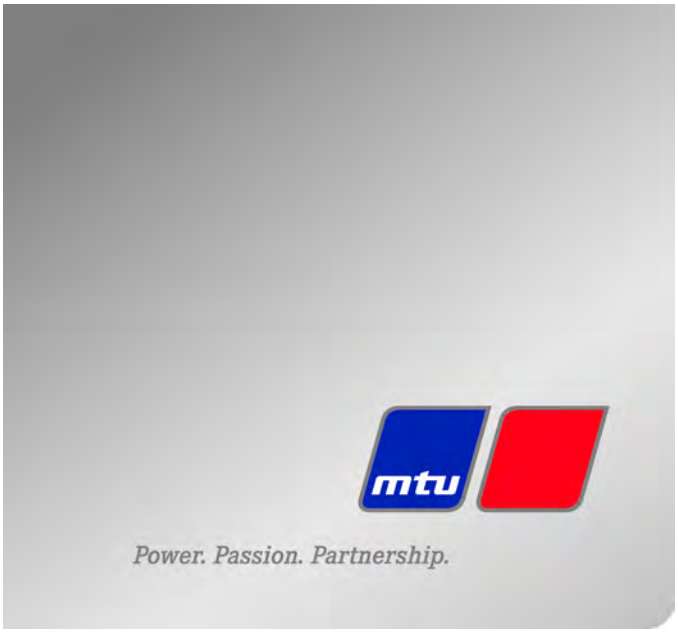
Operating Instructions

Diesel engine
12 V 4000 M93 x
16 V 4000 M93 x

MS150047/04E



Engine model	kW/cyl.	Application group
12V4000M93	195 kW/cyl.	1DS, continuous operation, variable, low load factors
12V4000M93L	215 kW/cyl.	1DS, continuous operation, variable, low load factors
16V4000M93	195 kW/cyl.	1DS, continuous operation, variable, low load factors
16V4000M93L	215 kW/cyl.	1DS, continuous operation, variable, low load factors

Table 1: Applicability

Printed in Germany

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

Subject to alterations and amendments.

Table of Contents

1 Safety

1.1 Important provisions for all products

Nameplate

The product is identified by nameplate, model designation or serial number and must match with 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:
- Incorrect use
- Operation, maintenance and repair by unqualified personnel
- Modifications or conversions
- Noncompliance with the safety instructions and warning notices

Correct use

The product is intended exclusively for the application specified in the contract or defined at the time of delivery.

This means that the equipment must be operated:
- Within the permissible operating parameters in accordance with the (→ product 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 (→ applicable Spare Parts Catalog)
- In the original as-delivered configuration or in a configuration approved by the manufacturer in writing (including engine control/parameters)
- In compliance with all safety instructions and in adherence to all warning notices in this manual
- In accordance with the maintenance requirements over the entire service life of the product (→ Maintenance Schedule)
- 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 is considered improper use and increases the risk of personnel injury or material damage in product operation.The manufacturer will accept no liability for such damage.

Modifications or conversions

Unauthorized modifications to the product compromise safety.

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

Spare parts

Only genuine spare parts must be used to replace components or assemblies.

The manufacturer will accept no liability or warranty claims for any damage caused by the use of other spare parts.

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 Safety regulations for startup and operation

Safety regulations for startup

Install the product correctly and carry out acceptance in accordance the manufacturer's specifications before putting the product into service.

Before the product is put into operation for the first time, all official authorizations must be available and commissioning preconditions met.

When putting the product into operation, always ensure
- that all maintenance and repair work has been completed;
- that all loose parts have been removed from rotating machine components;
- that no-one is present in the danger zone of rotating machine components.

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

Safety regulations for equipment operation

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

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

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

Malfunctions and emergency stop

The procedures for cases of emergency, in particular, emergency stop, must be practiced regularly.

The following steps must be taken if a malfunction of the system is recognized or reported by the system:
- Inform supervisor(s) in charge,
- Analyze the message,
- If required, carry out emergency operations e.g. emergency stop.

Operation

The following conditions must be fulfilled before starting the product:
- Wear ear protection.
- Ensure that the engine room is well ventilated.
- Do not inhale the exhaust gases of the product.
- Ensure that the exhaust system is free of leaks and that the gases are discharged to atmosphere.
- Mop up any leaked or spilt fluids and lubricants immediately or soak up with a suitable binding agent.
- Protect battery terminals, generator terminals or cables against accidental contact.

Operation of electrical equipment

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

Observe the safety instructions for these devices.

1.4 Safety regulations for maintenance and repair work

Safety regulations prior to 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 before starting maintenance work (risk of explosion of oil vapors, fluids and lubricants, risk of burning).

Before starting work, relieve pressure in systems and compressed-air lines which are to be opened. Use suitable containers of adequate capacity to catch fluids and lubricants.

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

Never carry out maintenance and repair work with the product in operation.

Carry out function checks on a product in operation only if expressly permitted to do so.

Secure the product against unintentional starting, e.g. with start interlock.

Attach "Do not operate" sign in the operating area or to control equipment.

Disconnect the battery. Lock circuit breakers.

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

Disconnect the control equipment from the product.

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

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

Safety regulations during maintenance and repair work

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

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

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

Carry out work only on assemblies or plants which are properly secured.

Never use lines for climbing.

Keep fuel injection lines and connections clean.

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

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

Ensure that all retainers and dampers are installed correctly.

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

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

Note cooling time for components which are heated for installation or removal (risk of burning).

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

Ensure particular cleanness during maintenance and repair work on the product. After completion of maintenance and repair work, make sure that no loose objects are in/on the product (e.g. cloths and cable ties)

Safety regulations after completion of maintenance and repair work

Before barring, make sure that nobody is standing in the danger zone of the product.

Check that all guards have been reinstalled and that all tools and loose parts have been removed after working on the product (in particular, the barring tool).

Welding work

Welding operations on the product or mounted units are not permitted. Cover the product when welding in its vicinity.

Before starting welding work:
- Switch off the power supply master switch.
- Disconnect the battery.
- Separate the electrical ground of electronic equipment from the ground of the unit.

No other maintenance or repair work must be carried out in the vicinity of the product while welding is going on. Risk of explosion or fire due to oil vapors and highly flammable fluids and lubricants.

Do not use product as ground terminal.

Never position the welding power supply cable adjacent to, or crossing 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 parts (e.g. exhaust pipes) which are to be welded from the product beforehand.

Hydraulic installation and removal

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

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

Do not attempt to bend or apply force to lines.

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

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

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

Working with batteries

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

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

Do not allow electrolyte to come in contact with skin or clothing.

Wear protective clothing and protective gloves.

Never place tools on the battery.

Before connecting the cable to the battery, check the battery polarity.Battery pole reversal may lead to injury through the sudden discharge of acid or bursting of the battery body.

Working on electrical and electronic assemblies

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

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

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

Do not secure cables on lines carrying fluids.

Do not use cable binders to secure cables.

Always use connector pliers to tighten union nuts on connectors.

Subject the device as well as the product to a function check on completion of all repair work. In particular, check the function of the engine emergency stop feature.

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

Working with laser equipment

When working with laser equipment, always wear special laser-protection goggles (hazard due to heavily focused radiation).

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

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

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

1.5 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 cloths 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 defenders in work areas 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 consumables 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.

Auxiliary materials, fluids and lubricants

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" tab 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 instructions 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 components 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.
- 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, fixtures or workpieces in any way.

Acids/alkalis/urea solution (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 eyedrops or clean tap water. Seek medical attention as soon as possible.

1.6 Standards for safety notices in the text

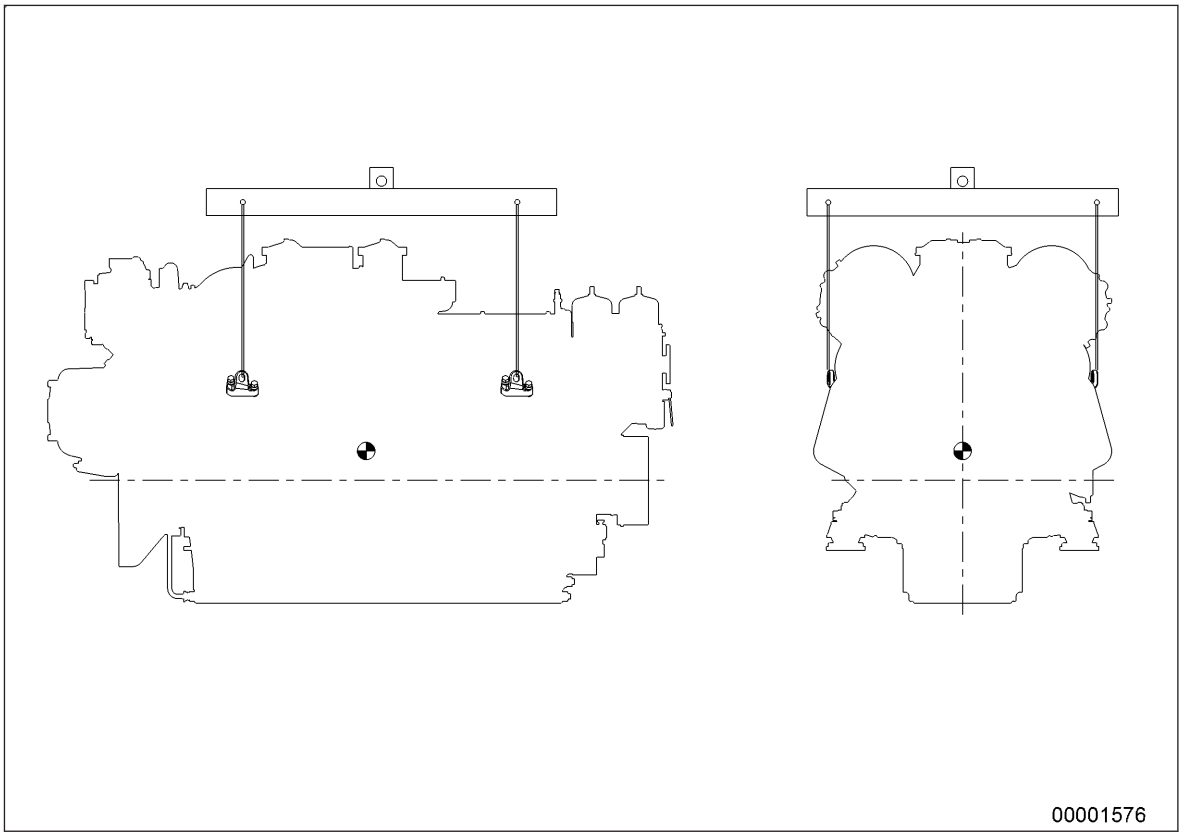
DANGER 	In the event of immediate danger. **Consequences: Death, serious or permanent injury!** • Remedial action.
WARNING 	In the event of a situation involving potential danger. **Consequences: Death, serious or permanent injury!** • Remedial action.
CAUTION 	In the event of a situation involving potential 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

▶ This manual with all safety instructions and safety notices must be issued to all personnel involved in operation, maintenance, repair or transportation.

1.7 Transport

Transport



Only use the lifting eyes provided to lift the engine.

The lifting eyes are designed for the transport of engine only, not for the transport of drive units (engine and transmission).

Only use transport and lifting devices approved by MTU.

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

Take the engine's center of gravity into account.

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

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

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

Setting the engine down after transport

Only set down engine on a firm, level surface.

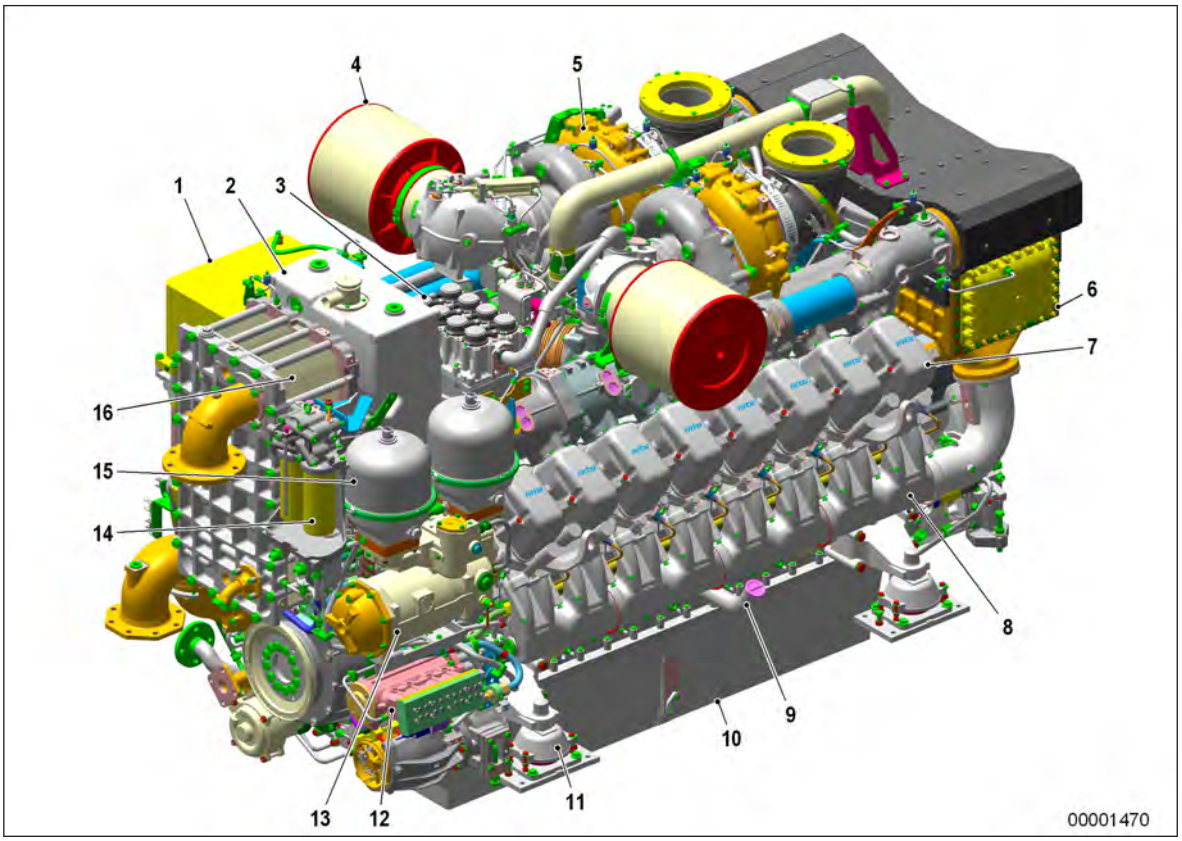
Make sure that the consistency and load-bearing capacity of the ground or support surface is adequate.

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

2 General Information

2.1 Engine layout

Also valid for 12V engines



1 Oil cooler
2 Coolant expansion tank
3 Crankcase breather
4 Air filter
5 Exhaust turbocharger
6 Intercooler
7 Cylinder head
8 Charge-air pipework
9 Oil filler neck
10 Oil pan
11 Engine mounting
12 HP fuel pump
13 Automatic oil filter
14 Fuel filter
15 Centrifugal oil filter(s)
16 Coolant cooler

Engine model designation

Key to the engine model designations 16V 4000 Mxyz	
12, 16	Number of cylinders
V	Cylinder arrangement: V engine
4000	Series
M	Application
x	Application segment (1, 2)
y	Design index (3)
z	R (reduced power/speed) L (enhanced power/speed)

2.2 Product description

Description of the engine

Engine

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

The engine is monitored by an engine control and monitoring system (ADEC).

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

Fuel system

Electronically controlled common-rail-injection system with HP pump, pressure accumulator (rail) and single injectors with integrated individual store.

The electronic control unit controls
- Start of injection
- Injection quantity
- Injection pressure

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 internal, engine-coolant-controlled charge-air cooling. The right-hand exhaust turbocharger is cut-in and cut-out on 12V and 16V engines with electronically-controlled, hydraulically-actuated flaps.

Cooling system

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

Heating of the charge air in idle and low-load operation prevents white smoke formation.

Seawater only flows through engine coolant and fuel heat exchanger as well as the raw water pump.

Service block

The service components are mounted on the auxiliary PTO end.

The arrangement facilitates easy access for maintenance operations.

Service components:
- Raw water pump, coolant pump
- Fuel duplex filter, switchable
- Automatic oil filter
- 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).

Engine Interface Module (EIM)

The Engine Interface Module (EIM) is the central connection box on the engine. Covers the entire minimum scope of a marine engine. Has no controls or parts requiring maintenance.

Functions:
- Starter control (start repetition, tooth alignment, starter protection)
- Generator monitoring
- Open bus interface to the plant (SAE J1939)
- Emergency stop function with line break monitoring
- Redundant power supply
- Optional control of emergency air-shutoff flaps
- Key switch logic
- Interface to ECU and EMU
- MCS5 dialog interface
- Control of an MTU lube-oil priming pump (power components in separate MTU PPC Box)
- Connection facility for an MTU Local Operating Station (LOS)
- Serial RS422 interface for diagnosis

The engine interface comprises two parts. The first part is connected to the engine wiring harness via a 62-pole Tyco connector X52. The second part comprises signals at higher current levels. These signals are led out via M threaded pins and also connected to the engine wiring harness.

Functions
- ECU supply
- EMU supply
- Plant signals (ECU7 connector X1)
- Bus interface (2x MCS5 CAN)
- CAN dialog output (1xMCS5 CAN)
- ECU and EMU emergency stop
- Electric starter
- Terminal 45 of starter A/B (starter engaged)
- Pneumatic starter
- Start-air pressure valve
- Start-air pressure sensor
- Barring gear (barring gear 1 and 2)
- Generator (with excitation control)
- Optional shut-down air flaps
- Control SSK 1+2
- Feedback SSK 1+2

Electronic Engine Control Unit (ECU)

Functions:
- Engine speed control with fuel and speed limitation dependent on engine status and operating conditions;
- Control of sequential turbocharging, cylinder bank cut-out and air recirculation function.
- 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)

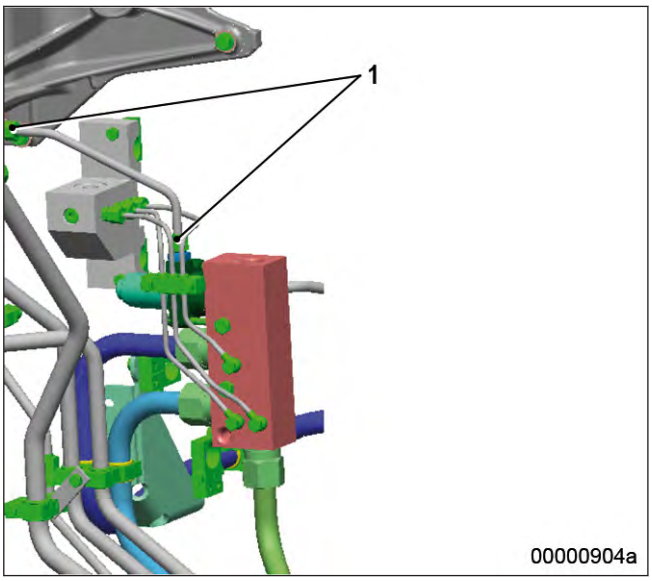
Functions:
- Alphanumeric, monochrome LCD display for monitoring of measured values as well as alarms when limits are violated;
- Pushbuttons for menu control and dimming unit;
- Combined control and display elements for local engine/gear control;
- Flashing light and horn for combined alarm in engine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

SOLAS – Fire safety requirements

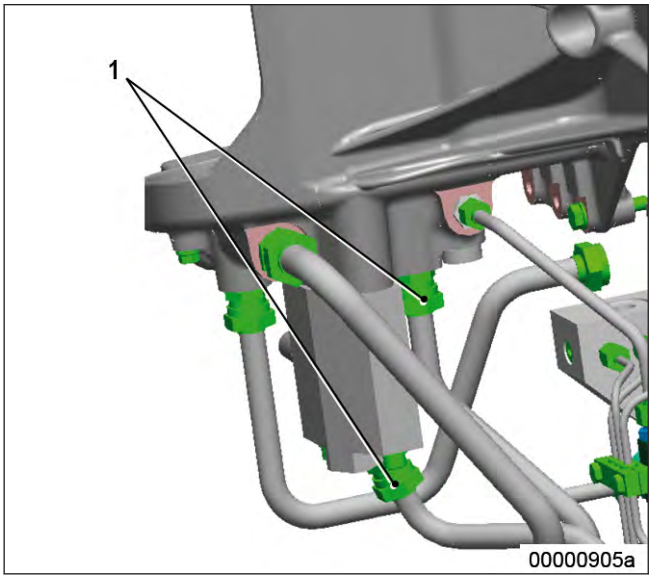
All lines with SOLAS-compliant covers for pipe connections, according to MTU standard MTN5233, are shown below.

Fuel system, fuel lines with fuel pressures exceeding 1.8 bar

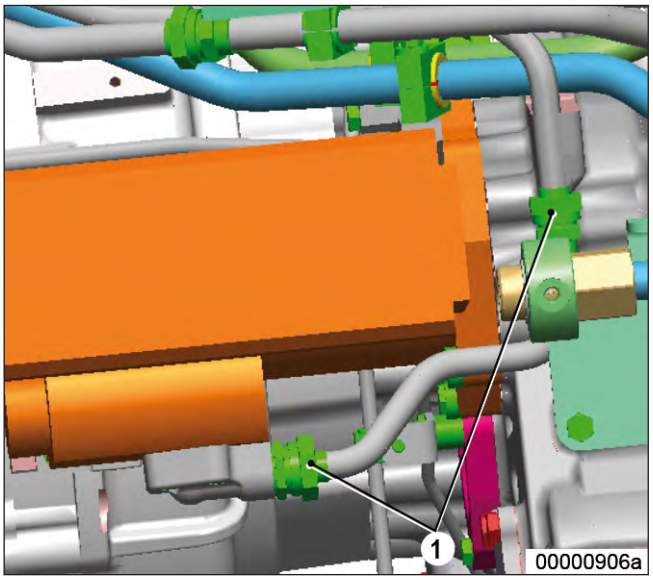
1 Fuel line to fuel filter head



1 Fuel line from/to fuel filter head

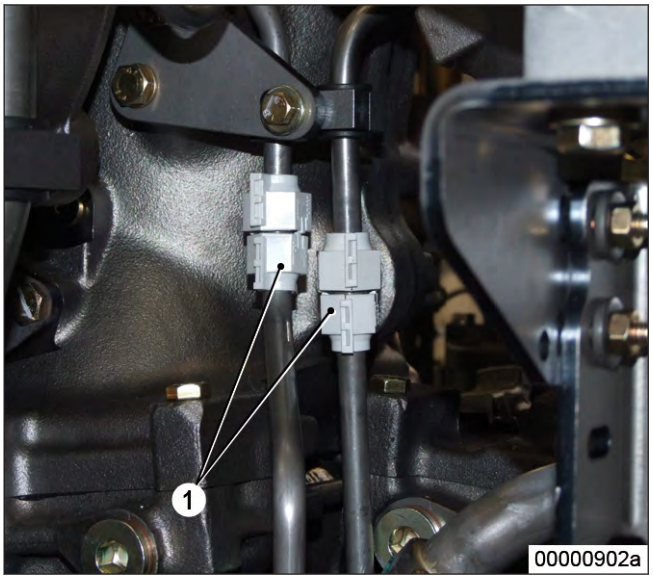


1 Fuel line to HP pump

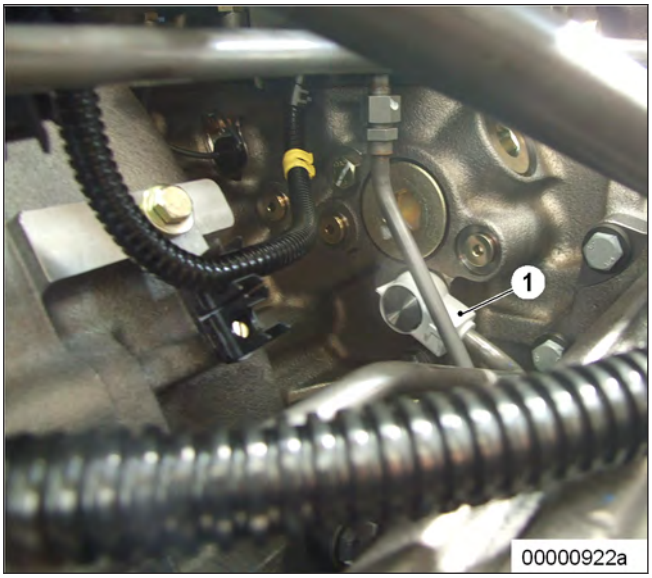


Lube oil system, oil lines with oil pressures exceeding 1.8 bar

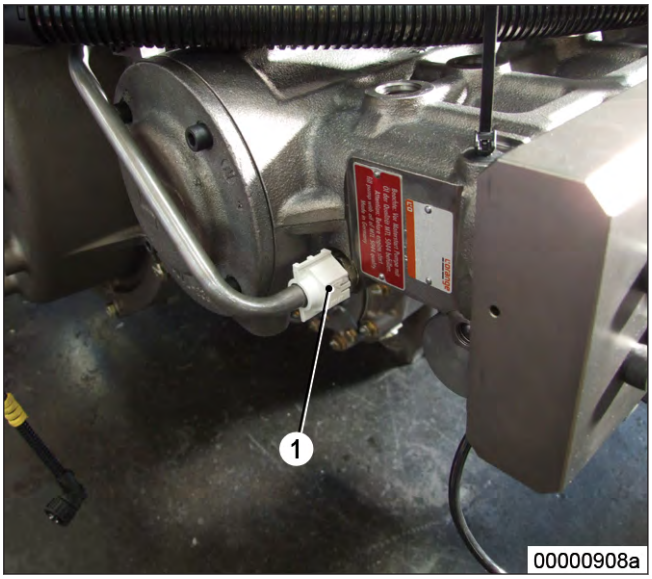
1 Parting line ETC oil supply free end



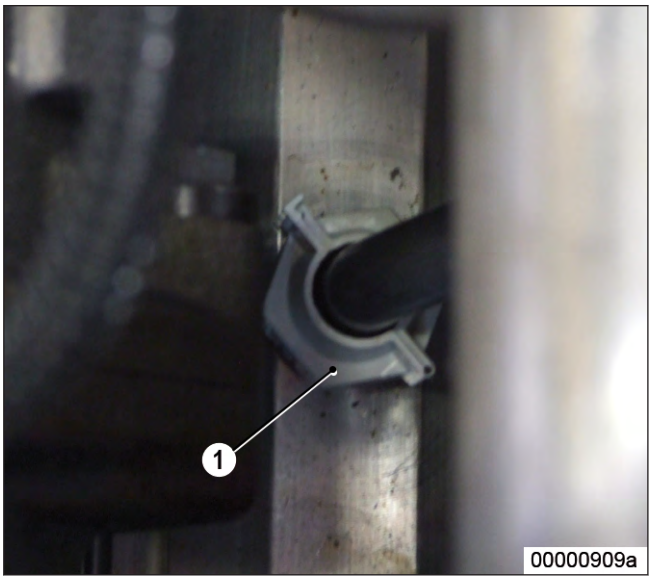
1 Oil line on equipment carrier



1 Oil supply to HP pump



1 Oil supply to flap control free end



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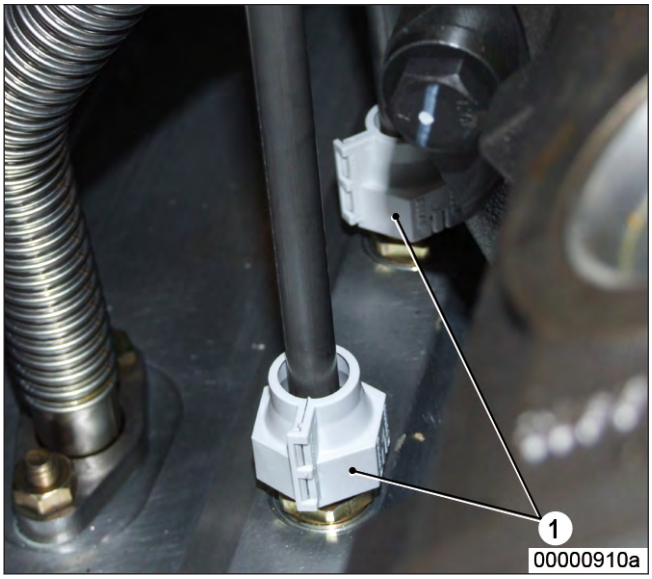
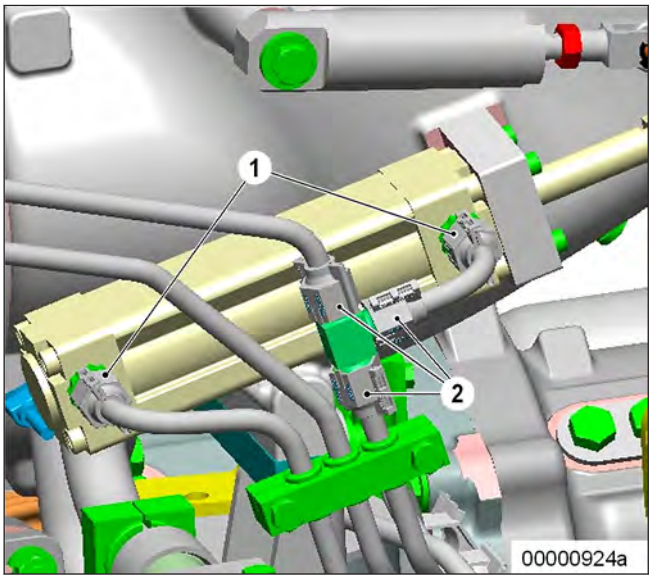
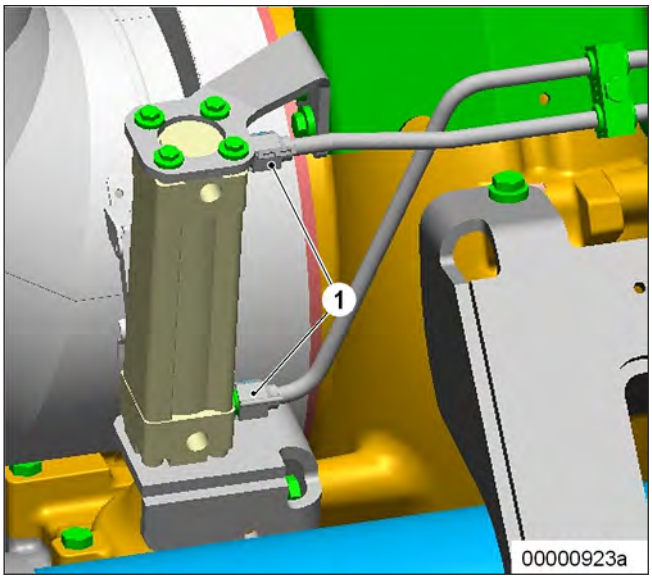
1 ETC oil supply on main oil gallery



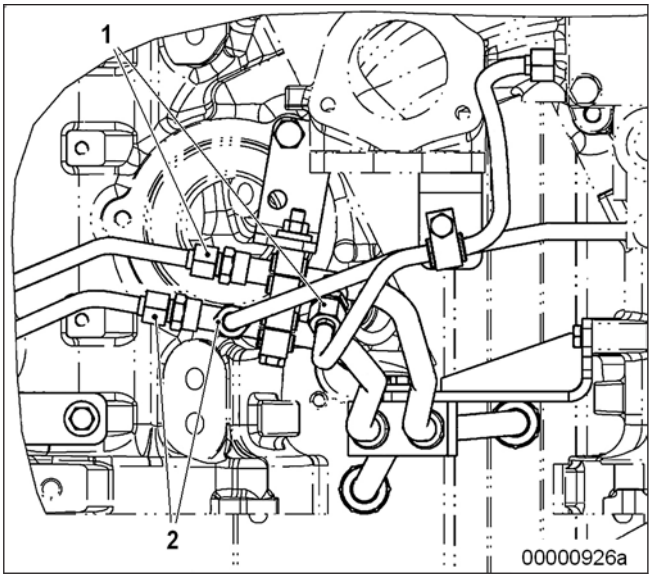
1 Switching cylinder air flap turbocharger B1
2 T piece flap control



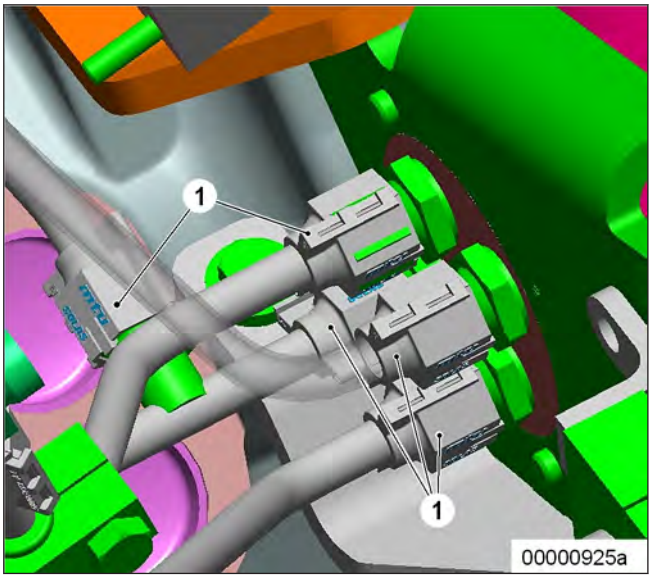
1 Switching cylinder exhaust flap turbocharger B1



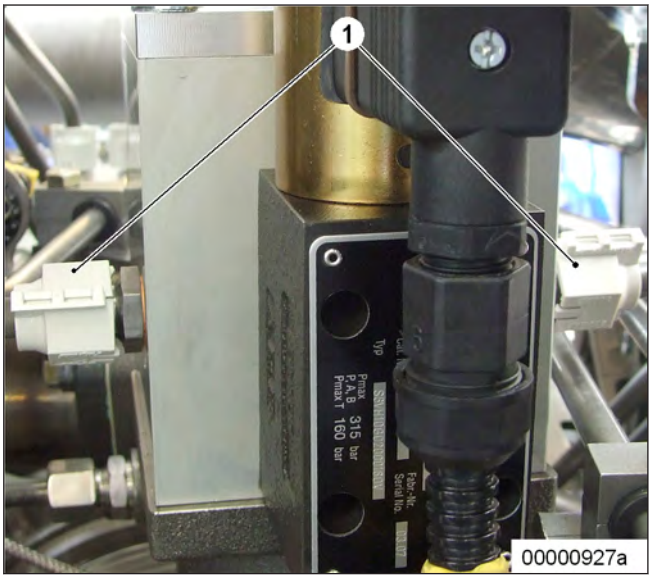
1 Oil line from main oil gallery
2 Oil line to main oil gallery



1 Flap control distributor



1 Air recirculation valve

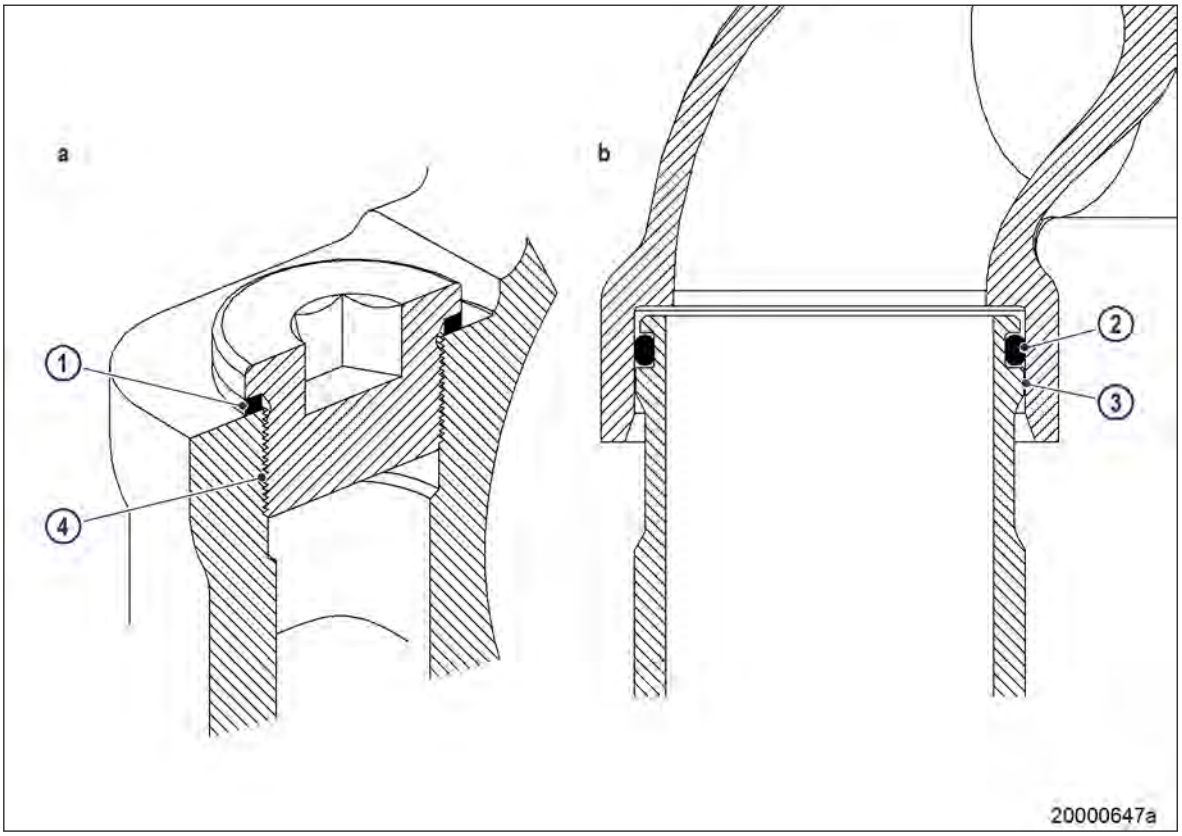


TIM-ID: 0000010056 - 005

Special connections

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

Plugs and sensors, plug-in pipe connections



Plugs and sensors (a)

Screw plugs (4) are either sealed with copper sealing rings (1) as per DIN or O-rings (ISO).

The fluid must first pass the thread in case of a loose threaded union or faulty sealing ring (1).

The pressure is so greatly reduced by this and the faulty sealing ring (1) that any leakage is not under pressure.

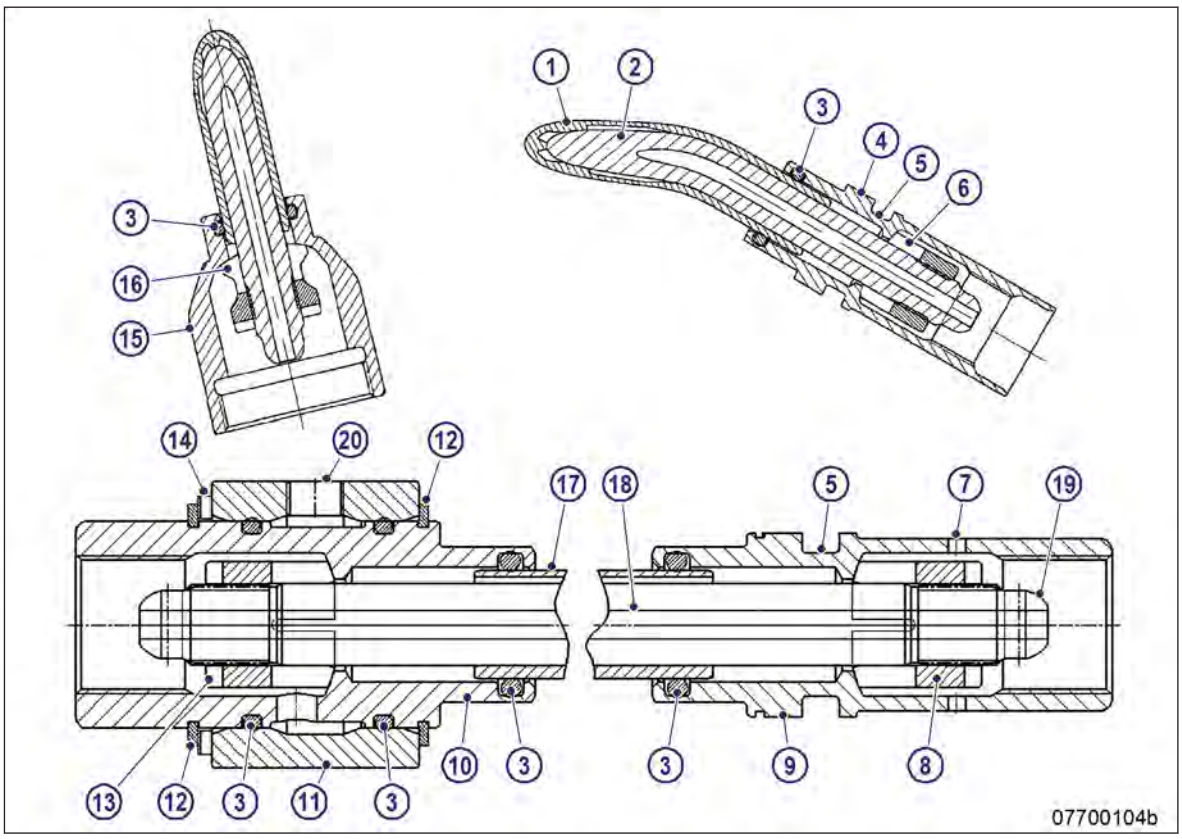
Plug-in pipe connection (b)

Design precludes lateral spray as the point of separation is shielded by the sleeve (3).

Only seepage along the pipeline is possible whereby the pressure is greatly reduced by a faulty O-ring (2).

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

High-pressure unions



1 Jacketed 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 Shims
15 Union nut
16 Thrust ring
17 Outer tube of HP fuel line
18 Internal tube of HP fuel line
19 Ball-type seal area
20 Leak fuel connection

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

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

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

This prevents leaking fuel from escaping.

