Operating Instructions

Diesel engine
12V 4000 M73, M73L, M93, M93L
16V 4000 M73, M73L, M93, M93L
20V 4000 M73, M73L, M93, M93L

MS150047/02E

Power. Passion. Partnership.

Printed in Germany

© 2012 Copyright MTU Friedrichshafen GmbH

This Publication is protected by copyright and may not be used in any way whether in whole or in part without the prior written permission of MTU Friedrichshafen GmbH. This restriction also applies to copyright, distribution, translation, micro-filming and storage or processing on electronic systems including data bases and online services.

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

DCL-ID: 0000017652 - 001

DCL-ID: 0000017652 - 001

1 Safety

1.1 General conditions

General

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

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

Correct use

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

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

Modifications or conversions

Unauthorized modifications to the engine represent a safety risk.

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

Spare parts

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

Reworking components

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

TIM-ID: 0000000860 - 017

1.2 Personnel and organizational requirements

Personnel requirements

All work on the engine shall be carried out by trained and qualified personnel only.

The specified legal minimum age must be observed.

The operator must specify the responsibilities of the operating, maintenance and repair personnel.

Organizational measures

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

Keep it at hand at the operating site of the engine so that it is available to operating, maintenance, repair and transport personnel at all times.

Use the manual as a basis for instructing personnel on engine operation and repair with an emphasis on explaining safety-relevant instructions.

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

For the identification and layout of the spare parts during maintenance or repair work, take photos or use the spare parts catalog.

Working clothes and protective equipment

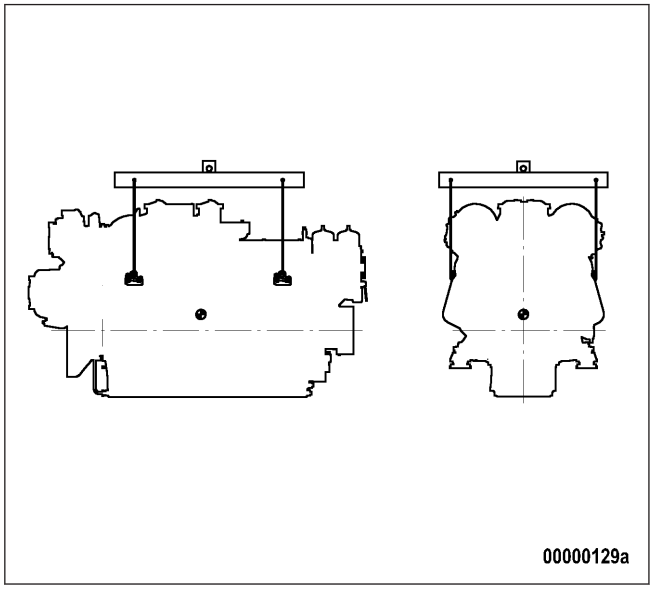
Wear proper protective clothing for all work.

Use the necessary protective equipment for the given work to be done.

TIM-ID: 0000000874 - 018

1.3 Transport

Transport



Lift the engine only with the lifting eyes provided.

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

Use only the transport and lifting equipment approved by MTU.

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

Take note of the engine center of gravity.

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

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

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

Setting the engine down after transport

Place the engine only on an even, firm surface.

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

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

TIM-ID: 0000002621 - 002

1.4 Safety regulations for maintenance and repair work

Safety regulations for maintenance and repair work

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

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

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

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

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

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

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

Observe the maintenance and repair instructions.

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

Secure the engine against accidental starting.

Disconnect the battery when electrical starters are fitted.

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

Disconnect the control equipment from the assembly or system.

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

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

Never use lines for climbing.

Keep fuel injection lines and connections clean.

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

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

Ensure that all retainers and dampers are installed correctly.

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

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

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

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

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

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

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

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

TIM-ID: 0000000879 - 023

Welding work

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

Do not use the assembly or system as ground terminal.

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

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

Hydraulic installation and removal

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

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

Do not attempt to bend or apply force to lines.

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

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

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

Working on electrical/electronic assemblies

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

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

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

Do not secure cables on lines carrying fluids.

Do not use cable binders to secure cables.

Always use connector pliers to tighten connectors.

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

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

Working with laser equipment

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

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

TIM-ID: 0000000879 - 023

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.

TIM-ID: 000000879 - 023

1.5 Auxiliary materials, fire prevention and environmental protection

Fire prevention

Rectify any fuel or oil leaks immediately; even quantities of oil or fuel on hot components can cause fires – therefore always keep the engine in a clean condition. Do not leave cloths soaking with fluids and lubricants on the engine. Do not store combustible materials near the engine.

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

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

Always have a suitable extinguishing agent (fire extinguisher) on hand and familiarize yourself fully with its handling.

SOLAS classification

On engines/plants with SOLAS classification, operational checks must include the following tasks:

- Check all covers (fitted in accordance with SOLAS requirements) on lube oil and fuel pipe connections (>1.8 bar) for damage, replace as necessary. (→ Page 15)

Noise

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

In all work areas with a sound pressure level in excess of 85 dB (A), wear ear protection (cotton wool, ear plug or capsules).

Environmental protection

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

Only fuels of the specified quality required to achieve emission limits must be used.

In Germany, the VAwS (=regulations governing the use of plants that may affect water quality) is applicable, which means work must only be carried out by authorized specialist companies (MTU is an authorized specialist company).

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

Auxiliary materials

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

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

TIM-ID: 0000002828 - 005

Lead

- When working with lead or lead-containing compounds, avoid direct contact to the skin and do not inhale lead vapors.
- Prevent the buildup of white powder of lead.
- Switch on fume extraction system.
- After coming into contact with lead or lead-containing materials, wash your hands!

Acids and alkaline solutions

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

Paints, enamels and varnishes

- When carrying out painting work outside the spray stands provided with fume extraction systems, ensure that the area is well ventilated. Make sure that neighboring work areas are not impaired.
- No open flames!
- No smoking!
- Observe all fire-prevention regulations!
- Always wear a mask providing protection against paint and solvent vapors!

Liquid nitrogen

- Store liquid nitrogen only in small quantities and always in specified containers without fixed covers.
- Avoid body contact (eyes, hands). Contact of this nature would cause frostbite and numbing.
- Wear protective clothing, protective gloves, closed shoes and protective goggles / safety mask!
- Make sure that working area is well ventilated. Suffocation will result at 88% contamination of breathing air with nitrogen.
- Take great care not to subject containers, fittings and tools to impact or shock.

Compressed air

Compressed air is air compressed at excess pressure and is stored in tanks from which it can be extracted.

The pressure at which the air is kept can be read off at pressure gauges which must be connected to the compressed air tanks and the compressed air lines.

When working with compressed air, safety precautions must be constantly observed:

- Pay special attention to the pressure level in the compressed air network and pressure vessel!
- Connecting devices and equipment must either be assembled for this pressure, or, if the permitted pressure for the connecting elements is lower than the pressure required, a pressure reducing valve and safety valve (set to permitted pressure) must form an intermediate connection. Hose couplings and connections must be securely attached!
- Always wear protective goggles when blowing off tools or extracting chips!
- The snout of the air nozzle is provided with a protective disk (e.g. rubber disk), which prevents airborne particles being reflected and thereby prevents injury to eyes.
- First shut off compressed air lines before compressed air equipment is disconnected from the supply line, or before equipment or tool is to be replaced!
- Unauthorized use of compressed air, e.g. forcing flammable liquids (danger class AI, AII and B) out of containers, results in a risk of explosion!
- Forcing compressed air into thin-walled containers (e.g. sheet metal, plastic, glass) for drying purposes or to check for leaks will result in a risk of bursting!
- Blowing dirt from soiled clothes while still worn is prohibited!

TIM-ID: 000000828 - 005

Used oil

Used oil may contain harmful combustion residues.

Rub your hands with skin protection cream!Wash your hands after contact with used oil.

TIM-ID: 0000002828 - 005

1.6 Conventions for safety instructions in the text

DANGER 	In the event of immediate danger. **Consequences: Death or serious injury** • Remedial action
WARNING 	In the event of potentially dangerous situations. **Consequences: Death or serious injury** • Remedial action
CAUTION 	In the event of dangerous situations. **Consequences: Minor injury or material damage** • Remedial action
NOTICE 	In the event of a situation involving potentially adverse effects on the product. **Consequences: Material damage.** • Remedial action • Additional product information

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

Safety instructions

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

TIM-ID: 0000000881 - 018

2 Product Summary

2.1 Engine Layout

2.1.1 Product description

Description of the engine

Engine

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

TIM-ID: 0000010056 - 002

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).

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.

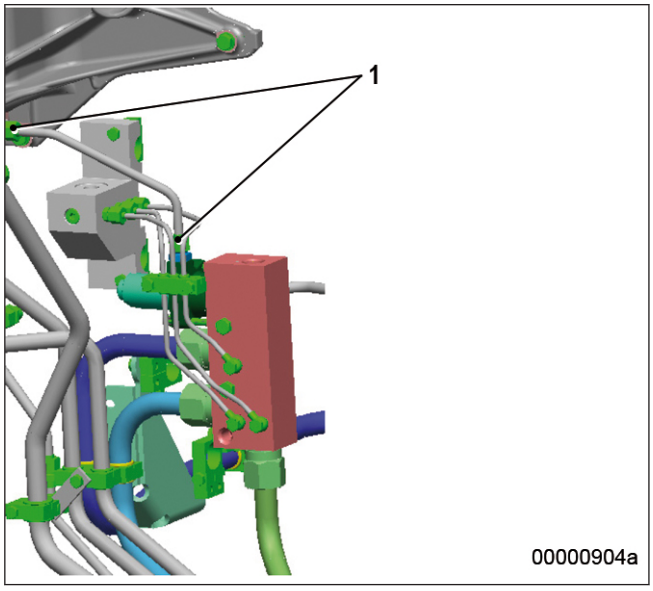
SOLAS – Fire protection specifications

Fuel system, fuel lines with fuel pressures exceeding 1.8 bar

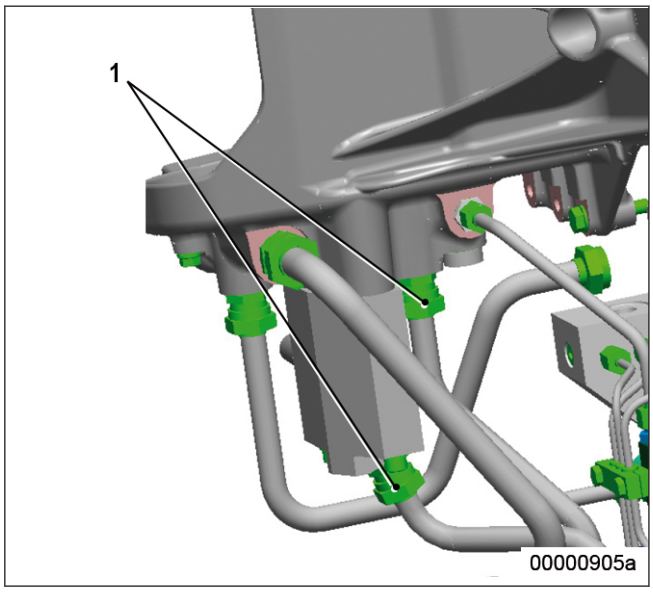
All lines with SOLAS-compliant covers for pipe connections, according to MTU standard MTN5233, are shown.

TIM-ID: 0000010056 - 002

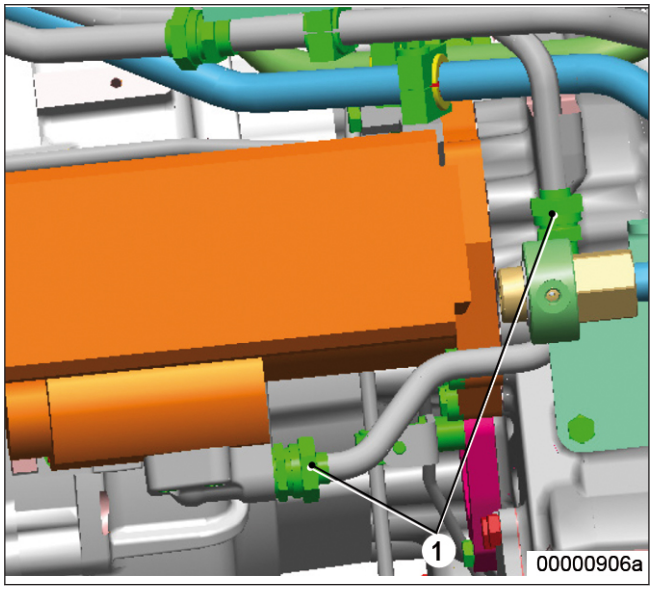
1 Fuel line to fuel filter head



1 Fuel line from/to fuel filter head



1 Fuel line to HP pump

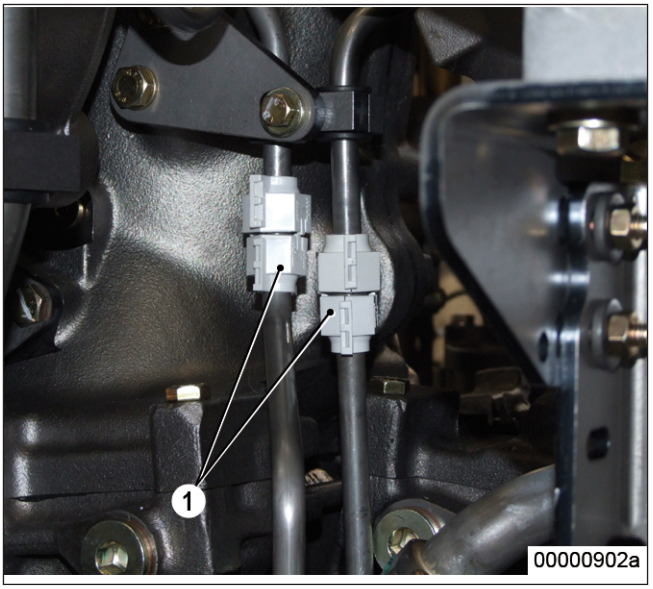


TIM-ID: 0000010056 - 002

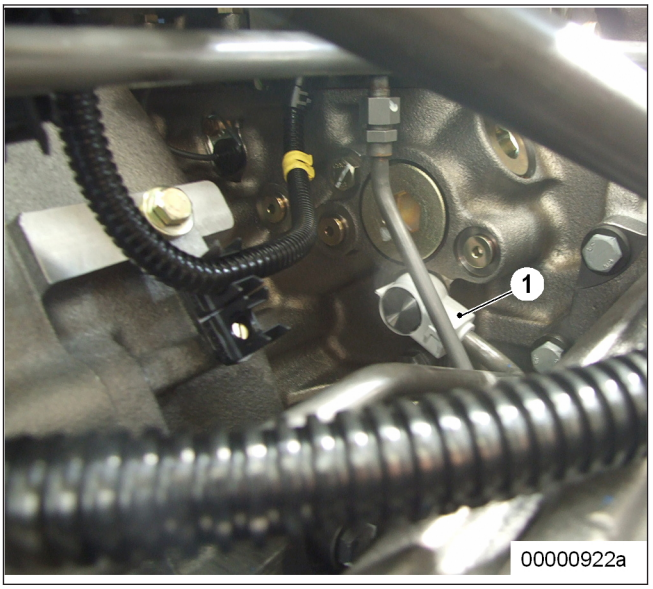
Lube oil system, oil lines with oil pressures exceeding 1.8 bar

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

1 Parting line ETC oil supply free end

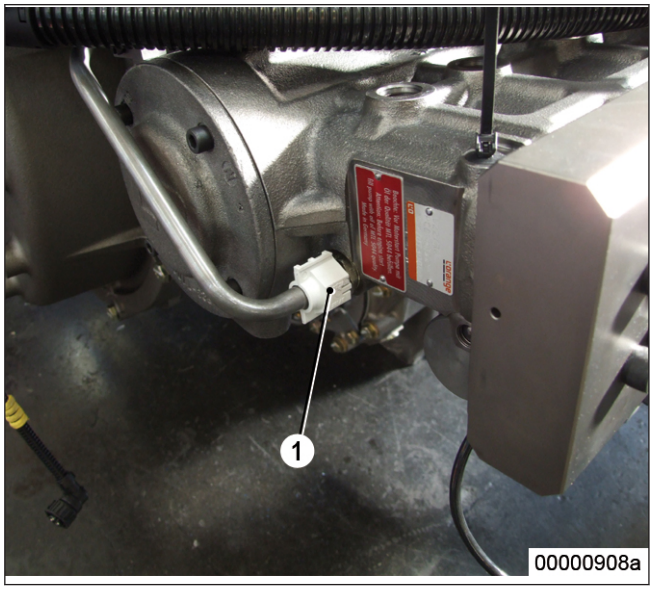


1 Oil line on equipment carrier

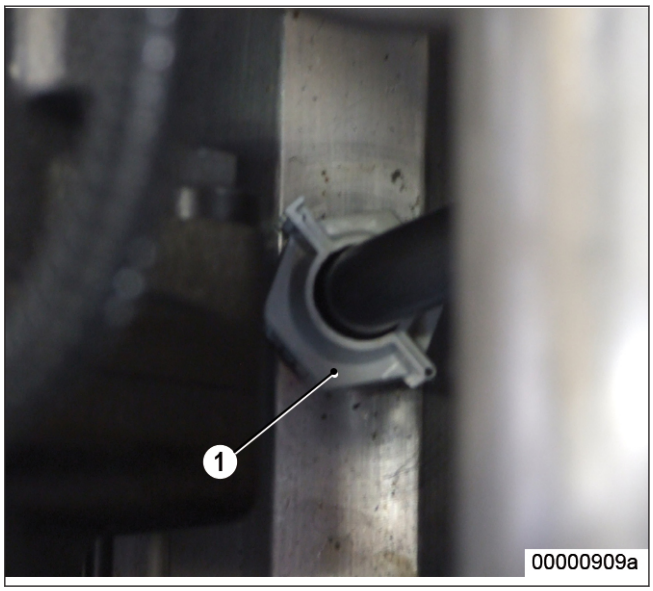


TIM-ID: 0000010056 - 002

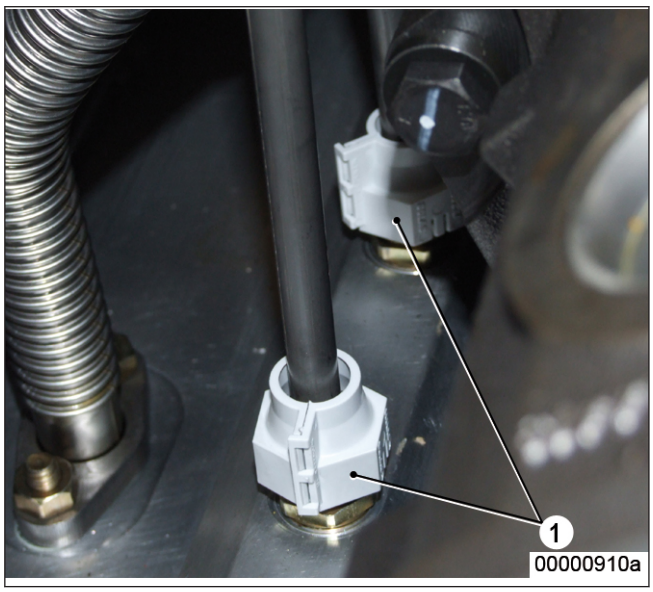
1 Oil supply to HP pump



1 Oil supply to flap control free end

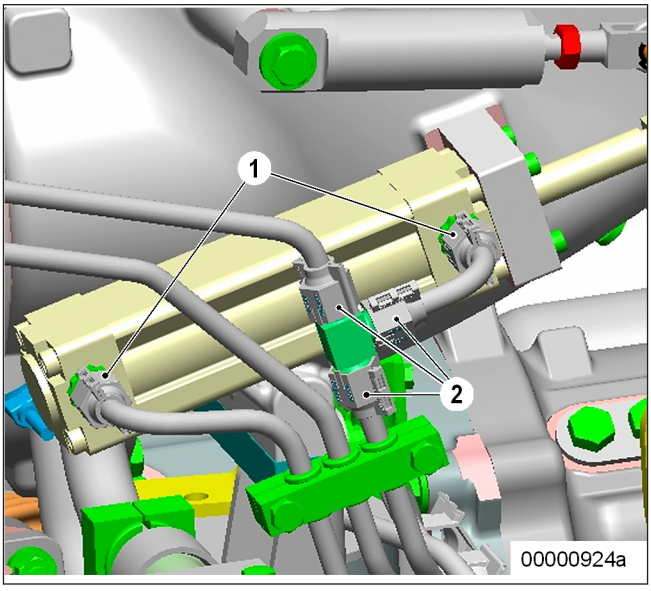


1 ETC oil supply on main oil gallery

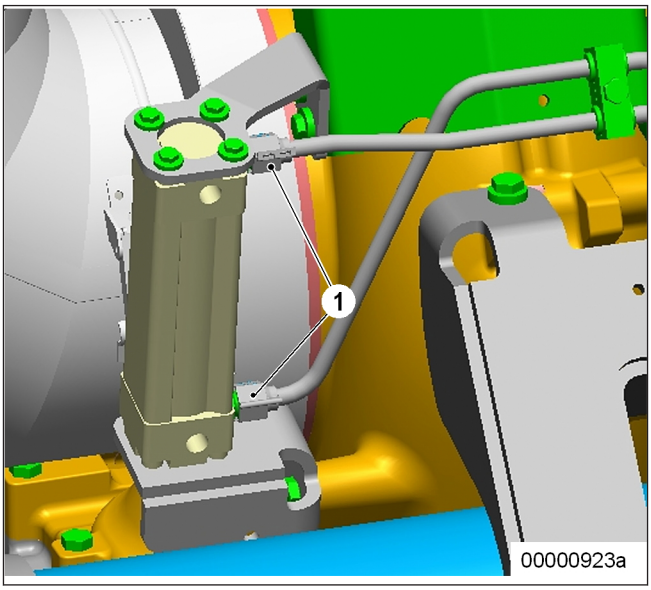


TIM-ID: 0000010056 - 002

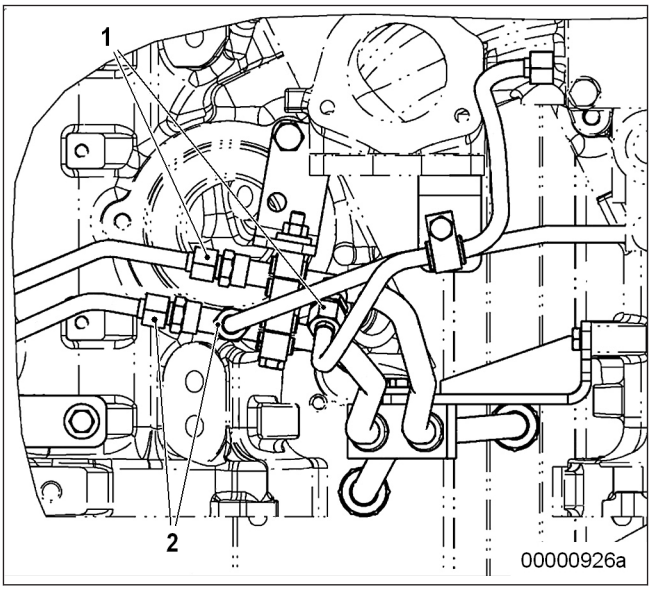
1 Switching cylinder air flap turbocharger B1
2 T piece flap control



1 Switching cylinder exhaust flap turbocharger B1

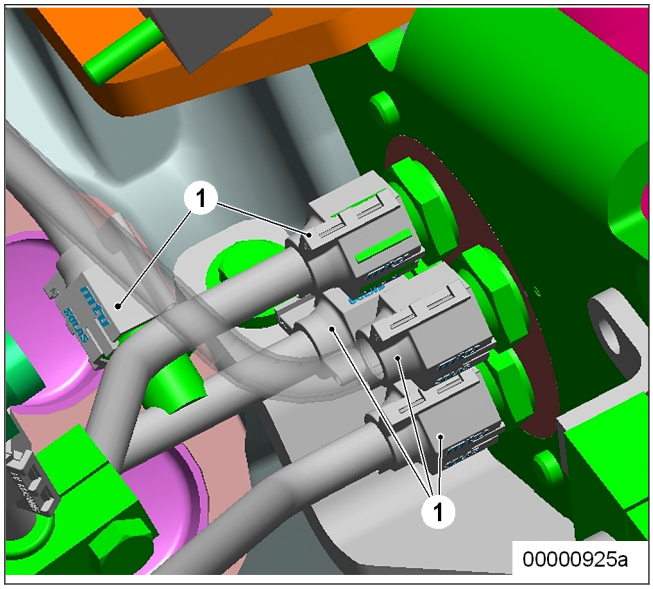


1 Oil line from main oil gallery
2 Oil line to main oil gallery

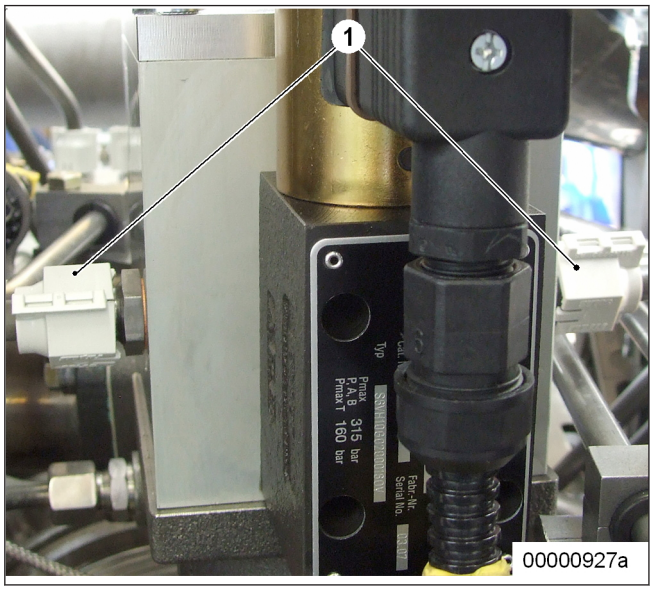


TIM-ID: 0000010056 - 002

1 Flap control distributor



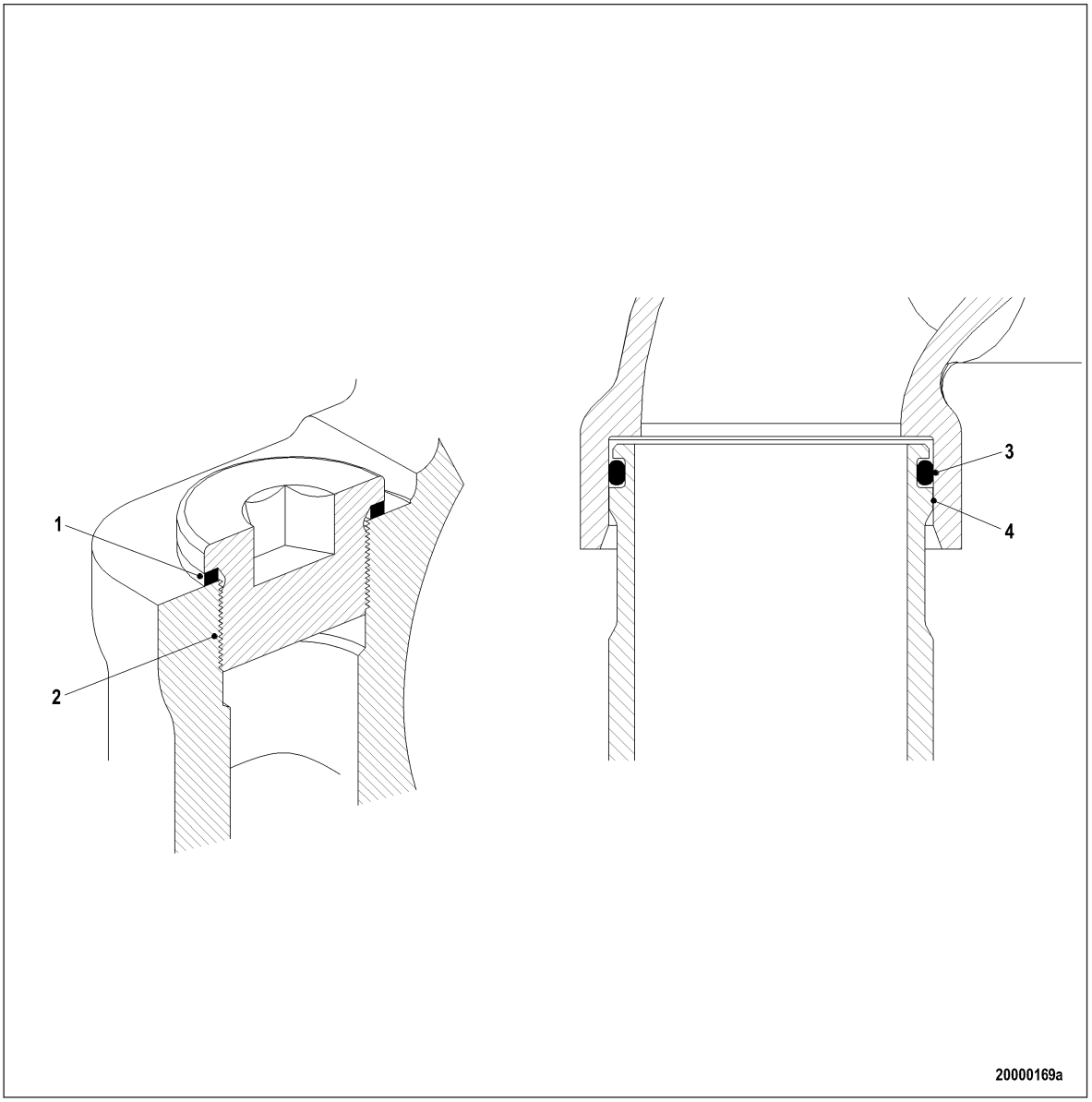
1 Air recirculation valve



Special unions

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

TIM-ID: 0000010056 - 002



Plug-in pipe union

Design precludes lateral spray as the point of separation is shielded by the sleeve (4).

