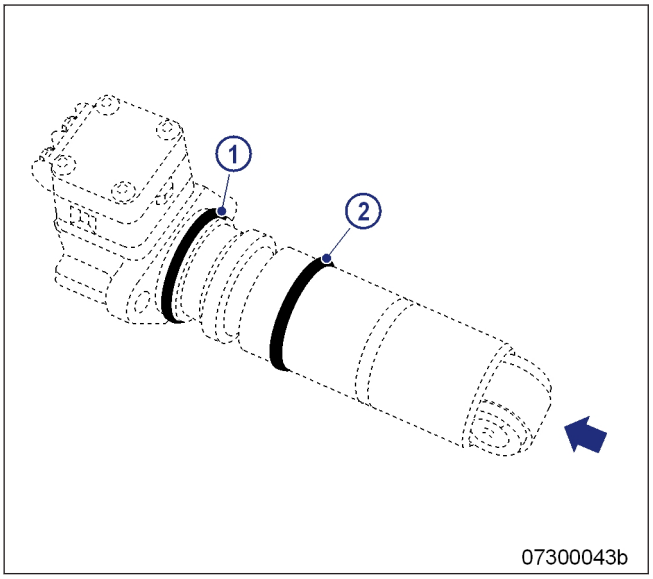
1. Remove all blanking plugs and covers.
2. Clean mating face of injection pump and roller.

Note: Sealing ring (1) Ø47 mm

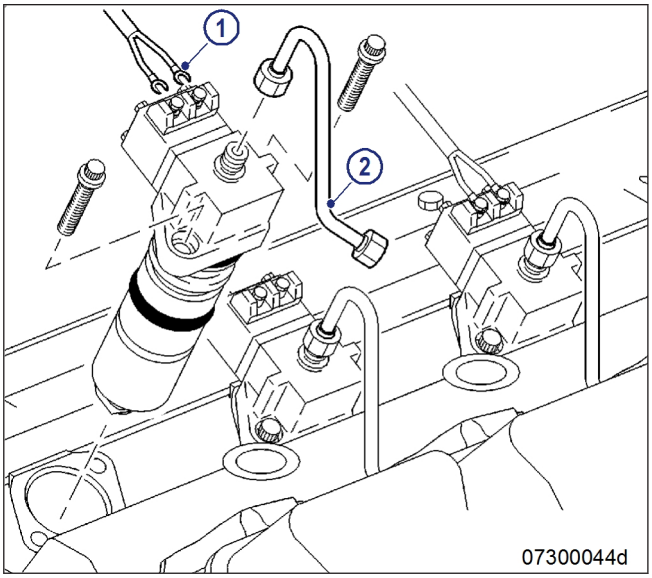
3. Coat sealing ring (1) with grease (Kluthe Hakuform 30-10/Emulgier) and wind on to injection pump.

Note: Sealing ring (2) Ø45 mm

4. Coat sealing ring (2) with grease (Kluthe Hakuform 30-10/Emulgier) and wind on to injection pump.
5. Coat roller (arrowed) with engine oil.
6. Clean sealing face and fuel bores in crankcase.
7. Use barring gear (→ Page 146) to position the pump cams on the camshaft at base circle.



8. Install injection pump, observing marked installation position.



9. Install securing screws of injection pump and tighten to specified torque using a torque wrench.

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

10. Install fuel line (2).
11. Tighten union nut on injection pump to specified 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 pressure pipe neck to specified 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 wiring (1).
14. Tighten screws to specified torque using a torque wrench.

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

Final steps

1. Remove engine barring gear (→ Page 146).
2. Clean mating faces on cylinder head and charge-air manifold.
3. Check gaskets for damage and replace as necessary.
4. Coat gaskets with grease (Kluthe Hakuform 30-10/Emulgier) and place onto cylinder head.
5. Install charge-air pipes.
6. Install engine control system (→ Page 220).
7. Open fuel supply line before fuel filter.
8. Vent fuel system (→ Page 171).

7.7 Injection Valve / Injector

7.7.1 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 166).

7.7.2 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 wrench bit	F30025897	1
Spider patch spanner	F30027425	1
Spider patch spanner	F30027424	1
Double-head box wrench	F30011450	1
Ratchet adapter	F30027340	1
Grease (Kluthe Hakuform 30-10/Emulgier)	X00029933	
Engine oil		
Pressure pipe neck	(→ Spare Parts Catalog)	

WARNING

Fuels are flammable and explosive.
Danger to life! Risk of burns!
- Avoid naked flames, electrical sparks and ignition sources.
- Do not smoke.
- Wear protective clothing, protective gloves, and goggles / safety mask.

WARNING

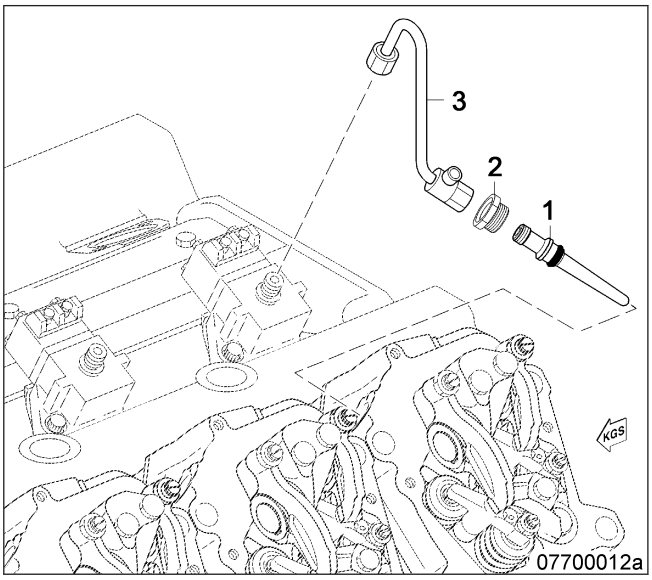
Compressed air gun ejects a jet of pressurized air.
Risk of injury to eyes and damage to hearing, risk of rupturing internal organs!
- Never direct air jet at people.
- Always wear safety goggles/face mask and ear defenders.

Preparatory steps

1. Remove cylinder head cover (→ Page 158).
2. Drain fuel (→ Page 170).

Replacing pressure pipe neck

1. Remove fuel line (3).
2. Remove thrust screw (2).
3. Pull off pressure pipe neck (1).
4. Coat sealing ring with grease (Kluthe Hakuform 30-10/Emulgier) and wind on to new pressure pipe neck (1).
5. Blow out fuel line (3) with compressed air.
6. Moisten taper 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.



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

Name	Size	Type	Lubricant	Value/Standard
Thrust screw		Tightening torque		40 Nm ± 5 Nm

10. Install fuel line (3).
11. Tighten union nut on injection pump to specified torque using a torque wrench.

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

12. Tighten union nut on pressure pipe neck to specified 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 (→ Page 158).
2. Vent fuel system (→ Page 171).

7.7.3 Injector - Removal and installation

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Puller	3555890163/00	1
Fuel suction device	F30378207	1
Torque wrench, 20-100 Nm	F30026582	1
Open-end wrench bit	F30025897	1
Spider patch spanner	F30027425	1
Spider patch spanner	F30027424	1
Double-head box wrench	F30011450	1
Ratchet adapter	F30027340	1
Grease (Kluthe Hakuform 30-10/Emulgier)	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 gun ejects a jet of pressurized air.
Risk of injury to eyes and damage to hearing, risk of rupturing internal organs!
- Never direct air jet at people.
- Always wear safety goggles/face mask and ear defenders.

Preparatory steps

1. Remove cylinder head cover (→ Page 158).
2. Drain fuel (→ Page 170).

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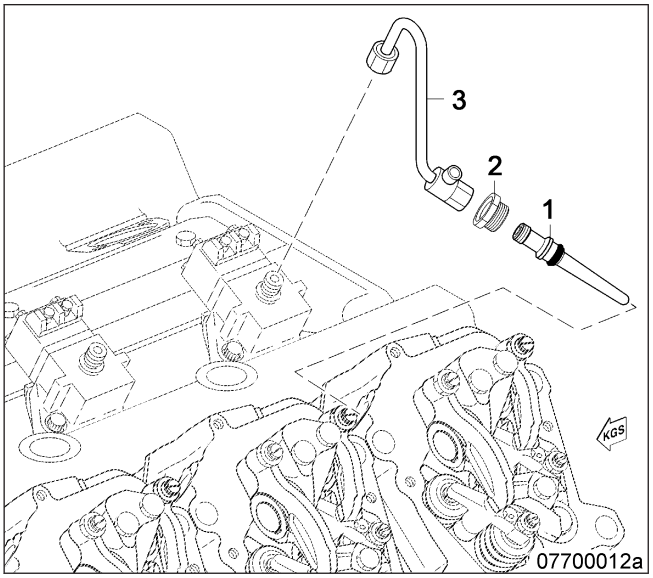
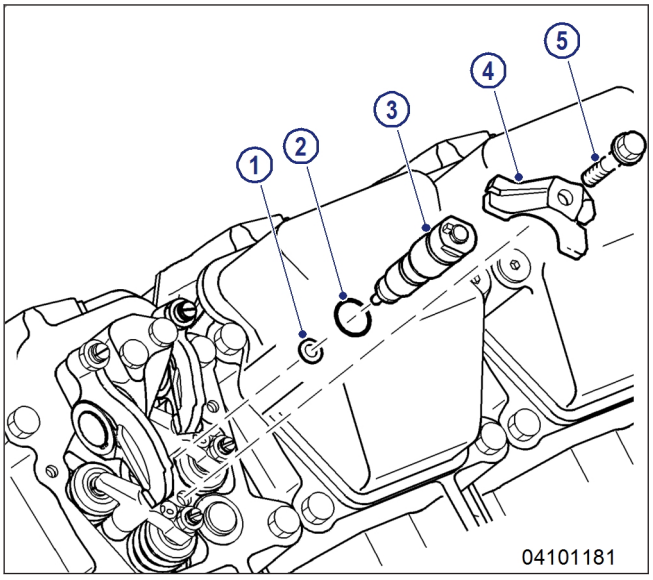
Removing injector

1. Remove leak-off-fuel lines.
2. Remove fuel line (3).
3. Remove thrust screw (2).
4. Pull off pressure pipe neck (1).
5. Extract fuel from the exposed bores using the suction device.



6. Remove screw (5).
7. Take off clamp (4).
8. Screw puller into injector.
9. Remove injector with puller.
10. Remove injector sealing ring (1) 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 onto injector.
4. Coat sealing ring (2) with grease and fit onto injector.
5. Press injector (3) into cylinder head by hand.

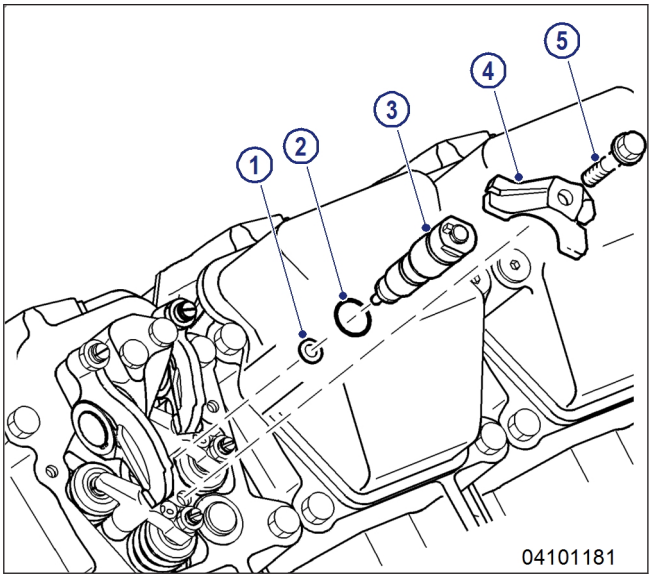
Result:
- The pin is at 11-o'clock position to the transversal axis of the engine.
- Pin is in recess of clamp (4).

6. Install clamp (4) with screw (5), positioning it correctly.

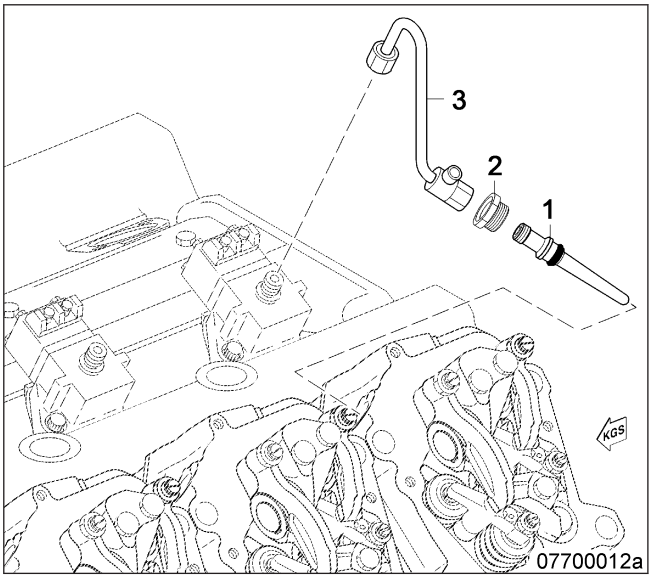
Result:
- Pin on injector is in the recess in the clamp.
- Forked clamp end is engaged in the cover recess.

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. Moisten taper of 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) to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Thrust screw		Tightening torque		40 Nm ±5 Nm

14. Tighten screw for clamp at injector to specified torque using a torque wrench.

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

15. Install fuel line (3).
16. Tighten union nut on injection pump to specified torque using a torque wrench.

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

17. Tighten union nut on pressure pipe neck to specified 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 158).
2. Vent fuel system (→ Page 171).

7.8 Fuel System

7.8.1 Fuel - Draining

Preconditions

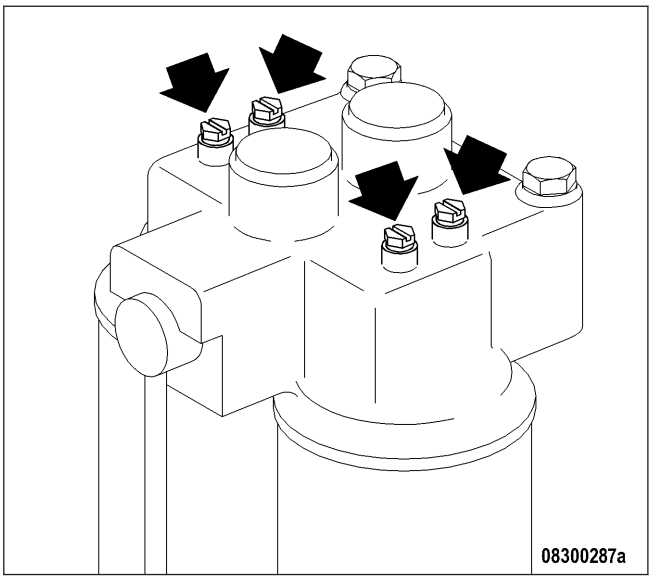
☑ Engine is stopped and starting disabled.

WARNING

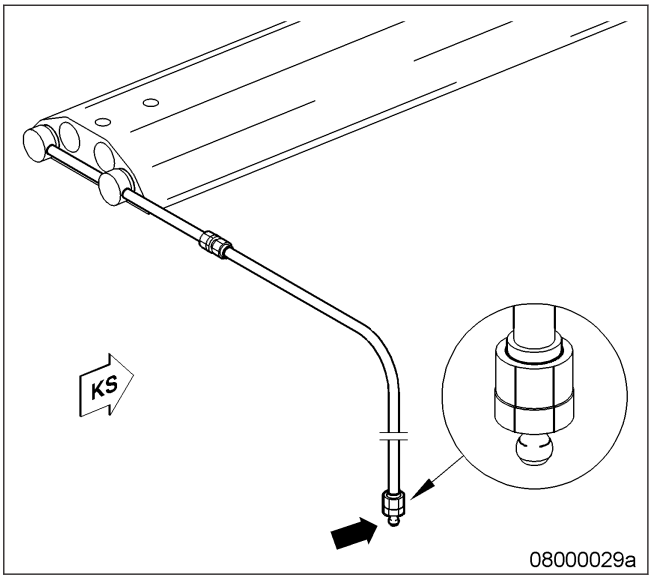
Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Draining fuel

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 threaded vent plugs on filter head.