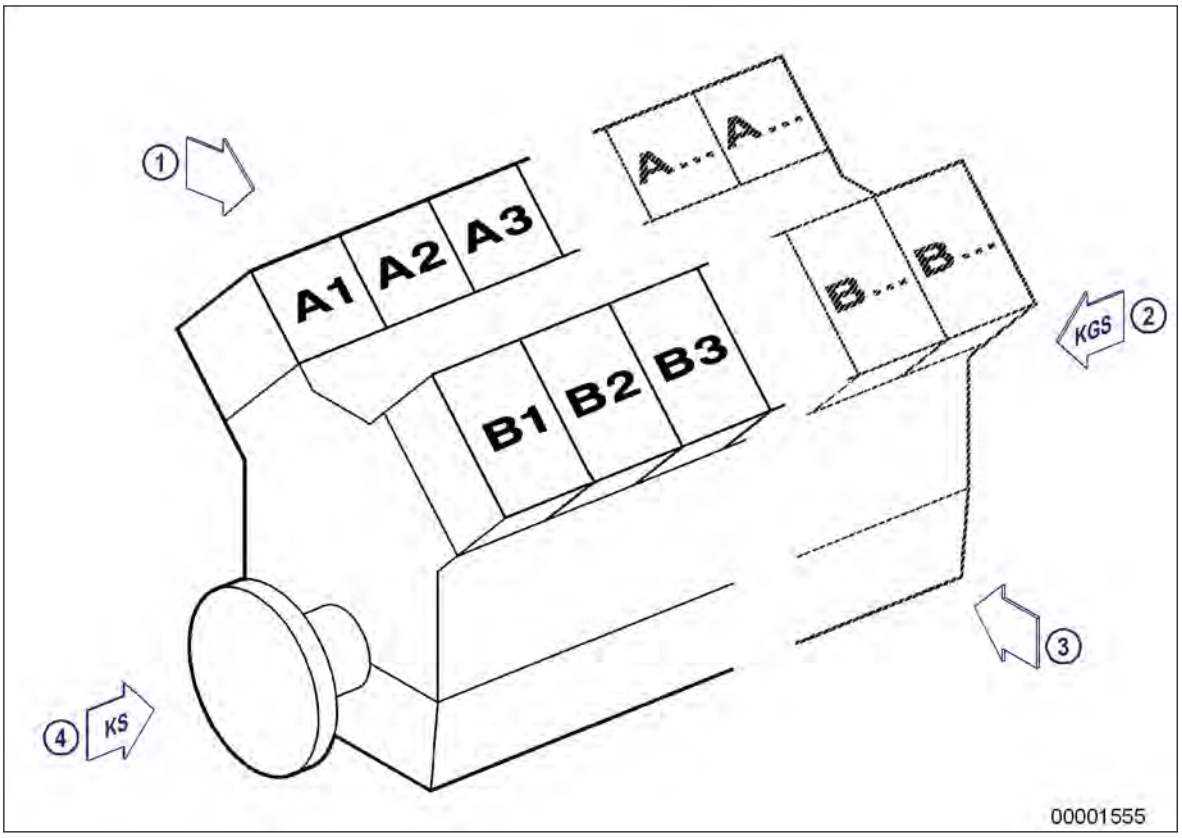
The union is confirmed as being SOLAS-compliant by DNV and GL.

2.3 Engine side and cylinder designations

Engine sides are always designated as viewed from the driving end (KS) (4).

For designation of the cylinders (to DIN ISO 1204) the letter "A" (1) is used to refer to the cylinders on the left-hand side of the engine and the letter "B" (3) to refer to the cylinders on the right-hand side. The cylinders of each bank are numbered consecutively, starting with No. 1 at the driving end.

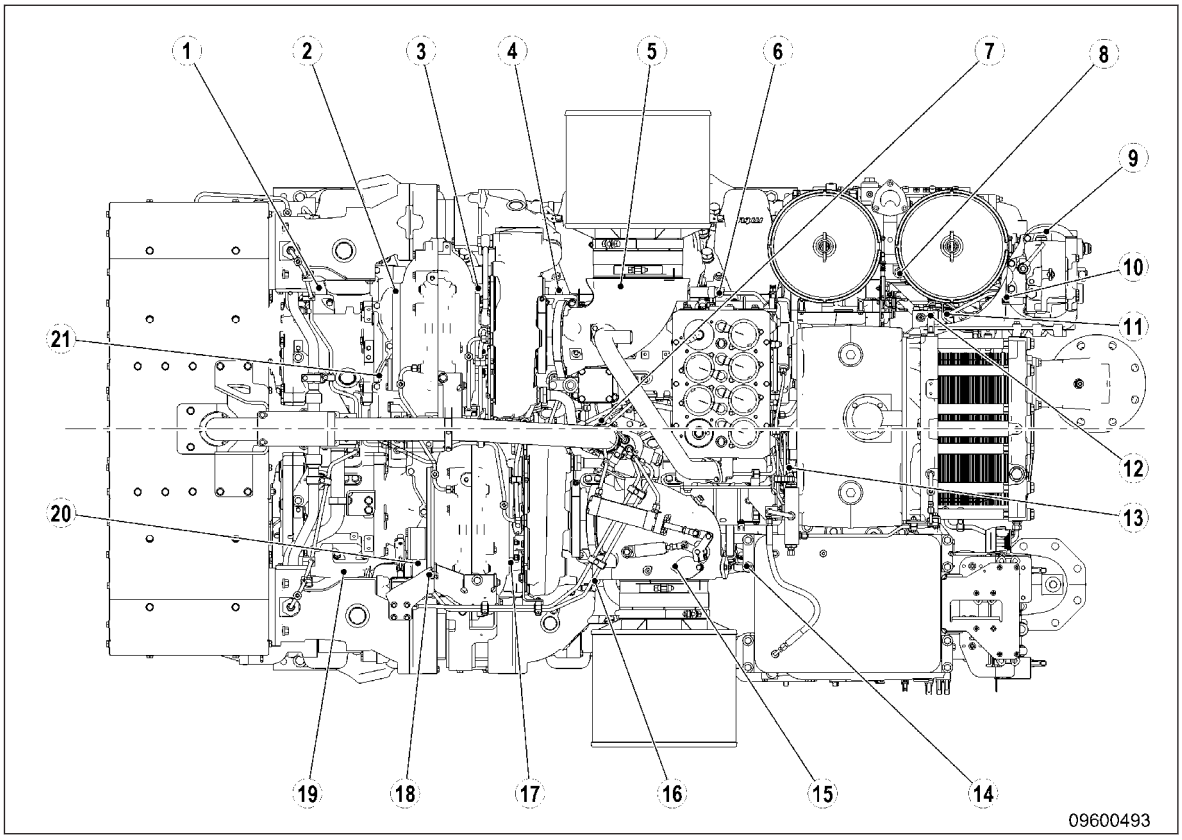
The numbering of other engine components also starts with no. 1 at the driving end.



1 Left-hand side of engine
2 Free end
3 Right-hand side of engine
4 Driving end

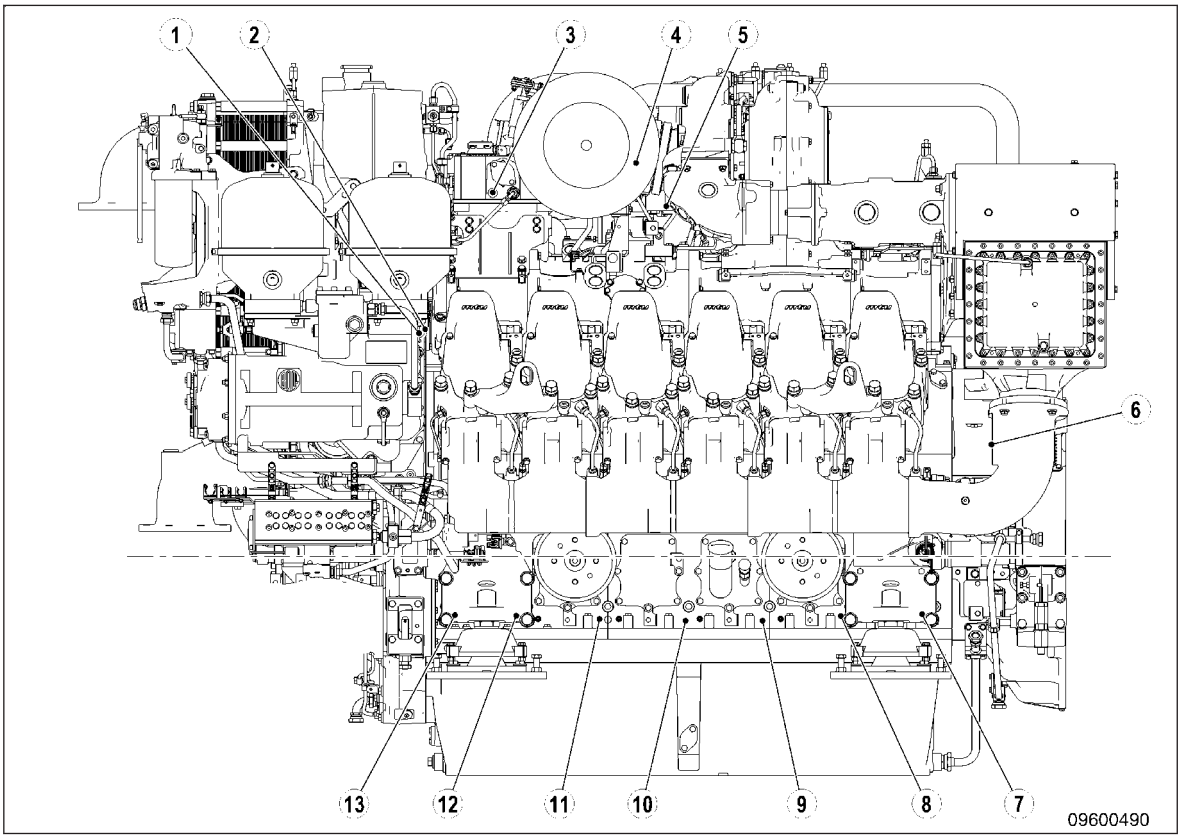
2.4 Sensors and actuators – Overview

12V 4000 M top view



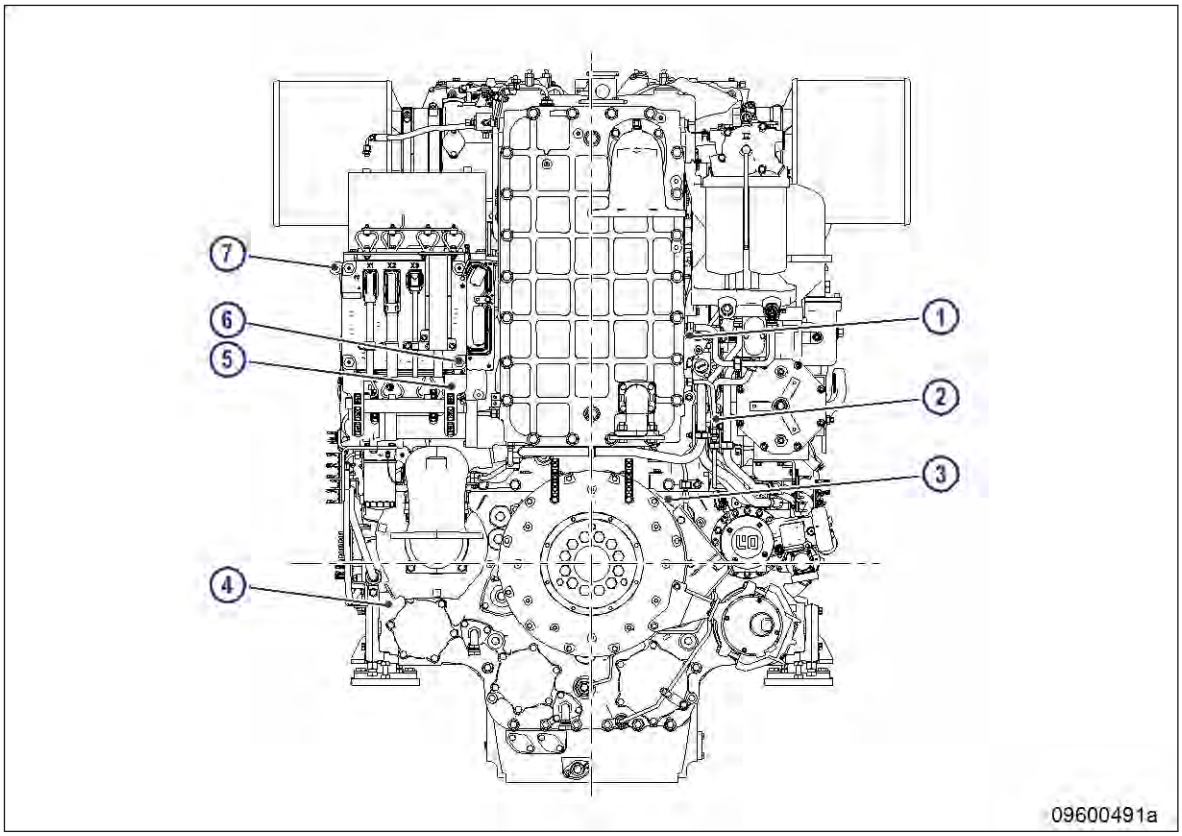
1 B4.A1 (exhaust temp. cyl. A1)
2 B4.A2 (exhaust temp. cyl. A2)
3 B4.A3 (exhaust temp. cyl. A3)
4 B4.A4 (exhaust temp. cyl. A4)
5 B4.A5 (exhaust temp. cyl. A5)
6 B4.A6 (exhaust temp. cyl. A6)
7 B49 (charge-air temp., air recirculation valve)
8 B5.2 (lube oil pressure after filter)
9 B34.2 (fuel pressure before filter)
10 B34.1 (fuel pressure after filter)
11 B5.3 (lube oil pressure before filter)
12 B48 (fuel pressure in common rail)
13 F33 (coolant level)
14 B4.B6 (exhaust temp. cyl. B6)
15 B4.B5 (exhaust temp. cyl. B5)
16 B4.B4 (exhaust temp. cyl. B4)
17 B4.B3 (exhaust temp. cyl. B3)
18 B4.B2 (exhaust temp. cyl. B2)
19 B4.B1 (exhaust temp. cyl. B1)
20 B4.22 (exhaust temperature, B bank)
21 B4.21 (exhaust temperature, A bank)

12V 4000 M left side



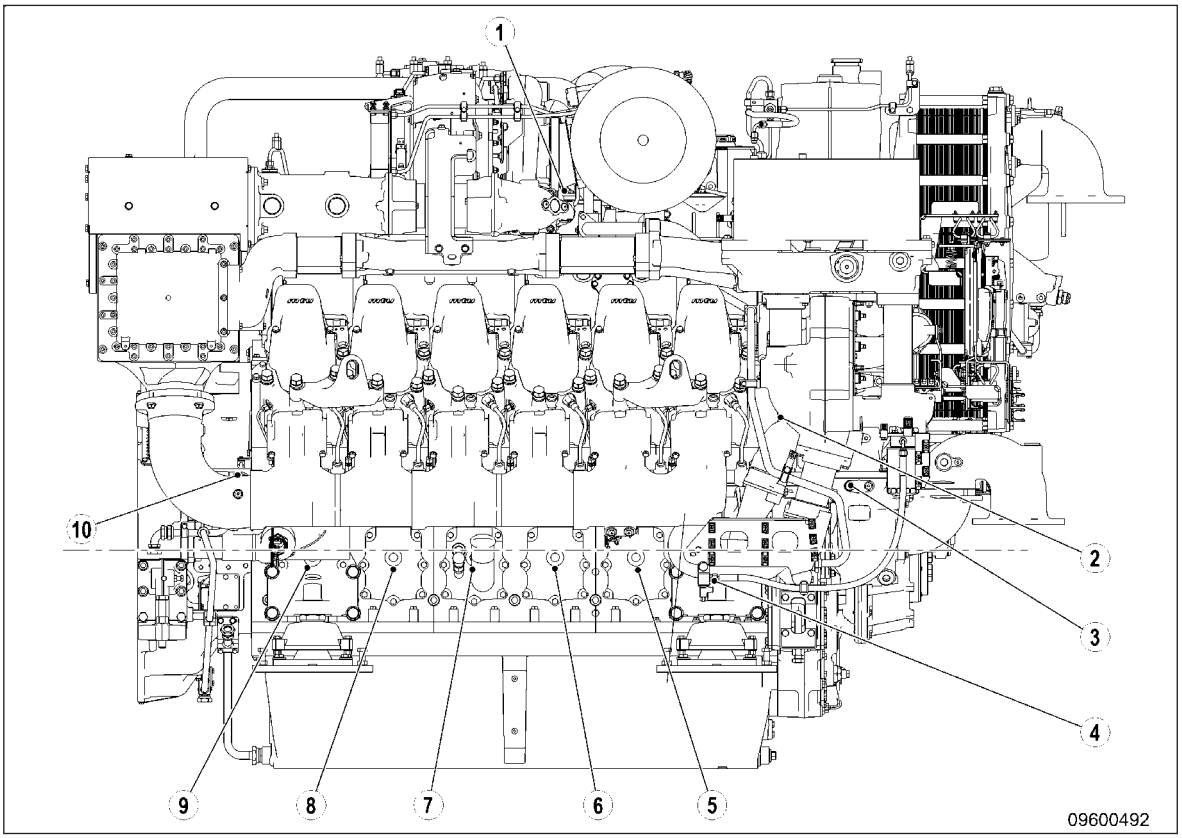
1 B5.1 (lube-oil pressure after filter)
2 B7 (lube oil temperature)
3 B50 (crankcase pressure)
4 B3 (intake air temperature)
5 B44.1 (turbocharger A speed)
6 B10 (charge-air pressure)
7 B57.1 (main bearing temp.)
8 B57.2 (main bearing temp.)
9 B57.3 (main bearing temp.)
10 B57.4 (main bearing temp.)
11 B57.5 (main bearing temp.)
12 B57.6 (main bearing temp.)
13 B57.7 (main bearing temp.)

12V 4000 M free end



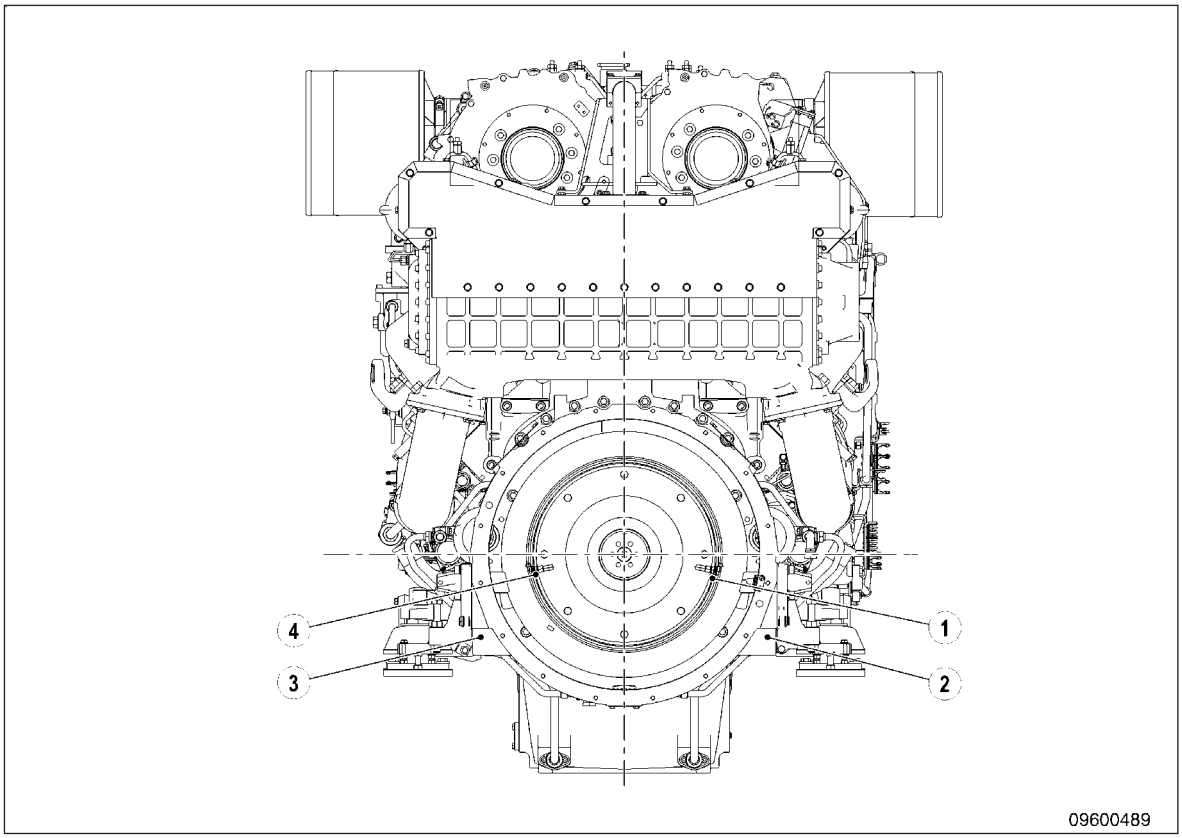
1 F46 (H-Fuel leakage)
2 B33 (T-Fuel, rail)
3 B1 (N-Camshaft)
4 B54 (P-Oil refill pump)
5 B6.2 (T-Coolant)
6 B6 (T-Coolant)
7 Connector XD1 – Dialog unit

12V 4000 M right side



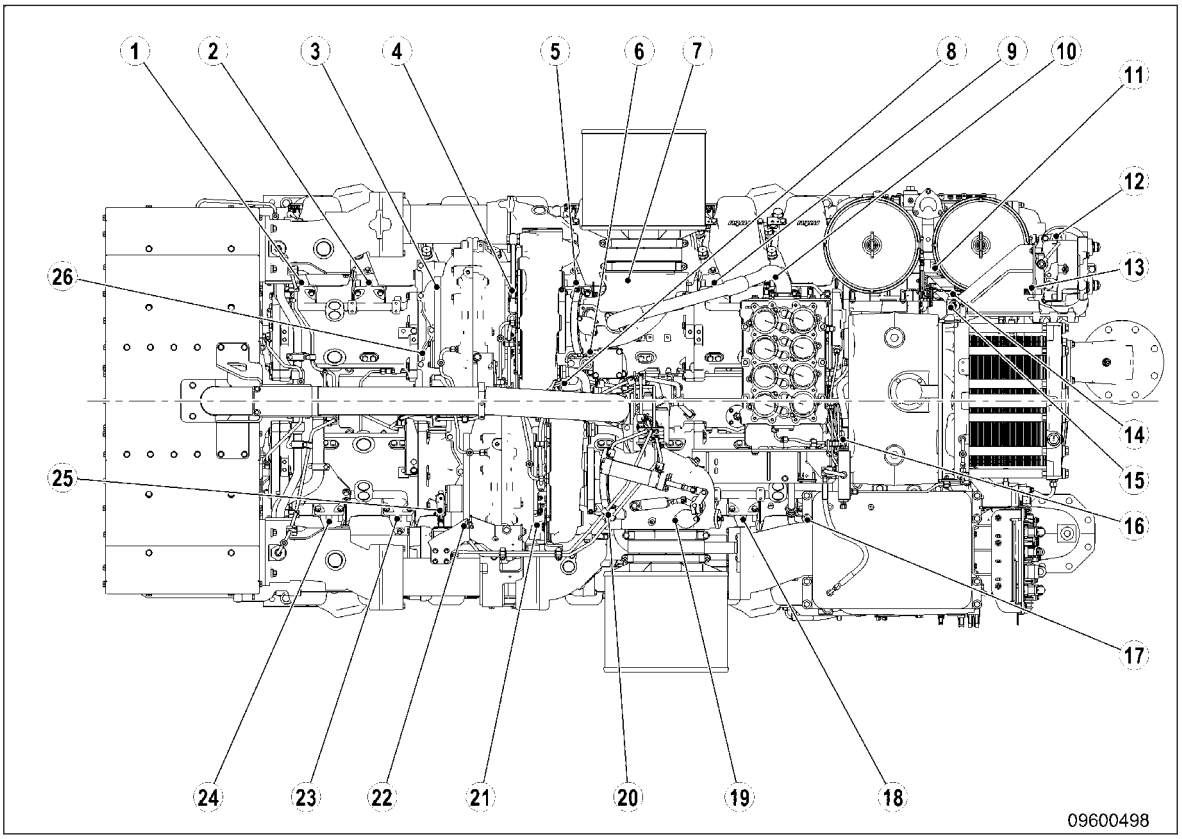
1 B44.2 (turbocharger B speed)
2 B16 (coolant pressure)
3 B21 (raw water pressure)
4 B77.B6 (spray oil temp. (conrod bearing)
5 B77.B5 (spray oil temp. (conrod bearing)
6 B77.B4 (spray oil temp. (conrod bearing)
7 B77.B3 (spray oil temp. (conrod bearing)
8 B77.B2 (spray oil temp. (conrod bearing)
9 B77.B1 (spray oil temp. (conrod bearing)
10 B9 (charge-air temperature)

12 V 4000 M driving end



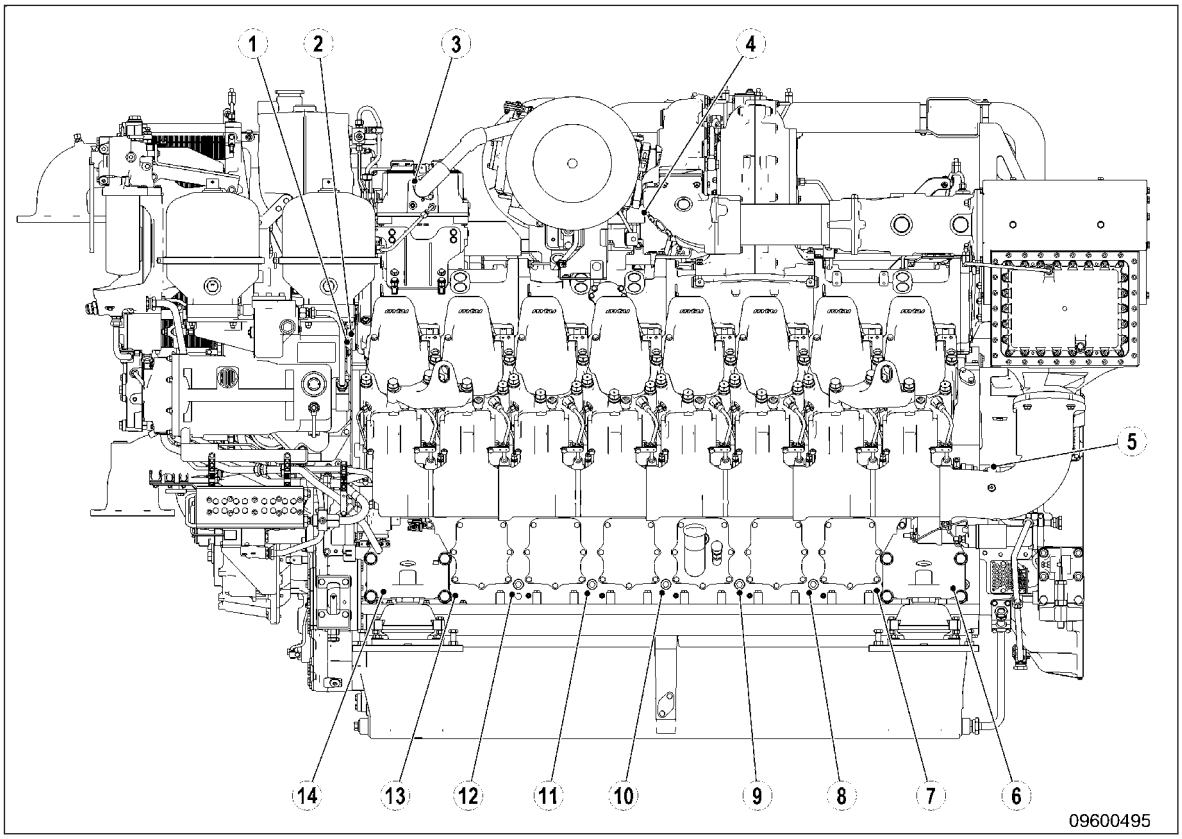
1 B13 (crankshaft speed)
2 S37.2 (safety switch)
3 S37.1 (safety switch)
4 B13.2 (crankshaft speed)

16V 4000 M top view



1 B4.A1 (exhaust temp. cyl. A1)
2 B4.A2 (exhaust temp. cyl. A2)
3 B4.A3 (exhaust temp. cyl. A3)
4 B4.A4 (exhaust temp. cyl. A4)
5 B4.A5 (exhaust temp. cyl. A5)
6 B3 (intake air temperature)
7 B4.A6 (exhaust temp. cyl. A6)
8 B49 (charge-air temp., air recirculation valve)
9 B4.A7 (exhaust temp. cyl. A7)
10 B4.A8 (exhaust temp. cyl. A8)
11 B5.2 (P lube oil downstream of filter)
12 B34.2 (fuel pressure before filter)
13 B34.1 (fuel pressure after filter)
14 B5.3 (lube oil pressure before filter)
15 B48 (fuel pressure in common rail)
16 F33 (coolant level)
17 B4.B8 (exhaust temp. cyl. B8)
18 B4.B7 (exhaust temp. cyl. B7)
19 B4.B6 (exhaust temp. cyl. B6)
20 B4.B5 (exhaust temp. cyl. B5)
21 B4.B4 (exhaust temp. cyl. B4)
22 B4.B3 (exhaust temp. cyl. B3)
23 B4.B2 (exhaust temp. cyl. B2)
24 B4.B1 (exhaust temp. cyl. B1)
25 B4.22 (exhaust temperature, B bank)
26 B4.21 (exhaust temperature, A bank)

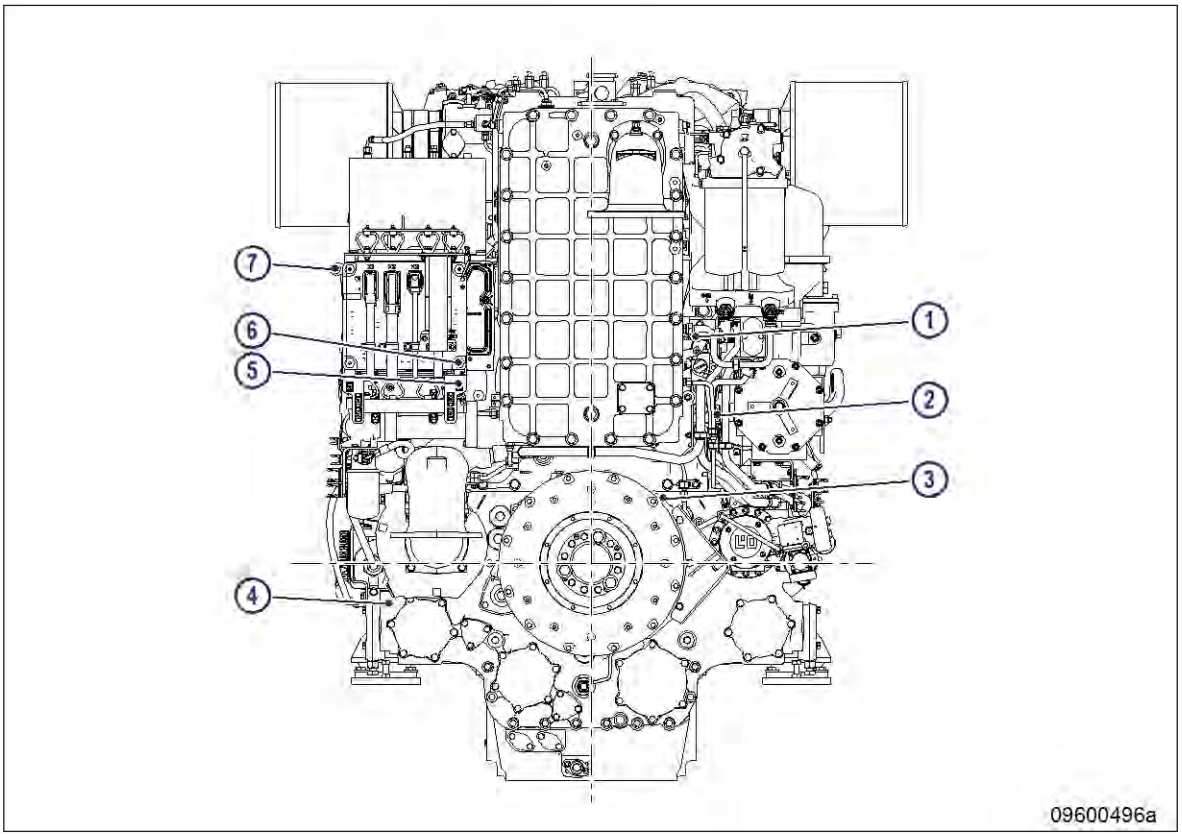
16V 4000 M left side



1 B5.1 (lube-oil pressure after filter)
2 B7 (lube oil temperature)
3 B50 (crankcase pressure)
4 B44.1 (turbocharger A speed)
5 B10 (charge-air pressure)
6 B57.1 (main bearing temp.)
7 B57.2 (main bearing temp.)
8 B57.3 (main bearing temp.)
9 B57.4 (main bearing temp.)
10 B57.5 (main bearing temp.)
11 B57.6 (main bearing temp.)
12 B57.7 (main bearing temp.)
13 B57.8 (main bearing temp.)
14 B57.9 (main bearing temp.)

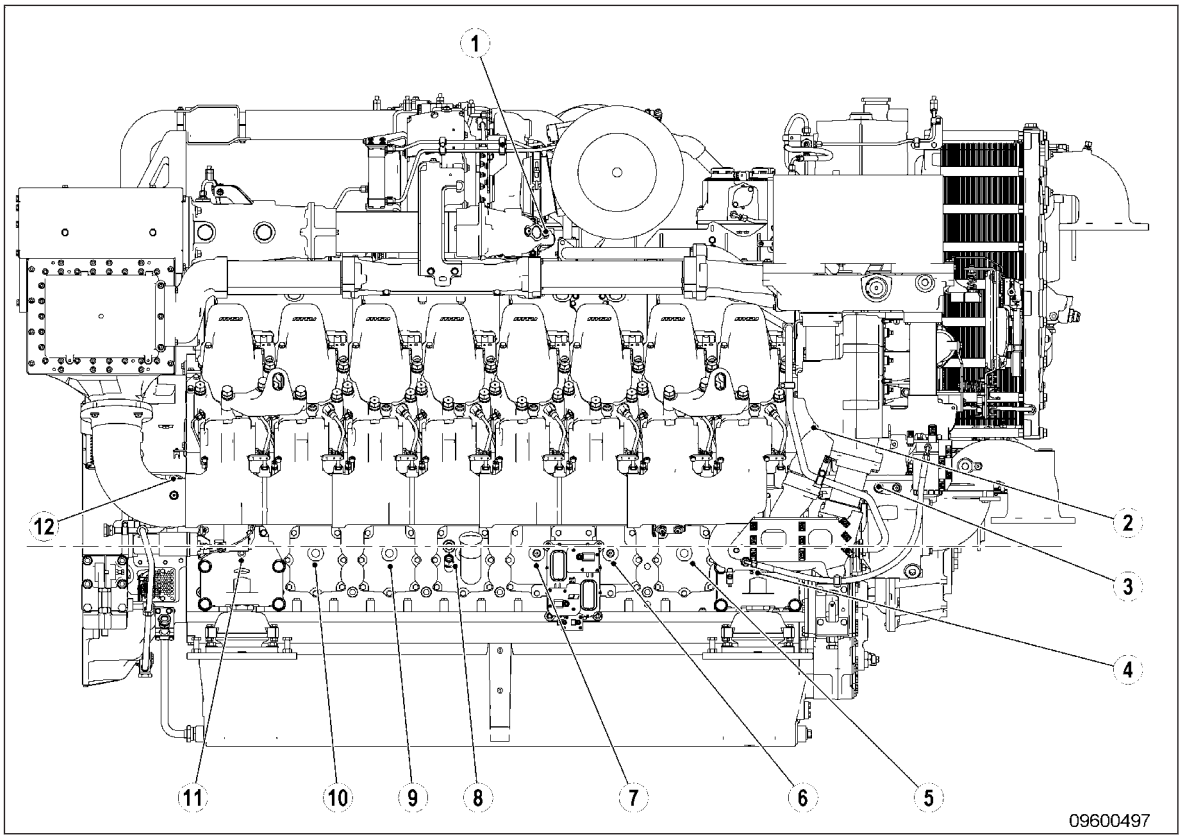
TIM-ID: 0000032308 - 003

16V 4000 M free end



1 F46 (H-Fuel leakage)
2 B33 (T-Fuel, rail)
3 B1 (N-Camshaft)
4 B54 (P-Oil refill pump)
5 B6.2 (T-Coolant)
6 B6 (T-Coolant)
7 Connector XD1 – Dialog unit

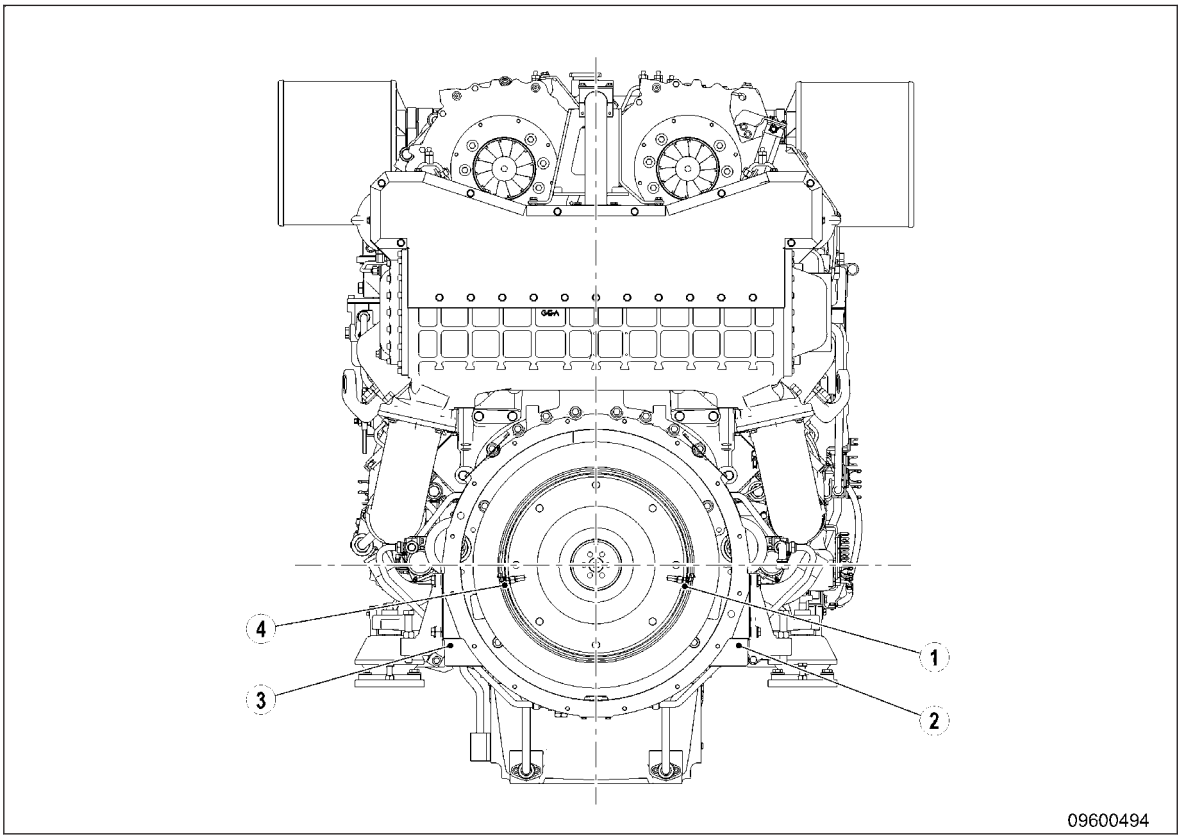
16V 4000 M right side



1 B44.2 (turbocharger B speed)
2 B16 (coolant pressure)
3 B21 (raw water pressure)
4 B77.B8 (spray oil temp. (conrod bearing)
5 B77.B7 (spray oil temp. (conrod bearing)
6 B77.B6 (spray oil temp. (conrod bearing)
7 B77.B5 (spray oil temp. (conrod bearing)
8 B77.B4 (spray oil temp. (conrod bearing)
9 B77.B3 (spray oil temp. (conrod bearing)
10 B77.B2 (spray oil temp. (conrod bearing)
11 B77.B1 (spray oil temp. (conrod bearing)
12 B9 (charge-air temperature)

TIM-ID: 0000032308 - 003

16V 4000 M driving end



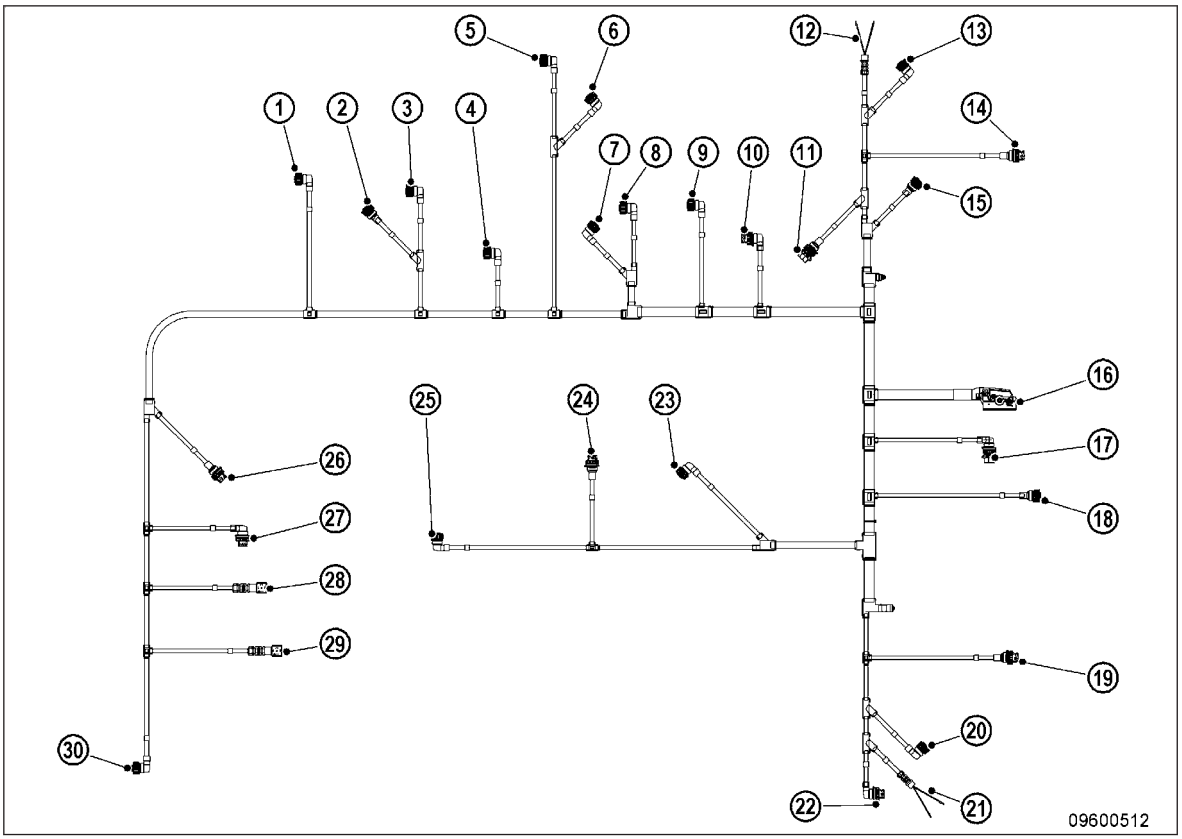
1 B13 (crankshaft speed)
2 S37.2 (safety switch)
3 S37.1 (safety switch)
4 B13.2 (crankshaft speed)