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

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

Plugs and sensors

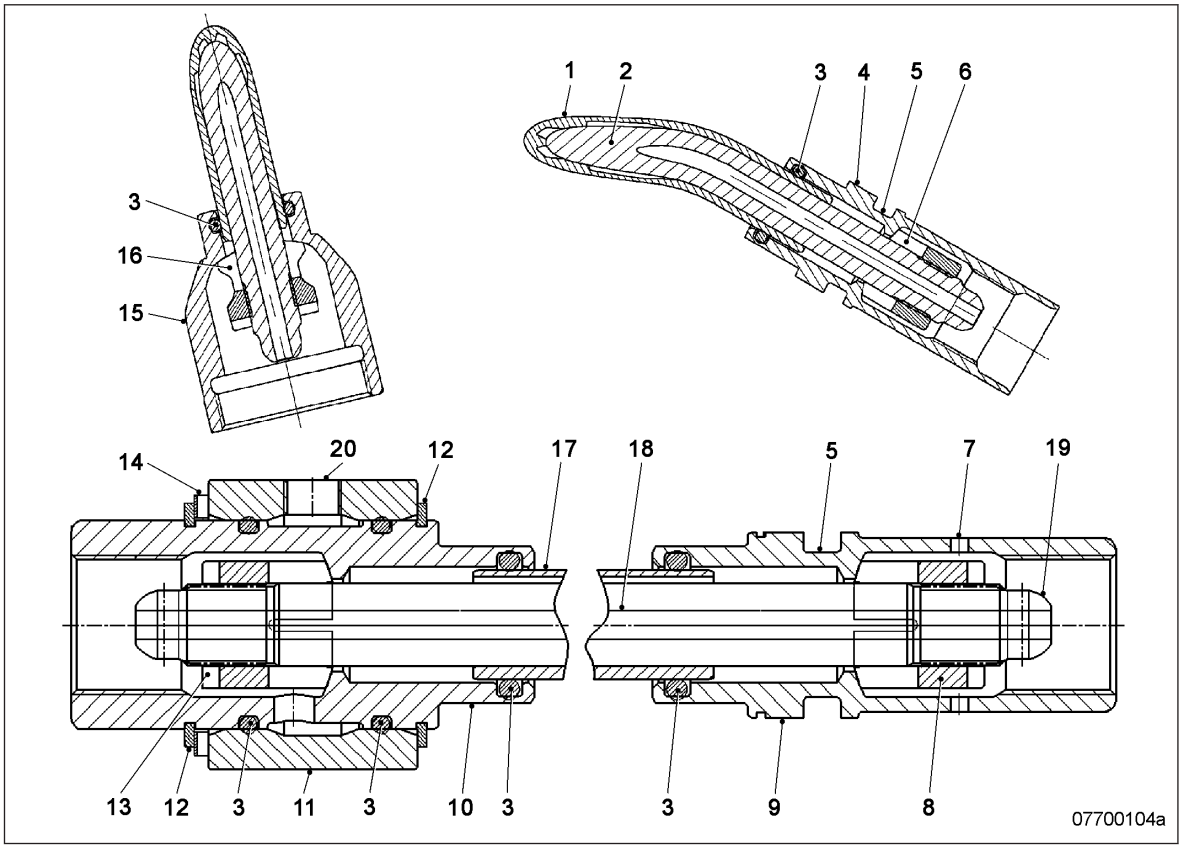
Screw plugs (2) are either sealed with copper sealing rings (1) as per DIN or O-rings (ISO).

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

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

TIM-ID: 0000010056 - 002

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 Compensating disks
15 Union nut
16 Thrust ring
17 Outer HP line pipe
18 Inner high-pressure 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).

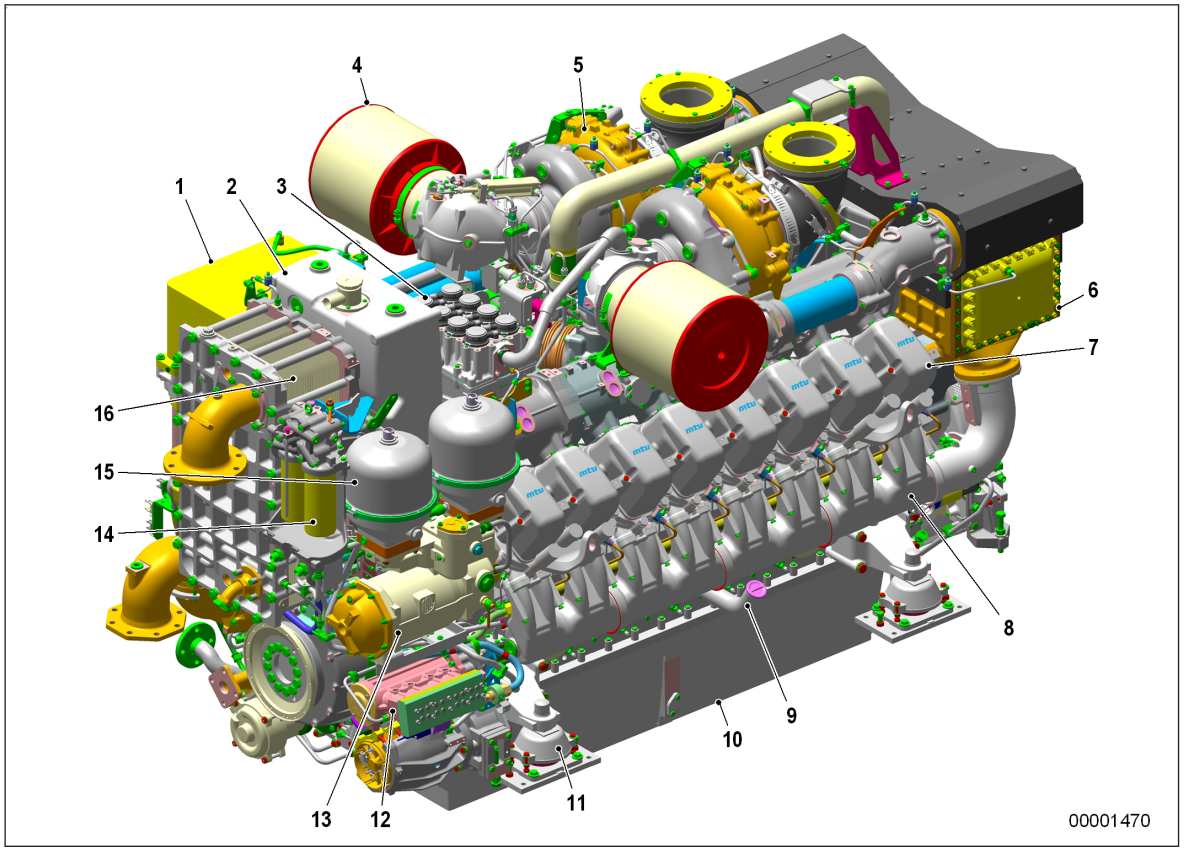
This prevents leaking fuel from escaping.

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

TIM-ID: 0000010056 - 002

2.1.2 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

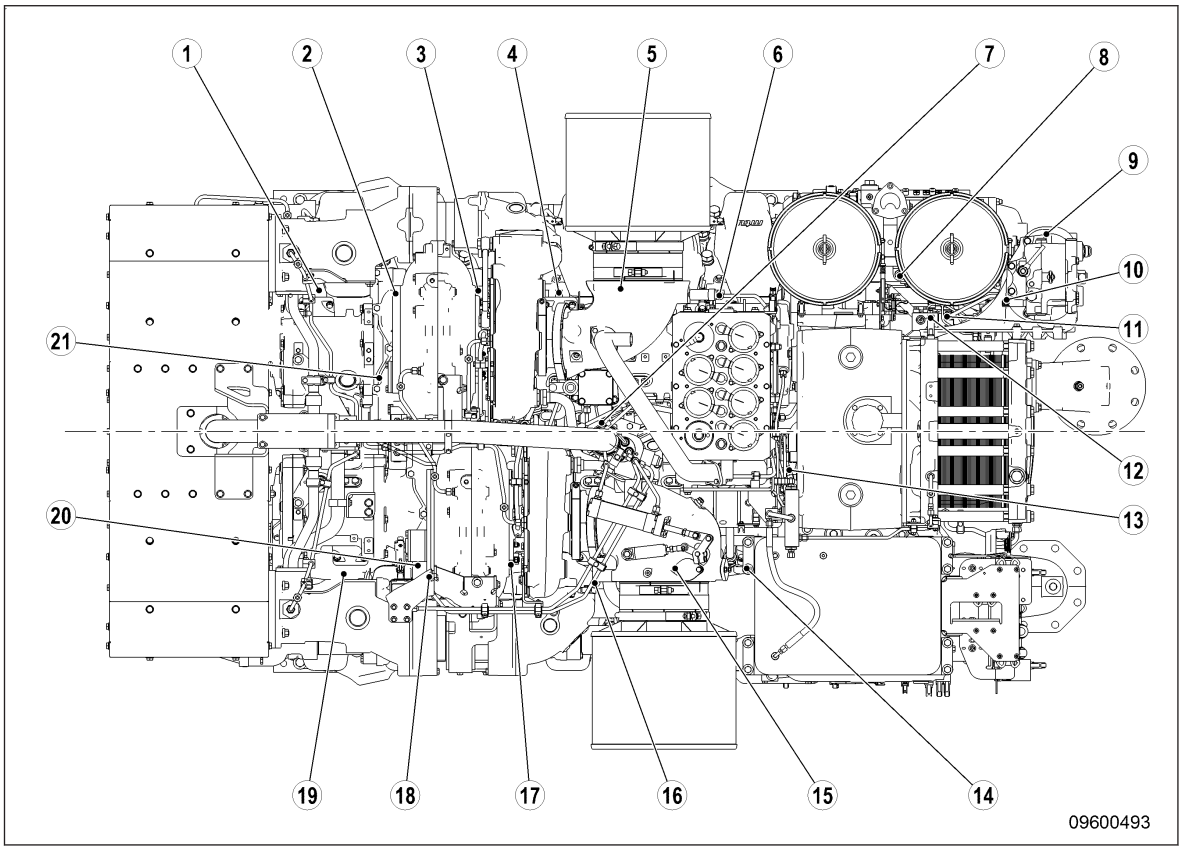
Engine model designation

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)

TIM-ID: 0000009991 - 004

2.1.3 Sensors, actuators and injectors – Overview

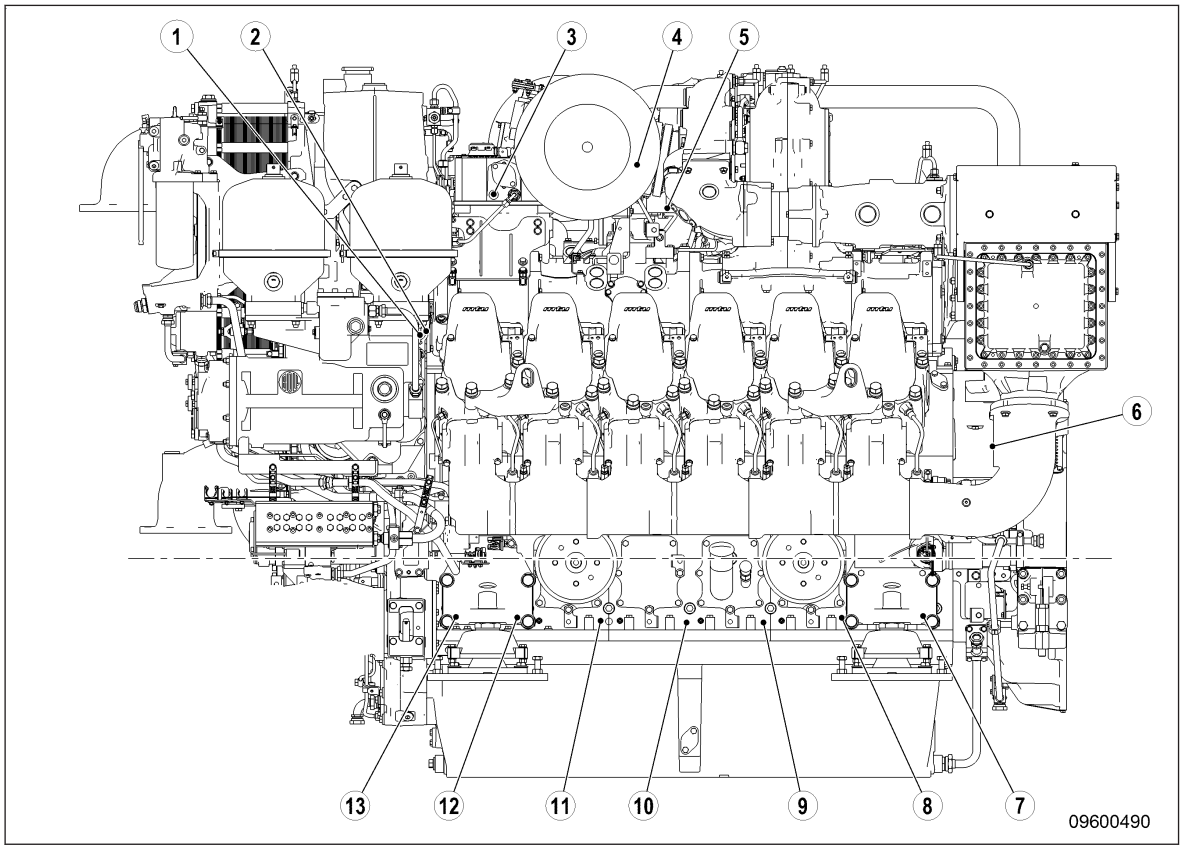
Top view 12V 4000 M



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)

TIM-ID: 0000032308 - 001

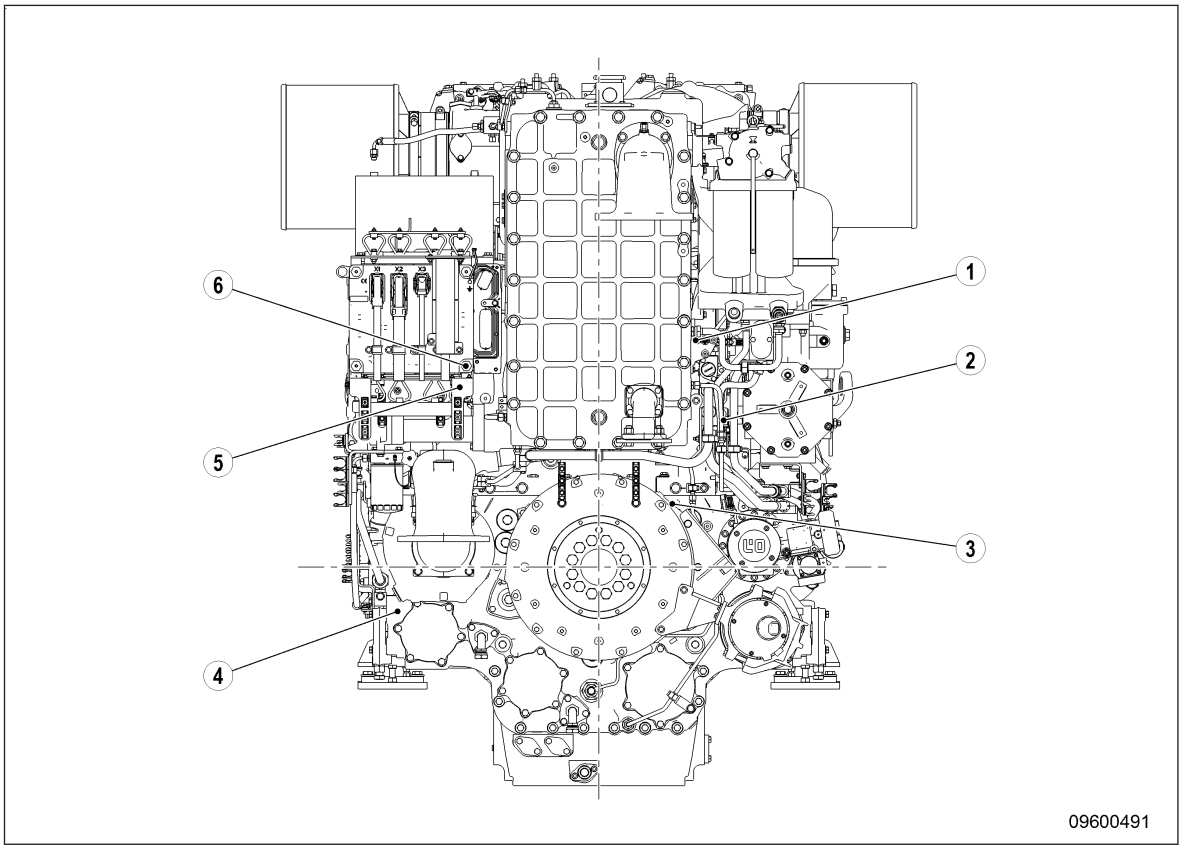
12V 4000 M left side



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.)

TIM-ID: 0000032308 - 001

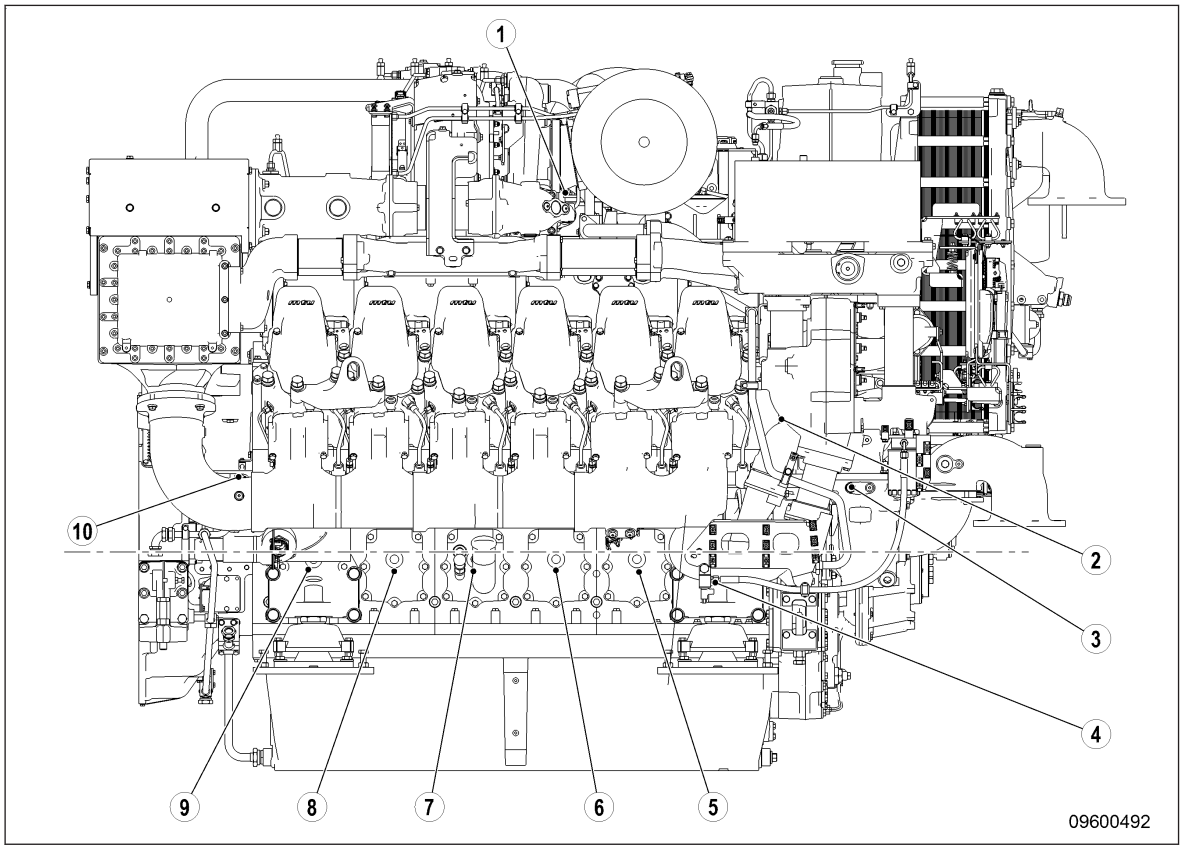
12V 4000 M free end



1 F46 (fuel level leakage)
2 B33 (fuel temp. (Rail)
3 B1 (camshaft speed)
4 B54 (oil refill pump pressure)
5 B6.2 (coolant temperature)
6 B6 (coolant temperature)

TIM-ID: 0000032308 - 001

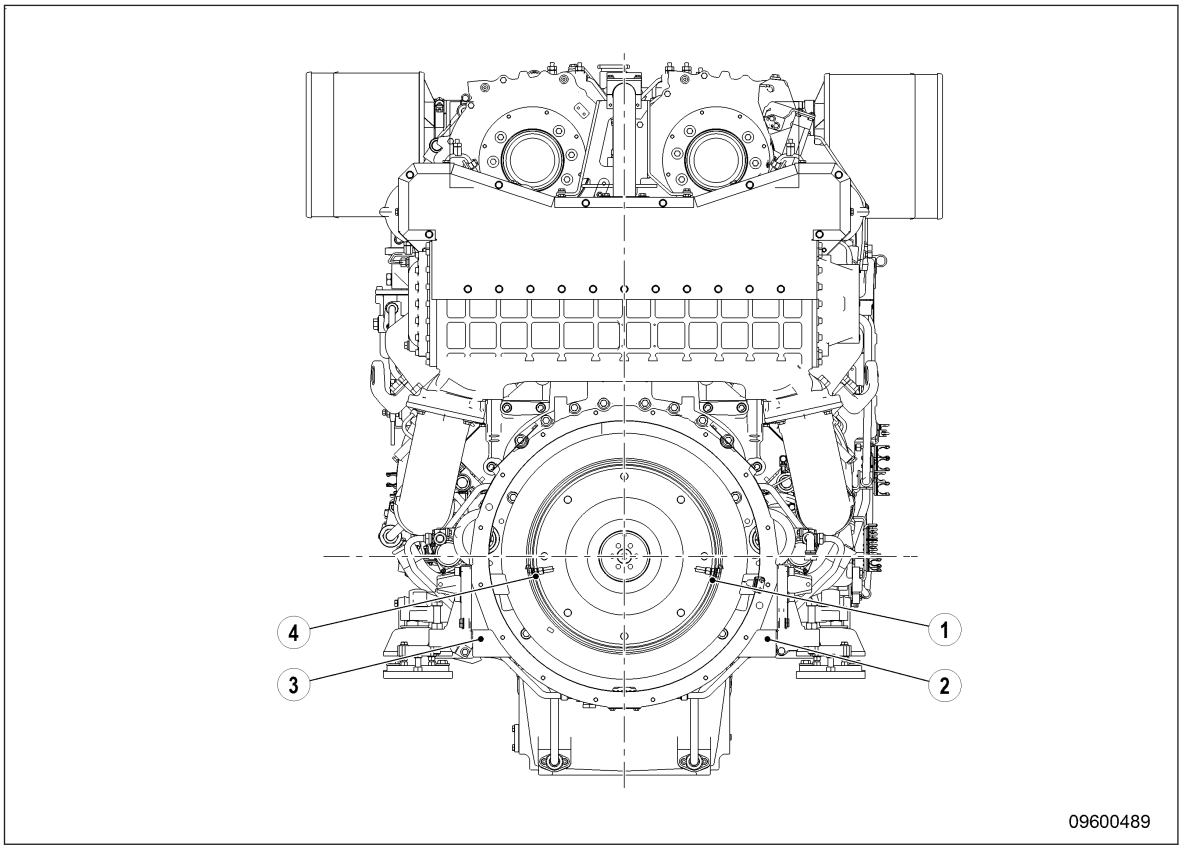
12V 4000 M right side



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)