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7.8.2 Fuel system - Venting

Preconditions

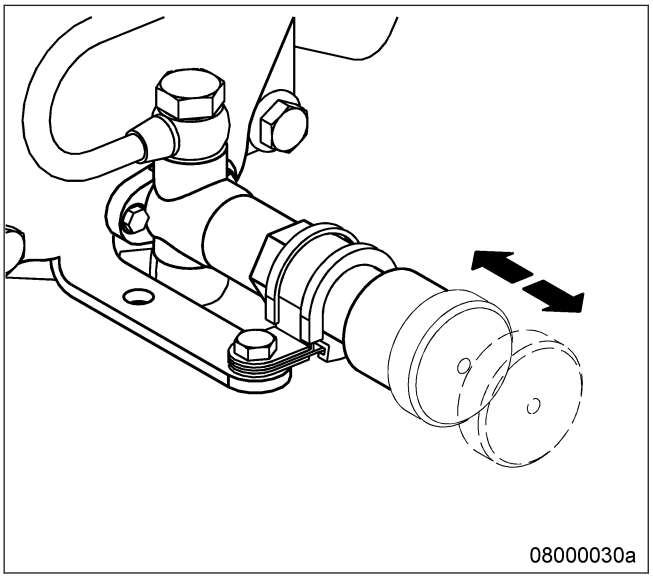
☑ Engine is stopped and starting disabled.

WARNING

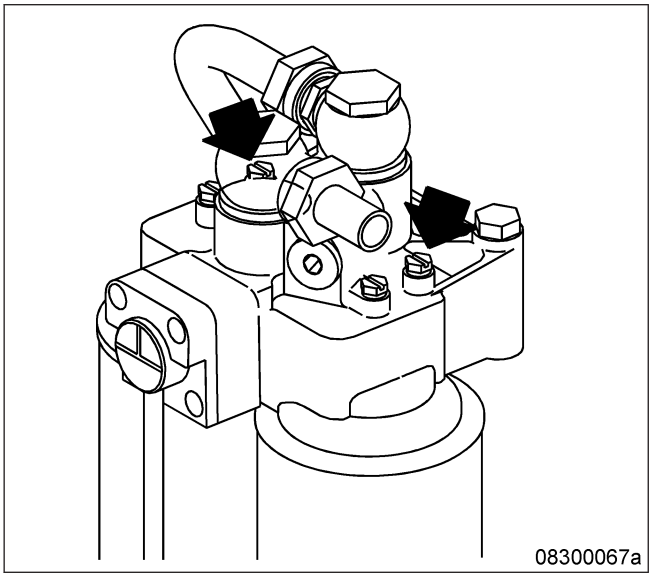
Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Venting fuel system

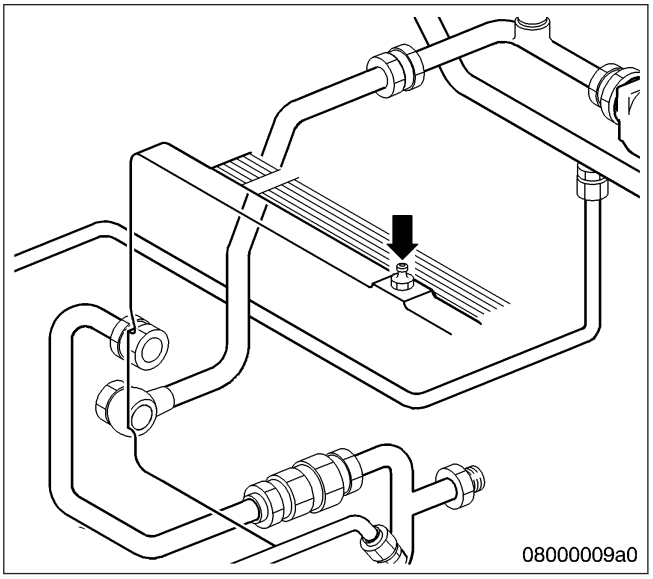
1. Unlock fuel priming pump, unscrew handle.



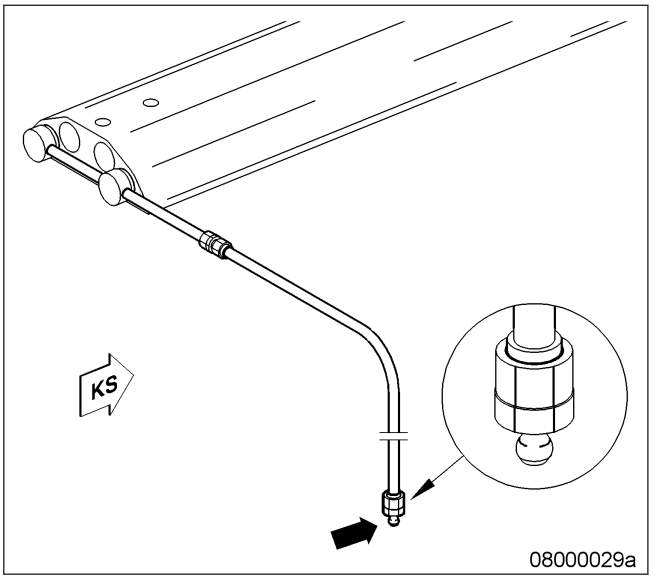
2. Open vent plugs on filter head.
3. Operate the pump with the handle until bubble-free fuel emerges at the vent plugs.
4. Close vent plugs on filter head.



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.



7.9 Fuel Filter

7.9.1 Fuel filter - Replacement

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

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

DANGER

Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING

Fuels are flammable and explosive.
Danger to life! Risk of burns!
- Avoid naked flames, electrical sparks and ignition sources.
- Do not smoke.
- Wear protective clothing, protective gloves, and goggles / safety mask.

WARNING

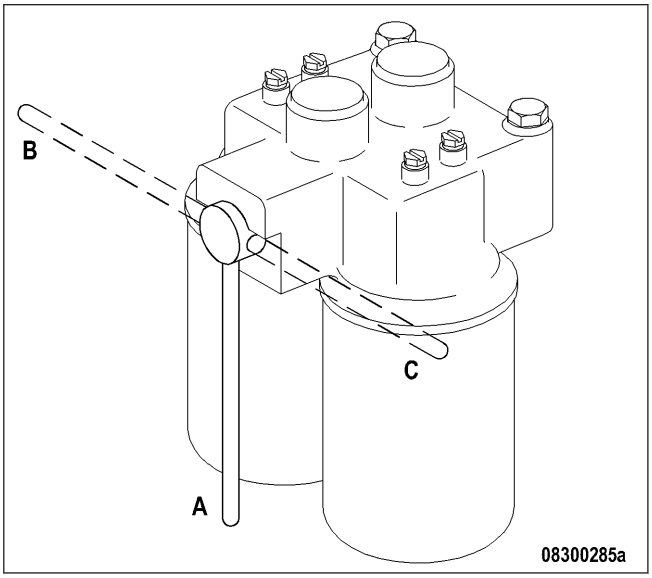
Loud engine noises with the engine running:
Risk of hearing damage!
- Wear ear protection.

NOTICE

Damage to component!
Severe material damage!
- For filter replacement with the engine running, operate the engine at low engine load.
- The filter which is to be replaced must be cut out for a brief period only.

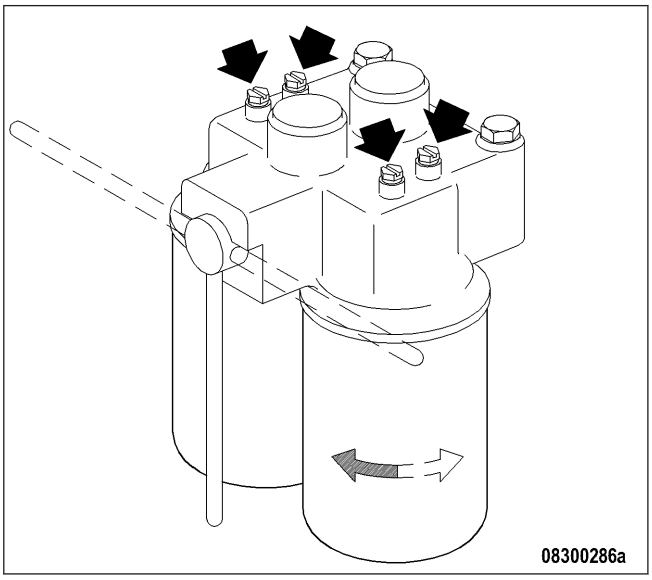
Replacing easy-change fuel filter with engine stopped

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 switched off easy-change filter with oil filter wrench.
3. Clean sealing surface on filter head.
4. Check seal on new easy-change filter and moisten with fuel.
5. Fit SOLAS shield (→ Page 18).
6. Screw on easy-change filter and tighten by hand.
7. Set three-way cock to operating position (both filters cut in).
8. Replace further fuel filters in the same way.
9. Vent fuel system (→ Page 171).



Replacing easy-change fuel filter with engine running

1. Cut out the filter to be replaced.
2. Open the threaded vent plugs at the filter head of the cut-out filter and make sure that the fuel filter is not pressurized.
3. Close threaded vent plugs.
4. Unscrew switched off easy-change filter with oil filter wrench.
5. Clean sealing surface on filter head.
6. Check seal on new easy-change filter and moisten with fuel.
7. Fit SOLAS shield (→ Page 18).
8. Screw on easy-change filter and tighten by hand.
9. Set three-way cock to operating position (both filters cut in).
10. Replace further fuel filters in the same way.



7.9.2 Fuel prefilter – Differential pressure check and adjustment of gauge

DANGER

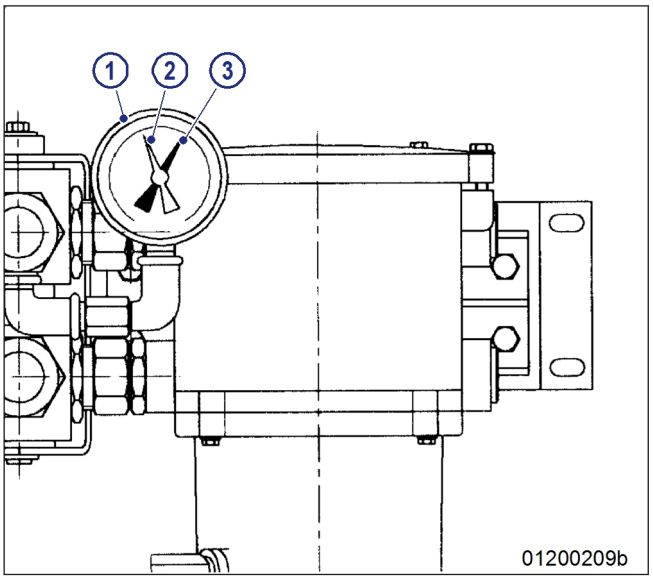
Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING

High level of engine noise when the engine is running.
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 ≥ 0.3 bar, flush filter element of the cut-in filter (→ Page 177).

7.9.3 Fuel prefilter - Draining

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

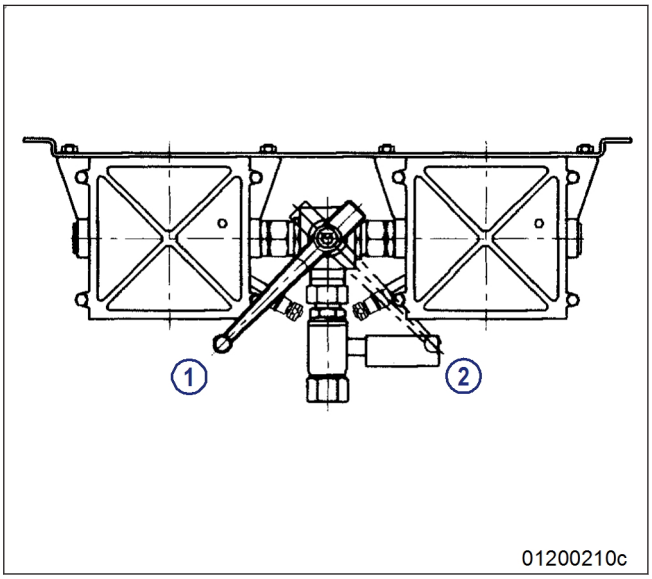
Designation / Use	Part No.	Qty.
Diesel fuel		
Seal	(→ Spare Parts Catalog)	

WARNING

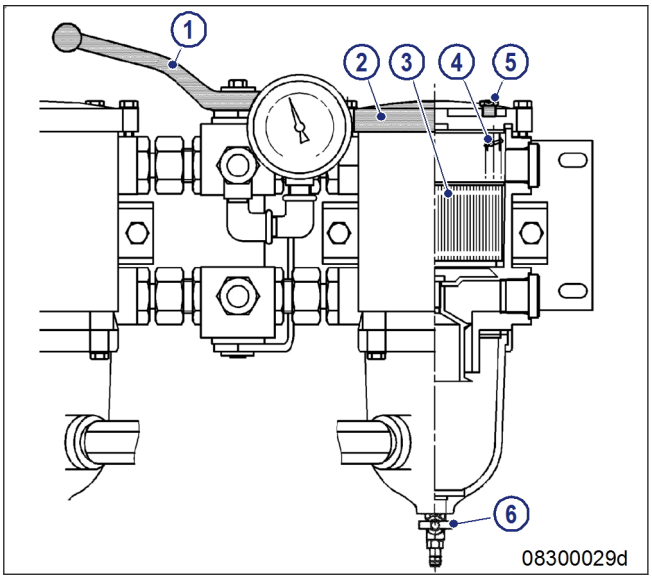
Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

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.



7.9.4 Fuel prefilter – Flushing

Special tools, Material, Spare parts

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

DANGER

Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING

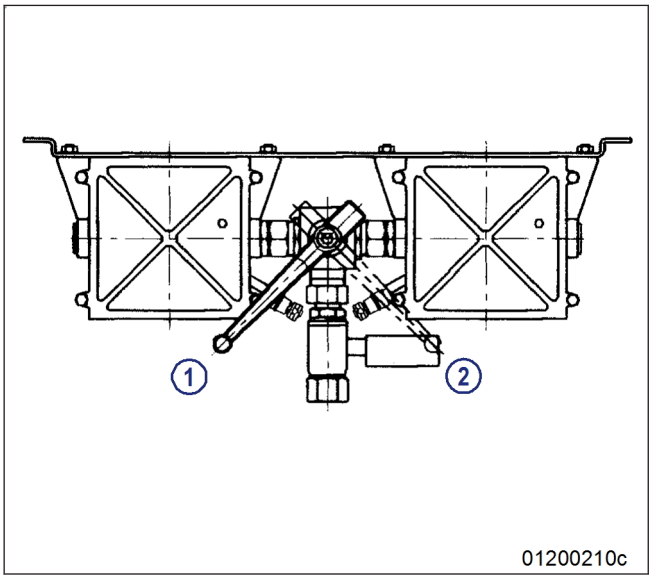
Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

WARNING

High level of engine noise when the engine is running.
Risk of damage to hearing!
- Wear ear protectors.

Fuel prefilter – Flushing

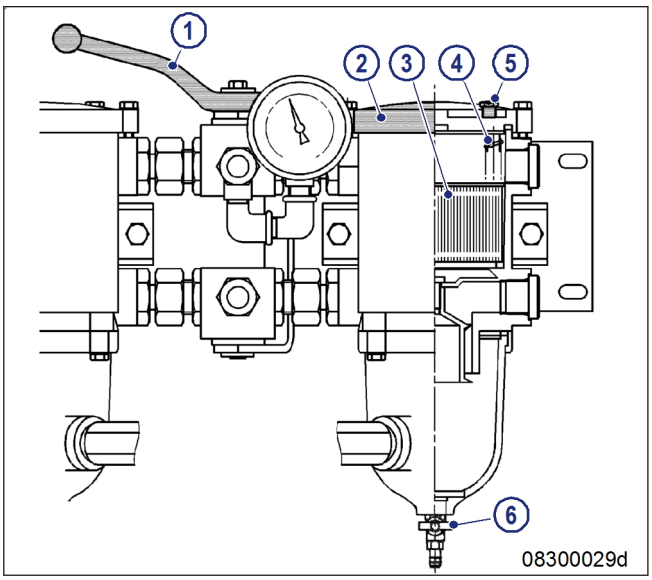
1. Cut out the contaminated filter.
   1 Left filter cut in
   2 Right filter cut in



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

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

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



Fuel prefilter – Filling with fuel

1. Stop engine (→ Page 115) and disable engine start.
2. Remove screws securing the cover and take off cover (2).
3. Fill filter housing with clean fuel.
4. Place new seal in cover (2).
5. Fit cover with gasket and secure it with screws.
6. Check differential pressure (→ Page 175).

Result: If flushing did not lead to an improvement of the differential pressure, replace filter element of fuel prefilter (→ Page 179).