2.5 Engine wiring harness – Overview

Designation	Pin assignment	
Engine wiring harness	X2	Governor ECU-7
	B1	Camshaft speed
	B3	Intake air temperature
	B4.21	Exhaust temperature, A side
	B4.22	Exhaust temperature, B-side
	B5.1	Lube oil pressure after filter
	B5.2	Lube oil pressure after filter
	B5.3	Lube oil pressure before filter
	B6	Coolant temperature
	B7	Lube oil temperature
	B9	Charge-air temperature
	B10	Charge-air pressure
	B13	Crankshaft speed
	B16	Coolant pressure
	B33	Fuel temperature
	B34.1	Fuel pressure after filter
	B34.2	Fuel pressure before filter
	B44.1	Exhaust turbocharger A speed
	B44.2	Exhaust turbocharger B speed
	B48	High-pressure fuel
	B49	Charge air before recirculation
	B50	Crankcase pressure
	B54	Refill pump pressure
	F33	Coolant level
	M8	Fuel pump
	F46	Leak fuel level
	S37.1	Start interlock limit switch A
	S37.2	Start interlock limit switch B
	X37	Start interlock turning
	Y26	Charge-air recirculation
	Y27	Turbocharger valve
	XG03	Generator
Engine wiring harness for injectors	X4	Governor ECU-7
	E4.X	KF thermostat heating
	Y39A1 to Y39AX	Injectors, engine side A
	Y39B1 to Y39BX	Injectors, engine side B
Adaption	X1	Engine Control Unit ECU
	X3	Engine Control Unit ECU Power

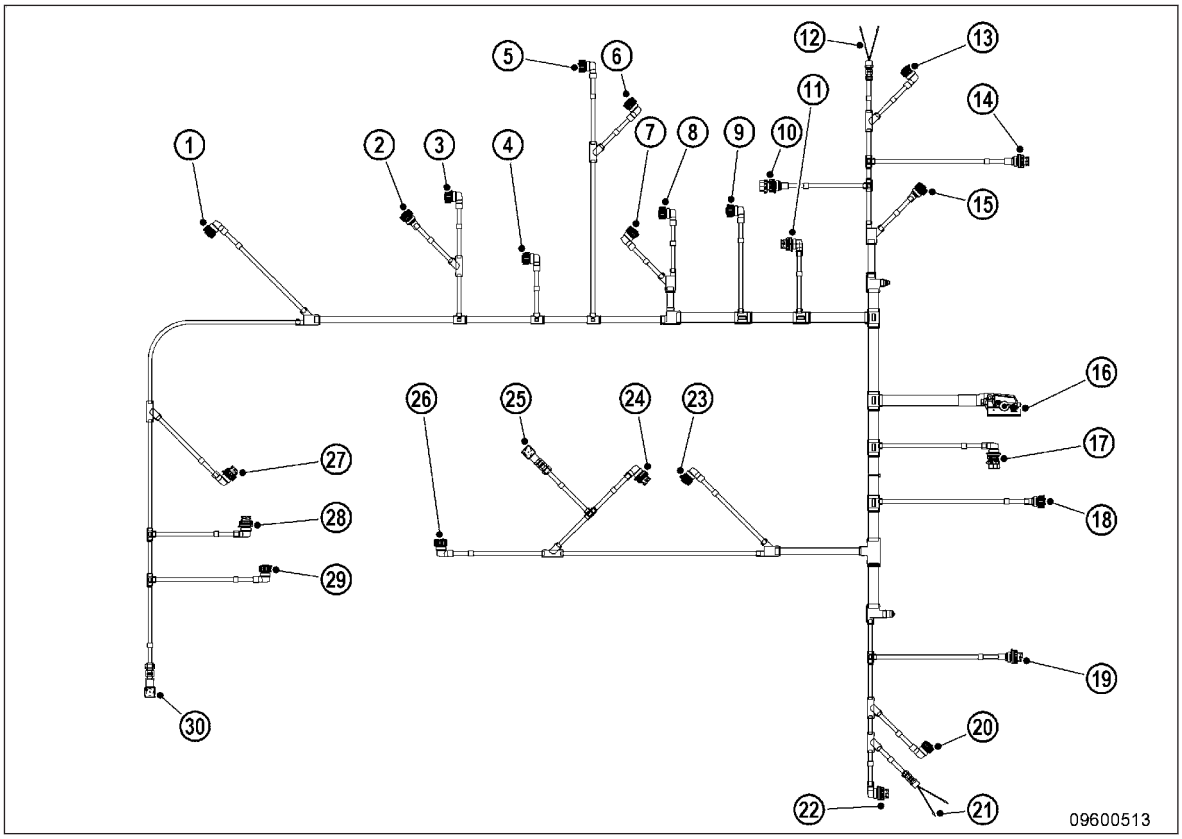
Designation	Pin assignment	
	X11	EMU Power
	X37	Start interlock
	X52	EIM engine box
	XB19	Starting-air pressure
	XD1	Dialog unit
	XY1	Starter

Engine wiring harness for sensors 12V



1 B50
2 B7
3 B5.1
4 B5.3
5 B34.2
6 B34.1
7 F46
8 B48
9 B33
10 B1
11 XG03
12 S37.1
13 B10
14 B4.21
15 M8
16 X2
17 X37
18 B6
19 B4.22
20 B9
21 S37.2
22 B13
23 B16
24 B44.2
25 F33
26 B49
27 B44.1
28 Y27
29 Y26
30 B3

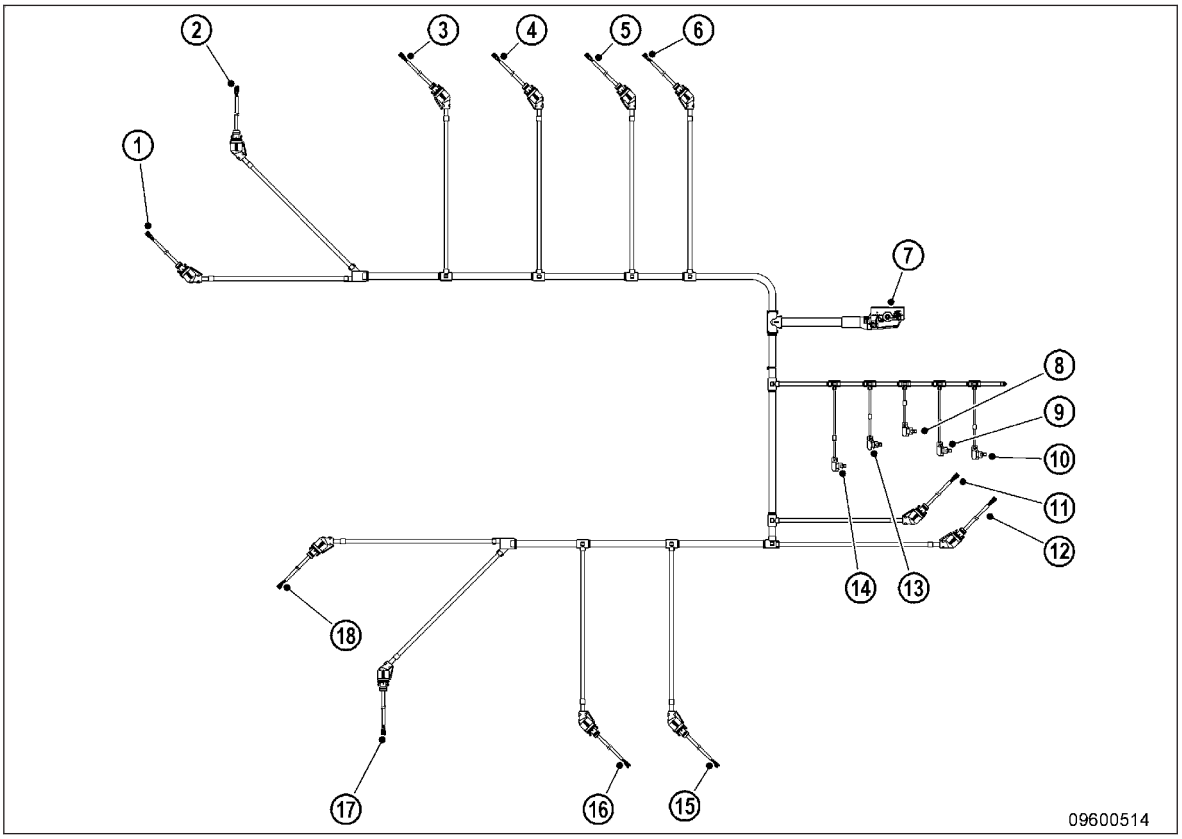
Engine wiring harness for sensors 16V



1 B50	11 B1	21 S37.2
2 B7	12 S37.1	22 B13
3 B5.1	13 B10	23 B16
4 B5.3	14 B4.21	24 B44.2
5 B34.2	15 M8	25 Y27
6 B34.1	16 X2	26 F33
7 F46	17 X37	27 B49
8 B48	18 B6	28 B44.1
9 B33	19 B4.22	29 B3
10 XG03	20 B9	30 Y26

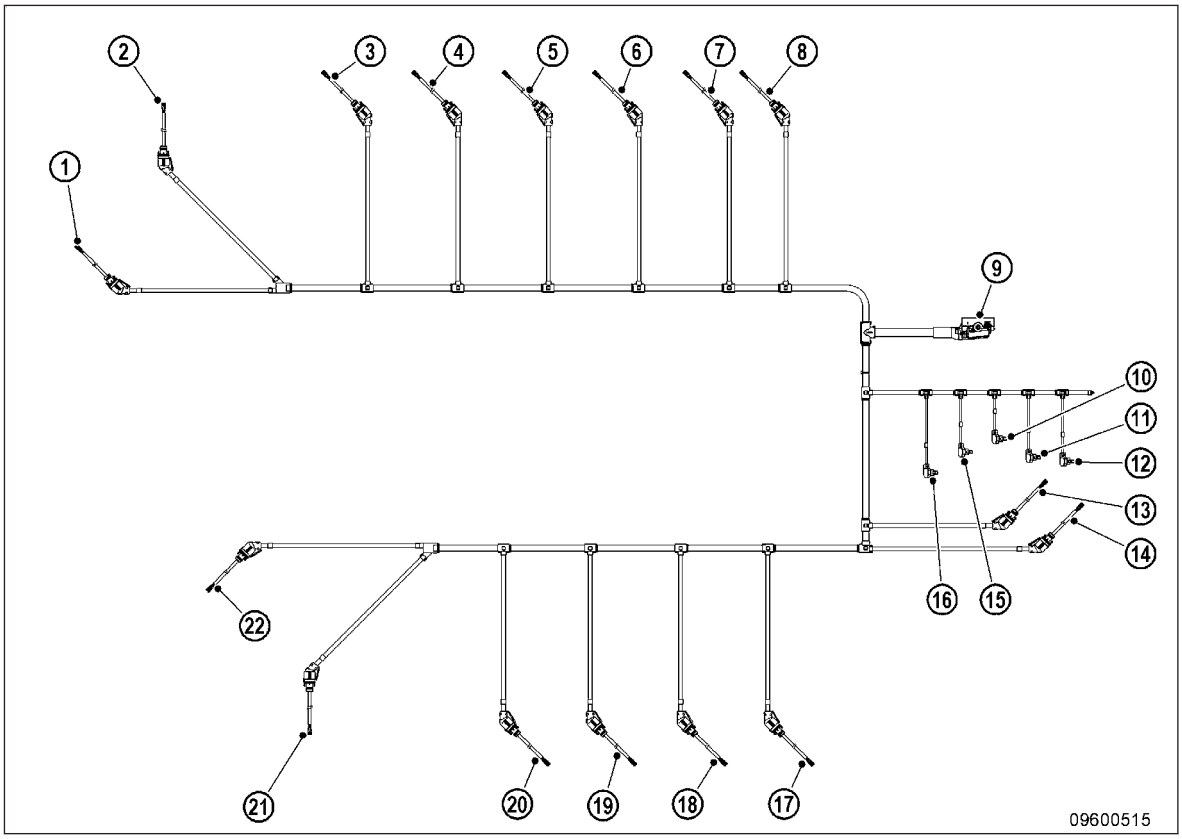
TIM-ID: 0000032681 - 002

Engine wiring harness for injectors 12V



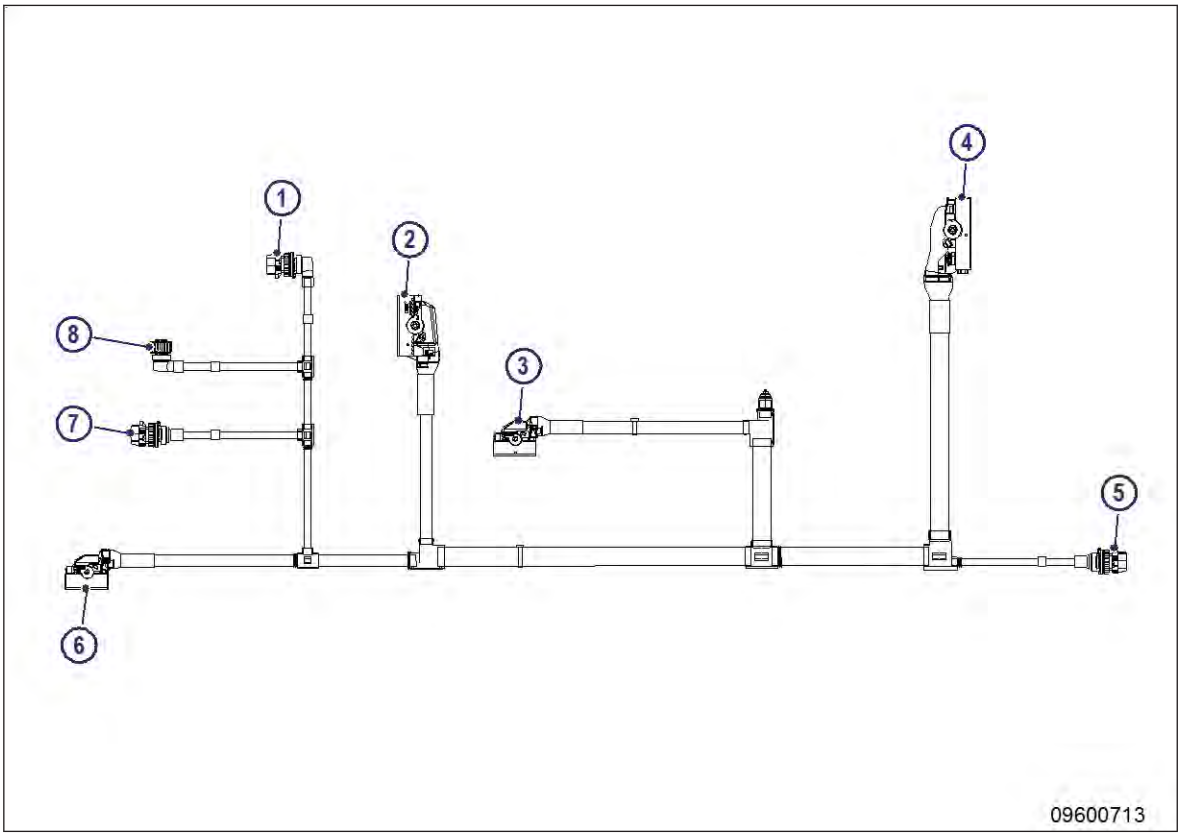
1 Y39A1	7 X4	13 E4.2
2 Y39A2	8 E4.3	14 E4.1
3 Y39A3	9 E4.4	15 Y39B4
4 Y39A4	10 E4.5	16 Y39B3
5 Y39A5	11 Y39B5	17 Y39B2
6 Y39A6	12 Y39B6	18 Y39B1

Engine wiring harness for injectors 16V



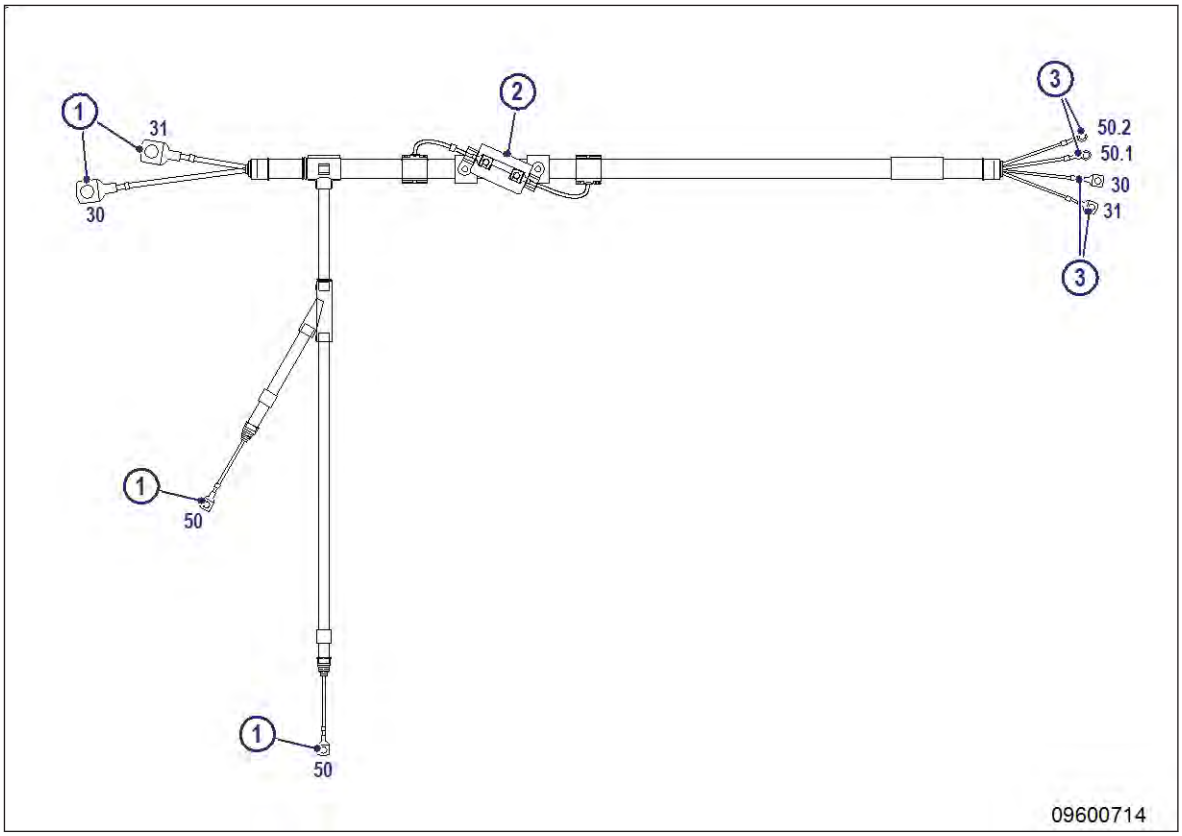
1 Y39A1
2 Y39A2
3 Y39A3
4 Y39A4
5 Y39A5
6 Y39A6
7 Y39A7
8 Y39A8
9 X4
10 E4.3
11 E4.4
12 E4.5
13 Y39B7
14 Y39B8
15 E4.2
16 E4.1
17 Y39B6
18 Y39B5
19 Y39B4
20 Y39B3
21 Y39B2
22 Y39B1

Engine wiring harness for EIM



1 XD1
2 X1
3 X3
4 X52
5 XY1
6 X11
7 XB19
8 X37

Engine wiring harness for electric starter



1 EIM terminals 2 Fuse F1 3 Starter terminals

3 Technical Data

3.1 ENGINE DATA 12V 4000M93, heat exchanger installed, EPA stage 2

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 changes (e.g. of power setting)
N Not yet defined value
- Not applicable
X Applicable

REFERENCE CONDITIONS

Engine model			12V 4000 M93
Application group			1DS
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	2100
Fuel stop power ISO 3046	A	kW	2340

GENERAL CONDITIONS (for maximum power)

Number of cylinders			12
Intake depression (new filter)	A	mbar	15
Intake depression, max.	L	mbar	30

MODEL RELATED DATA (basic design)

Number of cylinders			12
Cylinder arrangement: V angle		Degrees	90
Bore		mm	170
Stroke		mm	190
Displacement per cylinder		Liters	4.31
Displacement, total		Liters	51.72
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	-0.2
Raw water pump: Inlet pressure , max.	L	bar	0.5
Pressure loss in external raw water system, max.	L	bar	0.7

LUBE OIL SYSTEM

Number of cylinders			12
Lube oil operating temperature before engine, from	R	°C	70*
Lube oil operating temperature before engine, to	R	°C	78*
Lube oil operating pressure before engine, from	R	bar	6
Lube oil operating pressure before engine, to	R	bar	8
Lube oil operating pressure, low idle (meas. point: before engine)	R	bar	2.0

FUEL SYSTEM

Number of cylinders			12
Fuel pressure at engine supply connection, min. (when engine is starting)	L	bar	-0.1
Fuel pressure at engine supply connection, min. (when engine is running)	L	bar	-0.3
Fuel pressure at engine supply connection, max. (when engine is starting)	L	bar	1.5
Fuel supply flow, max.	R	liter/min	30

GENERAL OPERATING DATA

Number of cylinders			12
Firing speed, from	R	rpm	80
Firing speed, to	R	rpm	120

STARTING (electric)

Number of cylinders			12
Starter, rated 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	8
Starting-air pressure before starter motor, max.	R	bar	10

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. drive side down (design: max. operating inclinations)	L	Degrees	22.5

Number of cylinders			12
Longitudinal inclination, continuous max., driving end up (option: max. operating inclinations)	L	Degrees	10
Transverse inclination, constant max. (option: max. operating inclinations)	L	Degrees	22.5

CAPACITIES

Number of cylinders			12
Engine coolant, engine-side (with cooler)	R	Liters	360
Engine oil on initial filling (standard oil system) (option: max. operating inclinations)	R	Liters	260
Oil change quantity, max. (standard oil system) (option: max. operating inclinations)	R	Liters	205
Oil pan capacity at dipstick mark “min.” (standard oil system) (option: max. operating inclinations)	L	Liters	160
Oil pan capacity at dipstick mark “max.” (standard oil system) (option: max. operating inclinations)	L	Liters	200

WEIGHTS / MAIN DIMENSIONS

Number of cylinders			12
Engine dry weight (with attached standard accessories, without coupling)	R	kg	8010

ACOUSTICS

Number of cylinders			12
Exhaust noise, undamped - BL (free-field sound-pressure level Lp, 1m distance, ISO 6798, +3dB(A) tolerance)	R	dB(A)	115
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798, +2dB(A) tolerance)	R	dB(A)	104

3.2 ENGINE DATA 12V 4000M93, heat exchanger installed, IMO

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 changes (e.g. of power setting)
N Not yet defined value
- Not applicable
X Applicable

REFERENCE CONDITIONS

Engine model			12V 4000 M93
Application group			1DS
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	2100
Fuel stop power ISO 3046	A	kW	2340

GENERAL CONDITIONS (for maximum power)

Number of cylinders			12
Intake depression (new filter)	A	mbar	15
Intake depression, max.	L	mbar	30

MODEL RELATED DATA (basic design)

Number of cylinders			12
Cylinder arrangement: V angle		Degrees	90
Bore		mm	170
Stroke		mm	190
Displacement per cylinder		Liters	4.31
Displacement, total		Liters	51.72
Number of inlet valves per cylinder			2
Number of exhaust valves per cylinder			2

TIM-ID: 0000010911 - 001

RAW WATER CIRCUIT (open circuit)

Number of cylinders			12
Raw water pump: Inlet pressure, min.	L	bar	-0.2
Raw water pump: Inlet pressure , max.	L	bar	0.5
Pressure loss in external raw water system, max.	L	bar	0.7

LUBE OIL SYSTEM

Number of cylinders			12
Lube oil operating temperature before engine, from	R	°C	72*
Lube oil operating temperature before engine, to	R	°C	80*
Lube oil operating pressure before engine, from	R	bar	6
Lube oil operating pressure before engine, to	R	bar	8
Lube oil operating pressure, low idle (meas. point: before engine)	R	bar	2.0

FUEL SYSTEM

Number of cylinders			12
Fuel pressure at engine supply connection, min. (when engine is starting)	L	bar	-0.1
Fuel pressure at engine supply connection, min. (when engine is running)	L	bar	-0.3
Fuel pressure at engine supply connection, max. (when engine is starting)	L	bar	1.5
Fuel supply flow, max.	R	liter/min	30

GENERAL OPERATING DATA

Number of cylinders			12
Firing speed, from	R	rpm	80
Firing speed, to	R	rpm	120

STARTING (electric)

Number of cylinders			12
Starter, rated 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	8
Starting-air pressure before starter motor, max.	R	bar	10

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. drive side down (design: max. operating inclinations)	L	Degrees	22.5

Number of cylinders			12
Longitudinal inclination, continuous max., driving end up (option: max. operating inclinations)	L	Degrees	10
Transverse inclination, constant max. (option: max. operating inclinations)	L	Degrees	22.5

CAPACITIES

Number of cylinders			12
Engine coolant, engine-side (with cooler)	R	Liters	360
Engine oil on initial filling (standard oil system) (option: max. operating inclinations)	R	Liters	260
Oil change quantity, max. (standard oil system) (option: max. operating inclinations)	R	Liters	205
Oil pan capacity at dipstick mark “min.” (standard oil system) (option: max. operating inclinations)	L	Liters	160
Oil pan capacity at dipstick mark “max.” (standard oil system) (option: max. operating inclinations)	L	Liters	200

WEIGHTS / MAIN DIMENSIONS

Number of cylinders			12
Engine dry weight (with attached standard accessories, without coupling)	R	kg	8010

ACOUSTICS

Number of cylinders			12
Exhaust noise, undamped - BL (free-field sound-pressure level Lp, 1m distance, ISO 6798, +3dB(A) tolerance)	R	dB(A)	115
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798, +2dB(A) tolerance)	R	dB(A)	104

3.3 ENGINE DATA 12V 4000M93L, heat exchanger installed, EPA stage 2

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 changes (e.g. of power setting)
N Not yet defined value
- Not applicable
X Applicable

REFERENCE CONDITIONS

Engine model			12V 4000 M93L
Application group			1DS
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	2100
Fuel stop power ISO 3046	A	kW	2580

GENERAL CONDITIONS (for maximum power)

Number of cylinders			12
Intake depression (new filter)	A	mbar	15
Intake depression, max.	L	mbar	30

MODEL RELATED DATA (basic design)

Number of cylinders			12
Cylinder arrangement: V angle		Degrees	90
Bore		mm	170
Stroke		mm	190
Displacement per cylinder		Liters	4.31
Displacement, total		Liters	51.72
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	-0.2
Raw water pump: Inlet pressure , max.	L	bar	0.5
Pressure loss in external raw water system, max.	L	bar	0.7

LUBE OIL SYSTEM

Number of cylinders			12
Lube oil operating temperature before engine, from	R	°C	72*
Lube oil operating temperature before engine, to	R	°C	80*
Lube oil operating pressure before engine, from	R	bar	6
Lube oil operating pressure before engine, to	R	bar	8
Lube oil operating pressure, low idle (meas. point: before engine)	R	bar	2.0

FUEL SYSTEM

Number of cylinders			12
Fuel pressure at engine supply connection, min. (when engine is starting)	L	bar	-0.1
Fuel pressure at engine supply connection, min. (when engine is running)	L	bar	-0.3
Fuel pressure at engine supply connection, max. (when engine is starting)	L	bar	1.5
Fuel supply flow, max.	R	liter/min	30

GENERAL OPERATING DATA

Number of cylinders			12
Firing speed, from	R	rpm	80
Firing speed, to	R	rpm	120

STARTING (electric)

Number of cylinders			12
Starter, rated 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	8
Starting-air pressure before starter motor, max.	R	bar	10

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. drive side down (design: max. operating inclinations)	L	Degrees	22.5

Number of cylinders			12
Longitudinal inclination, continuous max., driving end up (option: max. operating inclinations)	L	Degrees	10
Transverse inclination, constant max. (option: max. operating inclinations)	L	Degrees	22.5

CAPACITIES

Number of cylinders			12
Engine coolant, engine-side (with cooler)	R	Liters	360
Engine oil on initial filling (standard oil system) (option: max. operating inclinations)	R	Liters	260
Oil change quantity, max. (standard oil system) (option: max. operating inclinations)	R	Liters	205
Oil pan capacity at dipstick mark “min.” (standard oil system) (option: max. operating inclinations)	L	Liters	160
Oil pan capacity at dipstick mark “max.” (standard oil system) (option: max. operating inclinations)	L	Liters	200

WEIGHTS / MAIN DIMENSIONS

Number of cylinders			12
Engine dry weight (with attached standard accessories, without coupling)	R	kg	8010

ACOUSTICS

Number of cylinders			12
Exhaust noise, undamped - BL (free-field sound-pressure level Lp, 1m distance, ISO 6798, +3dB(A) tolerance)	R	dB(A)	116
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)	105

3.4 ENGINE DATA 12V 4000M93L, heat exchanger installed, IMO

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 changes (e.g. of power setting)
N Not yet defined value
- Not applicable
X Applicable

REFERENCE CONDITIONS

Engine model			12V 4000 M93L
Application group			1DS
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	2100
Fuel stop power ISO 3046	A	kW	2580

GENERAL CONDITIONS (for maximum power)

Number of cylinders			12
Intake depression (new filter)	A	mbar	15
Intake depression, max.	L	mbar	30

MODEL RELATED DATA (basic design)

Number of cylinders			12
Cylinder arrangement: V angle		Degrees	90
Bore		mm	170
Stroke		mm	190
Displacement per cylinder		Liters	4.31
Displacement, total		Liters	51.72
Number of inlet valves per cylinder			2
Number of exhaust valves per cylinder			2

TIM-ID: 0000010940 - 001

RAW WATER CIRCUIT (open circuit)

Number of cylinders			12
Raw water pump: Inlet pressure, min.	L	bar	-0.2
Raw water pump: Inlet pressure , max.	L	bar	0.5
Pressure loss in external raw water system, max.	L	bar	0.7

LUBE OIL SYSTEM

Number of cylinders			12
Lube oil operating temperature before engine, from	R	°C	72*
Lube oil operating temperature before engine, to	R	°C	80*
Lube oil operating pressure before engine, from	R	bar	6
Lube oil operating pressure before engine, to	R	bar	8
Lube oil operating pressure, low idle (meas. point: before engine)	R	bar	2.0

FUEL SYSTEM

Number of cylinders			12
Fuel pressure at engine supply connection, min. (when engine is starting)	L	bar	-0.1
Fuel pressure at engine supply connection, min. (when engine is running)	L	bar	-0.3
Fuel pressure at engine supply connection, max. (when engine is starting)	L	bar	1.5
Fuel supply flow, max.	R	liter/min	30

GENERAL OPERATING DATA

Number of cylinders			12
Firing speed, from	R	rpm	80
Firing speed, to	R	rpm	120

STARTING (electric)

Number of cylinders			12
Starter, rated 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	8
Starting-air pressure before starter motor, max.	R	bar	10

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. drive side down (design: max. operating inclinations)	L	Degrees	22.5

Number of cylinders			12
Longitudinal inclination, continuous max., driving end up (option: max. operating inclinations)	L	Degrees	10
Transverse inclination, constant max. (option: max. operating inclinations)	L	Degrees	22.5

CAPACITIES

Number of cylinders			12
Engine coolant, engine-side (with cooler)	R	Liters	360
Engine oil on initial filling (standard oil system) (option: max. operating inclinations)	R	Liters	260
Oil change quantity, max. (standard oil system) (option: max. operating inclinations)	R	Liters	205
Oil pan capacity at dipstick mark “min.” (standard oil system) (option: max. operating inclinations)	L	Liters	160
Oil pan capacity at dipstick mark “max.” (standard oil system) (option: max. operating inclinations)	L	Liters	200

WEIGHTS / MAIN DIMENSIONS

Number of cylinders			12
Engine dry weight (with attached standard accessories, without coupling)	R	kg	8010

ACOUSTICS

Number of cylinders			12
Exhaust noise, undamped - BL (free-field sound-pressure level Lp, 1m distance, ISO 6798, +3dB(A) tolerance)	R	dB(A)	116
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)	105

3.5 ENGINE DATA 16V 4000M93, heat exchanger installed, EPA stage 2

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 changes (e.g. of power setting)
N Not yet defined value
- Not applicable
X Applicable

REFERENCE CONDITIONS

Engine model			16V 4000 M93
Application group			1DS
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	2100
Fuel stop power ISO 3046	A	kW	3120

GENERAL CONDITIONS (for maximum power)

Number of cylinders			16
Intake depression (new filter)	A	mbar	15
Intake depression, max.	L	mbar	30

MODEL RELATED DATA (basic design)

Number of cylinders			16
Cylinder arrangement: V angle		Degrees	90
Bore		mm	170
Stroke		mm	190
Displacement per cylinder		Liters	4.31
Displacement, total		Liters	68.96
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	-0.2
Raw water pump: Inlet pressure , max.	L	bar	0.5
Pressure loss in external raw water system, max.	L	bar	0.7

LUBE OIL SYSTEM

Number of cylinders			16
Lube oil operating temperature before engine, from	R	°C	72*
Lube oil operating temperature before engine, to	R	°C	80*
Lube oil operating pressure before engine, from	R	bar	6
Lube oil operating pressure before engine, to	R	bar	8
Lube oil operating pressure, low idle (meas. point: before engine)	R	bar	2.0

FUEL SYSTEM

Number of cylinders			16
Fuel pressure at engine supply connection, min. (when engine is starting)	L	bar	-0.1
Fuel pressure at engine supply connection, min. (when engine is running)	L	bar	-0.3
Fuel pressure at engine supply connection, max. (when engine is starting)	L	bar	1.5
Fuel supply flow, max.	R	liter/min	30

GENERAL OPERATING DATA

Number of cylinders			16
Firing speed, from	R	rpm	80
Firing speed, to	R	rpm	120

STARTING (electric)

Number of cylinders			16
Starter, rated 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	8
Starting-air pressure before starter motor, max.	R	bar	10

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. drive side down (design: max. operating inclinations)	L	Degrees	22.5

Number of cylinders			16
Longitudinal inclination, continuous max., driving end up (option: max. operating inclinations)	L	Degrees	10
Transverse inclination, constant max. (option: max. operating inclinations)	L	Degrees	22.5

CAPACITIES

Number of cylinders			16
Engine coolant, engine-side (with cooler)	R	Liters	540
Engine oil on initial filling (standard oil system) (option: max. operating inclinations)	R	Liters	320
Oil change quantity, max. (standard oil system) (option: max. operating inclinations)	R	Liters	270
Oil pan capacity at dipstick mark “min.” (standard oil system) (option: max. operating inclinations)	L	Liters	215
Oil pan capacity at dipstick mark “max.” (standard oil system) (option: max. operating inclinations)	L	Liters	260

WEIGHTS / MAIN DIMENSIONS

Number of cylinders			16
Engine dry weight (with attached standard accessories, without coupling)	R	kg	9600

ACOUSTICS

Number of cylinders			16
Exhaust noise, undamped - BL (free-field sound-pressure level Lp, 1m distance, ISO 6798, +3dB(A) tolerance)	R	dB(A)	116
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)	105

3.6 ENGINE DATA 16V 4000M93, heat exchanger installed, IMO

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 changes (e.g. of power setting)
N Not yet defined value
- Not applicable
X Applicable

REFERENCE CONDITIONS

Engine model			16V 4000 M93
Application group			1DS
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	2100
Fuel stop power ISO 3046	A	kW	3120

GENERAL CONDITIONS (for maximum power)

Number of cylinders			16
Intake depression (new filter)	A	mbar	15
Intake depression, max.	L	mbar	30

MODEL RELATED DATA (basic design)

Number of cylinders			16
Cylinder arrangement: V angle		Degrees	90
Bore		mm	170
Stroke		mm	190
Displacement per cylinder		Liters	4.31
Displacement, total		Liters	68.96
Number of inlet valves per cylinder			2
Number of exhaust valves per cylinder			2

TIM-ID: 0000010963 - 002

RAW WATER CIRCUIT (open circuit)

Number of cylinders			16
Raw water pump: Inlet pressure, min.	L	bar	-0.2
Raw water pump: Inlet pressure , max.	L	bar	0.5
Pressure loss in external raw water system, max.	L	bar	0.7

LUBE OIL SYSTEM

Number of cylinders			16
Lube oil operating temperature before engine, from	R	°C	72*
Lube oil operating temperature before engine, to	R	°C	80*
Lube oil operating pressure before engine, from	R	bar	6
Lube oil operating pressure before engine, to	R	bar	8
Lube oil operating pressure, low idle (meas. point: before engine)	R	bar	2.0

FUEL SYSTEM

Number of cylinders			16
Fuel pressure at engine supply connection, min. (when engine is starting)	L	bar	-0.1
Fuel pressure at engine supply connection, min. (when engine is running)	L	bar	-0.3
Fuel pressure at engine supply connection, max. (when engine is starting)	L	bar	1.5
Fuel supply flow, max.	R	liter/min	30

GENERAL OPERATING DATA

Number of cylinders			16
Firing speed, from	R	rpm	80
Firing speed, to	R	rpm	120

STARTING (electric)

Number of cylinders			16
Starter, rated 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	8
Starting-air pressure before starter motor, max.	R	bar	10

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. drive side down (design: max. operating inclinations)	L	Degrees	22.5

Number of cylinders			16
Longitudinal inclination, continuous max., driving end up (option: max. operating inclinations)	L	Degrees	10
Transverse inclination, constant max. (option: max. operating inclinations)	L	Degrees	22.5

CAPACITIES

Number of cylinders			16
Engine coolant, engine-side (with cooler)	R	Liters	540
Engine oil on initial filling (standard oil system) (option: max. operating inclinations)	R	Liters	320
Oil change quantity, max. (standard oil system) (option: max. operating inclinations)	R	Liters	270
Oil pan capacity at dipstick mark “min.” (standard oil system) (option: max. operating inclinations)	L	Liters	215
Oil pan capacity at dipstick mark “max.” (standard oil system) (option: max. operating inclinations)	L	Liters	260

WEIGHTS / MAIN DIMENSIONS

Number of cylinders			16
Engine dry weight (with attached standard accessories, without coupling)	R	kg	9600

ACOUSTICS

Number of cylinders			16
Exhaust noise, undamped - BL (free-field sound-pressure level Lp, 1m distance, ISO 6798, +3dB(A) tolerance)	R	dB(A)	116
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)	105

3.7 ENGINE DATA 16V 4000M93L, heat exchanger installed, EPA stage 2

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 changes (e.g. of power setting)
N Not yet defined value
- Not applicable
X Applicable

REFERENCE CONDITIONS

Engine model			16V 4000 M93L
Application group			1DS
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	2100
Fuel stop power ISO 3046	A	kW	3440

GENERAL CONDITIONS (for maximum power)

Number of cylinders			16
Intake depression (new filter)	A	mbar	15
Intake depression, max.	L	mbar	30

MODEL RELATED DATA (basic design)

Number of cylinders			16
Cylinder arrangement: V angle		Degrees	90
Bore		mm	170
Stroke		mm	190
Displacement per cylinder		Liters	4.31
Displacement, total		Liters	68.96
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	-0.2
Raw water pump: Inlet pressure , max.	L	bar	0.5
Pressure loss in external raw water system, max.	L	bar	0.7

LUBE OIL SYSTEM

Number of cylinders			16
Lube oil operating temperature before engine, from	R	°C	72*
Lube oil operating temperature before engine, to	R	°C	80*
Lube oil operating pressure before engine, from	R	bar	6
Lube oil operating pressure before engine, to	R	bar	8
Lube oil operating pressure, low idle (meas. point: before engine)	R	bar	2.0

FUEL SYSTEM

Number of cylinders			16
Fuel pressure at engine supply connection, min. (when engine is starting)	L	bar	-0.1
Fuel pressure at engine supply connection, min. (when engine is running)	L	bar	-0.3
Fuel pressure at engine supply connection, max. (when engine is starting)	L	bar	1.5
Fuel supply flow, max.	R	liter/min	30

GENERAL OPERATING DATA

Number of cylinders			16
Firing speed, from	R	rpm	80
Firing speed, to	R	rpm	120

STARTING (electric)

Number of cylinders			16
Starter, rated 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	8
Starting-air pressure before starter motor, max.	R	bar	10

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. drive side down (design: max. operating inclinations)	L	Degrees	22.5

Number of cylinders			16
Longitudinal inclination, continuous max., driving end up (option: max. operating inclinations)	L	Degrees	10
Transverse inclination, constant max. (option: max. operating inclinations)	L	Degrees	22.5

CAPACITIES

Number of cylinders			16
Engine coolant, engine-side (with cooler)	R	Liters	540
Engine oil on initial filling (standard oil system) (option: max. operating inclinations)	R	Liters	320
Oil change quantity, max. (standard oil system) (option: max. operating inclinations)	R	Liters	270
Oil pan capacity at dipstick mark “min.” (standard oil system) (option: max. operating inclinations)	L	Liters	215
Oil pan capacity at dipstick mark “max.” (standard oil system) (option: max. operating inclinations)	L	Liters	260

WEIGHTS / MAIN DIMENSIONS

Number of cylinders			16
Engine dry weight (with attached standard accessories, without coupling)	R	kg	9600

ACOUSTICS

Number of cylinders			16
Exhaust noise, undamped - BL (free-field sound-pressure level Lp, 1m distance, ISO 6798, +3dB(A) tolerance)	R	dB(A)	117
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