TIM-ID: 0000032308 - 001

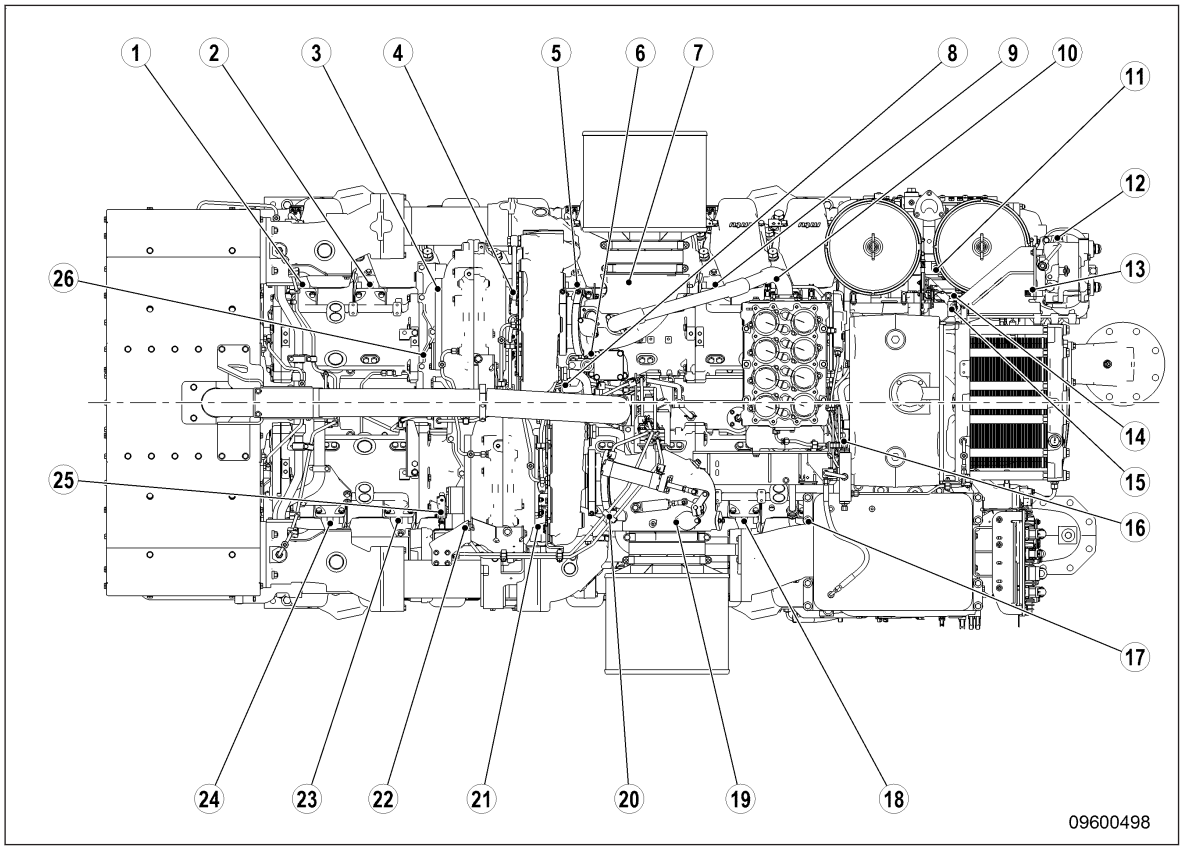
12 V 4000 M driving end



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

TIM-ID: 0000032308 - 001

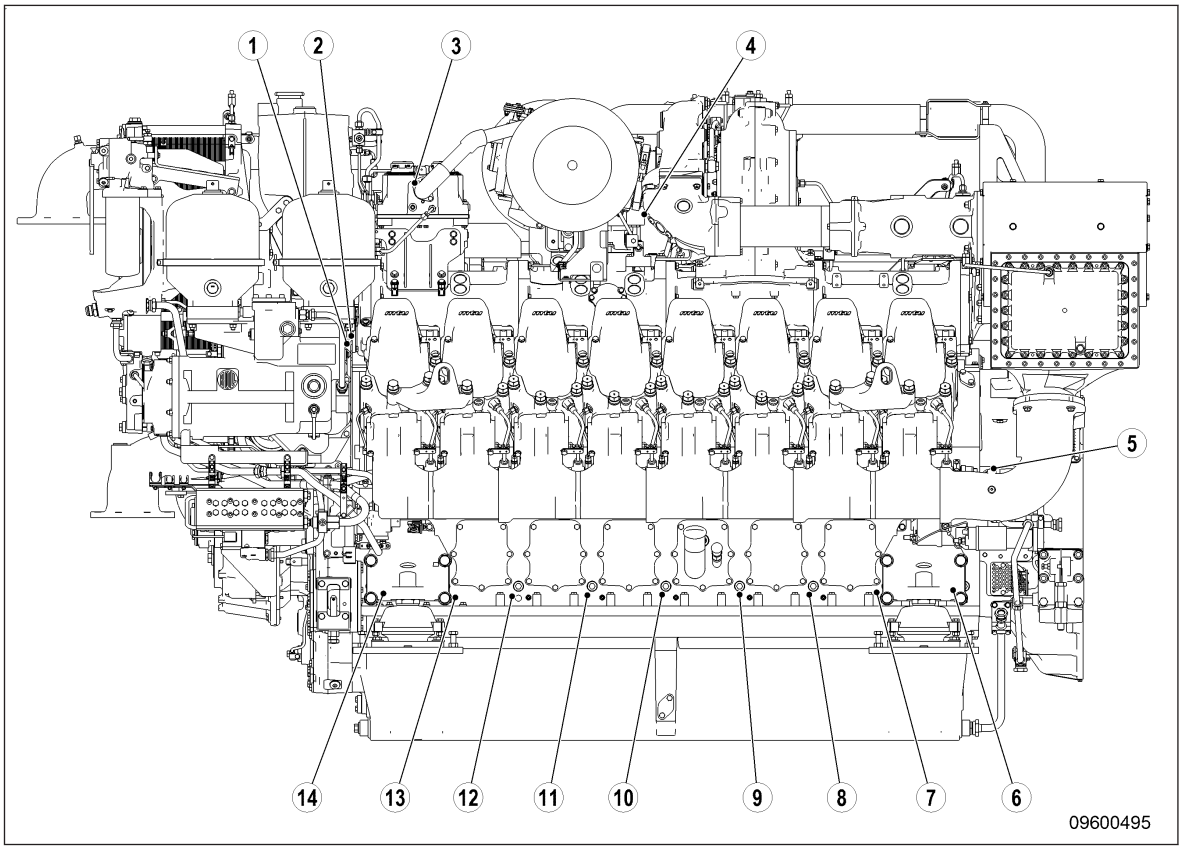
Top view 16V 4000 M



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)

TIM-ID: 0000032308 - 001

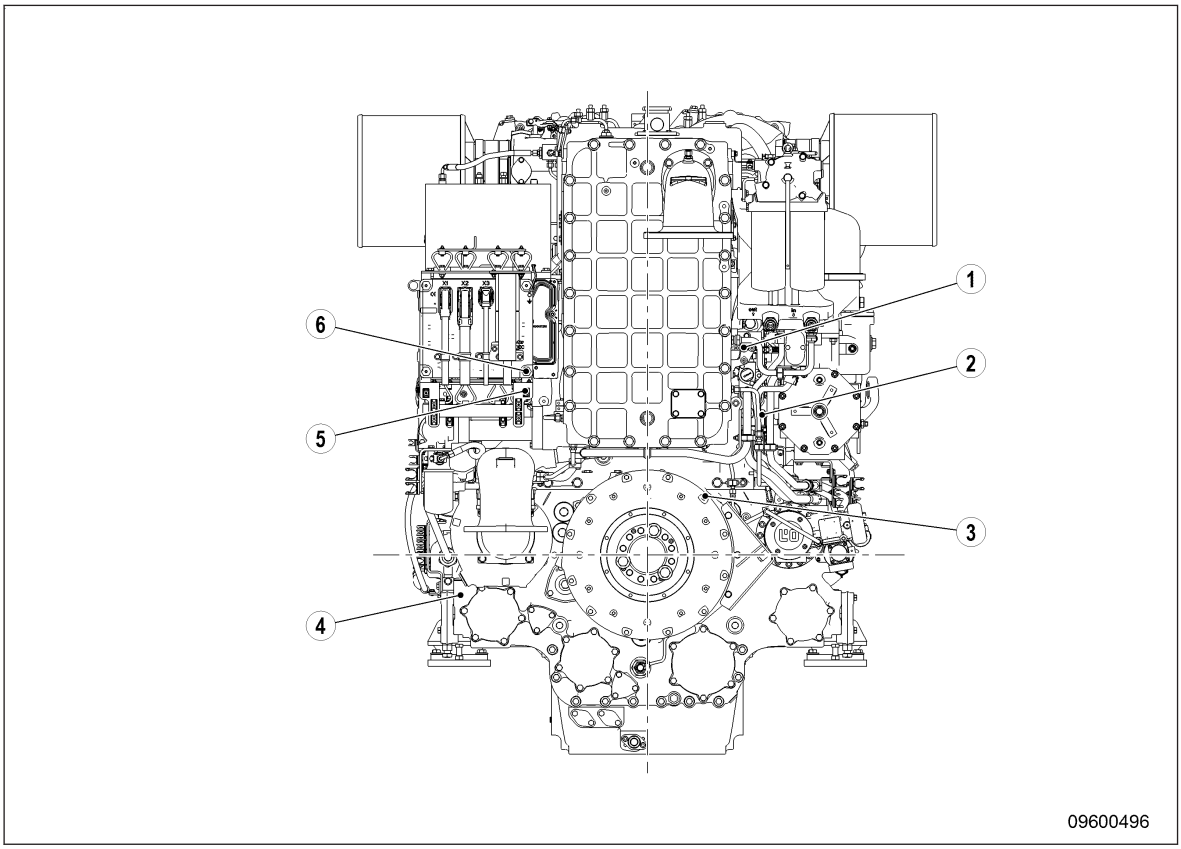
16V 4000 M left side



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 - 001

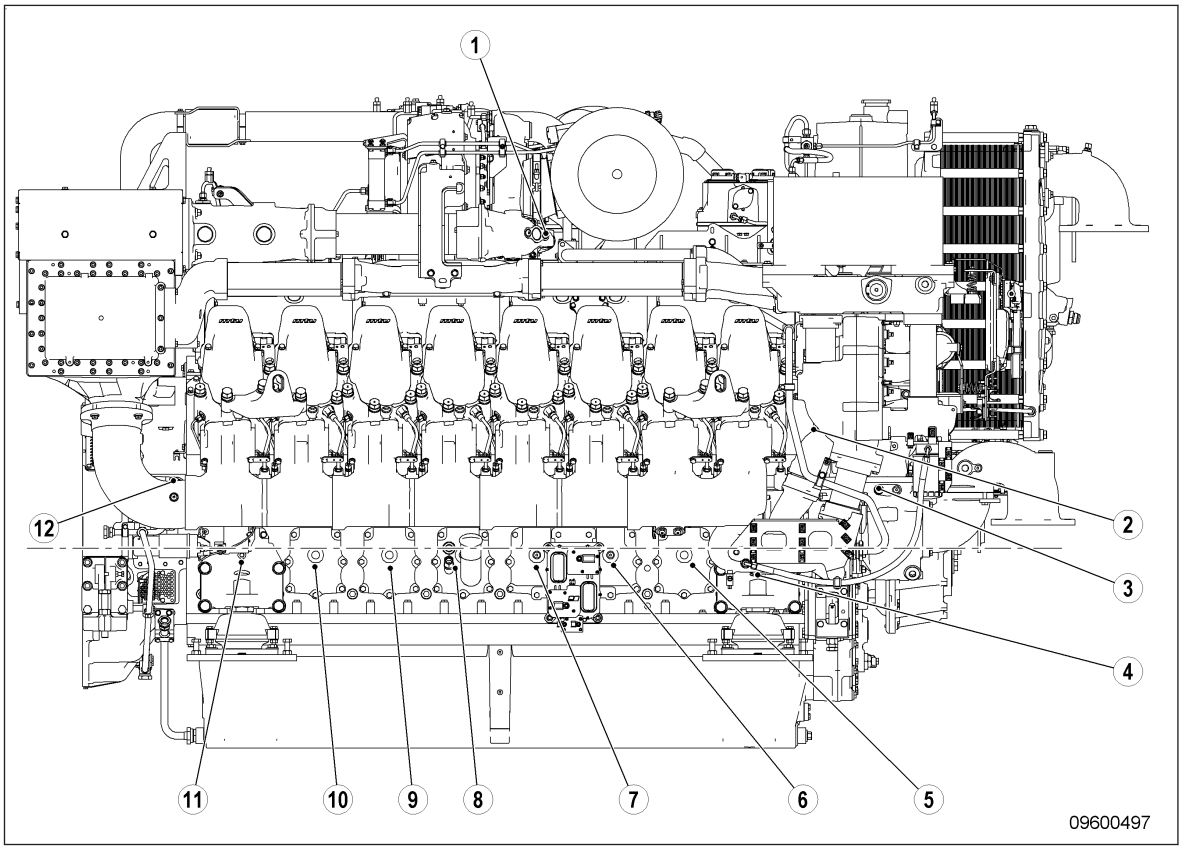
16V 4000 M free end



1 F46 (fuel level leakage)
2 B33 (fuel temp. (Rail))
3 B1 (camshaft speed)
4 B54 (oil refill pump pressure)
5 B6.2 (coolant temperature)
6 B6 (coolant temperature)

TIM-ID: 0000032308 - 001

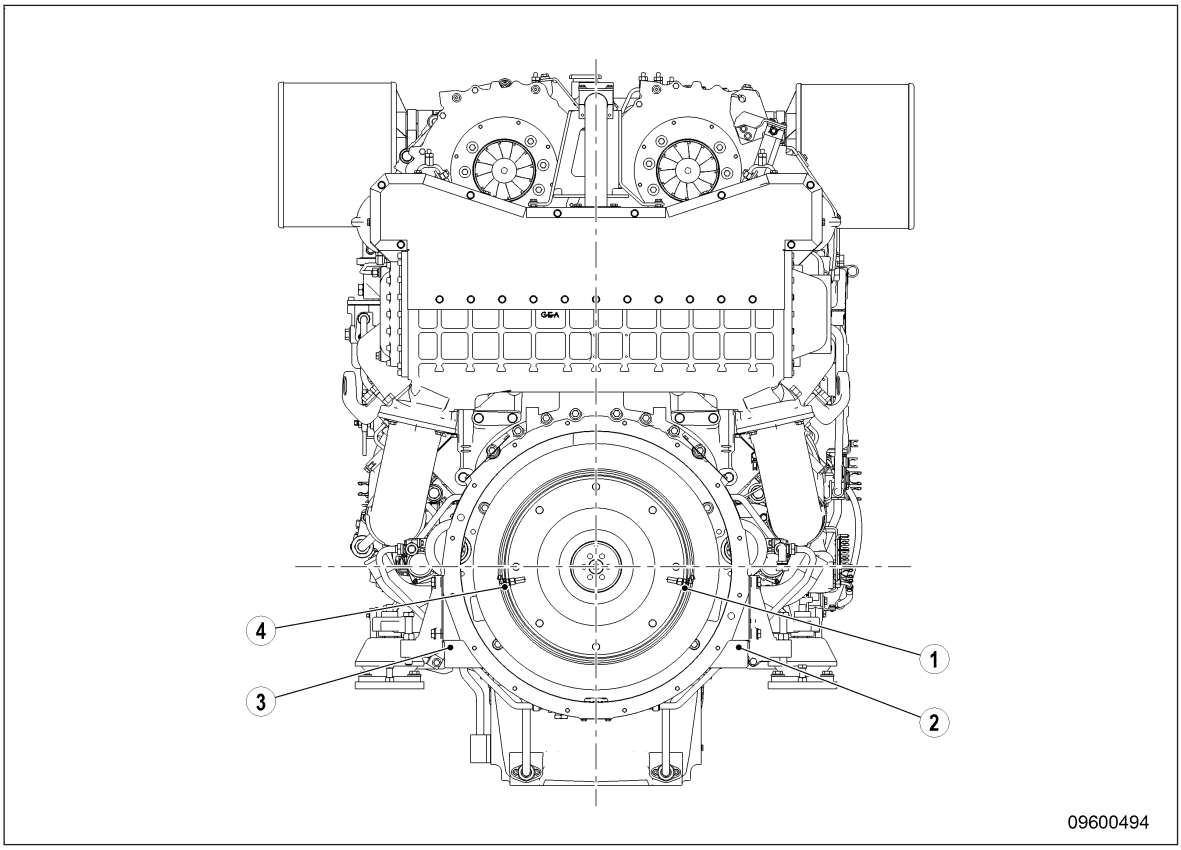
16V 4000 M right side



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 - 001

16V 4000 M driving end



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

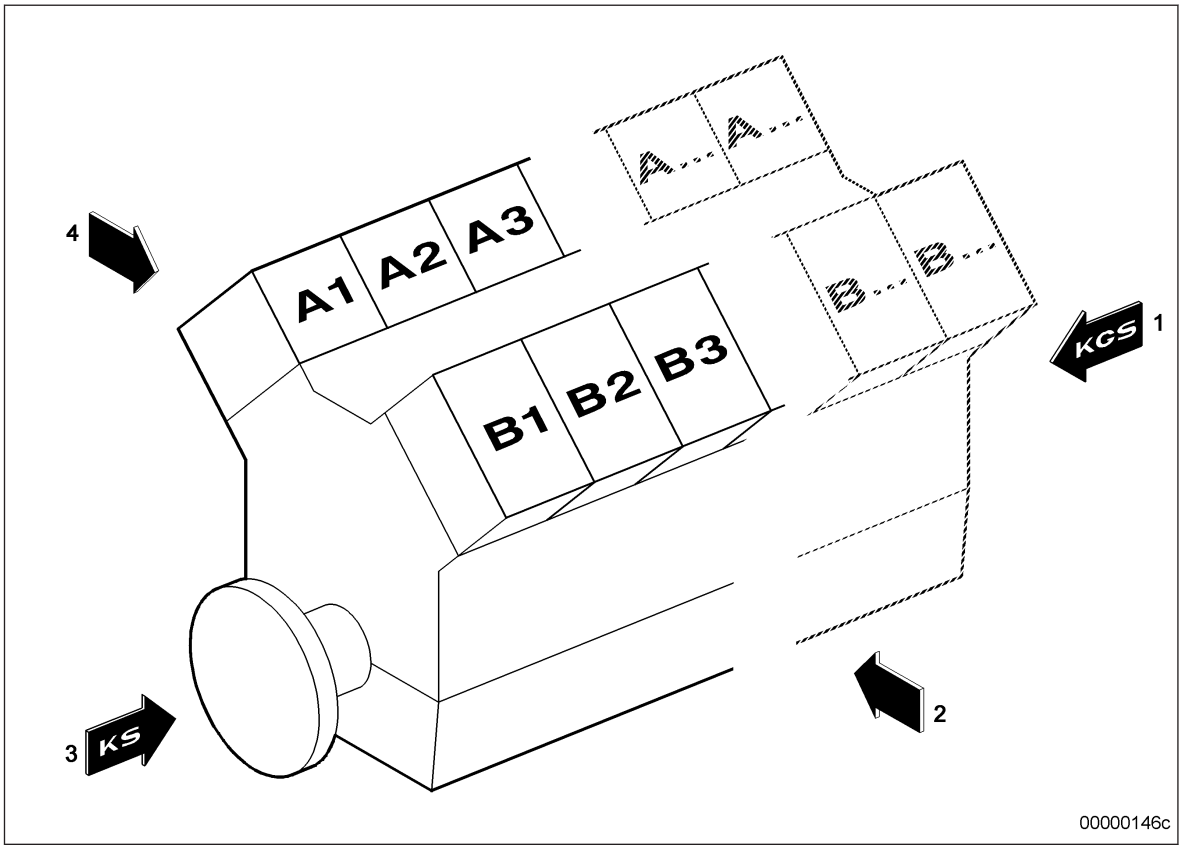
TIM-ID: 0000032308 - 001

2.2 Engine side and cylinder designations

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

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

Other components are numbered in the same way, i.e. starting with No. 1 at the engine's driving end.

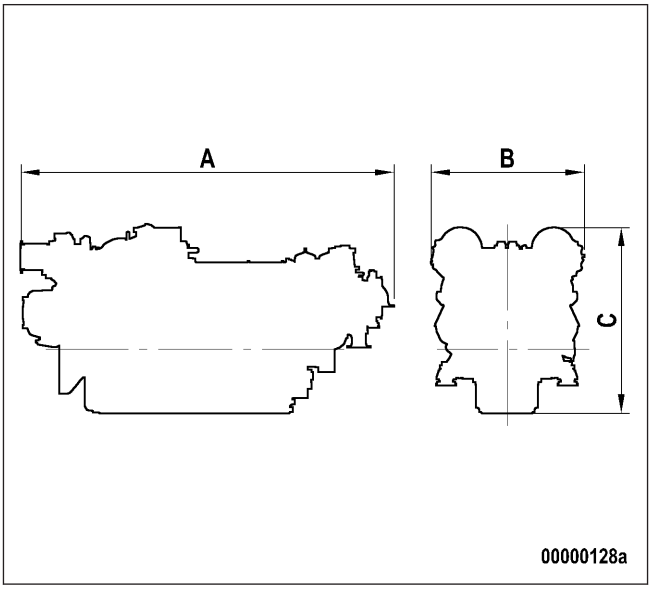


1 KGS = free end
2 Right engine side
3 KS = driving end
4 Left engine side

TIM-ID: 0000000863 - 018

2.3 Engine – Main dimensions

Engine – Main dimensions



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

TIM-ID: 0000010044 - 002

2.4 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

TIM-ID: 0000002796 - 003

2.5 Technical Data

2.5.1 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

TIM-ID: 0000010927 - 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	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

TIM-ID: 0000010927 - 001

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

TIM-ID: 0000010927 - 001

2.5.2 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

TIM-ID: 0000010911 - 001

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

TIM-ID: 0000010911 - 001

2.5.3 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

TIM-ID: 0000010954 - 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

TIM-ID: 0000010954 - 001

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

TIM-ID: 0000010954 - 001

2.5.4 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

TIM-ID: 0000010940 - 001

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

TIM-ID: 0000010940 - 001

2.5.5 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

TIM-ID: 0000010971 - 001

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

TIM-ID: 0000010971 - 001

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

TIM-ID: 0000010971 - 001

2.5.6 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 - 001

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

TIM-ID: 0000010963 - 001

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	400
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

TIM-ID: 0000010963 - 001

2.5.7 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

TIM-ID: 0000010984 - 001

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

TIM-ID: 0000010984 - 001

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	400
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

TIM-ID: 0000010984 - 001

2.5.8 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 - 001

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

TIM-ID: 0000010978 - 001

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	400
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

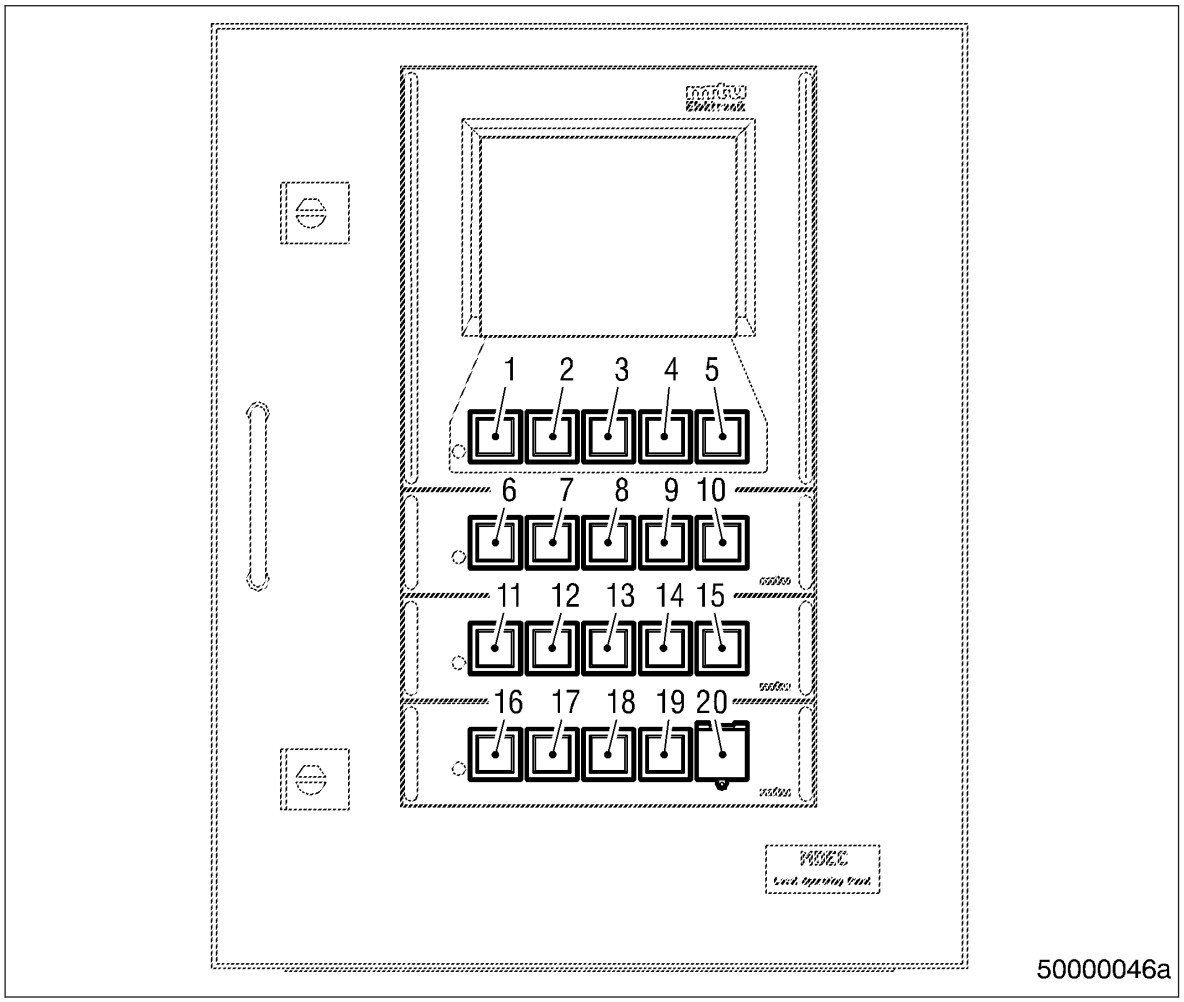
Number of cylinders			16
Exhaust noise, undamped - BL (free-field sound-pressure level Lp, 1m distance, ISO 6798, +3dB(A) tolerance)	R	dB(A)	117
Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798, +2dB(A) tolerance)	R	dB(A)	106

TIM-ID: 0000010978 - 001

3 Operation

3.1 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.