7.9.5 Fuel prefilter – Filter element replacement

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

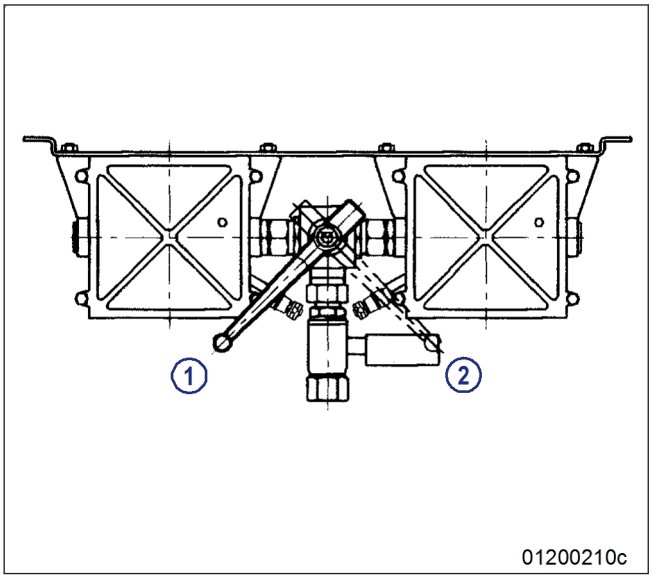
Designation / Use	Part No.	Qty.
Fuel		
Filter element	(→ Spare Parts Catalog)	
Seal	(→ Spare Parts Catalog)	

WARNING

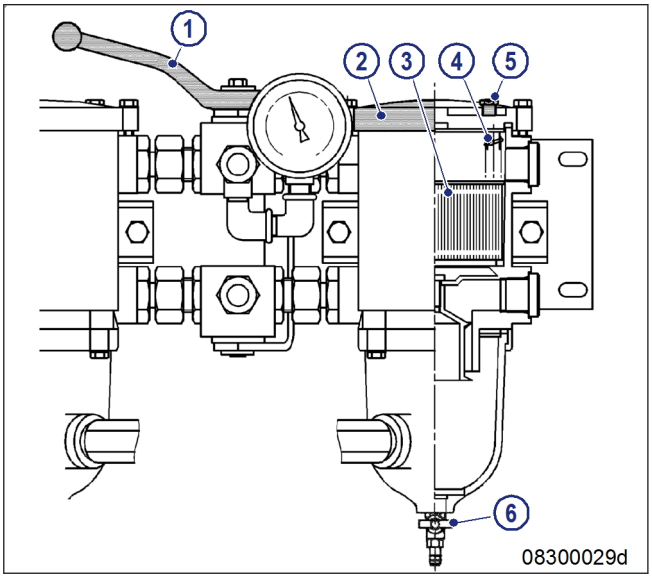
Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Replacing filter element

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



2. Open threaded vent plug (5) of contaminated filter.
3. Unlock drain valve (6) by pressing toggle and open.
4. Drain water and contaminants from the filter.
5. Close drain valve (6).
6. Remove screws securing cover and take off cover (2).
7. Remove spring housing (4) and filter element (3).
8. Insert new filter element (3) and spring housing (4).
9. Fill filter housing with clean fuel.
10. Place new gasket in cover (2).
11. Fit cover with gasket and secure it with screws.
12. Cut in the cut-out filter again.
13. Close threaded vent plug (5) when fuel emerges.
14. Set adjustable pointer of differential pressure gage (→ Page 175).



7.10 Charge-Air Cooling General, Left-Hand Side

7.10.1 Intercooler – Checking condensate drain line for coolant discharge and obstruction

DANGER

Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING

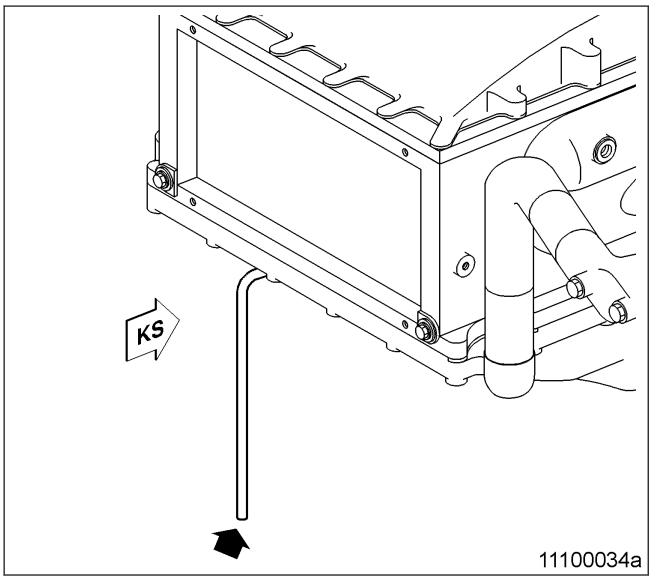
High level of engine noise when the engine is running.
Risk of damage to hearing!
- Wear ear protectors.

WARNING

Compressed air gun ejects a jet of pressurized air.
Risk of injury to eyes and damage to hearing, risk of rupturing internal organs!
- Never direct air jet at people.
- Always wear safety goggles/face mask and ear defenders.

Intercooler – Checking 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.



Emergency measures prior to engine start with a leaking intercooler

1. Remove injectors (→ Page 163).
2. Bar engine manually (→ Page 146).
3. Bar engine with starting system to blow out cylinder chambers (→ Page 147).
4. Install injectors (→ Page 166).

7.11 Air Filter

7.11.1 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 183).
2. Reset signal ring of contamination indicator (→ Page 184).

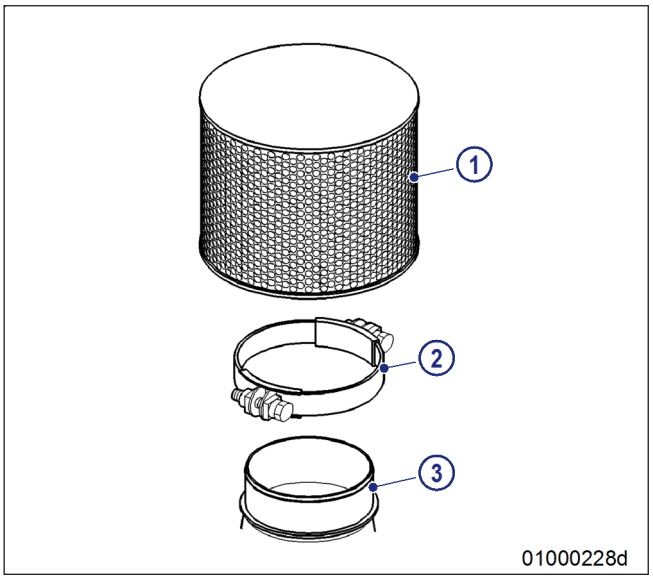
7.11.2 Air filter - Removal and installation

Preconditions

☑ Engine is stopped and starting disabled.

Air filter – Removal and installation

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



7.12 Air Intake

7.12.1 Service indicator - Signal ring position check (optional)

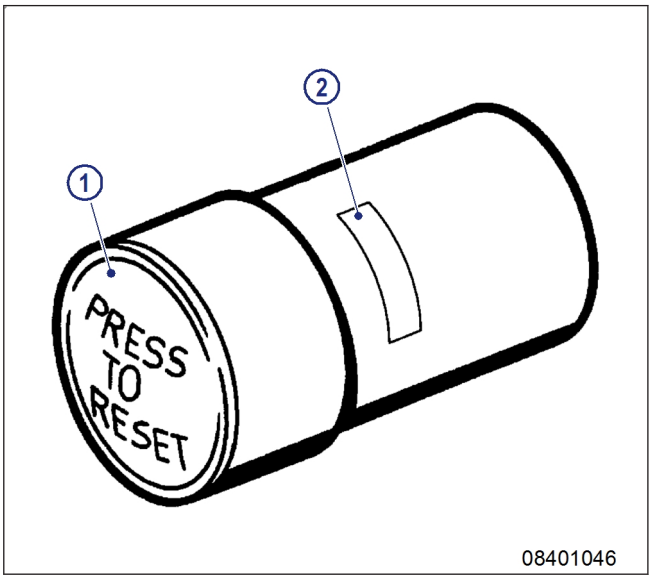
Preconditions

☑ 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 182).
2. After installation of new filter, press reset button (1).

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



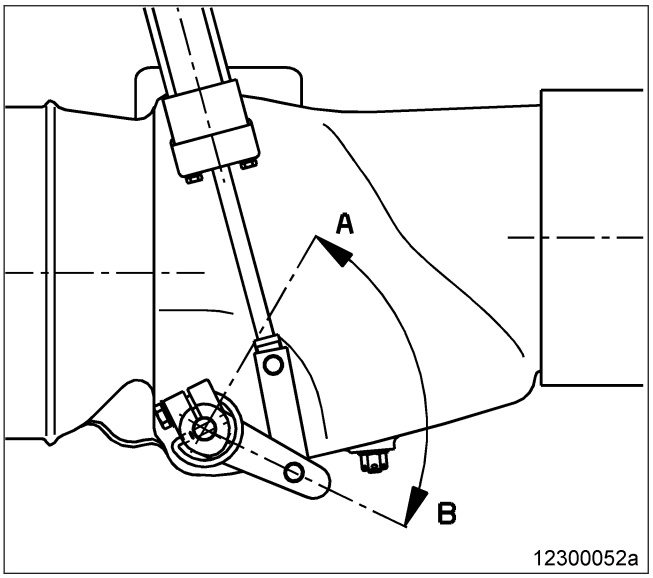
7.12.2 Air-flow control flap - Ease of movement check

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.



7.13 Starting Equipment

7.13.1 Starter – Condition check

Preconditions

☑ Engine is stopped and starting disabled.

Checking starter condition

1. Check securing screws of starter for secure seating and tighten if required.
2. Check wiring (→ Page 214).

7.14 Lube Oil System, Lube Oil Circuit

7.14.1 Engine oil – Level check

Preconditions

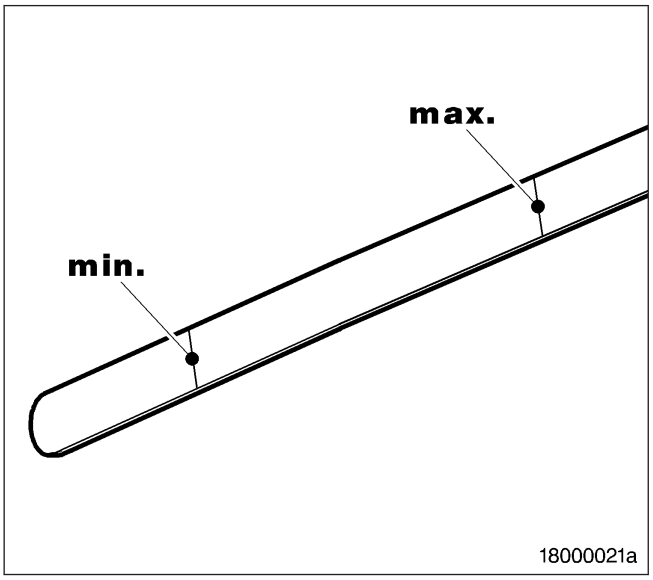
☑ Engine is stopped and starting disabled.

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 189).

4. If necessary, top up to "max." mark (→ Page 188).
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 189).

4. If necessary, top up to "max." mark (→ Page 188).
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

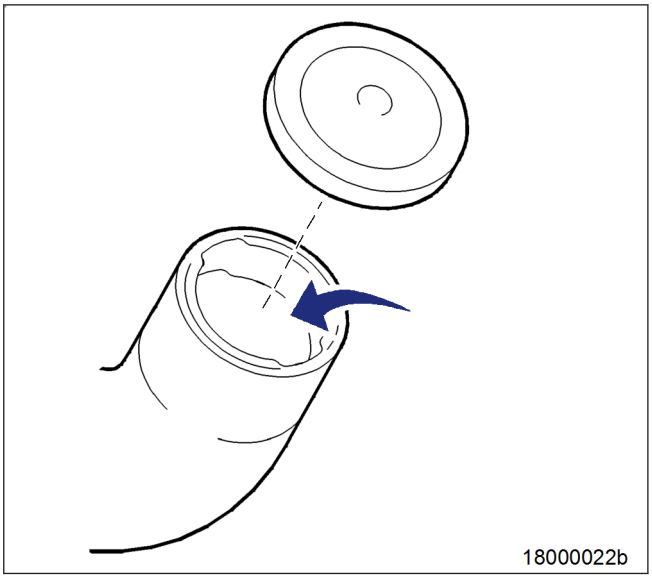
1. Provide a suitable container to collect the oil.
2. Remove drain plug and drain oil.
3. Install drain plug with new sealing ring.
4. Replace engine oil filter (→ Page 190).

Oil change with 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 190).

Filling with new oil

1. Open cover on filler neck.
2. Pour oil in at filler neck up to "max." mark at oil dipstick.
3. Close cover on filler neck.
4. Check engine oil level (→ Page 187).
5. After oil change and filter replacement, bar engine with starting system (→ Page 147).



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7.15 Oil Filtration / Cooling

7.15.1 Oil dipstick – Marking

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 oil		
Oil dipstick	(→ 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.

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 (→ engine data).
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 as necessary.
7. Fill in maximum oil quantity (→ engine data).
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)	
SOLAS shield	(→ Spare Parts Catalog)	

DANGER

Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING

High level of engine noise when the engine is running.
Risk of damage to hearing!
- Wear ear protectors.

WARNING

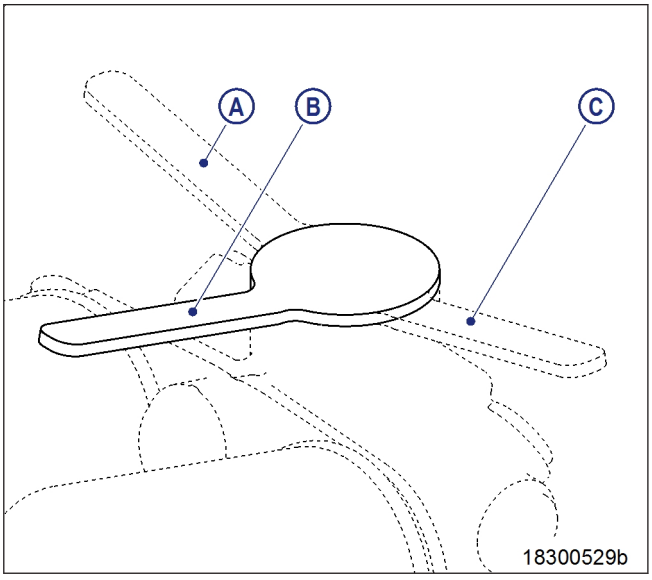
Hot oil.
Oil can contain combustion residues which are harmful to health.
Risk of injury and poisoning!
- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

NOTICE

Damage to component!
Severe material damage!
- For filter replacement with the engine running, operate the engine at low engine load.
- The filter which is to be replaced must be cut out for a brief period only.

Replacing oil filter with the engine stopped

1. Stop engine (→ Page 115) and disable engine start.
2. Cut out the filter to be replaced.
   - A Right filter cut out
   - B Both filters cut in (normal operating position)
   - C Left filter cut out



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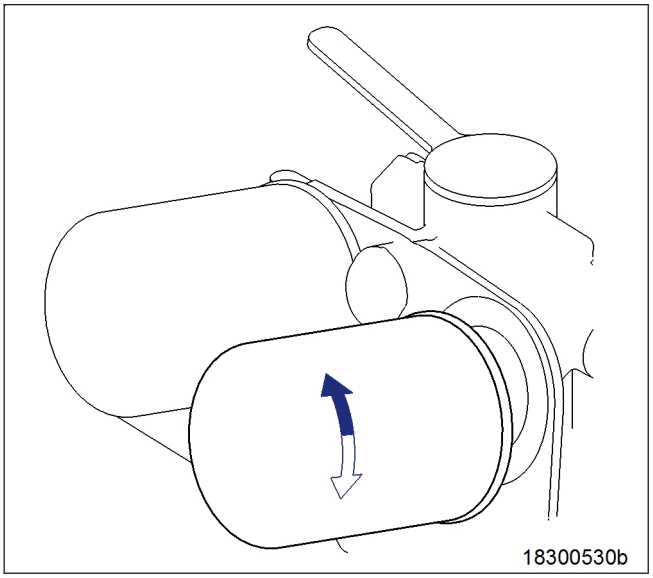
3. Unscrew cut-out oil filter with oil filter wrench.
4. Clean sealing surface on connecting piece.
5. Check condition of new oil filter sealing ring and coat it with oil.
6. Fit SOLAS shield (→ Page 133).
7. Screw on and tighten new oil filter by hand.
8. Replace other oil filters in the same way.
9. Switch filter to normal position.
10. After each oil change and filter replacement, crank engine with starting system (→ Page 147).
11. Check oil level (→ Page 187).