3.8 ENGINE DATA 16V 4000M93L, heat exchanger installed, IMO

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 changes (e.g. of power setting)
N Not yet defined value
- Not applicable
X Applicable

REFERENCE CONDITIONS

Engine model			16V 4000 M93L
Application group			1DS
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	2100
Fuel stop power ISO 3046	A	kW	3440

GENERAL CONDITIONS (for maximum power)

Number of cylinders			16
Intake depression (new filter)	A	mbar	15
Intake depression, max.	L	mbar	30

MODEL RELATED DATA (basic design)

Number of cylinders			16
Cylinder arrangement: V angle		Degrees	90
Bore		mm	170
Stroke		mm	190
Displacement per cylinder		Liters	4.31
Displacement, total		Liters	68.96
Number of inlet valves per cylinder			2
Number of exhaust valves per cylinder			2

TIM-ID: 0000010978 - 002

RAW WATER CIRCUIT (open circuit)

Number of cylinders			16
Raw water pump: Inlet pressure, min.	L	bar	-0.2
Raw water pump: Inlet pressure , max.	L	bar	0.5
Pressure loss in external raw water system, max.	L	bar	0.7

LUBE OIL SYSTEM

Number of cylinders			16
Lube oil operating temperature before engine, from	R	°C	72*
Lube oil operating temperature before engine, to	R	°C	80*
Lube oil operating pressure before engine, from	R	bar	6
Lube oil operating pressure before engine, to	R	bar	8
Lube oil operating pressure, low idle (meas. point: before engine)	R	bar	2.0

FUEL SYSTEM

Number of cylinders			16
Fuel pressure at engine supply connection, min. (when engine is starting)	L	bar	-0.1
Fuel pressure at engine supply connection, min. (when engine is running)	L	bar	-0.3
Fuel pressure at engine supply connection, max. (when engine is starting)	L	bar	1.5
Fuel supply flow, max.	R	liter/min	30

GENERAL OPERATING DATA

Number of cylinders			16
Firing speed, from	R	rpm	80
Firing speed, to	R	rpm	120

STARTING (electric)

Number of cylinders			16
Starter, rated 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	8
Starting-air pressure before starter motor, max.	R	bar	10

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. drive side down (design: max. operating inclinations)	L	Degrees	22.5

Number of cylinders			16
Longitudinal inclination, continuous max., driving end up (option: max. operating inclinations)	L	Degrees	10
Transverse inclination, constant max. (option: max. operating inclinations)	L	Degrees	22.5

CAPACITIES

Number of cylinders			16
Engine coolant, engine-side (with cooler)	R	Liters	540
Engine oil on initial filling (standard oil system) (option: max. operating inclinations)	R	Liters	320
Oil change quantity, max. (standard oil system) (option: max. operating inclinations)	R	Liters	270
Oil pan capacity at dipstick mark “min.” (standard oil system) (option: max. operating inclinations)	L	Liters	215
Oil pan capacity at dipstick mark “max.” (standard oil system) (option: max. operating inclinations)	L	Liters	260

WEIGHTS / MAIN DIMENSIONS

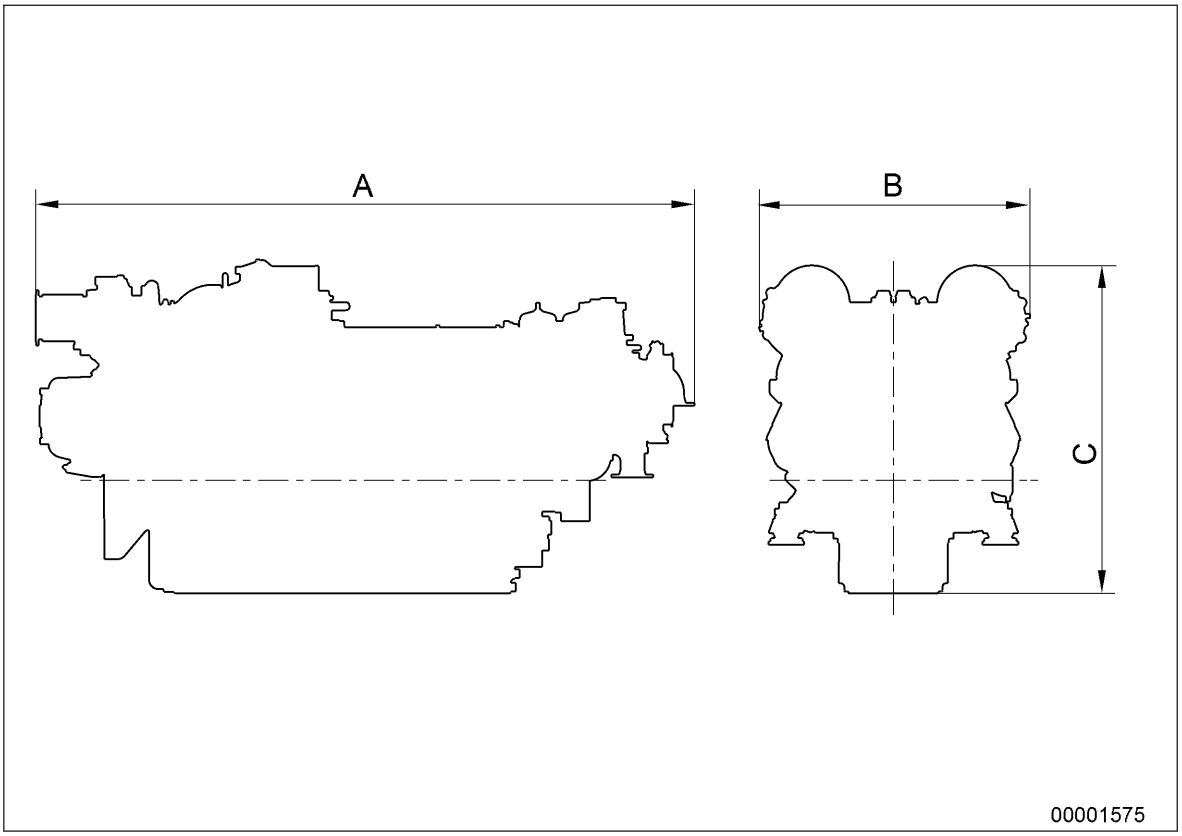
Number of cylinders			16
Engine dry weight (with attached standard accessories, without coupling)	R	kg	9600

ACOUSTICS

Number of cylinders			16
Exhaust noise, undamped - BL (free-field sound-pressure level Lp, 1m distance, ISO 6798, +3dB(A) tolerance)	R	dB(A)	117
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

3.9 Engine - Main dimensions

Engine – Main dimensions



Engine model	Length (A)	Width (B)	Height (C)
12 V 4000 M73/93 (L)	approx. 2991 mm	approx. 1463 mm	approx. 2368 mm
16 V 4000 M73/93 (L)	approx. 3583 mm	approx. 1463 mm	approx. 2368 mm
20 V 4000 M73/93 (L)	approx. 4192 mm	approx. 1484 mm	approx. 2368 mm

3.10 Firing order

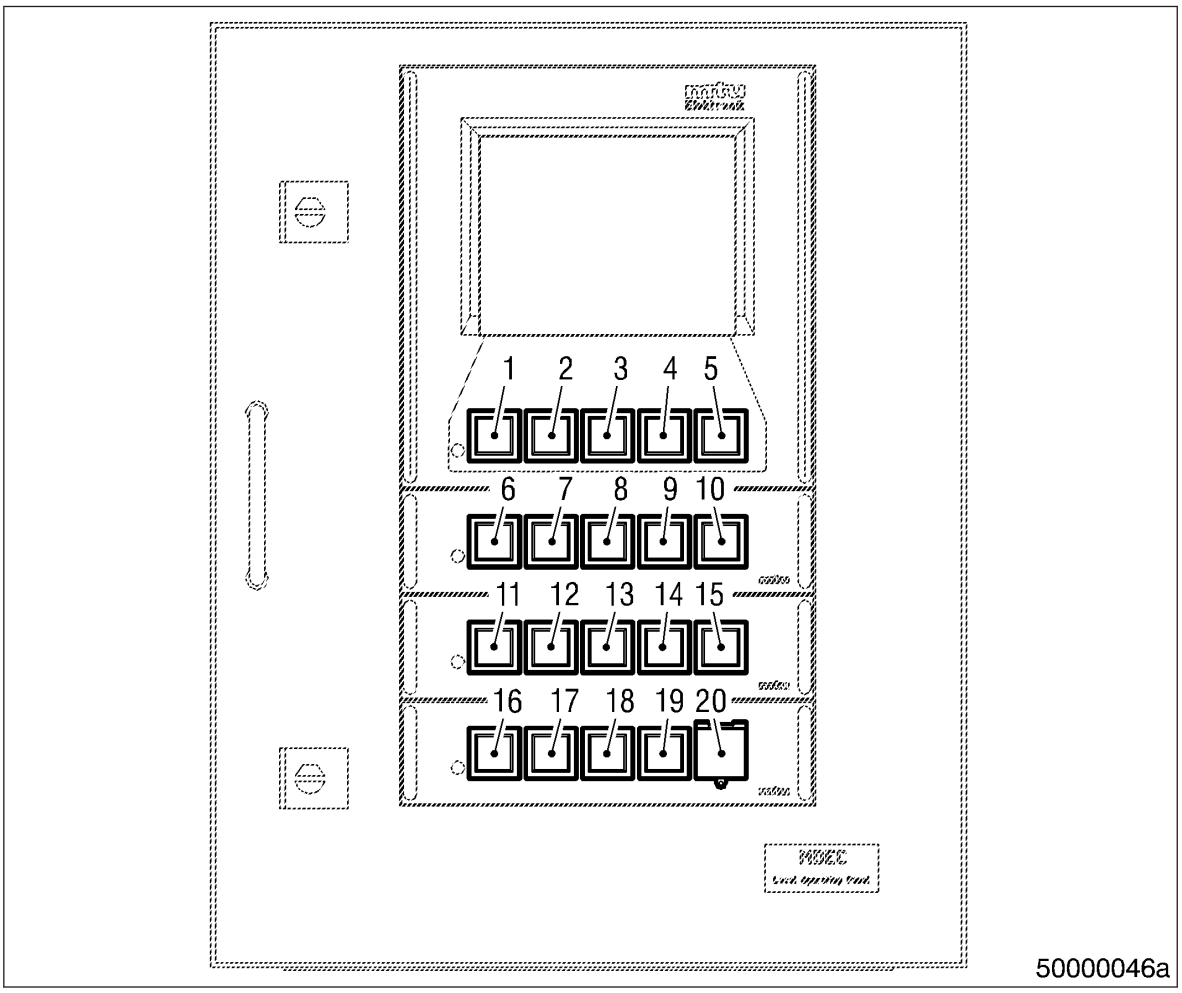
Firing order

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

4 Operation

4.1 LOP - Controls

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 switches between "Not ready for operation" and "Ready for operation". LED (spot) is illuminated when the button is in the "Ready for operation" position.
17	Green	LOCAL CONTROL	Pressing the button switches between local operation and remote control. 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 Fluids and Lubricants Specifications (A001061/..) are available.

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

Item	Action
Engine	Depreserve (→ MTU Fluids and Lubricants Specifications A001061/..).
Lube oil system	Check engine oil level (→ Page 162); Preheat engine oil if required. Lubricate valve gear (→ Page 133).
Raw water pump (if located above waterline)	Fill with water (approx. 3 – 4 liters).
Coolant circuit	If engine is out of service for more than one year, change coolant (→ Page 177).
Coolant circuit	Check coolant level (→ Page 176).
Coolant circuit	Heat coolant with coolant preheating unit.
HP fuel pump	Only for engines without oil priming pump Fill HP fuel pump with new engine oil (→ Page 139).
Engine control system	Switch master switch to ON; Press illuminated pushbutton READY FOR OPERATION (→ Page 69).
Engine Control Unit ECU	Check plug connections (→ Page 198).
EIM	Check plug connections (→ Page 200).
EMU 8	Check plug connections (→ Page 199).
LOP	Press illuminated pushbutton LAMP TEST (→ Page 69).

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

Preconditions

☑ Engine is stopped and starting disabled.

Putting into operation

Item	Action
Lube oil system	Check engine oil level (→ Page 162); Preheat engine oil if required.
Coolant circuit	Check coolant level (→ Page 176).
Coolant circuit	Heat coolant with coolant preheating unit.
Engine control system	Switch master switch to ON; Press illuminated pushbutton READY FOR OPERATION (→ Page 69).
LOP	Press illuminated pushbutton LAMP TEST (→ Page 69).
ECU	Check plug connections (→ Page 198).
EIM	Check plug connections (→ Page 200).
EMU 8	Check plug connections (→ Page 199).

4.4 Starting the engine

Preconditions

☑ External start interlock is not active.

☑ 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.

The engine can be started from the following points

Item	Action
Control stand	(→ Operating instructions for electronic system)
Local Operating Panel LOP	(→ Operating instructions for electronic system)
Local Operation Station LOS	(→ Operating instructions for electronic system)
CCU	(→ Operating instructions for electronic system)

4.5 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.

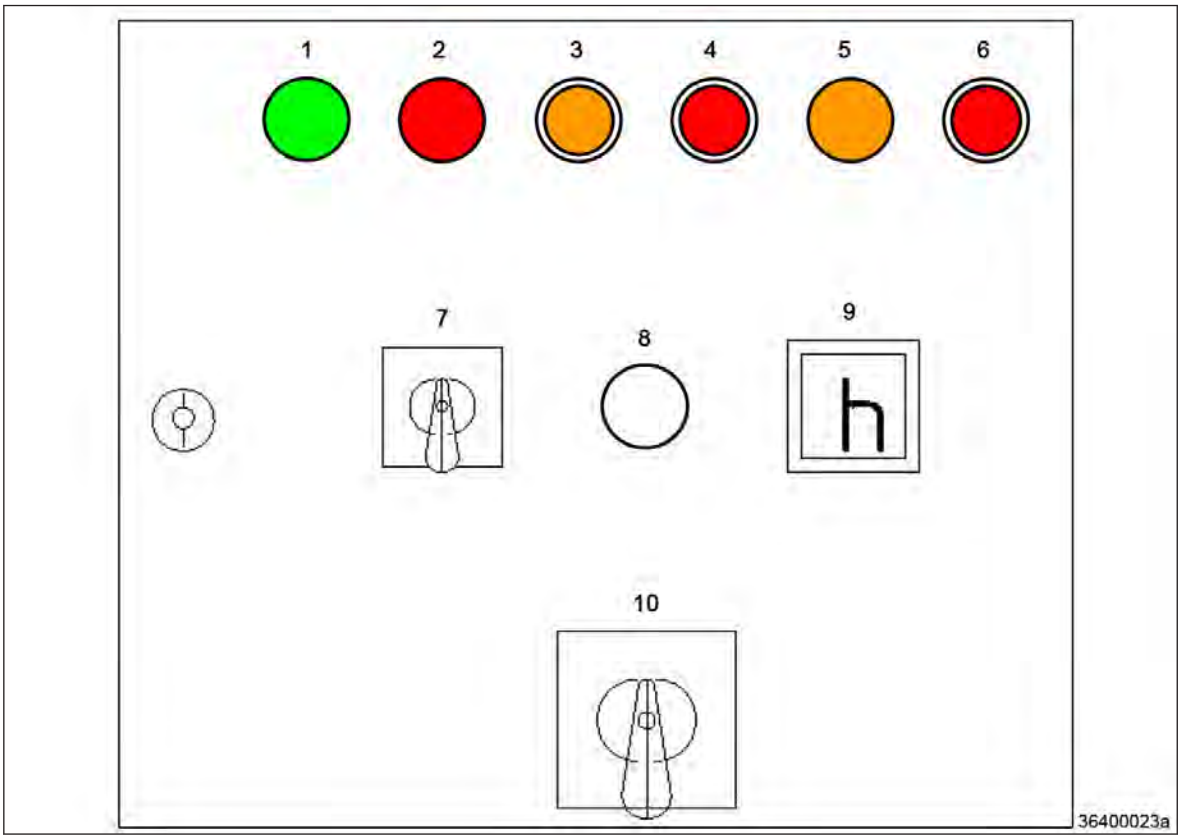
WARNING

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

Operational checks

Item	Action
Engine oil	Check engine oil level (→ Page 162).
Engine under load, engine at nominal speed	Visually inspect engine for leaks and general condition; Check speed, pressures and temperatures; Check engine and external lines for leaks; Check for abnormal running noises and vibration; Check exhaust color (→ Page 97).
Air filter	Check signal ring position of service indicator (→ Page 160); Replace air filter (→ Page 158) if the signal ring is completely visible in the service indicator observation window.
Intercooler	Check condensate drain(s) for water discharge and obstruction (→ Page 157).
Exhaust gas system	Check condensate drain for obstructions.
Fuel prefilter(s)	Drain water and contamination from fuel prefilter (if fitted) (→ Page 150). Check pointer position of differential pressure gage at fuel prefilter (if applicable).
HT coolant pump	Check relief bore for oil and coolant discharge and contamination (→ Page 181).
Raw water pump	Check relief bore for oil and water discharge and contamination (→ Page 183).

4.6 Fuel treatment system control cabinet – Control elements



No.	Color	Caption	Meaning/Function
1	Green	Signal lamp	Indicates „Pump running“
2	Red	Signal lamp	Indicates „Pump fault“
3	Yellow	Illuminated button	Indicates „Water drain“ / Press to drain water manually.
4	Red	Illuminated button	Indicates „Water alarm“ / Press to acknowledge.
5	Yellow	Signal lamp	Indicates „Filter warning“ due to increased differential pressure.
6	Red	Illuminated button	Indicates „Replace filter element“ / Press to acknowledge.
7		Switch	Pump operating mode “Remote– 0 – Manual” • Switch position “Remote”: Pump is controlled at LOP • Switch position “0”: Pump is switched OFF • Switch position “Manual”: Pump is started manually
8	White	Signal lamp	Indicates „Control voltage present”.
9		Hour meter	Indicates runtime of pump.
10		Master switch	

4.7 Tasks after extended out-of-service periods (>3 weeks)

Tasks after extended out-of-service periods (>3 weeks)

Note: Operate fuel treatment system for at least 5 minutes.

1. Start up fuel treatment system (→ Page 78).
2. Shut down fuel treatment system (→ Page 92).

4.8 Checks prior to start-up

Checks prior to start-up

1. Check tank and the entire pipework for cleanness. If microorganisms are detected:
   a) Clean affected components.
   b) Disinfect affected components with biocides (→ MTU Fluids and Lubricants Specifications A001061/..).
2. Close drain valves on housing.
3. Open all supply and discharge valves.
4. Switch on fuel treatment system (→ Page 81).
5. Check direction of rotation of pump.
6. Vent bypass and fuel lines of the system.
   a) Open ball valve for pressure tank.
   b) Open ball valve for overflow tank.
   c) Close ball valve at the inlet to the fuel treatment system.

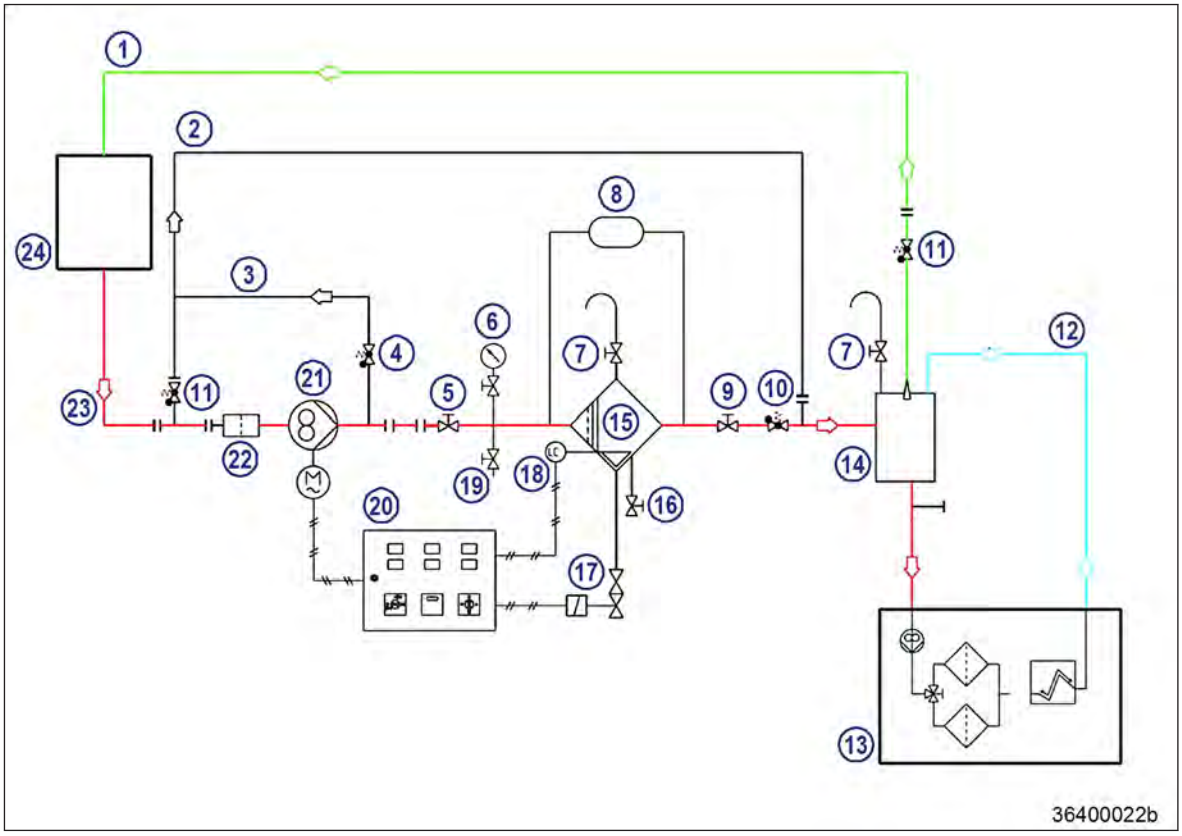
Result: Bypass line is vented via the overflow tank.

   d) Open ball valve at the inlet to the fuel treatment system.
7. Check the fuel treatment system for leaks.

Result: The fuel treatment system is ready for operation.

4.9 Fuel treatment system - Putting into operation

Overview of fuel treatment system



1 Pressure-free overflow
2 Bypass 1
3 Bypass 2
4 Safety valve, 3 bar
5 Ball valve, inlet
6 Pressure gage
7 Ventilation, sample extraction
8 Differential pressure gage
9 Ball valve, outlet
10 Check valve 700 mbar
11 Check valve 5 mbar
12 Return to overflow container
13 Engine
14 Overflow container
15 Water separator filter
16 Ball valve, drain
17 Automatic water drain
18 Water level electrode
19 Ball valve, sample extraction, inlet
20 Switchgear cabinet
21 Pump
22 Coarse filter
23 Fuel supply from tank
24 Tank

Switching on fuel treatment system

1. Switch on fuel treatment system (→ Page 81).
2. Check differential pressure at differential pressure gage (8). Differential pressure in a new system: 0.1 bar to 0.3 bar.

Result: If no differential pressure is measured, the coalescer filter element is probably being bypassed.

1. Remove coalescer filter element (→ Page 191).
2. Check sealing surfaces on coalescer filter element and in the pressure tank.

Initial operation: HAT

1. Replace fuel filter on engine (→ Page 147).

Note: Determine the suction pressure upstream of the engine-mounted fuel delivery pump.

2. Install pressure gage in fuel supply line from Yard fuel system to engine.
3. Switch on fuel treatment system and operate it for some minutes (→ Page 81).

Result: The fuel is drawn from tank (24), cleaned by the water separator filter (15) and then routed via overflow tank (14) back to tank (24). Water that collects in the tank is separated.

4. Start engine (→ Page 73).
5. Run engine at idling speed.
6. Check suction pressure (see technical data of the engine) at the engine-mounted fuel delivery pump.

Note: If the suction pressure is within the permissible limits and engine operation is satisfactory.

7. Increase engine speed to 1000 rpm and monitor suction pressure.
8. Check suction pressure at the engine-mounted fuel delivery pump.

Result: If the values are within the limits specified by the manufacturer, the system is ready to start filter replacement simulation with the engine running as part of the Harbor Acceptance Tests.

Simulation of filter replacement with the engine running: HAT

1. Switch on fuel treatment system (→ Page 81).
2. Start engine (→ Page 73).
3. Run engine at idling speed.
4. Close ball valve (5) at inlet to fuel treatment system.

Result: The pressure upstream of the fuel treatment system increases until the overflow valve at the pump unit opens and fuel flows through bypass (3) and bypass (2).

5. Open ball valve (19) .

Result: Fuel emerges. If no fuel emerges:

- Open ball valve (5) at inlet to fuel treatment system.
- No function of bypasses (2) and (3); carry out functional test of bypasses (2) and (3) .

6. Check suction pressure (see technical data of the engine) at the fuel delivery pump.

Note: If the suction pressure is within the permissible limits and engine operation is satisfactory.

7. Increase engine speed to 1000 rpm and monitor suction pressure.

Result: If all engine operating values are within the specified limits, open ball valve (5) at inlet to fuel treatment system.

Simulation of power failure (emergency): HAT

1. Switch on fuel treatment system (→ Page 81).
2. Start engine (→ Page 73).
3. Run engine at idling speed.
4. Switch off pump (21) at switchgear cabinet (20).

Result: The engine-mounted fuel delivery pump draws fuel via bypass (2) directly from tank (24).

5. Check suction pressure at the engine-mounted fuel delivery pump.

Note: If the suction pressure is within the permissible limits and engine operation is satisfactory.

6. Increase engine speed to 1000 rpm and monitor suction pressure.

Result: If the suction pressure is within the specified limits, simulation was successful.

Simulation of power failure (emergency): SAT

1. Switch on fuel treatment system (→ Page 81).
2. Start engine (→ Page 73).
3. Run engine at idling speed.
4. Switch off pump (21) at switchgear cabinet (20).

Result: The engine-mounted fuel delivery pump draws fuel via bypass (2) directly from tank (24).

5. Check suction pressure at the engine-mounted fuel delivery pump.

Note: If the suction pressure is within the permissible limits and engine operation is satisfactory.

6. Operate engine at full load and monitor suction pressure.

Result: If the suction pressure is within the specified limits, simulation was successful.

4.10 Fuel treatment system – Switching on

Preconditions

☑ The on-board power supply is switched on.

NOTICE

Risk of damage to engine/system.
Risk of severe damage to property!
- Before switching on, ensure that the engine/system is ready for operation.
- Before switching on, ensure that all housings are closed.
- Before switching on, ensure that no work is in progress anywhere on the entire system.

Fuel treatment system – Switching on

1. Carry out checks prior to start-up (→ Page 77).
2. Switch on master switch on switchgear cabinet.

Result: Signal lamp “Control voltage present” lights up.

3. Switch on switch for pump.

Result: Signal lamp “Pump running” lights up.

4.11 Stopping the engine

Stopping the engine via the automation system

Refer to automation system operating instructions

4.12 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).

4.13 Coupling - Engaging from LOP

Preconditions

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

☑ Engine speed in engagement window.

☑ No external engagement interlock active.

DANGER

Vessel is sailing blind.
In Local Operation mode, the propulsion plant is controlled from the engine room.
Risk of accidents!
- Only execute vessel movements on the instructions of a person who has visual contact with the area outside the vessel.

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

Item	Measure
LOP	Press COUPLING IN illuminated pushbutton (→ Page 69). • COUPLING IN button flashes. • Coupling is engaged. • After receiving the feedback signal from coupling, the COUPLING IN button is illuminated brightly.

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

Item	Measure
LOP	Press COUPLING AHEAD illuminated pushbutton (→ Page 69). • COUPLING AHEAD button flashes. • Gearbox is engaged in AHEAD direction. • After receiving the feedback signal from coupling, the COUPLING AHEAD button is illuminated brightly.

Engaging coupling in astern direction with reversing gearbox (FPP)

Item	Measure
LOP	Press COUPLING ASTERN illuminated pushbutton (→ Page 69). • COUPLING ASTERN button flashes. • Gearbox is engaged astern. • After receiving the feedback signal from coupling, the COUPLING ASTERN button is illuminated brightly.

4.14 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 69). • 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 69). • COUPLING NEUTRAL button flashes. • Gearbox is disengaged (neutral position). • After receiving the feedback signal from coupling, the COUPLING NEUTRAL button is illuminated brightly.

4.15 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 69). • 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.

4.16 Stopping the engine from LOP

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 69).
LOP	Operate engine at idle speed (→ Page 69).
Temperature indications	Wait until engine temperatures do not fall any further.
LOP	Press STOP illuminated pushbutton (→ Page 69). • STOP button is illuminated. • Engine at a standstill.

4.17 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).

4.18 Emergency stop from LOP

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 EMERGENCY STOP pushbutton (→ Page 69).
LOP	Press EMERGENCY STOP illuminated pushbutton. • Engine is stopped by disconnecting the power supply to the ECU. • On engines with emergency-air shutoff flaps: flaps close; • EMERGENCY STOP illuminated pushbutton flashes. Horn, flashing lamp etc. are tripped.

After emergency stop from LOP

Item	Measure
LOP	Press ALARM ACKNOWLEDGE illuminated pushbutton (→ Page 69). • Audible and visual signalization 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.

4.19 Emergency engine stop

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

1. Refer to automation system operating instructions.
2. Follow instructions.

4.20 After stopping the engine

Preconditions

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

After stopping the engine

Item	Action
Coolant circuit	Drain coolant (→ Page 178) 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 • Preserve engine (→ MTU Fluids and Lubricants Specifications A001061/..)

4.21 Fuel treatment system – Shutdown

Shutting down fuel treatment system

1. Press the illuminated pushbutton "Water drain" on the switch cabinet until water discharge from the outlet stops.
2. Switch off fuel treatment system.
3. Close ball valve at the inlet to the fuel treatment system.
4. Close ball valve at the outlet of the fuel treatment system.
5. Open drain valve until pressure has escaped from fuel treatment system.

4.22 Plant – Cleaning

Preconditions

☑ Engine stopped and starting disabled.

☑ Operating voltage is not present.

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.
5. Carry out external cleaning as follows:
   a) Seal all openings in a suitable fashion.
   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.

Note: Never aim compressed air directly at electronic components.

   e) Dry engine.

5 Maintenance

5.1 Maintenance schedule task reference table [QL1]

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

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

Task	Option	Maintenance tasks	
W0500		Check engine oil level.	(→ Page 162)
W0501		Visually inspect engine for leaks and general condition.	(→ Page 74)
W0502	X	Check intercooler condensate drain.	(→ Page 74)
W0503		Check service indicator of air filter.	(→ Page 160)
W0504		Check relief bores of HP fuel pump.	(→ Page 140)
W0505		Check relief bores of water pump(s).	(→ Page 181)
W0506		Check engine for abnormal running noises, exhaust color and vibrations.	(→ Page 74)
W0507	X	Drain water and contaminants from fuel pre-filter.	(→ Page 74)
W0508	X	Check reading on differential pressure gauge of fuel prefilter.	(→ Page 149)
W1001		Replace fuel filter or fuel filter element	(→ Page 147)
W1005		Replace air filter.	(→ Page 158)
W1006		Replace fuel injection valves/injectors.	(→ Page 141)
W1008		Replace engine oil filter when changing engine oil, or when the interval (years) is reached, at the latest.	(→ Page 168)
W1009	X	Check layer thickness of oil residues, clean and replace filter sleeve at each oil change, at the latest.	(→ Page 173)
W1011		Perform endoscopic examination.	(→ Page 129)
W1016		Generator: Check condition of coupling.	(→ Page 184)
W1036	X	Replace coolant filter.	No longer installed.
W1047		Check and clean oil indicator filter.	(→ Page 171)
W1076		Exhaust turbocharger: Clean compressor wheel (MTU-ZR turbocharger).	(→ Page 155)
W1207		Check and adjust valve clearance. ATTENTION! First adjustment after 1,000 operating hours.	(→ Page 134)
W1244	X	Check function of rod electrode.	(→ Page 189)
W1245	X	Check alarm function of differential pressure gauge.	(→ Page 188)
W1246	X	Check pump capacity.	(→ Page 190)

Task	Option	Maintenance tasks	
W1463		Check general condition of engine mounting (visual inspection).	(→ Page 185)
W1713		Injector: Reset drift correction (CDC) parameters.	(→ Page 194)

Table 2: Maintenance schedule task reference table [QL 1]

6 Troubleshooting

6.1 Fuel treatment system – Troubleshooting

Illuminated pushbutton “Water alarm” is lit.

Cause	Corrective action
When the maximum water level is reached, the water level electrode opens the water drain valve and water is discharged. If the opening period of the valve exceeds a preset limit (4 minutes), the pump will switch off and an alarm is initiated.	1. Press illuminated pushbutton “Water alarm” to acknowledge. 2. In addition to the automatic water drain function, water can also be drained manually. To do so, press the illuminated pushbutton “Water drain” to open the drain valve.

Signal lamp “Pump fault” is lit.

Cause	Corrective action
The drive motor is equipped with an overload protection. If the maximum permissible current consumption is exceeded, e.g. in case of a blockage or dry-running, the motor protection relay triggers and the pump is switched off.	▶ Reset motor protection relay.

Signal lamp “Warning filter” is lit.

Cause	Corrective action
The differential pressure exceeded 1.3 bar.	▶ Replace coalescer filter element (→ Page 191).

Illuminated pushbutton “Replace filter element” is lit.

Cause	Corrective action
The max. permissible differential pressure of 1.5 bar was exceeded. If the coalescer filter element is not replaced, pressure will increase further and the safety valve will open. Fuel will be led via the bypass directly into the overflow tank.	1. Replace coalescer filter element (→ Page 191). 2. Press illuminated pushbutton “Replace filter element” to acknowledge.

6.2 Troubleshooting

Engine does not turn when starter is actuated

Cause	Corrective action
Battery low or faulty	▶ Charge or replace (see special documentation).
Battery: Cable connections faulty	▶ Check if cable connections are properly secured (see special documentation).
Engine cabling or starter faulty	▶ Check if cable connections are properly secured, contact Service.
Engine wiring defective	▶ Check (→ Page 193).
Assemblies or connectors on LOP possibly loose	▶ Inspect visually.
Plug-in connections on Engine Control Unit possibly loose	▶ Check plug connections (→ Page 198).
Plug-in connections on Engine Interface Module (EIM) possibly loose	▶ Check plug connections (→ Page 200).
Fuse F1 (→ Page 36) in engine wiring harness faulty (fuse lamp on EIM flashes with relevant flashing code)	▶ Check fuse (replace if required) and re-start the system by actuating the key switch.
Running gear blocked (engine cannot be barred manually)	▶ Contact Service.

Engine turns but does not fire

Cause	Corrective action
Poor rotation by starter: Battery low or faulty	▶ Charge or replace battery (see special documentation).
Engine wiring defective	▶ Check (→ Page 193).
Engine Control Unit defective	▶ Contact Service.

Engine fires unevenly

Cause	Corrective action
Injector faulty	▶ Replace (→ Page 141).
Engine wiring defective	▶ Check (→ Page 193).
Engine Control Unit defective	▶ Contact Service.

Engine does not reach rated speed

Cause	Corrective action
Easy-change fuel filter clogged	▶ Replace (→ Page 147).
Air supply:Air filter clogged	▶ Check signal ring position of service indicator (→ Page 160).
Fuel injection: Injector faulty	▶ Replace (→ Page 141).
Engine wiring defective	▶ Check (→ Page 193).
Engine: Overloaded	▶ Contact Service.

Engine speed not steady

Cause	Corrective action
Fuel injection: Injector faulty	▶ Replace (→ Page 141).
Speed transmitter defective	▶ Contact Service.
Engine Control Unit defective	▶ Contact Service.

Charge air temperature too high

Cause	Corrective action
Engine coolant treatment incorrect	▶ Check (MTU test kit).
Intercooler clogged	▶ Contact Service.
Engine room: Air-intake temperature too high	▶ Check fans and air supply / ventilation ducts.

Charge-air pressure too low

Cause	Corrective action
Air supplyAir filter clogged	▶ Check signal ring position of service indicator (→ Page 160).
Intercooler clogged	▶ Contact Service.
Exhaust turbocharger defective	▶ Contact Service.

Coolant leaks at intercooler

Cause	Corrective action
Intercooler leaky, major coolant discharge	▶ Contact Service.

Black exhaust gas

Cause	Corrective action
Air supply:Air filter clogged	▶ Check signal ring position of service indicator (→ Page 160).
Fuel injection: Injector faulty	▶ Replace (→ Page 141).
Engine: Overloaded	▶ Contact Service.

Blue exhaust gas

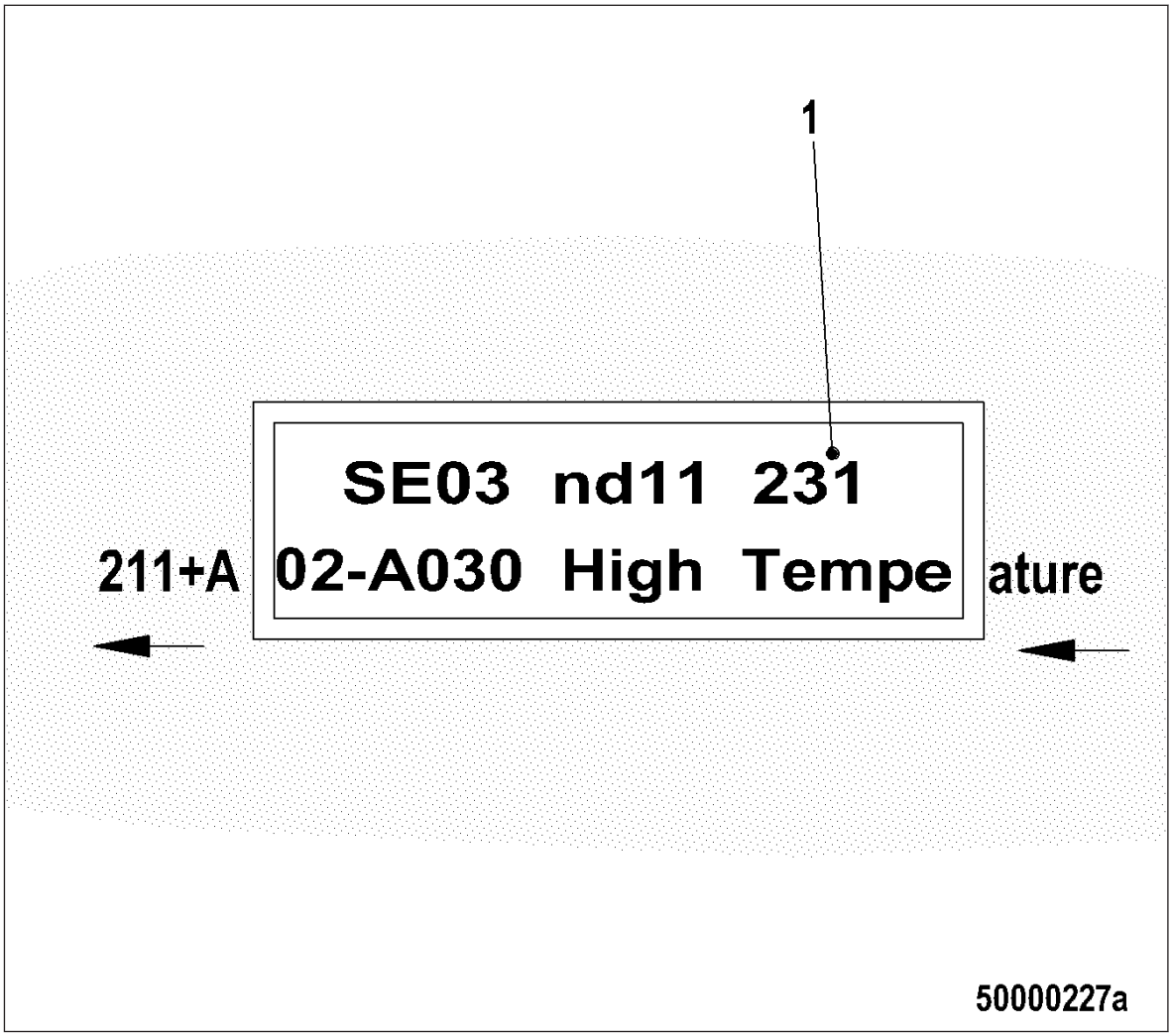
Cause	Corrective action
Too much oil in engine	▶ Drain engine oil (→ Page 163).
Oil separator or oil-preseparator of crankcase breather clogged	▶ Replace.
Exhaust turbocharger, cylinder head, piston rings, cylinder liner defective	▶ Contact Service.

White exhaust gas

Cause	Corrective action
Engine is not at operating temperature	▶ Run engine to reach operating temperature.
Intercooler leaky	▶ Contact Service.

6.3 ADEC (ECU 7) fault codes for Series 4000 engines, marine application

The fault code numbers are generated by the engine governor and transmitted to the display below (if fitted).



The fault code (1) comprises 3 digits.

Fault messages may also be caused by faulty sensors/actuators. Contact Service to have sensors/actuators tested and replaced as necessary if troubleshooting as described in the table (→ Page 101) proves unsuccessful.

For explanations of alarm configuration parameters, refer to PR 2.8008.100.

Fault code list (→ Page 101).

6.4 ADEC engine governor - Fault codes

29 – HI ETC Idle Speed too High

ZKP-Number: 18.004.206

Cause	Corrective action
Idle speed of one of the secondary turbochargers is too high.	▶ Contact Service.

38 – AL ETC Speed Deviation

ZKP-Number: 18.004.205

Cause	Corrective action
Speeds of one of the secondary turbochargers deviates from primary turbocharger speed.	1. Reduce power. 2. Contact Service.

39 – AL ETC2 CutIn Failure

ZKP-Number: 18.004.204

Cause	Corrective action
ETC2 could not be cut in.	1. Reduce power. 2. Contact Service.

81 – AL Rail Leakage

ZKP-Number: 18.004.046

Cause	Corrective action
Pressure gradient in rail is too low during starting or too high during stopping (HP system leaky or air in the system)	▶ Contact Service.

102 – AL Cons. Counter Defect

ZKP-Number: 18.004.624

Cause	Corrective action
Consumption meter faulty.	▶ Contact Service.

104 – AL Eng Hours Counter Defect

ZKP-Number: 18.004.623

Cause	Corrective action
Hourmeter faulty.	▶ Contact Service.