TIM-ID: 0000008861 - 002

Item	Color	Inscription	Meaning / Function
8	White	DIM ↓	Holding down the button decreases LCD background illumination.
9	White	LAMP TEST	Pressing the button initiates lamp test.
10	Red	TEST OVERSPEED	Pressing the button initiates overspeed test. LED (spot) lights up as long as the overspeed test is running.
11	Green	(depending on type of gearbox and propulsion)	FPP: Pressing the button engages gear ahead. CPP, WJ, VS: Pressing the button engages clutch. LED (spot) lights up when GCU feedback is active.
12	Green		FPP, CPP, WJ, VS: Pressing the button disengages clutch. LED (spot) lights up when GCU feedback is active.
13	Green		FPP: Pressing the button engages gear astern. CPP, VS: No function assigned. WJ: Holding down the button provides flushing of water jet intake channel (water-jet reverse) . LED (spot) lights up when GCU feedback is active.
14	White	ENGINE SPEED INCREASE	Engine speed is increased as long as the button is held down.
15	White	ENGINE SPEED DECREASE	Engine speed is decreased as long as the button is held down.
16	Green	READY FOR OPERATION	Pressing the button 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.

TIM-ID: 0000008861 - 002

3.2 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 long out-of-service periods (>3 months)

Item	Action
Engine	Depreserve (→ MTU Fluids and Lubricants Specifications A001061/..).
Lube oil system	Check engine oil level (→ Page 140); Preheat engine oil if required.
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 155).
Coolant circuit	Check coolant level (→ Page 154).
Coolant circuit	Heat coolant with coolant preheating unit.
Engine Control Unit	Check plug connections (→ Page 176).
HP fuel pump	Only for engines without oil priming pump Fill HP fuel pump with new engine oil (→ Page 124)
Engine Control System	Switch master switch to ON; Press illuminated pushbutton READY FOR OPERATION (→ Page 62).
LOP	Press illuminated pushbutton LAMP TEST (→ Page 62).

TIM-ID: 0000010093 - 004

3.3 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 140); Preheat engine oil if required.
Coolant circuit	Check coolant level (→ Page 154).
Coolant circuit	Heat coolant with coolant preheating unit.
Engine Control System	Switch master switch to ON; Press illuminated pushbutton READY FOR OPERATION (→ Page 62).
LOP	Press illuminated pushbutton LAMP TEST (→ Page 62).

TIM-ID: 0000010656 - 003

3.4 Starting the engine

Preconditions

☑ External start interlock is not active.

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

DANGER

Unguarded rotating and moving engine components.
Risk of serious injury – danger to life!
- Before barring or starting the engine, make sure that nobody is in the danger zone.

WARNING

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

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)

TIM-ID: 0000002240 - 003

3.5 Operational checks

DANGER

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

WARNING

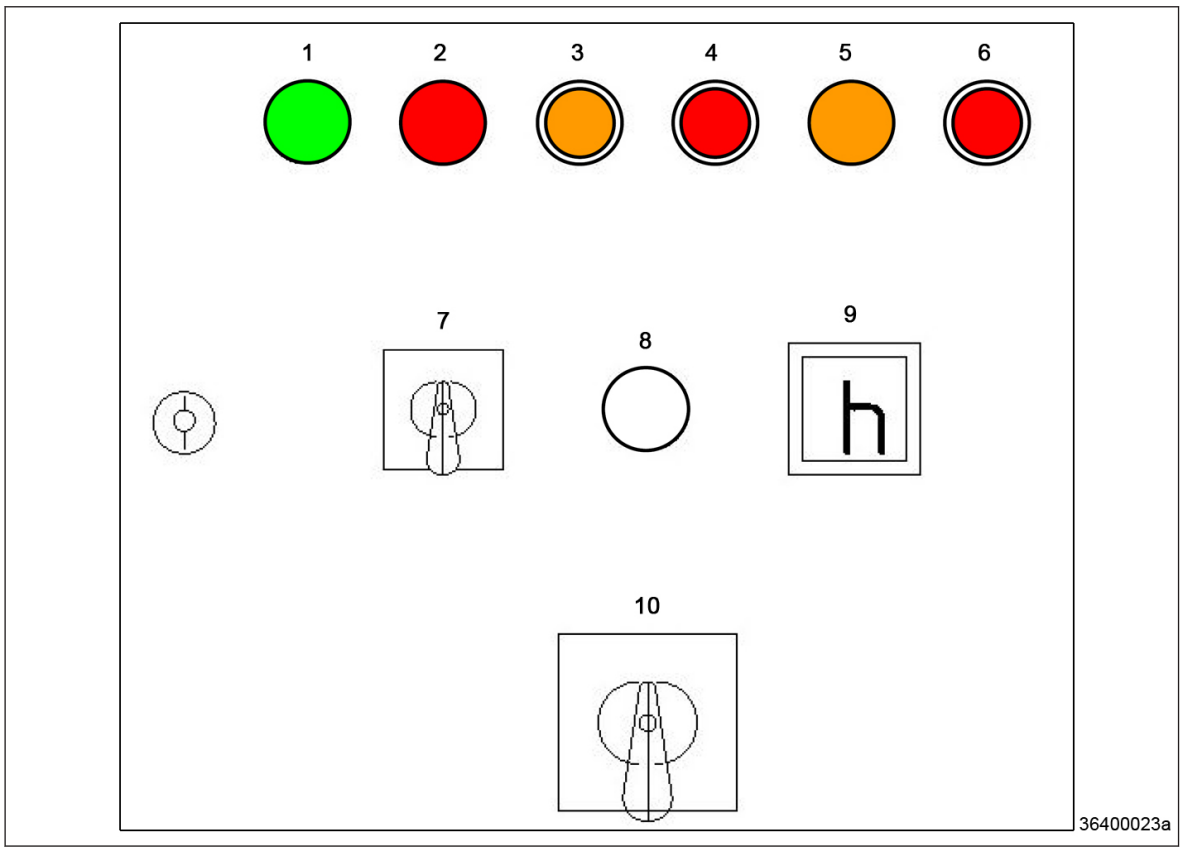
Engine noise above 85 dB (A).
Risk of damage to hearing!
- Wear ear protectors.

Operational checks

Item	Action
Engine oil	Check engine oil level (→ Page 140).
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 82).
Air filter	Check signal ring position of service indicator (→ Page 138); Replace air filter (→ Page 136) if the signal ring is completely visible in the service indicator observation window.
Intercooler	Check condensate drain(s) for water discharge and obstruction (→ Page 135).
Exhaust gas system	Check condensate drain for obstructions.
Fuel prefilter(s)	Drain water and contamination from fuel prefilter (if fitted) (→ Page 78). 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 159).
Raw water pump	Check relief bore for oil and water discharge and contamination (→ Page 162).

TIM-ID: 0000010131 - 005

3.6 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	

TIM-ID: 0000015755 - 004

3.7 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 71).
2. Shut down fuel treatment system (→ Page 77).

TIM-ID: 0000007730 - 005

3.8 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 73).
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.

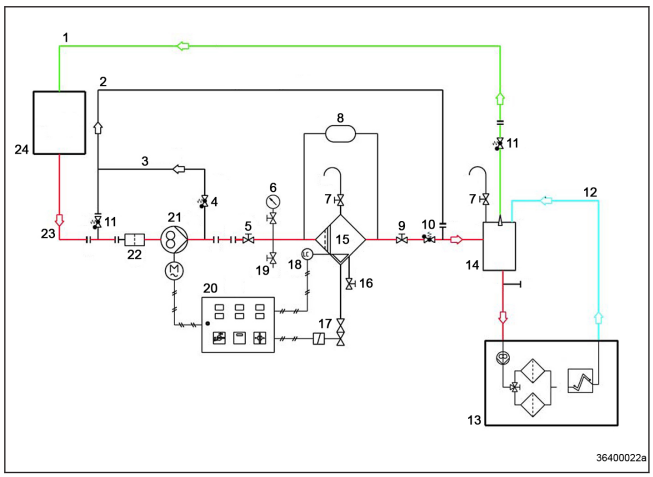
   d) Open ball valve at the inlet to the fuel treatment system.
7. Check the fuel treatment system for leaks.

Result: The fuel treatment system is ready for operation.

TIM-ID: 0000007736 - 005

3.9 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 73).
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 172).
2. Check sealing surfaces on coalescer filter element and in the pressure tank.

Initial operation: HAT

1. Replace fuel filter on engine (→ Page 131).

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 73).

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 66).
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.

TIM-ID: 0000015773 - 005

Simulation of filter replacement with the engine running: HAT

1. Switch on fuel treatment system (→ Page 73).
2. Start engine (→ Page 66).
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 73).
2. Start engine (→ Page 66).
3. Run engine at idling speed.
4. Switch off pump (21) on 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 73).
2. Start engine (→ Page 66).
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.

TIM-ID: 0000015773 - 005

3.10 Fuel treatment system – Switching on

Preconditions

☑ The on-board power supply is switched on.

CAUTION

Damage to engine/plant.
Major material damage!
- Before switching on, ensure that the engine/plant 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.

Switching on fuel treatment system

1. Carry out checks prior to start-up (→ Page 70).
2. Switch on master switch on switch cabinet.

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

3. Switch on switch for pump.

Result: Signal lamp “Pump running” lights up.

TIM-ID: 0000007731 - 005

3.11 Stopping the engine

Stopping the engine via the automation system

Refer to automation system operating instructions

TIM-ID: 0000017528 - 004

3.12 Emergency engine stop

CAUTION

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

Emergency stop

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

TIM-ID: 0000017530 - 004

3.13 After stopping the engine

Preconditions

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

After stopping the engine

Item	Action
Coolant circuit	Drain coolant (→ Page 156) 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/..)

TIM-ID: 0000002324 - 007

3.14 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.

TIM-ID: 0000007732 - 005

3.15 Fuel prefilter – Draining

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

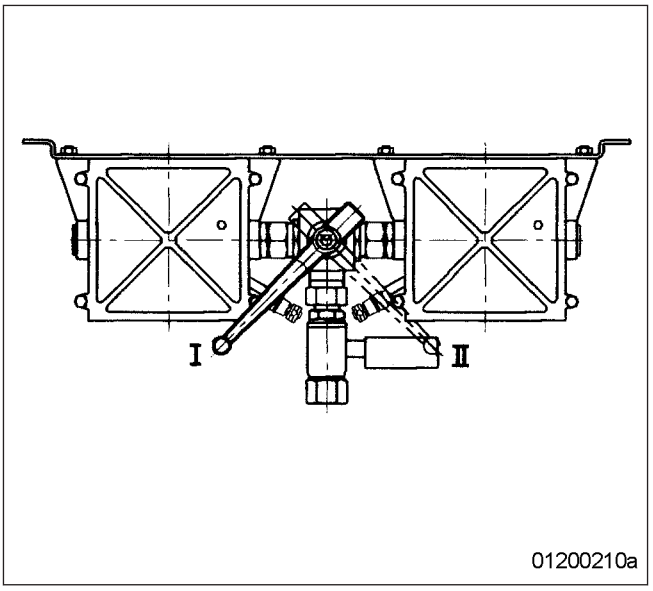
Designation / Use	Part No.	Qty.
Diesel fuel		
Seal	(→ Spare Parts Catalog)	

WARNING

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

Draining fuel prefilter

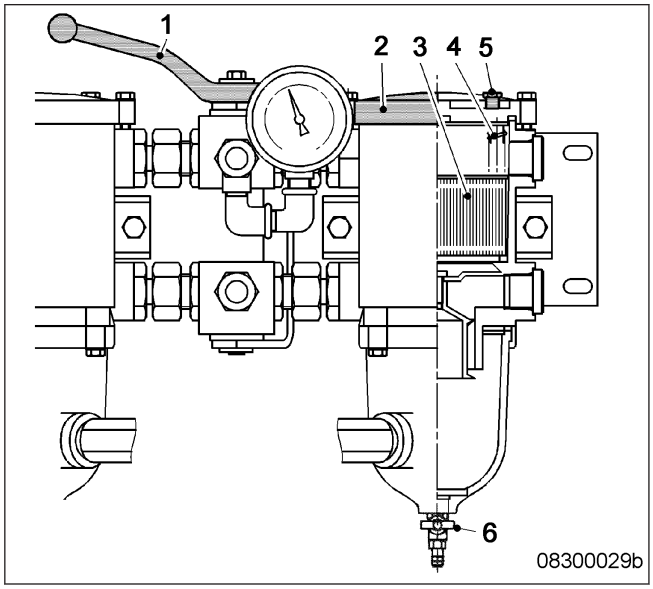
I Left filter cut in
II Right filter cut in



1. Switch off filter to be drained.

TIM-ID: 0000019514 - 001

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 securing cover and take off cover (2).
7. Fill filter housing with clean fuel.
8. Place new seal in cover (2).
9. Fit cover with seal and secure it with screws.
10. Switch on cut-out filter again.
11. Close threaded vent plug (5) when fuel emerges from system.



TIM-ID: 0000019514 - 001

3.16 Plant – Cleaning

Preconditions

☑ Engine is stopped and starting disabled.

☑ Operating voltage is not applied.

Special tools, Material, Spare parts

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

WARNING

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

WARNING

Water jet.
Risk of injury and scalding!
- Do not direct water jet at persons.
- Wear protective clothing, gloves, and goggles / safety mask.

CAUTION

Excessive reaction time of cleaning agents on components.
Damage to component!
- Observe manufacturer's instructions.
- Wear protective clothing, gloves, and goggles / safety mask.

NOTICE

Dry with compressed air.
Damage to component!
- Never aim compressed air directly at electronic components.

Plant – Cleaning

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

Note: Never aim compressed air directly at electronic components.

5. Dry engine.

TIM-ID: 0000010171 - 023

4 Maintenance

4.1 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	Maintenance tasks	
W0500	Check engine oil level	(→ Page 140)
W0501	Visually inspect engine for leaks and general condition	(→ Page 67)
W0502	Check intercooler drain(s)	(→ Page 135)
W0503	Check air filter maintenance indicator	(→ Page 138)
W0505	Check relief bores on coolant pump(s)	(→ Page 159)
W0506	Check engine for abnormal running noises, exhaust color and vibrations	(→ Page 67)
W0507	Drain water and dirt from fuel prefilter (if applicable)	-
W0508	Check reading on differential pressure gage of fuel prefilter (if fitted)	-
W1001	Replace fuel filter or fuel filter element	(→ Page 131)
W1002	Check valve clearance	(→ Page 119)
W1005	Replace air filter	(→ Page 136)
W1006	Replace fuel injectors	(→ Page 125)
W1008	Replace engine oil filter at each oil change or when the time limit (years) is reached, at the latest	-
W1009	Check layer thickness of oil residue, clean and replace filter sleeve (if fitted) when the oil is changed at the latest	(→ Page 151)
W1011	Perform endoscopic inspection of combustion chambers	(→ Page 114)
W1016	Battery-charging generator: Check condition of coupling	-
W1029	Check air pipework between air filter and exhaust turbocharger for leaks and damage	(→ Page 67)
W1036	Replace coolant filter	(→ Page 161)
W1047	Check and clean oil indicator filter	(→ Page 149)
W1076	Exhaust turbocharger: Clean compressor wheel	(→ Page 133)
W1244	Check operation of rod electrode (if applicable)	(→ Page 170)
W1245	Differential-pressure gage, check alarm function (if applicable)	(→ Page 169)
W1246	Check pump performance (if applicable)	(→ Page 171)
W1463	Check general condition of engine mounting (visual inspection)	(→ Page 165)
W1487	Check intercooler for contamination	(→ Page 135)

Table 1: Maintenance schedule task reference table [QL1]

TIM-ID: 0000036097 - 001

5 Troubleshooting

5.1 Troubleshooting

Engine does not turn when starter is actuated

Component	Probable cause	Task
Battery	Low or defective	Charge or replace (see manufacturer's documentation).
	Cable connections defective	Check whether cable connections are properly secured (see manufacturer's documentation).
Starter	Engine wiring or starter defective	Check whether cable connections are properly secured, contact Service.
Engine wiring	Defective	Check (→ Page 174).
LOP	Seating of assemblies or connectors possibly loose	Inspect visually.
ECU	Plug-in connections possibly loose	Check plug connections (→ Page 176).
Engine	Running gear blocked (engine cannot be barred manually)	Contact Service.

Engine turns on starting but does not fire

Component	Probable cause	Task
Starter	Poor rotation by starter: Battery low or defective	Charge or replace battery (see manufacturer's documentation).
Engine wiring	Defective	Check (→ Page 174).
ECU	Defective	Contact Service.

Engine fires unevenly

Component	Probable cause	Task
Fuel injection equipment	Injector defective	Replace (→ Page 125).
Engine wiring	Defective	Check (→ Page 174).
ECU	Defective	Contact Service.

Engine does not reach rated speed

Component	Probable cause	Task
Fuel supply	Easy-change fuel filter clogged	Replace (→ Page 131).
Air supply	Air filter clogged	Check signal ring position of service indicator (→ Page 138).
Fuel injection equipment	Injector defective	Replace (→ Page 125).
Engine wiring	Defective	Check (→ Page 174).
Engine	Overload	Contact Service.

TIM-ID: 0000010521 - 001

Engine speed not steady

Component	Probable cause	Task
Fuel injection equipment	Injector defective	Replace (→ Page 125).
Speed sensor	Defective	Contact Service.
ECU	Defective	Contact Service.

Charge-air temperature too high

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

Charge-air pressure too low

Component	Probable cause	Task
Air supply	Air filter clogged	Check signal ring position of service indicator (→ Page 138).
Intercooler	Contaminated	Contact Service.
Exhaust turbocharger	Defective	Contact Service.

Coolant leaks on intercooler

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

Exhaust gas black

Component	Probable cause	Task
Air supply	Air filter clogged	Check signal ring position of service indicator (→ Page 138).
Fuel injection equipment	Injector defective	Replace (→ Page 125).
Engine	Overload	Contact Service.

Exhaust gas blue

Component	Probable cause	Task
Engine oil	Too much oil in engine	Drain engine oil (→ Page 141).
	Oil separator or oil preseparator of crankcase breather clogged	Replace.
Exhaust turbocharger, cylinder head, piston rings, cylinder liner	Defective	Contact Service.

TIM-ID: 0000010521 - 001

Exhaust gas white

Component	Probable cause	Task
Engine	Not at operating temperature	Run engine to reach operating temperature.
Intercooler	Leaking	Contact Service.

TIM-ID: 0000010521 - 001

5.2 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 172).

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 172). 2. Press illuminated pushbutton “Replace filter element” to acknowledge.

TIM-ID: 0000031170 - 001

5.3 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
Speed 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
Hour meter faulty.	▶ Contact Service.

TIM-ID: 0000018389 - 002

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 defective; Short circuit or wire break	▶ Check sensor and cabling, replace as necessary.

TIM-ID: 0000018389 - 002

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.

TIM-ID: 0000018389 - 002

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.

TIM-ID: 0000018389 - 002

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 sensor and cabling to connector B1, replace as necessary. 2. Error cleared after restarting the engine.

TIM-ID: 0000018389 - 002

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.

TIM-ID: 0000018389 - 002

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

TIM-ID: 0000018389 - 002

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

TIM-ID: 0000018389 - 002

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

TIM-ID: 0000018389 - 002

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

TIM-ID: 0000018389 - 002

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.

TIM-ID: 0000018389 - 002

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.

TIM-ID: 0000018389 - 002

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.

TIM-ID: 0000018389 - 002

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.

TIM-ID: 0000018389 - 002

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.

TIM-ID: 0000018389 - 002

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.

TIM-ID: 0000018389 - 002

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.

TIM-ID: 0000018389 - 002

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 is additionally stopped in this case.	▶ Start ITS. If the ITS diagnosis result is "electronics OK", note further fault messages (e.g. cabling faults).

362 – AL Injector 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 is additionally stopped in this case.	▶ 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 is additionally stopped in this case.	▶ Start ITS. If the ITS diagnosis result is "electronics OK", note further fault messages (e.g. cabling faults).

TIM-ID: 0000018389 - 002

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 is additionally stopped in this case. 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)

TIM-ID: 0000018389 - 002

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.

TIM-ID: 0000018389 - 002

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 wiring, 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.

TIM-ID: 0000018389 - 002

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
Tripped by crash recorder triggering due to engine shutdown.	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
Initialization error of crash recorder.	1. Check settings 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.

TIM-ID: 0000018389 - 002

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 due to a missing consumer, 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 due to a missing consumer, 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
Battery is not charged by battery-charging generator.	▶ 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.

TIM-ID: 0000018389 - 002

506 – AL Low Starter Voltage

ZKP-Number: 14.500.906

Cause	Corrective action
The battery voltage is too low for the starting process.	▶ Check starter battery 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 sends a different ID number than expected.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.

TIM-ID: 0000018389 - 002

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.

TIM-ID: 0000018389 - 002

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.

TIM-ID: 0000018389 - 002

6 Task Description

6.1 Engine

6.1.1 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

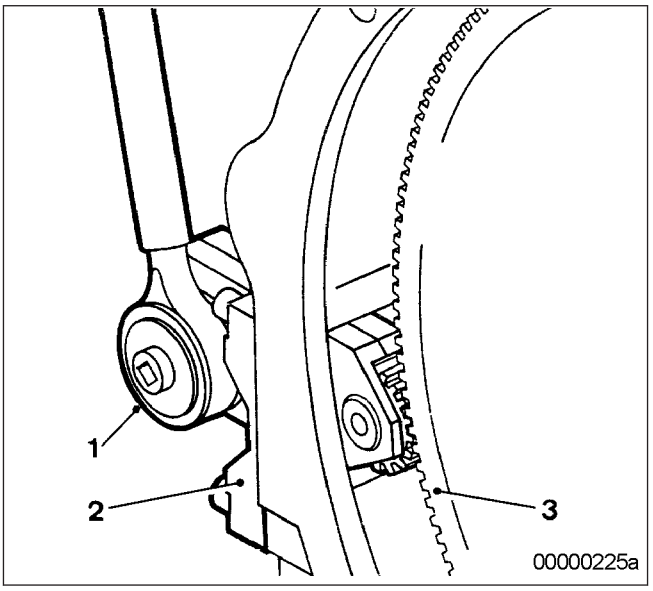
Unguarded rotating and moving engine components.
Risk of serious injury – Danger to life!
- Before barring the engine, ensure that nobody is in the danger zone.

Engine – Barring manually

1. Remove guard plate.

Result: Safety switch preventing engine starting 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.



TIM-ID: 0000010503 - 003

6.1.2 Engine – Barring with starting system

Barring using the automation system

Refer to automation system operating instructions

TIM-ID: 0000017532 - 003

6.2 Cylinder Liner

6.2.1 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 123).
2. Remove injector (→ Page 126).

Positioning crankshaft at BDC

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

Endoscopic examination of cylinder liner

Findings	Action
• Thin carbon coating on circumference of carbon scraper ring • Slight localized additive deposits at top edge • Localized smooth areas on bottom edge • Carbon deposits on circumference in clearance between top piston ring and bottom edge of carbon scraper ring • First signs of marks left by top piston ring • Bright mark on entire circumference • Consistent honing pattern without objections • First signs of marks left by lower cooling bores • Running pattern seems darker	No action required
• 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 116).
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.

TIM-ID: 0000000015 - 013

Final steps

1. Install injector (→ Page 126).
2. Install cylinder head cover (→ Page 123).

TIM-ID: 0000000015 - 013

6.2.2 Cylinder liner – Instructions and comments on endoscopic and visual examination

Terms used for endoscopic examination

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

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

TIM-ID: 0000000014 - 013

Findings	Measure
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.

TIM-ID: 0000000014 - 013

6.3 Valve Drive

6.3.1 Valve gear – Lubrication

Preconditions

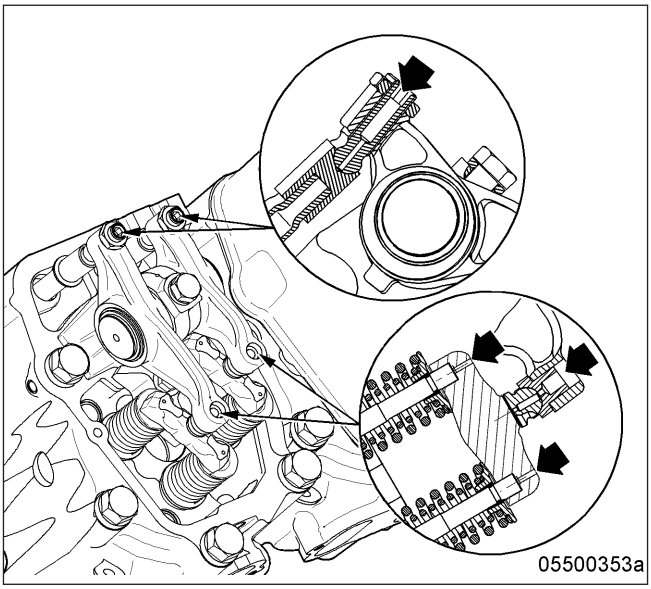
☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine oil		

Valve gear – Lubrication

1. Remove cylinder head covers (→ Page 123).
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 123).



TIM-ID: 0000000921 - 007

6.3.2 Valve clearance – Check and adjustment

Preconditions

☑ Engine is stopped and starting disabled.