Replacing oil filter with the engine running

1. Reduce engine speed to <1100 rpm.
2. Unscrew cut-out oil filter with oil filter wrench.
3. Clean sealing surface on connecting piece.
4. Check condition of new oil filter sealing ring and coat it with oil.
5. Fit SOLAS shield (→ Page 133).
6. Screw on and tighten new oil filter by hand.
7. Replace other oil filters in the same way.
8. Switch filter to normal position.
9. Check oil level (→ Page 187).

7.15.3 Centrifugal oil filter and filter sleeve – Cleaning and replacement

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

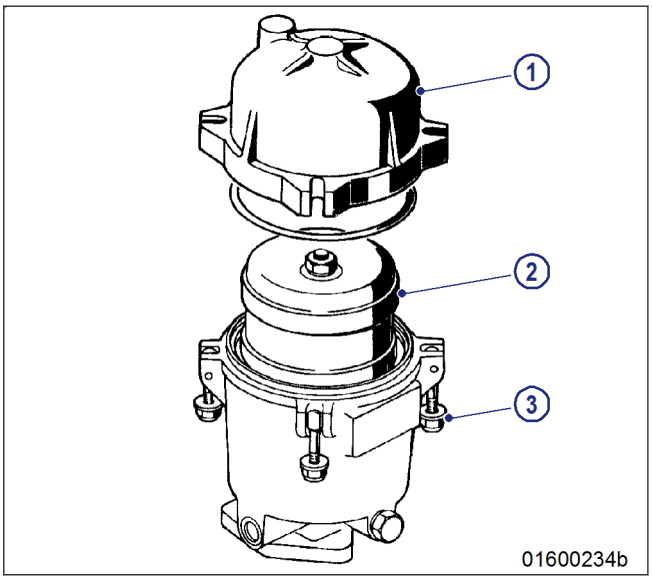
Designation / Use	Part No.	Qty.
Oil filter wrench	F30379104	1
Cold cleaner(Hakutex 50)	X00056751	1
Filter sleeve	(→ Spare Parts Catalog)	
O-ring	(→ Spare Parts Catalog)	
O-ring	(→ Spare Parts Catalog)	

WARNING

Compressed air gun ejects a jet of pressurized air.
Risk of injury to eyes and damage to hearing, risk of rupturing internal organs!
- Never direct air jet at people.
- Always wear safety goggles/face mask and ear defenders.

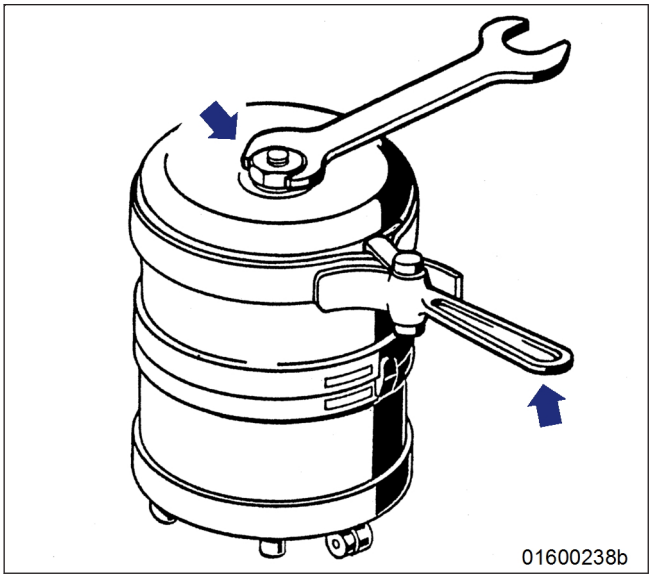
Removing rotor of centrifugal oil filter

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

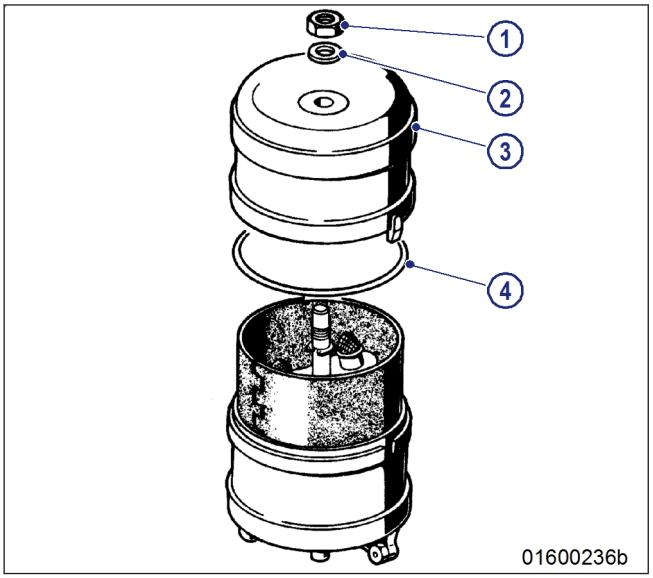


Cleaning centrifugal oil filter and replacing filter sleeve

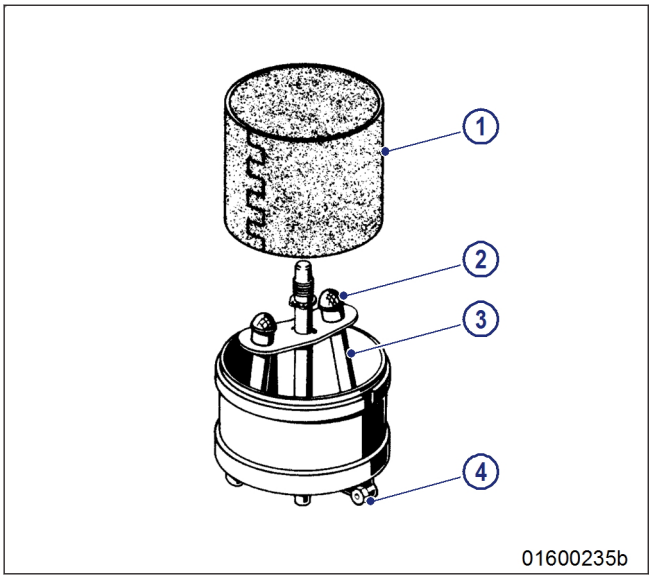
1. Remove nut, holding the rotor with an oil filter wrench.



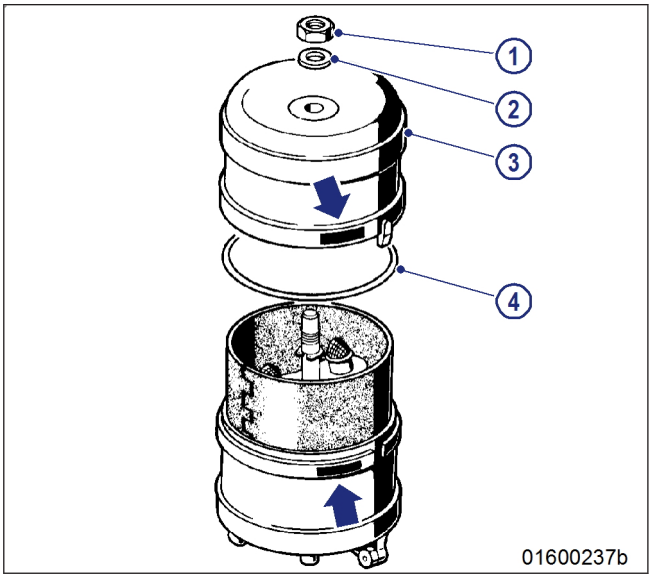
2. Remove nut (1), washer (2), rotor cap (3) and O-ring (4).



3. Remove filter 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 O-ring (4).
10. Set on rotor cap (3), observe marks.
11. Fit washer (2).



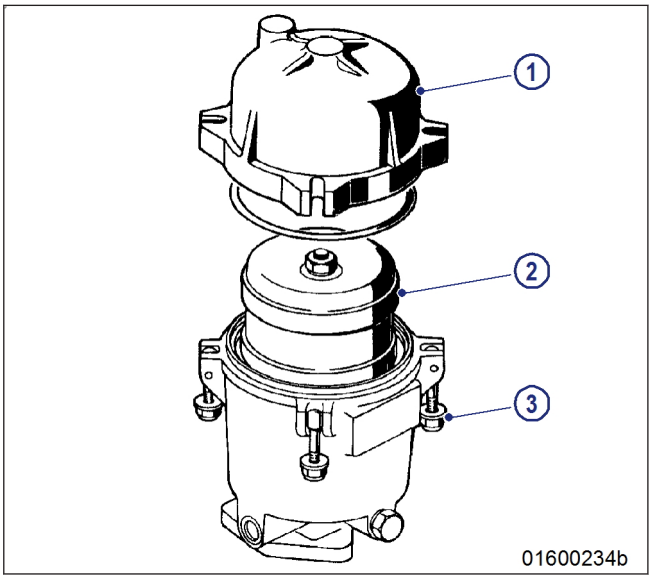
12. Hold rotor (new design) with oil filter wrench and tighten nut (1) to specified torque using a torque wrench.

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

13. Hold rotor (old design) with oil filter wrench and tighten nut (1) to specified torque using a torque wrench.

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

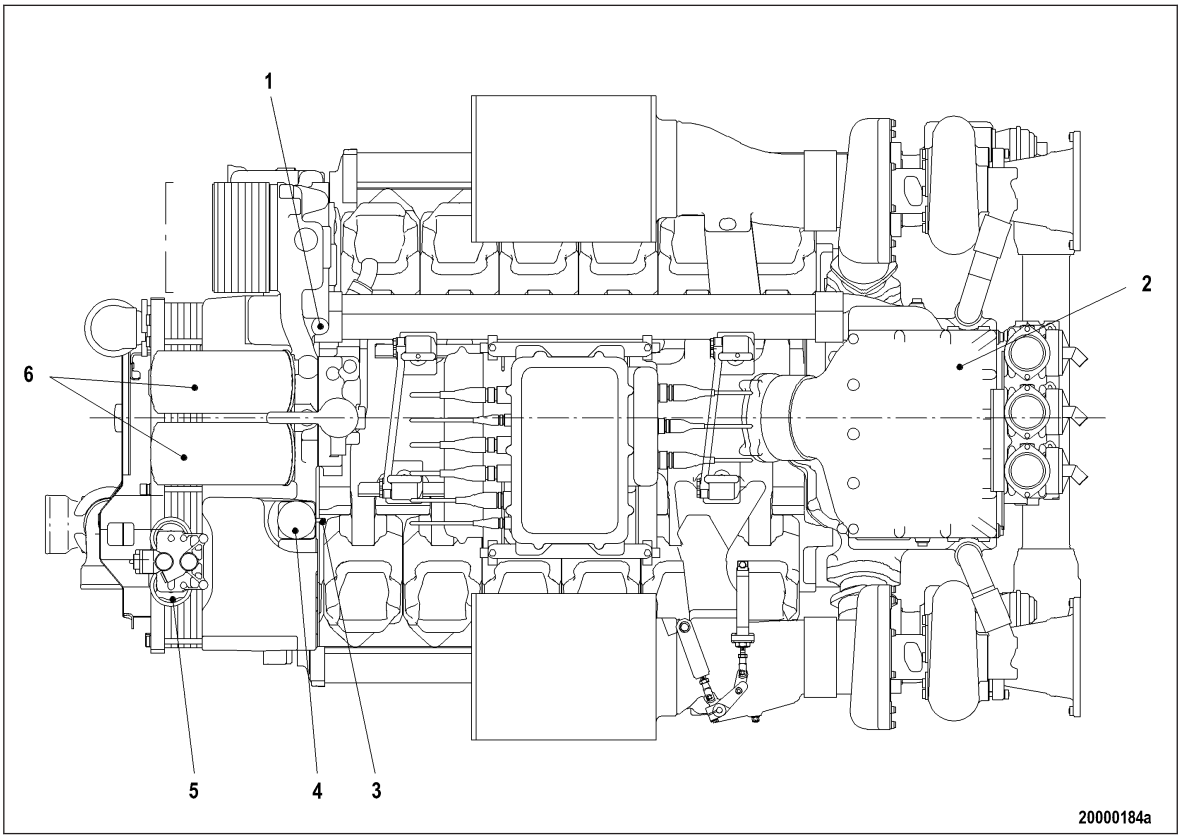
14. Insert complete rotor (2) into the housing and check for ease-of-movement.
15. Set housing cover (1) with new O-ring onto lower section, observe marks.
16. Tighten nuts (3) crosswise and evenly.



7.16 Coolant Circuit, General, High-Temperature Circuit

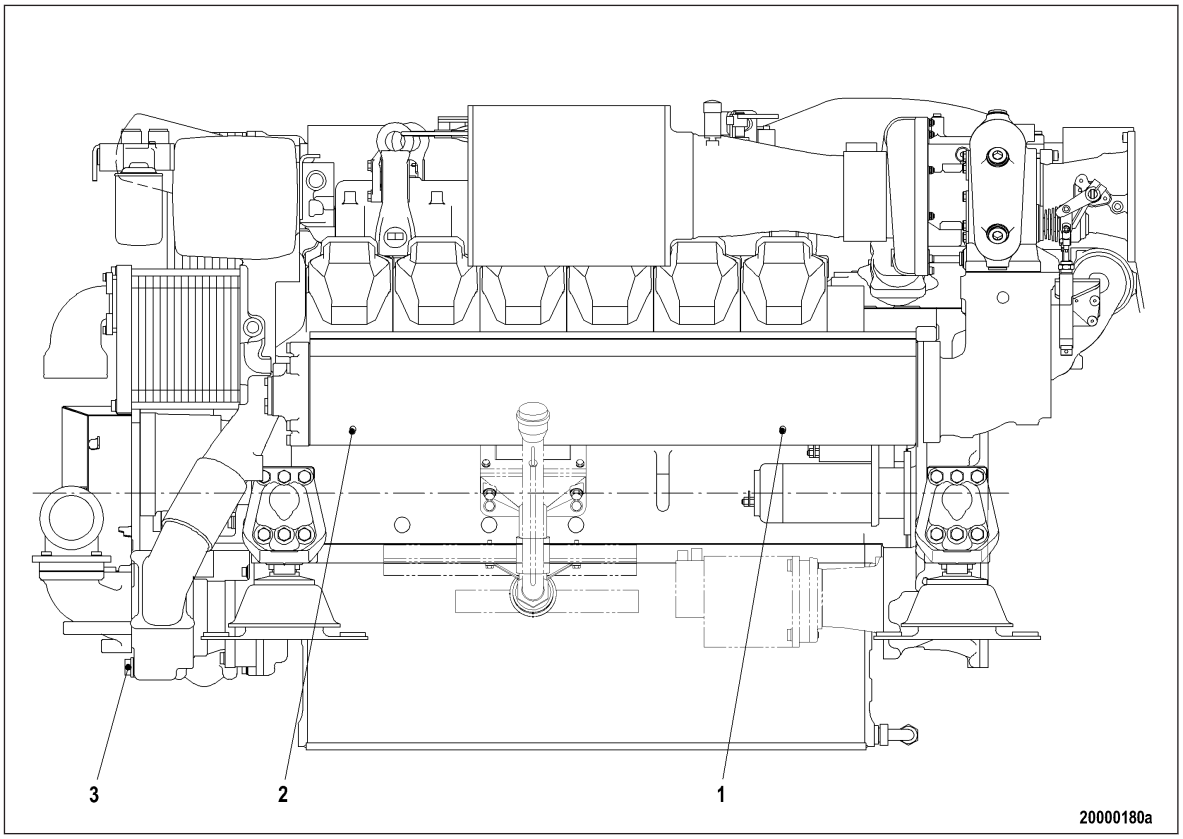
7.16.1 Drain and venting points

Top side



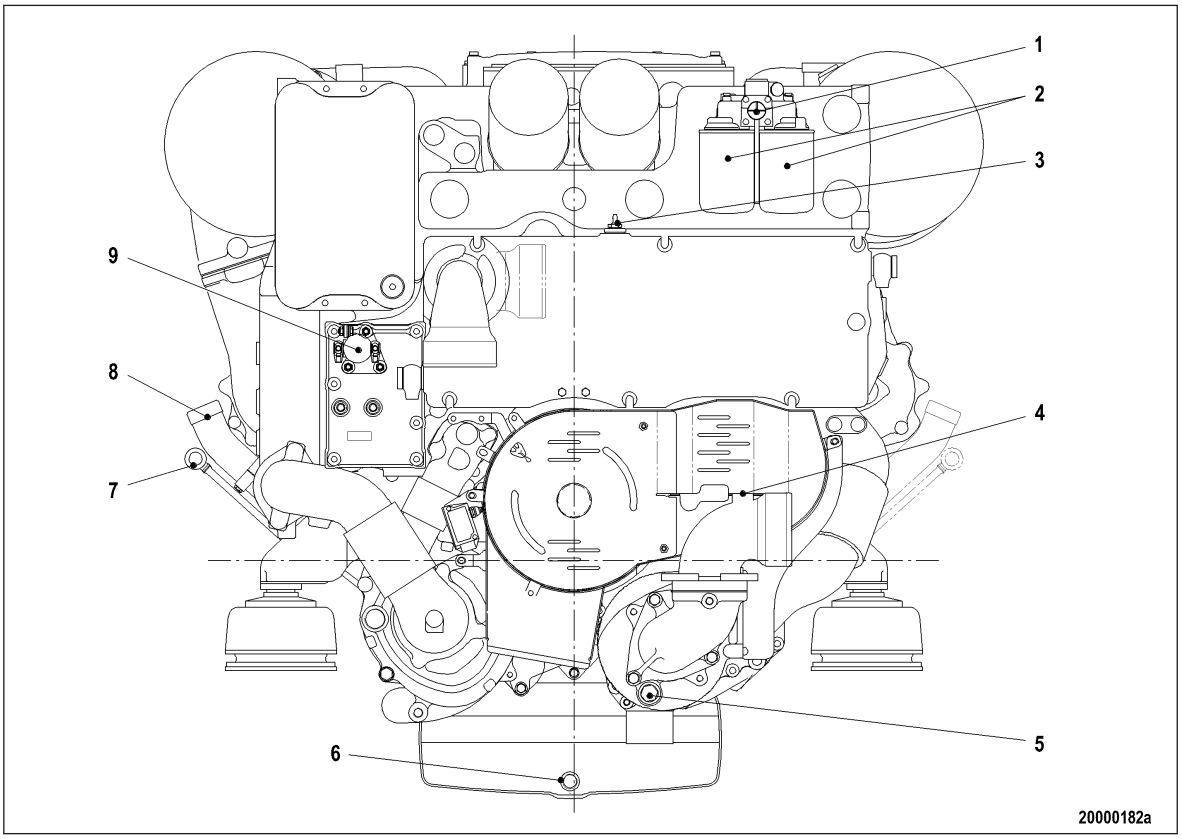
1 Engine coolant vent
2 Intercooler
3 Overflow line
4 Engine coolant expansion tank
5 Fuel filter
6 Engine oil filter