141 – AL Power too high

ZKP-Number: 11.088.007

Cause	Corrective action
This alarm occurs if the average value of power over the last 24 hours exceeded the maximum value specified in PR1.1088.001.	▶ Reduce power.

142 – AL MCR exceeded 1 hour

ZKP-Number: 11.088.006

Cause	Corrective action
This alarm occurs if the MCR was exceeded for more than 1 hour within the last 12 hours.	▶ Reduce power.

201 – SD T-Coolant

ZKP-Number: 18.004.570

Cause	Corrective action
Coolant temperature sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B6), replace as necessary. 2. Error cleared after restarting the engine.

202 – SD T-Fuel

ZKP-Number: 18.004.572

Cause	Corrective action
Coolant temperature sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B33), replace as necessary. 2. Error cleared after restarting the engine.

203 – SD T-Charge Air

ZKP-Number: 18.004.571

Cause	Corrective action
Charge-air temperature sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B9), replace as necessary. 2. Error cleared after restarting the engine.

204 – SD Level Lube Oil

ZKP-Number: 18.004.602

Cause	Corrective action
lube oil level sensor faulty; Short circuit or wire break	▶ Check sensor and cabling, replace as necessary.

205 – SD T-Coolant Intercooler

ZKP-Number: 18.004.574

Cause	Corrective action
Intercooler coolant temperature sensor faulty; Short circuit or wire break	▶ Check sensor and cabling (B26), replace as necessary.

206 – SD T-Exhaust A

ZKP-Number: 18.004.576

Cause	Corrective action
Exhaust temperature sensor on A-side faulty; Short circuit or wire break	▶ Check sensor and cabling (B4.21), replace as necessary.

207 – SD T-Exhaust B

ZKP-Number: 18.004.577

Cause	Corrective action
Exhaust temperature sensor on B-side faulty; Short circuit or wire break	▶ Check sensor and cabling (B4.22), replace as necessary.

208 – SD P-Charge Air

ZKP-Number: 18.004.566

Cause	Corrective action
Charge-air pressure sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B10), replace as necessary. 2. Error cleared after restarting the engine.

211 – SD P-Lube Oil

ZKP-Number: 18.004.563

Cause	Corrective action
Lube oil pressure sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B5), replace as necessary. 2. Error cleared after restarting the engine.

212 – SD P-Coolant

ZKP-Number: 18.004.564

Cause	Corrective action
Coolant pressure sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B16), replace as necessary. 2. Error cleared after restarting the engine.

213 – SD P-Coolant Intercooler

ZKP-Number: 18.004.569

Cause	Corrective action
Intercooler coolant pressure sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B43), replace as necessary. 2. Error cleared after restarting the engine.

214 – SD P-CrankCase

ZKP-Number: 18.004.568

Cause	Corrective action
Crankcase pressure sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B50), replace as necessary. 2. Error cleared after restarting the engine.

215 – SD P-HD

ZKP-Number: 18.004.567

Cause	Corrective action
Rail pressure sensor faulty; high-pressure regulator emergency mode; Short circuit or wire break	1. Check sensor and cabling (B48), replace as necessary. 2. Error cleared after restarting the engine.

216 – SD T-Lube Oil

ZKP-Number: 18.004.575

Cause	Corrective action
Lube oil temperature sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B7), replace as necessary. 2. Error cleared after restarting the engine.

219 – SD T-Intake Air

ZKP-Number: 18.004.573

Cause	Corrective action
Intake air temperature sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B3), replace as necessary. 2. Error cleared after restarting the engine.

220 – SD Level Coolant Water

ZKP-Number: 18.004.584

Cause	Corrective action
Coolant level sensor faulty; Short circuit or wire break	1. Check sensor and cabling (F33), replace as necessary. 2. Error cleared after restarting the engine.

221 – SD P-Diff-Lube Oil

ZKP-Number: 18.004.585

Cause	Corrective action
Lube oil differential pressure sensor faulty; Short circuit or wire break	1. Check sensor and cabling (F25), replace as necessary. 2. Error cleared after restarting the engine.

222 – SD Level Leakage Fuel

ZKP-Number: 18.004.582

Cause	Corrective action
Leak-off fuel level sensor faulty; Short circuit or wire break	1. Check sensor and cabling (F46), replace as necessary. 2. Error cleared after restarting the engine.

223 – SD Level Coolant Intercooler

ZKP-Number: 18.004.583

Cause	Corrective action
Coolant level sensor of intercooler faulty; Short circuit or wire break	1. Check sensor and cabling (F57), replace as necessary. 2. Error cleared after restarting the engine.

227 – SD P-Lube Oil before Filter

ZKP-Number: 18.004.620

Cause	Corrective action
Sensor for lube oil pressure before filter faulty; Short circuit or wire break	1. Check sensor and cabling (B5.3), replace as necessary. 2. Error cleared after restarting the engine.

228 – SD P-Fuel before Filter

ZKP-Number: 18.004.595

Cause	Corrective action
Fuel pressure sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B5.3), replace as necessary. 2. Error cleared after restarting the engine.

229 – AL Stop Camshaft Sensor Defect

ZKP-Number: 18.004.562

Cause	Corrective action
Engine shutdown due to camshaft sensor fault (and a prior crankshaft sensor fault in the same operating cycle).	1. Check connector and cabling to sensor B1, replace as necessary. 2. Error cleared after restarting the engine.

230 – SD Crankshaft Speed

ZKP-Number: 18.004.498

Cause	Corrective action
Crankshaft sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B13), replace as necessary. 2. Error cleared after restarting the engine.

231 – SD Camshaft Speed

ZKP-Number: 18.004.499

Cause	Corrective action
Camshaft sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B1), replace as necessary. 2. Error cleared after restarting the engine.

232 – SD Charger 1 Speed

ZKP-Number: 13.011.128

Cause	Corrective action
Speed sensor of primary turbocharger faulty; Short circuit or wire break	1. Check sensor and cabling (B44.1), replace as necessary. 2. Error cleared after restarting the engine.

233 – SD Charger 2 Speed

ZKP-Number: 13.011.129

Cause	Corrective action
Speed sensor of secondary turbocharger faulty; Short circuit or wire break	1. Check sensor and cabling (B44.2), replace as necessary. 2. Error cleared after restarting the engine.

239 – SD P-Diff Fuel

ZKP-Number: 18.004.598

Cause	Corrective action
Fuel differential pressure sensor faulty; occurs only in combination with alarm "SD P-Fuel before Filter" or "SD P-Fuel after Filter".	▶ Note further fault messages. Pressure sensor before or after filter is faulty.

240 – SD P-Fuel

ZKP-Number: 18.004.565

Cause	Corrective action
Fuel pressure sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B34), replace as necessary. 2. Error cleared after restarting the engine.

241 – SD T-Umblasen

ZKP-Number: 18.004.581

Cause	Corrective action
Recirculation temperature sensor faulty; Short circuit or wire break	1. Check sensor and cabling (B49), replace as necessary. 2. Error cleared after restarting the engine.

242 – SD T-Coolant (R)

ZKP-Number: 18.004.622

Cause	Corrective action
Redundant coolant temperature sensor faulty; Short circuit or wire break	1. Check sensor and cabling, replace as necessary. 2. Error cleared after restarting the engine.

244 – SD P-Lube Oil (R)

ZKP-Number: 18.004.621

Cause	Corrective action
Redundant lube oil pressure sensor faulty; Short circuit or wire break	1. Check sensor and cabling, replace as necessary. 2. Error cleared after restarting the engine.

301 – AL Timing Cylinder A1

ZKP-Number: 18.004.500

Cause	Corrective action
Time-of-flight measuring fault of injector in cylinder A1: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

302 – AL Timing Cylinder A2

ZKP-Number: 18.004.501

Cause	Corrective action
Time-of-flight measuring fault of injector in cylinder A2: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

303 – AL Timing Cylinder A3

ZKP-Number: 18.004.502

Cause	Corrective action
Time-of-flight measuring fault of injector in cylinder A3: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

304 – AL Timing Cylinder A4

ZKP-Number: 18.004.503

Cause	Corrective action
Time-of-flight measuring fault of injector in cylinder A4: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

305 – AL Timing Cylinder A5

ZKP-Number: 18.004.504

Cause	Corrective action
Time-of-flight measuring fault of injector in cylinder A5: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

306 – AL Timing Cylinder A6

ZKP-Number: 18.004.505

Cause	Corrective action
Time-of-flight measuring fault of injector in cylinder A6: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

307 – AL Timing Cylinder A7

ZKP-Number: 18.004.506

Cause	Corrective action
Time-of-flight measuring fault of injector in cylinder A7: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

308 – AL Timing Cylinder A8

ZKP-Number: 18.004.507

Cause	Corrective action
Time-of-flight measuring fault of injector in cylinder A8: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

309 – AL Timing Cylinder A9

ZKP-Number: 18.004.508

Cause	Corrective action
Time-of-flight measuring fault of injector in cylinder A9: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

310 – AL Timing Cylinder A10

ZKP-Number: 18.004.509

Cause	Corrective action
Time-of-flight measuring fault of injector in cylinder A10: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

311 – AL Timing Cylinder B1

ZKP-Number: 18.004.510

Cause	Corrective action
Time-of-flight measuring fault of injector B1: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

312 – AL Timing Cylinder B2

ZKP-Number: 18.004.511

Cause	Corrective action
Time-of-flight measuring fault of injector B2: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

313 – AL Timing Cylinder B3

ZKP-Number: 18.004.512

Cause	Corrective action
Time-of-flight measuring fault of injector B3: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

314 – AL Timing Cylinder B4

ZKP-Number: 18.004.513

Cause	Corrective action
Time-of-flight measuring fault of injector B4: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

315 – AL Timing Cylinder B5

ZKP-Number: 18.004.514

Cause	Corrective action
Time-of-flight measuring fault of injector B5: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

316 – AL Timing Cylinder B6

ZKP-Number: 18.004.515

Cause	Corrective action
Time-of-flight measuring fault of injector B6: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

317 – AL Timing Cylinder B7

ZKP-Number: 18.004.516

Cause	Corrective action
Time-of-flight measuring fault of injector B7: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

318 – AL Timing Cylinder B8

ZKP-Number: 18.004.517

Cause	Corrective action
Time-of-flight measuring fault of injector B8: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

319 – AL Timing Cylinder B9

ZKP-Number: 18.004.518

Cause	Corrective action
Time-of-flight measuring fault of injector B9: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

320 – AL Timing Cylinder B10

ZKP-Number: 18.004.519

Cause	Corrective action
Time-of-flight measuring fault of injector B10: Time-of flight measured value extremely low or extremely high.	▶ If alarm occurs frequently, replace solenoid valve of injector

321 – AL Wiring Cylinder A1

ZKP-Number: 18.004.520

Cause	Corrective action
Short-circuit in injector cabling to cylinder A1. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

322 – AL Wiring Cylinder A2

ZKP-Number: 18.004.521

Cause	Corrective action
Short-circuit in injector cabling to cylinder A2. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

323 – AL Wiring Cylinder A3

ZKP-Number: 18.004.522

Cause	Corrective action
Short-circuit in injector cabling to cylinder A3. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

324 – AL Wiring Cylinder A4

ZKP-Number: 18.004.523

Cause	Corrective action
Short-circuit in injector cabling to cylinder A4. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

325 – AL Wiring Cylinder A5

ZKP-Number: 18.004.524

Cause	Corrective action
Short-circuit in injector cabling to cylinder A5. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

326 – AL Wiring Cylinder A6

ZKP-Number: 18.004.525

Cause	Corrective action
Short-circuit in injector cabling to cylinder A6. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

327 – AL Wiring Cylinder A7

ZKP-Number: 18.004.526

Cause	Corrective action
Short-circuit in injector cabling to cylinder A7. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

328 – AL Wiring Cylinder A8

ZKP-Number: 18.004.527

Cause	Corrective action
Short-circuit in injector cabling to cylinder A8. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

329 – AL Wiring Cylinder A9

ZKP-Number: 18.004.528

Cause	Corrective action
Short-circuit in injector cabling to cylinder A9. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

330 – AL Wiring Cylinder A10

ZKP-Number: 18.004.529

Cause	Corrective action
Short-circuit in injector cabling to cylinder A10. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

331 – AL Wiring Cylinder B1

ZKP-Number: 18.004.530

Cause	Corrective action
Cabling fault in injector cabling to cylinder B1. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

332 – AL Wiring Cylinder B2

ZKP-Number: 18.004.531

Cause	Corrective action
Cabling fault in injector cabling to cylinder B2. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

333 – AL Wiring Cylinder B3

ZKP-Number: 18.004.532

Cause	Corrective action
Cabling fault in injector cabling to cylinder B3. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

334 – AL Wiring Cylinder B4

ZKP-Number: 18.004.533

Cause	Corrective action
Cabling fault in injector cabling to cylinder B4. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

335 – AL Wiring Cylinder B5

ZKP-Number: 18.004.534

Cause	Corrective action
Cabling fault in injector cabling to cylinder B5. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

336 – AL Wiring Cylinder B6

ZKP-Number: 18.004.535

Cause	Corrective action
Cabling fault in injector cabling to cylinder B6. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

337 – AL Wiring Cylinder B7

ZKP-Number: 18.004.536

Cause	Corrective action
Cabling fault in injector cabling to cylinder B7. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

338 – AL Wiring Cylinder B8

ZKP-Number: 18.004.537

Cause	Corrective action
Cabling fault in injector cabling to cylinder B8. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

339 – AL Wiring Cylinder B9

ZKP-Number: 18.004.538

Cause	Corrective action
Cabling fault in injector cabling to cylinder B9. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

340 – AL Wiring Cylinder B10

ZKP-Number: 18.004.539

Cause	Corrective action
Cabling fault in injector cabling to cylinder B10. Result: Misfiring	1. Rectify short circuit in injector solenoid valve circuit (positive to negative) (e.g. by injector replacement) 2. Error cleared after restarting the engine.

341 – AL Open Load Cylinder A1

ZKP-Number: 18.004.540

Cause	Corrective action
Disruption fault in injector cabling to cylinder A1. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

342 – AL Open Load Cylinder A2

ZKP-Number: 18.004.541

Cause	Corrective action
Disruption fault in injector cabling to cylinder A2. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

343 – AL Open Load Cylinder A3

ZKP-Number: 18.004.542

Cause	Corrective action
Disruption fault in injector cabling to cylinder A3. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

344 – AL Open Load Cylinder A4

ZKP-Number: 18.004.543

Cause	Corrective action
Disruption fault in injector cabling to cylinder A4. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

345 – AL Open Load Cylinder A5

ZKP-Number: 18.004.544

Cause	Corrective action
Disruption fault in injector cabling to cylinder A5. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

346 – AL Open Load Cylinder A6

ZKP-Number: 18.004.545

Cause	Corrective action
Disruption fault in injector cabling to cylinder A6. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

347 – AL Open Load Cylinder A7

ZKP-Number: 18.004.546

Cause	Corrective action
Disruption fault in injector cabling to cylinder A7. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

348 – AL Open Load Cylinder A8

ZKP-Number: 18.004.547

Cause	Corrective action
Disruption fault in injector cabling to cylinder A8. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

349 – AL Open Load Cylinder A9

ZKP-Number: 18.004.548

Cause	Corrective action
Disruption fault in injector cabling to cylinder A9. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

350 – AL Open Load Cylinder A10

ZKP-Number: 18.004.549

Cause	Corrective action
Disruption fault in injector cabling to cylinder A10. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

351 – AL Open Load Cylinder B1

ZKP-Number: 18.004.550

Cause	Corrective action
Disruption fault in injector cabling to cylinder B1. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

352 – AL Open Load Cylinder B2

ZKP-Number: 18.004.551

Cause	Corrective action
Disruption fault in injector cabling to cylinder B2. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

353 – AL Open Load Cylinder B3

ZKP-Number: 18.004.552

Cause	Corrective action
Disruption fault in injector cabling to cylinder B3. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

354 – AL Open Load Cylinder B4

ZKP-Number: 18.004.553

Cause	Corrective action
Disruption fault in injector cabling to cylinder B4. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

355 – AL Open Load Cylinder B5

ZKP-Number: 18.004.554

Cause	Corrective action
Disruption fault in injector cabling to cylinder B5. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

356 – AL Open Load Cylinder B6

ZKP-Number: 18.004.555

Cause	Corrective action
Disruption fault in injector cabling to cylinder B6. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

357 – AL Open Load Cylinder B7

ZKP-Number: 18.004.556

Cause	Corrective action
Disruption fault in injector cabling to cylinder B7. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

358 – AL Open Load Cylinder B8

ZKP-Number: 18.004.557

Cause	Corrective action
Disruption fault in injector cabling to cylinder B8. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

359 – AL Open Load Cylinder B9

ZKP-Number: 18.004.558

Cause	Corrective action
Disruption fault in injector cabling to cylinder B9. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

360 – AL Open Load Cylinder B10

ZKP-Number: 18.004.559

Cause	Corrective action
Disruption fault in injector cabling to cylinder B10. Result: Misfiring	1. Check continuity of injector cabling or exclude open load in solenoid valve circuit (e.g. by injector replacement) 2. Error clearance: After each working cycle.

361 – AL Power Stage Low

ZKP-Number: 18.004.496

Cause	Corrective action
Internal electronic fault (electronics possibly faulty). If bit "1.1020.021" (Power Stage Failure: Stop Engine) is set, engine will be shut down as additional measure.	▶ Start ITS. If the ITS diagnosis result is "electronics OK", note further fault messages (e.g. cabling faults).

362 – AL Power Stage High

ZKP-Number: 18.004.497

Cause	Corrective action
Internal electronic fault (electronics possibly faulty). If bit "1.1020.021" (Power Stage Failure: Stop Engine) is set, engine will be shut down as additional measure.	▶ Start ITS. If the ITS diagnosis result is "electronics OK", note further fault messages (e.g. cabling faults).

363 – AL Stop Power Stage

ZKP-Number: 18.004.560

Cause	Corrective action
Internal electronic fault (electronics possibly faulty). If bit "1.1020.021" (Power Stage Failure: Stop Engine) is set, engine will be shut down as additional measure.	▶ Start ITS. If the ITS diagnosis result is "electronics OK", note further fault messages (e.g. cabling faults).

365 – AL Stop MV-Wiring Ground

ZKP-Number: 18.004.561

Cause	Corrective action
Injector cabling fault. If bit "1.1020.021" (Power Stage Failure: Stop Engine) is set, engine will be shut down as additional measure. Possible causes: 1. Short circuit of positive connection of one or more injectors to ground 2. Short circuit of negative connection of one or more injectors to ground	▶ Check wiring, replace wiring harness as necessary.

371 – AL Wiring TO 1

ZKP-Number: 18.004.634

Cause	Corrective action
Short circuit or wire break on transistor output 1 (TO 1).	1. Check charger valve/cabling, repair as necessary. 2. Replace engine governor

372 – AL Wiring TO 2

ZKP-Number: 18.004.635

Cause	Corrective action
Short circuit or wire break on transistor output 2 (TO 2).	1. Check air recirculation valve/cabling, repair as necessary 2. Replace engine governor

373 – AL Wiring TO 3

ZKP-Number: 18.004.636

Cause	Corrective action
Short circuit or wire break on transistor output 3 (TO 3).	▶ Check wiring of charger valve 2 (marine engine)

374 – AL Wiring TO 4

ZKP-Number: 18.004.637

Cause	Corrective action
Short circuit or wire break on transistor output 4 (TO 4).	▶ Check wiring of charger valve 3 (marine engine)

390 – AL MCR exceeded

ZKP-Number: 11.085.009

Cause	Corrective action
DBR/MCR feature: MCR (maximum continuous rating) was exceeded.	1. If the alarm occurs temporarily, no action required. 2. If the alarm is permanently active, contact Service.

396 – TD T-Coolant Sensor Deviation

ZKP-Number: 10.480.193

Cause	Corrective action
Maximum deviation of coolant temperature values from sensors	1. Check sensor and cabling, replace as necessary. 2. Contact Service.

397 – TD P-Oil Sensor Deviation

ZKP-Number: 10.480.293

Cause	Corrective action
Maximum deviation of lube oil pressure values from sensors	1. Check sensor and cabling, replace as necessary. 2. Contact Service.

417 – SD Level Water Fuel Prefilter

ZKP-Number: 18.004.594

Cause	Corrective action
Water level sensor in fuel prefilter faulty; Short circuit or wire break	▶ Check sensor and cabling, replace as necessary.

419 – SD T-Coolant b.Engine

ZKP-Number: 18.004.604

Cause	Corrective action
Coolant inlet temperature sensor faulty; Short circuit or wire break	▶ Check sensor and cabling (B3), replace as necessary.

444 – SD U-PDU

ZKP-Number: 18.004.578

Cause	Corrective action
Injector power stage sensor defect; Internal fault in ECU 7.	▶ Replace ECU 7.

445 – SD P-Ambient Air

ZKP-Number: 18.004.580

Cause	Corrective action
Ambient air pressure sensor faulty.	1. Check pressure sensor and cabling, replace as necessary. 2. Replace engine governor.

464 – SD P-AUX 1

ZKP-Number: 18.004.589

Cause	Corrective action
Analog input signal for Aux 1 pressure faulty; Short circuit or wire break	▶ Check pressure sensor and cabling, replace as necessary.

468 – SD T-AUX 1

ZKP-Number: 18.004.579

Cause	Corrective action
Analog input signal for Aux 1 temperature faulty;	1. Check signal transmitter and cabling, replace as necessary. 2. Replace engine governor.

469 – SD AUX 1

ZKP-Number: 18.004.590

Cause	Corrective action
Analog input signal for Aux 1 faulty; Short circuit or wire break	▶ Check signal transmitter and cabling, replace as necessary.

470 – SD T-ECU

ZKP-Number: 18.004.587

Cause	Corrective action
Temperature sensor for ECU faulty; Short circuit or wire break	▶ Check sensor and cabling, replace as necessary.

471 – SD Coil Current

ZKP-Number: 18.004.592

Cause	Corrective action
Control of HP fuel control block faulty; Short circuit or wire break	▶ Check sensor and cabling, replace as necessary.

473 – AL Wiring PWM_CM2

ZKP-Number: 18.004.593

Cause	Corrective action
Cable break or short circuit on channel PWM_CM2.	1. Check cabling. 2. Contact Service.

475 – AL CR Trigger Engine Stop

ZKP-Number: 18.010.009

Cause	Corrective action
Activated if the crash recorder was triggered due to an engine stop.	1. Determine cause of trigger/engine stop and rectify. 2. Contact Service.

476 – AL Crash Rec. Init. Error

ZKP-Number: 18.010.007

Cause	Corrective action
Crash recorder initialization error.	1. Check setting with DiaSys. 2. Contact Service.

482 – SD T-Exhaust C

ZKP-Number: 18.004.596

Cause	Corrective action
Exhaust temperature sensor on A-side faulty; Short circuit or wire break	▶ Check sensor and cabling (B4.23), replace as necessary.

483 – SD T-Exhaust D

ZKP-Number: 18.004.597

Cause	Corrective action
Exhaust temperature sensor on A-side faulty; Short circuit or wire break	▶ Check sensor and cabling (B4.24), replace as necessary.

492 – AL ETC4 CutIn Failure

ZKP-Number: 18.004.202

Cause	Corrective action
ETC4 could not be cut in.	▶ Check control valve on ETC 4.

493 – AL ETC3 CutIn Failure

ZKP-Number: 18.004.203

Cause	Corrective action
ETC3 could not be cut in.	▶ Check control valve on ETC 3.

500 – AL Wiring POM Starter 1

ZKP-Number: 14.500.900

Cause	Corrective action
A wiring fault was detected in the connection between starter 1 and POM. This may be a missing consumer, a wire break, or a short circuit.	▶ Check connection between POM and starter.

501 – AL Wiring POM Starter 2

ZKP-Number: 14.500.901

Cause	Corrective action
A wiring fault was detected in the connection between starter 2 and POM. This may be a missing consumer, a wire break, or a short circuit.	▶ Check connection between POM and starter.

502 – AL Open Load POM Alternator

ZKP-Number: 14.500.902

Cause	Corrective action
Open load was detected at the connection of the battery-charging generator on the POM.	▶ Check connection between POM and starter.

503 – AL Battery Not Charging

ZKP-Number: 14.500.903

Cause	Corrective action
The battery-charging generator does not charge the battery.	▶ Check battery-charging generator and cabling.

504 – AL CAN POM Node Lost

ZKP-Number: 14.500.904

Cause	Corrective action
POM missing on CAN bus.	▶ Check connection and POM. If alarm occurs in combination with alarm 508, the resistor in the POM cabling is missing.

506 – AL Low Starter Voltage

ZKP-Number: 14.500.906

Cause	Corrective action
battery voltage is too low to accomplish a starting procedure.	▶ Check battery-charging generator and cabling.

507 – AL POM Error

ZKP-Number: 14.500.907

Cause	Corrective action
A general POM error occurred.	▶ Replace POM.

508 – AL Wrong POM-ID

ZKP-Number: 14.500.908

Cause	Corrective action
POM transmits an unexpected ID number. If alarm occurs in combination with alarm 504, the resistor in the POM cabling is missing.	▶ Check POM wiring harness.

519 – Oillevel Calibration Error

ZKP-Number: 10.158.921

Cause	Corrective action
Error when writing the calibration value into the Flash or SD memory of the level sensor; associated PV: AL Group 6 Mot Bit 11	1. Check sensor and cabling, replace as necessary. 2. Contact Service.

525 – SD P-Lube Oil (R2)

ZKP-Number: 18.004.638

Cause	Corrective action
Redundant lube oil pressure sensor faulty; Short circuit or wire break	▶ Check sensor and cabling, replace as necessary.

526 – SD T-Coolant (R2)

ZKP-Number: 18.004.639

Cause	Corrective action
Redundant coolant temperature sensor faulty; Short circuit or wire break	▶ Check sensor and cabling, replace as necessary.

527 – TD EngineSpd. Sensor Deviation

ZKP-Number: 10.480.093

Cause	Corrective action
Maximum deviation of speed sensors	1. Check cabling of speed sensors. Observe additional messages. 2. Contact Service.

528 – SD Engine Speed 3rd Sensor

ZKP-Number: 12.500.102

Cause	Corrective action
Redundant crankshaft sensor faulty; Short circuit or wire break	▶ Check sensor and cabling, replace as necessary.

576 – AL ESCM Override

ZKP-Number: 11.075.083

Cause	Corrective action
Violation of corrected MCR or DBR/MCR curve. Engine overload!	▶ Reduce power.

577 – SD T-Lube Oil Pan

ZKP-Number: 10.137.900

Cause	Corrective action
Temperature sensor in oil pan defective; Short circuit or wire break	▶ Check sensor and cabling, replace as necessary.

582 – AL Emergency Stop Failed

ZKP-Number: 11.005.006

Cause	Corrective action
This alarm occurs if the engine fails to come to a standstill within a specified (by parametrization) a period of time after the emergency stop signal was output.	▶ The delay between the emergency stop signal and this alarm signal is set in parameter 1.1005.4.

588 – SD P-Oil Refill Pump

ZKP-Number: 10.159.910

Cause	Corrective action
Pressure sensor faulty; Short circuit or wire break	▶ Check sensor and cabling, replace as necessary.

596 – AL Develop PR Set

ZKP-Number: 18.004.645

Cause	Corrective action
The parameter set used is a test parameter set.	▶ The alarm remains active until a series-production parameter set was installed.

600 – SD T-Exhaust A+B

ZKP-Number: 18.004.646

Cause	Corrective action
SD T-Exhaust A and T-Exhaust B	▶ Check sensor and cabling, replace as necessary.

601 – SD ETC1+ETC2

ZKP-Number: 13.011.227

Cause	Corrective action
SD ETC1 and ETC2	▶ Check sensor and cabling, replace as necessary.

625 – SD P-Fuel before Prefilter

ZKP-Number: 18.004.600

Cause	Corrective action
Analog input signal for pressure before prefilter faulty; Short circuit or wire break	1. Check pressure sensor and cabling, replace as necessary. 2. Error cleared after restarting the engine.

7 Task Description

7.1 Engine

7.1.1 Engine - Barring manually

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

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

DANGER

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

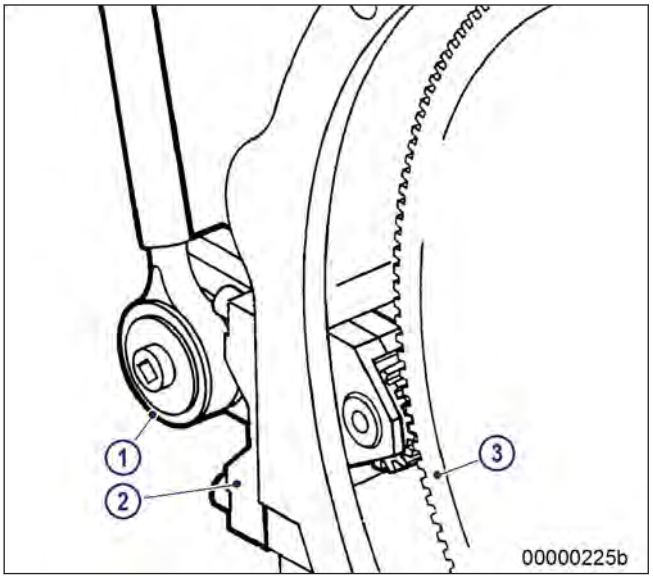
- Before cranking the engine, make sure that there are no persons in the engine's danger zone.
- After finishing work on the engine, make sure that all safety devices are put back in place and all tools removed from the engine.

Engine – Barring manually

1. Remove guard plate.

Result: Safety switch preventing engine starting is activated.

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



7.1.2 Engine - Barring with starting system

Barring using the automation system

Refer to automation system operating instructions

7.2 Cylinder Liner

7.2.1 Cylinder liner – Endoscopic examination

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

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

Preparatory steps

1. Remove cylinder head cover (→ Page 138).
2. Remove injector (→ Page 142).

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	Action
• Thin carbon coating on circumference of carbon scraper ring • Slight localized additive deposits at top edge • Singular smooth areas at lower edge • Carbon deposits on circumference in clearance between top piston ring and bottom edge of carbon scraper ring • First signs of marks left by top piston ring • Bright mark on entire circumference • Consistent honing pattern without objections • First signs of marks left by lower cooling bores • Running pattern seems darker	No action required
• Dark areas with even or varying degrees of discoloration • Beginning and end of the discoloration are not sharply defined and do not cover the entire stroke area • Dark areas in the upper section of the cooling bore, remaining circumference without objections • Piston rings without objections	Further endoscopic examination required as part of maintenance work
• On the entire circumference, apart from light areas of discoloration (that do not impair operation) clearly darker stripes that start at the top piston ring • Heat discoloration in the direction of stroke and honing pattern damage • Heat discoloration of piston rings	Cylinder liner must be replaced; Service must be contacted

1. Compile endoscopy report using the table.
2. Use technical terms for description of the liner surface (→ Page 131).
3. Depending on findings:
   - do not take any action or
   - carry out a further endoscopic examination as part of maintenance work or
   - contact Service; cylinder liner must be replaced.

Final steps

1. Install injector (→ Page 142).
2. Install cylinder head cover (→ Page 138).

7.2.2 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.

7.3 Valve Drive

7.3.1 Valve gear - Lubrication

Preconditions

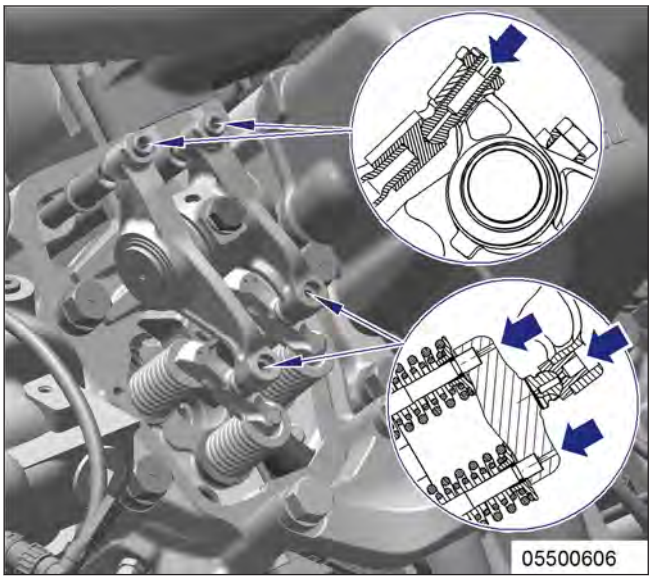
☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine oil		

Valve gear – Lubrication

1. Remove cylinder head covers (→ Page 138).
2. Fill oil chambers of valve bridges with oil.
3. Fill oil chambers of rocker arms and adjusting screws with oil.
4. Install cylinder head covers (→ Page 138).



7.3.2 Valve clearance – Check and adjustment

Preconditions

☑ Engine shut down and starting disabled.

☑ Engine coolant temperature is max. 40 °C.

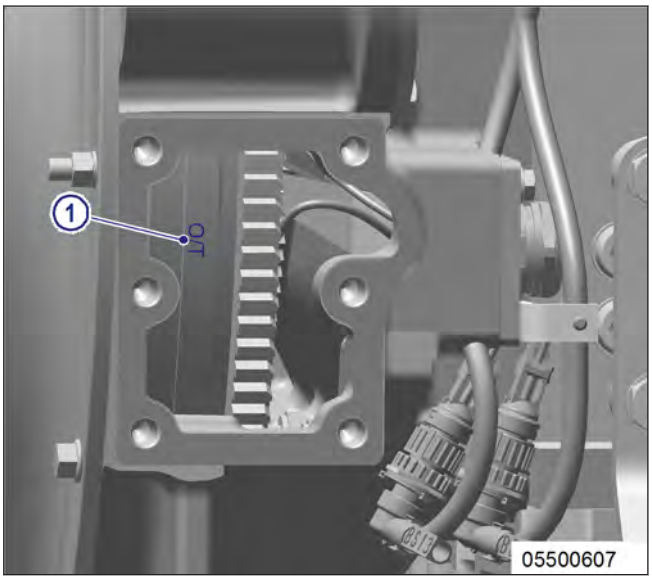
☑ Valves are closed.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Feeler gauge	Y20098771	1
Torque wrench, 60-320 Nm	F30452768	1
Box wrench socket, 24 mm	F30039526	1
Engine oil		

Preparatory steps

1. Remove cylinder head cover (→ Page 138).
2. Install barring device (→ Page 127).
3. The OT (TDC) marking (1) (if fitted) on the flywheel must not be used for reference.



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4. Rotate crankshaft with barring device in direction of engine rotation until the "OT-A1" marking and pointer are aligned.

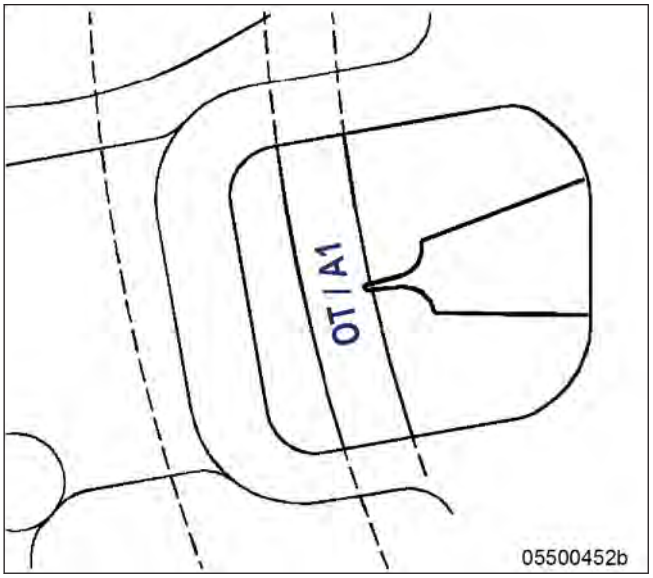


Diagram for 8V engines (two crankshaft positions)

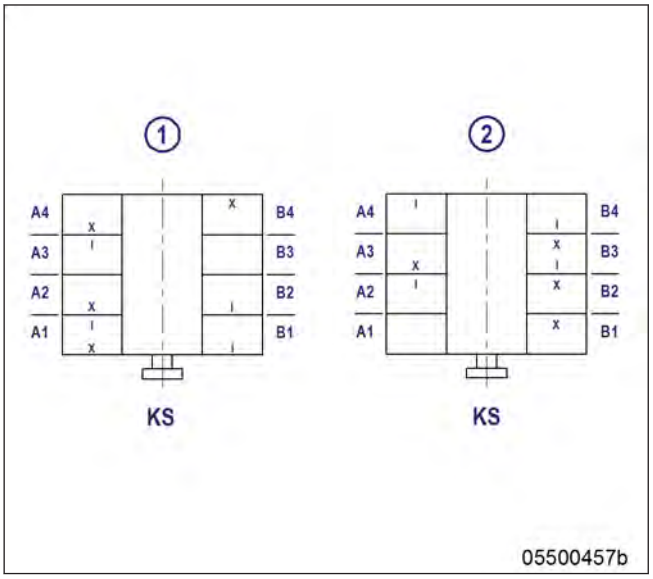


Diagram for 12V engines (two crankshaft positions)

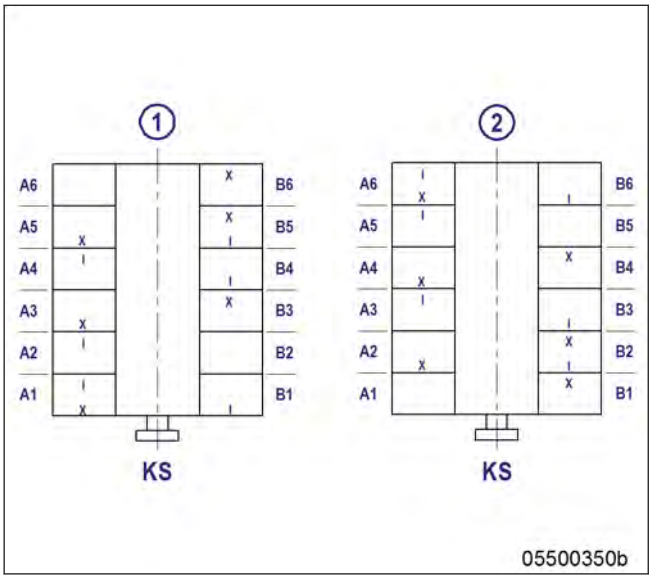


Diagram for 16V engines (two crankshaft positions)

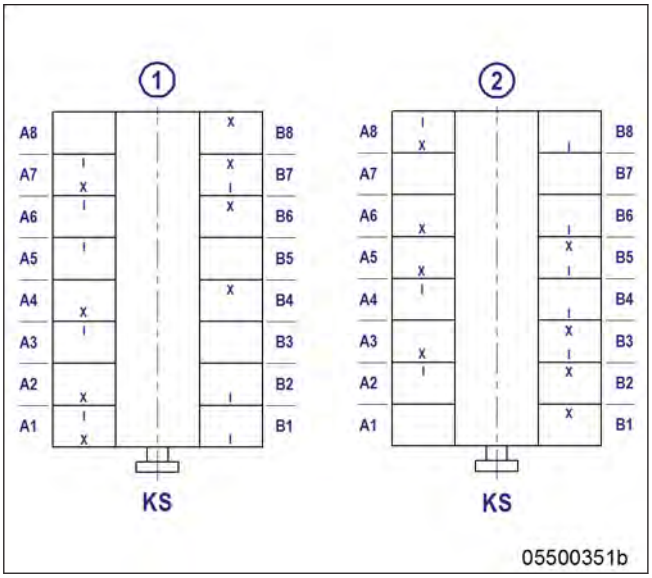
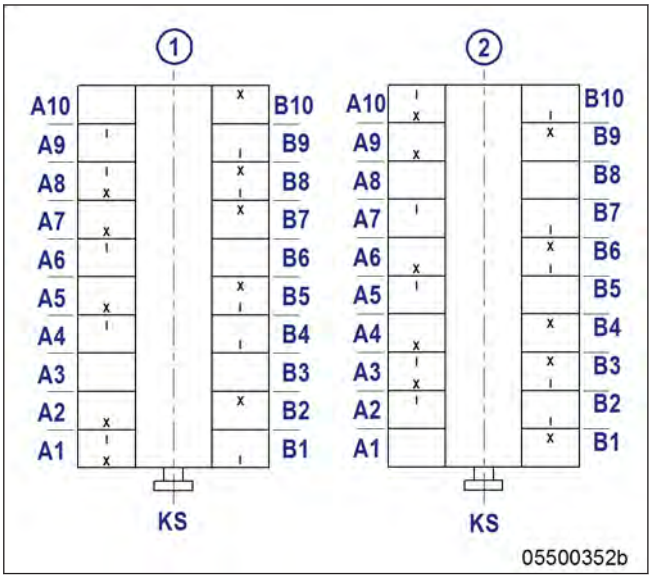


Diagram for 20V engines (two crankshaft positions)

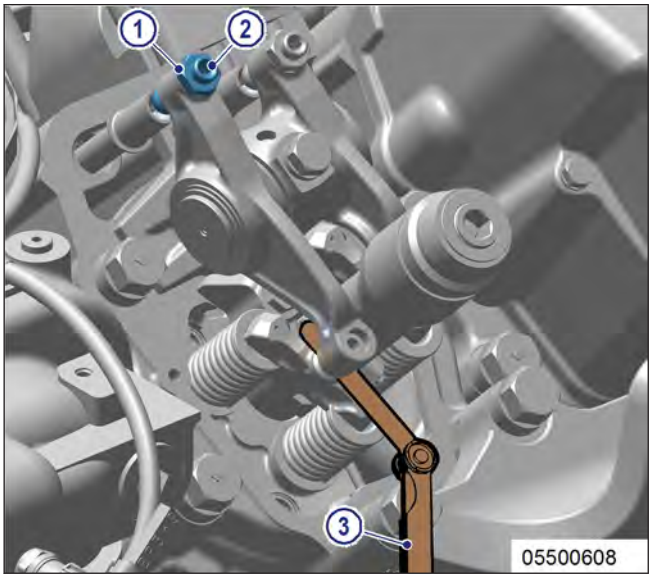


Checking valve clearance at two crankshaft positions

1. Check TDC position of piston in cylinder A1:
   - If the rocker arms are unloaded on cylinder A1, the piston is in firing TDC.
   - If the rocker arms are under load on cylinder A1, the piston is in overlap TDC.
2. Check valve clearance with cold engine:
   - Inlet (long rocker arm) = 0.2 mm ±0.05 mm
   - Exhaust (short rocker arm) = 0.5 mm ±0.05 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. Release locknut (1).
2. Insert feeler gauge (3) between valve bridge and rocker arm.
3. Use Allen key to set adjusting screw (2) so that the specified valve clearance is established.
4. Feeler gauge (3) must just pass through gap.