☑ Engine coolant temperature is max. 40 °C.

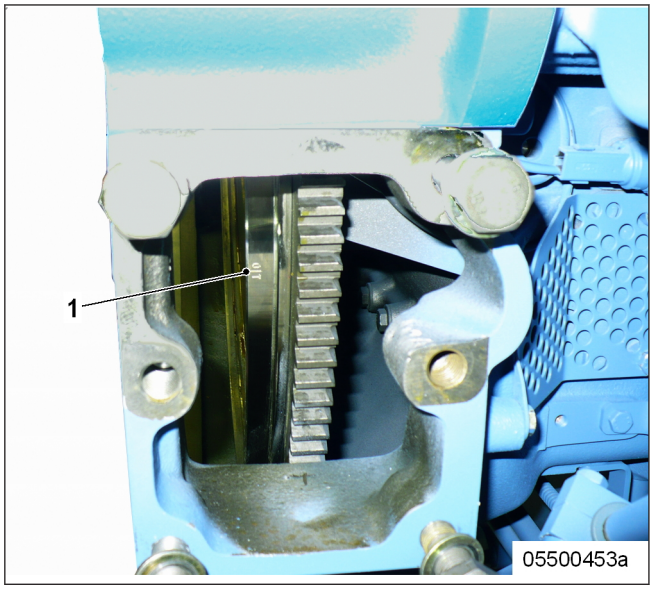
☑ Valves are closed.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Feeler gauge	Y20098771	1
Torque wrench, 60-320 Nm	F30452768	1
Box wrench socket, 24 mm	F30039526	1
Ratchet adapter	F30027341	1
Engine oil		

Preparatory steps

1. Remove cylinder head cover (→ Page 123).
2. Install barring device (→ Page 112).
3. The TDC marking (1) (if fitted) on the flywheel must not be used for reference.



TIM-ID: 0000000922 - 008

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

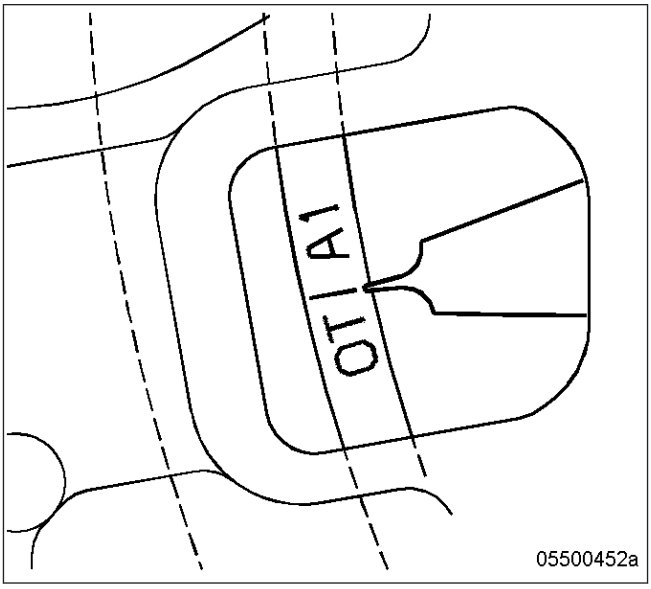


Diagram for 8V engines (two crankshaft positions)

1 Cylinder A1 is in firing TDC
2 Cylinder A1 is in overlap TDC
I Inlet valve
X Exhaust valve

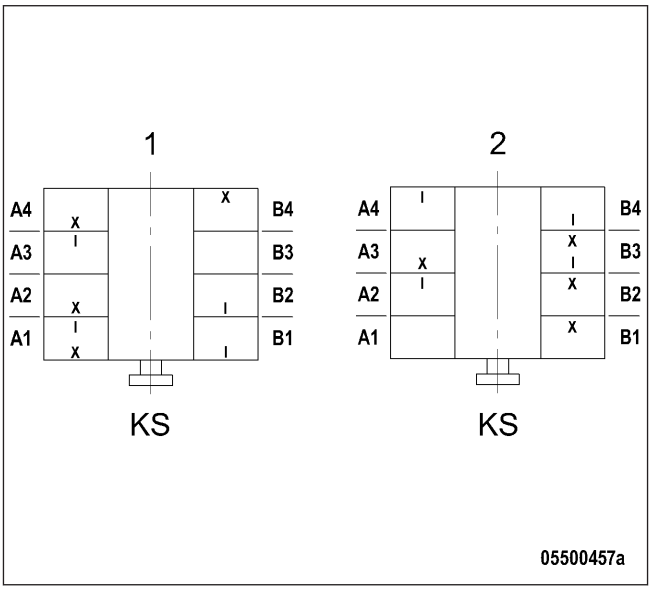
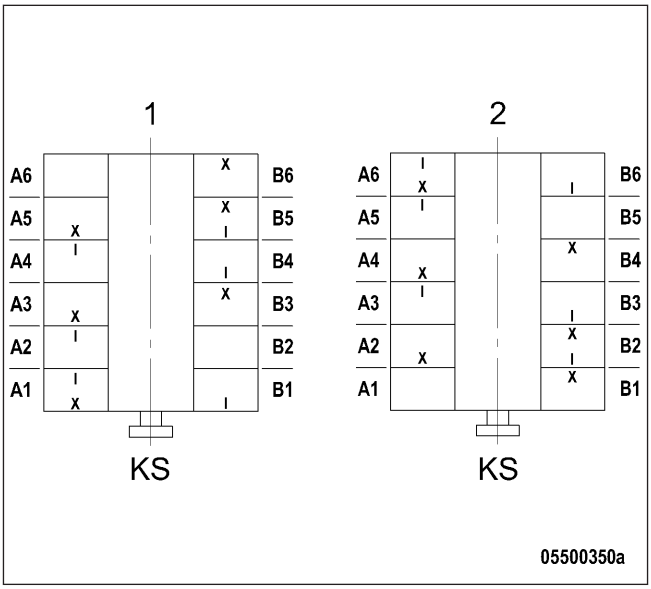


Diagram for 12V engines (two crankshaft positions)

1 Cylinder A1 is in firing TDC
2 Cylinder A1 is in overlap TDC
I Inlet valve
X Exhaust valve



TIM-ID: 0000000922 - 008

Diagram for 16V engines (two crankshaft positions)

1 Cylinder A1 is in firing TDC
2 Cylinder A1 is in overlap TDC
I Inlet valve
X Exhaust valve

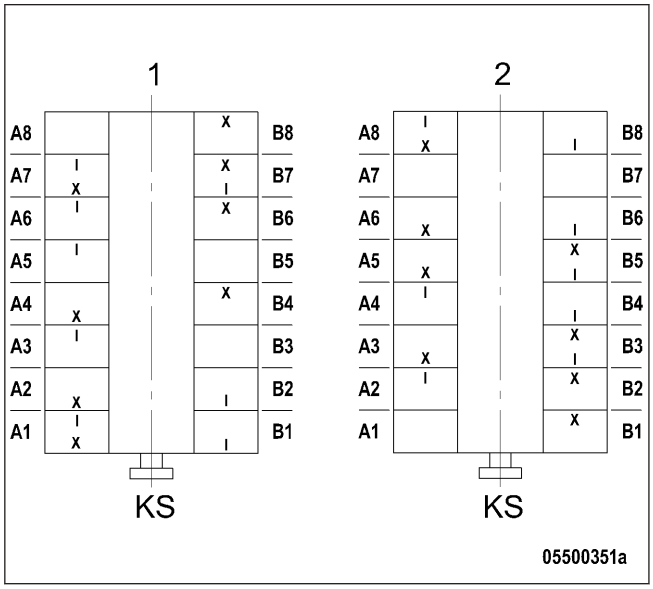
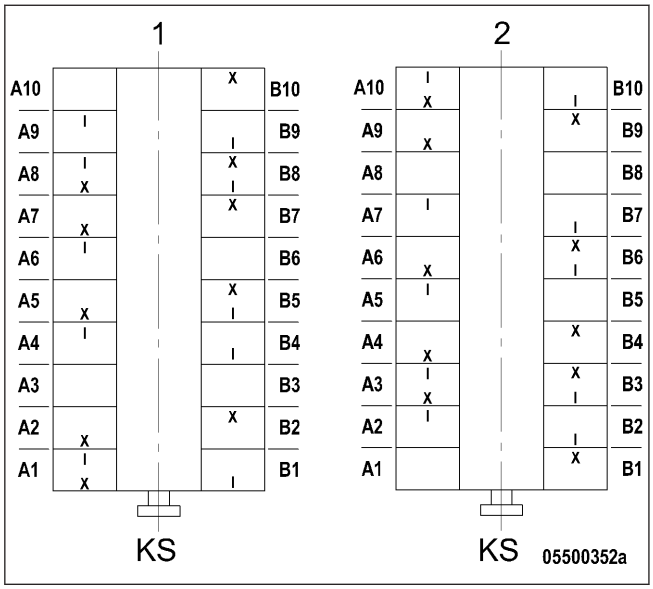


Diagram for 20V engines (two crankshaft positions)

1 Cylinder A1 is in firing TDC
2 Cylinder A1 is in overlap TDC
I Inlet valve
X Exhaust valve



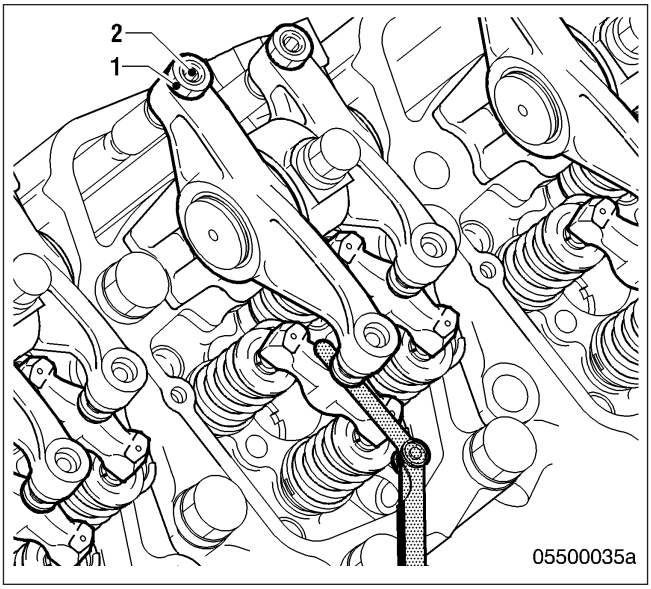
Checking valve clearance at two crankshaft positions

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 adjustment with cold engine:
   - Inlet (long rocker arm) = 0.2 mm
   - Exhaust (short rocker arm) = 0.5 mm
3. Check all valve clearances in two crankshaft positions (firing TDC and overlap TDC of cylinder A1) as per diagram.
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.

TIM-ID: 0000000922 - 008

Adjusting valve clearance

1. Release locknut (1).
2. Insert feeler gauge 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 must just pass through the 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 112).
2. Install cylinder head cover (→ Page 123).

TIM-ID: 0000000922 - 008

6.3.3 Cylinder head cover – Removal and installation

Preconditions

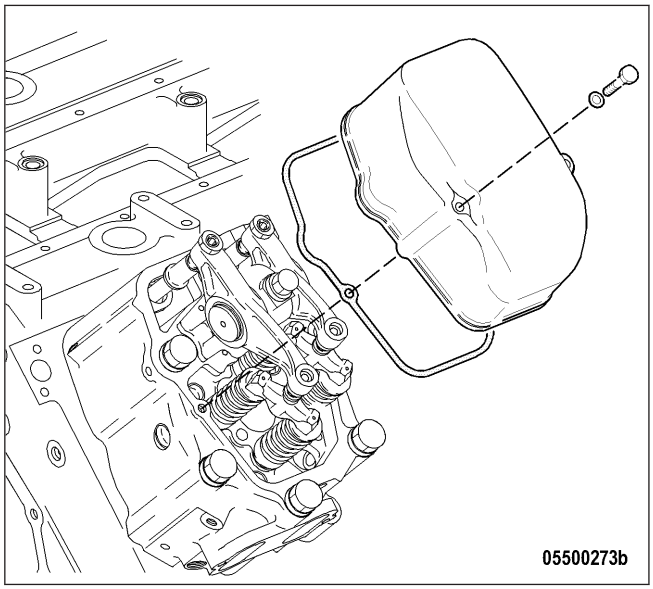
☑ Engine is stopped and starting disabled.

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.

TIM-ID: 0000000923 - 006

6.4 Valve Gear

6.4.1 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

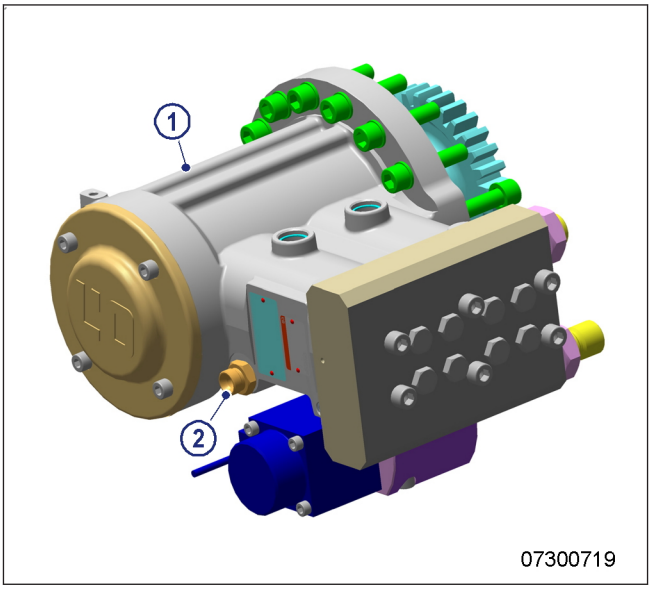
Oils/oil vapors are combustible.
Risk of fire!
- No open flames, no electric sparks. Do not smoke. Avoid ignition sources.

CAUTION

Fuel system high-pressure pump not filled with engine oil.
Damage to components, major material damage!
- Make sure that the high-pressure fuel pump is filled with engine oil before installation or initial operation.

Filling HP pump

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



TIM-ID: 0000001640 - 008

6.5 Injection Valve / Injector

6.5.1 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 126).

TIM-ID: 0000000022 - 013

6.5.2 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
Torque wrench, 60-320 Nm	F30452768	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

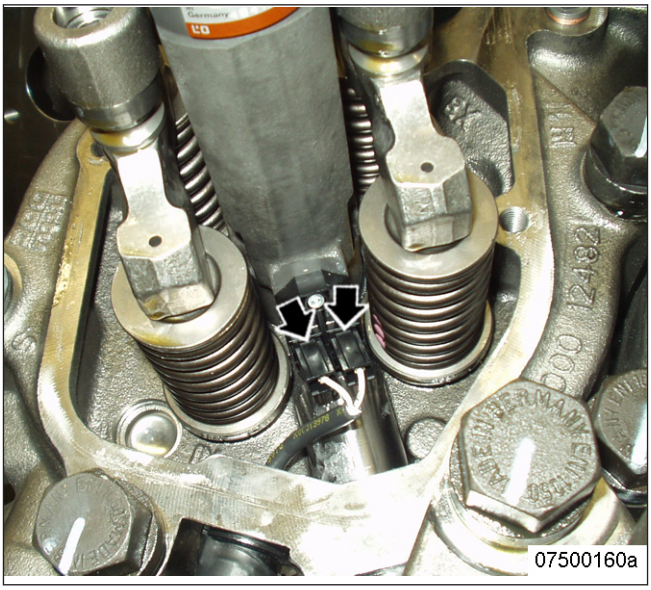
Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Preparatory steps

1. Shut off fuel supply to engine.
2. Remove cylinder head cover (→ Page 123).

Removing injector

1. Disconnect cable connector on injector.

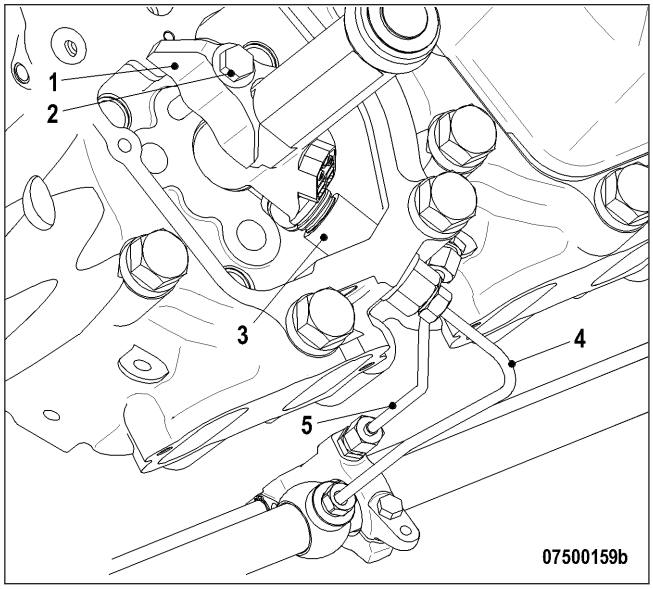


TIM-ID: 0000000925 - 006

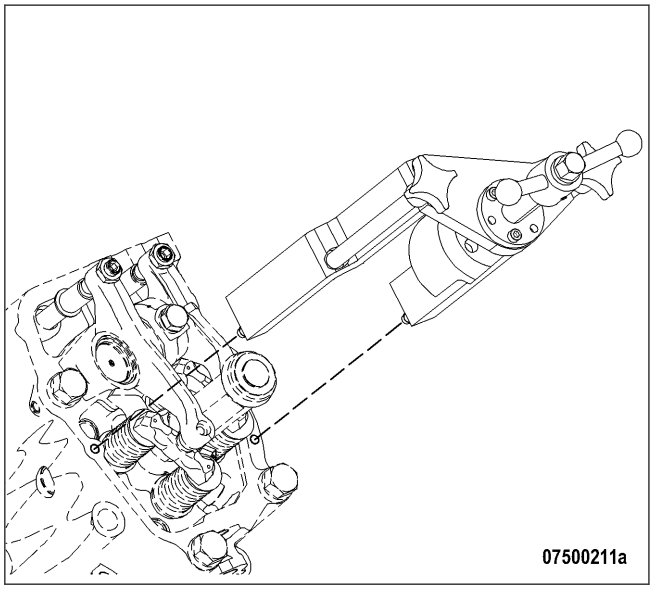
2. Remove HP fuel line (4).
3. Remove return line (5).

Note: The injector accumulator will be emptied when removing the adapter.

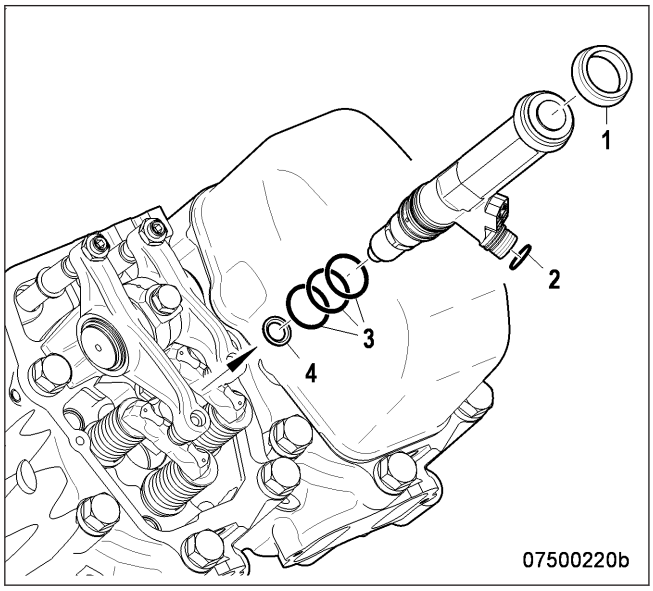
4. Remove adapter (3).
5. Remove screw (2) and take off hold-down clamp (1).



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



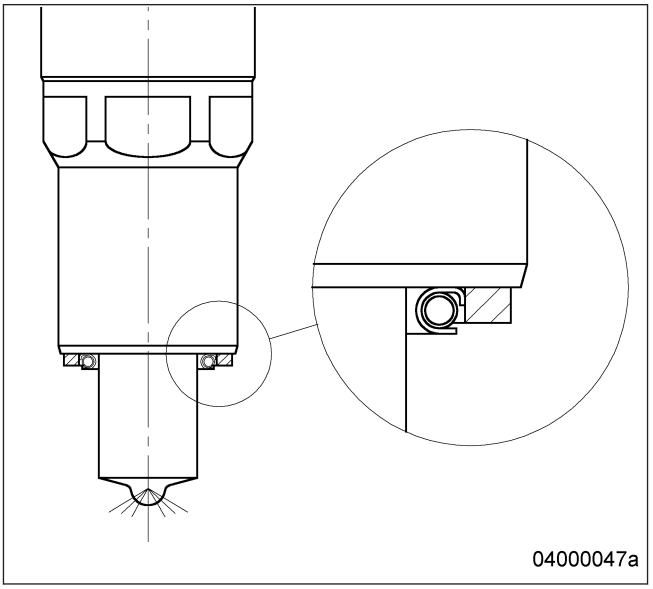
9. Remove sealing ring (4) from injector or use a self-made hook to take it out of the cylinder head.
10. Remove O-rings (3), O-ring (2) and damper ring (1) from injector.
11. Clean all mating and sealing surfaces.
12. Cover all connections and bores, or seal with suitable plugs.



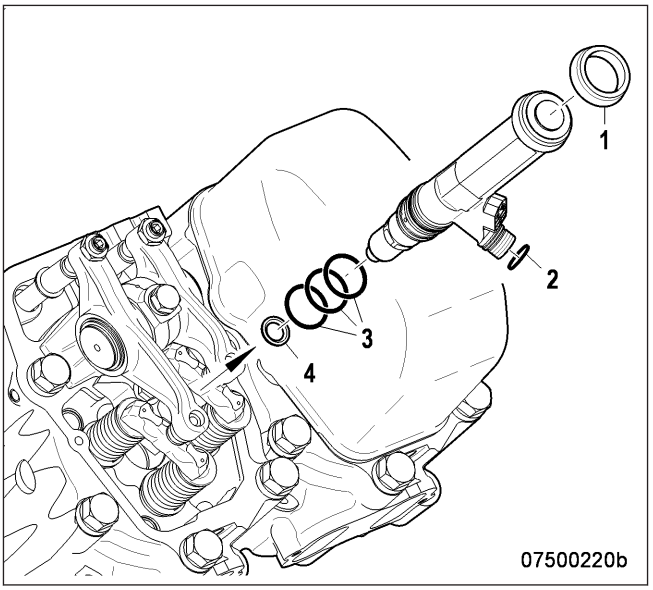
TIM-ID: 0000000925 - 006

Installing injector

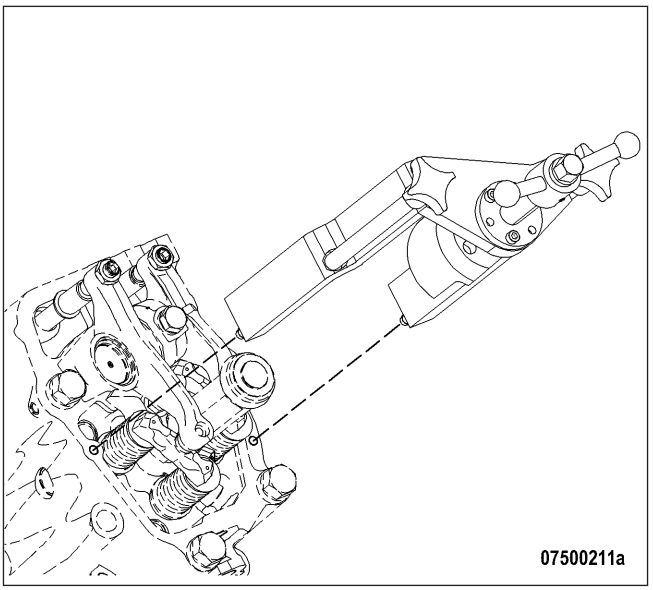
1. Remove plug before installing the injector. (Do not remove the plug from the HP line before installing the adapter.)
2. Coat injector with assembly paste at the seat of the nozzle clamping nut.
3. Fit new sealing ring (4) (included in the scope of supply of the injector) with grease on injector, observe installation position of sealing ring (4).



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.

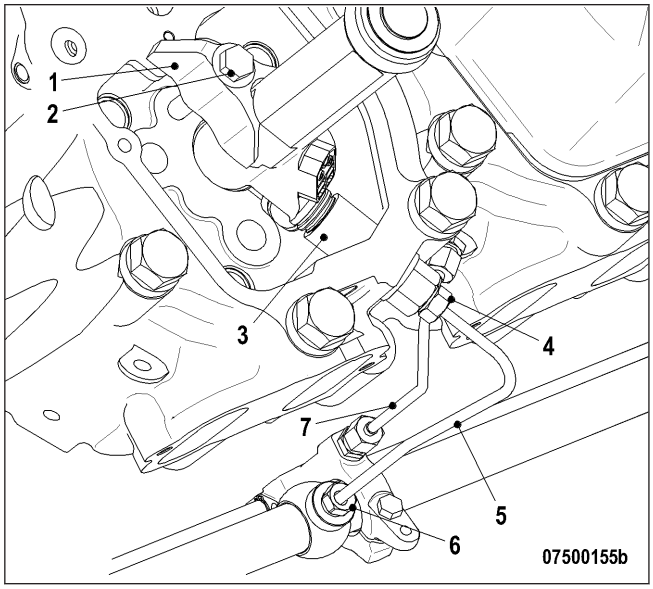


5. Clean sealing face on cylinder head and protective sleeve with milling cutter.
6. Insert injector into cylinder head, ensuring that the HP line adapter is correctly aligned.
7. Use installation/removal tool to press in injector.
8. Remove installation/removal tool.