Left side



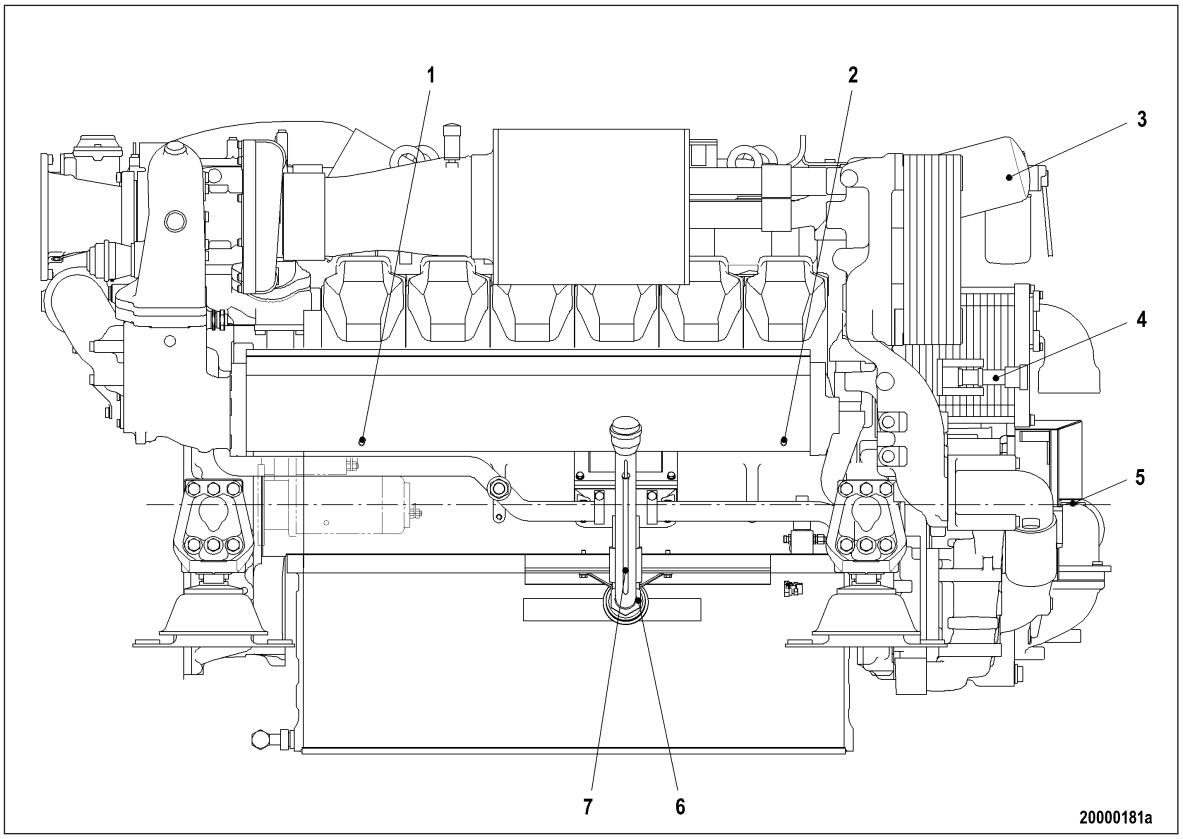
1 Engine coolant drain plug
2 Engine coolant drain plug
3 Raw water pump drain plug

Free end (KGS)



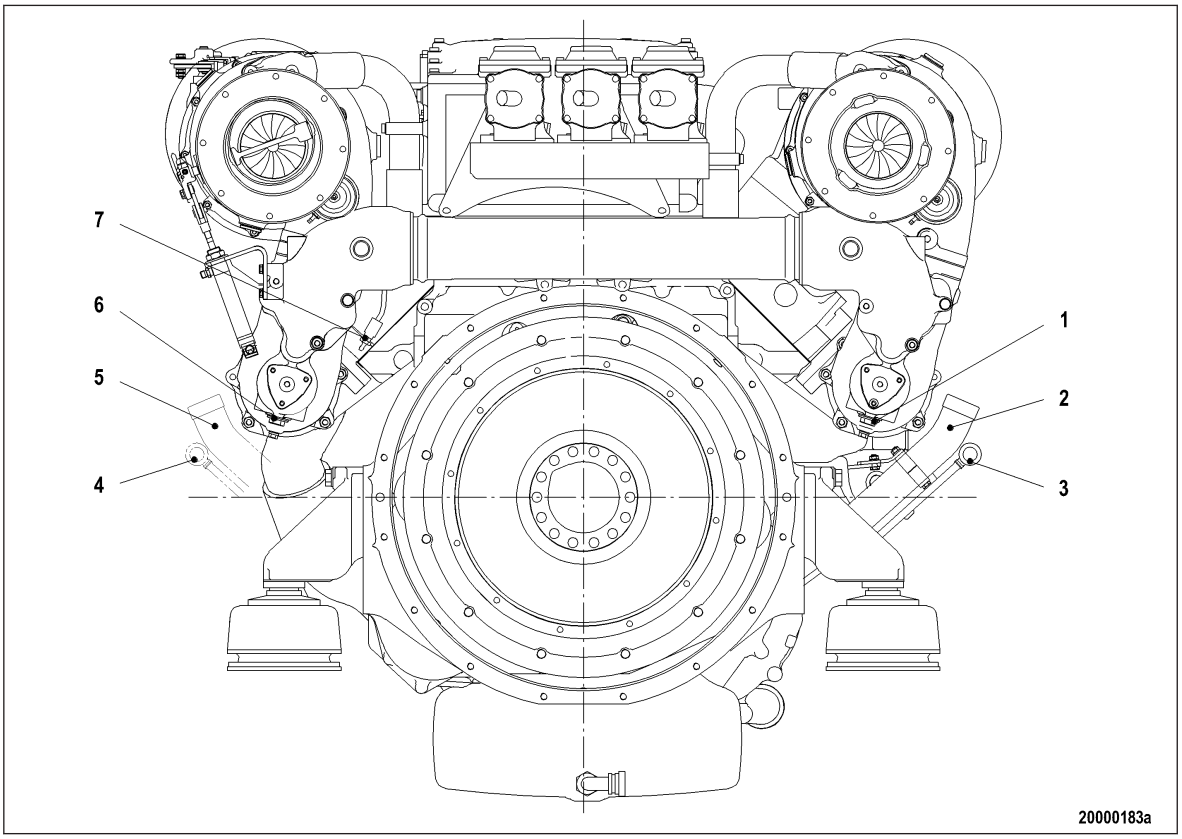
1 Three-way cock
2 Fuel filter
3 Fuel vent valve
4 Raw water pump filling plug
5 Raw water pump drain plug
6 Connection for oil extraction
7 Oil dipstick (connection left or right engine side optional)
8 Oil filler neck (connection left or right engine side optional)
9 Fuel priming pump

Right side



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-fuel tank

Driving end (KS)



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

7.16.2 Engine coolant - Level check

Preconditions

☑ Engine is stopped and starting disabled.

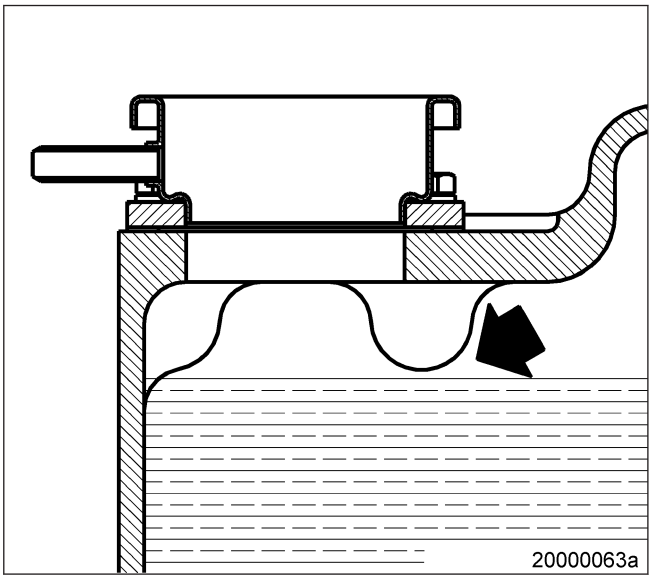
☑ MTU Fluids and Lubricants Specification (A001061/..) is available.

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.

Coolant-level check at filler neck:

1. Turn breather valve on coolant expansion tank (→ Page 28) counterclockwise until 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).



Coolant-level check by means of level sensor:

1. Switch engine control system on and check display (coolant level is automatically monitored by the engine control system).
2. If required, top up with treated engine coolant (→ Page 203).

7.16.3 Engine coolant - Change

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Coolant		

Engine coolant change

1. Drain engine coolant (→ Page 202).
2. Fill with engine coolant (→ Page 203).

7.16.4 Engine coolant - Draining

Preconditions

☑ Engine is stopped and starting disabled.

WARNING

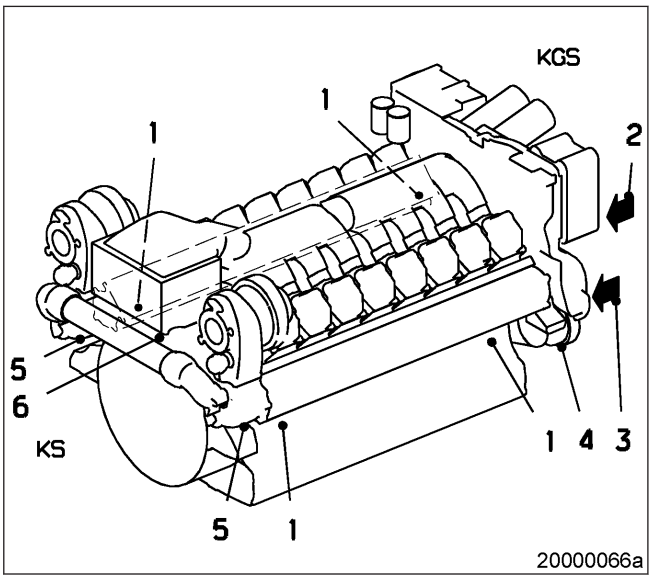
Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

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 counter-clockwise 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

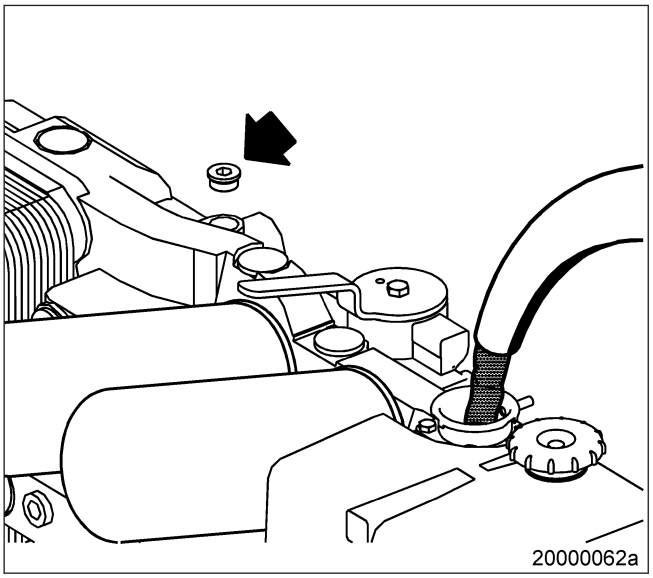
Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

NOTICE

Cold coolant in hot engine can cause thermal stress.
Possible formation of cracks in the engine!
- Fill / top up coolant only into cold engine.

Engine coolant – Filling

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 counter-clockwise 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 200).



7.16.6 HT coolant pump – Relief bore check

DANGER

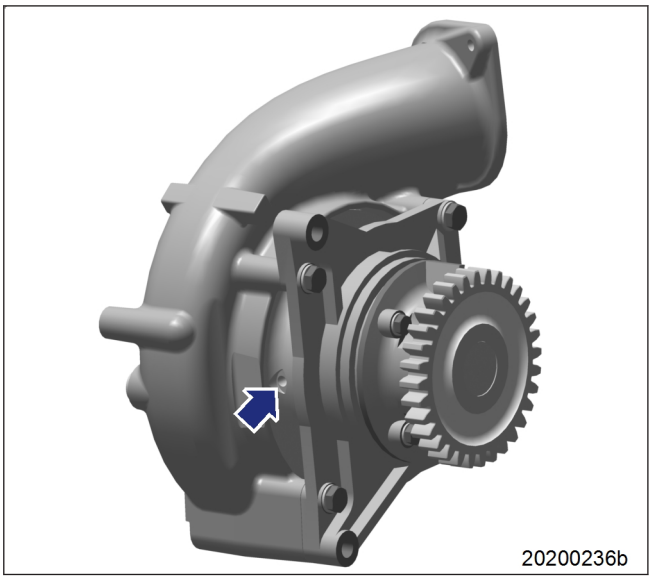
Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING

High level of engine noise when the engine is running.
Risk of damage to hearing!
- Wear ear protectors.

HT coolant pump – Relief bore check

1. Check relief bore (arrow) for oil and coolant discharge.
2. Stop engine (→ Page 115) and disable engine start.
3. Clean the relief bore (arrow) 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

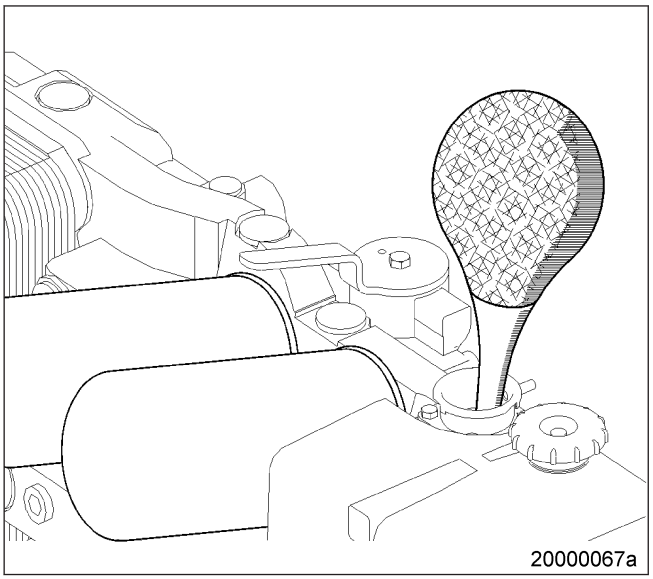
Designation / Use	Part No.	Qty.
MTU test kit	5605892099/00	1

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 202).