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

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

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

Final steps

1. Remove barring device (→ Page 127).
2. Install cylinder head cover (→ Page 138).

7.3.3 Cylinder head cover – Removal and installation

Preconditions

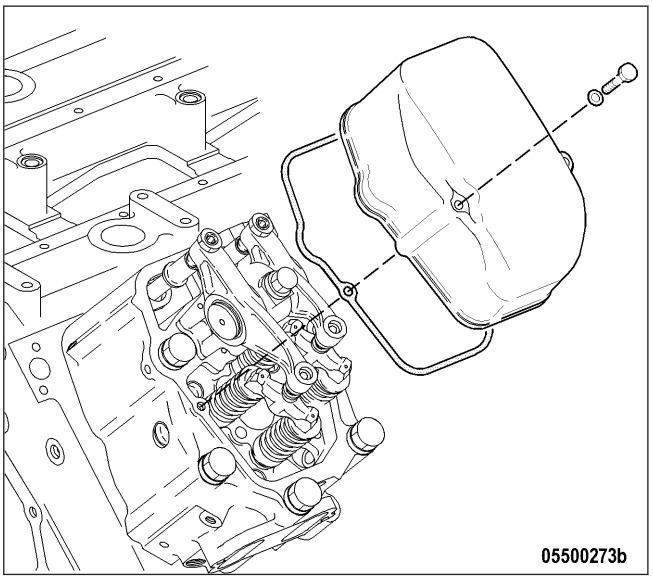
☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

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

Removing cylinder head cover

1. Clean very dirty cylinder head covers prior to removal.
2. Remove screws.
3. Remove cylinder head cover with gasket from cylinder head.



Installing cylinder head cover

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

7.4 Injection Pump / HP Pump

7.4.1 HP pump - Filling with engine oil

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine oil		

WARNING

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

WARNING

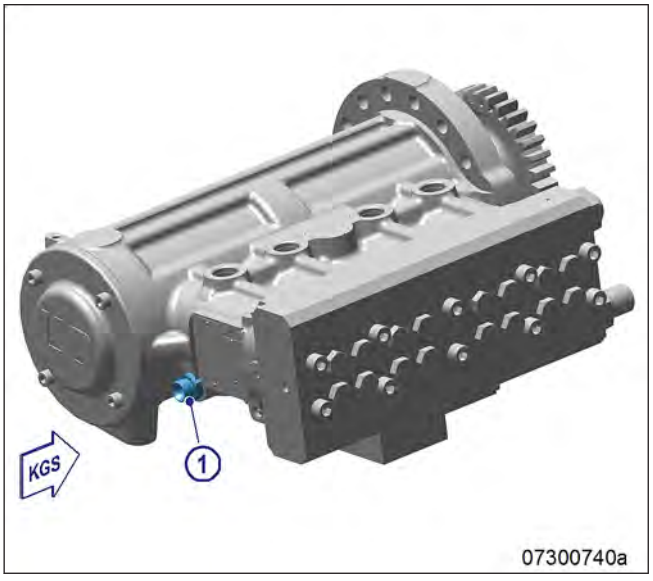
Oils/oil vapors are combustible/explosive.
Risk of fire and explosion!
- Avoid open flames, electric sparks and ignition sources.
- Do not smoke.

NOTICE

HP fuel pump not filled with engine oil.
Damage to components, major material damage!
- Ensure that th HP fuel pump is filled with engine oil before it is installed or put into operation.

Filling HP pump

1. Remove plug screw (1).
2. Use pump oiler to fill HP pump with engine oil until engine oil emerges.
3. Install plug screw (1).



7.4.2 HP pump – Relief bore check

DANGER

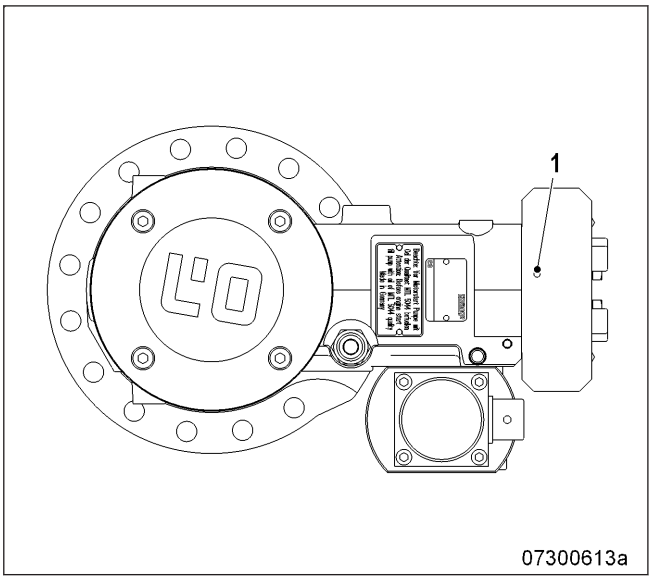
Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING

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

HP pump – Relief bore check

1. Visually inspect relief bore (1) for fuel discharge.
2. For jacketed HP lines, leakage is indicated by the yellow combined alarm.
3. If fuel discharge is found or indicated, contact Service.



7.5 Injection Valve / Injector

7.5.1 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 142).

7.5.2 Injector - Removal and installation

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Installation/removal tool	F6789889	1
Milling cutter	F30452739	1
Torque wrench, 0.5-5 Nm	0015384230	1
Torque wrench, 10-60 Nm	F30452769	1
Ratchet	F30027340	1
Torque wrench, 60-320 Nm	F30452768	1
Ratchet	F30027341	1
Assembly paste (Optimoly Paste White T)	40477	1
Grease (Kluthe Hakuform 30-10/Emulgier)	X00029933	1
Engine oil		
O-ring	(→ Spare Parts Catalog)	

WARNING

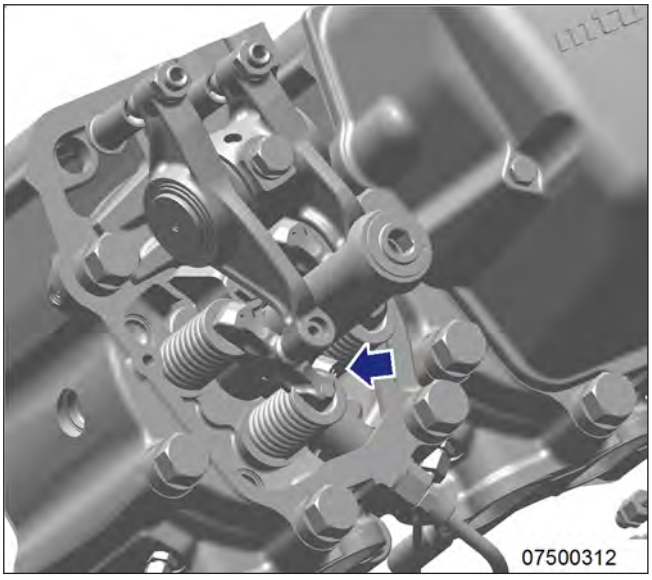
Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Preparatory steps

1. Shut off fuel supply to engine.
2. Remove cylinder head cover (→ Page 138).

Removing injector

1. Disconnect connectors on injector.

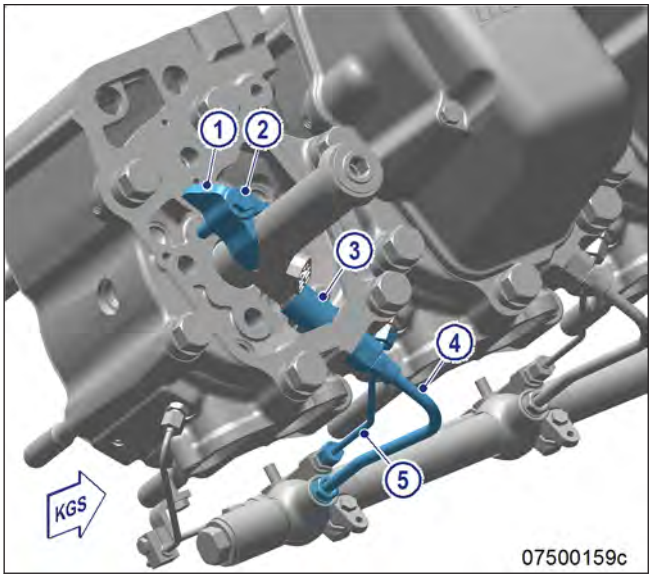


TIM-ID: 0000000925 - 009

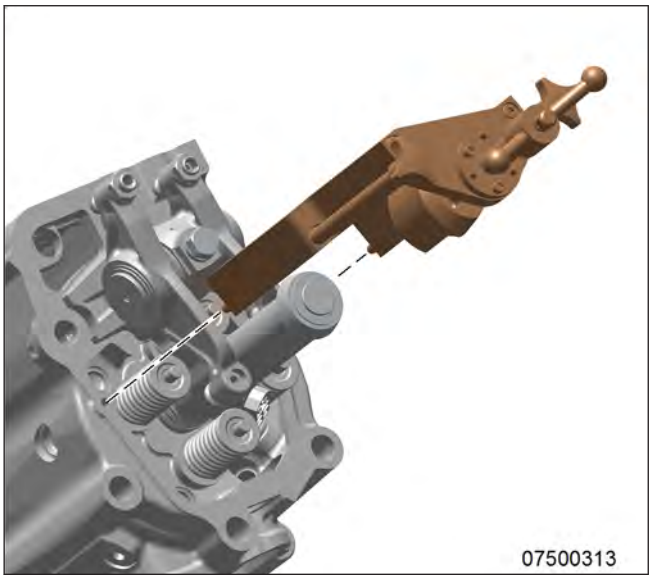
2. Remove HP fuel line (4).
3. Remove return line (5).

Note: While the adapter is removed, the injector is drained.

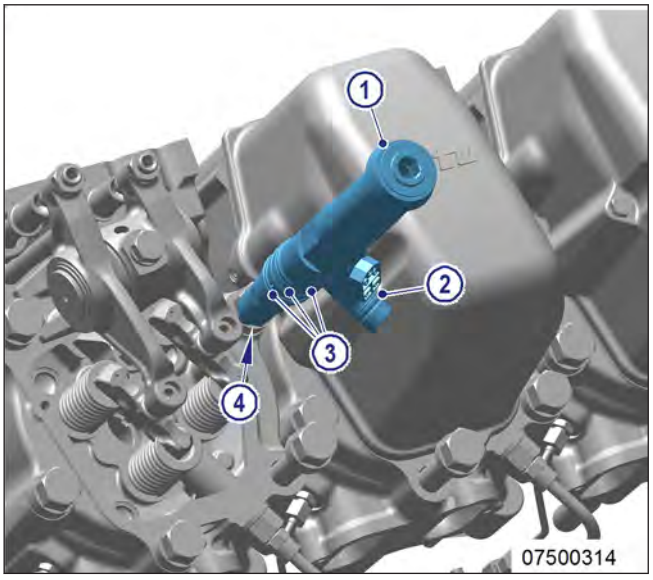
4. Remove adapter (3).
5. Remove screw (2) and take off hold-down clamp (1).



6. Install installation/removal tool on cylinder head.
7. Remove injector with installation/removal tool.
8. Remove installation/removal tool.

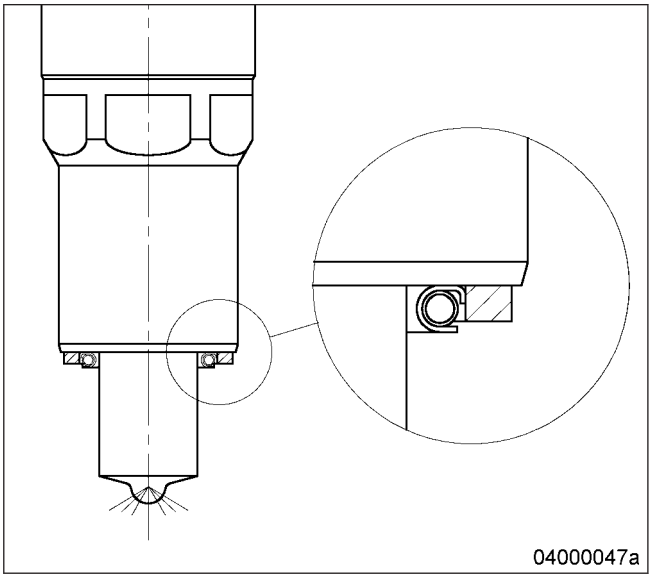


9. Remove sealing ring (4) from injector or use a self-made hook to take it out of the cylinder head.
10. Remove O-rings (3), O-ring (2) and damper ring (1) from injector.
11. Clean all mating and sealing surfaces.
12. Cover all connections and bores, or seal with suitable plugs.

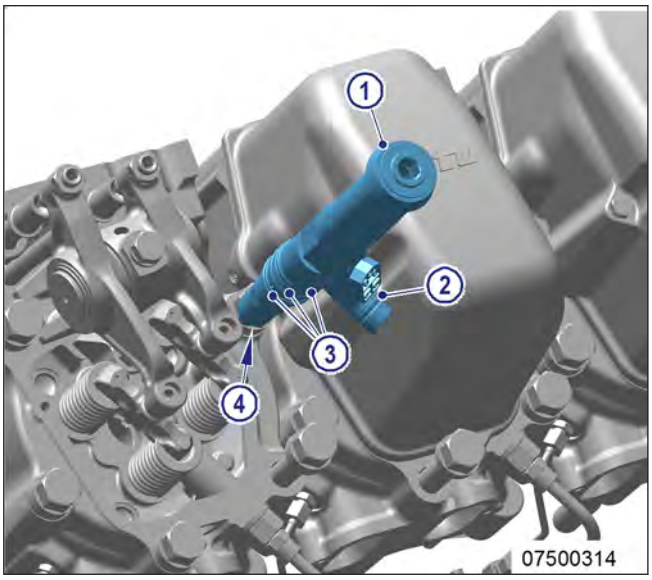


Installing injector

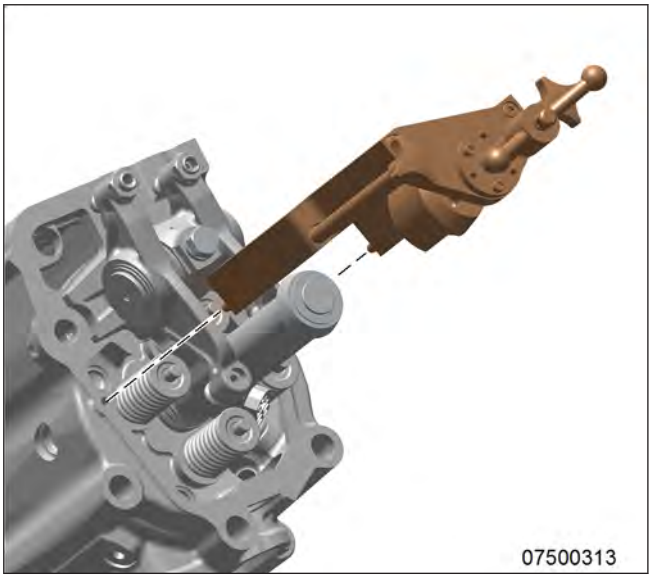
1. Remove plug before installing the injector. (Do not remove the plug from the HP line before installing the adapter.)
2. Coat injector with assembly paste at the seat of the nozzle retaining nut.
3. Fit new sealing ring (included in the scope of supply of the injector) with grease on injector, observe installation position of sealing ring.



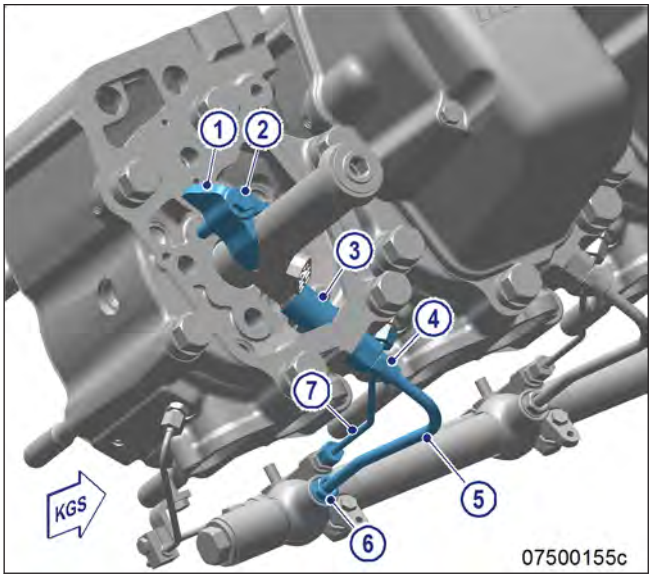
4. Fit new O-rings (3) (included in the scope of supply of the injector), O-ring (2) and damping ring (1) onto the injector and coat with grease.
5. Remove oil carbon from sealing face on cylinder head and protective sleeve with milling cutter.
6. Insert injector into cylinder head, ensuring that the HP line adapter is correctly aligned.



7. Press in injector with installation/removal tool.
8. Remove installation/removal tool.



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



10. Fit hold-down clamp (1) in the correct position and use torque wrench to tighten screw (2) to the specified initial tightening torque.

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

Note: Ensure special cleanness.

11. Coat thread and sealing cone of adapter (3) with engine oil.

12. Install adapter (3) and use torque wrench to tighten to the specified initial tightening torque.

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

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

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

14. Tighten adapter (3) with torque wrench to the specified tightening torque.

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

15. Install return line (7).

Note: Ensure special cleanness.

16. Coat thread and sealing cone of HP line (5) with engine oil.

Note: Two HP line versions (single- and double-walled) with different torques as described below.

17. Mount single-walled HP line (5) and use torque wrench to tighten to the specified torque. Tightening sequence:
    1 Rail (6)
    2 Adapter (4)

Name	Size	Type	Lubricant	Value/Standard
Union nut / thrust screw		Tightening torque		30 Nm + 5 Nm

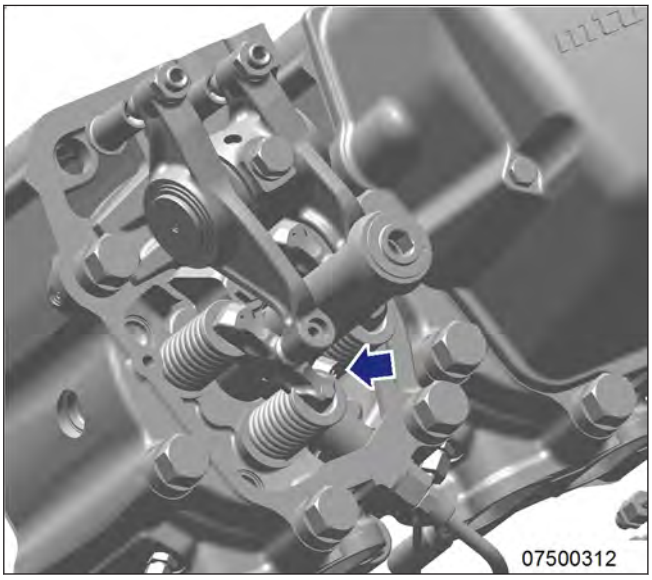
18. Mount double-walled HP line (5) and use torque wrench to tighten to the specified torque. Tightening sequence:
    1 Adapter (4)
    2 Rail (6)

Name	Size	Type	Lubricant	Value/Standard
Union nut / thrust screw		Tightening torque		40 Nm + 5 Nm

19. Fit connectors on injector.

Note: Failure to reset drift compensation (CDC) will void the emissions certification.

20. Reset drift compensation (CDC) with DiaSys® (→ E531920/...). If DiaSys® is not available, contact Service.



Final steps

1. Install cylinder head cover (→ Page 138).
2. Open fuel supply to engine.

7.6 Fuel Filter

7.6.1 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
Diesel 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 combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

WARNING

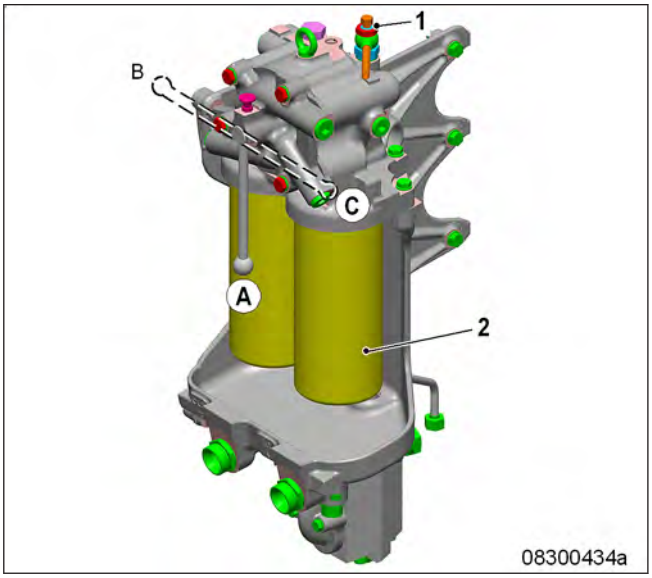
High level of engine noise when the engine is running.
Risk of damage to hearing!
- Wear ear protectors.

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.

Fuel filter replacement with the engine stopped

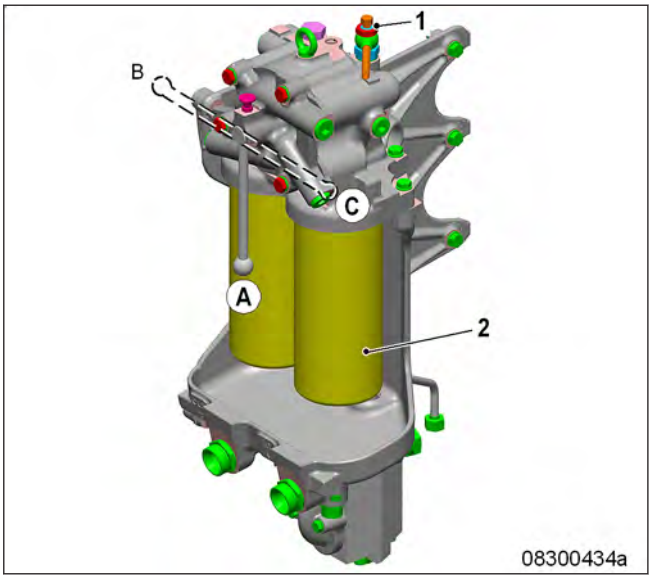
A Both filters cut in
B Left filter cut out
C Right filter cut out
1 Fuel vent
2 Fuel filter



1. Cut out the filter to be replaced.
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 16).
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 (1).

Fuel filter replacement with the engine running

1. Cut out the filter to be replaced.
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 16).
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.



7.6.2 Fuel prefilter – Differential pressure gauge check and adjustment

DANGER

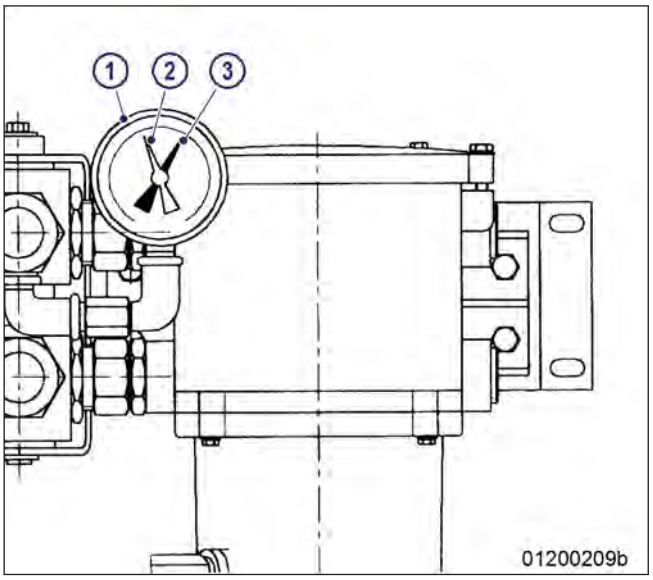
Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING

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

Adjusting differential pressure gauge

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



Checking differential pressure of fuel prefilter

1. With the engine running at full load or rated power, read off pressure at gauge (1).
2. If differential pressure as indicated between position of adjustable pointer (2) and pressure-indicating pointer (3) of pressure gauge is ≥ 0.3 bar, flush filter element of the cut-in filter (→ Page 151).

7.6.3 Fuel prefilter - Draining

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

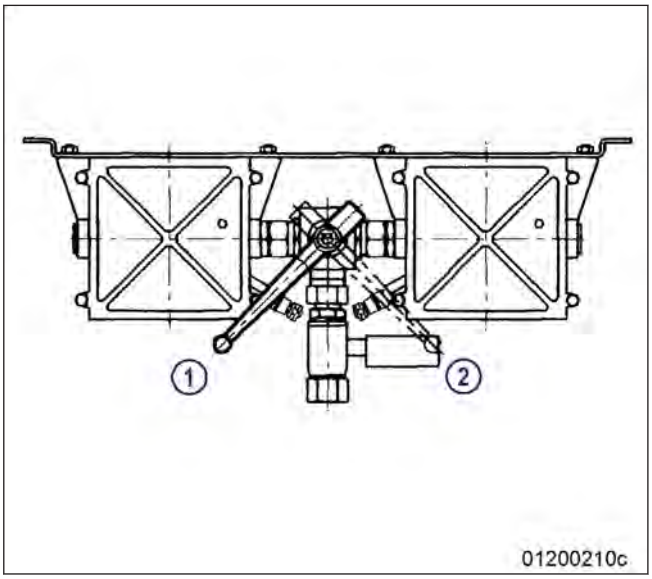
Designation / Use	Part No.	Qty.
Diesel fuel		
Gasket	(→ Spare Parts Catalog)	

WARNING

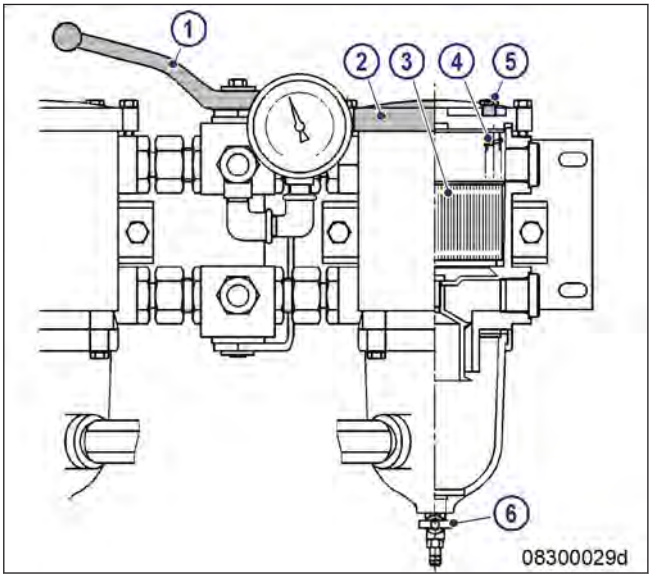
Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Fuel prefilter – Draining

1. Cut out filter to be drained.
   1 Left filter cut in
   2 Right filter cut in



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



7.6.4 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

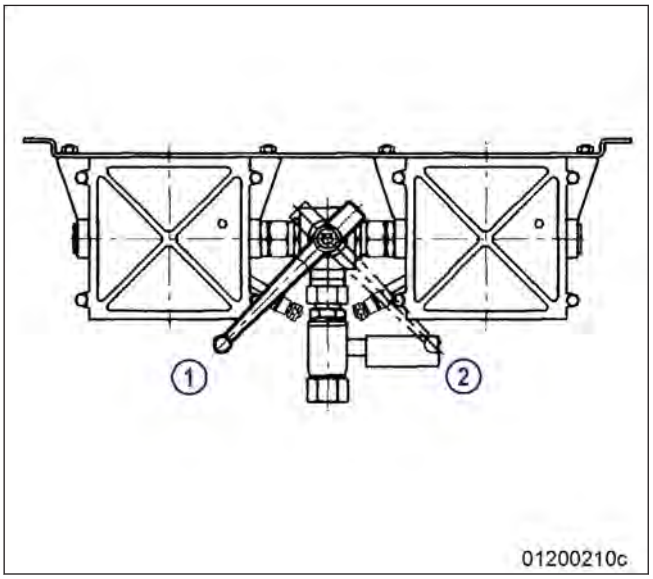
Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

WARNING

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

Fuel prefilter – Flushing

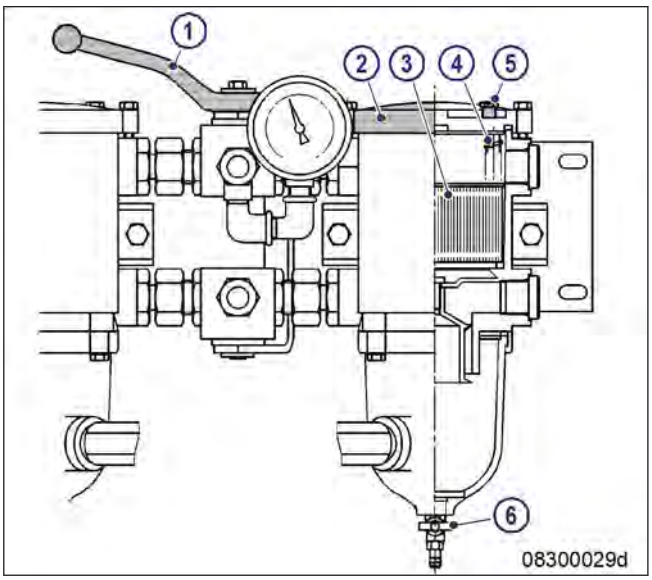
1. Cut out the contaminated filter.
   1 Left filter cut in
   2 Right filter cut in



2. Open 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 vent plug (5) and drain cock (6).



Fuel prefilter – Filling with fuel

1. Stop engine (→ Page 82) 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 gasket in cover (2).
5. Fit cover with gasket and secure it with screws.
6. Check differential pressure (→ Page 149).

Result: If flushing did not lead to an improvement of the differential pressure, replace filter element of fuel prefilter (→ Page 153).

7.6.5 Fuel prefilter – Filter element replacement

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

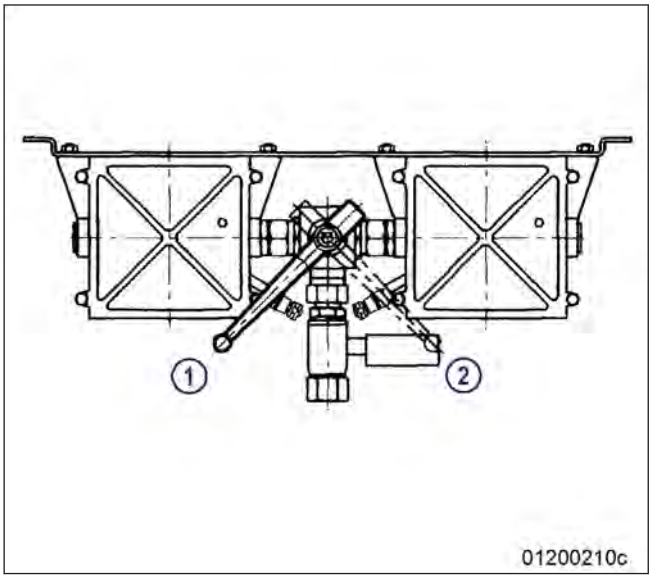
Designation / Use	Part No.	Qty.
Diesel fuel		
Filter element	(→ Spare Parts Catalog)	
Gasket	(→ Spare Parts Catalog)	

WARNING

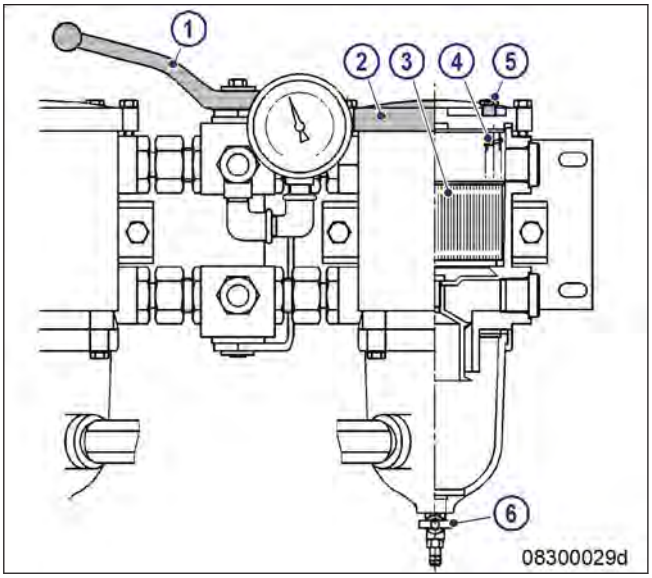
Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Replacing filter element

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



2. Open threaded vent plug (5) of contaminated filter.
3. Unlock drain valve (6) by pressing toggle and open it.
4. Drain water and dirt from filter.
5. Close drain valve (6).
6. Remove screws securing the cover and take off cover (2).
7. Remove spring housing (4) and filter element (3).
8. Insert new filter element (3) and spring housing (4).
9. Fill filter housing with clean fuel.
10. Place new gasket in cover (2).
11. Fit cover with gasket and secure it with screws.
12. Cut in the cut-out filter again.
13. Close threaded vent plug (5) when fuel emerges.
14. Adjust the differential pressure gauge (→ Page 149).



7.7 Exhaust Turbocharger

7.7.1 Compressor wheel - Cleaning

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Cold cleaner	X00056750	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

Chemical substances.
Risk of irritation and chemical burns!
- Observe the instructions of the cleaning agent manufacturer.

NOTICE

Incorrect installation of electric lines .
Damage to component!
- Note down line assignment to connections before removal.

NOTICE

Inappropriate cleaning tool.
Risk of damage to component!
- Observe manufacturer's instructions.
- Use appropriate cleaning tool.

Preparatory steps

1. Drain engine coolant (→ Page 178).
2. Remove air filter (→ Page 159).
3. Remove exhaust system after exhaust turbocharger.
4. Remove exhaust flap with actuators.
5. Remove air intake.

Compressor wheel – Cleaning

Note: Do not use wire brush, scraper or similar tools for cleaning!

1. Clean compressor housing with paint brush or smooth brush.
2. Clean compressor wheel and bearing housing with cold cleaner.
3. Thoroughly blow out all parts with compressed air to remove cold cleaner.

Final steps

1. Install air intake.
2. Install exhaust flap with actuators.
3. Install exhaust system after exhaust turbocharger.
4. Install air filter (→ Page 159).
5. Fill with engine coolant (→ Page 179).

7.8 Charge-Air Cooling

7.8.1 Intercooler - Check water drain 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

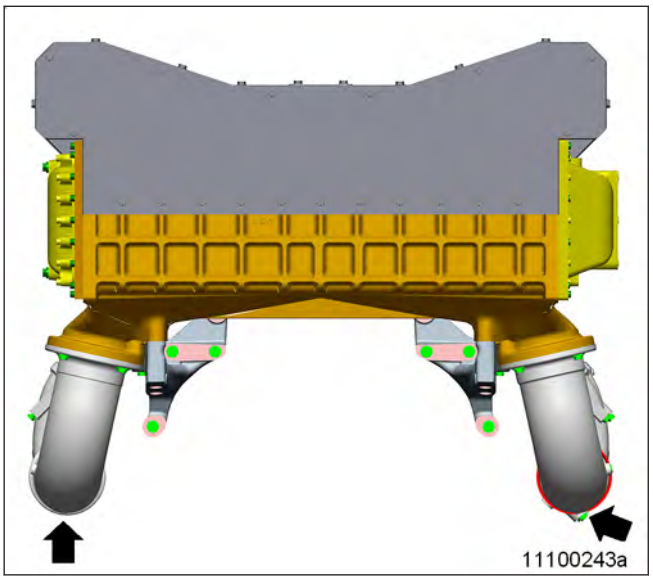
High level of engine noise when the engine is running.
Risk of damage to hearing!
- Wear ear protectors.

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.

Checking intercooler water drain for coolant discharge and obstruction

1. With the engine running check the drain bore(s) on the right and left of the engine for emerging air (at driving end). If no air emerges:
2. Clean drain bore(s) and blow out with compressed air.
3. Significant coolant discharge indicates a leaking intercooler. Contact Service.



Emergency measures prior to engine start with a leaking intercooler

1. Remove injectors (→ Page 142).
2. Bar engine manually (→ Page 127).
3. Bar engine with starting system to blow out cylinder chambers (→ Page 127).
4. Install injectors (→ Page 142).

7.9 Air Filter

7.9.1 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 159).
2. Reset signal ring of contamination indicator (→ Page 160).

7.9.2 Air filter - Removal and installation

Preconditions

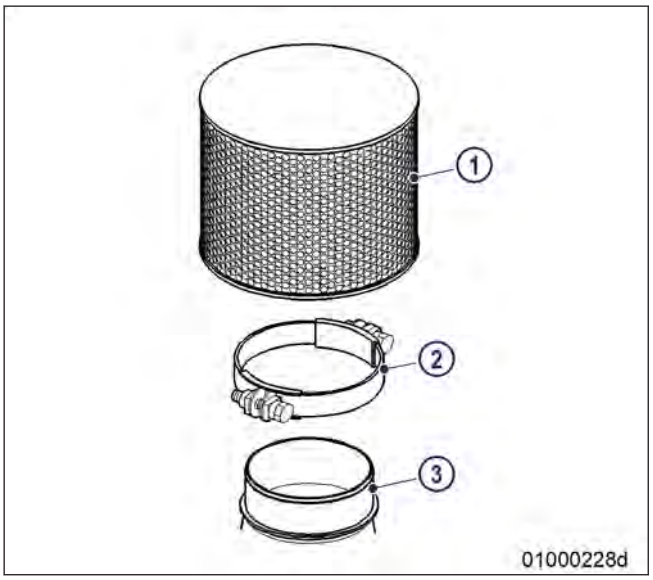
☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 4-20 Nm	F30044239	1

Air filter – Removal and installation

1. Release 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 connecting flange of the intake housing (3) and clean it.
4. Place new air filter (1) with clamp (2) onto intake housing (3).



5. Tighten screw on clamp (2) with torque wrench to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw	-	Tightening torque		5 Nm

7.10 Air Intake

7.10.1 Service indicator - Signal ring position check (optional)

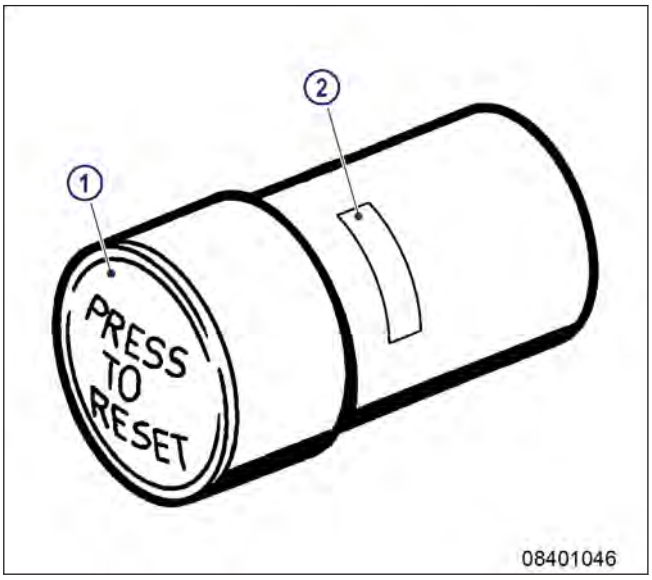
Preconditions

☑ 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 158).
2. After installation of new filter, press reset button (1).

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



7.11 Starting Equipment

7.11.1 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 193).

7.12 Lube Oil System, Lube Oil Circuit

7.12.1 Engine oil - Level check

Preconditions

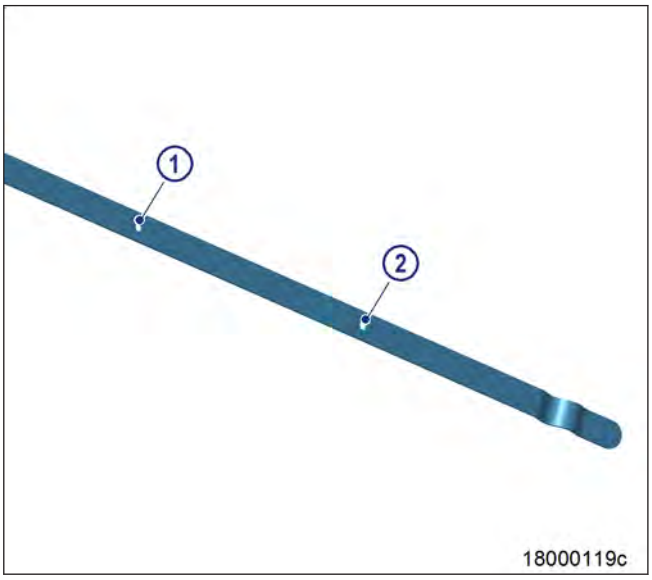
☑ Engine is stopped and starting disabled.

Oil level check prior to engine start

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

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

3. The oil level must reach mark (1) or exceed mark (1) by up to 2 cm.
4. Top up with oil to mark (1) as necessary (→ Page 163).
5. Insert dipstick into guide tube up to the stop.



Oil level check after the engine is stopped

1. 5 minutes after stopping the engine, remove oil dipstick from the guide tube and wipe it.
2. Insert dipstick into guide tube to stop, withdraw after approx. 10 seconds and check oil level.
3. Oil level must be between marks (1) and (2).
4. Top up with oil to mark (1) as necessary (→ Page 163).
5. Insert dipstick into guide tube up to the stop.

7.12.2 Engine oil - Change

Preconditions

☑ Engine is stopped and starting disabled.

☑ Engine is at operating temperature.