TIM-ID: 0000000925 - 006

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)

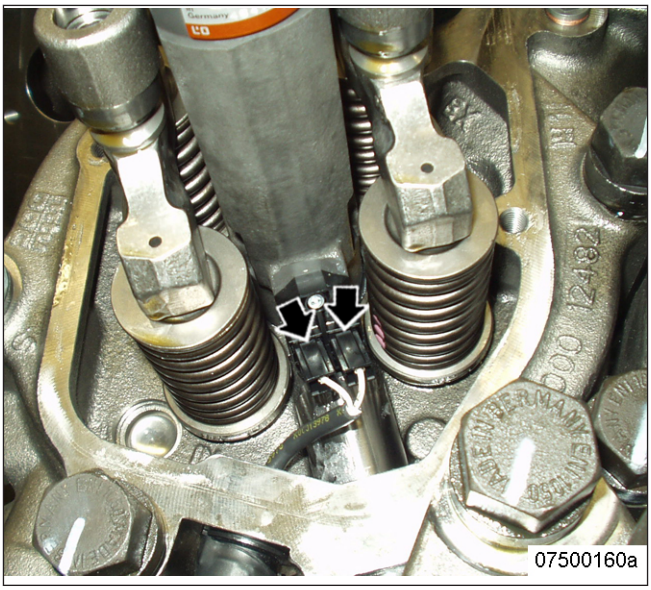
Name	Size	Type	Lubricant	Value/Standard
Union nut / thrust screw		Tightening torque		30 Nm + 5 Nm

TIM-ID: 0000000925 - 006

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 cable connector onto injector.



Final steps

1. Install cylinder head cover (→ Page 123).
2. Open fuel supply to engine.

TIM-ID: 0000000925 - 006

6.6 Fuel Filter

6.6.1 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

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

WARNING

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

WARNING

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

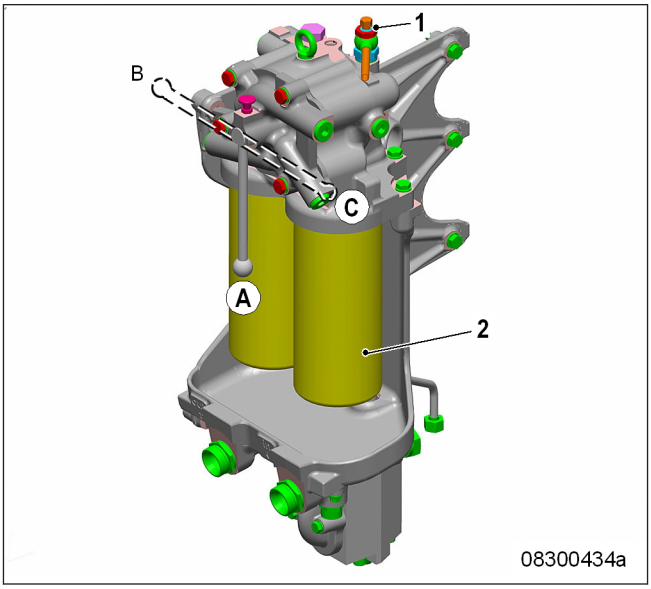
CAUTION

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

TIM-ID: 0000012705 - 001

Fuel filter replacement with the engine stopped

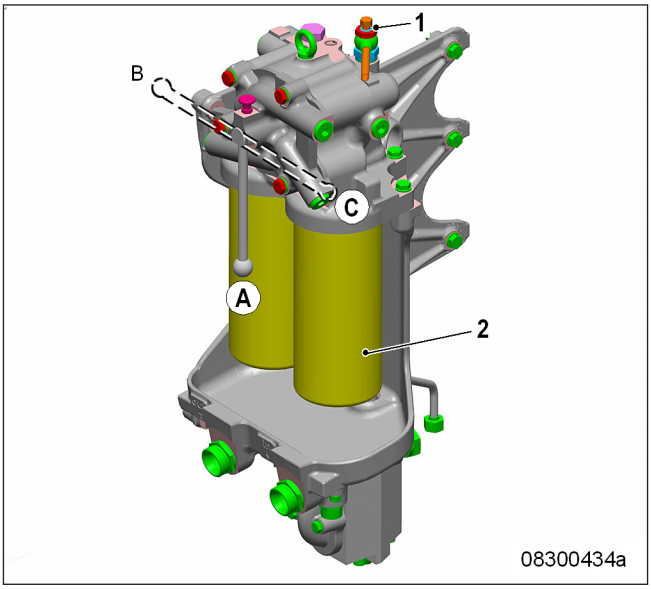
A Both filters operating
B Left filter cut out
C Right filter cut out
1 Fuel vent
2 Fuel filter



1. Cut out the filter to be replaced.
2. Remove cut-out easy-change filter using the oil filter wrench.
3. Clean the sealing face of the filter head.
4. Check sealing ring of the new easy-change filter and coat it with fuel.
5. Install SOLAS shielding (→ Page 15).
6. Install and tighten easy-change filter 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. Remove cut-out easy-change filter using the oil filter wrench.
3. Clean the sealing face of the filter head.
4. Check sealing ring of the new easy-change filter and coat it with fuel.
5. Install SOLAS shielding (→ Page 15).
6. Install and tighten easy-change filter by hand.
7. Set three-way cock to operating position (both filters cut in).
8. Replace further fuel filters in the same way.



TIM-ID: 0000012705 - 001

6.7 Charge-Air Cooling

6.7.1 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
Risk of injury!
- Do not direct compressed-air jet at persons.
- Wear protective goggles / safety mask and ear protectors.

WARNING

Chemical substances.
Risk of irritation and chemical burns!
- Always obey manufacturer's instructions for use!

CAUTION

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.

CAUTION

Unsuitable cleaning tool.
Damage to component!
- Observe manufacturer's instructions.
- Use appropriate cleaning tool.

Preparatory steps

1. Drain engine coolant.(→ Page 156)
2. Remove air filter.(→ Page 137)
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.

TIM-ID: 0000034852 - 001

Final steps

1. Install air intake.
2. Install exhaust flap with actuators.
3. Install exhaust system after exhaust turbocharger.
4. Install air filter.(→ Page 137)
5. Fill with engine coolant.(→ Page 157)

TIM-ID: 0000034852 - 001

6.7.2 Intercooler – Check water drain for coolant discharge and obstruction

DANGER

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

WARNING

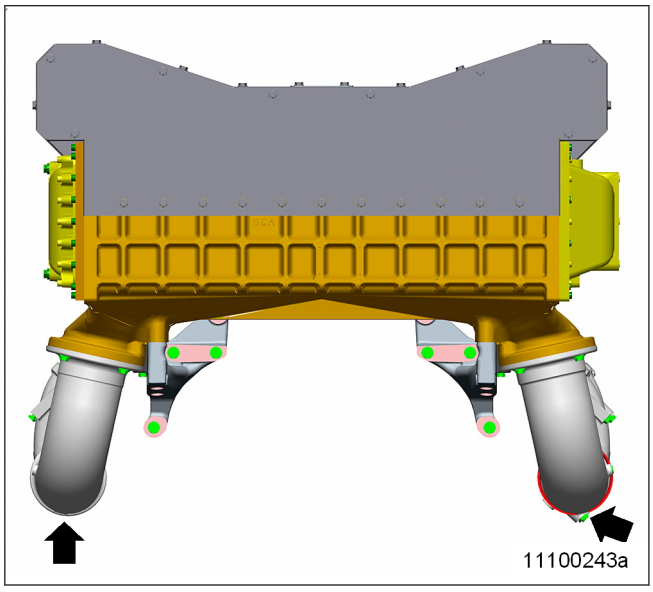
Engine noise above 85 dB (A).
Risk of damage to hearing!
- Wear ear protectors.

WARNING

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

Checking intercooler 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 126).
2. Bar engine manually (→ Page 112).
3. Bar engine with starting system to blow out cylinder chambers (→ Page 112).
4. Install injectors (→ Page 126).

TIM-ID: 0000013246 - 007

6.8 Air Filter

6.8.1 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 137).
2. Reset signal ring of contamination indicator (→ Page 138).

TIM-ID: 0000005447 - 009

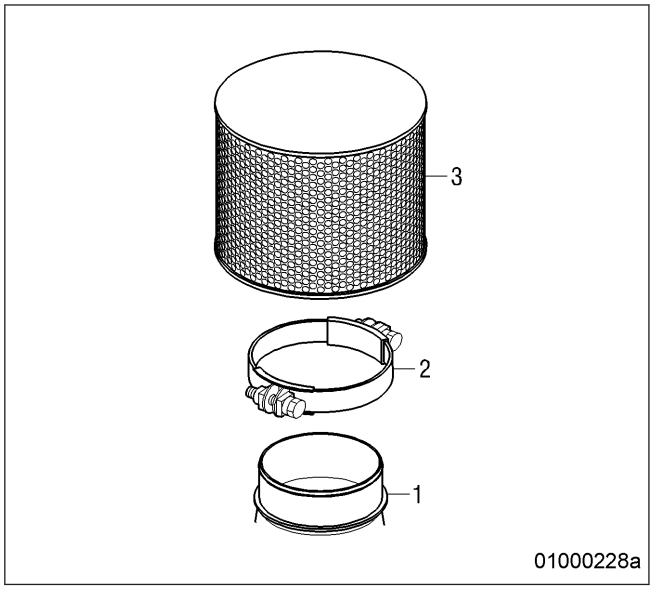
6.8.2 Air filter – Removal and installation

Preconditions

☑ Engine is stopped and starting disabled.

Removing and installing air filter

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



TIM-ID: 0000005457 - 006

6.9 Air Intake

6.9.1 Contamination indicator – Signal ring position check (optional)

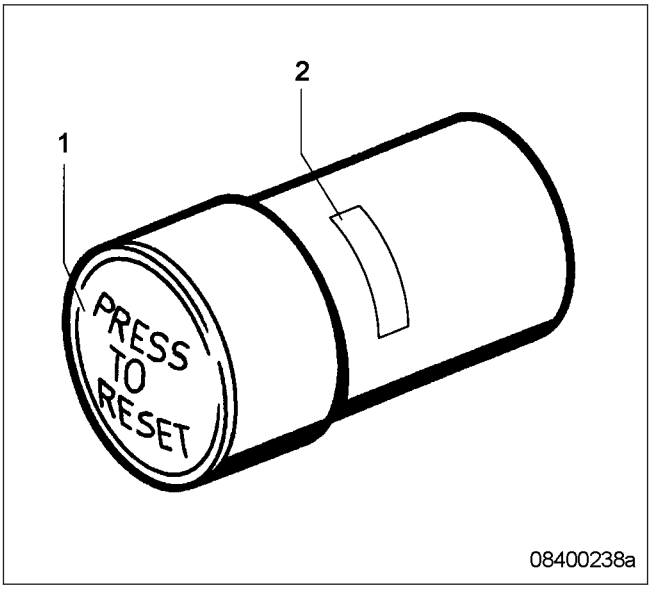
Preconditions

☑ Engine is stopped and starting disabled.

Checking signal ring position

1. If the signal ring is completely visible in the observation window (2), replace air filter (→ Page 136).
2. After installation of new filter, press reset button (1).

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



TIM-ID: 0000005484 - 007

6.10 Starting Equipment

6.10.1 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 174).

TIM-ID: 0000000905 - 017

6.11 Lube Oil System, Lube Oil Circuit

6.11.1 Engine oil level – Check

Preconditions

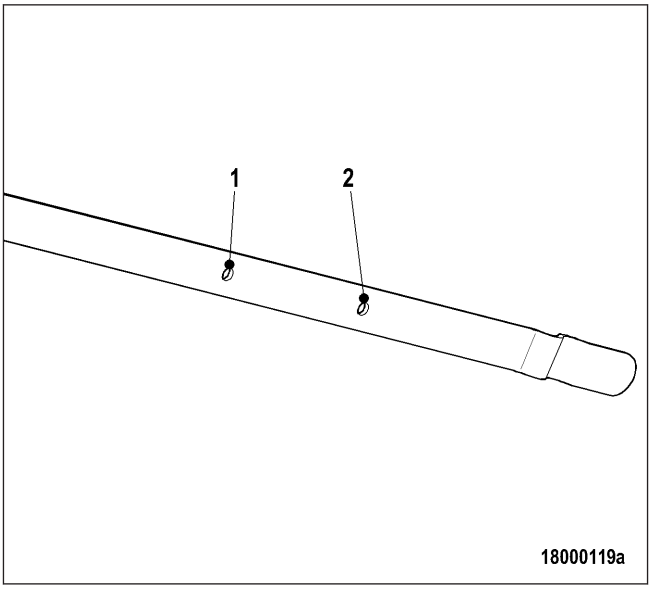
☑ Engine shut down and starting disabled.

Checking oil level prior to engine start

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

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

3. The oil level must reach mark (1) or exceed mark (1) by up to 2 cm.
4. Top up with oil to mark (1) as necessary (→ Page 141).
5. Insert oil dipstick into guide tube up to the stop.



Checking oil level after the engine is stopped

1. 5 minutes after stopping the engine, remove oil dipstick from the guide tube and wipe it.
2. Insert oil dipstick into guide tube up to stop, withdraw after approx. 10 seconds and check oil level.
3. Oil level must be between marks (1) and (2).
4. Top up with oil to mark (1) as necessary (→ Page 141).
5. Insert oil dipstick into guide tube up to the stop.

TIM-ID: 0000000931 - 009

6.11.2 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 adapter	F30027341	1
Engine oil		
Sealing ring	(→ Spare Parts Catalog)	

WARNING

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

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

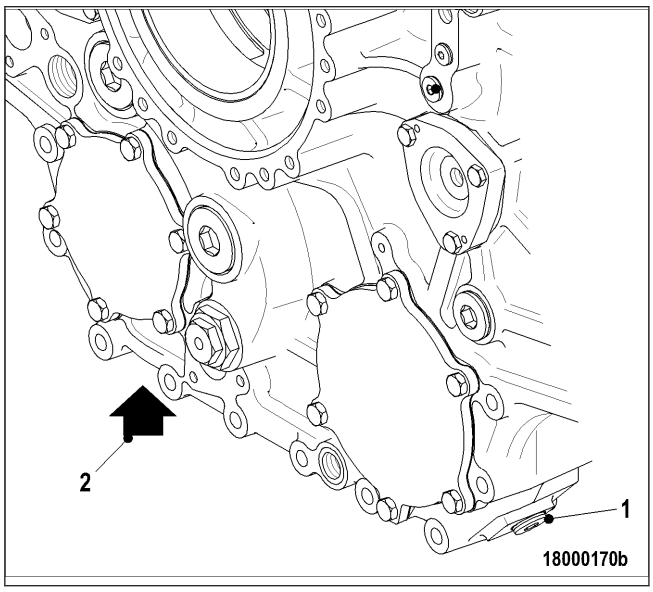
1. Provide a suitable container in which to collect the oil.
2. Remove drain plug(s) and drain oil.
3. Install drain plug(s) with new sealing ring.

Oil change using semirotary hand pump: Oil extraction

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

Draining residual oil at the equipment carrier

1. Provide a suitable container in which 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 149).
4. Install drain plug(s) with new sealing ring.



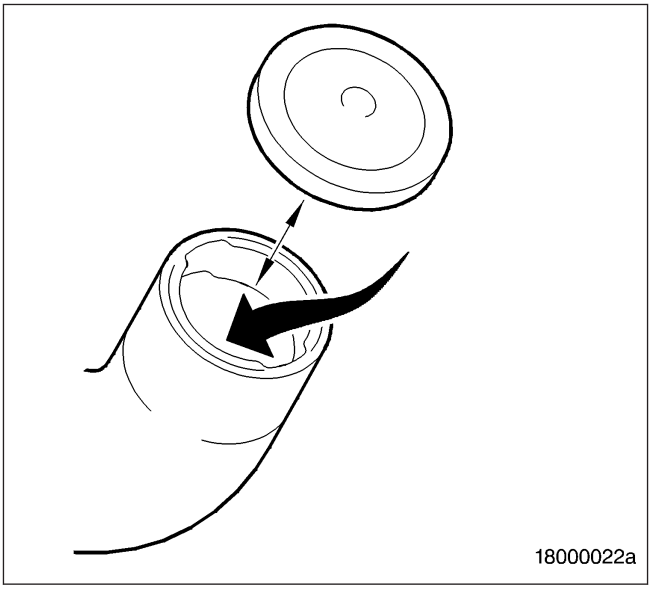
TIM-ID: 0000014100 - 001

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

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

Filling new oil

1. Open cover of filler neck.
2. Pour oil in at filler neck up to "max." mark at oil dipstick.
3. Close cover of filler neck.
4. Check engine oil level (→ Page 140).
5. After oil change, bar engine with starting system (→ Page 113).



TIM-ID: 0000014100 - 001

6.11.3 Engine oil – Sample extraction and analysis

Preconditions

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

Special tools, Material, Spare parts

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

DANGER

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

WARNING

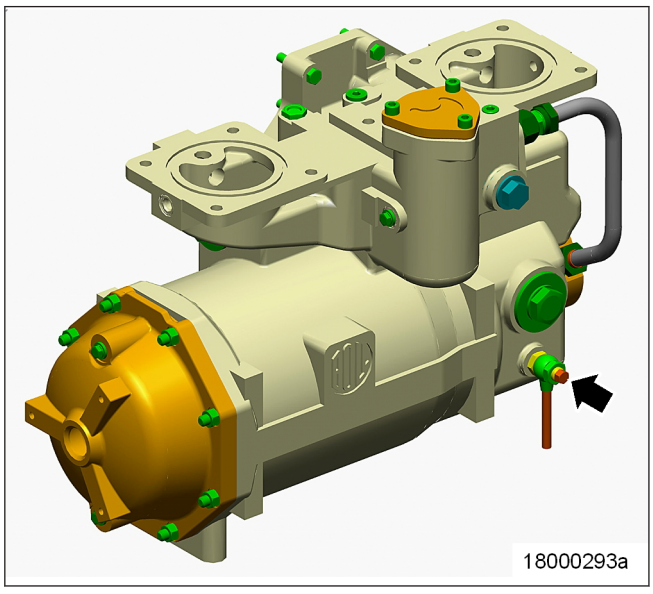
Hot oil.
Oil can contain combustion residues which are harmful to health.
Risk of injury and poisoning!
- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

WARNING

Engine noise above 85 dB (A).
Risk of damage to hearing!
- 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 of the MTU test kit, check engine oil for:
   - Dispersing capacity (spot test);
   - Water content;
   - Dilution by fuel.



TIM-ID: 0000014114 - 003

6.12 Oil Filtration / Cooling

6.12.1 Oil indicator filter – Cleaning

Preconditions

☑ Engine is stopped and starting disabled

Special tools, Material, Spare parts

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

WARNING

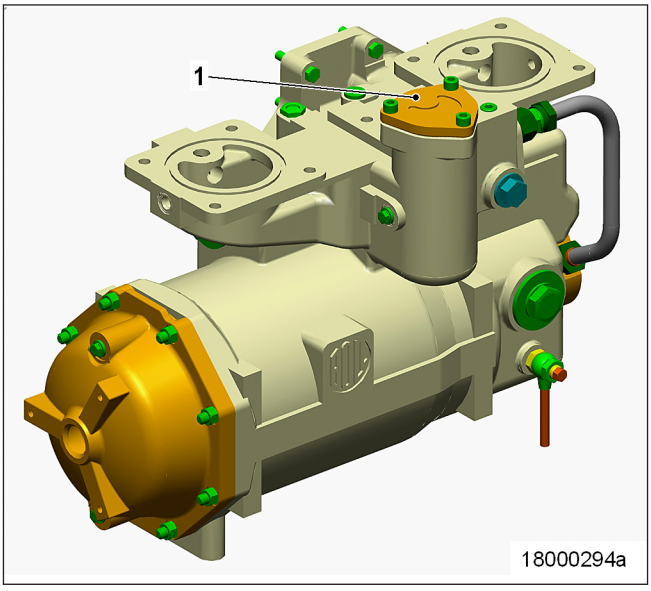
Hot oil.
Oil can contain combustion residues which are harmful to health.
Risk of injury and poisoning!
- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

WARNING

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

Removing strainer

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



TIM-ID: 0000014187 - 002

Cleaning strainer

1. Shake coarse deposits out of strainer.
2. Clean all metallic parts with cleaning agent (Snow-White 11-0), then rinse with cleaning agent (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.

TIM-ID: 0000014187 - 002

6.12.2 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

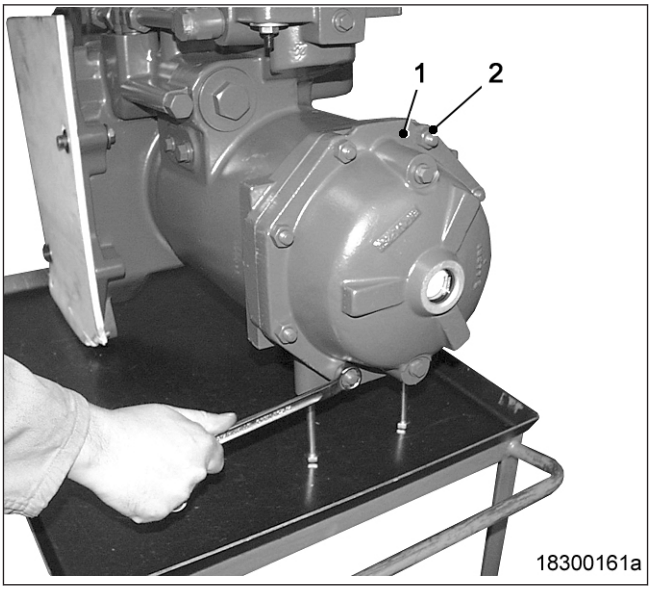
Hot oil.
Oil can contain combustion residues which are harmful to health.
Risk of injury and poisoning!
- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

CAUTION

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

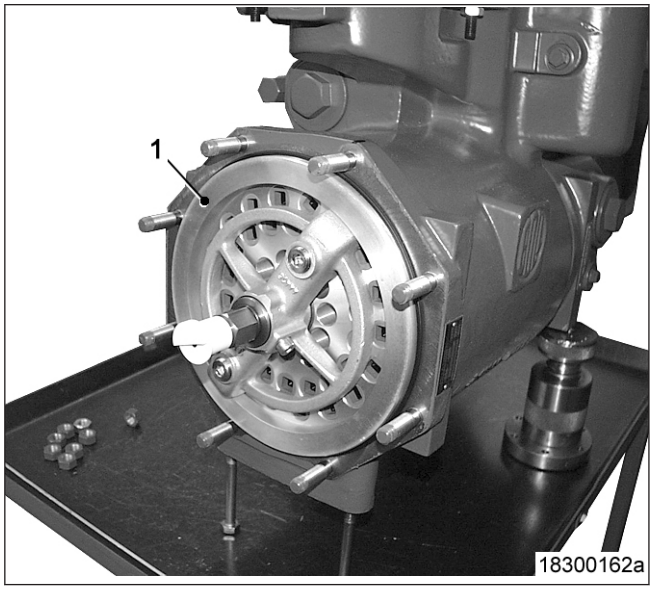
Oil filter candles – Removal

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

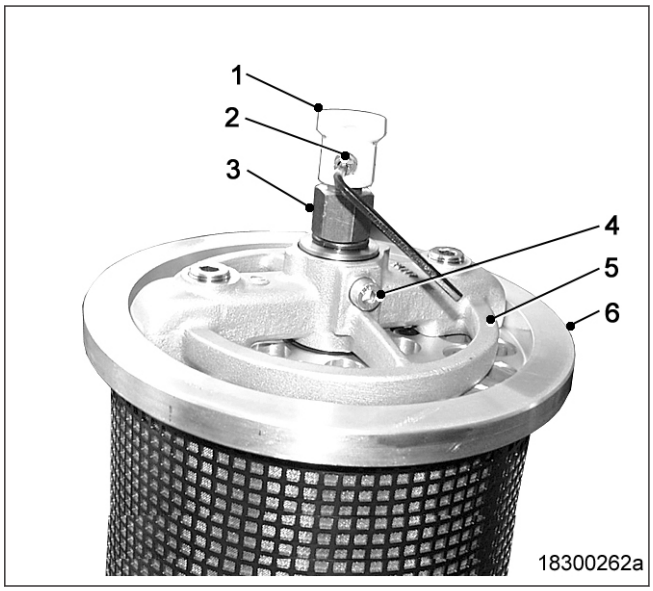


TIM-ID: 0000006401 - 003

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



5. Remove screw (2).
6. Withdraw 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 insert upside down 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.

TIM-ID: 0000006401 - 003

Oil filter candles – Installation

1. For installation follow reverse sequence of working steps.
2. In addition, the following work must be performed:
   - Replace all sealing elements with new parts.
   - Coat O-rings with grease.
   - Insert O-rings in grooves.
   - Pay attention to installation position of fillister-head screw to slot in shaft.

TIM-ID: 0000006401 - 003

6.12.3 Oil indicator filter – Check

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
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

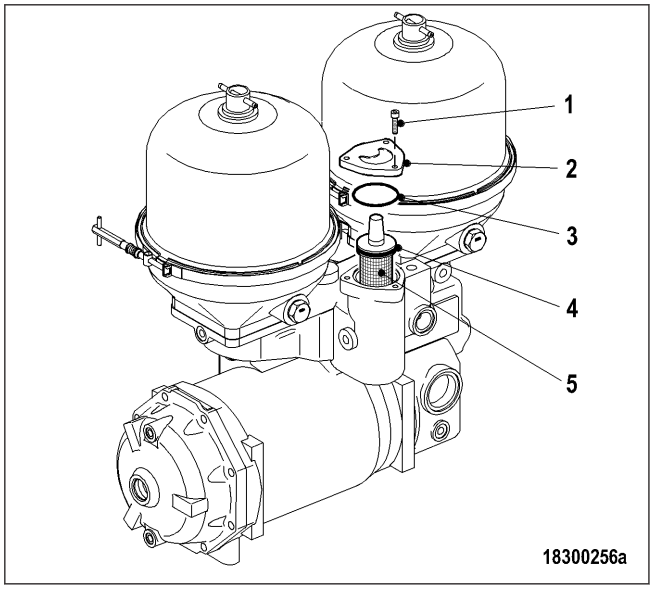
Compressed air
Risk of injury!
- Do not direct compressed-air jet at persons.
- Wear protective goggles / safety mask and ear protectors.

CAUTION

Unsuitable cleaning tool.
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.



TIM-ID: 0000006402 - 001

Checking strainer

Item	Findings	Task
Strainer	Metallic residues	• Clean • Monitor engine operation • Check strainer daily • Contact Service.
Strainer	Damaged	Replace
Square-section ring	Damaged	Replace
O-ring	Damaged	Replace

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.