7.17 Raw Water Pump with Connections

7.17.1 Raw water pump - Priming

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

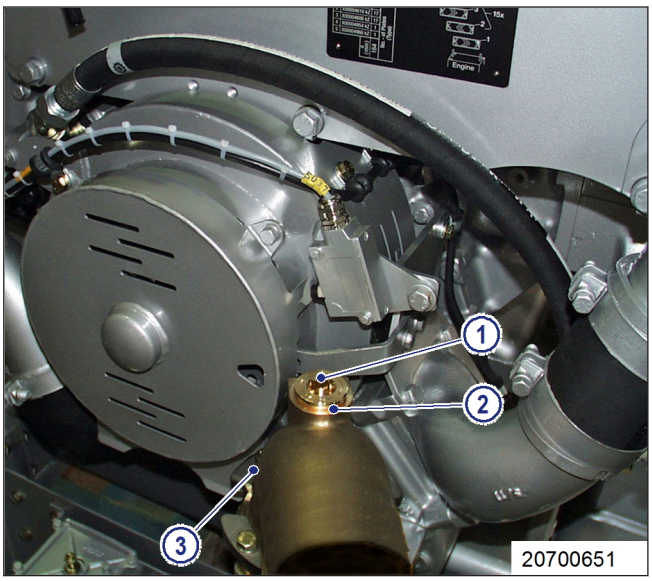
Designation / Use	Part No.	Qty.
Sealing ring	(→ Spare Parts Catalog)	

Raw water pump – Priming

Note: To prevent the raw water pump from running dry and being damaged and to ensure proper intake performance, the pump must be filled with 3 to 4 liters of water in the following cases:

- Before initial operation.
- Following repair /maintenance work or pump exchange
- After extended out-of-service period (to compensate for evaporation loss or water drained off from the system during winter lay-up periods).

1. Remove plug screw (1) on raw water elbow (3).
2. Fill 3 to 4 liters of water into the system through the opening.
3. Install plug screw (1) with new sealing ring (2) and tighten.



7.17.2 Raw water pump - Relief bore check

DANGER

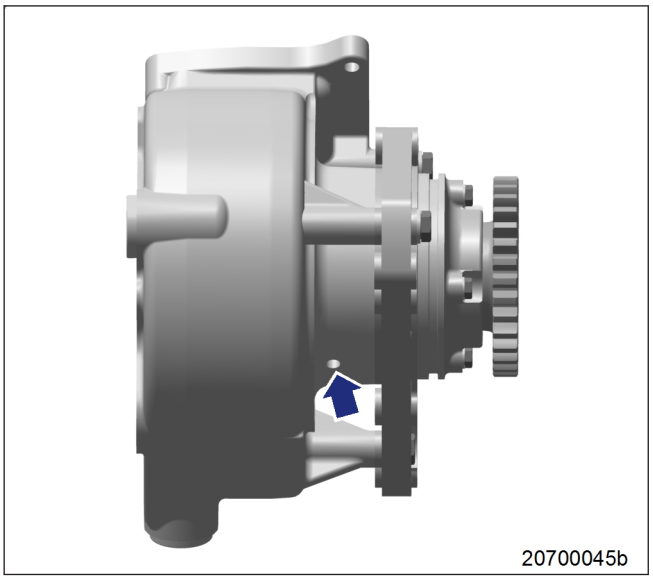
Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING

High level of engine noise when the engine is running.
Risk of damage to hearing!
- Wear ear protectors.

Raw water pump – Relief bore check

1. Check relief bore for oil and coolant discharge.
2. Stop engine (→ Page 115) 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.



7.18 Belt Drive

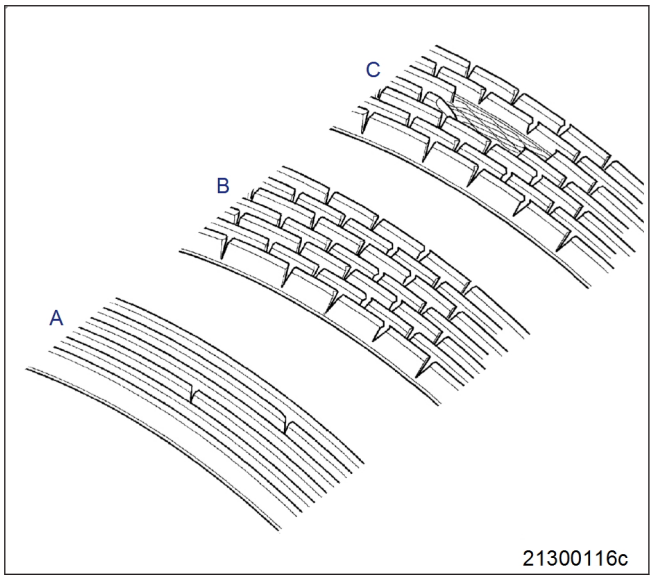
7.18.1 Drive belt - Condition check

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 B	Cracks on entire circumference	Replace (→ Page 211)
Drive belt C	Chunking	
Drive belt	Belt is oily, shows signs of over-heating	

7.19 Battery-Charging Generator

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

Preconditions

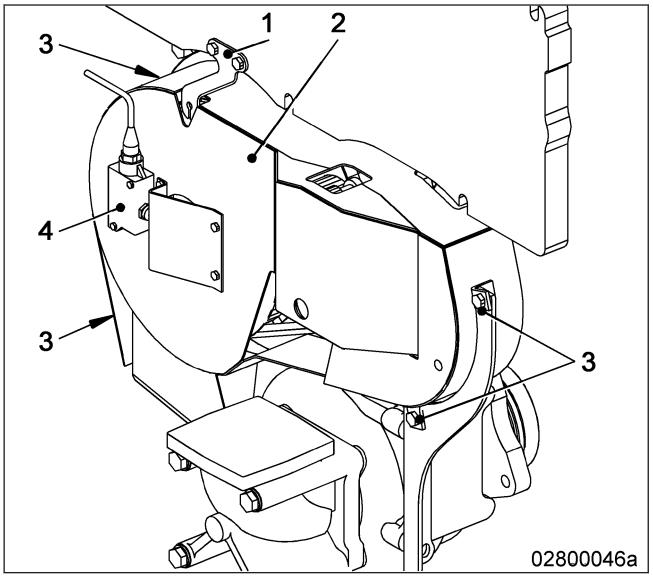
☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

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

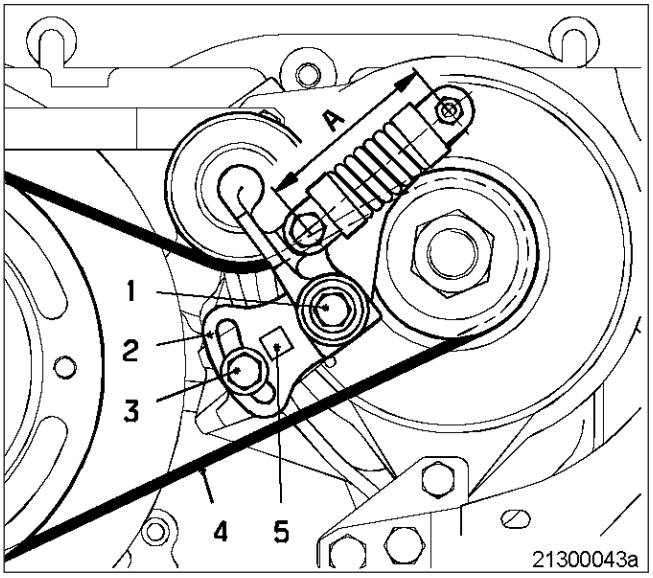
Preparatory steps

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 208).



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 mm ± 1.5 mm, readjust belt tension.

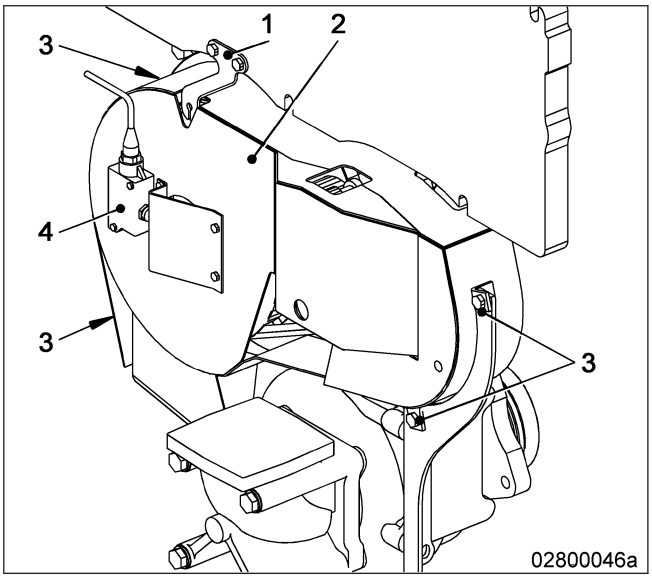


Adjusting belt tension

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.

Replacing drive belt

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.

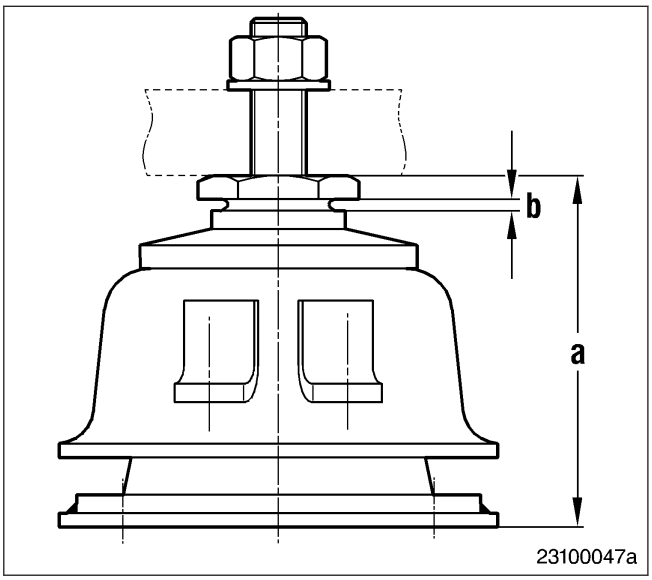
☑ Engine is under static load.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Vernier caliper, 300 mm	Y20000275	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

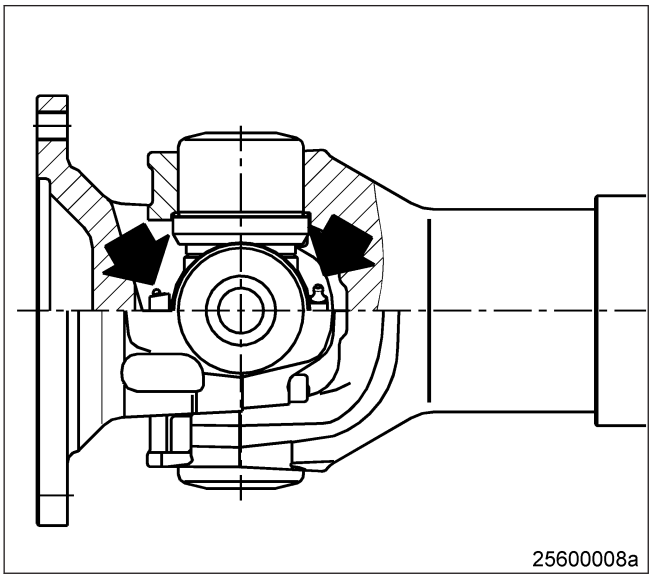
Designation / Use	Part No.	Qty.
Lithium-soap greases according to DIN2-KP K-20		

NOTICE

Damage to component.
Severe material damage!
- Do not press in grease at high pressure or with hard strokes.
- Permissible lubrication pressure max. 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. Verify that all cable clips are closed and in proper condition.
4. Replace cable clips if defective.
5. Check that cable clamps are firm, tighten loose cable clamps.
6. Replace faulty cable clamps.
7. Visually inspect the following electrical line components for damage:
   - Connector housing
   - Contacts
   - Sockets
   - Cables and terminals
   - Plug-in contacts

Result: Contact Service if cable conductors are damaged.

Note: Close male connectors that are not plugged in with the protective cap supplied.

8. Clean dirty connector housings, sockets and contacts using isopropyl alcohol.
9. 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

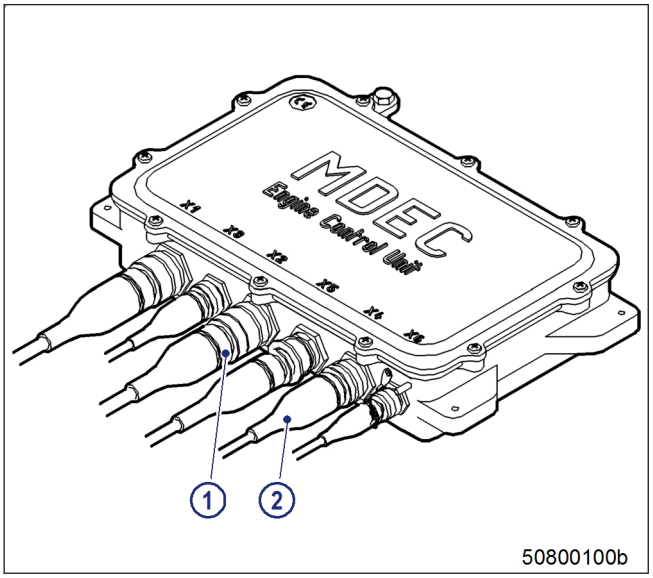
☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Connector pliers	F30017884	1
Isopropyl alcohol	X00058037	1

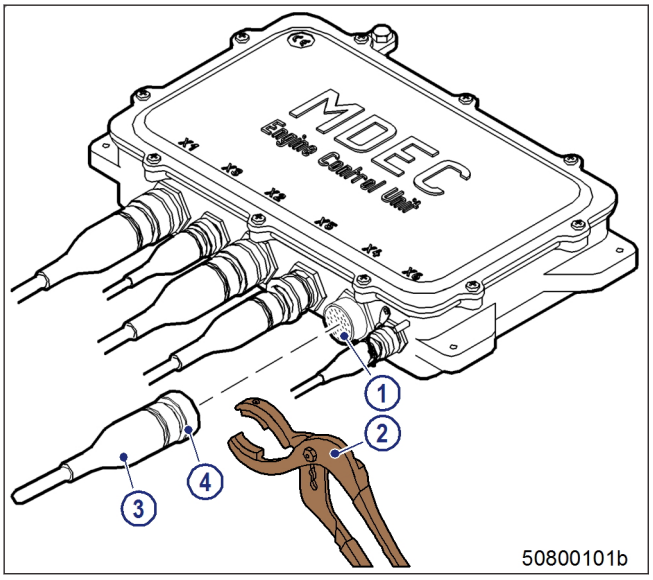
Engine governor and connectors – Cleaning

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 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 governor connections (→ Page 218).



7.23.2 Engine monitoring unit and connectors – Cleaning

Preconditions

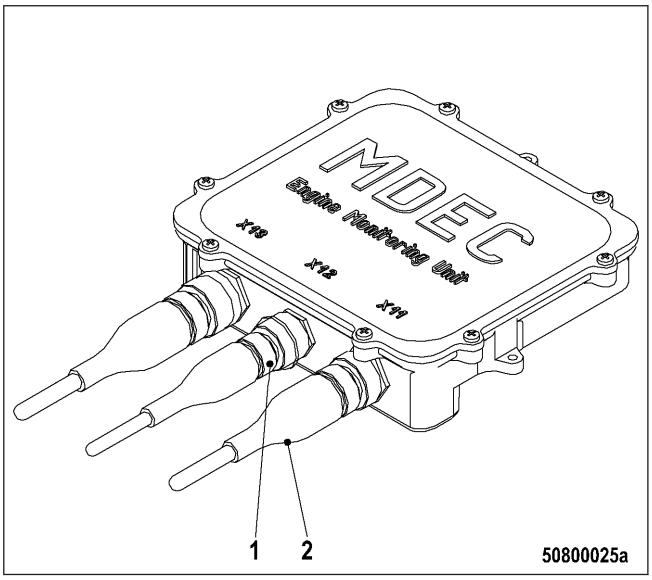
☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Connector pliers	F30017884	1
Isopropyl alcohol	X00058037	1

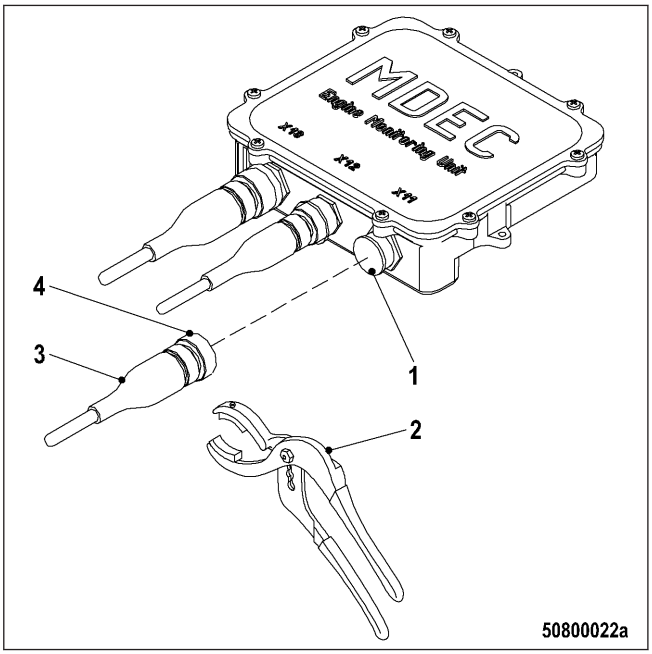
Engine monitoring unit and connectors – Cleaning

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 219).