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

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench	F30027337	1
Ratchet	F30027341	1
Engine oil		
Sealing ring	(→ Spare Parts Catalog)	

WARNING

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

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

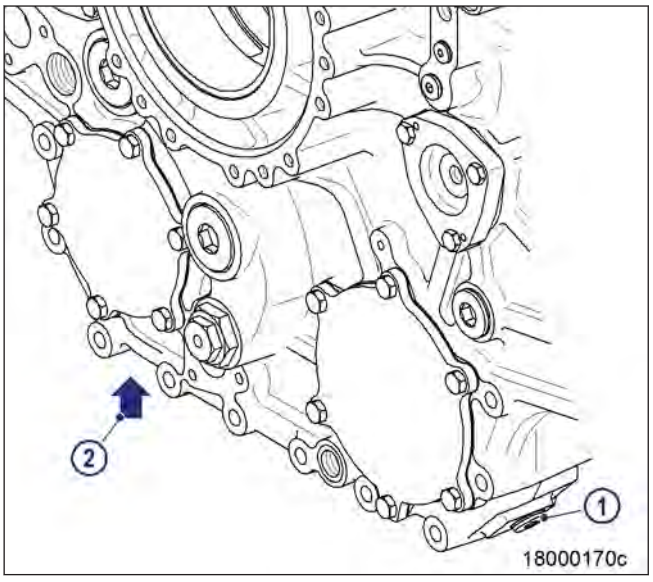
1. Provide a suitable container to collect the oil.
2. Remove drain plug(s) and drain oil.
3. Install drain plug(s) with new sealing ring.

Oil change using semirotary hand pump: Oil extraction

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

Draining residual oil at equipment carrier

1. Provide a suitable container to collect the oil.
2. Remove drain plugs (1) and (2) and drain oil:
   - Approx. 12 liters at (1)
   - Approx. 5 liters at (2)
3. Check oil indicator filter (→ Page 171).
4. Install drain plug(s) with new sealing ring.

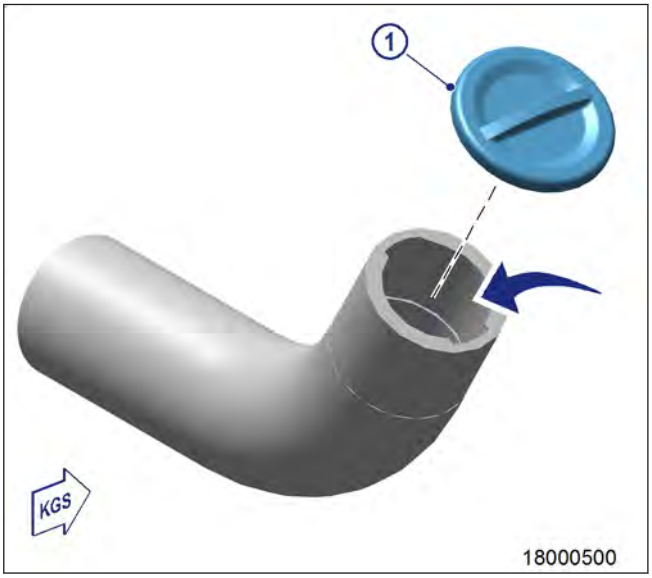


5. Tighten drain plugs (1) and (2) with torque wrench to the specified torque:

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

Filling with new oil

1. Open cover (1) on filler neck.
2. Pour oil in at filler neck up to "max." mark at oil dipstick.
3. Close cover (1) on filler neck.
4. Check engine oil level (→ Page 162).
5. After oil change, bar engine with starting system (→ Page 128).



7.12.3 Engine oil – Sample extraction and analysis

Preconditions

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

Special tools, Material, Spare parts

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

DANGER

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

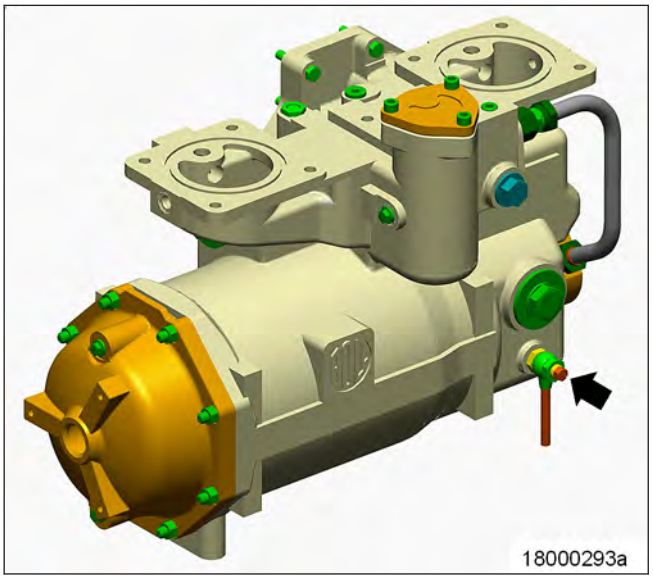
Hot oil.
Oil can contain combustion residues which are harmful to health.
Risk of injury and poisoning!
- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

WARNING

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

Engine oil sample extraction and analysis

1. With the engine running at operating temperature, open screw on automatic oil filter by 1 to 2 turns.
2. Drain approx. 2 liters engine oil to flush out the oil sludge.
3. Drain approx. 1 liter engine oil into a clean container.
4. Close screw.
5. Using the equipment and chemicals in the MTU test kit, analyze the engine oil for:
   - Dispersion capability (spot test);
   - Water content;
   - Dilution by fuel.



7.13 Oil Filtration / Cooling

7.13.1 Oil indicator filter - Cleaning

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Cleaner (Snow-White 11-0)	X00054118	1
Cleaner (Hakupur 312)	30390	1
Engine oil		
O-ring	(→ Spare Parts Catalog)	1
O-ring	(→ Spare Parts Catalog)	1
Strainer	(→ Spare Parts Catalog)	1

WARNING

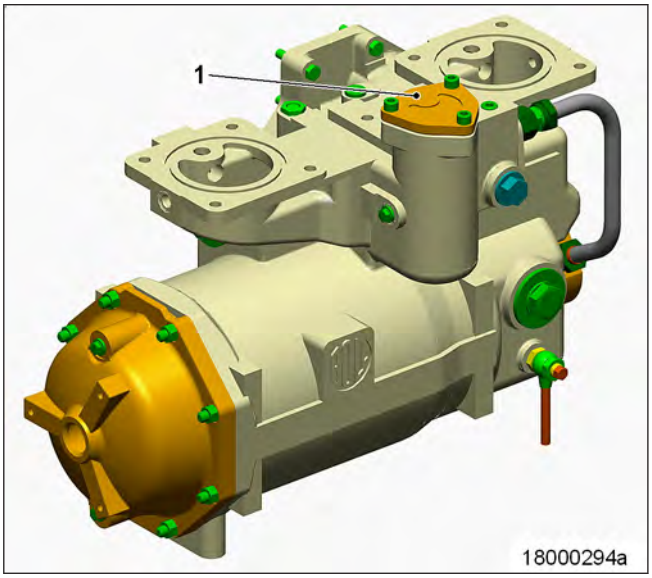
Hot oil.
Oil can contain combustion residues which are harmful to health.
Risk of injury and poisoning!
- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

WARNING

Compressed air 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 strainer

1. Remove cover (1).
2. Remove strainer from housing and allow oil to drip into container.



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Cleaning strainer

1. Shake coarse contamination out of strainer.
2. Clean all metallic parts with cleaner (Snow-White 11-0), then rinse with cleaner (Hakupur 312).
3. Use a soft brush to remove stubborn deposits from strainer if required. Ensure that the mesh is not damaged.
4. Carefully blow out strainer with compressed air from outside to inside.

Checking strainer

1. Check strainer for damage.
2. Fit new strainer if damaged or severely contaminated.

Installing strainer

1. Insert strainer with new O-ring into housing.
2. Fill housing with new engine oil.
3. Install cover (1) with new O-ring.

7.13.2 Automatic oil filter – Oil filter candles replacement

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Grease (Kluthe Hakuform 30-10/Emulgier)	X00029933	1
Engine oil		
O-ring	(→ Spare Parts Catalog)	
Oil filter candles	(→ Spare Parts Catalog)	

WARNING

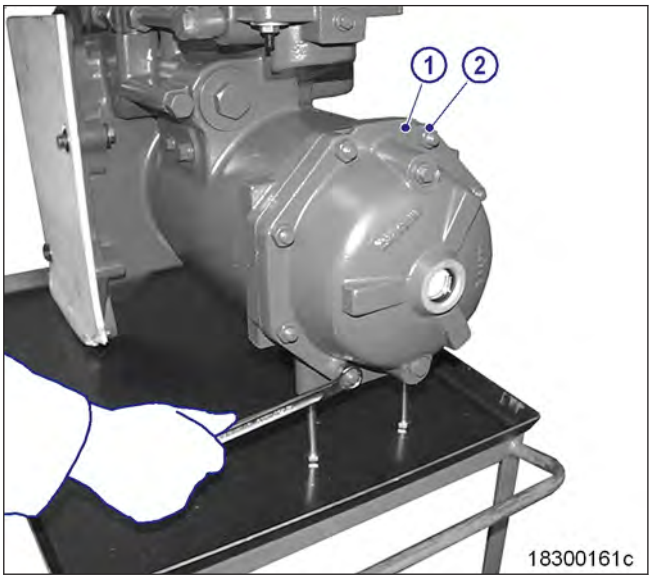
Hot oil.
Oil can contain combustion residues which are harmful to health.
Risk of injury and poisoning!
- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

NOTICE

Contamination of components.
Damage to component!
- Observe manufacturer's instructions.
- Check components for special cleanliness.

Removing oil filter candles

1. Remove nuts (2) from oil filter cover (1).
2. Remove oil filter cover (1).



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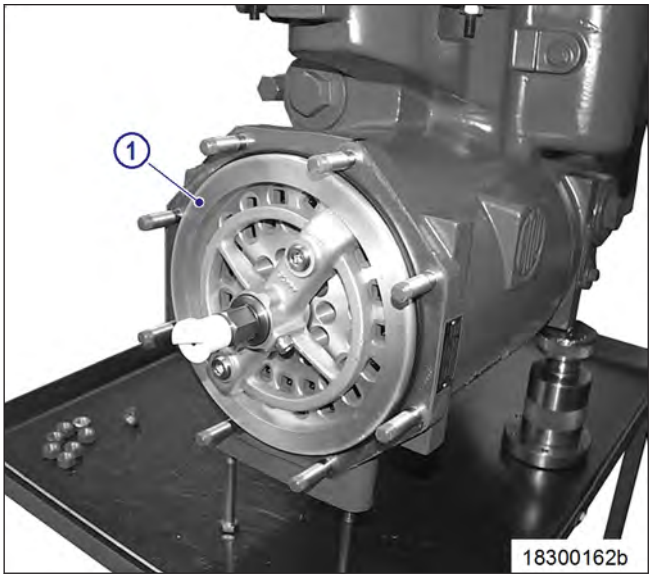
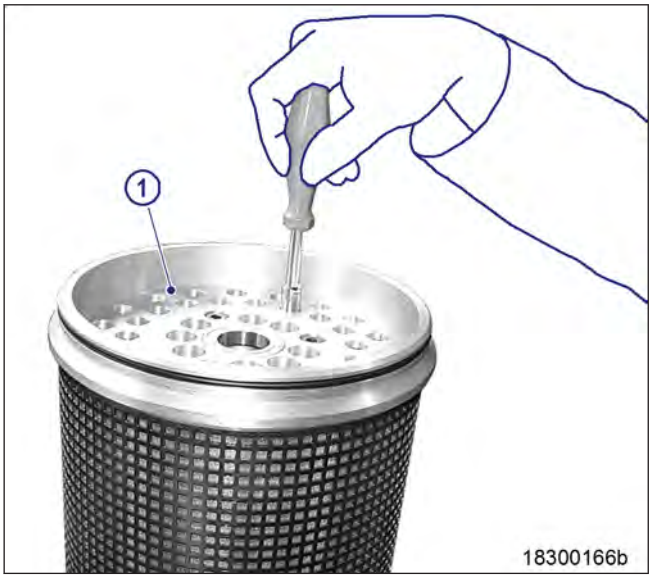
3. Withdraw oil filter element (1).
4. Remove O-ring.



5. Remove screw (2).
6. Withdraw plastic spinner (1) with spring.
7. Remove nut (3).
8. Take off spring washer and washer.
9. Remove screw (4).
10. Remove flushing arm (5) from screen plate (6).

11. Turn filter element by 180° and use appropriate tool to push out filter candles (1).
12. Turn filter insert by 180° and insert new filter candles (1) with chamfer facing downwards.



Installing oil filter candles

1. For installation follow reverse sequence of working steps.
2. Additionally, the following instructions are to be observed:
   - Replace all sealing elements.
   - Coat O-rings with grease.
   - Insert O-rings in grooves.
   - Observe position of cylinder screw to elongated hole on shaft.

7.13.3 Oil indicator filter – Cleaning and check

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Cleaner (Snow-White 11-0)	40460	1
Cleaner (Hakupur 312)	30390	1
Engine oil		
Strainer	(→ Spare Parts Catalog)	
Square-section ring	(→ 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.

WARNING

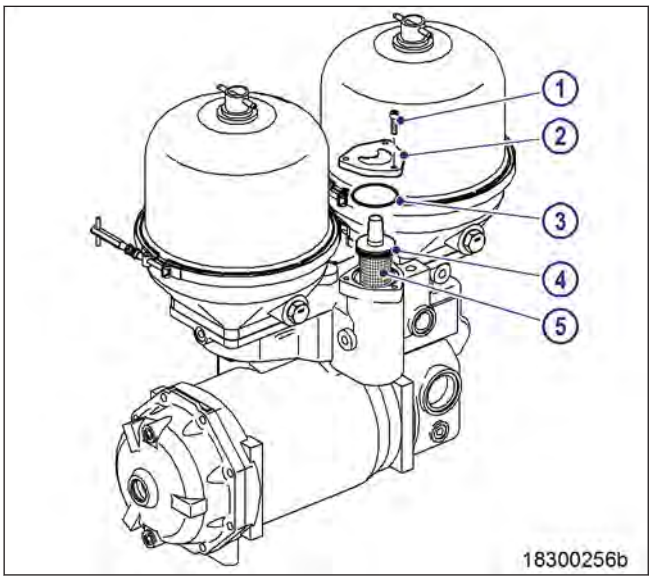
Compressed air gun ejects a jet of pressurized air.
Risk of injury to eyes and damage to hearing, risk of rupturing internal organs!
- Never direct air jet at people.
- Always wear safety goggles/face mask and ear defenders.

NOTICE

Inappropriate cleaning tool.
Risk of damage to component!
- Observe manufacturer's instructions.
- Use appropriate cleaning tool.

Removing strainer

1. Clean oil indicator filter before disassembling it.
2. Remove screws (1).
3. Take off cover (2) with O-ring (3).
4. Take strainer (5) from filter housing.



Checking strainer

Item	Findings	Measure
Strainer	Metallic residues	• Clean • Monitor engine operation • Check strainer daily • Contact Service
Strainer	Damaged	Fit new part
Square-section ring	Damaged	Fit new part
O-ring	Damaged	Fit new part

Cleaning strainer

1. Wash strainer (5) with cleaner.
2. Remove stubborn deposits with soft brush.
3. Blow out strainer (5) with compressed air from inside.

Installing strainer

1. Coat square-section ring (4) on strainer (5) with engine oil and install strainer (5).
2. Coat O-ring (3) with engine oil and fit in filter housing.
3. Fit cover (2) and secure with screws (1) and washers.

7.13.4 Centrifugal oil filter – Cleaning and filter-sleeve replacement

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 6-50 Nm	F30027336	1
Cold cleaner (Hakutex 60)	X00056750	1
Filter sleeve	(→ Spare Parts Catalog)	
Sealing ring	(→ Spare Parts Catalog)	

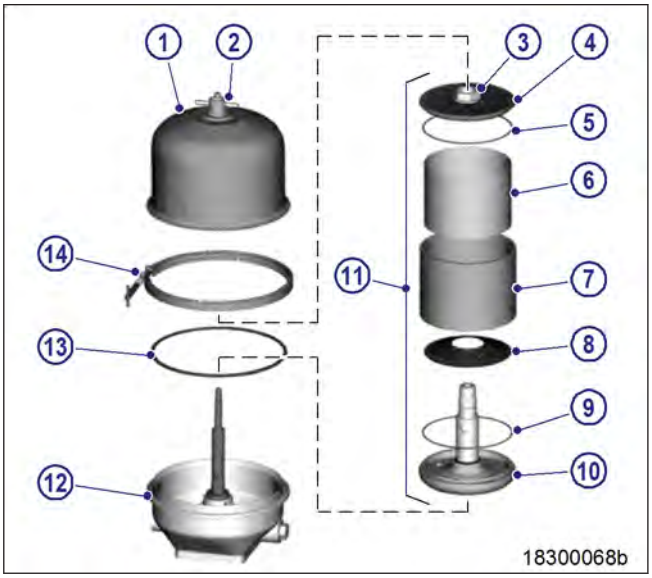
WARNING

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

WARNING

Compressed air 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.

Centrifugal oil filter – Cleaning and filter-sleeve replacement



1. Remove clamp (14).
2. Release cover screw (2) and take off cover (1).
3. Carefully lift rotor (11), allow oil to drain and remove from housing.
4. Holding the rotor (11) firmly, release rotor cover nut (3).
5. Take off rotor cover (4).
6. Remove filter sleeve (6).
7. Measure thickness of oil residues on filter sleeve (6).

Result: If the thickness of the oil residue layer exceeds the maximum value of 45 mm, shorten the maintenance interval.

8. Disassemble rotor tube (7), conical disk (8) and rotor base (10).
9. Wash rotor cover (4), rotor tube (7), conical disk (8) and rotor base (10) with cold cleaner.
10. Blow out with compressed air.
11. Check sealing ring (9), fit new one if necessary.
12. Assemble rotor tube (7), conical disk (8) and rotor base (10) with sealing ring (9).
13. Insert new filter sleeve (6) in rotor tube (7) with the smooth paper surface facing the wall.
14. Check sealing ring (5), fit new one if necessary.
15. Mount rotor cover (4) with sealing ring (5).
16. Tighten rotor cover nut (3) with torque wrench to the specified torque.

Name	Size	Type	Lubricant	Value/Standard
Nut		Tightening torque		35 Nm to 45 Nm

17. Place rotor (11) in housing (12) and check for ease of movement.
18. Check sealing ring (13), fit new one if necessary.
19. Fit sealing ring (13) on housing (12).
20. Fit cover (1).
21. Tighten cover screw (2) by hand.
22. Install clamp (14) and tighten with torque wrench to the specified torque.

Name	Size	Type	Lubricant	Value/Standard
Clamp		Tightening torque		8 Nm to 10 Nm

23. Tighten cover screw (2) with torque wrench to the specified torque.

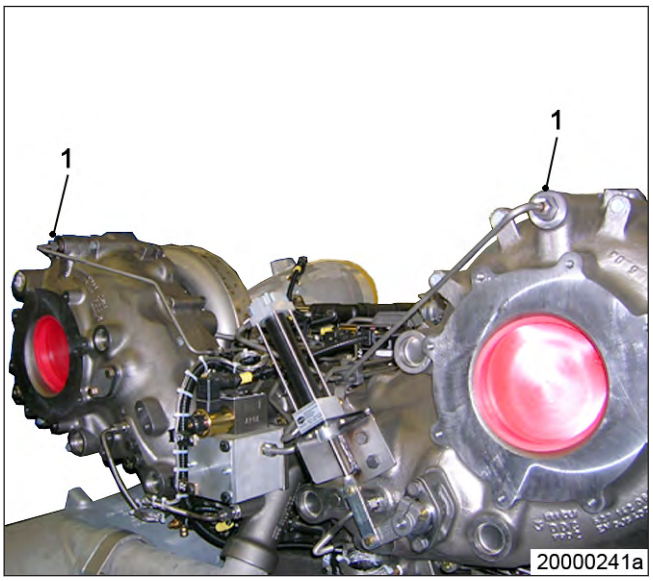
Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque		5 Nm to 7 Nm

7.14 Coolant Circuit, General, High-Temperature Circuit

7.14.1 Venting points

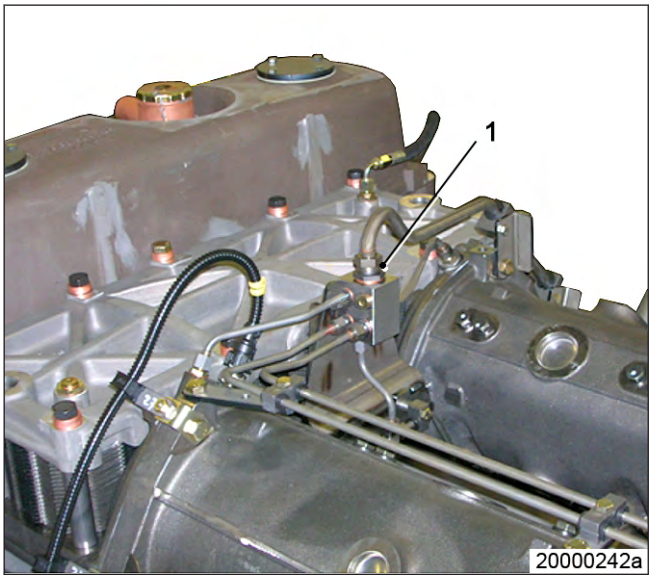
Coolant lines on ETC

1 Venting point



Vent line – Cross-distributionn expansion tank

1 Venting point



7.14.2 Engine coolant - Level check

Preconditions

☑ Engine is stopped and starting disabled.

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

WARNING

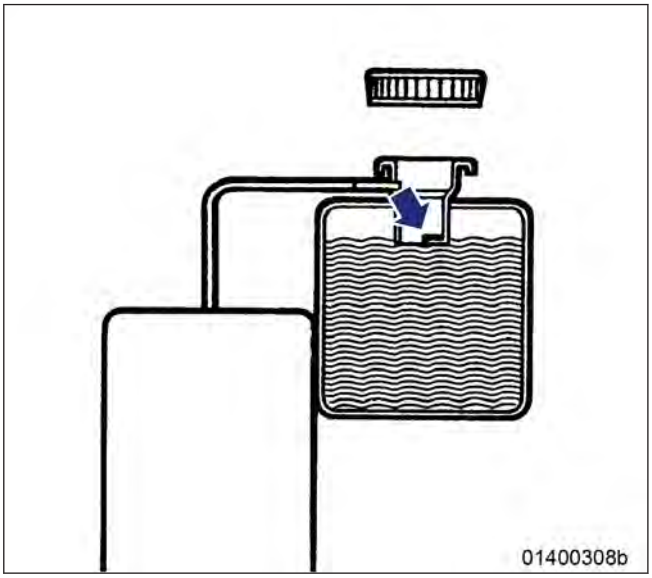
Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Checking engine coolant level at filler neck:

1. Turn breather valve on coolant expansion tank counterclockwise to the first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.
3. Check engine coolant level (coolant must be visible at the bottom edge of the filler neck's cast eye).

Checking engine coolant level at remote cooler:

1. Check engine coolant level (coolant must be visible at marker plate).
2. Top up engine coolant if necessary (→ Page 179).
3. Check and clean breather valve.
4. Place breather valve on filler neck and close.



Checking engine coolant level via level sensor:

1. Switch on engine control system and check readings on the display.
2. Top up engine coolant if necessary (→ Page 179).

7.14.3 Engine coolant - Change

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Coolant		

Engine coolant change

1. Drain engine coolant (→ Page 178).
2. Fill with engine coolant (→ Page 179).

7.14.4 Engine coolant draining

Preconditions

☑ Engine is stopped and starting disabled.

WARNING

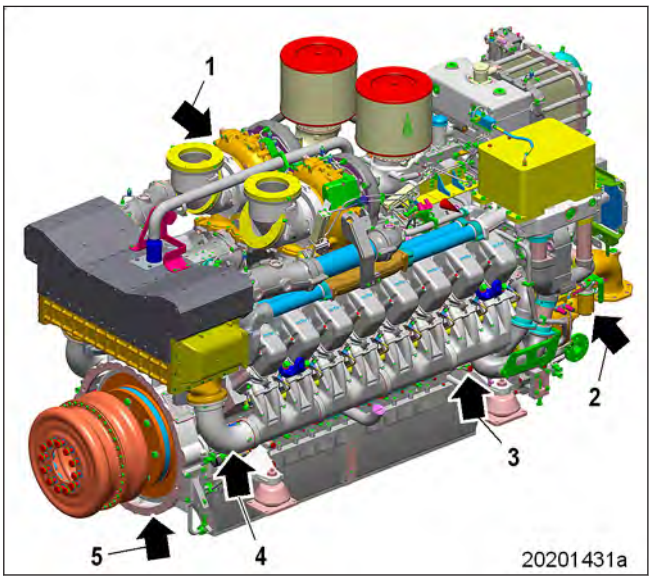
Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Preparatory steps

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

Engine coolant draining

1. Turn breather valve of filler neck on 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 the expansion tank through filler neck.
4. Open drain valves and drain plugs and drain coolant at the following points:
   - Preheating unit
   - Elbow of HT coolant pump (2)
   - Crankcase, left and right side (3)
   - T piece (5) on engine driving end;
   - Intercooler
   - Carrier housing (1)



Final steps

1. Seal all open drain points
2. Place breather valve onto filler neck and close it.

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7.14.5 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

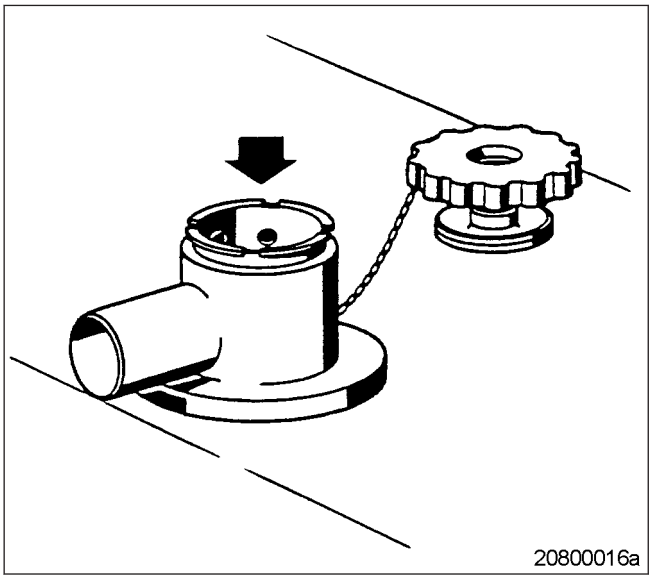
Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

NOTICE

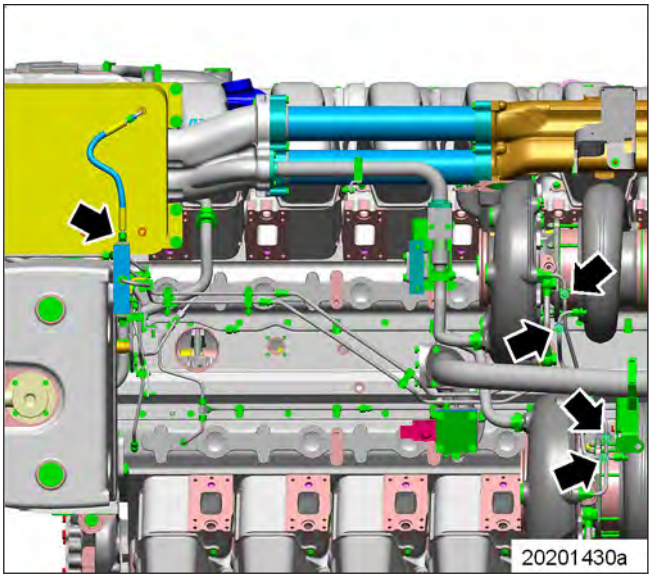
Cold coolant in hot engine can cause thermal stress.
Possible formation of cracks in the engine!
- Fill / top up coolant only into cold engine.

Preparatory steps

1. Turn breather valve on filler neck of expansion tank counterclockwise to first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.



Filling coolant through filler neck



1. Open vent points on distributor, oil heat exchanger and exhaust turbochargers (arrowed).
2. Fill in coolant in expansion tank via filler neck until coolant level at top edge of filler neck remains constant.
3. When coolant emerges from the vent points, close vent points one by one, proceeding from the lowest point upwards.
4. Check satisfactory condition of breather valve and clean sealing surfaces if required.
5. Place breather valve on filler neck and close until it engages (first lock).
6. Start engine (→ Page 73).
7. After 10 seconds of engine operation without load, shut down the engine (→ Page 82).
8. Turn breather valve counterclockwise and remove.
9. Check coolant level (→ Page 176) and top up engine coolant as required:
   a) Repeat the steps from “Start engine” (→ Step 6) until coolant no longer needs topping up.
   b) Check satisfactory condition of breather valve and clean sealing surfaces if required.
   c) Place breather valve on filler neck and close.

Final steps

1. Start engine and run without load for some minutes.
2. Check coolant level (→ Page 176) and top up coolant as required.

7.14.6 Engine coolant pump - Relief bore check

DANGER

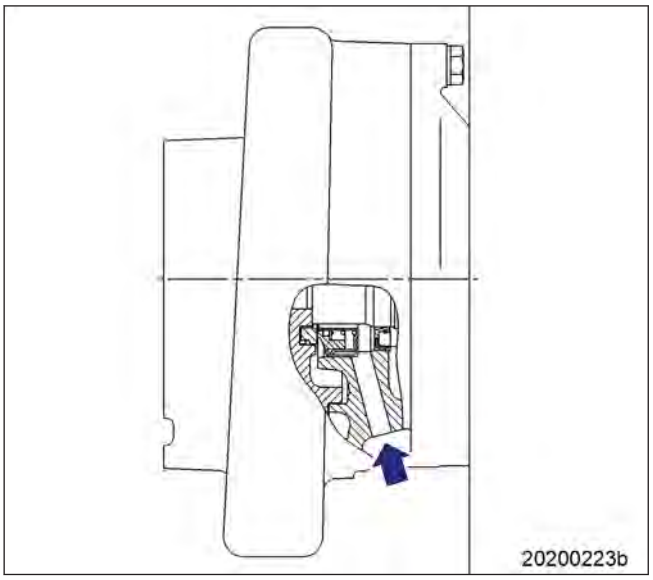
Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING

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

Engine coolant pump – Relief bore check

1. Check relief bore for oil and coolant discharge.
2. Stop engine (→ Page 73) and disable engine start, observe general safety instructions on maintenance and repair.
3. Clean the relief bore with a wire if it is dirty.
   - Permissible coolant discharge: up to 10 drops per hour;
   - Permissible oil discharge: up to 5 drops per hour.
4. If discharge exceeds the specified limits: Contact Service.



7.14.7 Engine coolant - Sample extraction and analysis

Preconditions

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

Special tools, Material, Spare parts

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

DANGER

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

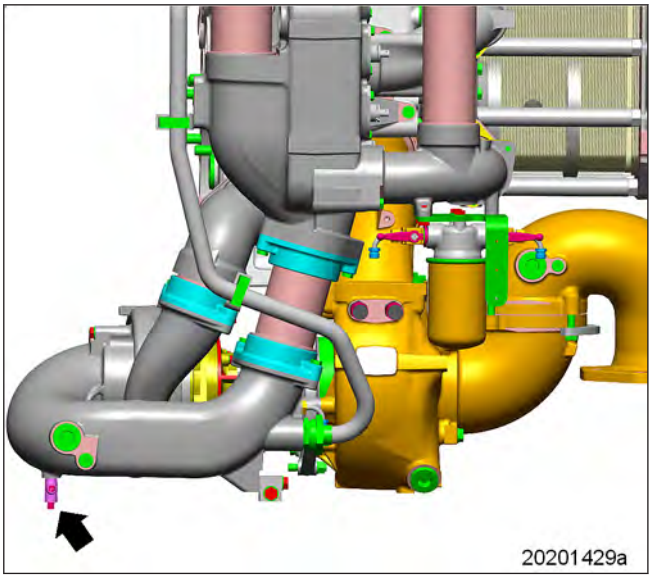
Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

WARNING

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

Engine coolant – Sample extraction and analysis

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



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7.15 Raw Water Pump with Connections

7.15.1 Raw water pump - Relief bore check

DANGER

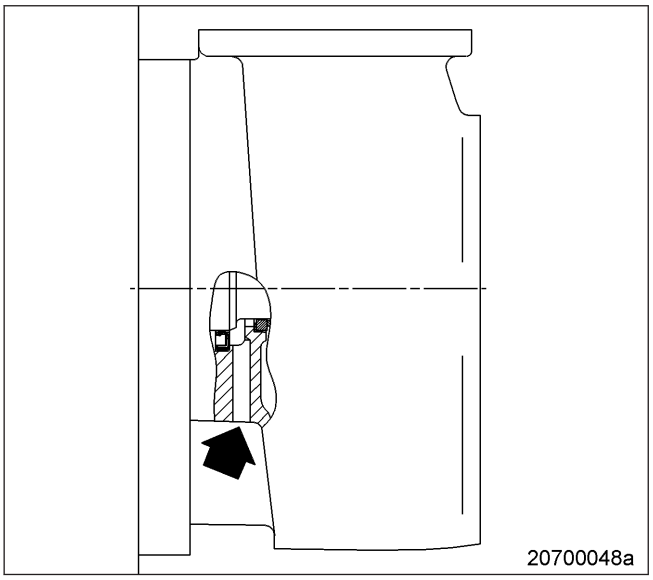
Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Only run the engine at low power. Keep away from the engine's danger zone.

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 raw water discharge.
2. Stop engine (→ Page 73) and disable engine start, observe general safety instructions on maintenance and repair.
3. Clean the relief bore with a wire if it is dirty.
   - Permissible raw water 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 Battery-Charging Generator

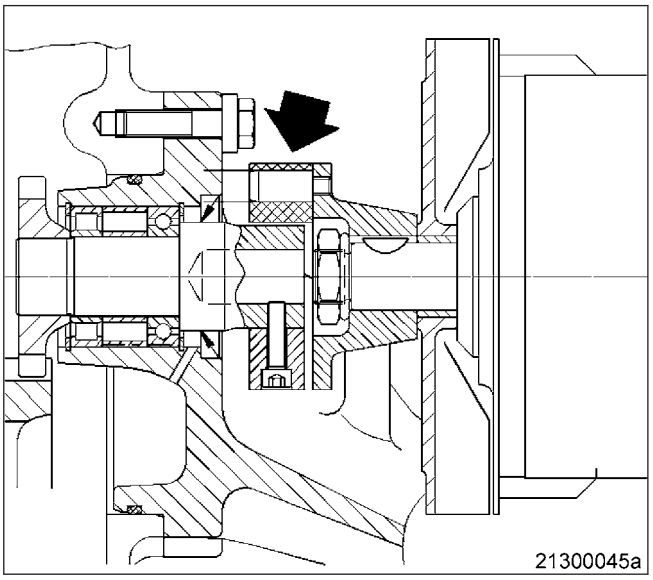
7.16.1 Battery-charging generator drive – Coupling condition check

Preconditions

☑ Engine is stopped and starting disabled.

Battery-charging generator drive – Coupling condition check

1. Remove protective cover.
2. Check resilient coupling for cracks (arrow) and plastic deformation.
3. In case of severe deformation or cracking: (→ Contact Service).
4. Install protective cover.



7.17 Engine Mounting / Support

7.17.1 Engine mounting – Check

Engine mounting – Check

Item	Findings	Action
Visually inspect mounts.	• Damage • Brittleness • Deformation • Crack formation • Swelling visible	Replace (contact Service).

7.18 Auxiliary PTO

7.18.1 Bilge pump - Relief bore check

DANGER

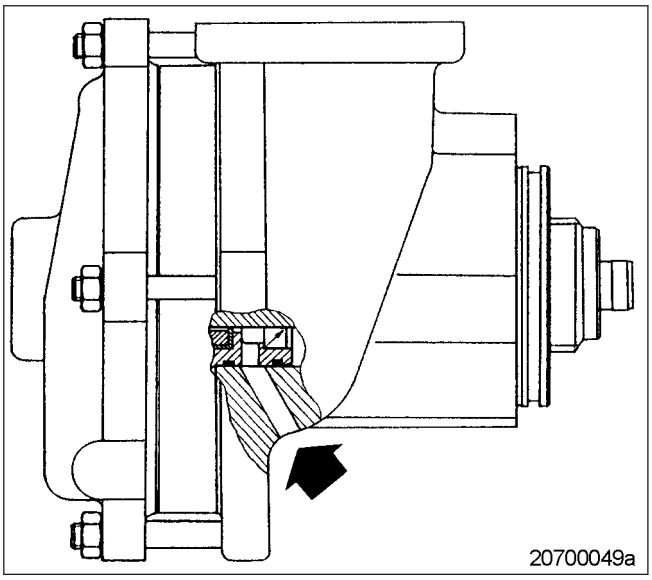
Rotating and moving engine parts.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING

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

Bilge pump – Relief bore check

1. Check relief bores for oil and water discharge.
2. Stop engine (→ Page 82) and disable engine start.
3. Clean relief bores with a wire if dirty.
   - Permissible water 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.



7.19 Fuel Supply System

7.19.1 Water drain valve – Check

Water drain valve – Check

1. Open water drain valve.
2. Check water outlet for obstructions.
3. Close water drain valve.

7.19.2 Differential pressure gauge - Check

WARNING

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

Checking differential pressure gauge

1. Switch on fuel treatment system (→ Page 81).
2. Set the alarm points at the differential pressure gauge to zero.

Result: Alarm is initiated with preset delay.

3. Reset the alarm points at the differential pressure gauge to the specified values.

7.19.3 Water level probe (3-in-1 rod electrode) – Check

Preconditions

☑ System is put out of operation and emptied.

WARNING

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

Checking water level probe (3-in-1 rod electrode)

1. Disconnect connector from water level probe.
2. Unscrew water level probe.
3. Disconnect connector from water level probe.
4. Immerse water level probe into a tank filled with water until water level reaches the thread.
5. Switch system on.

Result: Water drain valve opens.

6. Leave water level probe in tank.

Result: Alarm must be triggered with the preset delay.

7. Switch off the system.
8. Disconnect connector from water level probe.
9. Remove water level probe from tank.
10. Screw in water level probe.
11. Connect connector for water level probe.
12. Fill and vent the system then put it into operation.

7.19.4 Pump capacity - Check

WARNING

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

Pump capacity – Check

1. Install suitable pressure gauge at the neck of the intake side of the pump.
2. Check pump pressure.
   a) Switch on fuel treatment system (→ Page 81).

Note: The pressure limiting valve at the pump might respond and open. Audible noise is caused by overflowing fuel and can be disregarded.

   b) Close ball valve at the outlet of the fuel treatment system.
   c) Check pressure at the pressure gauge in the inlet to the fuel treatment system and note down.
3. Check pump pressure with reduced suction.
   a) Reduce suction pressure of pump to -0.8 bar with the shutoff valve at the pump intake side.
   b) Check pressure at the pressure gauge in the inlet to the fuel treatment system and note down.
   c) Open ball valve at inlet and outlet of fuel treatment system.
4. Calculate wear limit.

Example:	
Measured value (normal condition).	3 bar
Measured value (reduced suction condition).	2.6 bar
If the measured value (reduced suction condition) is 10% lower than the measured value (normal condition), the wear limit is reached. Repair pump (contact Service).	

7.19.5 Coalescer filter element – Replacement

Preconditions

☑ System is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 6-50 Nm	F30027336	1
Ratchet	F30027339	1
Diesel fuel		
Engine oil		
Coalescer filter element	(→ Spare Parts Catalog)	
Gasket	(→ Spare Parts Catalog)	

WARNING

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

NOTICE

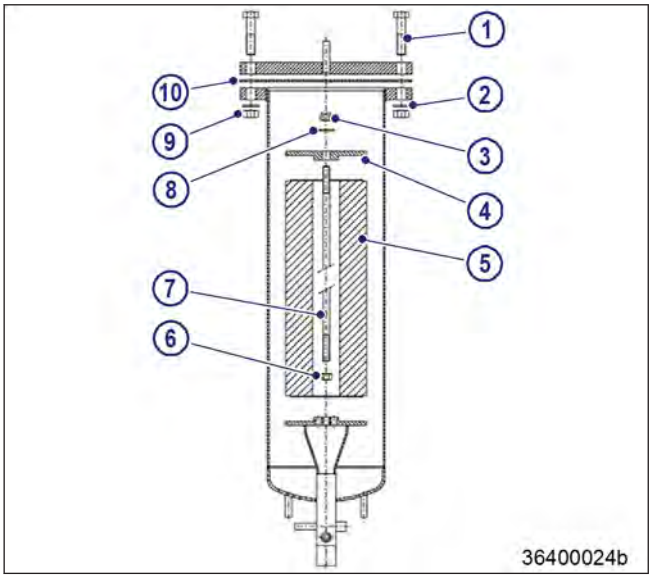
Contamination of components.
Damage to component!
- Observe manufacturer's instructions.
- Check components for special cleanliness.

NOTICE

Incorrect installation of components and lines.
Damage to component!
- Ensure that components/lines are installed so that they are never under tension or strain.
- Ensure correct installation position of components.

Coalescer filter element – Replacement

1. Close ball valve at the inlet and outlet of the fuel treatment system.
2. Open drain valve.
3. Drain fuel.
4. Close drain valve.
5. Remove nuts (9) and washers (2).
6. Remove screws (1).
7. Remove cover with gasket (10).
8. Remove nut (3), washer (8) and end plate (4).
9. Remove coalescer filter element (5).
10. Catch fuel as it runs out.
11. Clean housing with a non-linting cloth, rinse with fuel if required.
12. Check housing for corrosion.
13. Clean housing sealing surfaces.
14. Install coalescer filter element (5).
15. Install end plate (4), washer (8) and nut (3).



16. Tighten nut (3) to specified tightening torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Nut	M16	Tightening torque	(Engine oil)	30 Nm +3 Nm

17. Fit gasket (10).
18. Install cover.
19. Install screws (1), washers (2) and nuts (9).
20. Tighten nuts (9).
21. Open ball valve at the inlet and outlet of the fuel treatment system.

Result: The fuel treatment system is ready for operation.

7.20 Wiring (General) for Engine/Gearbox/Unit

7.20.1 Engine wiring - Check

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

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

Checking engine wiring

1. Check securing screws of cable clamps on engine and tighten loose threaded connections.
2. Ensure that cables are fixed in their clamps and cannot swing freely.
3. Check that cable clamps are firm, tighten loose cable clamps.
4. Replace faulty cable clamps.
5. 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.

6. Clean dirty connector housings, sockets and contacts using isopropyl alcohol.
7. Ensure that all sensor connectors are securely engaged.

7.21 Accessories for (Electronic) Engine Governor / Control System

7.21.1 CDC parameters - Reset with DiaSys®

Preconditions

☑ Engine is stopped and starting disabled.