TIM-ID: 0000006402 - 001

6.12.4 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)	
Sealing ring	(→ Spare Parts Catalog)	

WARNING

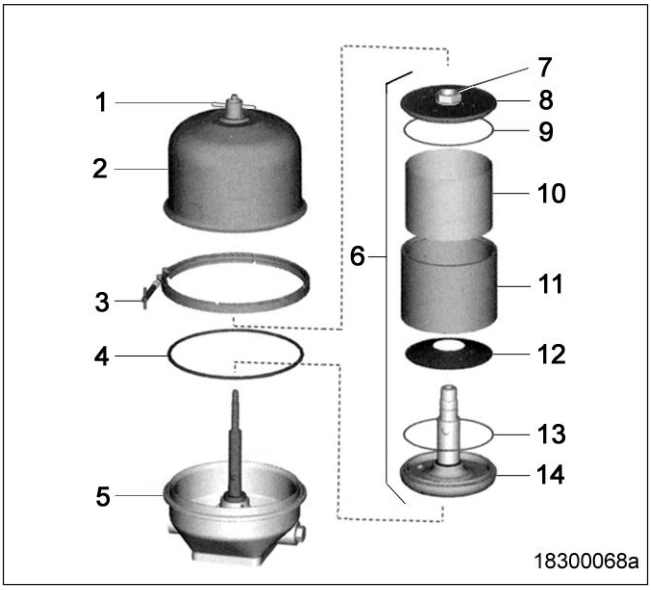
Hot oil.
Oil can contain combustion residues which are harmful to health.
Risk of injury and poisoning!
- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

WARNING

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

TIM-ID: 0000000934 - 007

Centrifugal oil filter – Cleaning and filter-sleeve replacement



1. Remove clamp (3).
2. Release cover screw (1) and take off cover (2).
3. Carefully lift rotor (6), allow oil to drain and remove from housing.
4. Holding the rotor (6) firmly, release rotor cover nut (7).
5. Take off rotor cover (8).
6. Remove filter sleeve (10).
7. Measure thickness of oil residues on filter sleeve (10).
8. If maximum layer thickness of oil residues exceeds 45 mm, shorten maintenance interval.
9. Disassemble rotor tube (11), conical disk (12) and rotor base (14).
10. Wash rotor cover (8), rotor tube (11), conical disk (12) and rotor base (14) with cold cleaner.
11. Blow out with compressed air.
12. Check sealing ring (13), fit new one if necessary.
13. Assemble rotor tube (11), conical disk (12) and rotor base (14) with sealing ring (13).
14. Insert new filter sleeve (10) in rotor tube (11) with the smooth paper surface facing the wall.
15. Check sealing ring (9), fit new one if necessary.
16. Mount rotor cover (8) with sealing ring (9).
17. Tighten rotor cover nut (7) with torque wrench to the specified torque.

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

18. Place rotor (6) in housing (5) and check for ease of movement.
19. Check sealing ring (4), fit new one if necessary.
20. Fit sealing ring (4) on housing (5).
21. Fit cover (2).
22. Fit cover screw (1) by hand.
23. Install clamp (3) and tighten with torque wrench to the specified torque.

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

24. Tighten cover nut (1) with torque wrench to the specified torque.

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

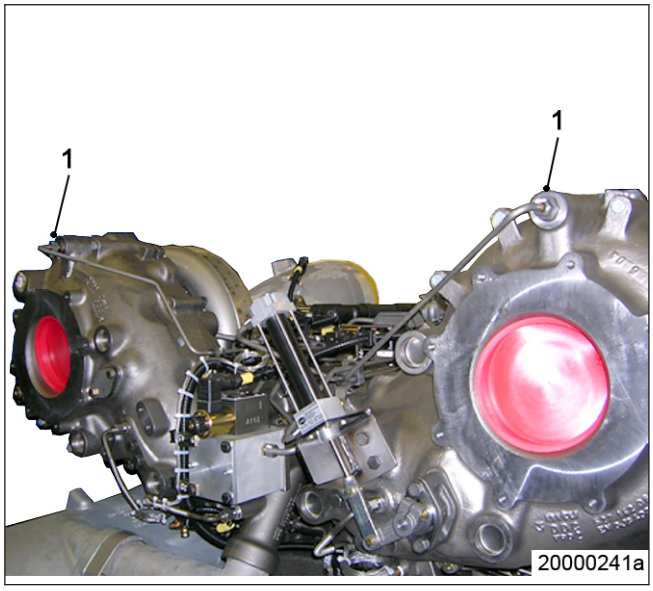
TIM-ID: 0000000934 - 007

6.13 Coolant Circuit, General, High-Temperature Circuit

6.13.1 Venting points

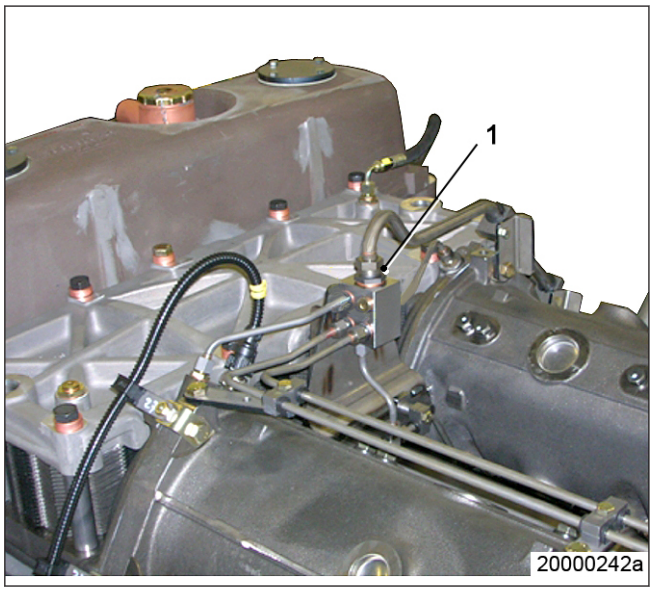
Coolant lines on ETC

1 Venting point



Vent line – Cross-distributionn expansion tank

1 Venting point



TIM-ID: 0000006694 - 002

6.13.2 Engine coolant – Level check

Preconditions

☑ Engine is stopped and starting disabled.

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

WARNING

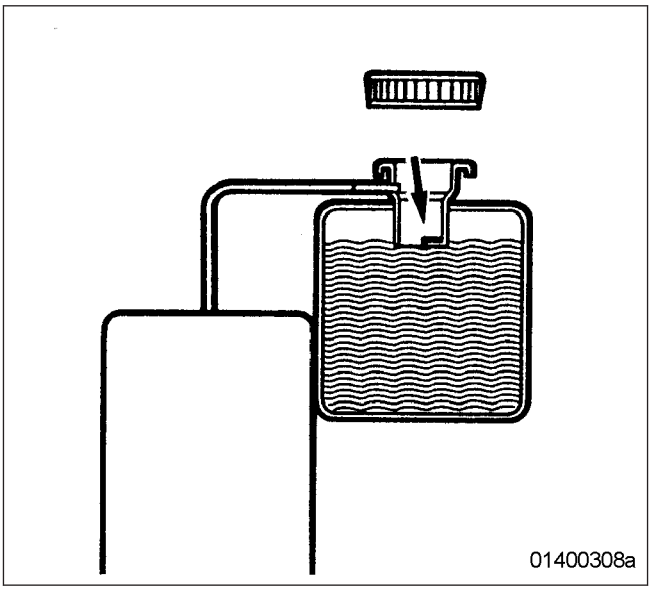
Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

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 coolant level (coolant must be visible at the lower edge of the cast-in eye).

Checking engine coolant level at remote cooler:

1. Check coolant level (coolant must be visible at marking plate).
2. Top up coolant if necessary (→ Page 157).
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 coolant if necessary (→ Page 157).

TIM-ID: 0000000937 - 011

6.13.3 Engine coolant – Change

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine coolant		

Changing engine coolant

1. Drain engine coolant (→ Page 156).
2. Fill with engine coolant (→ Page 157).

TIM-ID: 0000000036 - 029

6.13.4 Engine coolant draining

Preconditions

☑ Engine is stopped and starting disabled.

WARNING

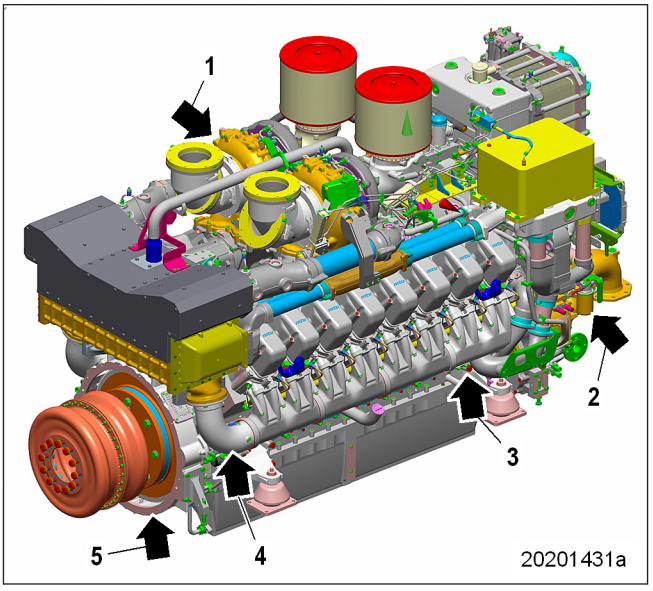
Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

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.

TIM-ID: 0000014595 - 001

6.13.5 Engine coolant – Filling

Preconditions

☑ Engine is stopped and starting disabled.

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

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine coolant		

WARNING

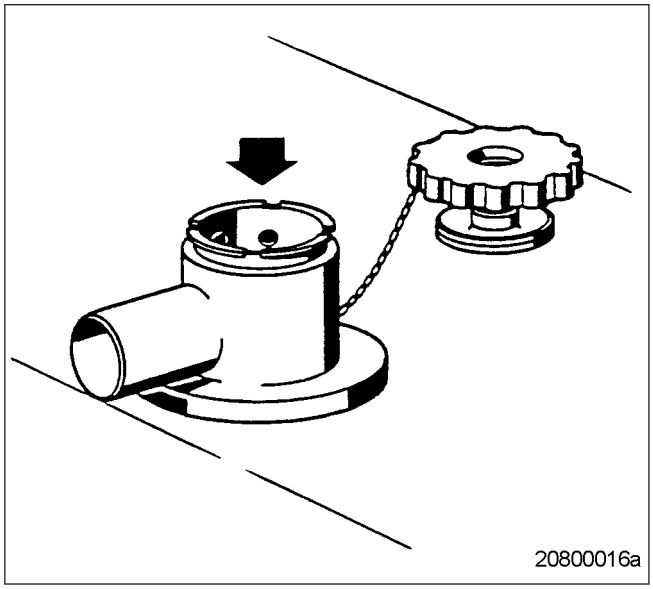
Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

CAUTION

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

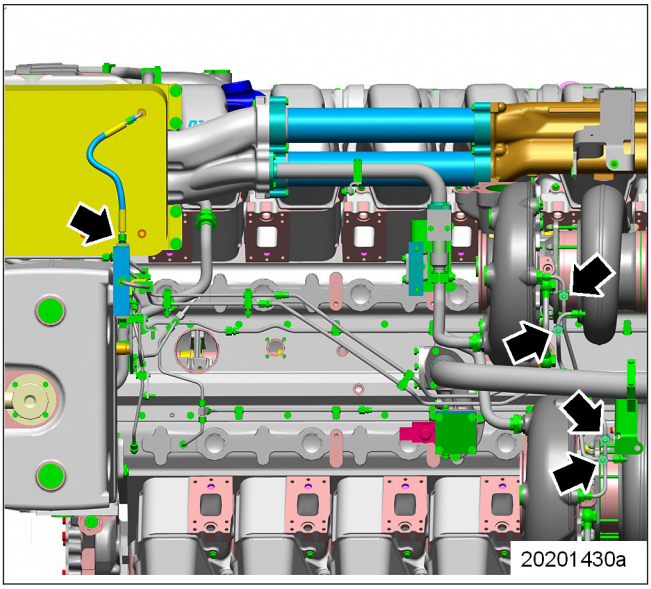
Preparatory steps

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.



TIM-ID: 0000036684 - 001

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 66).
7. After 10 seconds of engine operation without load, shut down the engine (→ Page 74).
8. Turn breather valve counterclockwise and remove.
9. Check coolant level (→ Page 154) 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 154) and top up coolant as required.

TIM-ID: 0000036684 - 001

6.13.6 Engine coolant pump – Relief bore check

DANGER

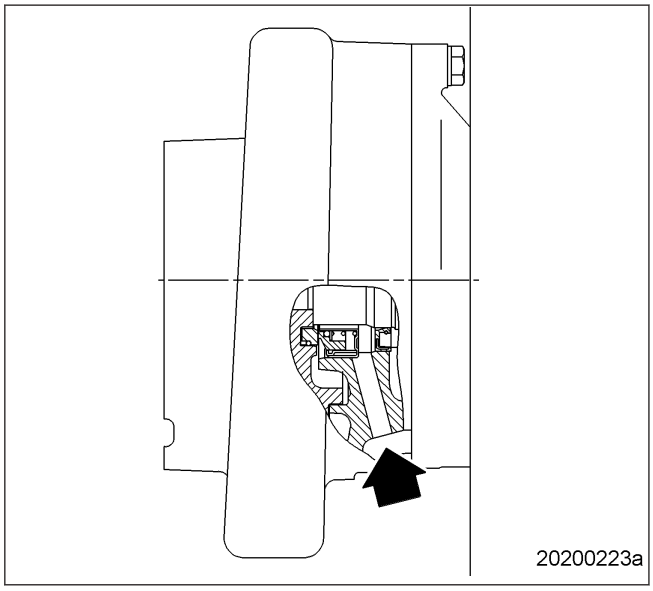
Unguarded rotating and moving engine components.
Risk of serious injury – danger to life!
- Take special care when working on a running engine.

WARNING

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

Engine coolant pump – Relief bore check

1. Check relief bore for oil and coolant discharge.
2. Shut down engine (→ Page 66) and disable engine start, observe general safety instructions “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.



TIM-ID: 0000014623 - 002

6.13.7 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

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

WARNING

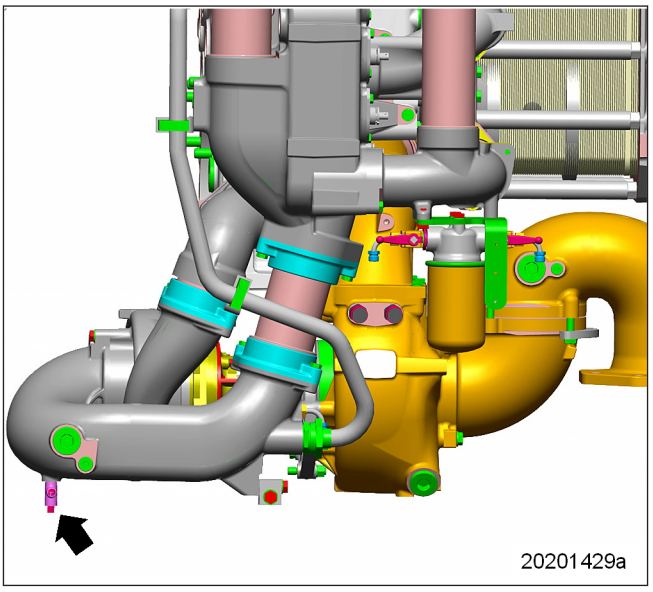
Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

WARNING

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

Engine coolant – Sample extraction and analysis

1. With the engine running, open drain valve (1).
2. Rinse extraction point by draining approx. 1 liter of engine 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 engine coolant for:
   - Antifreeze concentration
   - Corrosion inhibitor concentration
   - pH value
6. Engine coolant change intervals (→ MTU Fluids and Lubricants Specifications).



TIM-ID: 0000014608 - 004

6.13.8 Coolant filter – Replacement

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

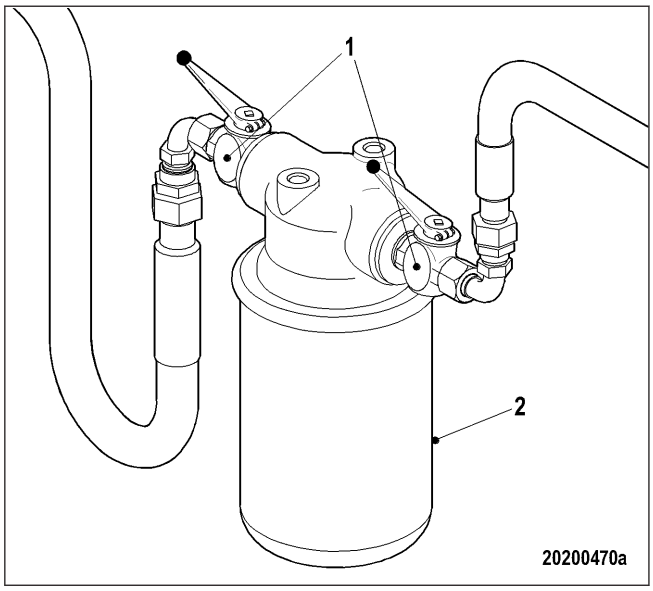
Designation / Use	Part No.	Qty.
Filter wrench	F30379104	1
Engine oil		
Coolant filter	(→ Spare Parts Catalog)	

WARNING

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

Coolant filter – Replacement

1. Close shut-off cocks (1).
2. Remove coolant filter (2) with filter wrench.
3. Clean sealing surface on connecting piece.
4. Coat seal on new coolant filter with engine oil.
5. Screw on coolant filter and tighten hand-tight.
6. Open shut-off cocks (1).



TIM-ID: 0000006858 - 006

6.14 Raw Water Pump with Connections

6.14.1 Raw water pump – Relief bore check

DANGER

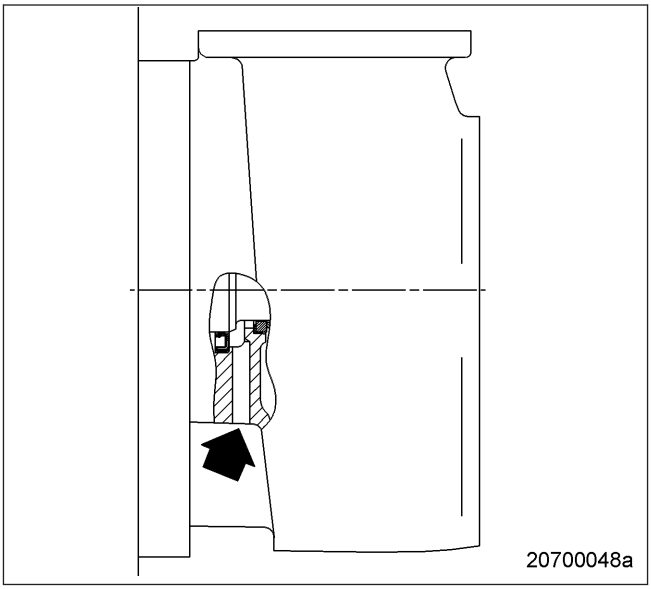
Unguarded rotating and moving engine components.
Risk of serious injury – danger to life!
- Take special care when working on a running engine.

WARNING

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

Raw water pump – Relief bore check

1. Check relief bore for oil and raw water discharge.
2. Shut down engine (→ Page 66) and disable engine start, observe general safety instructions “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.



TIM-ID: 0000015174 - 003

6.15 Battery-Charging Generator

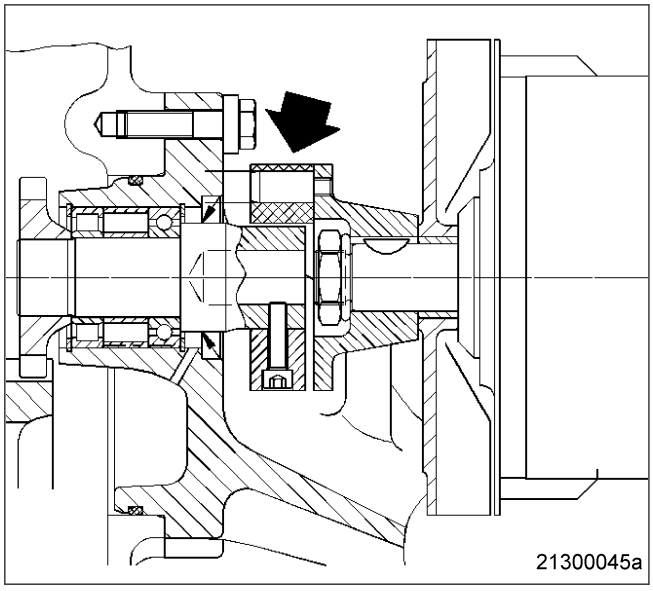
6.15.1 Battery-charging generator drive – Coupling condition check

Preconditions

☑ Engine shut down and starting disabled.

Checking condition of battery-charging generator drive coupling

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



TIM-ID: 0000007390 - 006

6.16 Engine Mounting / Support

6.16.1 Engine mounts – Checking securing screws for firm seating

Preconditions

☑ Engine is stopped and starting disabled.

Engine mounts – Checking securing screws for firm seating

1. Check securing screws for firm seating.
2. Tighten loose threaded connections.

TIM-ID: 0000007548 - 007

6.16.2 Engine mounts – Resilient element check

Preconditions

☑ Engine is stopped and starting disabled.

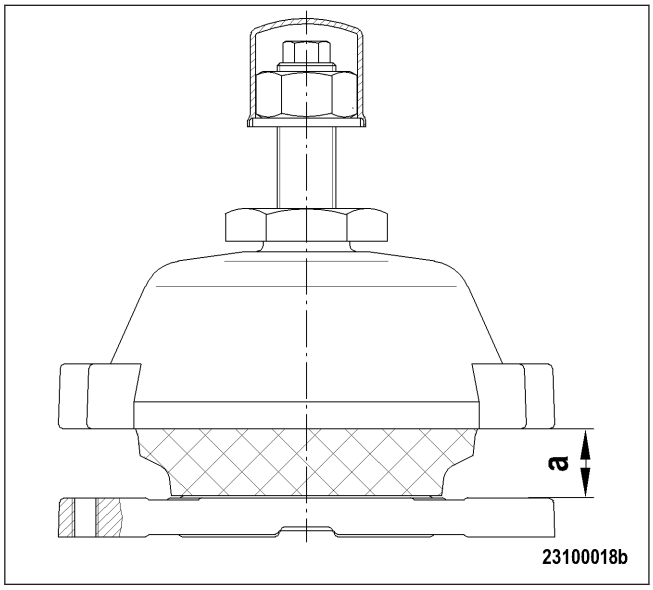
☑ Engine is filled with coolant and engine oil.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Feeler gauge	Y20010128	1
Calipers	Y20001743	1
Box wrench	F30379609	1
Engine oil		

Engine mounts – Checking the condition of resilient elements

1. Wipe rubber surface with dry cloth, do not use organic detergents.
2. Check resilient elements for crack formation and deformation by visual inspection.
3. Have cracked mounts replaced, contact Service.



Engine mounts – Measuring adjustment dimension

1. Measure dimension (a) with Vernier caliper.

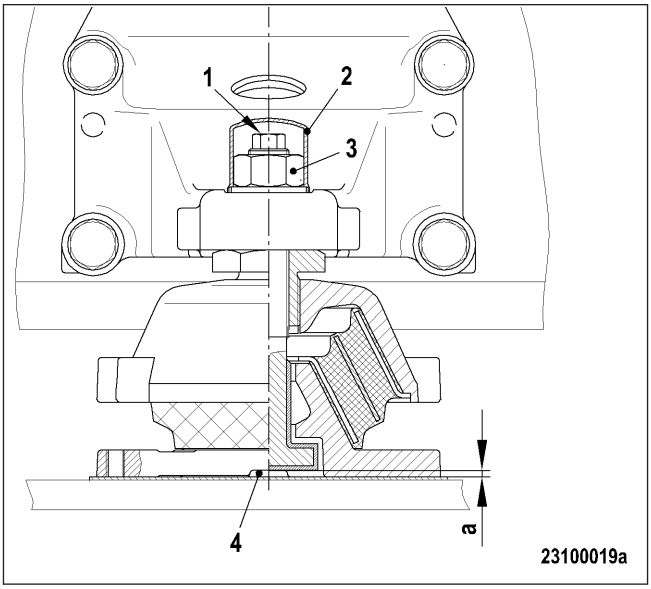
Note: On new blocked mounts, the adjustment dimension is approx. 28 mm.

2. If the measured value of dimension a = 20 mm is lower than the specified value, the resilient element must be replaced, contact Service.

TIM-ID: 0000007556 - 004

Engine mounts – Checking buffer clearance

1. Take off protective cap (2).
2. Check marking (1):
   - With marking 30: a = 3 mm +0,3 mm.
   - With marking 40: a = 4 mm +0,3 mm.
3. Check dimension (a) with feeler gauge on measuring groove (4).
4. If dimension (a) deviates from the above specifications, adjust buffer clearance.



Engine mounts – Buffer clearance adjustment

1. Undo nut (3).
2. Adjust buffer clearance by turning the central buffer (1).
3. Coat mating face of nut (3) and thread of central buffer (1) with a little engine oil. Engine oil must not get in contact with the rubber elements of the resilient mount.
4. Tighten nut (3) to the specified tightening torque securing the central buffer (1) to prevent it turning.

Name	Size	Type	Lubricant	Value/Standard
Nut	M27 x 2	Tightening torque	(Engine oil)	580 Nm +50 Nm

5. Fit protective cap (2).

TIM-ID: 0000007556 - 004

6.17 Auxiliary PTO

6.17.1 Bilge pump – Relief bore check

DANGER

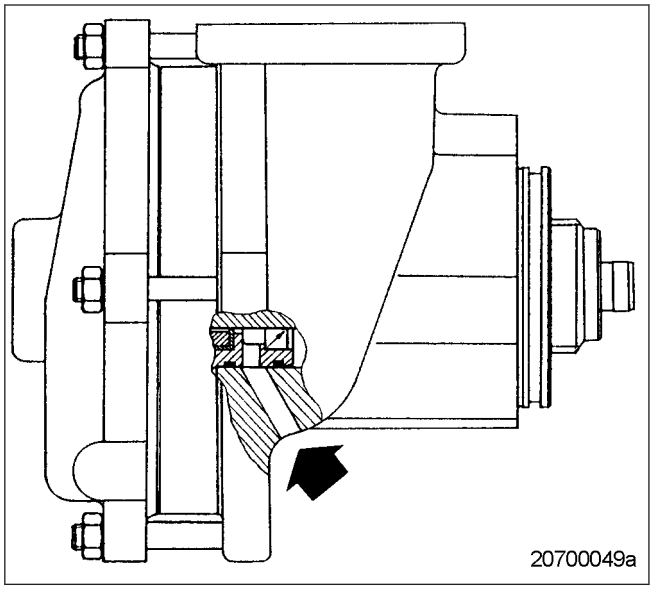
Unguarded rotating and moving engine components.
Risk of serious injury – danger to life!
- Take special care when working on a running engine.