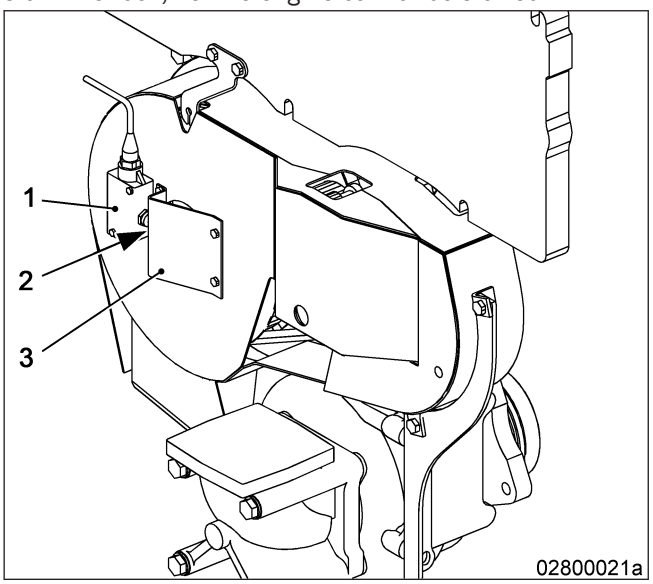
7.23.3 Start interlock limit switch - Check

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 ECU - Plug connections check

Preconditions

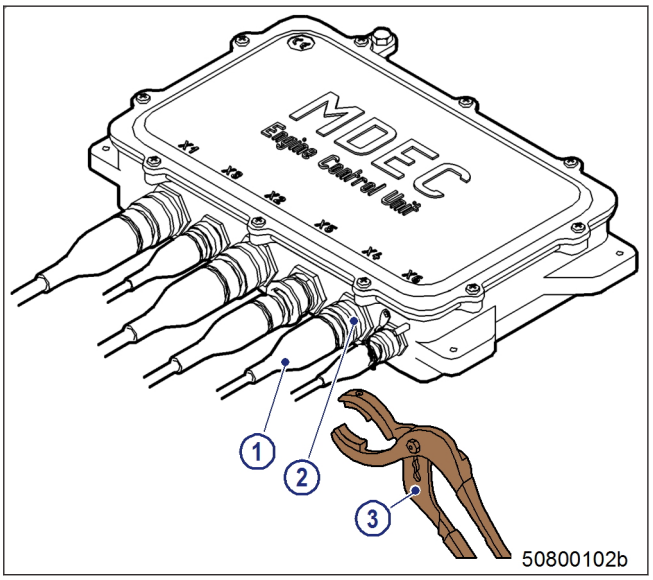
☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Connector pliers	F30017884	1

Checking plug connection to ECU

1. Use connector pliers (3) to make certain that all plug-in connections of ECU are securely seated.
2. Tighten loose bayonet couplings (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 couplings are defective, contact Service.



7.23.5 Engine monitoring unit - Plug connections check

Preconditions

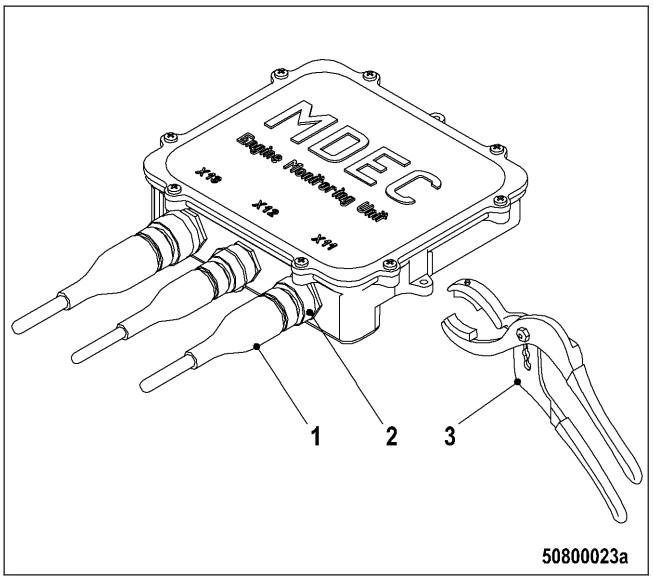
☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Connector pliers	F30017884	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 couplings (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 couplings are defective, contact Service.



7.23.6 Engine governor - Removal and installation

Preconditions

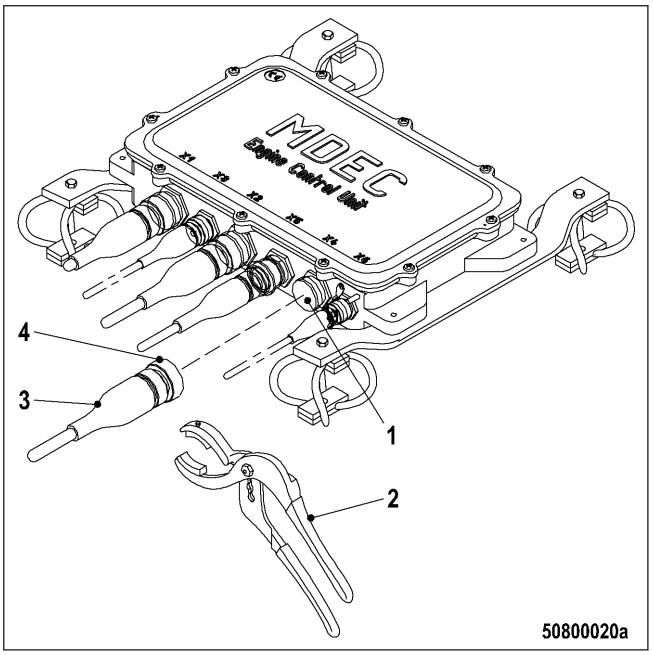
☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

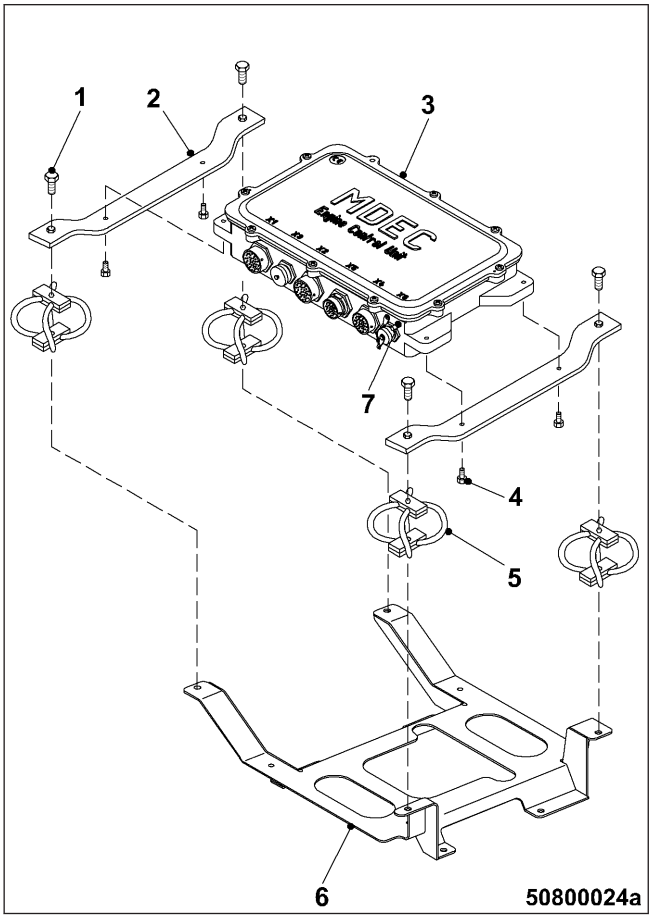
Designation / Use	Part No.	Qty.
Connector pliers	F30017884	1
Covering caps for Cannon sockets		

Removing engine governor 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 governor grounding stud (7).
6. If the screws (4) are easily accessible:
   1. Screw off screws (4).
   2. Remove engine governor housing (3) from mounting brackets (2).
   3. Unscrew mounting brackets (2), cable shock absorbers (5) and further securing parts (6) as one unit from engine.
7. If the screws (4) are not easily accessible:
   1. Remove screws (1).
   2. Remove engine governor housing (3) together with mounting brackets (2).
   3. Unscrew cable shock absorbers (5) and further securing parts (6) as one unit from engine.



Installing engine governor 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 latch 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

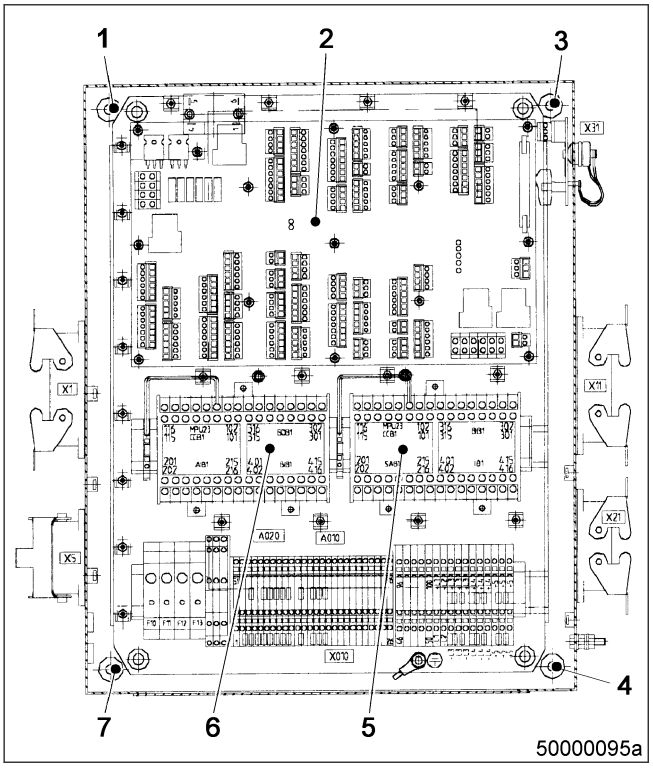
1. If READY FOR OPERATION pushbutton is illuminated brightly, press switch briefly.

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.

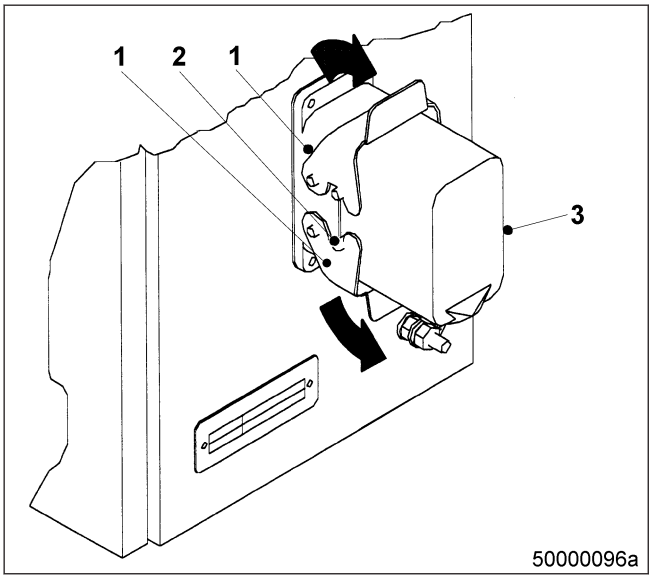
Checking housing and internal assemblies for secure seating

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.



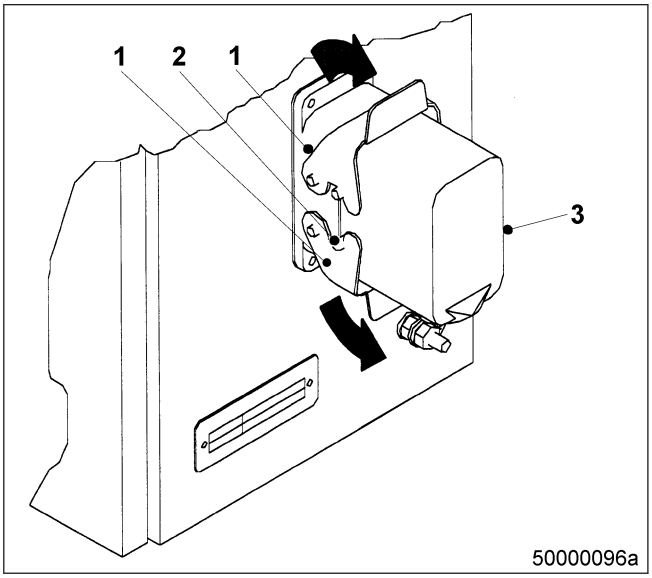
Checking plug connections

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.



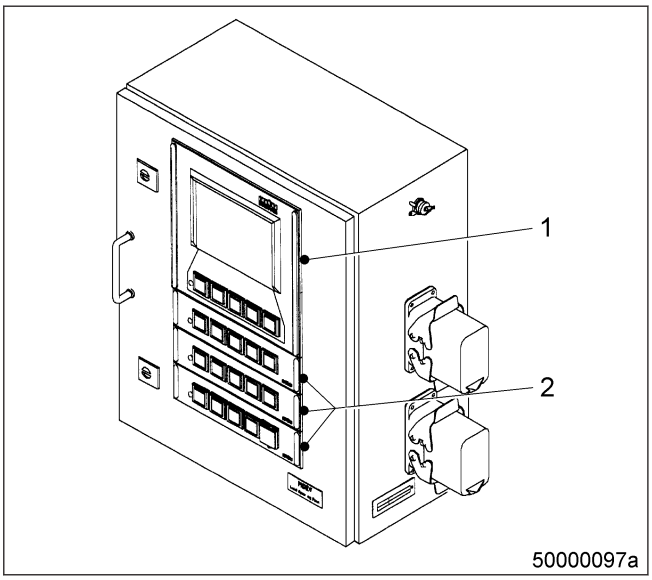
Checking unassigned connector sockets

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.

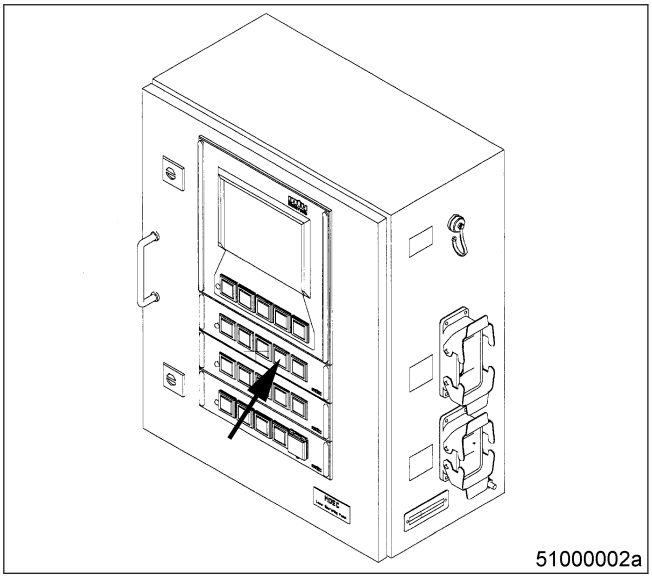


Performing lamp test

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.



TIM-ID: 0000008868 - 006

7.24.3 LOP - Test procedures

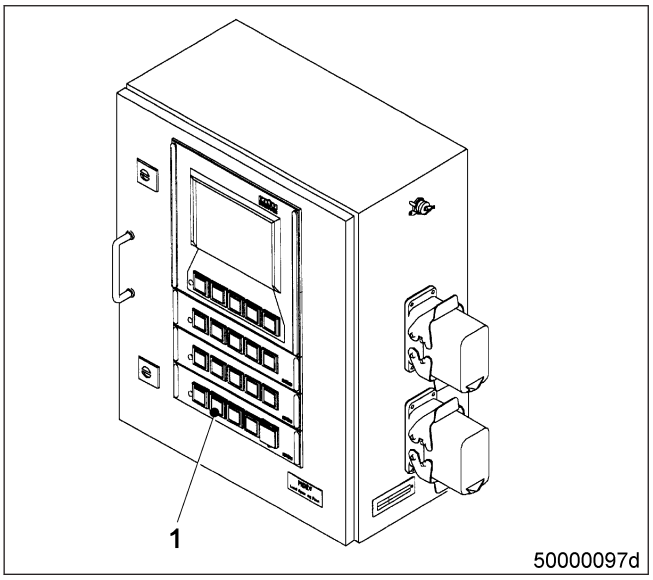
Preconditions

☑ 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 pushbutton (1) is illuminated brightly (local control mode is active);.