Resetting CDC parameters (DiaSys® is available)

Note: The CDC parameters must be reset, otherwise the emission certification of the engine is no longer applicable.

▶ Reset the CDC parameters with DiaSys® (→ Manufacturer's documentation).

Resetting CDC parameters (DiaSys® is not available)

Note: The CDC parameters must be reset, otherwise the emission certification of the engine is no longer applicable.

▶ Contact Service.

7.21.2 EMU and connectors – Cleaning

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Isopropyl alcohol		

EMU and connectors – Cleaning

1. Remove coarse dirt from housing surface using a cloth moistened with isopropyl alcohol.
2. Remove dirt from the connector and cable surfaces with isopropyl alcohol.
3. Check legibility of cable labels. Clean or replace illegible labels.

Cleaning severely contaminated connectors on EMU

1. Release the latch and pull off connector.
2. Clean connector housings, connector socket housings and all contacts with isopropyl alcohol.
3. When connectors, sockets and all contacts are dry: Fit connectors and latch.

7.21.3 Limit switch for start interlock – Check

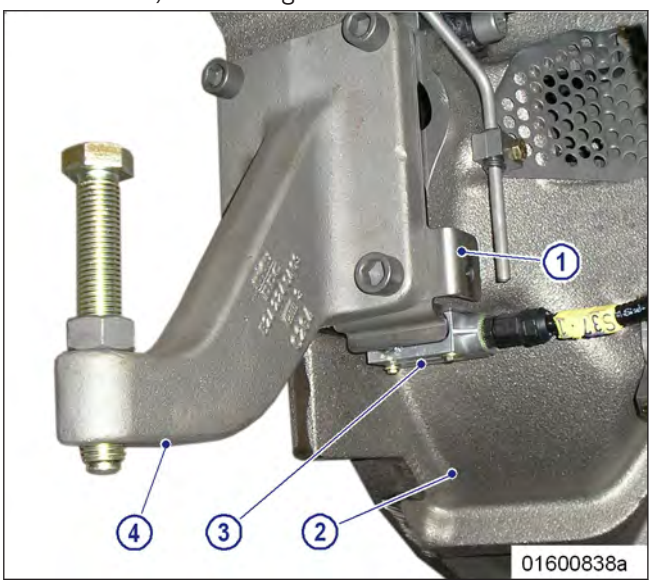
Preconditions

☑ Engine is stopped and starting disabled.

Note: In the OFF position, the limit switch initiates a start interlock, i.e. the engine cannot be started.

Checking limit switch for start interlock

1. Check whether switches (3) and guard plate (1) with engine support (4) are installed on both sides of flywheel housing (2).
2. Check whether both switches (3) are actuated.
3. If switches (3) and/or guard plate (1) with engine support (4) is/are not installed:
   - Screw on guard plate (1) with engine support (4).
   - Then screw on switch (3), ensuring that the switch (3) is actuated by the guard plate (1).
4. If switch (3) and guard plate (1) are installed, but switch (3) is in the OFF position:
   - Make certain that the guard plate (1) at the side of the switch (3) is not distorted.
   - Release guard plate (1) and screw on such that the switch (3) is actuated.



7.21.4 Engine governor and connectors – Cleaning

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

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

Note: Always use test connectors to enter the connectors. Never use test leads for this purpose.Otherwise the contacts could be bent.

Engine governor and connectors – Cleaning

1. Remove coarse dirt from housing surface with isopropyl alcohol.
2. Remove dirt from connector and cable surfaces with isopropyl alcohol.
3. Check legibility of cable labels. Clean or replace illegible labels.

Cleaning severely contaminated connectors on the engine governor

Note: Seal unused connectors with the supplied protective cap.

1. Release the latch and pull off connectors.
2. Clean connector housings, connector socket housings and all contacts with isopropyl alcohol.
3. When connectors, sockets and all contacts are dry: Fit connectors and lock them.

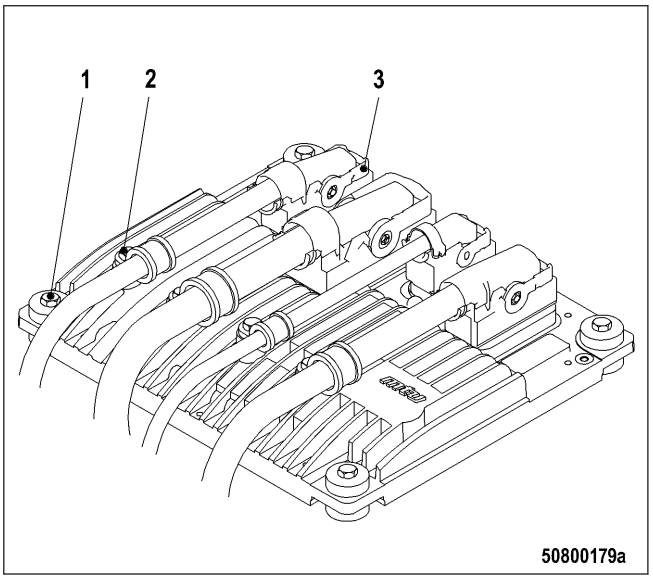
7.21.5 Engine Control Unit ECU 7 – Checking plug connections

Preconditions

☑ Engine is stopped and starting disabled.

Check plug connections on ECU 7

1. Check all connectors on ECU for firm seating. Ensure that clips (3) are engaged.
2. Check screws (2) of cable clamps on ECU for firm seating. Ensure that cable clamps are not faulty.



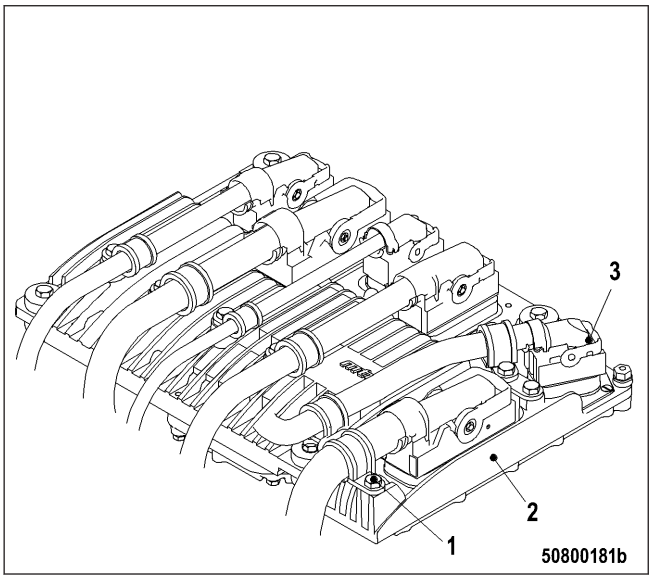
7.21.6 Engine Monitoring Unit EMU 8 – Plug connections check

Preconditions

☑ Engine is stopped and starting disabled.

Checking EMU plug connections

1. Check both connectors on EMU (2) for firm seating. Make sure that clips (3) are engaged.
2. Check screws (1) of cable clamps on EMU (2) for firm seating. Make sure that cable clamps are not defective.



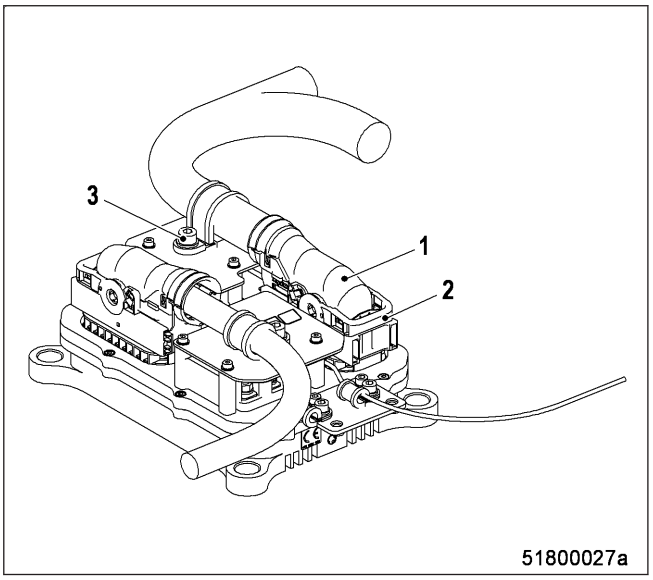
7.21.7 Interface module plug connections - Check

Preconditions

☑ Engine is stopped and starting disabled.

Checking EIM plug connections

1. Check both Tyco plugs (62-pole) (1) on EIM for firm seating. Make sure that the clips (2) are engaged.
2. Check screws (3) of cable clamps on EIM for firm seating. Ensure that cable clamps are not faulty.



7.21.8 ECU 7 engine governor - Removal and installation

Preconditions

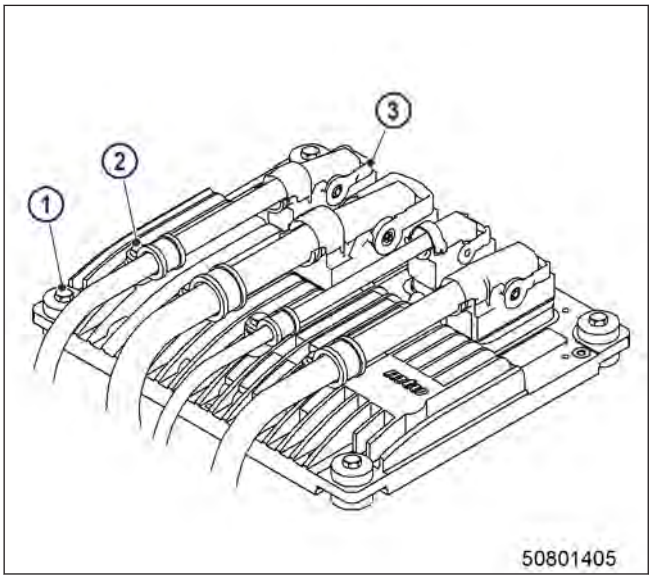
☑ Engine is stopped and starting disabled.

NOTICE

Wrong engine governor installed.
Engine damage!
- When reassembling an engine, make sure that the governor with the data record for the given engine is installed.

Removing engine governor from engine

1. Note or mark assignment of cables and connectors.
2. Remove all screws (2).
3. Undo latches (3) of the connectors.
4. Disconnect all connectors.
5. Remove screws (1).
6. Take off engine governor.



Installing engine governor on engine

1. Install in reverse order. Ensure correct assignment of connectors and sockets in so doing.
2. Check resilient mount before installing.

Result: Replace resilient mount if porous or defective.

7.21.9 EMU 8 - Removal and installation

Preconditions

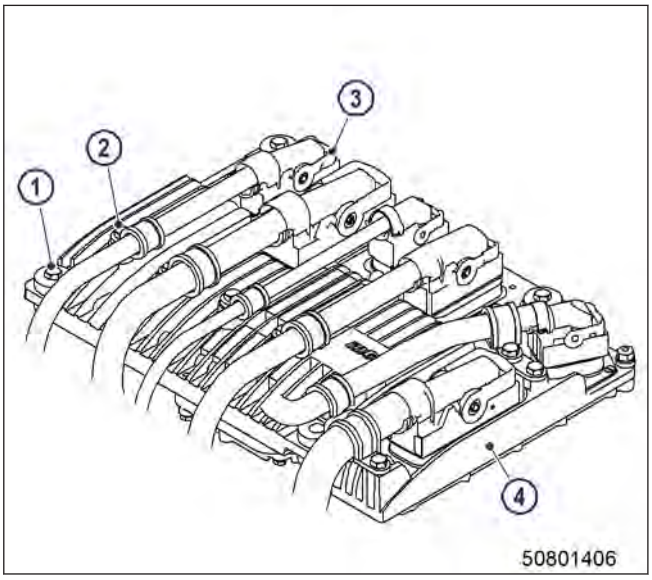
☑ Engine is stopped and starting disabled.

NOTICE

Wrong engine governor installed.
Engine damage!
- When reassembling an engine, make sure that the governor with the data record for the given engine is installed.

Remove ECU with EMU from engine

1. Note or mark assignment of cables and connectors.
2. Remove all screws (2).
3. Undo clips (3) on connectors.
4. Disconnect all connectors.
5. Remove screws (1).
6. Remove ECU (1) with EMU (4).



Removing EMU

1. Unscrew screws on base of EMU (4).
2. Remove EMU (4) from ECU (1).

Installing EMU

1. Place EMU (4) on ECU (1).
2. Screw in and tighten screws on base of EMU (4).

Installing ECU with EMU on engine

1. Install in reverse order. Ensure correct assignment of plugs and sockets.
2. Check resilient mount before installing.

Result: If resilient mount is porous or defective then replace it.

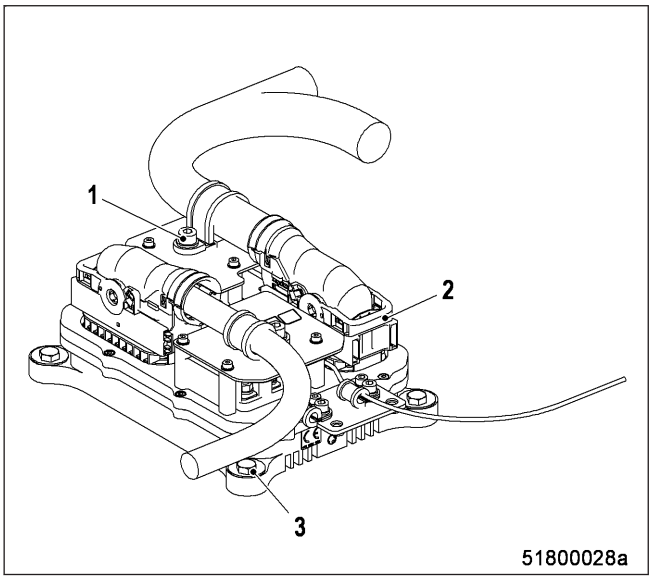
7.21.10 Engine Interface Module EIM - Removal and installation

Preconditions

☑ Engine is stopped and starting disabled.

Removing EIM from the engine

1. Note or mark assignment of cables and connectors.
2. Unscrew all screws (1).
3. Undo clips (2) on connectors.
4. Disconnect all connectors.
5. Unscrew power and starter cable.
6. Remove screws (3).
7. Take off EIM.



Installing EIM on the engine

1. Install in reverse order. When doing so, observe correct assignment between cables and plugs.
2. Check seal before installing.

Result: Replace seal if porous or defective.

Downloading software

1. The new EIM still does not have appropriate FSW and parameter/descriptor module (the diagnostic lamp (DILA) indicates flashing code 4 when the power supply is connected, (→ Page 204)).
2. The FSW and the parameter/descriptor module must first be downloaded from the central database (CDB) based on the relevant engine number using the DiaSys software tool, and then loaded in the EIM.

7.21.11 Diagnostic features of EIM

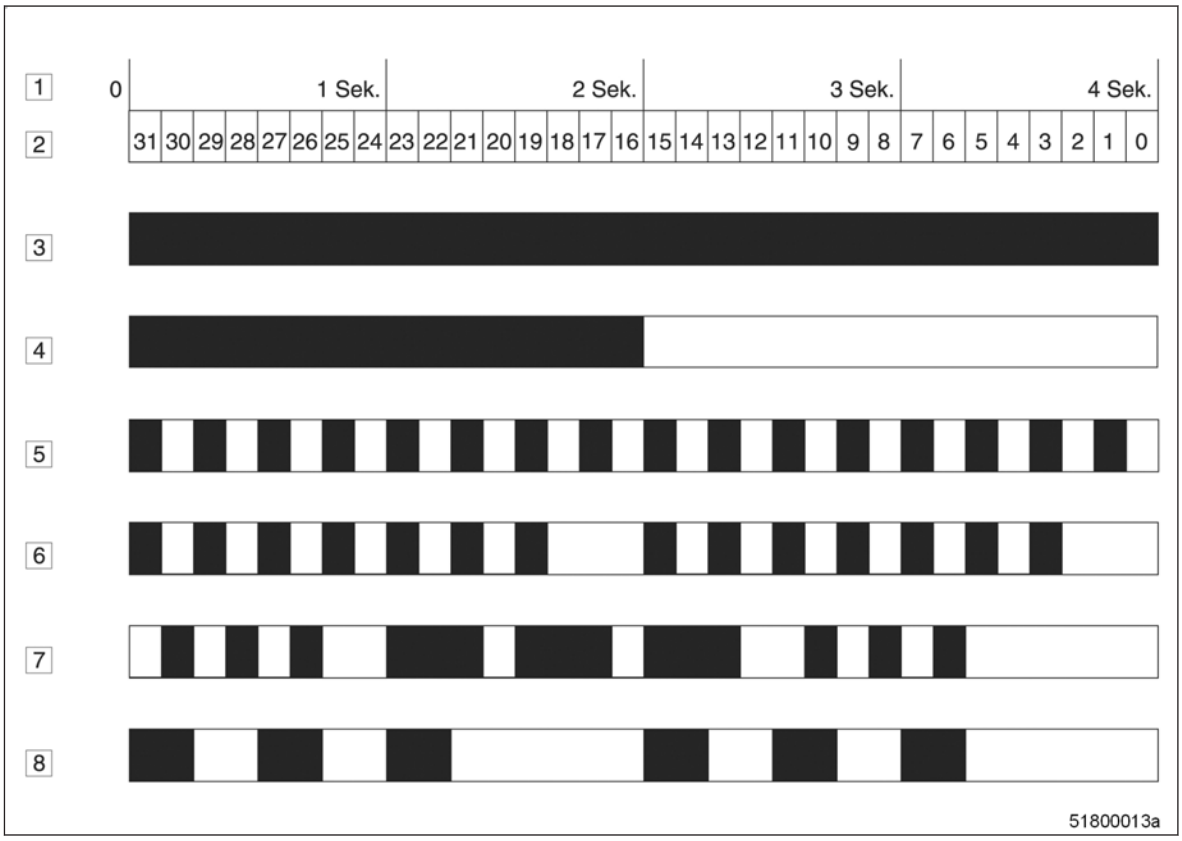
Diagnostic lamp (DILA)

A diagnostic lamp (LED, blue) is integrated in the housing of the Engine Interface Module (EIM).

It indicates the operating status of the EIM.

Functions of diagnostic lamp DILA	
DILA lights	Engine Interface Module (EIM) is OK
DILA dark	EIM supply voltage missing or diagnostic lamp activation is faulty.
DILA flashes	Hardware or software fault in the Engine Interface Module.

The diagnostic lamp (DILA) signals the following states:



1 Time in seconds
2 Timing: 1/8 s
3 Ready for operation
4 Application loader active
5 External RAM faulty
6 External FLASH faulty
7 No firmware
8 Application crashed

Fuse lamp (SILA)

A second indicator is the fuse lamp.

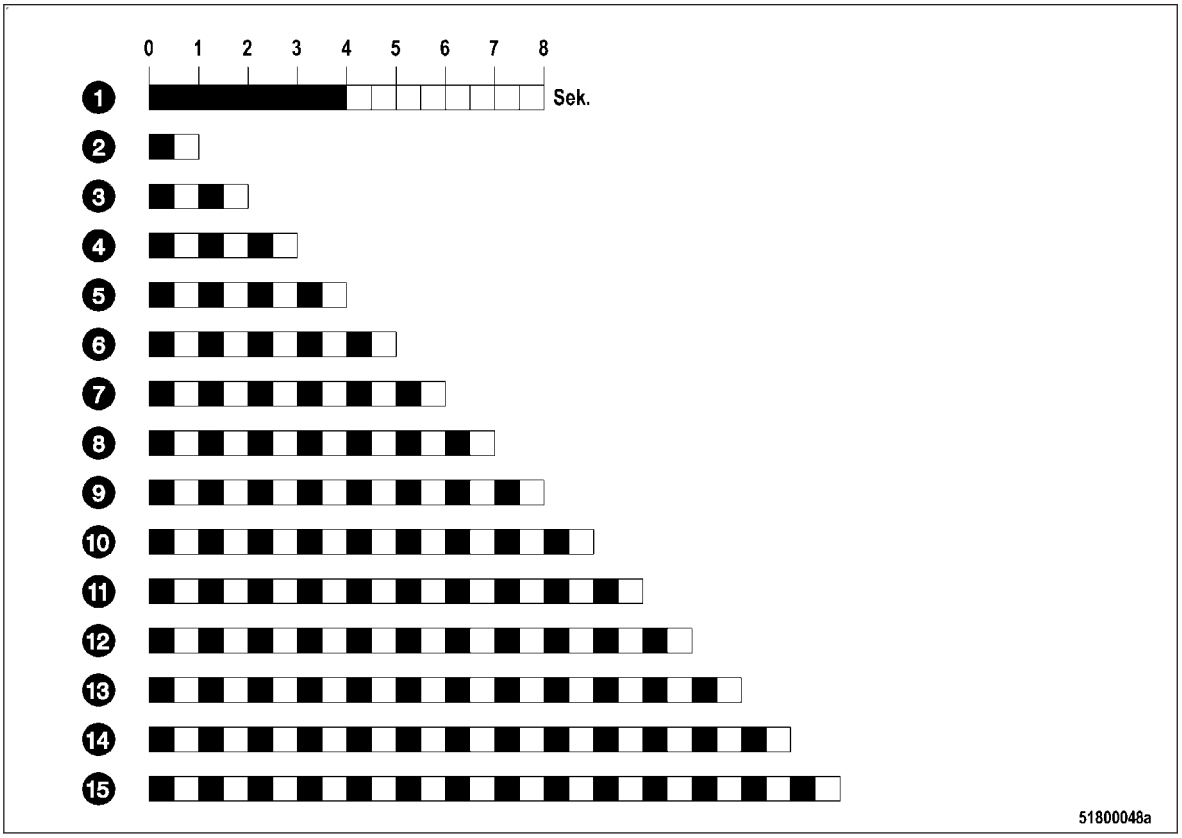
This is also integrated in the housing of the Engine Interface Module. It indicates the status of the fuses.

An orange LED is provided to allow diagnosis of a “tripped fuse” fault directly at the unit as it is often difficult to pinpoint a fault in the field without cabling diagrams.

This LED is activated by the controller.

Functions of fuse lamp SILA	
SILA dark	Norma operating state.
SILA flashes orange	One or more fuses have tripped.

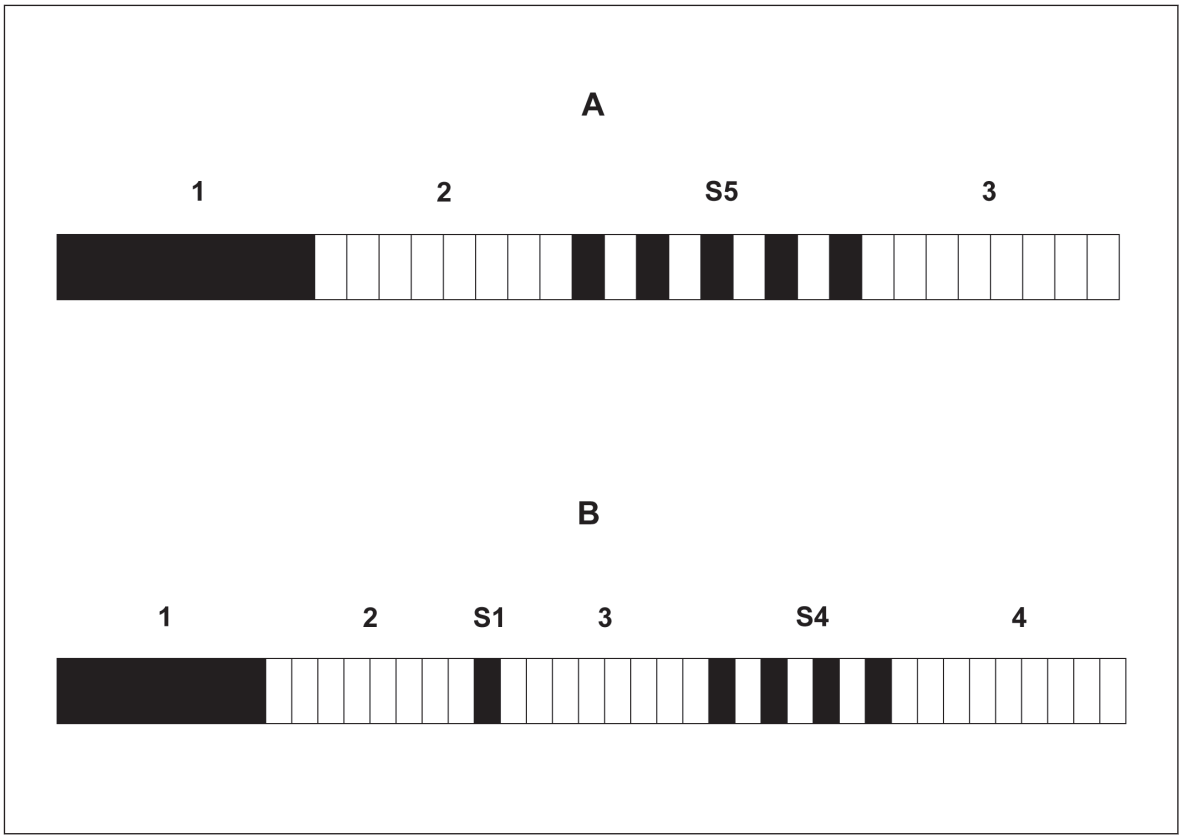
The fuse lamp (SILA) signals the following states:



1 Preamble
2 ECU current path failed (S1)
3 MCS current path failed (S2)
4 EMU current path failed (S3)
5 Starter voltage: Terminal 30, 31 not connected and PR 10.0600.001 has value 1 or 2 (S4)
6 VSP current path failed (S5)
7 SLD current path failed (S6)
8 DDV current path failed (S7)
9 Gear monitoring current path failed (S8)
10 Emergency stop current path failed – 24V internal (S9)
11 ES pushbutton current path failed – 24V external (S10)
12 Key switch current path failed (S11)
13 SDAF 1+2 current path failed (S12)
14 PIM current path failed (S13)
15 Spare current path failed (S14)

The failed current paths are signaled consecutively following the preamble (LED on for 4 seconds (1)). There is a pause lasting 4 seconds in between.

Sample flashing sequences



A Fuse S5 failure (1/2 second steps)

B Fuse S1 and fuse S4 failure (1/2 second steps)

Note:

These bit sequences are transmitted constantly.

Information about the status of the current paths of the EIM is also provided in the CAN message "Status internal power supply".

7.22 Emergency Instrumentation (Local Operating Panel)

7.22.1 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.

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
BR	Baureihe	Series
BV	Betriebsstoffvorschrift	MTU Publication No. A01061/..
CAN	Controller Area Network	Data bus system, bus standard
CPP	Controllable Pitch Propeller	
DILA	Diagnostic lamp	on EIM
DIN	Deutsches Institut für Normung e. V.	At the same time identifier of German standards (DIN = “Deutsche Industrie-Norm”)
DIS	Display unit	Display panel
DL	Default Lost	Alarm: Default CAN bus failure
ECS	Engine Control System	Engine management system
ECU	Engine Control Unit	Engine governor
EDM	Engine Data Module	Memory module for engine data
EIM	Engine Interface Module	Interface to engine monitoring system
EMU	Engine Monitoring Unit	Engine monitoring unit
ETK	Ersatzteilkatalog	Spare Parts Catalog
FPP	Fixed Pitch Propeller	Fixed pitch propeller
GCU	Gear Control Unit	Gear control unit
GMU	Gear Monitoring Unit	Gear monitoring unit
HAT	Harbour Acceptance Test	
HI	High	Alarm: Measured value exceeds 1st maximum limit
HIHI	High High	Alarm: Measured value exceeds 2nd maximum limit
HT	High Temperature	
ICFN	ISO - Continuous rating - Fuel stop power - Net	Engine power rating as per DIN-ISO 3046-7
IDM	Interface Data Module	Memory module for interface data
IMO	International Maritime Organization	
ISO	International Organization for Standardization	International umbrella organization for all national standardization institutes
KGS	Kraftgegenseite	Engine free end in accordance with DIN ISO 1204
KS	Kraftseite	Engine driving end in accordance with DIN ISO 1204
LCD	Liquid Crystal Display, Liquid Crystal Device	Liquid crystal display
LCU	Local Control Unit	Local control unit (LOP subassembly)

Abbreviation	Meaning	Explanation
LED	Light Emitting Diode	Light emitting diode
LMU	Local Monitoring Unit	Local monitoring unit (LOP subassembly)
LO	Low	Alarm: Measured value lower than 1st minimum limit
LOLO	Low Low	Alarm: Measured value lower than 2nd minimum limit
LOP	Local Operating Panel	Control console, control panel
LOS	Local Operating Station	Local operating station
MCS	Monitoring and Control System	
MG	Message	
MPU	Microprocessor Unit, Microprocessing Unit	Microprocessor (unit)
OT	Oberer Totpunkt	Top Dead Center
P-xyz	Pressure-xyz	Pressure measuring point xyz
PAN	Panel	Control panel
PCU	Propeller Control Unit	
PIM	Peripheral Interface Module	
RCS	Remote Control System	
RL	Redundancy Lost	Alarm: Redundant CAN bus failure
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)
SILA	Sicherungslampe	Fuse lamp on EIM
SOLAS	International Convention for the Safety of Life at Sea	
SS	Safety System	Safety system alarm
SSK	Schnellschlussklappe(n)	Emergency-air shutoff flap(s)
T-xyz	Temperature-xyz	Temperature measuring point xyz
TD	Transmitter Deviation	Alarm: Sensor comparison fault
UT	Unterer Totpunkt	Bottom Dead Center
VS	Voith Schneider	Voith Schneider drive
WJ	Water Jet	Water jet drive
WZK	Werkzeugkatalog	Tool Catalog
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 Index

T

V

W

9.2 Spare Parts

Air filter	
Part No.:	
Qty.: Used in:	7.9.1 Air filter – Replacement (→ Page 158)

Coalescer filter element	
Part No.:	
Qty.: Used in:	7.19.5 Coalescer filter element – Replacement (→ Page 191)

Easy-change filter	
Part No.:	
Qty.: Used in:	7.6.1 Fuel filter – Replacement (→ Page 147)

Filter element	
Part No.:	
Qty.: Used in:	7.6.5 Fuel prefilter – Filter element replacement (→ Page 153)

Filter sleeve	
Part No.:	
Qty.: Used in:	7.13.4 Centrifugal oil filter – Cleaning and filter-sleeve replacement (→ Page 173)

Gasket	
Part No.:	
Qty.: Used in:	7.3.3 Cylinder head cover – Removal and installation (→ Page 138)
Qty.: Used in:	7.6.3 Fuel prefilter – Draining (→ Page 150)
Qty.: Used in:	7.6.5 Fuel prefilter – Filter element replacement (→ Page 153)
Qty.: Used in:	7.19.5 Coalescer filter element – Replacement (→ Page 191)

Injector	
Part No.:	
Qty.: Used in:	7.5.1 Injector – Replacement (→ Page 141)

O-ring	
Part No.:	
Qty.: Used in:	7.5.2 Injector – Removal and installation (→ Page 142)
Qty.: Used in:	1 7.13.1 Oil indicator filter – Cleaning (→ Page 166)
Qty.: Used in:	1 7.13.1 Oil indicator filter – Cleaning (→ Page 166)
Qty.: Used in:	7.13.2 Automatic oil filter – Oil filter candles replacement (→ Page 168)
Qty.: Used in:	7.13.3 Oil indicator filter – Cleaning and check (→ Page 171)

Oil filter candles	
Part No.:	
Qty.: Used in:	7.13.2 Automatic oil filter – Oil filter candles replacement (→ Page 168)

Seal	
Part No.:	
Qty.: Used in:	7.6.4 Fuel prefilter – Flushing (→ Page 151)

Sealing ring	
Part No.:	
Qty.: Used in:	7.12.2 Engine oil – Change (→ Page 163)
Qty.: Used in:	7.13.4 Centrifugal oil filter – Cleaning and filter-sleeve replacement (→ Page 173)

Square-section ring	
Part No.:	
Qty.: Used in:	7.13.3 Oil indicator filter – Cleaning and check (→ Page 171)

Strainer	
Part No.:	
Qty.: Used in:	1 7.13.1 Oil indicator filter – Cleaning (→ Page 166)
Qty.: Used in:	7.13.3 Oil indicator filter – Cleaning and check (→ Page 171)

Synthetic ring	
Part No.:	
Qty.: Used in:	7.6.1 Fuel filter – Replacement (→ Page 147)

9.3 Consumables

Assembly paste (Optimoly Paste White T)	
Part No.:	40477
Qty.: Used in:	1 7.5.2 Injector – Removal and installation (→ Page 142)

Cleaner (Hakupur 312)	
Part No.:	30390
Qty.: Used in:	1 4.22 Plant – Cleaning (→ Page 93)
Qty.: Used in:	1 7.13.1 Oil indicator filter – Cleaning (→ Page 166)
Qty.: Used in:	1 7.13.3 Oil indicator filter – Cleaning and check (→ Page 171)

Cleaner (Snow-White 11-0)	
Part No.:	X00054118
Qty.: Used in:	1 7.13.1 Oil indicator filter – Cleaning (→ Page 166)

Cleaner (Snow-White 11-0)	
Part No.:	40460
Qty.: Used in:	1 7.13.3 Oil indicator filter – Cleaning and check (→ Page 171)

Cold cleaner	
Part No.:	X00056750
Qty.: Used in:	1 7.7.1 Compressor wheel – Cleaning (→ Page 155)

Cold cleaner (Hakutex 60)	
Part No.:	X00056750
Qty.: Used in:	1 7.13.4 Centrifugal oil filter – Cleaning and filter-sleeve replacement (→ Page 173)

Coolant	
Part No.:	
Qty.: Used in:	 7.14.3 Engine coolant – Change (→ Page 177)

Diesel fuel	
Part No.:	
Qty.: Used in:	7.6.1 Fuel filter – Replacement (→ Page 147)
Qty.: Used in:	7.6.3 Fuel prefilter – Draining (→ Page 150)
Qty.: Used in:	7.6.5 Fuel prefilter – Filter element replacement (→ Page 153)
Qty.: Used in:	7.19.5 Coalescer filter element – Replacement (→ Page 191)

Engine coolant	
Part No.:	
Qty.: Used in:	7.14.5 Engine coolant – Filling (→ Page 179)

Engine oil	
Part No.:	
Qty.: Used in:	7.3.1 Valve gear – Lubrication (→ Page 133)
Qty.: Used in:	7.3.2 Valve clearance – Check and adjustment (→ Page 134)
Qty.: Used in:	7.4.1 HP pump – Filling with engine oil (→ Page 139)
Qty.: Used in:	7.5.2 Injector – Removal and installation (→ Page 142)
Qty.: Used in:	7.12.2 Engine oil – Change (→ Page 163)
Qty.: Used in:	7.13.1 Oil indicator filter – Cleaning (→ Page 166)
Qty.: Used in:	7.13.2 Automatic oil filter – Oil filter candles replacement (→ Page 168)
Qty.: Used in:	7.13.3 Oil indicator filter – Cleaning and check (→ Page 171)
Qty.: Used in:	7.19.5 Coalescer filter element – Replacement (→ Page 191)

Fuel	
Part No.:	
Qty.: Used in:	7.6.4 Fuel prefilter – Flushing (→ Page 151)

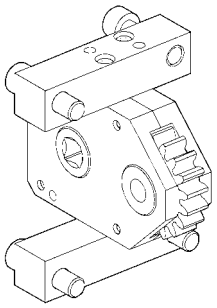
Grease (Kluthe Hakuform 30-10/Emulgier)	
Part No.:	X00029933
Qty.: Used in:	1 7.5.2 Injector – Removal and installation (→ Page 142)
Qty.: Used in:	1 7.13.2 Automatic oil filter – Oil filter candles replacement (→ Page 168)

Isopropyl alcohol	
Part No.:	X00058037
Qty.: Used in:	1 7.20.1 Engine wiring – Check (→ Page 193)
Qty.: Used in:	1 7.21.4 Engine governor and connectors – Cleaning (→ Page 197)

Isopropyl alcohol	
Part No.:	X00058037
Qty.: Used in:	1 7.22.1 LOP and connectors – Cleaning (→ Page 207)

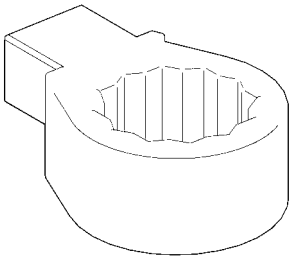
9.4 Special Tools

Barring device



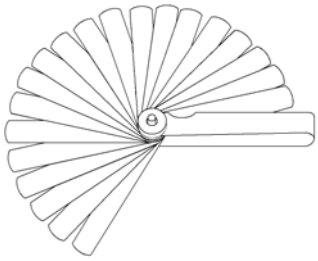
Part No.:	F6555766
Qty.:	1
Used in:	7.1.1 Engine – Barring manually (→ Page 127)

Box wrench socket, 24 mm



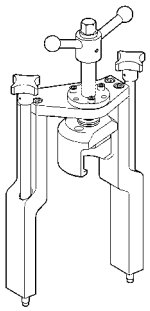
Part No.:	F30039526
Qty.:	1
Used in:	7.3.2 Valve clearance – Check and adjustment (→ Page 134)

Feeler gauge



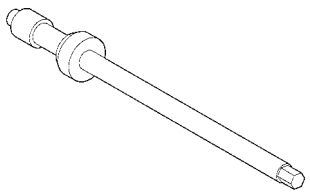
Part No.:	Y20098771
Qty.:	1
Used in:	7.3.2 Valve clearance – Check and adjustment (→ Page 134)

Installation/removal tool



Part No.:	F6789889
Qty.:	1
Used in:	7.5.2 Injector – Removal and installation (→ Page 142)

Milling cutter

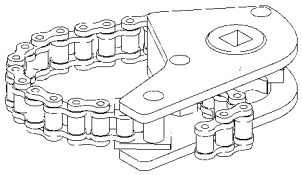


Part No.:	F30452739
Qty.: Used in:	1 7.5.2 Injector – Removal and installation (→ Page 142)

MTU test kit

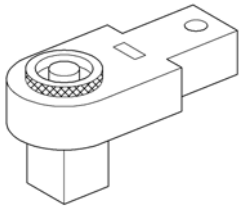
Part No.:	5605892099/00
Qty.: Used in:	1 7.12.3 Engine oil – Sample extraction and analysis (→ Page 165)
Qty.: Used in:	1 7.14.7 Engine coolant – Sample extraction and analysis (→ Page 182)

Oil filter wrench



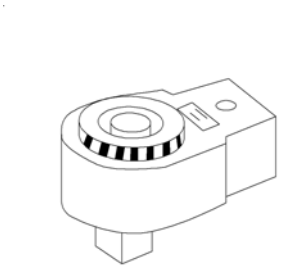
Part No.:	F30379104
Qty.: Used in:	1 7.6.1 Fuel filter – Replacement (→ Page 147)

Ratchet



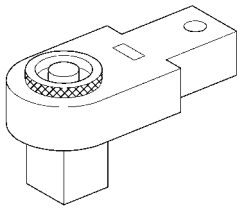
Part No.:	F30027340
Qty.: Used in:	1 7.5.2 Injector – Removal and installation (→ Page 142)

Ratchet



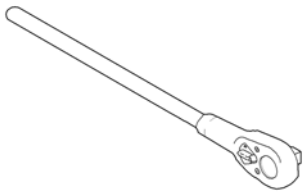
Part No.:	F30027341
Qty.: Used in:	1 7.5.2 Injector – Removal and installation (→ Page 142)
Qty.: Used in:	1 7.12.2 Engine oil – Change (→ Page 163)

Ratchet



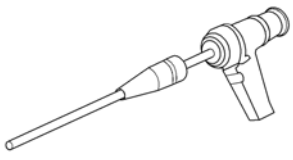
Part No.:	F30027339
Qty.: Used in:	1 7.19.5 Coalescer filter element – Replacement (→ Page 191)

Ratchet head with extension



Part No.:	F30006212
Qty.: Used in:	1 7.1.1 Engine – Barring manually (→ Page 127)

Rigid endoscope



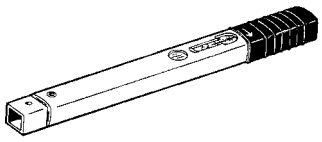
Part No.:	Y20097353
Qty.: Used in:	1 7.2.1 Cylinder liner – Endoscopic examination (→ Page 129)

Steam jet cleaner

Part No.:	-
Qty.:	1
Used in:	4.22 Plant – Cleaning (→ Page 93)

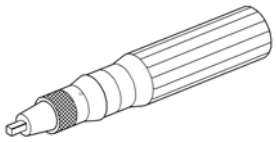
Torque wrench

Part No.:	F30027337
Qty.:	1
Used in:	7.12.2 Engine oil – Change (→ Page 163)



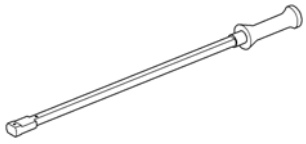
Torque wrench, 0.5-5 Nm

Part No.:	0015384230
Qty.:	1
Used in:	7.5.2 Injector – Removal and installation (→ Page 142)

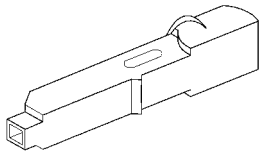


Torque wrench, 10-60 Nm

Part No.:	F30452769
Qty.:	1
Used in:	7.5.2 Injector – Removal and installation (→ Page 142)

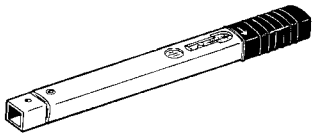


Torque wrench, 4-20 Nm



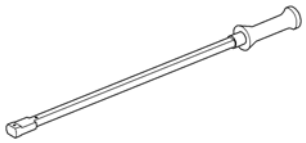
Part No.:	F30044239
Qty.: Used in:	1 7.9.2 Air filter – Removal and installation (→ Page 159)

Torque wrench, 6-50 Nm



Part No.:	F30027336
Qty.: Used in:	1 7.13.4 Centrifugal oil filter – Cleaning and filter-sleeve replacement (→ Page 173)
Qty.: Used in:	1 7.19.5 Coalescer filter element – Replacement (→ Page 191)

Torque wrench, 60-320 Nm



Part No.:	F30452768
Qty.: Used in:	1 7.3.2 Valve clearance – Check and adjustment (→ Page 134)
Qty.: Used in:	1 7.5.2 Injector – Removal and installation (→ Page 142)