WARNING

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

Checking bilge pump relief bore

1. Check relief bores for oil and water discharge.
2. Stop engine (→ Page 74) 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.



TIM-ID: 0000015791 - 003

6.18 Fuel Supply System

6.18.1 Water drain valve – Check

Water drain valve – Check

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

TIM-ID: 0000007733 - 007

6.18.2 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 73).
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.

TIM-ID: 0000007737 - 005

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

Preconditions

☑ System is put out of service and emptied.

WARNING

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

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

1. Disconnect plug from water level probe.
2. Unscrew water level probe.
3. Disconnect plug from water level probe.
4. Immerse water level probe into a tank filled with water until water level reaches the thread.

Result: Water drain valve opens.

5. Leave water level probe in tank.

Result: Alarm must be triggered with the preset delay.

6. Disconnect plug from water level probe.
7. Remove water level probe from tank.
8. Screw in water level probe.
9. Connect plug for water level probe.
10. Put the fuel treatment system into operation.

TIM-ID: 0000007739 - 006

6.18.4 Pump capacity – Check

WARNING

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

Checking pump capacity

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 73).

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 it.
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 it.
   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).	

TIM-ID: 0000007740 - 007

6.18.5 Coalescer filter element – Replacement

Preconditions

☑ System is switched off and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 6-50 Nm	F30027336	1
Ratchet adapter	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.

CAUTION

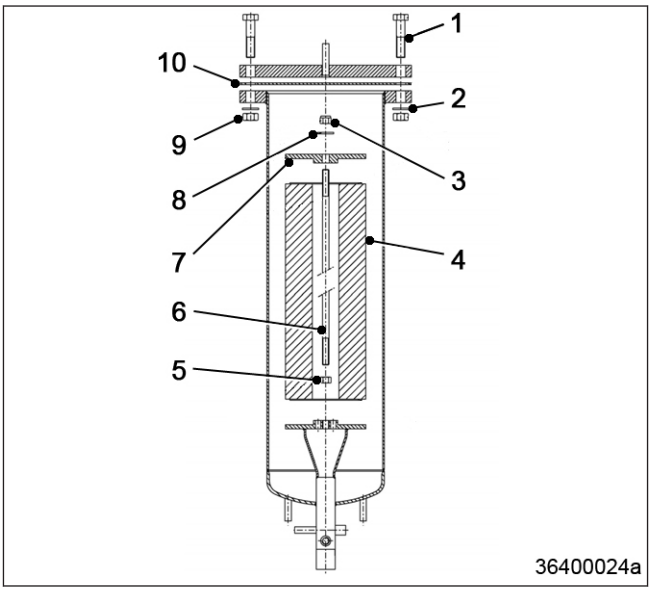
Contamination of components.
Damage to component!
- Observe manufacturer's instructions.
- Check components for special cleanness.

CAUTION

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 nut (9) with washer (2).
6. Remove screws (1).
7. Remove cover with gasket (10).
8. Remove nut (3), washer (8) and end plate (7).
9. Remove coalescer filter element (4).
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.
15. Install end plate (7), washer (8) and nut (3).



TIM-ID: 0000007735 - 007

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 screw (1), washer (2) and nut (9).
20. Tighten nut (9).
21. Open ball valve at the inlet and outlet of the fuel treatment system.

Result: The fuel treatment system is ready for operation.

TIM-ID: 0000007735 - 007

6.19 Wiring (General) for Engine/Gearbox/Unit

6.19.1 Engine wiring – Check

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

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

Engine wiring – Check

1. Check securing screws of cable clamps on engine and tighten loose threaded connections.
2. Ensure that cables are fixed in their clamps and cannot swing freely.
3. Check that cable ties are firm, tighten loose cable ties.
4. Replace faulty cable ties.
5. Visually inspect the following electrical line components for damage:
   - connector housings;
   - contacts;
   - sockets;
   - cables and terminals;
   - plug-in contacts.
6. (→ Contact Service) if cable conductors are damaged.

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

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

TIM-ID: 0000000029 - 018

6.20 Accessories for (Electronic) Engine Governor / Control System

6.20.1 Start interlock limit switch – Check

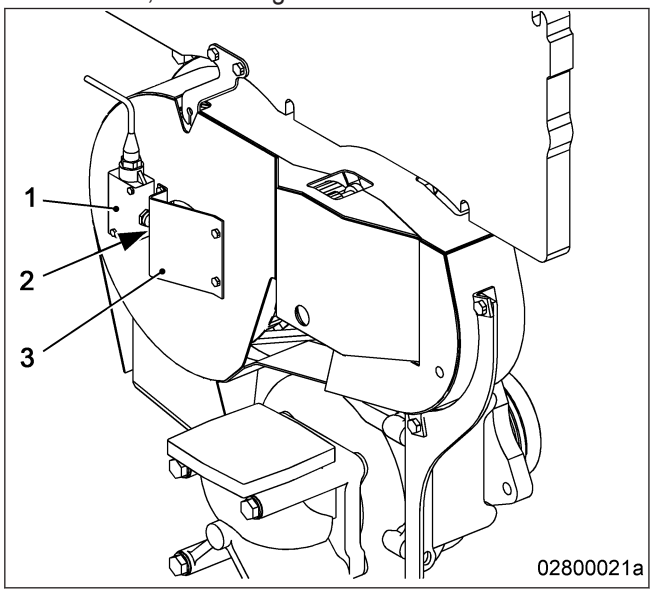
Preconditions

☑ Engine is stopped and starting disabled.

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

Start interlock limit switch – Check

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



TIM-ID: 0000008444 - 005

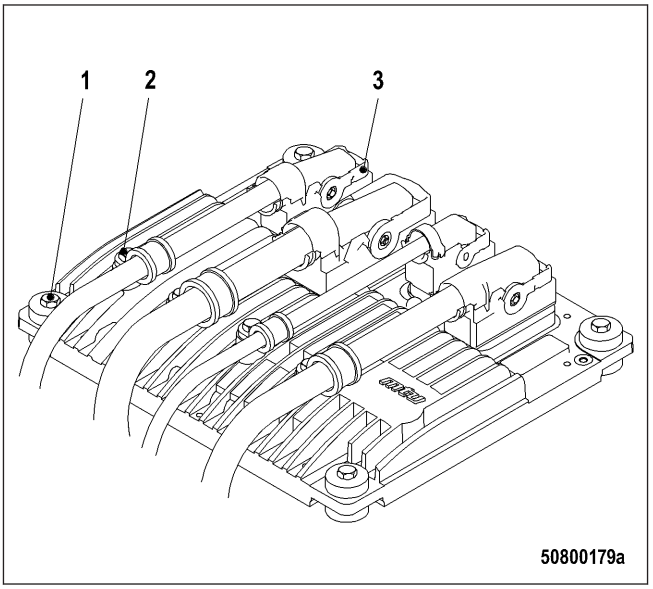
6.20.2 Engine Control Unit ECU 7 – Checking plug connections

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.



TIM-ID: 0000016847 - 005

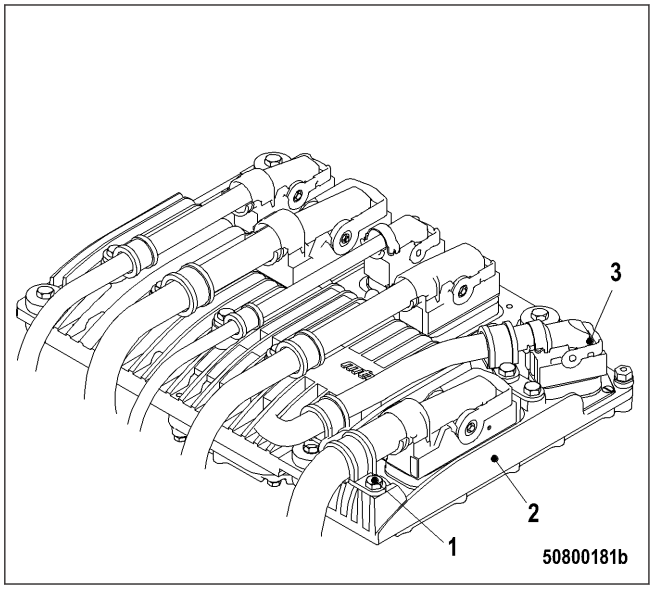
6.20.3 Engine monitoring unit EMU – Plug connection check

Preconditions

☑ Engine is stopped and starting disabled.

Checking EMU plug connections

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



TIM-ID: 0000016798 - 004

6.20.4 ECU 7 engine governor – Removal and installation

Preconditions

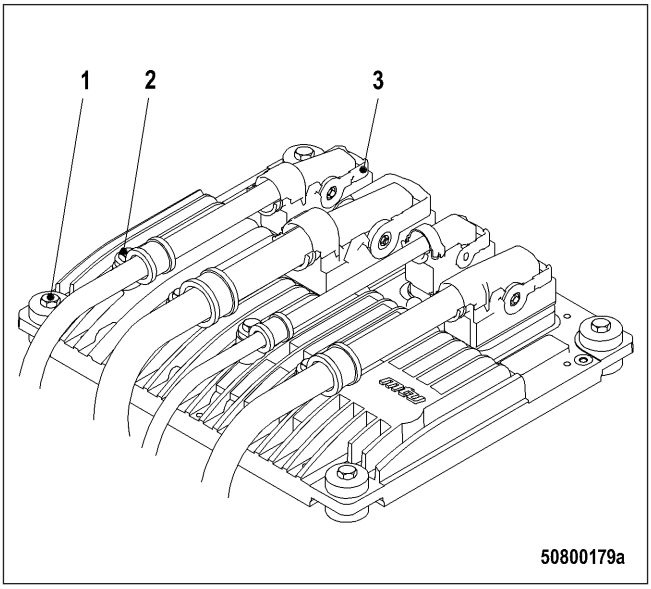
☑ Engine is stopped and starting disabled.

CAUTION

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. Remove all connectors.
5. Remove screws (1).
6. Take off engine governor.



Installing engine governor on engine

1. Install in reverse order. In doing so, ensure correct assignment of connectors and sockets.
2. Check rubber mount before installation.

Result: If the rubber mount is porous or defective, replace it.

TIM-ID: 0000000049 - 005

6.20.5 EMU 7 – Removal and installation

Preconditions

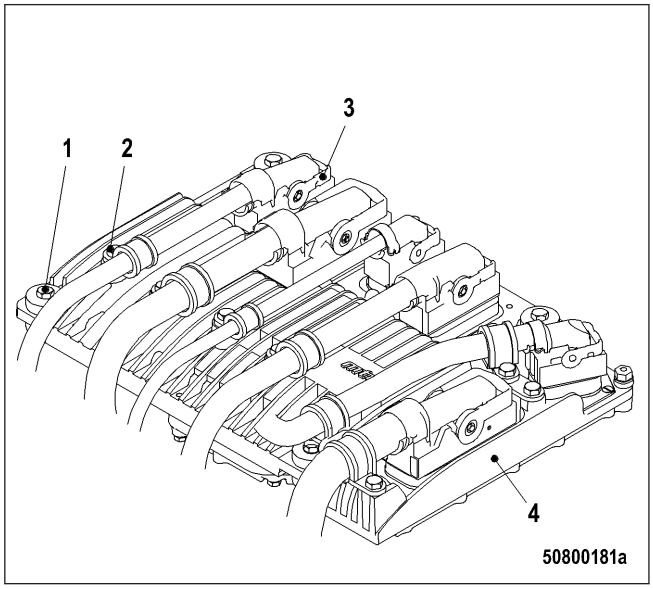
☑ Engine is stopped and starting disabled.

CAUTION

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 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. Undo 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 connectors and sockets in so doing.
2. Check resilient mount before installing.

Result: Replace resilient mount if porous or defective.

TIM-ID: 0000016799 - 004

7 Appendix A

7.1 Abbreviations

Abbreviation	Meaning	Explanation
ADEC	Advanced Diesel Engine Control	Engine governor
AL	Alarm	Alarm (general)
ANSI	American National Standards Institute	Governing body for US American standards
ATL	Abgasturbolader	Exhaust turbocharger
BR	Baureihe	Series
BV	Betriebsstoffvorschrift	Fluids and Lubricants Specifications, MTU Publication No. A01061/..
CAN	Controller Area Network	Data bus system, bus standard
CPP	Controllable Pitch Propeller	
DIN	Deutsches Institut für Normung e. V	German Standardization Organization, at the same time identifyer of German standards ("Deutsche Industrie-Norm")
DIS	Display unit	
DL	Default Lost	Alarm: Default CAN bus failure
ECS	Engine Control System	
ECU	Engine Control Unit	Engine governor
EDM	Engine Data Module	
EIM	Engine Interface Module	Interface to engine monitoring system
EMU	Engine Monitoring Unit	
ETK	Ersatzteilkatalog	Spare Parts Catalog
FPP	Fixed Pitch Propeller	
GCU	Gear Control Unit	
GMU	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	Power specification in accordance with DIN-ISO 3046-7
IDM	Interface Data Module	
IMO	International Maritime Organisation	International maritime organisation
ISO	International Organization for Standardization	
KGS	Kraftgegenseite	Engine free end in accordance with DIN ISO 1204

TIM-ID: 0000002050 - 002

Abbrevia-tion	Meaning	Explanation
KS	Kraftseite	Engine driving end in accordance with DIN ISO 1204
LCD	Liquid Crystal Display, Liquid Crystal Device	
LCU	Local Control Unit	LOP subassembly
LED	Light Emitting Diode	
LMU	Local Monitoring Unit	LOP subassembly
LO	Low	Alarm: Measured value lower than 1st minimum limit
LOLO	Low Low	Alarm: Measured value lower than 2nd minimum limit
LOP	Local Operating Panel	
LOS	Local Operating Station	
MCS	Monitoring and Control System	
MG	Message	Message
MPU	Microprocessor Unit, Microprocessing Unit	
OT	Oberer Totpunkt	Top dead center
P-xyz	Pressure-xyz	Pressure measuring point xyz
PAN	Panel	Operating 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	
SS	Safety System	Indicated alarm is initiated by the safety system
SSK	Schnellschlussklappe(n)	Shut-down air 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	
WZK	Werkzeugkatalog	Tools Catalog
ZKP	Zugehörigkeit-Kategorie-Parameter	Numbering plan for ADEC ECU signals

TIM-ID: 0000002050 - 002

7.2 MTU contacts/service partners

Service

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

Local support

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

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

24h hotline

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

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

Spare parts service

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

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

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

Your contact at Headquarters:

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

Phone: +49 7541 908555

Fax: +49 7541 908121

TIM-ID: 0000000873 - 012

8 Appendix B

8.1 Index

DCL-ID: 0000017652 - 001

DCL-ID: 0000017652 - 001

8.2 Spare Parts

Assembly paste (Optimoly Paste White T)	
Part No.:	40477
Qty.: Used in:	1 6.5.2 Injector – Removal and installation (→ Page 126)

Cleaning agent (Hakupur 312)	
Part No.:	30390
Qty.: Used in:	1 3.16 Plant – Cleaning (→ Page 80)
Qty.: Used in:	1 6.12.1 Oil indicator filter – Cleaning (→ Page 144)

Cleaning agent (Snow-White 11-0)	
Part No.:	40460
Qty.: Used in:	1 6.12.1 Oil indicator filter – Cleaning (→ Page 144)

Cold cleaner	
Part No.:	X00056750
Qty.: Used in:	1 6.7.1 Compressor wheel – Cleaning (→ Page 133)

Cold cleaner (Hakutex 60)	
Part No.:	X00056750
Qty.: Used in:	1 6.12.4 Centrifugal oil filter – Cleaning and filter-sleeve replacement (→ Page 151)

Diesel fuel	
Part No.:	
Qty.: Used in:	 3.15 Fuel prefilter – Draining (→ Page 78)
Qty.: Used in:	 6.6.1 Fuel filter – Replacement (→ Page 131)
Qty.: Used in:	 6.18.5 Coalescer filter element – Replacement (→ Page 172)

Engine coolant	
Part No.:	
Qty.: Used in:	 6.13.3 Engine coolant – Change (→ Page 155)
Qty.: Used in:	 6.13.5 Engine coolant – Filling (→ Page 157)

DCL-ID: 0000017652 - 001

Engine oil	
Part No.:	
Qty.: Used in:	6.3.1 Valve gear – Lubrication (→ Page 118)
Qty.: Used in:	6.3.2 Valve clearance – Check and adjustment (→ Page 119)
Qty.: Used in:	6.4.1 HP pump – Filling with engine oil (→ Page 124)
Qty.: Used in:	6.5.2 Injector – Removal and installation (→ Page 126)
Qty.: Used in:	6.11.2 Engine oil – Change (→ Page 141)
Qty.: Used in:	6.12.1 Oil indicator filter – Cleaning (→ Page 144)
Qty.: Used in:	6.12.2 Automatic oil filter – Oil filter candles replacement (→ Page 146)
Qty.: Used in:	6.13.8 Coolant filter – Replacement (→ Page 161)
Qty.: Used in:	6.16.2 Engine mounts – Resilient element check (→ Page 165)
Qty.: Used in:	6.18.5 Coalescer filter element – Replacement (→ Page 172)

Grease (Kluthe Hakuform 30-10/Emulgier)	
Part No.:	X00029933
Qty.: Used in:	1 6.5.2 Injector – Removal and installation (→ Page 126)

Grease (Kluthe Hakuform 30-10/Emulgier)	
Part No.:	X00029933
Qty.: Used in:	1 6.12.2 Automatic oil filter – Oil filter candles replacement (→ Page 146)

Isopropyl alcohol	
Part No.:	X00058037
Qty.: Used in:	1 6.19.1 Engine wiring – Check (→ Page 174)

DCL-ID: 0000017652 - 001

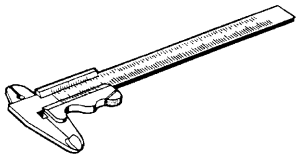
8.3 Consumables

Barring device	
Part No.:	F6555766
Qty.:	1
Used in:	6.1.1 Engine – Barring manually (→ Page 112)

Box wrench	
Part No.:	F30379609
Qty.:	1
Used in:	6.16.2 Engine mounts – Resilient element check (→ Page 165)

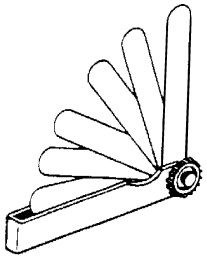
Box wrench socket, 24 mm	
Part No.:	F30039526
Qty.:	1
Used in:	6.3.2 Valve clearance – Check and adjustment (→ Page 119)

Calipers	
Part No.:	Y20001743
Qty.:	1
Used in:	6.16.2 Engine mounts – Resilient element check (→ Page 165)



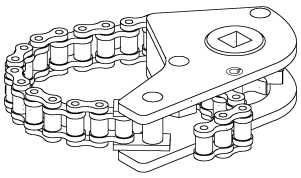
Feeler gauge	
Part No.:	Y20098771
Qty.:	1
Used in:	6.3.2 Valve clearance – Check and adjustment (→ Page 119)

Feeler gauge	
Part No.:	Y20010128
Qty.:	1
Used in:	6.16.2 Engine mounts – Resilient element check (→ Page 165)



DCL-ID: 0000017652 - 001

Filter wrench



Part No.:	F30379104
Qty.:	1
Used in:	6.13.8 Coolant filter – Replacement (→ Page 161)

Installation/removal tool

Part No.:	F6789889
Qty.:	1
Used in:	6.5.2 Injector – Removal and installation (→ Page 126)

Milling cutter

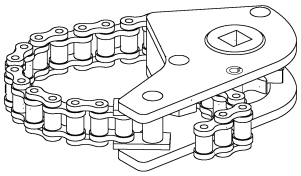
Part No.:	F30452739
Qty.:	1
Used in:	6.5.2 Injector – Removal and installation (→ Page 126)

MTU test kit

5605892099/00

Part No.:	5605892099/00
Qty.:	1
Used in:	6.11.3 Engine oil – Sample extraction and analysis (→ Page 143)
Qty.:	1
Used in:	6.13.7 Engine coolant – Sample extraction and analysis (→ Page 160)

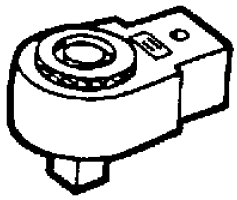
Oil filter wrench



Part No.:	F30379104
Qty.:	1
Used in:	6.6.1 Fuel filter – Replacement (→ Page 131)

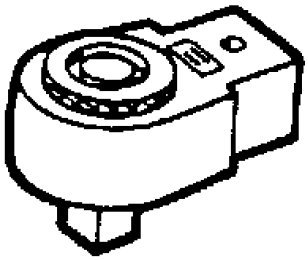
DCL-ID: 0000017652 - 001

Ratchet adapter



Part No.:	F30027341
Qty.: Used in:	1 6.3.2 Valve clearance – Check and adjustment (→ Page 119)
Qty.: Used in:	1 6.11.2 Engine oil – Change (→ Page 141)

Ratchet adapter



Part No.:	F30027339
Qty.: Used in:	1 6.18.5 Coalescer filter element – Replacement (→ Page 172)

Ratchet head with extension

Part No.:	F30006212
Qty.: Used in:	1 6.1.1 Engine – Barring manually (→ Page 112)

Rigid endoscope

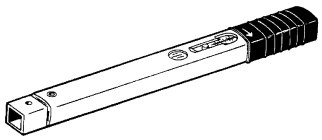
Part No.:	Y20097353
Qty.: Used in:	1 6.2.1 Cylinder liner – Endoscopic examination (→ Page 114)

Steam jet cleaner

Part No.:	-
Qty.: Used in:	1 3.16 Plant – Cleaning (→ Page 80)

DCL-ID: 0000017652 - 001

Torque wrench



Part No.:	F30027337
Qty.: Used in:	1 6.11.2 Engine oil – Change (→ Page 141)

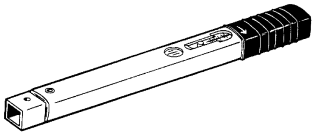
Torque wrench, 0.5-5 Nm

Part No.:	0015384230
Qty.: Used in:	1 6.5.2 Injector – Removal and installation (→ Page 126)

Torque wrench, 10-60 Nm

Part No.:	F30452769
Qty.: Used in:	1 6.5.2 Injector – Removal and installation (→ Page 126)

Torque wrench, 6-50 Nm



Part No.:	F30027336
Qty.: Used in:	1 6.12.4 Centrifugal oil filter – Cleaning and filter-sleeve replacement (→ Page 151)
Qty.: Used in:	1 6.18.5 Coalescer filter element – Replacement (→ Page 172)

Torque wrench, 60-320 Nm

Part No.:	F30452768
Qty.: Used in:	1 6.3.2 Valve clearance – Check and adjustment (→ Page 119)
Qty.: Used in:	1 6.5.2 Injector – Removal and installation (→ Page 126)

DCL-ID: 0000017652 - 001

8.4 Special Tools

Air filter	
Part No.:	
Qty.: Used in:	6.8.1 Air filter – Replacement (→ Page 136)

Coalescer filter element	
Part No.:	
Qty.: Used in:	6.18.5 Coalescer filter element – Replacement (→ Page 172)

Coolant filter	
Part No.:	
Qty.: Used in:	6.13.8 Coolant filter – Replacement (→ Page 161)

Easy-change filter	
Part No.:	
Qty.: Used in:	6.6.1 Fuel filter – Replacement (→ Page 131)

Filter sleeve	
Part No.:	
Qty.: Used in:	6.12.4 Centrifugal oil filter – Cleaning and filter-sleeve replacement (→ Page 151)

Gasket	
Part No.:	
Qty.: Used in:	6.3.3 Cylinder head cover – Removal and installation (→ Page 123)
Qty.: Used in:	6.18.5 Coalescer filter element – Replacement (→ Page 172)

Injector	
Part No.:	
Qty.: Used in:	6.5.1 Injector – Replacement (→ Page 125)

DCL-ID: 0000017652 - 001

O-ring	
Part No.:	
Qty.: Used in:	6.5.2 Injector – Removal and installation (→ Page 126)
Qty.: Used in:	1 6.12.1 Oil indicator filter – Cleaning (→ Page 144)
Qty.: Used in:	1 6.12.1 Oil indicator filter – Cleaning (→ Page 144)
Qty.: Used in:	6.12.2 Automatic oil filter – Oil filter candles replacement (→ Page 146)
Qty.: Used in:	6.12.3 Oil indicator filter – Check (→ Page 149)

Oil filter candles	
Part No.:	
Qty.: Used in:	6.12.2 Automatic oil filter – Oil filter candles replacement (→ Page 146)

Seal	
Part No.:	
Qty.: Used in:	3.15 Fuel prefilter – Draining (→ Page 78)

Sealing ring	
Part No.:	
Qty.: Used in:	6.11.2 Engine oil – Change (→ Page 141)
Qty.: Used in:	6.12.4 Centrifugal oil filter – Cleaning and filter-sleeve replacement (→ Page 151)
Qty.: Used in:	6.12.4 Centrifugal oil filter – Cleaning and filter-sleeve replacement (→ Page 151)

Square-section ring	
Part No.:	
Qty.: Used in:	6.12.3 Oil indicator filter – Check (→ Page 149)

Strainer	
Part No.:	
Qty.: Used in:	1 6.12.1 Oil indicator filter – Cleaning (→ Page 144)
Qty.: Used in:	6.12.3 Oil indicator filter – Check (→ Page 149)

DCL-ID: 0000017652 - 001

Synthetic ring	
Part No.:	
Qty.:	
Used in:	6.6.1 Fuel filter – Replacement (→ Page 131)

DCL-ID: 0000017652 - 001