Switching between Local and Remote mode (automatic on-board network)

1. Press LOCAL OPERATION pushbutton (1).

Result:
- LOCAL OPERATION pushbutton (1) flashes: Setting does not correspond with feedback signal from Engine Control Unit.
- LOCAL OPERATION pushbutton (1) is illuminated at basic brightness: Remote mode active.

2. Press LOCAL OPERATION pushbutton (1) again.

Result: LOCAL OPERATION pushbutton (1) is illuminated brightly (Local 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 Engine Monitoring Unit.

1. Press OVERSPEED TEST illuminated pushbutton (3). Observe speed limit and speed simulated by Engine Monitoring Unit on display.

Result:
- Engine Control Unit is de-energized by the safety system.
- Engine governing is completely deactivated.
- On engines with emergency air-shutoff flaps: Flaps close.
- EMERGENCY STOP illuminated pushbutton (2) flashes;. Alarm signalling by horn, flashing light etc. is initiated. ALARM ACKNOWLEDGE pushbutton (1) is illuminated brightly.

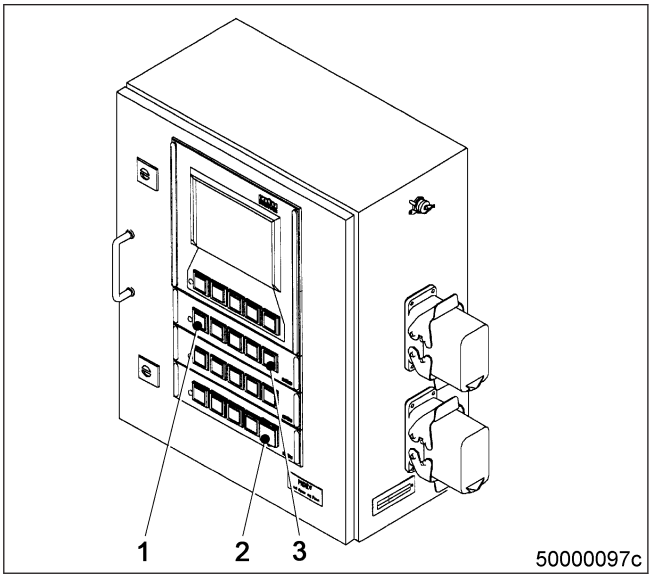
2. Press ALARM ACKNOWLEDGE pushbutton (1).

Result: Audible and visual alarm signaling stops.

3. Press ALARM ACKNOWLEDGE pushbutton (1) again.

Result: Power supply to Engine Control Unit is provided.

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



Emergency stop simulation with the engine at standstill

1. Open cap of EMERGENCY STOP pushbutton (2).
2. Press EMERGENCY STOP pushbutton (2).

Result:
- Engine Control Unit is deenergized by the safety system.
- Engine governing is completely deactivated.
- On engines with emergency air-shutoff flaps: Flaps close.
- EMERGENCY STOP pushbutton (2) flashes;. Alarm signalling by horn, flashing light etc. is initiated. ALARM ACKNOWLEDGE pushbutton (1) is illuminated brightly.

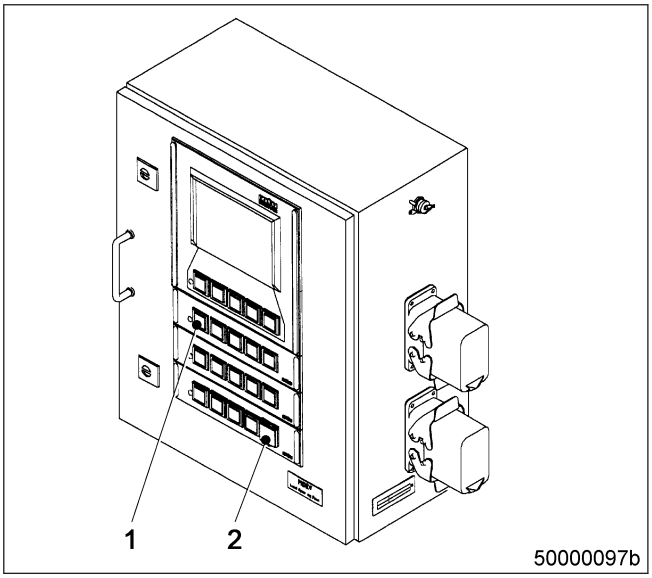
3. Press ALARM ACKNOWLEDGE pushbutton (1).

Result: Audible and visual alarm signaling stops.

4. Press ALARM ACKNOWLEDGE pushbutton (1) again.

Result: Power supply to Engine Control Unit is provided.

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



8 Appendix A

8.1 Abbreviations

Abbreviation	Meaning	Explanation
ADEC	Advanced Diesel Engine Control	Engine governor
AL	Alarm	Alarm (general)
ANSI	American National Standards Institute	Association of American standardization organizations
ATL	Abgasturbolader	Exhaust turbocharger (ETC)
BR	Baureihe	Series
BV	Betriebsstoffvorschrift	MTU Fluids and Lubricants Specifications, Publication 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 limit value
HT	High Temperature	
ICFN	ISO – Continuous rating – Fuel stop power – Net	Power specification in accordance with DIN-ISO 3046-7
IDM	Interface Data Module	
IMO	International Maritime Organization	

Abbreviation	Meaning	Explanation
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
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

Abbreviation	Meaning	Explanation
WZK	Werkzeugkatalog	Tool Catalog (TC)
ZKP	Zugehörigkeit-Kategorie-Parameter	Assignment category parameter; number scheme for signals from the ADEC engine governor

8.2 MTU contact persons/service partners

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 person in our Customer Assistance Center:

E-mail: info@mtu-online.com

Tel.: +49 7541 9077777

Fax: +49 7541 9077778

Asia/Pacific: +65 6100 2688

North and Latin America: +1 248 560 8000

Spare parts service

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

With this aim in mind, we can call on a globally networked spares logistics system, a central warehouse at headquarters and on-site stores at our subsidiary companies, agencies and service workshops.

Your contact at Headquarters:

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

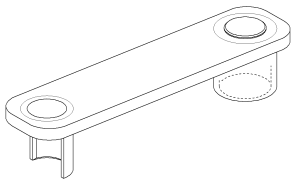
Tel.: +49 7541 908555

Fax: +49 7541 908121

9 Appendix B

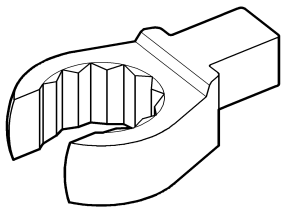
9.1 Special Tools

Assembly device



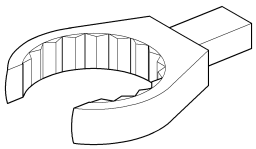
Part No.:	F6559691
Qty.:	1
Used in:	7.19.1 Battery-charging generator drive – Drive belt check and adjustment (→ Page 209)

Box wrench



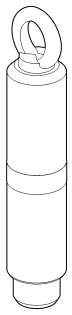
Part No.:	F30038493
Qty.:	1
Used in:	7.6.2 Injection pump – Removal and installation (→ Page 160)

Box wrench bit, 17 mm



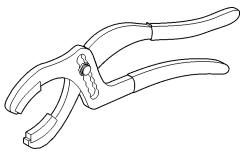
Part No.:	F30030450
Qty.:	1
Used in:	7.5.1 Valve clearance – Check and adjustment (→ Page 155)

Centering jig



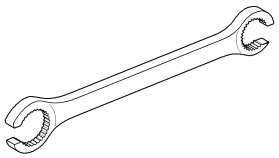
Part No.:	F6783025
Qty.: Used in:	1 7.5.2 Cylinder head cover – Removal and installation (→ Page 158)

Connector pliers



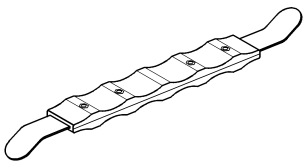
Part No.:	F30017884
Qty.: Used in:	1 7.2.2 Engine – Barring with starting system (→ Page 147)
Qty.: Used in:	1 7.23.1 Engine governor and connectors – Cleaning (→ Page 215)
Qty.: Used in:	1 7.23.2 Engine monitoring unit and connectors – Cleaning (→ Page 216)
Qty.: Used in:	1 7.23.4 ECU – Plug connections check (→ Page 218)
Qty.: Used in:	1 7.23.5 Engine monitoring unit – Plug connections check (→ Page 219)
Qty.: Used in:	1 7.23.6 Engine governor – Removal and installation (→ Page 220)

Double-head box wrench



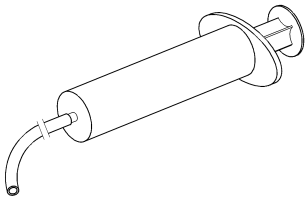
Part No.:	F30011450
Qty.: Used in:	1 7.7.2 HP fuel line – Pressure pipe neck replacement (→ Page 164)
Qty.: Used in:	1 7.7.3 Injector – Removal and installation (→ Page 166)

Feeler gauge



Part No.:	Y4342013
Qty.:	1
Used in:	7.5.1 Valve clearance – Check and adjustment (→ Page 155)

Fuel suction device

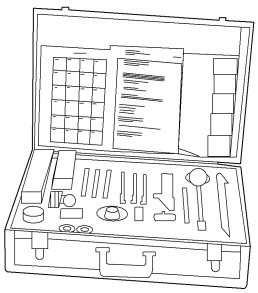


Part No.:	F30378207
Qty.:	1
Used in:	7.7.3 Injector – Removal and installation (→ Page 166)

Mandrel

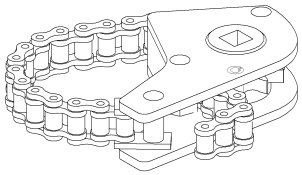
Part No.:	8205892861/08
Qty.:	1
Used in:	7.19.2 Battery-charging generator drive – Drive belt replacement (→ Page 211)

MTU test kit



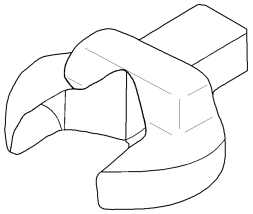
Part No.:	5605892099/00
Qty.:	1
Used in:	7.16.7 Engine coolant – Sample extraction and analysis (→ Page 205)

Oil filter wrench



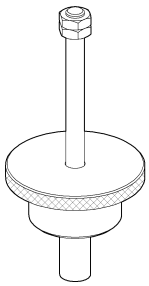
Part No.:	F30379104
Qty.: Used in:	1 7.9.1 Fuel filter – Replacement (→ Page 173)
Qty.: Used in:	1 7.15.2 Engine oil filter – Replacement (→ Page 190)
Qty.: Used in:	1 7.15.3 Centrifugal oil filter and filter sleeve – Cleaning and replacement (→ Page 192)

Open-end wrench bit



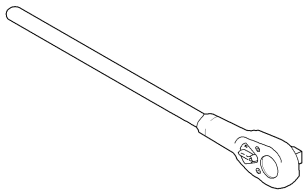
Part No.:	F30025897
Qty.: Used in:	1 7.7.2 HP fuel line – Pressure pipe neck replacement (→ Page 164)
Qty.: Used in:	1 7.7.3 Injector – Removal and installation (→ Page 166)

Puller



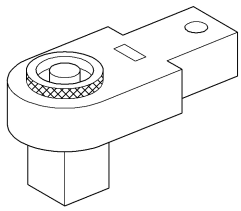
Part No.:	3555890163/00
Qty.: Used in:	1 7.7.3 Injector – Removal and installation (→ Page 166)

Ratchet



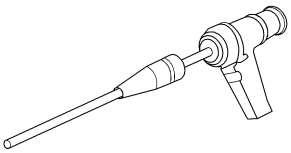
Part No.:	F30006212
Qty.: Used in:	1 7.2.1 Engine – Barring manually (→ Page 146)

Ratchet adapter



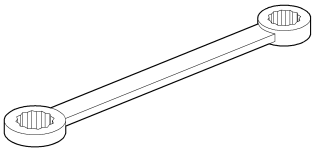
Part No.:	F30027340
Qty.: Used in:	1 7.4.1 Crankcase ventilation – Oil separator element replacement, diaphragm check and replacement (→ Page 152)
Qty.: Used in:	1 7.7.2 HP fuel line – Pressure pipe neck replacement (→ Page 164)
Qty.: Used in:	1 7.7.3 Injector – Removal and installation (→ Page 166)

Rigid endoscope



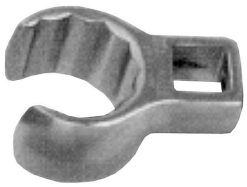
Part No.:	Y20097353
Qty.: Used in:	1 7.3.1 Cylinder liner – Endoscopic examination (→ Page 148)

Socket



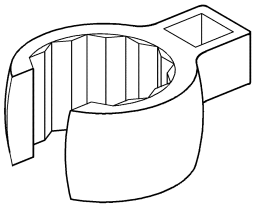
Part No.:	F30005655
Qty.: Used in:	1 7.2.1 Engine – Barring manually (→ Page 146)

Spider patch spanner



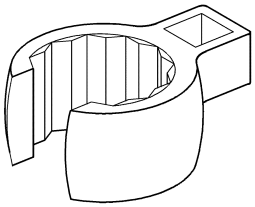
Part No.:	F30027425
Qty.: Used in:	1 7.7.2 HP fuel line – Pressure pipe neck replacement (→ Page 164)
Qty.: Used in:	1 7.7.3 Injector – Removal and installation (→ Page 166)

Spider patch spanner



Part No.:	F30027424
Qty.: Used in:	1 7.7.2 HP fuel line – Pressure pipe neck replacement (→ Page 164)
Qty.: Used in:	1 7.7.3 Injector – Removal and installation (→ Page 166)

Spider patch spanner, AF19



Part No.:	F30027424
Qty.: Used in:	1 7.6.2 Injection pump – Removal and installation (→ Page 160)

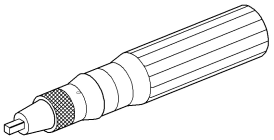
Spider patch spanner, AF22

Part No.:	F30027425
Qty.: Used in:	1 7.6.2 Injection pump – Removal and installation (→ Page 160)

Steam jet cleaner

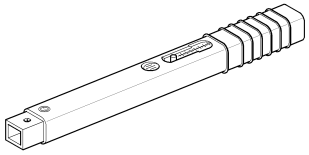
Part No.:	-
Qty.: Used in:	1 4.14 Plant – Cleaning (→ Page 119)

Torque wrench, 0.5-5 Nm



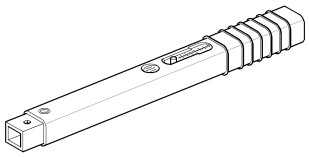
Part No.:	0015384230
Qty.: Used in:	1 7.6.2 Injection pump – Removal and installation (→ Page 160)

Torque wrench, 20-100 Nm



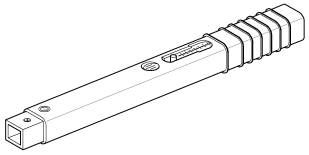
Part No.:	F30026582
Qty.: Used in:	1 7.6.2 Injection pump – Removal and installation (→ Page 160)
Qty.: Used in:	1 7.7.3 Injector – Removal and installation (→ Page 166)

Torque wrench, 20-100 Nm



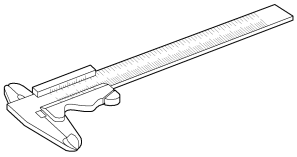
Part No.:	F30026582
Qty.: Used in:	1 7.5.1 Valve clearance – Check and adjustment (→ Page 155)
Qty.: Used in:	1 7.7.2 HP fuel line – Pressure pipe neck replacement (→ Page 164)

Torque wrench, 6-50 Nm



Part No.:	F30027336
Qty.: Used in:	1 7.4.1 Crankcase ventilation – Oil separator element replacement, diaphragm check and replacement (→ Page 152)

Vernier caliper, 300 mm



Part No.:	Y20000275
Qty.:	1
Used in:	7.20.1 Engine mounting – Checking condition of resilient mounts (→ Page 212)

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